THE FIRST BIG OIL HUNT.
VENEZUELA - 1911-1916

by
Ralph Arnold, George A. Macready and
Thomas W. Barrington

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DEDICATION

This book is dedicated to Walter R. Nobs, who gave his life in the course of the pioneering for oil in Venezuela. He died in Maracaibo on September 14, 1913.

As a memorial to Mr. Nobs, the authors quote the expression of love and loyalty as given by Enrique J. Aguerrevere of Caracas, Venezuela.

"It is not surprising that we took to each other keenly and that no friction ever developed between men looking at the facts of life from such different, if not opposite,
points of view.

"The fact is that we both, American and Venezuelan, were anxious to learn from each other what the other had to offer, most particularly the language. Friendships developed then which are today as firm as ever.

"I recall the names of many of the geologists, and especially that of the unfortunate Walter R. Nobs. I met this fine boy shortly before his death, in the village of Bobures.

"He had been infected by what we think is a fly that lays an egg under the skin of its victim, and this egg develops later into quite a large worm, with the usual sequence of swelling of the part affected, and with fever. Besides that, he had his usual share of malaria.

"No doctors were available in that far-away place. One fellow who pretended to be a doctor (but had only a grammar school education) gave him a quinine injection which developed later into tetanus.

"When Nobs and I met in Bobures, we were scheduled to go over and survey together some claims in the extreme south-eastern part of the Lake Maracaibo, close to the shore villages of San Antonio and Santa Maria.

"He was a hard working, strong young chap and wanted to go along with me in spite of the fact that he was obviously feeling very bad and low. I finally convinced him that he should go back to Maracaibo where he could get some medical help. His trip must have been a terrible ordeal for him, judging from his physical condition when I saw him last."

FOREWORD

The appearance of the book on the first big oil hunt in Venezuela by Ralph Arnold, George A. Macready and Thomas W. Barrington is indeed a great contribution to the history of petroleum in Venezuela. To me, the most outstanding feature of this excellent work is the reminiscence of the pioneering spirit of all those men, Americans and Venezuelans, who by their joint efforts gave so much of themselves to the discovery of oil in my country.

It is taken for granted today that Venezuela's oil plays a very important role in the world oil industry, but most people tend to forget the dedication and sacrifices of those geologists, engineers, workers, whose achievements were so invaluable to the development of the oil industry of Venezuela, and some of whom lost their lives because of the difficult conditions in which they worked. Venezuela in those days was rather a rural country and means of communication in the interior were almost non-existent. Outside the capital and a few other important cities, medical facilities were lacking, so the geological and engineering parties were mostly on their own.

It is worth recalling that at that time there were no geological maps or even a good general map of the country available, and the Government had not developed a technical staff to supervise the exploration and development activities. The work of those pioneers was undoubtedly a major step in the discoveries of important oil structures in Venezuela and in the tremendous growth of what is today one of the most important oil areas of the world. In no small part those original pioneers also brought about the fostering of friendship and mutual respect that now exist between Venezuelans and Americans.

It was only in the year 1930 that the Government of Venezuela realized the need of setting up a training program to produce national technicians, and for that purpose sent a few young men to the oilfields, and others to American universities. That group became the nucleus of a technical organization which has grown to be the present advisory and administrative body of the government in oil and mining policies and practices.

The smooth relations of today are the fruit of many years of joint efforts by officials of both the Government and the oil industry, who have always believed that the development of the oil resources of the country must be carried out on the basis of mutual benefits and cooperation, taking primarily into account the national interest of Venezuela.

Another reflection of those pioneering days is the concept of human relations in the oil industry, which only in recent years has been emphasized. It is common practice in the oil industry today—in contrast with past behaviour—to evaluate the results obtained in all areas in the field of human relations, in order to develop with national aims, interests and aspirations, and to determine means for maintaining and fostering the existing good relations with all levels of constituted authority on the basis of mutual respect and understanding.

Dr. Arnold is to be complimented for the accomplishment of such an interesting work that will enrich the literature of world petroleum history.

CARLOS PEREZ DE LA COVA
Minister Counselor for Petroleum Affairs,
Embassy of Venezuela.
Washington, D. C.
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We are indebted to the Shell Oil Company for the data upon which this book is based: or the photographs, maps and especially for the beautiful current map of northern Venezuela.

PART I

CHAPTER 1

Introduction

From 1911 to 1916 one of the most far-reaching and important explorations in the history of the oil industry was undertaken by the General Asphalt Company. The territory covered was the northern part of Venezuela, South America, and the southern part of the Island of Trinidad, British West Indies.

Now, nearly fifty years after the work is done, it has been deemed worthwhile to give a history of the survey, supplemented by personal statements by some of the men regarding the part they played in the drama. In many instances the authors have had to depend almost entirely on their memory; in other cases notes, reports, photographs, maps and letters to the family build a platform on which the story rises. Some of the most important work was done by those who passed on before this symposium was thought of, but their contributions are recorded by others.

All in all, the picture is not complete, but it will give an idea to those who are interested in the oil industry as of today, the conditions which existed in that part of the world nearly fifty years ago, and of the paucity of knowledge regarding the geography, topography, geology, and general conditions which existed at the time this work was undertaken.

For instance, there were no maps worthy of the name to be found in most of the regions explored. Practically nothing was known of the geology of the country—no geologic maps or stratigraphic sections, no paleontology, and no foundation on which to work. We had to start from scratch. A little information regarding formations was available about some of the asphalt deposits. There was only one oil well in the whole of Venezuela, which, when it was bailed, produced forty gallons of oil. The oil was used in the nearby refinery, which was the first in the country. They produced kerosene and, later, some gasoline. There was one automobile in Tachira, a few around Caracas, Valencia and three or four around Maracaibo.

There were practically no roads passable for automobiles, and few that could be used for ox carts. Most all freight was handled by pack trains. There were a few narrow gauge rail roads going inland from beach heads along the coast or on Lake Maracaibo or on certain rivers, to haul the products of the land to water transportation.

Living accommodations were nil, as was suitable food, except in the larger towns. From the time one went into the hinterland until he came out, he never slept in anything but a hammock. Health conditions were terrible. Leprosy, yellow fever, typhoid fever, many forms of malaria and amoebic dysentery were present.

With one exception, none of the geologists spoke Spanish.

This was the Venezuela into which our men plunged in search of oil. That they were successful is shown by the Venezuela of today.

A brief history of the companies which operated in the area and a statement regarding the term of the concessions under which they operated are given. As nearly as possible, the papers have been arranged in geographic order from east to west because the work started in Trinidad, lapped over into eastern Venezuela, and westward to the Maracaibo Basin.

As was natural, permission to publish any of the results of the work by the geologists themselves was refused by the companies who paid for the explorations, and it was not until years after this pioneer work was completed that any comprehensive treatise on the geology and oil resources of Venezuela appeared. As in any symposium, there will be certain overlapping of the texts, while on the other hand there will be discontinuations in the general plan of presentation. These are to be expected in any chronicle of events which happened nearly fifty years ago, by men of divergent training and occupation interests. The survivors are now scattered all over North and South America. However, it is better to have the recordings now by the men who actually were involved in this great drama, than to leave the history to be written by some professional historian later after the actors have all passed on.

CHAPTER 2

ARNOLD'S ENTRY INTO TRINIDAD

My entry into geologic work in Trinidad and Venezuela was rather roundabout. I knew Herbert and Theodore Hoover from college days. In March, 1911, on a trip from New York to London, my wife, Winninette, and I were on the same boat with Herbert Hoover and became well acquainted with him. On arrival in London we became the house guests of the Theodore Hoovers and I became the office guest of Herbert and Theodore Hoover at No. 1, London Wall buildings.

An associate of the Hoover brothers, named Lyndon Bates, had options on a considerable block of prospective oil land in the southern part of the Island of Trinidad, British West Indies. These options had been submitted to the Goldfields of South Africa, Ltd., one of the biggest mining companies in the world, of which Herbert Hoover was consulting engineer. This company was to put up the money for the development of the Trinidad properties. Naturally, they wanted the properties checked by a disinterested engineer. Herbert Hoover recommended me for the job, and he suggested to me the fee I should charge for my work. This was 2,000 guineas, or about $10,000, plus expenses. Hoover carefully explained to me that all professional fees in London were reckoned in guineas instead of pounds sterling, because there were only twenty shillings in a pound, while there were twenty-one shillings in a guinea. I was immediately retained by the Company to make the examination.

At this point a rather exciting chain of incidents took place. Great Britain had practically no oil supplies of her own and was very anxious to develop the oil reserves of her colony, Trinidad. By doing this, there would be oil for the British Navy. Lord Harris, president of the Goldfields Company, thought it would be a good idea to sound out the navy as to their needs for oil in the Caribbean area.

This would give his company a backlog of a contract for government oil in case they developed oil in the Trinidad holdings. Lord Harris decided I was the one to get the figures on the fuel needs of the navy.

Because of his high position in the government, he had no difficulty in securing an appointment for me with the high ranking admirals of His Majesty's navy. At the appointed time I went to the Admiralty and was ushered into a group of as gruff a bunch of old sea salts as ever sat around a table. My mission had been made known to the committee in advance, so with notebook in hand I started in quizzing them about the number and size of boats which might be expected to rendez-vous at Port of Spain, capital of Trinidad.

Also, the amount of oil they would require under normal conditions, and other questions of a rather confidential nature regarding the British fleet.

Everything went along smoothly until I innocently made some comparison between Trinidad oil and California oil. One of the admirals pricked up his ears. "You seem to know a good deal about California oil," he observed. "Yes," I replied, "I had charge of the geologic investigations in the California oil fields for the United States Geological Survey for several years." Almost in unison the committee shouted, "Are you an American?" From the time I answered in the affirmative, Daniel in the lions' den had nothing on me. "Spy," "undercover man," and a few more similar terms were heard in the discussion about me. They were united in their decision to detain me and have me investigated.

About that time I was able to catch the ear of the chairman. I suggested that as I was sent on the mission by Lord Harris, I would like to have them communicate with him and he could clear the situation. Fortunately, Lord Harris was in his office and when he heard the story he, in a few words, absolved me of all blame. However, he did agree that the data he wanted would be obtained by an English engineer.

After several interesting trips into the English countryside, Mrs. Arnold and I proceeded to fit ourselves out in complete tropical regalia. We sailed from Southampton, England, on the Royal Mail Steamer Packet "Clyde," June 7, 1911. The boat was a medium sized passenger and freighter. We stopped at St. Michaels, Azores, for several hours. It is a gem in the Atlantic, about which many books have been written.

One of the pleasant parts of the boat trip was our meeting with interesting people among our fellow passengers. Those who attracted our attention most were a small group of English and Scottish clerks who were going down to join the clerical staffs of some of the large foreign companies who were operating in the island. Our principal attention finally sifted down to a small Scots accountant named Alexander Fraser. We had no way of ascertaining his professional qualifications, but we had no doubt as to his being 100% Scots, especially as to his language. We could hardly understand him and neither could some of the other boys in his party. They teased him and for that reason Mrs. Arnold proceeded to take Alex under her wing, and from that time on he enjoyed life free from molestation. Also, as I remember it, she taught him some American English. We got to know Alex very well and to admire his staunch qualities.

OUR INTRODUCTION TO THE TROPICS

As we approached the island of Trinidad from the north, the most striking thing was the unique shade of green foliage which covered the sides of the mountain. It was a color you never see in the temperate zones, but I have found it all over the tropics where the land comes down to the salt water. It seems to be a combination of the temperature and the salt air near the ocean

which produces the particular shade of green. We passed through the Dragon's Mouth, the little strait between the main island of Trinidad and the Venezuelan mainland. It should be noted here that the geologic formations across the Gulf of Paria and the strike and character in general are about the same on both sides of the Gulf.

John Means, who originally investigated the leases for Mr. Hoover, met us at the boat. He took us to the Queens Park Hotel, which is the most noted of the hotels in the British West Indies.

At the time we were there they had a very distinguished guest in the person of General Castro, the President-in-exile of Venezuela. He spent most of his time on the veranda talking to his supporters who were trying to organize a junta to put him back into power. He never made the grade. Had he ever landed in Venezuela, he would never have gotten beyond the beach line. Castro left Trinidad to go to Europe for medical attention, expecting that his Vice-President, Gomez, would give up the presidency as soon as Castro returned. It was a bad guess. Gomez remained in power as long as I was working in Venezuela.

Looking over the island with Mr. Means, I noted many interesting things, such as the large number of East Indians who have brought their culture intact into that country. At that time they comprised about 50% of the population. About 30% was Negro and the remaining population was French and other races, including the English. The colored races are recognized by the British as they are in most of their colonies, and it was not unusual to see a Negro judge sitting on the bench trying white persons. We saw an East Indian fiesta while we were in Port of Spain and it was most colorful with the various floats which were made up in true Indian style and colors.

After becoming accustomed to the climate and conditions, I left with Means for the south side of the island, to examine the leases upon which I was to report for the Goldfields. My first day in the tropical jungle was exceedingly interesting. I was intrigued by so many new aspects of the vegetation that I nearly lost track of what I was supposed to be doing. The trees and plants of all kinds, particularly orchids, were in evidence on the trails which were cut through the forest to reach the seepages and outcrops of rocks which Means had discovered in his preliminary work. One of the first things that I noticed was the steep dip of virtually all of the beds, mostly sandstone, which lie under the forest. We ran into several mud volcanoes, and oil and gas seepages, which occur along the axis of the two major anticlines that parallel the south coast of the island. I was very much interested in these as I had previously seen mud volcanoes in the Imperial Valley, California, and across the line in Mexico, near the mouth of the Colorado River. The difference between the Trinidad mud volcanoes and those in California was that the gases which produce the volcanoes in Trinidad were petroleum gases which come up from the oil deposits underlying the anticlines on this island, while the Imperial Valley gases are carbon dioxide or sulphur.

These volcanoes are of various sizes and range from a few feet across to some that will cover an acre or two of ground. These volcanoes are very docile for most of their existence, but when the top vents seal over and the gases have no way to escape, there is great pressure built up beneath the ground. The natives have no fear of these volcanoes as long as gas and water are seeping out. After the vents seal over, they keep away from them as though they were a center of smallpox infection. They have good cause for this attitude, for when the volcanoes reach a

pressure beyond the breaking point of the overlying rocks, they blow up, breaking everything around the vent, and anyone who might happen to be near would have little chance of escaping.

On the first day out we were introduced to the regular afternoon downpour which floods the forest as if someone were pouring the water out of barrels. You can hear the thunder shower coming through the forest with a roar. They hit with great regularity about four o'clock. In fact, you can set your watch by these storms. They last about half an hour. After the storm has subsided, the clean green verdure and the songs of the birds which come out to celebrate the passing of the storm are exquisite things to remember.

Means and I covered most of the southern anticline, after which we went to Brighton. There I began to gather information about the wells which were being drilled around the Pitch Lake. Pitch Lake, or Trinidad Lake, as it is sometimes called, is a big seepage which covers several hundred acres. At several points in the lake there are soft spots where the oil and gas come up to the surface; these places are called the "mothers" of the lake. The oil comes up and spreads out upon the surface of the lake and gradually hardens until one can walk on it. If one stands still almost anywhere on the lake for over a minute, he begins to sink into the asphalt. If he gets too close to the "mother," he may quickly keep on sinking into oblivion.

The asphalt for shipment is removed in metal cars on tracks which are laid out on the surface of the asphalt. The asphalt is cut into blocks, thrown into the cars and moved by overhead tramway to the docks which extend into the Gulf of Paria at Brighton. During the years that this deposit has been mined the lake has sunk about 14 feet. This gives an idea of the amount of asphalt which has been taken out in that period of time.

While in Trinidad I had the complete cooperation of the management and engineers of the asphalt company regarding data of the wells being drilled adjacent to the lake. Later, I obtained valuable information about the sub-surface conditions of the formations and oil sands which underlie the edge of the lake.

On our way north by boat, I prepared my report on the leases which I examined for the Goldfields and had this in shape when I arrived in New York. Here I had the report transcribed and the pictures made ready to include in it. When I went to deliver my report to the office of the Goldfields in New York I had a rather remarkable experience. With my report I had included a copy of my expense account and also a bill. With this bill was my check for $200.00. I was asked what the check was for, and when I said it was a return of the excess expense account which had been advanced to me in London, Mrs, Ida R. Koverman, who had taken my papers, motioned to all of the other employees in the office to come to the window—she had something to show them which they had never seen before and probably would never see again—a man who had returned part of an expense account.

This closed my connections with Goldfields of South Africa, Ltd. However, it opened another door for me. It was the introduction to another important survey—the pioneering for petroleum in the vast regions of Venezuela.

My report to the Goldfields was dated July 18, 1911. The following September I had returned to New York and there I met John Mack who was president of the General Asphalt Co. Mr. Mack

asked me to call at the Philadelphia office of his company. When I arrived there, he asked if I was interested in going back to the tropics, because if I was, his company intended offering me the job of surveying nearly the entire country of Venezuela.

On my first trip to Trinidad, I had see boats which belonged to his company in the harbor, with no oil to fill them. Mack asked me if I could fill their empty tankers with Trinidad oil. I told him I could do the job if I were furnished with enough geologists to assist me. My offer was accepted and I signed a contract on a yearly basis and started to
work.

My instructions from the company were to "get all the men I needed," which was not easy. At that time there were few geologists available and practically none had experience in oil. I employed graduate students from thegeology departments of Stanford, University of Chicago, Cornell, Harvard, Yale, Columbia and other colleges over the country. My first group consisted of about five or six men. However, before the survey was completed, I had employed fifty-two American geologists for this work.

If I wanted the job, Mack said, I would have to understand there was no time for a lot of geological preliminaries. Our first job was to find oil and bring it out of the ground. Our second job would be to discover and lay claim to every single piece of potential oil land in Venezuela. Even in those early days, through stories, he had heard of oil seeps far inland in Venezuela, and with his grasp of the commercial possibilities of any oil-potential area as large as that in all of Venezuela, Mack believed he might have a big oil empire within his grasp.

Mack was a fiery man, insistent on governing the company with an iron hand. As he talked, it became apparent his company was in serious trouble in Venezuela, even as it had a great opportunity. The company had been cutting asphalt out of the pitch lake I had seen on Trinidad, and out of another in Venezuela, since 1888. Mack and some other directors of his company had long sought the right to drill for oil in Venezuela. Now, under the new President, Gomez, small oil concessions had been granted near the Guanoco Pitch Lake.

In addition, through Gomez and the company's other friends in Venezuela, it seemed likely that oil concessions over the whole northern part of the country might soon become available. Mack saw this as a phenomenal opportunity. But other men, high in his company, had been in doubt in the very beginning about going into the oil business. At that time, faced with losses in their Trinidad operation, they were less and less inclined to venture into oil. The Guanoco Pitch Lake oil concession had already been peddled around Europe and nobody wanted to buy it. If no oil was found soon, the concession would expire, and that would sink all Mack's chances of pushing his company into the oil business.

At Brighton, on the coast of Trinidad, the company had established a major oil base. Tankers had been secured and were waiting to be loaded. Huge oil tanks had been set up on the island, waiting for the wells to produce. Geologists had already spent a year mapping that area on Trinidad and at Guanoco where Mack hoped to find oil. A crew of American engineers was still building the depot on Trinidad. American drillers were drilling wells frantically. But there was no oil to pump into the tanks, no oil to run into the tankers waiting offshore and no return, in short, on all the money the company had already invested.

When I left the company's office I was fully aware of the tremendous task which lay before me. I also knew we were going to learn a lot about the new science of petroleum geology before this task was finished.

Back in my own office I wired George Macready, who was teaching at Stanford University. He was graduated by Stanford with a degree in geology and mining in 1910, in the summers before his graduation he worked at mining in Nevada. I also knew he had cut his teeth on California oil fields, and was familiar with the techniques we were be using on Trinidad and in Venezuela.

His account of his entry into South American oil discovery and development follows.

CHAPTER 3

MACREADY'S ENTRY INTO TRINIDAD

The latter part of 1911 was a busy year for me. My time was spent working from my offices in Los Angeles and New York, supervising the work and getting men started into the field. Macready was already at work, studying available geological data, examining wells and facilities and traveling over as much of the island as he could in order to make personal surveys. He went to Trinidad faced with a problem which would have disheartened most men. There was another geologist there, a highly respected American, Dr. Arthur C. Veatch, who had had a crew working for the asphalt company for a year. In effect, Veatch was being replaced, although most of his crew did not know it. They were being allowed to finish the mapping they had started and that was all. We were being sent to find the oil.

Nor had they had an easy time of it. They had gone to Trinidad in 1910. When Veatch and his crew arrived in Port of Spain, company officials there were surprised to discover three women in the party, in addition to Veatch's wife, and two of the women were newly-weds. The third was a very capable paleontologist, Miss Carlotta Maury.

One of the new brides, Mrs. Alfred Schultz, wrote to me many years after her trip a description of what they found after leaving Port of Spain, at Guanoco Pitch Lake in Venezuela.

"Our first view of the little native village, lying on a side hill with only thatched roof houses, no streets, and an air of squalor, was too much for the other bride. She put her head on my shoulder and wept.

"A path led away from the village, past the pitch lake where a dozen or more laborers were digging gobs of pitch, putting it on their heads and carrying it to cars that would take it to a freighter lying at the wharf. A short walk from the lake brought us to the house that would be our quarters until our own home could be built.

"We were bothered all the time we lived in the house by a strange thumping overhead, but none of the men would tell us what caused it. Not until after we left did they explain it was a snake they had locked in the attic to catch rats. It became too big to take out again with safety, so

they left it there. The sounds we heard over our heads, mostly at night, were the thumps of the snake catching his dinner.

"In January, 1911, Guanoco was almost entirely destroyed by fire. It started in the village butcher shop, we were told, and it swept through the village, finally igniting a building used for storing explosives. Several natives were injured in the explosion. The fire left the village in ashes. The foreman at the Guanoco Pitch Lake, a man named Hendrie, was injured, too, and later died of his injuries.

"After only two months, my husband was hospitalized with typhoid malaria, and after three months of treatment there, we went home."

Other accounts of their stay there indicated that nearly all of them were bothered with ill health. Further, when the drilling was begun, they were not even consulted. Veatch said years later that he had had no hand in advising the drillers. The engineers, or perhaps the drillers themselves, had selected the sites. He had not even known about the wells being drilled on Trinidad until he returned to find a lot of dry holes.

When Macready arrived, Veatch and his crew were quite ready to go home, and because of payment difficulties, Veatch took his geological maps with him back to the United States, leaving Macready with none of the careful work that had taken a full year to complete.

It was not until later, after settling with the company, that we were able to get the maps back again.

At that time there was a single oil well producing 40 gallons of oil a day in Tachira, Venezuela. It had been drilled in 1880. Venezuelans, bailed the well by hand and carried the oil away in buckets.

At one time Germans had attempted to find oil by drilling huge holes in the ground and sinking large caissons into them. General Asphalt had drilled ordinary wells and also failed.

On Trinidad the company had drilled several wells. By the early part of 1911 there were 10 producing wells and 20 dry holes, and their producing wells kept decreasing in production.

That was the situation Macready found when he arrived.

He had not yet been disillusioned when he described his entrance into the area off Brighton by boat:

"I came up on the shore steamer and my first view of Brighton was of one of the most beautiful landscapes I've ever seen. The water of the gulf was clear blue. Anchored offshore were five steamers. Behind them, the hill had been landscaped all the way to the pitch lake, which is on a hilltop, about three quarters of a mile from the pier.

"White and green bungalows dotted the grassy hillside. On the skyline, the oil derricks were visible. Over at the right was an enormous tank farm with a total capacity, I learned later, of

750,000 barrels of oil. There were coconut trees along the shore on both sides of the development.

"On landing, I met the staff, nearly all civil engineers. Not a single geologist is here."

In the meantime, and before I had left again for Trinidad, something happened that drew Macready's attention back to the oil possibilities with dramatic suddenness.

At 4:30 A.M. on November 4, 1911, a fisherman named Freddy James was fishing in Erin Bay, off the southwest coast of Trinidad, when he noticed a hump in the water that appeared at first to be an overturned boat. At closer examination it proved to be a piece of land standing 30 feet out of the water where there had never been land before.

He had been over that same spot, or near it, in his boat, the night before, James said, and there was no island then.

Later investigations revealed that some other fisherman had seen a violent agitation in the water over that spot some five days before. They located the place as a reef called Despatch Reef, just offshore of the village of Chatham.

Freddy James sailed his fishing boat back to Chatham that morning and reported his discovery. A police sergeant named A. F. G. Wilkey started toward the spot at four o'clock that afternoon. After a 45-minute sail, Wilkey said, he saw the new small island. The water around it was warm, he said, and when he started to land, the ocean began to bubble and boil; he could smell sulphur.

Wilkey sailed back to Chatham and pulled his boat up on the shore. At six o'clock he heard thunder coming from the new island and black smoke began to curl upward from it. Suddenly the island burst into flames and the flames leaped 300 to 400 feet into the air.

In less than 10 minutes, he said, the flames had subsided to 10 or 12 feet, and burned like that for the rest of the night.

Macready, back at Brighton, some 14 miles away, saw the flames shoot into the air just after 6 P.M. Veatch saw them, too. Fifty miles away, residents of Port of Spain saw the flames in the sky.

Eight miles to the northwest of the new island, Thornton Harrigas, justice of the peace of the village of Santa Ysabela, felt the shock, heard the thunder, and saw an "immense canopy of smoke and the whole of this burst into flame and remained brilliant for quite a few minutes."

Using his glasses, Harrigas saw "two torches emanating from an island. This island was about 200 yards long. One torch was at the northern end of the island, the height of the flame being about 300 feet; the other torch was at the southern end; the color of the flame was the same as the top of an ordinary gas jet, a pale straw."

The next morning the low, flat mud island was clearly visible from the land. The British island governor kept the news quiet, as best he could. No one was permitted to examine the island until he had formally taken possession in the name of the crown.

But four days later Macready went by boat to the island and found it was another mud volcano; this one, however, about 8 $^{1/2}$ acres of mud and rock with traces of oil tar; a total of about 696,960 tons of earth that had been blown out of the lower Tertiary strata through two craters by an enormous explosion of petroleum gas.

I visited the new island with Macready in November, 1911, at which time the island was still quivering slightly and the two craters were emitting small quantities of water and gas.

The island was a most intriguing and impressive sight, Macready continued his work, with something more impressive to occupy his thoughts than the discouraging confusion he had discovered when he arrived. When I arrived on November 26, 1911, we were ready to begin our first survey of Trinidad and the eastern parts of Venezuela.

CHAPTER 4

EARLY HISTORY OF THE SOUTH CARIBBEAN (BEFORE 1870)

By George A. Macready

Both Trinidad and Venezuela were discovered by Columbus on his third voyage in July 1498, at which time he found both peopled by Indians who have long since disappeared from Trinidad. This was the first discovery of the mainland or "Tierra Firme" of America. Continuing north to Hispaniola he passed the island he named Margarita. His discovery of a mainland created such interest that an expedition under Alonso de Ojeda was sent out in 1499 to explore the new lands.

Ojeda landed at several places along the Peninsula of Paria and then continued west along the coast as far as Cabo de la Vela on the Peninsula of Paraguana. He observed the Indian villages built on piles over Lake Maracaibo, which reminded him of Venice so much that he gave the name of Venezuela (Little Venice) to the lands he explored. On board his ship was a Florentine merchant named Amerigo Vespucci, who later on took an expedition of his own to Brazil. He then wrote an entertaining account of both expeditions, representing himself as their leader. His writing was published in 1509 in *Cosmographia*, with the result that the new-found continent was given the name of "America."

Following the Ojeda voyage, another expedition under Nino and the Guerra [brothers] visited the coast and offshore islands of Venezuela and obtained gold and pearls from the Indians. Following these two expeditions, a band of fifty adventurers from Spain established a settlement on Cubagua in 1500 to exploit the pearl fisheries. They were soon joined by a horde of nondescripts who, when the pearl fisheries approached exhaustion, turned to the mainland to capture Indians, who were taken into slavery.

In 1513 three Franciscan monks settled near Cumana and about the same year a group of Dominicans settled near Piritu farther west near Barcelona. Although the churchmen got along

nicely with the Indians for several years, they were visited in 1518 and 1520 by groups of Cubaguans who, at friendly meetings with the monks and Indians, outraged the Indians and carried others off to slavery. All. of the monks and some of the Cubaguans were killed by angry Indians.

In 1520 Gonzalez de Ocampo was dispatched from Spain with an armed force to settle the country. He founded a city named Nueva Toledo where Cumana now stands. His successor, Bartolome de las Casas, observing the slave raids of the Cubaguans, commenced a fortress on the peninsula of Araya opposite Nueva Toledo to be garrisoned to combat the slave raids. After conflicting changes of administration the fortress was completed and the present town of Cumana founded by Jacome Castellon. In 1530 an earthquake destroyed the fortress.

In 1521 the settlement of Cubagua was taken over by the royal government and renamed Nueva Cadiz. In 1527 the town of La Asuncion was founded on Margarita Island. Farther west small groups of colonists had settled along the coast as far west as the Gulf of Maracaibo. Although they lived amicably with the Indians at first, they later on indulged in the slave trade, which angered the Indians. To stop this trade, Juan de Ampies was sent in with an armed force and founded the town of Santa Ana de Coro (now Coro) in 1527.

Thus, by 1527, only 35 years after Columbus's discovery, we find four towns established in Venezuela: Cumana, Nueva Cadiz, La Asuncion and Coro. A church started at Coro in 1527 and occupied about 1530 was still in active use when visited in 1912. This church is said to be the oldest in South America.

About 1528, in part payment of loans from the Welser Bankers of Augsburg, Juan de Ampies gave that group the exploitation and administration of Venezuela. Ambrosius Alfinger was made governor of Coro, then the capital, and replaced Ampies. Then followed a series of avaricious expeditions, intrigues among the Spaniards and Germans—quarrels, killings, and an authentic case of cannibalism in which the Indian servants were eaten for food. A great deal of exploration was accomplished, particularly into the interior and highlands. The Welser rule practically ended in 1545 when their governor was killed, and was ended formally in 1558.

Merida was founded in 1542, Borburata (now Puerto Cabello) in 1549, Nueva Segovia (now Barquisimeto) in 1552, Nueva Valencia in 1552,Trujillo in 1556, San Felipe earlier, and Villa de San Francisco (now Caracas) in 1560 (by Francisco Fajardo). In 1577 the colonial government of Venezuela was moved from Coro to Caracas, where it has remained ever since. From 1577 until 1797, the colony of Venezuela was a history of pirate coastal raids, sporadic ventures into church and political exploits, incorporation with, separation from New Granada (now Colombia), and finally a trade monopoly granted by the King of Spain to the Compania Guipuzcoana, which created much colonial dissatisfaction with the royal government and lasted from 1724 to 1778. The University of Caracas was founded in 1721.

The first definite rebellion to separate from Spain was attempted in 1797 under the leadership of Gual and Espapa, but was immediately put down with executions. Another unsuccessful rebellion was led in 1806 by Francisco Miranda, who had fought with Americans in the American Revolution. In 1811, 24 deputies elected by seven provinces (Caracas, Barinas, Barcelona, Cumana, Margarita, Merida and Trujillo) chose Miranda as president of the Junta. On

July 5, 1811, this group adopted the Declaration of Independence and, from that date, Venezuela became a sovereign nation, free from Spain.

From 1811 to 1821 followed ten years of warfare between Spain and factions of the revolutionists, who were led by Simon Bolivar, until June 24, 1821, when the Spanish army was defeated at Carabobo. The last of the royalists capitulated in Puerto Cabello in 1823 to the Great Colombia consisting of Venezuela, Colombia, Ecuador and Peru. In 1830 Venezuela separated from the Great Colombia to become an independent nation. Jose Antonio Paez was elected the first president of Venezuela in April, 1831.

Between 1831 and 1880 presidents changed frequently until Guzman Blanco was elected president in 1880. Crespo succeeded Blanco in 1884. In 1901 General Cipriano Castro seized the presidency by force and held it until he left for Europe in 1909. He was succeeded by Juan Vicente Gomez.

Trinidad, an island of 1975 square miles, is within sight of the South American mainland. Although many of the Caribbean islands frequently changed hands as a result of wars between European nations, Trinidad remained under Spanish rule until 1797 when it was captured by the British who have held the island ever since.

EARLY ASPHALT AND PETROLEUM OPERATIONS - 1870 to 1908

The asphalt deposits of Pitch Lake in Trindad and Bermudez Lake in Venezuela were known to the Indians even before Columbus arrived, and they undoubtedly dug small quantities of asphalt to repair their canoes and utensils. Between 1860 and 1875, Wall and Sawkins spent several years making geologic surveys of British possessions in and around

the Caribbean, including Trinidad, Jamaica and British Guiana. Their published works were remarkably accurate and were the only regional geological investigations available 1912.

In Venezuela, in September 1878, a concession of 100 hectares was issued to Manuel Antonio Pulido near La Petroleo close to Colombian border in what is now the state of Tachira. He, with others, formed the Compañia Petrolera del Tachira and dug several wells. The petroleum was refined locally in a 600 gallon still, for use in nearby towns. In 1913 one well had been yielding 30 gallons of oil daily for thirty years.

In 1890 a man named Graham drilled a well near the south edge of the Capure pitch lake seepage. The casing of the hole can still be seen protruding above the ground. Reports about this well are conflicting. Mr. Graham himself states that the well was drilled to a depth of 1,200 feet; he encountered a thin water sand at an uncertain depth and that he got a strong flow of oil from the bottom of the well. This last statement is contradicted by people who were familiar with the well when it was being drilled. It is obvious that if the well had been a commercial success, more wells would have been drilled. Evidently, the reports of good production are untrue.

H. D. Borger (Am. Assoc. Pet. Geol, Bull. Vol. 36, 1952, p. 2293) states regarding the Graham well: "The oil industry of Eastern Venezuela was initiated in 1890 by the Graham

Company of Trinidad. Four shallow wells were drilled at La Brea, on Isla Capure near Pedernales. Asphalt and shows of gas were encountered, but the project was .abandoned."

In West Virginia, U. S. A., in the year 1883, Barber Asphalt Paving Company was incorporated by a Washington, D. C., real estate operator, Amzi Lorenzo Barber. Control of the Pitch Lake on the Island of Trinidad was extended in 1893 to the Bermudez or Guanoco asphalt lake in eastern Venezuela. Barber's business has been conducted through various subsidiaries and several consolidations have taken place, but it was known as General Asphalt Company, which pioneered for petroleum in Venezuela. Today it is known as Barber Oil Corporation. The Asphalt Company was the only important representative of foreign capital in Venezuela.

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Around 1904 the Castro regime confiscated the pitch lake, which led to serious diplomatic rupture with the U. S. A. When Gomez became President in 1908, his first policy was to improve relations with foreign powers. In keeping with that policy, he gave the Asphalt Company two concessions:

1. A concession in 1910 which comprised certain acreage around the pitch lake, which they could exploit for petroleum; and 2. A concession in 1912 comprising practically the whole of Venezuela north of the Orinoco and Apure rivers, with the exception of a few central states.

The 1910 concession, being very small and adjacent to the pitch lake, was operated by t.he

Asphalt Company quite conveniently. The 1912 concession was found to be too large for them, and seeing that they were primarily in the bitumen business, they attempted to interest the major American oil companies in the venture without success. The Caribbean Petroleum Company, a New Jersey corporation, was formed in November 1911 with the General Asphalt Company as a 100% subsidiary to hold the concession which they were then negotiating.

CHRONOLOGICAL HISTORY OF THE DEVELOPMENT OF PETROLEUM IN mTRINIDAD AND VENEZUELA

As compiled by George A. Macready

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My attention was first drawn to the possibilities of petroleum along the south margin of the Caribbean Sea in 1911, about a year and a half after graduating from Stanford, which time I had spent in geological field work on the Pacific Coast of the United States.

In response to telegraphic communication with Dr. Ralph Arnold for geological field work in Trinidad, British West Indies, I grabbed the job with no delay, expecting a pleasant vacation boating, swimming and fishing among tropical islands, picnics under the coconut palms, and plenty of *señoritas* and Creole belles for entertainment.

At a brief conference with Dr. Arnold in New York I learned I was to gather geological data on petroleum operations of the General Asphalt Company (Barber Asphalt Co.) and t.hat he would follow to review my findings and make his report. I took the first available steamer to Trinidad and on arrival I found that Arnold was right about the work: I was not there for a picnic.

The Asphalt Company had been mining and exporting asphalt for a number of years from the famous Pitch Lake of Trinidad and from the Bermudez Asphalt Lake of Venezuela, their volume of business amounting to $15,000,000 annually. In 1908 they had encountered oil in a test well beside the Trinidad Lake. About a year before my arrival they had commenced an elaborate and extravagant exploration for petroleum in Trinidad and Venezuela originated by John M. Mack, President of General Asphalt Co.

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When I arrived the extravaganza had become a panicky fiasco with about 5,000 acres under lease and fee ownership around the Trinidad Pitch Lake and a prospecting concession in eastern Venezuela, one oilfield on Trinidad consisting of six good producers surrounded by more than twenty dry holes, a recently completed million barrel tank farm standing empty, a fleet of five tank steamers at anchor offshore waiting for oil which was not available, a management in a panic resulting in 90% turnover of managing and technical personnel, a concession almost ready to be granted covering petroleum in about half of northern Venezuela, and stockholders clamoring to learn where their money had gone.

In Venezuela only three projects had been drilled for oil, two of which were at tidewater and virtually abandoned as unproductive, and a one-barrel producer ninety feet deep near the Colombian boundary. Geological publications and maps of Venezuela were almost non-existent. On Trinidad excellent land maps and good geological publications were available.

It was under these discouraging conditions that Dr. Arnold in January 1912 took over the geological investigations and prevailed upon General Asphalt Co. to apply geological techniques to their oil development operations. Within one year Vessigny oil field was discovered in Trinidad and Trinidad operations were thereafter on a profitable basis. Within two years a thousand-barrel well was discovered, the first oilfield in eastern Venezuela at Guanoco, in 1913. Within three years the first oil-field in Maracaibo basin was discovered at Mene Grande in 1914 with a thirty thousand barrel well.

The Trinidad debacle of 1911 had frightened American oil operators away from the South Caribbean. Prompt evaluation by Dr. Arnold of the immense possibilities of Venezuela along with the Trinidad and Guanoco discoveries was a big factor in interesting the Shell organization to invest in the Venezuelan project in 1913. With only a two-year concession to select areas for exploitation, more than $1^{1/4}$ million acres were selected by the Caribbean Company for exploitation. In addition, $3^{1/2}$ million acres were acquired immediately after the Caribbean selections in the Vigas and Aranguren concessions as a result of this investigation, which enabled the Shell-General Asphalt joint organization to become and remain for many years the largest oil producer in Venezuela.

The geological project under Dr. Arnold was the first geological exploration ever undertaken on a nationwide basis for discovery and development of petroleum. None of us then knew what the ultimate result would be.

The region to explore was 1,000 miles long by 300 miles wide. The 500 hectare exploitation areas had to be selected before July 1913 in the Bermudez Co. concession and before January 1914 in the Caribbean Co. concession. It was not possible in so short a time to attempt detailed mapping or geological mapping. Therefore, a rapid reconnaissance was made to determine the

most attractive districts in which areas were selected to be re-examined geologically after 1914 and also after selections to investigate prior concessions for acquirement.

Because of large scale asphalt mining operations by the sponsor in Trinidad and eastern Venezuela, the investigations commenced at Trinidad and progressed westward. British Government attitude prevented acquiring additional acreage on Trinidad, where production was from Tertiary horizons. Working westward in Venezuela, numerous asphalt deposits found were invariably in alluvium near the contact of pre-Tertiary rocks with structural relations obscure. In July 1912 the first field parties started in western Venezuela and found small seepages in Falcon, Yaracuy and Trujillo associated with folded sediments which appeared to be Tertiary. In the fall of 1912 Merritt and Joslin, the first field party to investigate Zulia, reported large seepages and numerous Tertiary outcrops. When I visited Mene Grande in October 1912 with them, I saw the first large Tertiary anticlinal structure I had seen in Venezuela associated with the largest asphalt deposit I had seen west of Guanoco. Dr. Arnold promptly saw the importance of Maracaibo Basin as a potential oil producing region. It was his report of November 1912 that was a large factor in interesting the Shell organization to join General Asphalt in the Venezuelan project. In February 1913 selection and survey of exploitation areas were increased by Bermudez, and Caribbean Company in November 1912. 1913 was devoted to selections for Bermudez and Caribbean Co. areas, and then in 1914 and 1915 selections were examined, and in addition, the Vigas and Aranguren concessions investigated and acquired.

Until 1924 the Shell-General Asphalt joint operation was the only producer of petroleum in Venezuela. Since 1945 Venezuela has been the second-largest producing country in annual production in the world. In cumulative production since 1857, Venezuela has ranked third since 1940, and in 1954 passed Russia to rank second to United States.

As compiled by A.P.I. in Facts and Figures (11th edition), world cumulative productions 1857 to 1953 inclusive compare as follows:

47,816,633,000 barrels from United States
7,534,668,000 barrels from U.S.S.R (Russia)
7,477,460,000 barrels from, VENEZUELA
6,366,331,000 barrels from Arab states combined, including Iran, Bahrein Island, Iraq, Kuwait, Quatar, and Saudi Arabia
2,710,119,000 barrels from Mexico
1,467,626,000 barrels from Indonesia.

Compared to California production (11th edition): In 1953 Venezuela produced 644,244,000 barrels, making cumulative total 7,477,460,000 barrels.

In 1953 California produced 264,433,000 barrels, making cumulative total 9,698,542,000 barrels.

One third of the Venezuelan production amounting to 2,500,000,000 barrels was produced by Shell-General Asphalt operations from lands acquired under the General Asphalt Co. geological survey of 1912 to 1916.

CHAPTER 5

CONDITIONS IN 1911
By Ralph Arnold

The first part of the Venezuelan story is important, not merely as a personal chronicle, but as a story of the times. The roundabout manner in which the expedition began reveals the rather hectic, the increasingly international nature of the oil industry then.

The young geologists were usually sent to Venezuela for only a year because of the climate and the other threats to the health of an American. Some of them returned early with malaria. Some stayed on for many years. While they were there, none of them led uneventful lives, yet not one failed to record the geologically important information in a manner that was useful.

On my trips to Trinidad and Venezuela to inspect the latest areas surveyed, they would assemble from different parts of the country, traveling to meet me by horse or burro or boat or on foot. Then they conducted me on tours of their areas, and they did their best to walk my legs off just as other young geology students might have done on a simple field.

But these young geologists, all of whom were excited at the prospect of combining their geology with travels in a new, distant country, were confronted with many more adventures than they dreamed of when they first came to me to apply for jobs. That they were able to live through such adventures and still not lose some of the indomitable spirit of their student days has always amazed me.

Macready was the first geologist employed in this Venezuelan work. He not only went down first, but he also had charge of placing the men as they arrived in Trinidad and Venezuela. His experience in this part of the activities is given in the interesting paragraphs following:

"The first step in organizing our exploration was to engage geologists. Dan Nolan and Clarence Peterson were engaged and immediately started by train for New York. Harold E. Boyd, A. H. Garner, Franklin S. Prout and 'Pike' A. S. Henley were engaged to start work in eastern Venezuela within a short time. 'Brick' Elliott was engaged for the office at Caracas where he was to gather what information was available from government and educational sources and receive and compile the numerous field reports.

"While these men were on their way I was delegated to visit Mr. Veatch at Washington, D. C., and gather what I could of his survey in Venezuela. He had returned to the United States during the reorganization of 1911, taking all of his maps and field notes with him as security for back pay and expenses. While on Trinidad I had obtained most of his Trinidad maps. In spite of the bitterness between Veatch and the Asphalt Company, as far as I could see, he turned over the material in excellent and complete condition. The survey had been discontinued abruptly and no conclusions were ventured by Veatch, but I was surprised at the careful and painstaking character of the field mapping. During subsequent comparison of his mapping with the field geology, I was amazed at the accuracy of the work, which was all the more interesting when one sees the rainy, swampy, heavily timbered area in which he worked. Plane table field maps were made on white celluloid sheets instead of paper because of the rainy climate.

"Dan Nolan was the first geologist sent down. There were plenty of geologists trained for field mapping, but in 1911 very few had had any experience on an oil well. Nolan was engaged largely because I knew he was roughnecking on a rotary well near Taft and knew enough about mechanics of a well to start our subsurface work at Trinidad. It was one of Dr. Arnold's requirements before accepting the assignment that a geologist be stationed wherever drilling was in progress, so that information applicable for future use in guiding projected well development could be gathered and preserved. I often recall our hurry getting Nolan to the job. He had been expecting a bit of sightseeing in New York before sailing. However, I met him on the train as he passed through Philadelphia, briefed him on his new job as we sped to New York. The train entered New York through the Hudson tubes and discharged passengers in the station below 30 Church Street. Up the elevator to the Asphalt office on the tenth floor, for more briefing and tickets, then down the elevator to the third floor and into the elevated railroad train which took us to the Flatbush dock in Brooklyn, just in time to board the steamer. And he was off for Trinidad in January 1912 without touching ground in New York.

"Clarence Peterson, who had accompanied Nolan from California, returned with me to Philadelphia where we compiled what data was available for Venezuela. In February Peterson and I went to Guanoco, Venezuela, to start the Venezuelan exploration.

"One peculiarity and difficulty of the exploration was quickly in evidence. It was sponsored by a corporation primarily in the asphalt business and having only a limited experience in petroleum producing. Asphalt mining, selling and paving being their principal business, they saw everything in terms of asphalt. Their ideas of Venezuela were vaguely that it consisted principally of the asphalt lake and Caracas, with not much else. Very few of their personnel had seen any more of Venezuela. They had little conception of the size of the Caribbean concession which was a thousand miles long by three hundred miles wide in contrast to the few square miles of either Guanoco Asphalt mine or Caracas. The nature of operation of the two businesses was different. Asphalt was mined in small limited areas by unskilled labor at as low a cost as possible and shipped directly to the United States for processing and sale. Petroleum operations were to be scattered over immense areas with high exploration hazards of finding the oil, and operations by highly skilled well-paid groups of men, using expensive specialized tools with which to produce the oil.

"Neither the Asphalt Company nor anyone else had any conception of the immense petroleum potentialities of Venezuela in 1912. No one even dreamed that Venezuela would become the second largest oil producing nation in the world.

"With the Asphalt Company's mining interests concentrated in Trinidad and Guanoco, it was natural for us to start at the eastern part of Venezuela and work westward.

"The first exploration was to select location for a test well on or near the Bermudez Asphalt Lake. The Asphalt Company had spent large sums developing a market for the superior qualities of Bermudez and Trinidad asphalt. But around 1910 they began meeting increasing competition from Mexican petroleum asphalt. In 1912 the Bermudez petroleum concession had less than a year and a half remaining. The last thing in the world the Asphalt Company could endure would be to, have a competitor develop a supply of petroleum asphalt from under their sacred asphalt

lake. In Trinidad the Asphalt Company did not face this hazard because they owned in fee nearly all land surrounding their asphalt lake.

"During February and March of 1912, Peterson and I made an examination of the geology around Guanoco. The asphalt lake was 'way out in the swamp, seven miles northeast from Guanoco. Guanoco was at the edge of the great swamp near the tip of a group of mountains extending north. From the Guanoco hills the general geologic strike included at least one good anticline striking northeast toward the asphalt lake. North of Bermudez Lake, about a mile, another group of hills appeared to have a similar parallel structural strike. An examination of the Asphalt Lake showed that the livest 'mothers' or asphalt seepages were in the eastern part of the lake. About May 1912 the exact location for the well was authorized in the eastern part of the asphalt lake, and Fred Feisthammel, Will Fowler, and myself set the stake by pushing a ten foot pole down into the soft mud at a spot where no asphalt would be liable to injure a rig foundation Several weeks were consumed hauling train loads of shale ballast to the spot for a rig foundation. Drilling started in August 1912.

"In March 1912 Harold Boyd and Han Garner appeared on the scene and were spilled out in the swamp at the village of Caripito to start Caribbean Company's examination. They outfitted principally at Maturin, capital of the state of Monagas, but most of their field work was along the south margin of the Serrania Central or large area of mountains of eastern Venezuela. Their area was a difficult puzzle. Mountains extended for miles to the north, made up almost entirely of Cretaceous or similar sediments such as shale, sandstone and limestone. To the south were the flat llanos or plains extending for miles to the Orinoco River, containing practically no structural outcrops and made up of nearly flat recent appearing sediments.

"Boyd and Garner worked together for nearly two years in Monagas and neither developed any severe illness. Their camps were usually in dirt floor thatch huts close to their work. Each camp had a few saddle horses and pack burros for their use, and they operated with a relatively small crew the first year, but additional labor was employed when staking of exploitation concessions was done in 1913. They did not encounter much swamp work as most of the geological exposures were in foothills from which numerous rivers and creeks flowed. Most of their area was covered by alternating grass sabanas and clumps of trees, not much of which could be called lumber timber. In general, the people were poor and illiterate, but friendly, with almost no criminal element."

CHAPTER 6

CONDITIONS IN VENEZUELA IN 1912
By George A. Macready

When oil exploration work was commenced in Venezuela, the first geologists had to start from scratch without many of the geological, mechanical, engineering and transportation facilities present day geologists take for granted.

The country had not completely recovered from nearly one hundred years of intermittent revolutions and dictatorships. Many of the buildings, roadways, towns and improvements built by the Spanish had been damaged and neither repaired nor replaced.

The only maps available were some obtained from the government, which, although very helpful, were only approximate. One had to be ever watchful for enormous errors, such as towns out of place or rivers shown going in the wrong direction.

The only geological maps and data available were scattered in a few works by old school naturalists who included more zoology, anthropology, astronomy, botany, senoritas, and other sciences than geology.

Many of our present day geological aids had not been developed. Microfauna, geophysics, mineralogy, core drilling, air surveys and electric logging had not been applied to oilfield exploration. In well drilling, wooden derricks, cable tools, grip ring rotaries, one-lung engines, non-upset drill pipe, uncemented water shutoffs, and yellow dog rig lights were still regular practice. The only automobiles were a few in Caracas and Trinidad and one at Carupano. A few ox carts were used in the llanos, near Lake Maracaibo and near Caracas, but elsewhere there were no wagon roads. A few railroads extended from ports inland. Postal service was inefficient to useless. A fair telegraph service provided brief communications and transfer of money with aid of local merchants.

Only three wells had been drilled for oil in Venezuela. About 1880 a well had been drilled in Tachira in the Andes without very encouraging results. Val de Travers Oil Company drilled a dry hole near an asphalt deposit at Guanoco west of the Gulf of Paria about 1910. Near Cumana a well with a Galician rig was drilled by Venezuelan Oil Fields Exploration Company under the Tregelles concession about 1911.

With this sketch information to start with, the General Asphalt Company handed the geologists a concession of approximately 200,000 square miles (1,000 miles long and 200 miles wide). The geologists had two years within which to select the areas to be developed.

The only previous oil experience the Asphalt Company had had was four years of operations in Trinidad resulting in huge expenditures and no profits. Early exploration was handicapped by being carried on as a side issue of the asphalt business, which was of a totally different nature. This situation was most noticeable when drilling started in Trinidad and eastern Venezuela. The local asphalt management outlook was narrowed to their desire to mine asphalt at low cost with unskilled labor from mines discovered by their predecessors and with transportation facilities already installed. They could not understand operations over thousands of square miles, or the urgent need of heavy expensive tools and highly skilled labor, or why such tools were set aside and others substituted when underground conditions changed, or why, after spending a lot of money on a wildcat well, it would be written off without production. They did not have any idea of the hazards of oil production.

Venezuela lies entirely within the tropics. The concession investigated extended from 7 to 12 degrees north latitude. In addition, the southern portion of Venezuela extended south nearly to the Equator.

In the tropics climate depends on altitude, and in Venezuela ranged from oppressive heat at sea level to perpetual snow on high peaks near the Colombian border. Climate is further modified

by rainfall which varies with the winds and degree of shelter or interference by mountains. Because of the trade winds, the tendency in Venezuela was for rainy east slopes and arid west slopes of mountains, with some of the coastal islands almost arid.

Because of climatic conditions the highlands of the Andes and of Caracas were selected by early Spanish settlers as the most desirable places within which to live. Upland climate was very cool, swamps were not common, crops were good, and people were more active and progressive than in the lowlands. However, there were some crops such as cacao, coconuts and rubber which attracted settlers to lowlands. There is not a great seasonal difference in climate throughout the year.

Topographically, northern Venezuela is built about a spur from the eastern Cordillera of the Andes extending through Trujillo and Caracas along the northern coast of Venezuela and on into Trinidad. To the south the mountains decrease to foothills and then fade into the great plains or llanos of the Orinoco River valley. To the north the mountains drop abruptly to the ocean except near Lake Maracaibo, which is a great geological basin between the Central Cordillera of the Andes in Colombia and the Venezuelan spur above mentioned.

The vegetation of Venezuela can be summed up as follows. In the lower delta of the Orinoco River and bordering the west side of the Gulf of Paria are immense swamps and forests of large trees interspersed with grassy sabanas. Rainfall here is around 60 inches. Mangroves predominate near tidewater, but inland a great variety of tree species occurs which cover the hills of northern Monagas and southern Sucre. Great grassy plains cover the llanos for miles north and south of the Orinoco, except where broken by strips of wooded bottomlands along rivers. As one goes west along the northern mountains of Venezuela the trees become smaller and a few arid areas occur. In Yaracuy and the eastern part of Falcon large tree forests are present which diminish in size as one approaches Lake Maracaibo. Mangroves along the east side of Lake Maracaibo are stunted, but along the southwest side of the lake are again large. The coastal islands of Margarita, Tortuga, and the Dutch islands of Bonaire, Curaçao and Aruba are arid.

As a source of timber, the variety of trees is so great and so many are of no structural value that oil operators found it more economical to import rig timbers sawed to size from the United States. Systematic timber cutting was found too expensive.

There were very few large-scale farms or cultivated areas in Venezuela in 1912. Most cultivation was for local use, such as casabe, plantains and vegetables. There were numerous cacao plots among the forested localities surrounding the Gulf of Paria and at several places along the north coast. Coconuts were confined to sandy coves along the seacoast. Coffee was grown in the mountain areas where rainfall and timber were not too plentiful, but was a principal crop around Caracas and the Andes. Maize patches were present near all villages.

Water supply in Venezuela is reasonably abundant in most districts. There is an over abundance even to floods during the rainy season in the forested and wet districts. During the dry season most of the streams in the forested regions have water, as do the larger rivers of the lowlands. In the drier districts there is a scarcity of stream water during the dry season, such as near Cumana and among the coastal islands where recourse is had to dug wells or water holes. For industrial use, water is reasonably fresh, except near Lake Maracaibo, which is brackish, the

extent of it varying with the seasons. For domestic use, most stream water is polluted, because it is customary for each village to run its sewage and debris into the streams. However, although I would not drink unboiled water from the clearest mountain streams in the coffee-raising districts, I frequently drank unboiled water direct from the swamps east of Guanoco which, although red with vegetation, had no human pollution.

I encountered no deep wells for water supply. In the arid regions, domestic water was occasionally obtained from shallow dug wells With the exception of a few cities like Caracas and Puerto Cabello, the towns had no pipeline facilities and depended on packing kegs or skins or water on burros from the nearest river.

In places where oil development camp were started and others besides geologists were brought in, Yankee-type houses with kitchens were built and Yankee service provided. The field geologists, however, had to improvise compromises between Yankee desires and native customs which varied with conditions. I did not see a half dozen real stoves in Venezuela outside of the Caracas District and the Yankee camps. Nearly all cooking was done on bonfires or charcoal burners, and if the habitation was more than temporary, the burners were set up on a mud-covered bench. Refrigeration was unknown.

Field geologists lived principally on local produce. Canned foods were available only at seaport towns and were used when obtainable. Most villages had open-air markets where vegetables, poultry and other items could be purchased. Vegetables included plantains (a cooking banana extensively used), eggplant, tanias, yams, ocumo, corn, and okra. Fruits available were oranges (which ripened with a dark green skin), limes, mangoes, bananas of numerous varieties, coconuts, coffee and cocoa. Semi-prepared foods were casabe cakes (about as tasty as sawdust pie), local white cheese, arepas (a heated ball of corn meal) and papelon (crude cane sugar cakes). Meat and poultry included pork (from scavenger pigs and not koshered at all), chickens of various ages, occasionally beef, where there were sufficient people to buy an entire beef, some milk, and eggs which passed among natives about like money for about a penny apiece, and now and then wild game, such as venison, and fish.

It was customary for the cook to awaken everybody at daybreak with a cup of coffee. This was made of coffee beans crushed by hand and dried in a frying pan until black, then boiled with papelon and water to a thick syrup. It was far stronger than any Yankee coffee. Breakfast and lunch were light and often combined, and supper was served about dark.

In the tropics daylight bounces out with sunrise and disappears immediately with sunset, without any twilight. If shelter is available, siestas are taken around noon. It is almost impossible to get any action from local towns-people during the middle of the day. Tropical rain squalls occur without warning and disappear as quickly, to be followed by clear, hot sunshine.

The entire country was thoroughly impoverished after its long term of civil strife so that people in towns and rural districts were all financially very poor by North American standards. Wages were very low, with unskilled labor around five cents per hour. But except along the seacoast, there was very little thievery or drunkenness. I have often marveled how cash money could be entrusted to native messengers and have often trusted over one hundred dollars to

barefoot native messengers without loss of delivery even though they had to walk miles to their destination and received wages less than a dollar per day.

In Venezuela matches and salt are government monopolies. In the West Indies Negroes in the back country seldom see enough money to buy matches. It was a common occurrence to pass a native on a trail carrying a heap of burning coals on a spade or flat board obtained from a neighbor to carry to his own house to start a fire.

Public utilities were very rare. A few towns had electric lights generated by producer gas from coal or charcoal or by water power. Lanterns and lamps were none too common. Poorer people relied on tallow candles for night light and usually went to bed soon after sundown. Their beds were usually woven grass hammocks strung between posts of thatch huts or from adobe walls. Apparently neither the early Spanish nor the Indians understood the use of pipes for transportation of liquids. They usually relied on open ditches or kegs on burro back. Only a few towns had water mains in streets, and Caracas was the only town with public sewer mains. Even there, the first sewers were laid with two-inch diameter street mains resulting in uncomfortable congestion in the downtown section for years.

The transportation system of Venezuela was an outgrowth of the early Spanish system commencing about the year 1500, but which was interrupted around the year 1800 by a long series of revolutions and dictatorships during which many of the Spanish advances were ruined. Between the years 1800 and 1900 several railroads and other enterprises were spotted haphazardly through the country as a result of deals between various dictators and foreign capital.

Within 30 years after Columbus' first voyage the Spanish founded several towns along the north coast of Venezuela, including Cumana in 1520, and Coro about the same time. The corner stone on the church at Coro was dated 1527, yet in 1913 the church was still in use and in fair condition.

From the coastal towns the Spanish extended their occupation inland and into the mountains, establishing towns at frequent intervals. The towns were systematically laid out with a central plaza surrounded by church, civil and military buildings. Surrounding the plaza, streets were laid out along which residences and shops were erected. Many buildings were substantially constructed of adobe or masonry with tile roofs. The more pretentious residences were frequently built around an enclosed patio, giving the family close privacy, with living conditions resembling those of the more prosperous people of old Spain.

The transportation system originated before the days of steel or power-driven machinery and was laid out primarily for horseback and pack mule transportation. In a few places provision was made for two wheeled ox carts, such as in the flat plains near the Orinoco River and near a few of the less mountainous towns. From the principal coastal ports small boats were used along the coast or up rivers to inland towns.

It was interesting to notice how directly pack trails went from point to point. Those surveyed during the geological mapping often kept within a quarter mile of the air line between destinations ten miles apart, although wiggling and squirming with short turns around trees, rocks

and cliffs. Grades were not so objectionable for animal traffic, so trails went straight over most mountains.

In 1911 the same general lines of travel were still in use with the addition of docks at a few ports and a few short railroads into mountain towns. British, French, Dutch, German, Italian and Spanish steamers made regular calls at Trinidad, Carupano, Cumana, Guanta, La Guaira, Puerto Cabello and Dutch Curaçao on their route from Europe to Panama. An American line connected New York with La Guaira and Maracaibo via Curaçao. Asphalt was shipped from Guanoco and iron ore from Imataca by chartered steamers to the United States. The Venezuelan Coastal Steamship line ran from Maracaibo to Ciudad Bolivar, calling at large and small ports along the route. Small paddle-wheel steamers went up the Orinoco River above Ciudad Bolivar. Nearly all foreign, commerce was handled by this system with the addition of an occasional foreign tramp steamer or sailboat. Local distribution was by small sailboat, pack train, or local railroad.

In 1911 the commerce of Venezuela was principally agricultural with exports of agricultural products, asphalt and iron ore and ports of manufactured articles. Principal exports were coffee, cacao, coconuts, rubber, beef, asphalt and iron ore.

Except for asphalt and iron ore, this commerce was largely controlled by European import-export merchants who established themselves permanently at various ports and interior cities. Proceeds from sale of manufactured articles imported by them were immediately used to purchase Venezuelan products for export to their home countries. Large, profitable business resulted without cash credits and debits becoming top-heavy and with profit on sale purchase and transport of both imports and exports.

Many American firms did not appear to understand this type of trading and persisted in sending salesmen down to make short stays in each of several countries to sell for cash or bank credit, and separate buyers on some short stays to buy for cash. Result was that products purchased, such as coffee or cacao, were frequently from European merchants, and products sold had to be on long-time credits or not at all. European merchants made the profits and Americans were left with top-heavy, unbalanced accounts. The aggressive "go-getters" and impatient American salesmen were partticularly unsuccessful.

On January 2, 1912, the Venezuelan government granted to Max Valladares a two-year petroleum concession similar to the lapsed Tregelles concession for all of northern Venezuela. This was assigned to the Caribbean Petroleum Company, a subsidiary of General Asphalt,Co., and Dr. Ralph Arnold was engaged to direct the geological operations of all their holdings.

From then on, conditions became more encouraging and were soon on a profitable basis.

It fell to my lot to contact the various field parties and to make a "hurry up" reconnaissance of all northern Venezuela to get a geological inventory of what we had. In this I visited every state in Venezuela, except the three states south of the Orinoco and Tachira. Of these only Tachira was in the concession.

In spite of the limited time, absence of geological maps, large and unknown areas, and the discouraging situation in Trinidad in 1911, this organization proved highly successful.

In Trinidad several test wells were started for developing new production. Well Number 35 was started in Vessigny Valley about a mile above the dry holes of the Brighton Field and in July 1912 came in at 15,000 barrels per day as the discovery well for the Vessigny field. Numerous additional productive wells were drilled in this field, but under the geological guidance of Dan Nolan, and when the limits of production were approached, a flock of dry holes was avoided.

In the Forest Reserve Lot One, Well Number 1 encountered a strong flow of gas and was followed by Number 2 which in August 1913 was placed on production at a depth of 510 feet as the discovery well for Lot One Oil Field. Subsequently this field provided a number of very prolific shallow producers.

In Venezuela, on the Bermudez Asphalt Lake, Bababui Well #1 was started in August 1912, and after great difficulty — because of heavy oil—was suspended in August 1913 at a depth of 615 feet, flowing up to 1,000 barrels of heavy oil daily as the discovery well for the first commercial oil field in Venezuela.

In 1912 additional geological parties were put in the field in western Venezuela. From my early reconnaissance it was determined that the most promising districts for petroleum were
(1) the area surrounding Lake Maracaibo,
(2) the hilly area of Falcon, Lara and Yaracuy, and (3) the area of eastern Venezuela west from the Gulf of Paria and north of the Orinoco River.

In contrast to the discouraging situation in January 1912 when General Asphalt Company after enormous investment had only ten producers from thirty wells, and an enormous concession in Venezuela of unknown value which had been rejected by European capital, the condition in 1915 was a profitable production on Trinidad, a commercial oil field discovered in Venezuela, and a large number of promising prospective oil structures in Venezuela.

By 1915, instead of being discouraging, the Venezuelan oil prospects were apparently too large for the General Asphalt Company to handle alone, so an arrangement was made for joint operation with the Shell Group.

By 1916 commercial oil production had been discovered in Mene Grande east of Lake Maracaibo, and from then on operations rapidly expanded with discoveries of new fields both in western and eastern Venezuela every year.

This was the first large scale foreign exploration project by American interests, and its success is largely due to the wise geological guidance of Dr. Arnold; *it* did not become confused in a large and expensive mass of detail as had been the case in Trinidad and eastern Venezuela prior to 1912.

In Venezuela most of 1912 was spent getting field geological parties started and learning what, if anything, of value might be found. It fell to my lot to make a widespread reconnaissance for linking the intervening areas between parties and inspecting other areas which might require investigation. In this reconnaissance I visited every state in Venezuela except the four extreme southern states (Amazonas, Apure, Zamora, and Tachira).

When Dr. Arnold took over the geological exploration, exploratory wells were almost immediately authorized as follows:

1. #35 in Trinidad on Vessigny River, to test an anticlinal structure in outcropping tar sands.
2. #36 in Trinidad, about a mile from #35, to test a flank or saddle position of an uplifted area.
3. Well #1, Lot One, to test a wide anticlinal amphitheater on crown leased lands in Morne L'Enfer Forest.
4. Guanoco Well (Bababui #1), to explore beneath the area near the Venezuelan Asphalt Lake.

The #35 started in May 1912 after delay getting men, materials and roads. #36 started very soon after #35. Lot One Well was delayed until June 1913 by negotiations with government authorities and legal obstacles. The Guanoco Well was postponed until Peterson and I were able to inspect the ground, and then by necessity of ballasting a foundation and building the rig so that it was not started until August 1912.

Until July 1912 drilling and geological operations were all preliminary routine with very little to break the monotony.

Concession terms required that each 500-hectare area be surveyed and the plat signed by a Venezuelan engineer, of whom there were not many available. All those available were engaged by the Caribbean and Bermudez companies and, in addition, geologists and surveyors from Trinidad and the U.S.A. opened traces (trails) through the jungle and laid out lines so that the Venezuelan engineers only needed to review the surveys and make the plats required.

The Venezuelan engineers ranged from very good and energetic to those less ambitious. Among those in eastern Venezuela were Rafael Torres, Santiago Aguerrevere, Enrique Aguerrevere, Pedro Aguerrevere, Martin Tovar and Louis Pacheco, whom I found conscientious and capable workers.

During Christmas of 1912 Enrique Aguerrevere and I placed the east-end corners far out in the swamp east of the asphalt lake where we camped nearly two weeks and lived off monkeys, parrots, wild duck, and bony fish for meat. Each morning alligators poked their heads through the water lilies and smacked their big jaws at us. Enrique named the place "Monkey Land."

During 1912 Boyd and Garner investigated the northern portion of Monagas and part of Anzoategui. Here they encountered a large number of seepages in a belt twenty miles long by two miles wide between Caripito and Aragua de Maturin. Most of the seepages were in the alluvial area south of the high mountains, except near Punceres where oil occurred in Cretaceous shale and limestone near the alluvial area. Seepages were largest near Punceres and Quiriquiri and Sabaneta. Another group of seepages occurred near El Breal and Chapopotal about 15 miles south of Punceres, where the asphalt exuded from flat sediments of the Llanos group. At Chapopotal occurred some large angular blocks of hard sandstone resembling the marine sandstone near Punceres.

In November 1912 surveying of 24 areas in the Punceres and Chapopotal areas was authorized to commence immediately. At that time the Quiriquiri and Punceres and Chapopotal regions appeared very attractive.

Farther west, near the western boundary of Monagas, a single seepage was found by Boyd and Garner near Hato Pirital, and four explotation areas were selected.

In Anzoategui a seepage was reported near Cantaura, and four areas tentatively selected for investigation.

During 1912 Boyd and Garner did not make any investigation south of Maturin. The southern part of Monagas was known to be a plain extending to the Orinoco River, where basement rocks were reported.

Also, in March 1912 A. S. "Pike" Henley and Franklin S. Prout started work near Guanta and covered the northeast coastal part of Anzoategui, Sucre, and Nueva Esparta. They secured the services of a small sloop with a two-or-three-man crew which served excellently as camp and headquarters. From the boat they were able to walk many miles inland, occasionally staying a few days at some in village. Nearly all of their area was arid, with plenty of cactus, except for some of the cultivated foothill valleys. Geologically, they plenty of outcrops and fairly interesting geology to work, but nothing very promising for petroleum. A coal mine a few miles inland from Guanta was interesting, but not very prosperous. Guanta had a beautiful harbor in the lee of a group of islands on which were coconut groves and other cultivation. Cumaná was situated at the entrance of the Gulf of Cariaco and functioned as a port for rich cocoa and coffee plantations in the high mountain south of the coast. The Gulf of Cariaco is one of the largest and finest natural harbors I have ever seen. It is about forty miles long by ten miles wide and completely landlocked except for a narrow entrance at its west end near Cumana. Hills and mountains on all sides protect the gulf from storms. Cumana was an interesting, quiet town with fair hotel and electric light system produced by producer gas plant. On the shore of the gulf opposite Cumana a well had been drilled at Manicuare under the Tregelles Concession, and at the time of Prout and Henley's visit was idle, with a watchman on the grounds; it stopped in schist at 335 feet and never resumed drilling. Prout and Henley also covered the Margarita Islands north of the mainland. The islands are arid, geological outcrops abundant, and one or twoasphalt seepages, but structurally none too promising for petroleum. The people depend largely on fishing and pearl diving. Physically, the Margaritans are healthier and huskier than most Venezuelans and appear to have been largely of Spanish ancestry with less mixture of Indian and almost no mixture of Negro ancestry. They are very good seamen and much in demand as longshoremen and sailors.

Geologically, the formations found by Prout and Henley were principally Cretaceous or early Tertiary shales, sandstone, coal and limestone. A large band of crystalline metamorphics made up the core of the Peninsula of Araya and extended east to Trinidad, apparently separated by an east-west fault from the sediments south of the fault. Small patches or veneers of recent marine Tertiary occurred among the islands and along the coast. A few small seepages of asphalt were found, apparently along faults, without much relation to folding.

Henley was the older of the two and acted as chief of party. He was very well liked by the local people. Prout was six feet five inches tall and a good-natured young fellow who attracted

attention immediately in a district where most people were small. People were particularly inquisitive as to how many yards of cloth he required for a suit and how long were his legs.

The evidences of petroleum deposits found in Sucre by Henley and Prout were none too good, but some exploitation areas were selected largely as protection in event of discovery by the only well drilled under the expired Tregelles concession. The core of the Peninsula of Araya is schist on the north side of the great east-west fault which passes through the Gulf of Cariaco. Outcrops of late Tertiary sands and clays occur around the schist core, and near Manicuare an outcrop of oil sand six feet thick dips steeply south into the Gulf of Cariaco. The well above mentioned was drilled near Manicuare and was later reported to have bottomed in schist. Prospects were none too promising, but eight exploitation areas totaling 4,000 hectares were selected.

Near Cumana similar Tertiary outcrops occurred, with Cretaceous sediments in the mountains to the south. Unverified oil seepages were reported in Cumana. Although not very promising, two exploitation areas were selected in Cumana.

In Nueva Esparta, on Margarita Island, basement rocks make up much of Margarita Island, but at the extreme west end is a low dipping anticline of late Tertiary sands in which a chloroform cut for oil was obtained. Here one area was selected for exploitation.

The Island of Cubagua was held under a prior concession by other parties. This island is a low arch or anticline in late Tertiary or Quaternary beds into which holes have been dug. Several gallons of 20° oil seeps into the holes daily and was being marketed locally by the concessionaires.

About March 1912 J. E. "Brick" Elliott was sent to Caracas to compile field reports and gather governmental data. He managed to obtain from the government offices the best map of Venezuela. It was used as a basis and guide for all our field parties and for sending in field reports. The map was a lucky break for the field parties, even though there were places subject to criticism from parties accustomed to high-class maps. Venezuela had never had a comprehensive land survey such as we in the United States have.

In April 1912 Richard A. Conkling was sent down to Guanoco to aid in the Bermudez Company investigations. About that time I had started a reconnaissance of all Venezuela, so Conkling was teamed with Peterson near El Pilar. Most of the Bermudez Company investigations were in densely timbered, rugged hills and mountains fringing or out in the extensive mangrove swamps which made up most of the area. Peterson had seen enough of Venezuela and left soon after Conkling's arrival. J. E. Pogue was sent down to work with Conkling, but returned to the United States after a very brief stay. Conkling was left to work alone in a very dismal part of Venezuela. Geologically it consisted of an enormous swamp, high crystalline mountains bordering the north of the swamp, rugged mountains of Cretaceous shales, limestone and sandstone to the west, the Gulf of Paria to the east, and much more swamp to the south. Most travel was by canoe along tidal sloughs or *caños*, by wading in the swamp, and an occasional foot hike into the hills. There were a few settlements near which cocoa groves were cultivated, since that was the only pay crop that was profitable in the moist, humid climate. A few small asphalt seepages occurred in the swamp, usually near the base of hills. The people were about the worst group in Venezuela, made up largely of Negro escapees from Trinidad, Venezuelan undesirables

waiting opportunity to escape to Trinidad, and occasional beachcombers always thirsty for liquor. Living accommodations were very poor. Mosquitoes were the worst and largest of any place I ever saw. Each time I saw Conkling in the field he had a large bandana handkerchief draped from his hat and tied under his chin so that only his nose and eyes were visible. Each time he closed his notebook the pages were blotted with bloody crushed mosquitoes.

In June 1912 six more geologists were sent down and after briefing at Caracas were assigned to work in pairs in the area between Puerto Cabello and Lake Maracaibo.

Barnabas Bryan and Emil Huguenin covered parts of Yaracuy, Lara and Falcon. Outfitting at Tucacas, they traveled overland through cocoa and coffee plantations via San Felipe to Barquisimeto. Geological outcrops were scattered, but mostly of softer rocks like Tertiary and some Cretaceous. Small seepages were found, around which additional investigations were suggested. This part of their traverse was through prosperous well settled country. From Barquisimeto they then turned north to Coro passing through a disagreeable desert country of stunted sticker brush and poverty stricken settlements to arrive at Coro during a severe famine. Proceeding east to Cumarebo they encountered mosquito infested country. Huguenin contracted malaria and was instructed to return to Caracas, which he did, by an adventurous trip on a dilapidated yacht. Bryan joined Arrel at Coro. Huguenin returned to the United States in December.

Dell B. Arrel and T. A. Bendrat were assigned to the Coro-Cumarebo district where they had an unpleasant time in the famine district, but encountered seepages and Tertiary formations which required additional investigation. Bendrat returned to the United States in October.

Jackson and Hasbrouck outfitted at Barquisimeto and traveled overland through mountains into Trujillo, encountering older sediments and crystalline rocks. Both became ill in September. Jackson returned to the United States about November 1912 and Hasbrouck, after working with Eckes a short time, returned in February 1913.

Bryan and Arrel were teamed together at Coro at the close of 1912.

In July 1912 Floyd C. Merritt and Garnet A. Joslin were sent to Venezuela and became the first party to get into the Maracaibo Geological Basin. Outfitting at Coro, they raversed overland along the lowlands east of Lake Maracaibo, through Falcon, Zulia, Trujillo and Merida to the south side of the lake. This was a very disagreeable area of hot lowlands covered by stunted bushes and cactus with only occasional unconsolidated outcrops and plenty of mosquitoes. But they also encountered large asphalt deposits such as El Menito, Lagunillas, Mene Grande and others which occurred in areas of unconsolidated outcrops resembling Tertiary sediments along what appeared to be a geological structural line from El Menito to Mene Grande.

The findings of Merritt and Joslin were more attractive for petroleum than anything reported by parties west of Trinidad. When I visited Mene Grande in October 1912 with Merritt and Joslin I saw the most promising area I had seen in Venezuela. The asphalt deposits were larger than any I had seen, except those at Trinidad and Guanoco. Furthermore, the asphalt deposits were in a shallow amphitheater partly surrounded by low hills with outcrops of tar sands arranged like an anticlinal rim rock and which reminded me of Lot One Anticline on Trinidad. All three of us

were agreed that concession areas should be taken for exploitation. These were the first seepages I had seen in Venezuela that appeared directly associated with a large structural uplift.

Dr. Arnold promptly recommended that exploitation areas be immediately surveyed and claimed, and selected Mene Grande as the site for the first test well in Maracaibo Basin.

About August 1912 Charles R. Eckes came to Venezuela via Trinidad and was assigned to replace Byron Jackson and work with Bernard Hasbrouck in the mountains of Trujillo.

Hasbrouck became ill very soon, so Eckes worked the remainder of 1912 alone, until he became ill with typhoid fever.

CHAPTER 7

START OF GOOD RESULTS IN 1912
By George A. Macready

Our first good break occurred at Trinidad in July 1912 when Vessigny #35 blew out at the rate of 15,000 barrels per day from 1,466 feet and wrecked itself within a day. Nobody was expecting such an event and the cable tool well was not prepared for high gas pressure. The news was cabled to the main office at Philadelphia and the reply came back: "Do you mean 15,000 barrels or 1,500 barrels?" After verification, another well was authorized a location away as #37, which started drilling in October 1912. Drilling by rotary with perforated drill pipe, #37 came in in November 1912 with initial production of 8,000 barrels per day and continued to flow for several years. From then on, for about two years, Vessigny field was a series of gushers, fires, fishing jobs, and plenty of oil. Vessigny was the first oil field in Trinidad to show an operating profit.

About the same time a local planter, C. F. Stollmeyer, drilled a well about 200 feet west from the boundary of Lot 1 with a portable water well machine and native crew. The Stollmeyer well, at depth of 295 feet, blew out and flowed with initial production of 1,500 barrels per day for about two months, when it sanded up. Then a big rainstorm washed out the earthen storage sump and carried most of the oil to sea.

Over in Venezuela Bababui #1, which started in August, was having increasing flows of heavy oil during drilling amounting to nearly 100 barrels per day, until at 565 feet depth in October 1912 no further progress could be made. After trials with other forms of equipment the well was eventually carried to its final depth of 615 feet in August 1913, at which time it flowed through open casing at the rate of 900 barrels per day.

The geological exploration in Venezuela had been going on for nearly a year with no startling discoveries, although numerous oil seepages were found. This being the first systematic geological exploration on a nationwide basis, no one was sure or had any idea what the results would be.

It was not until we came to the eastern borders of Lake Maracaibo that anything entrancing appeared. During September and October of 1912, Dr. Arnold, Mr. Proctor and I made a tour of inspection of Venezuela commencing at Trinidad and proceeding west. On Trinidad petroleum

production occurred in soft, unconsolidated Tertiary sediments. In eastern Venezuela no Tertiary sediments were observed, except a few patches on the coast, but numerous asphalt seepages occurred in swamp and alluvial deposits not far from the base of mountains made up of hard, brittle Cretaceous rocks, with few structural relations noticeable. Along the Caribbean shore on the north coast of Sucre and in the mountains near Caracas, high mountains of crystalline metamorphics occurred. Northwest of Caracas, in the states of Yaracuy, Lara and Falcon, was an extensive hilly area with structure obscured by vegetation, but with numerous oil and asphalt seepages of moderate size and sediments that might range from Cretaceous to Recent. The area was thinly settled and transportation poor.

Getting farther west into the area covered by Merritt and Joslin, we found a broad lowland plain between the hills and the east shore of Lake Maracaibo, covered by stunted trees and cactus, lots of mosquitoes, and thinly settled. However, several large asphalt seepages were found.

It was the discovery of the large asphalt deposit on what was apparently a large geological structure at Mene Grande that gave the first clue to the immense possibilities of Venezuela. Not only was the structure itself of interest, but it was on the flank of what appeared to be an immense sedimentary basin between two branches of the Andes Mountains with Lake Maracaibo near the middle of the basin.

Dr. Arnold was the first to appreciate the magnitude of the basin and not only recommended immediate drilling tests of the Mene Grande structure, but an intensified investigation of the entire Maracaibo basin.

During 1913 the Aranguren concession covering districts of Bolivar and Maracaibo and 75% interest in the Vigas concession covering the District of Colon (both in Zulia) were acquired by the Shell-General Asphalt joint operation.

CHAPTER 8

LAKE MARACAIBO, BETWEEN SEPTEMBER 9 AND OCTOBER 14, 1912
[by Ralph Arnold]

Louis J. Proctor, general manager of the General Asphalt Company holdings in Venezuela, with offices in Caracas, and Mr. George A. Macready, chief geologist of the company, accompanied me on the trip. Other company geologists, whom I had sent into the country after my taking over the geologic work, were picked up at various points throughout the trip and accompanied us over their respective areas. Their names will be mentioned later.

OUR ITINERARY

September 27, 1912. We sailed from Port-of-Spain, Trinidad, on the schooner "Ofelia." When we went on board we saw several young lambs tethered to the railing. We thought they were being transported to some port-of-call. We were mistaken. Early the next morning we heard some pitiful bleatings, then a wham. The next meal we had "lamb" chops. Meat does not keep in the tropics—no refrigeration —so it is served "fresh," very fresh.

We had bunks below decks, but we preferred to sleep on deck. The sea was calm, the weather balmy, and our whole trip on the "Ofelia" was a holiday. From Port-of-Spain we sailed north through the Dragon's Mouth, which separates Trinidad from Venezuela, and then on into the Caribbean Sea.

September 28. We turned west and sailed along the north side of the Arismendi Peninsula and the north shore of the State of Sucre, arriving at Pampatar, a port on the east end of the Island of Santa Margarita, Nueva Esparta. Here we were joined by F. S. Prout, who, with A. S. Henley, was covering this part of the country. A 'fine fort erected here by Castro seemed to be more for defense from the land than from the sea.

The island is arid, the usual tall, thin corrugated cacti and thorny bushes being in evidence, especially along the coast. Fishing and pearl fishing are the principal industries. The pearls are noted for their pink color and brilliance.

Schists and granites form the core of the island, with terraces of late Tertiary and Quaternary forming a fringe along the coast. Some steep dipping Eocene beds are present. One terrace rises to 300 feet above sea level. Most of the terraces are formed or capped by great quantities of beautifully preserved shells, mostly living species. The beaches are covered with shells. When the people found out I was a shell collector, they nearly mobbed me trying to sell me specimens. There are no evidences of oil on Santa Margarita Island.

September 29. The Island of Cubagua was visited on this date. It is a low-lying island a few miles south of the middle of Santa Margarita Island. Pleistocene deposits composed almost entirely of recent species of shells, beautifully preserved, cover the island. At the western end of Cubagua a small seepage of fine grade oil is found in a low-arched anticline. This was our first seepage for this trip. The general conditions surrounding it did not look good, but to play safe I recommended taking some areas. Cubagua is a conchologists' and paleontologists' paradise. One could write a monograph on its living and fossil shells.

September 30. The western end of the Peninsula of Araya was examined. It is arid and the vegetation consists of thorny bushes. Schists predominate, but Tertiary sandstones overlie them along the coast. At Manicuare, just east of the southwest tip of the peninsula, we saw our first evidence of an effort to produce oil. It was the drilling rig of the Venezuelan Oil Fields Exploration Company. It was apparently drilled in the Tertiary sandstones not far from schist. No oil was encountered. The well was located here because of a seepage from vertical oil sands which we saw one mile southeast of Manicuare. This occurrence is in the general belt of the long fault that extends from the northern part of Trinidad, through the Gulf of Cariaco and thence westward along the north coast of Venezuela. The territory did not impress me as good for oil.

October 1, 1912. This date was spent in the vicinity of Cumana, Sucre, a good-sized town at the mouth of the Gulf of Cariaco. Prout and Henley made their headquarters here. The mountains rise back of the coastal plain around Cumana. The Manzanares River, a beautiful tree-lined stream, enters the sea at the mouth of the Gulf. The plain is arid and offers some exposures of Tertiary rocks. Vertical beds suggest that the big fault passing just north of Cumana has produced a highly broken zone near it. Some silicious shales, reminding me of the "Monterey" (Miocene) shale of California, are found in the hills two miles south of Cumana. Southwest of Cumana the

blue limestones at the base of the yellow shale series are folded into an asymetric anticline with the steep dips on the coastal side. The general conditions in the Cumana region did not impress me as favorable for oil.

October 2. Proctor, Macready and I started on muleback for Guanoco via Monagas. Our first day took us up the Manzanares River to our first camp about 8 miles above Cumanacoa.

En route we passed over a mountain range with horizontal Cretaceous sandstones and shales at the summit. Nothing looked encouraging for oil.

October 3. We went from our first camp through rugged mountains to San Antonio, Monagas. The roads, or rather trails, through this part of the country have been used for hundreds of years by the Venezuelans with wooden-wheeled carts and saddle animals, and are worn down to trenches 8 or 10 feet deep, especially where they pass over ridges. Their surface is rocky and rough. West of the summit near San Antonio the drainage lines run south into the Orinoco drainage system.

October 4. The terrain from San Antonio to Aragua de Maturin is mountainous. The rocks through the mountains are Cretaceous. The vegetation is heavy in contrast to the arid Cumana country. We reached Aragua de Maturin at night. Here the mountains end and the great Llanos or open plains country begins. No favorable evidences for oil were found in the mountains. Boyd and Garner joined us at Aragua de Maturin.

October 5. Things began to look interesting as we proceeded southeast from Aragua de Maturin. We were in the Llanos country at the base of the mountains where orogenic movements produce structures and seepages. We were right. After passing through Chaguaramal, we headed toward El Breal, a name that fairly reeked with oil.

The flat gravel-sand-clay beds of the Llanos Formation blanketed the whole country, but where lines of structure in the underlying Cretaceous occur, seepages may push up through the "blanket." One large flat one and other smaller seepages were examined at El Breal. Chapopotal Creek, $1^{1/2}$ miles south of El Breal, furnished several seepages and oil sands. This country looks good for oil development. We were getting into the oil belt.

October 6. We spent the day in the vicinity of Punceres and along the banks of the ceres River, especially $2^{1/2}$ miles west of the Punceres. At the latter locality the Cretaceous oil sands and oil impregnated limestones, dipping at low angles toward the southwest, gave a clue as to the Cretaceous origin of the oil. One and one-half miles west of Punceres, the Cretaceous is covered by flat-lying Tertiary thin-bedded, fine sandstones and clays typical of the Tertiary of eastern Venezuela and Trinidad. Many oil seepages occur in the region, some accompanied by sulfur water, particularly $1^{1/2}$ miles northwest of La Cruz.

Hard going marked travel in the brush-covered limestone blocks. Wasps were common. The *Jefe* of one of the little villages insisted on taking the lead and guiding us through the thickets. At one place the old man became very vociferous and demonstrative and beat a hasty retreat yelling, *"Vespes! Vespes!"* We soon learned the meaning of the word and, incidentally, lost our pilot.

October 7. Quiriquiri, Monagas, was the center of our activities. Our sleeping hammocks, five in one palm-thatched shack, were covered with mosquito netting to protect against the malarial mosquitoes which infest this edge of the Llano country. One-half mile above the village, oil impregnated gravels overlie the upturned white limestone. A large oil seepage occurred one mile southeast of Quiriquiri; other oil seepages and gas springs were found in the vicinity. At the time of our visit only one family lived here. Banana leaf sidings and palm thatching are used in house construction at Sabana de Caripito. This impressed us as real oil country.

October 8. Arrived at Caripito and then went to Guanoco, Monagas, which I had examined in my second trip to Trinidad. We bade good-bye to Boyd and Garner and forsook our faithful mules for the Company's trim little gasoline launch "Carib," which took us to Pedernales Delta.

October 10. Spent an interesting day in going over the great seepage at Pedernales. Asphalt cones, recently bogged animals, crabs, snakes, lizards and birds, and old, partly sunken caissons and an old asphalt refinery were to be seen here. Efforts to recover asphalt by a German company prior to 1900 were abandoned in that year.

Pedernales is on the northern tip of the Delta of the Orinoco between two of the numerous mouths through which this great river enters the Atlantic Ocean. Although no geologic evidence other than the great seepage is to be seen, yet the area lies on what may be the westward extension of the highly petroliferous Southern Anticline of Trinidad. Furthermore, extending this hypothetical line into Monagas would carry it into the region of the important mud volcanoes around Maturin. For those reasons I was optimistic as to the oil possibilities from Pedernales westward to Maturin and eastward toward Icacos Point, the westernmost land in Trinidad.

October 13. By this time we were well on our way to Trinidad, passing by Cristobal, Colon, the port-of-entry to eastern Venezuela, where we obtained our clearance papers. This port lies on the tip of the Arismendi Peninsula, across the Gulf of Paria from Port of Spain. None of the rocks along this peninsula has even a remote connection with oil. After clearing the Carib, we went to Brighton, the asphalt company's headquarters, where we checked over new developments in this oil district.

The most important advancement was the bringing in of the Vessigny Well No. 35 near Brighton with a daily production of from 15,000 to 20,000 barrels of oil per day. The location was by Macready and Nolan, with McKnight superintendent. This was by far the best well ever drilled in Trinidad.

Our party had increased to Mrs. Arnold, her sister, Oraletta Stokes, Proctor, Macready, Nolan, McKnight, Scott, myself, and one or two others.

October 14. Had a gathering of geologists and others at Trinidad Oilfields, Ltd., Well No. 7. Present were A. Beebe-Thompson, famous English geologist, Proctor, Macready, Nolan, Feisthammel, McKnight and Scott. Returned to Port of Spain.

October 15. Took steamer "Ballantia" to La Guaira.

October 16. Reached La Guaira, Distrito Federal, rented a carriage and drove west to Capo Blanco, where steeply dipping, thin-bedded sandstones and shales of Tertiary age are overlaid by horizontal Pleistocene gravel. The mountains are schist and granite. No evidences of oil. The country is arid, thick patches of cacti along the coast, and low brush over the hills. Driftwood is used for fuel and tile roofing is used as in Caracas and the inland towns.

October 17. Spent the day checking over things in the fine office and, piloted by J. E. "Brick" Elliott, took in the sights of the Capital.

October 18. Left Caracas on the narrow guage Caracas and Valentia Railroad, the "Road of a Thousand (almost) Tunnels." All I remember of this trip is rugged mountains and "smoke in my eyes." The map says we passed Maracay, President Gomez' big cattle ranch, and Lake Valencia. Arrived at Valencia and changed to the Valencia-Porto Cabello cogwheel railroad. Road follows drainage lines mostly through the Coast Range. No evidence of possible oil-producing formations on the entire trip.

October 19 and 20. Spent the time looking over Porto Cabello, Carabobo, the most important port between La Guaira and Maracaibo. A clean, efficient waterfront, neat light-

colored buildings. Hotel de los Banos, a dry-dock and a small but attractive residential district made up this town. Water hyacinths and coconuts are abundant in the suburbs. Raised fossiliferous beaches occur in the edges of the building zone; no evidences of oil.

October 21. We sailed on the sloop "Angelina," arriving at La Vela, Falcon, port for the State of Miranda, the same day. Rode over to Coro, where we stayed at the good Hotel Coriana. Bryan, F. C. Merritt, Joslin and Arrel joined us here.

October 22. The country around Coro (as, in fact, the whole of northern Miranda) is arid, and as a result the geology is beautifully exposed. Also, the buildings are well preserved. The old church at Coro, built in 1530, forty years after Columbus discovered America, is still in a fine state of preservation. There having been no rain for over a year, the crops were all dried up and famine prevailed over the area. Starving children, reduced to skin and bones, tore at the heartstrings of all of us and caused the geologists and our company to dig deep into our pockets for money. We rented a single horse" and buggy, with Bryan as driver, to see the sights. Cacti, some of which were 40 feet high, a cholla cactus type, and low, thorny trees, comprised the vegetation. A dam built by the Spaniards in the 17th century and rebuilt in 1866 lay abandoned three miles

south of Coro. Plenty of water falls in the mountains south of arid Coro and should be utilized. One oil seepage six miles west of Coro was the only direct evidence of oil, but there were one or more assymetric anticlines and a dome in the general region that should offer good traps. Coal occurs in the same formation.

October 23 and 24. We took the schooner "Amadeo" at La Vela for Maracaibo. A small spotted deer and terrier were Macready's playmates on the boat.

October 25. Arrived at Castillo de San Carlos, Zulia, at the entrance to Lago de Maracaibo. Took two days to negotiate the distance to Maracaibo.

October 27. Went to the Hotel Zulia, a rather small two-story frame building. The son of the woman who ran the hotel was the manager of the leper colony on the island, which lies in the lake just off the town of Maracaibo. This man went back and forth between the hotel and the leper colony daily. It did not make us feel any safer about using towels or handling anything in the hotel when we knew the close contact between this man and the colony. The town of Maracaibo is built on the Llanos formation, which is irregularly bedded and sometimes folded, and underlies all of the country around the town. Part of the day was spent with Macready and Joslin getting acquainted with the characteristics of the Llanos. The people live in adobe, or mud houses, with various types of thatching, although some use tile roofs. The country back of Maracaibo is cut up into little ravines which are crisscrossed through the Llanos formation. The town of Maracaibo is scattered over the level plain along the sides of the lake. Some structure is found adjacent to the town on the west. Maracaibo is the center of all sorts of trading, particularly pottery and fruits, coconuts, etc.

October 28. Our first trip out of Maracaibo was with Joslin and F. C. Merritt and took us to El Mene southeast of Maracaibo in the steam launch "Aquila" (eagle), from which we reached shore in a dugout canoe. El Mene is on the east side of the lake a short distance from the shore. Several important and active seepages were found in and around El Mene.

October 29. We made a second trip to El Mene, this time on the gasoline launch. We were accompanied by Joslin and Mr. Ray, the American Consul at Maracaibo.

Elevated flower and vegetable gardens were found in some of the yards, being raised out of reach of the hogs and goats which run rampant in this part of the country. The bake ovens also were on elevated platforms here. Oxen were used for hauling heavy burdens on two-wheeled carts. Considerable shipping is done out of Maracaibo to the lake ports in small sailing boats.

I was so impressed with the seepages around El Mene and with the reports I heard about the stupendous seepage of Mene Grande south of El Mene that I asked Macready to examine the district and give me a tentative report on it. I am including a condensed summary of Macready's memorandum.

October 31. Proctor and I took the steamer "Maracaibo" to Curaçao on November 1st, leaving Macready in Maracaibo. Spent the day in Curaçao. Examined the coral reef and lime cemented gravels in the bluff on the coast *side* of the passage between the inner and outer harbor, and took many pictures in the town and suburbs. Sailed with Proctor for La Guaira on the Red D liner "Philadelphia."

November 2. Landed at La Guaira and proceeded to Caracas where we stayed until November 6th.

November 6. Mrs. Arnold, Miss Stokes and I went to La Guaira, boarded the "Philadelphia." Spent the day around Porto Cabello with Jackson. Left for Curaçao.

November 7. Spent day at Curaçao. One of the industries in Curaçao is the manufacture of panama hats, which are made in large quantities and sold wholesale. Many of the people use their spare time in weaving these hats. My wife and sister-in-law, Ora Stokes, were in

Curaçao with me. We met Mr. E. H. Cheney, the American Consul, and Mrs. Cheney who have a beautiful little home in the outskirts. Captain B.F.Hitchborn,of the "Philadelphia," became one of our close friends, because we made so many trips on this Red D liner. We departed for New York on the "Philadelphia." I worked on my report on the way up, and by the time I reached New York I had a rough outline which I had had copied by the purser of the "Philadelphia." In this way I saved time in completing my reports promptly. The report is as follows.

Preliminary Report
CARIBBEAN PETROLEUM COMPANY

Venezuela
November 27, 1912
Summary of Report

The concession of the Caribbean PetroleumCompany covers the oil rights in the Delta of the Orinoco, and the States of Sucre, Anzoategui, Nueva Esparta, Monagas, Lara, Carabobo, Yaracuy, Falcon, Zulia, Tachira, Merida and Trujillo, embracing an area of approximately 200,000 square miles. The formations involved in the geology of the region include pre-Cretaceous granite, gneiss, schist, and quartzite; Cretaceous limestone, shale, clay and calcareous sandstone; and Quaternary gravel, sand and clay, all more or less affected by folding and faulting. The oil occurs in the Cretaceous in the eastern part of Venezuela and south of Lake Maracaibo; in the Tertiary in Nueva Esparta, Falcon and the region about Lake Maracaibo, and in the Quaternary at most of the localities where seepages occur. The seepages are among the largest in the world. Anticlines and monoclines are apparently the most favorable structural locations for the accumulation of the oil in this country.

The following selections were made for retention and development under the concession:

Monagas: Oil occurs in Cretaceous monoclines and anticlines; indications good to excellent ; 20 areas of 500 hectares each between Aragua de Maturin and Caripito; 4 to 8 areas at El Breal and Chapopotal; 4 areas at Hato Pirital; total of 28 areas.

Anzoategui: Oil believed to occur in Cretaceous; indications good; 4 areas tentatively selected at Maria, near Cantaura.

Sucre: Oil occurs in Tertiary monocline and anticlines; indications poor; 8 areas at western end of the Peninsula of Araya; 2 areas at Cumana; also 6 areas in the Cretaceous at Maremare and Pauji if the Bermudez Company fails to select these; indications at least two localities mediocre; total possible areas 16.

Nueva Esparta: Oil occurs in Tertiary low anticline; indications poor to good; 1 area at western end of Margarita; and 1 area at Cubagua if this concession is secured; total possible areas, 2.

Falcon; Oil occurs in Tertiary anticline; indications poor; 4 areas in region of Coro.

Zulia: Oil occurs in Tertiary monocline or anticline; indications excellent; 3 areas at El Mene; 24 areas at San Timoteo with immediate drilling of test well; total areas 27.

Trujillo: Oil occurs in monocline or anticline ; indications good; 6 areas in region west of Valera.

Total number of areas of 500 hectares each tentatively selected, 87, including a total of 43,500 hectares or 174 square miles. Recommend 1 test well immediately.

CHAPTER 9

PRELIMINARY REPORT ON CONCESSION OF CARIBBEAN PETROLEUM COMPANY IN VENEZUELA

By Ralph Arnold

Introduction

This report is based on a personal examination of most of the supposed favorable localities for petroleum at present known in the region under examination and on full notes of my assistants on those localities which lack of time forbade my visiting. My own examination covered a period of practically two months from the time I left New York, September 17th, 1912, until my return, November 15th. Mr. Lewis J. Proctor, General Manager, and Mr. George A. Macready, Chief Field Geologist, of the Company, accompanied me on the entire trip from the time of leaving Port of Spain, Trinidad, September 26th to my departure from Caracas, November 4th. I take this occasion to extend my sincere thanks to these two gentlemen for their hearty cooperation and assistance without which it would have been impossible to cover such a large area in such a comparatively short time. I am also indebted to my various assistants for their cooperation during the time spent in their respective areas.

Area of Concession

The Concession of the Caribbean Petroleum Company covered the oil rights not otherwise taken in the Territory of the Delta of the Orinoco and the States of Sucre, Anzoategui, Nueva Esparta, Monagas, Lara, Carabobo, Yaracuy, Falcon, Zulia, Tachira, Merida and Trujillo. The oil rights may be taken on areas of any size or shape, but it is the policy of the Company to confine selections to rectangles of 500 hectares. The selection must be made, the areas surveyed and staked out, and the plans of the areas presented to the Minister of Fomento of Venezuela before January 2, 1914.

The terms of the Concession allow three years from January 2, 1914 within which to begin work. The royalty consists of 2 bolivars (40 cents) per ton (about 7 cents per barrel) for the net oil recovered, and 1 bolivar per hectare (about $8^{1/3}$ cents per acre) yearly rental; no royalty or rental to be paid until actual beginning of operations on each particular area.

Geology and Structure

General Statement. As all of the known commercial deposits of oil in the world are in or associated with sedimentary rocks, it is essential in examining possible oil territory to learn something of its sedimentary formations and their structure. Before describing the areas which have been segregated as possibly or probably oil-bearing, it will be well to give briefly the general sequence of the rock formations as we have found them in northern Venezuela and adjacent territory. The principal divisions include: (A) a pre-Cretaceous group of schists, limestones, quartzites, gneiss and granite, (B) a Cretaceous group of limestones, sandstones and shales, (C) a Tertiary group of sandstones, shales, impure limestones, and clays and (D) Quaternary deposits of incoherent sands, clays and alluvium. The total thickness of the entire sedimentary series probably lies between 15,000 and 25,000 feet. These beds are affected by folds and faults, usually simple, but in certain regions more or less complex. The series of beds in order, beginning with the oldest, are:

A. *The Pre-Cretaceous Group:* This group yields no direct evidence of petroleum. It may be divided into the following series:

1. Gneiss, schist, and other metamorphic rocks, more or less mineralized, which occur south of the Orinoco River, in northern Venezuela and northern Trinidad. Petroleum seepages occur near the schist at Manicuare, State of Sucre, and at Boca Chica, Margarita Island.

2. "Andes granite" and associated plutonic or coarsely crystalline rocks, occurring on Margarita Island, and in the core of the main range between Caracas and Porto Cabello. No evidences of petroleum have been found in these rocks.

3. The "Tocuyo series" of limestone, quartzite, indurated or hardened sandstone and shale, occurring at Tocuyo, and possibly also between Yaguaraparo and Irapa. The age of this series is questionable; it may be Cretaceous. No evidence of petroleum has so far been found in this series.

B. *The Cretaceous Group:* This group is believed to be the ultimate source of much of the oil in Venezuela and Trinidad and carries seepages at many localities. For convenience, it may be divided as follows:

4. Thick-bedded brown sandstone, about 3,000 feet thick, found north of Punceres and between Yaguaraparo and Irapa. No evidence of petroleum has so far been found in this sandstone.

5. The "Punceres series" of thick-bedded sandstone and limestone and thin-bedded calcareous shale from 600 to 1,000 feet thick; carries fossils of lower Cretaceous age. It is oil-bearing in the vicinity of Punceres, Quiriquiri, etc. It is my opinion that much of the petroleum found in eastern Venezuela and Trinidad has its ultimate source in the organic remains (now largely represented by limestone) in this series and the next two overlying ones.

6. The "Guanoco shale," 3,000 to 4,000 feet thick, thin-bedded and calcareous, especially toward the base of the series. Carries fossils at several localities. Occurs at Guanoco, Guanaguana, Aragua de Maturin, Los Morros, etc. This series is the immediate source of the oil and asphalt at Guanoco pitch lake. It should be carefully examined for oil wherever it outcrops.

7. The "Gueriquen series" of thick-bedded fossiliferous limestones and sandstone at least 3,000 feet thick. Occurs immediately south of Cumana and on Manzanares River, at El Pilar, Maremare, Rio Santa Isabel, Mount Guanoco, Guariquen, etc. These beds are probably the source of the oil seepages at Maremare, Pauji, and possibly elsewhere in that region.

C. *The Tertiary Group:* Owing to the necessarily superficial work so far done on this series, the divisions and correlations are tentative and subject to revision. The beds in this great group yield oil seepages at several localities so far examined. It may be divided tentatively as follows:

8. The "Naricual series" of carbonaceous shale and micaceous sandstone, 1,500 to 3,000 feet thick; is characterized by workable coal beds, probably of Eocene or Oligocene age. Outcrops in range south of Cumana near Guanta, Naricual coal mines, Agua Caliente, etc. No evidences of petroleum so far found in these beds.

9. The "Coro series" of impure limestone, sandstone and sandy shale outcropping south of Coro, on Margarita, Chichiriviche, Guaidima, etc. Oil seepages west of Coro and gas spring south of Coro in this series.

10. "Trinidad oil series" including the lower and upper oil sand series of Trinidad; probably includes the beds near Maracaibo. Yields oil seepages at Pedernales. Age may be Eocene to Miocene.

11. "Alter Tertiary series," probably Pliocene in age, including the gray clays, soft sands and lignitic and porcellanite series of Brighton, Trinidad, Punceres, Soro, Güiria, Irapa, etc.

D. *Quaternary Deposits:* Under this heading are classed the raised-beach and marine and river terrace deposits, alluvial fans, etc. They can be roughly divided as follows:

12. "Marine terrace deposits," such as those on Margarita Island, Araya Peninsula and Cubagua Island, containing numerous fossils, almost all species still living. Contains oil at Boca Chica and Cubagua.

13. "Llanos beds" of more or less incoherent sandstones and gravels covering all the older formations in the Llanos region from Aragua de Maturin to Barquisimeto and the whole of the Orinoco River Valley. This formation contains oil and seepages at many places, notably Chapopotal, El Breal, and other localities where the older oil yielding formations are believed to lie but a short distance below the surface.

14. Recent deposits of alluvium, sand and clay, often impregnated with oil in the vicinity of seepages.

Structure. The structure of the northern part of Venezuela is characterized by a series of folds and faults for the most part extending in an east-west direction. Probably the most important of these features is the great fault zone which extends from the eastern edge of Trinidad, westward along the south base of the schist mountains of northern Trinidad and the Peninsula of Paria, along the south edge of the Araya Peninsula and thence westward to Porto Cabello, and possibly

beyond. This great line of disturbance determines in a general way the northern coastline of Venezuela. Eastward from Barcelona the region south of the fault consists of several important, usually asymmetric folds in the Cretaceous beds. The south flanks of these folds are usually the steeper, except where they approach the Llanos country, in which case the folds flatten out and the beds plunge under the thin veil of "Llanos beds" usually at low angles, and are believed to lie in gentle waves under this whole region. Northwestward from Porto Cabello to Coro and southwestward from Coro probably to beyond Maracaibo Lake, the region north of the fault or its westward extension as a line of disturbance, is occupied by Tertiary beds folded into more or less local asymmetric anticlines with the steep flank facing north. East of the point immediately north of Higuerote the younger beds are south of the fault, that is, the downthrow of the fault has been on the south side, while west of this point the younger beds and downthrow are on its northern side. This fault has had a dominant influence in the formation of the topographic features of the northern coastline. As structure plays a most important part in oil accumulation, a detailed knowledge of the folds and faults of the country is essential.

Origin and Occurrence of the Oil. The origin of the oil in Venezuela is at present obscure and its modes of occurrence little understood. In general, the origin of oil is a matter of much controversy even in the best known fields in the world, and would not be touched upon here except for its obvious importance as relating to the probable distribution and ways of occurrence of the oil in the region under discussion. From the best evidence in hand, I am inclined to believe that the oil in Trinidad and the eastern part of Venezuela originates from the organic remains in the Cretaceous and accumulates at various horizons in and above this group of rocks. The origin of the oil at Boca Chica, Cubagua and Coro is more obscure. I have no theory as to the ultimate source of the oil about Maracaibo Lake because of the scanty evidence on this subject at present in hand.

DESCRIPTIONS AND CONCLUSIONS CONCERNING FAVORABLE LOCALITIES

General Statement. In the following paragraphs will be found descriptions and recommendations concerning these localities where, through personal examination or otherwise, I have recommended the selection of areas for future development. It must be remembered that this list is only tentative and that actual drilling will develop facts which may materially affect either favorably or unfavorably the conclusions upon which I have based these first selections.

Areas in the State of Monagas

1. Punceres and Vicinity

General Statement. A large number of oil seepages occur in a belt a mile or so wide extending from a point a short distance east of Aragua de Maturin in an east-northeasterly direction to Caripito a distance of some 30 miles. An examination of a considerable number of these seepages leads to the conclusion that their occurrence is due to the presence of oil-bearing rocks at or near the surface.

With but one or two exceptions, the seepages occur at or near exposures of south-dipping limestone or shale of the Punceres or lower Cretaceous series and it is my belief that commercial quantities of oil will be found by penetrating at depths the zone which includes the oil-bearing beds of the region.

Among the important seepages visited were the ones on the Punceres River two miles west of Punceres, which are of small extent, but indicate the source of the oil as the fluid comes direct from cracks in the sandstone and limestone, usually accompanied by sulphur water. At the main seepage there is evidence of intermittent flows with more or less energy.

At Quiriquiri the seepages occur in the alluvium along the river bank and also come from horizontal gravel beds impregnated from the immediately underlying vertical limestone beds. In the forest south of Quiriquiri are one large and many small seepages. They appear to come from soft, practically horizontal sand beds, probably of late origin, or from the alluvium, and to my mind indicate the presence at no great depth of the older limestones or sandstones which outcrop not far north of Quiriquiri.

At Sabaneta oil may be seen dripping from the horizontal gravel beds along the banks of the river, and just east of the river are numerous seepages throughout the forest. At one place in particular there is a very active seepage of oil, gas, and sulphur water coming from steep-dipping limestone beds. The seepages about here, though not large, are numerous and cover quite an extensive area. Personally, I saw no seepages east of the Sabaneta region, but as the geologic conditions are practically uniform both west and east of Sabaneta, I advise selecting territory as far east as Caripito.

Conclusion. The exposures indicate a more or less uniform south-dipping monocline from west of Punceres to Caripito. The seepages indicate a zone of oil-impregnated beds which is affected by this monocline, and which dips southward under the Llanos region. The evidence warrants selecting a belt of territory bounded on the north by a line connecting the northernmost seepages in a general way and extending southward for 3 miles or far enough to include practically all of the territory in which it appears likely that the oil zone can be penetrated by wells 3,000 feet deep or less. This belt will make about 20 areas of 500 hectares each. The drilling at Guanoco should throw much light on the occurrence of the oil in this whole eastern Venezuela region, so that selections for sites for test wells in the Punceres region will be left until later. In general, however, it is believed that a well striking the supposed oil zone at a depth of from 1,200 to 2,000 feet opposite some of the larger outcrop seepages will give the region a pretty fair test.

2. Chapopotal and El Breal

General Statement. These two localities, the names of which both mean asphaltum or an asphalt seepage, lie about 6 miles east of Chaguamaral and 15 miles south of Punceres. The Llanos beds form the principal exposures in the vicinity, lying horizontal and being cut by the stream trenches.

El Breal is characterized by several important seepages, the main one of which is quite active, covers over an acre and rises about 6 or 8 feet above the surface of the ground. It is surrounded by numerous lesser seepages, some of which attain considerable size. The sides of the ravines which drain the area of the seepages are often covered with asphaltum which has flowed down their courses at former periods. No evidences of beds older than the llanos are found at El Breal.

Chapopotal is the name given to some live seepages occurring on the banks of a creek $1^{1/2}$ miles south of El Breal. These seepages line up along a course having a general eastwest direction as do also those at El Breal. A horizontal oil-impregnated sand between two clay layers occurs along the creek. Furthermore, some large angular blocks of hard sandstone closely resembling certain sandstones of the "Punceres series" occur at the main seepage of Chapopotal. One or more zones in the llanos beds exposed in the ravines between El Breal and Chapopotal are strongly impregnated with oil.

Conclusion. The seepages clearly indicate the presence of an important oil reservoir somewhere beneath the surface here and their alignment along courses practically parallel with the strike of the principal structures of the mountains to the north, coupled with the occurrence of the hard sandstone blocks at the Chapopotal seepages, makes me believe that the seepages mark the crest of one or more anticlines in the underlying Cretaceous oil-bearing zone. Whether or not the main reservoir or zone approaches near the surface or whether it lies at a depth and the oil escapes through fractures produced by the bending of the beds at the axis is a question which only the drill can answer. The drilling at Guanoco should throw some light on the question as to the probabilities in this zone, also. I consider the Chapopotal-El Breal region the most promising of any in eastern Venezuela, with the possible exception of Guanoco. The evidence is strong enough to warrant selecting all of the territory within a rectangle bounded by a line one mile north of El Breal running parallel with the lines of seepages, another line one mile south of Chapopotal and both extending at least two and possibly four miles in both directions from the seepages. Such a rectangle will include from 4 to 8 areas of 500 hectares each. The exact number will be determined after a detailed survey of the region of the seepages. It is possible that future work may warrant selecting a strip of territory connecting the El Breal and Punceres areas.

3. Hato Pirital

An isolated seepage occurs at Hato Pirital which may indicate conditions similar to those existing at Chapopotal and El Breal. Although I have not visited this locality, I consider the occurrence of enough importance to select a rectangle 2 miles wide in a general north-south direction and 4 miles long in an east-west direction, including four areas of 500 hectares each, the seepages to be in the center of the rectangle.

Area in the State of Anzoategui

1. Maria, near Cantaura

A seepage similar to the one at Hato Pirital is reported at Maria, near Cantaura, in the State of Anzoategui. If an examination proves this seepage to be what it is said to be, I would advise selecting an area around it similar in size, shape and relative position with regard to the asphalt as that indicated for Hato Pirital.

Areas in the State of Sucre

1. Peninsula of Araya

General Statement. The formations exposed at the western end of the Peninsula of Araya include pre-Cretaceous schist; sandstones and clays of Miocene or Pliocene age; and horizontal terrace deposits of Quaternary age. The schists which make up the main portion of the peninsula

are flanked at their western extremity by sandstones, which are folded into a low southwesterly trending anticline southwest of Manicuare and lie as a northwest-dipping monocline north of [las] salinas. About a mile east of Manicuare the sandstone and shale beds dip south from 70° to 90° and are separated from the schist by what is believed to be the great Trinidad-Venezuelan fault described under "Structure."

A well denned oil sand 6 to 8 feet thick occurs in the sandstone series near the schist contact 1 mile east of Manicuare and in conformity with these beds dips south under the Gulf of Cariaco at an angle of from 70° to 90°. Oil seepages also occur in the western outskirts of the village of Manicuare. It is near these latter seepages that the Tregelles Company is drilling for oil.

Conclusions. The outcropping oil sand and the oil seepages near Manicuare, coupled with the seepage at Cubagua Island just north of the Peninsula of Araya, indicate the presence of petroleum in the Tertiary series of this region. The structure, especially the anticline at the western end of the Peninsula, is also favorable for oil accumulation. But a probable adequate source for commercial quantities of petroleum, such as is offered by the Cretaceous series south and east of here, appears to be lacking in the region north of the fault, so that I am not enthusiastic about the region as a possible source of oil. In view of the drilling done by the Tregelles people and the possibility of commercial quantities of oil being present somewhere in the region, I consider it good policy to keep a hold here, at least temporarily, and with that end in view I recommend the selection of practically all of the territory underlain by the Tertiary sandstone and shale series. This will make about 8 areas of 500 hectares each. Their shape will be decided upon after a preliminary survey. The coast line of the end of the Peninsula will determine three sides of the territory to be selected.

2. Region about Cumana

General Statement. The mountains south of Cumana are composed of the folded Cretaceous rocks, while the little point of land on which Cumana itself is located is underlain by Tertiary rocks, some of which are probably to be correlated with those at the western end of the Peninsula of Araya. Near the Cretaceous contact the Tertiary rocks are quite sharply folded, but just southeast of the city of Cumana the folding is gentle and a broad anticline is developed in the sandstone and clay.

Our geologists found no direct evidence of petroleum in this region, but the finding of asphaltum in or near Cumana was reported to them. I am skeptical as to the reliability of these reports.

Conclusion. Since there is evidence of petroleum in the Tertiary rocks on the Peninsula of Araya only a few miles north, and faint possibility of its presence right at Cumana; also since the Cretaceous rocks, which I believe to be the main source of the oil of eastern Venezuela not only possibly but probably underlie the Tertiary beds around Cumana, and in view of the favorable structural conditions resulting from the anticline affecting the Tertiary beds, I recommend the selection of two areas at Cumana, one on each side of the above mentioned anticline and with their longer dimension parallel to the axis of the anticline. I am no more enthusiastic over the possibilities here than I am over those on the Peninsula of Araya, but in view of all the

conditions, I believe it expedient to make the selections, the cost of surveying of which will be only nominal.

3. Maremare and Pauji

Should the Bermudez Company fail to comply with the terms of its concession on the six areas at Maremare and Pauji, I recommend that these six areas be taken over by the Caribbean Petroleum Company and operated as a part of its concession.

Areas in the State of Nueva Esparto

1. Margarita Island

General Statement. The only locality on Margarita Island where evidences of petroleum have been found is at the western extremity, just northwest of Boca Chica Lagoon. Here a series of practically flat late Tertiary or Quaternary sandstones lap up on the schists which occupy the main portion of this part of the island. Some gummy material associated with sulphur occurs in certain beds of this sandstone series, this gum giving a decided hydrocarbon or oil test with chloroform. A low, rather poorly denned anticline extending in a northwest-southeast direction is developed in the sandstone about one-half mile from the schist contact.

Conclusion. I would class this locality with that at Manicuare, and say that although I do not consider the indications very encouraging for the accumulation of commercial quantities of petroleum, I would recommend the selection of one area of 500 hectares to include all of the area underlain by the sandstone series.

2. Cubagua Island

General Statement. This island consists of a low arch or anticline of late Tertiary or Quaternary beds. At the western end of the island, one of these sand beds, which is immediately overlain by an impervious clay layer, is saturated with oil of good quality and light gravity (about 20° Baumé, I should judge by looking at it). At two or three places at this end of the island holes have been dug and the oil accumulates at the rate of several gallons per day and is sold for local use.

Conclusion. Although this island is held by other parties, I look on it as the most favorable locality, from a structural standpoint, for the accumulation of oil of any in this particular part of Venezuela. For that reason, the Company should have in mind the eventual acquiring of the concessions covering the island if proper terms can be arranged.

Area in the State of Falcon

1. West of Coro

General Statement. The rocks in the vicinity of Coro are of Miocene sandstones and shales overlain by later gravels and sands. These rocks are folded into prominent asymmetric anticlines, the northern flanks of which are the steeper; in some cases the dip is practically vertical.

Six miles southwest of Coro is a small oil seepage located practically at the crest of one of these anticlines. The conditions here are illustrated in the figure already referred to. Not only do the beds dip away from the seepage both north and south, but the beds how around in a semi-circle and dip also east and west. In other words, the seepage occurs at the apex of a dome or quaquaversal developed on an anticline that extends far to the east and west of the seepage. Workable coal beds occur in the beds overlying the ones yielding the seepage.

Conclusion. Assuming hypothesis to be true, I would recommend the selection of two areas, each approximately one mile wide and two miles long and containing 500 hectares each, beginning at the seepage and extending south, the longer axis of the rectangle to extend in an east-west direction. Owing to the small size of this seepage, I am not enthusiastic as to the possibilities of the region, but the structural conditions are ideal, and for that reason, coupled with the possibility of larger seepages occurring in the same formations not far to the west (these are now being examined), I make the above recommendations.

2. South of Coro

General Statement. A structural condition affecting the same beds and in general similar to the one just described occurs south of Coro. From the axis of this fold or dome there is a small emanation of sulphur water accompanied by inflammable gas.

Conclusion. Although the evidence offered by the inflammable gas is not by any means conclusive, still in view of the ideal structural conditions present and the oil seepage occurring not far away (six miles) in the same beds and under practically similar structural conditions, I deem it advisable to select two areas each one mile wide north and south and two miles long, one on each side of the gas spring. I would never advise drilling at either of the Coro localities until we have more evidence of the presence of commercial quantities of petroleum in the shape of important seepages to the east, west or south of the general region of Coro.

Areas in the State of Zulia

1. El Mene

General Statement. The region about Maracaibo Lake was the last visited on my recent trip, and owing to the limited time at my disposal, I was able to visit only one locality of importance. The rocks in the region of the city of Maracaibo consist of thin-bedded sandstones and clays, probably of Miocene age, considerably folded, and overlain unconformably by rusty sandstones and clays containing numerous dark-colored iron seams and concretions. Just east of the village of El Mene, 15 miles southeast of Maracaibo on the east side of the lake, are large seepages known as " Tembl[ad]or " and "El Mene." Each includes over an acre of asphalt deposits and the seepages from which these come are active at the present time. The seepages examined extend over a belt two miles long by a quarter of a mile wide lying in a nearly east-west direction.

Conclusion. From the size and activity of the seepages, and the importance of the asphalt turn deposits in the region of El Mene, I wasled to believe that this part of the country is destined to yield large quantities of oil. Further than this I am not prepared to go, as the data regarding the

probable location of the important reservoirs of the oil are so meagre that it would be hazardous to give opinions. However, I believe that the evidence warrants selecting a strip of land approximately two miles wide and three miles long, so located that the east-west line of seepages will lie along the longitudinal axis of the rectangle. This would make 3 areas of 500 hectares each.

2. San Timoteo

General Statement. The following is compiled from a report especially prepared by Mr. Macready following an examination by him just after we parted company at Maracaibo:

Two groups of seepages occur 12 miles east of San Timoteo near Los Barrosos, one called El Menito, one mile west of Los Barrosos; the other called Mene Grande, 2 miles south. The first covers an area one-half mile in diameter at the south end of a range of mountains, the deposits occurring at the outcrop of a series of oil sands which dip south 10° in the western part of the area and swing around to south-east 25° in the eastern. Several of these seepages are exceedingly gassy.

The area of seepages south of Los Barrosos occurs at the outcrop of a zone of oil-impregnated sands which dip south 15° at the western extremity of the area and may be traced for two miles toward the northeast where they dip east. The oil zone here is about 400 feet thick.

Conclusion. The evidence offered in the region of Los Barrosos is extremely encouraging, as it indicates a well defined zone or zones of oil sands in the Tertiary series that underlies the region about Lake Maracaibo. The structure of the beds is also practically ideal, in that they apparently form part of a great plunging anticline, a type of structure that has yielded some of the best oil fields in the world. The gassy character of the seepages is also highly encouraging.

In view of the evidence offered, I recommend the selection of all of the land enclosed in a rectangle whose western side is 2 miles west of the El Menito seepage, its northern two miles north of the same seepage and the eastern and southern sides each 3 miles from the nearest seepage of Mene Grande. This will make about 24 areas of 500 hectares each.

I also recommend the immediate drilling of a test well at a point between one-half and three-fourths of a mile southeast of the southeasternmost seepage at Mene Grande, to test the oil sands on the axis of the plunging fold which apparently carries the oil zones down in this direction at an angle of 15° to 20°.

Areas in the State of Trujillo

1. West of Valera

General Statement. Mr. Macready reports a series of oil-bearing clayey shales outcropping in the mountainous region west of Valera. They are associated with hard sandstone and limestone and are believed to be of Cretaceous age. The seepages cover a zone one-half mile long and one-eighth mile wide. The oil from the seepages is greenish in color and its use locally as a lubricating oil indicates an excellent quality. It is soaked up in blankets from the surface of the seepages and afterwards squeezed into receptacles.

Conclusions. A considerable territory embracing the oil seepages has been outlined by Mr. Macready as possibly oil-bearing and should be selected and surveyed into areas of 500 hectares each. This territory will include about 5 or 6 such areas. I prefer to examine the locality personally before recommending a.well location.

RALPH ARNOLD
Consulting Geologist and Petroleum Engineer
Washington, D. C., November 27,1912

CHAPTER 10

THE ROYAL DUTCH SHELL ENTERS VENEZUELA

Upon the completion of my report dated November 27, 1912, it was delivered to the office of the General Asphalt Company, of Philadelphia. Naturally, it was offered to various oil companies in the United States for development. None was interested. Finally, as a last resort, Mr. James Clarke Curtin, representative of the Company, carried my report to London, to the office of the Royal/Dutch Shell Oil Company. Here, the real value of the Venezuelan concessions was realized. Negotiations followed. The Royal Dutch/Shell Oil Company paid $10,000,000 for a 51 per cent interest in the General Asphalt Company's Caribbean Petroleum Company.

Sir Henri Deterding was at that time the president of the Dutch Shell and was responsible for this sale. I herewith include the quotation from his book. *An International Oil Man,* page 97, regarding that sale:

"Unquestionably, our biggest achievement to date from a geological standpoint remains our development of the Venezuelan Oilfields. Although recognized at the close of last century as a potential producer of petroleum and concessions in the region had occasionally shown natural oil indications, Venezuela had grown, nevertheless, to be considered almost a lost hope for profitable production at the time when we first cast our eyes thither.

"So, I made, perhaps, the most speculative venture of my life when on behalf of our companies I bought from the General Asphalt Company, of Philadelphia, a long-term concession, which had been granted to it, covering enormous areas in all parts of the country. Around five million dollars had been spent on working this concession fruitlessly and it had been hawked around the United States for some time before we stepped in. Many experienced oilmen considered it to be a rather doubtful bargain on my closing that deal.

"Why, then, did I run so heavy a risk? I admit having been impressed by a favourable report from that expert American geologist, Dr. Ralph Arnold, on the potential value of these huge fields, and I had faith in the representations of Mr. James Clarke Curtin and General Avery Andrews who came to London from Philadelphia to negotiate the deal. But even so, there were as yet no producing wells in Venezuela of any account and before we could make certain that such wells existed, we had obviously to expend a colossal sum of money. The venture was a very big hazard. Why, then, did I tackle it? Because I felt this big bid in Venezuela gamble would be justified. And so, ultimately, it was."

PART II
CHAPTER 11
OPERATIONS IN 1913
By George A. Macready

At the beginning of 1913 the immense petroleum possibilities of Venezuela were becomingb apparent to those in the management, and particularly to Dr. Arnold who was the first to realize the immense potentialities.

Discovery of Vessigny Oilfield, which proved to be a prolific oilfield of small area, established petroleum operations of General Asphalt Company in Trinidad on a profitable basis.

The heavy oil produced at Bababui #1 near Guanoco, Venezuela, had established the discovery of the first oilfield in eastern Venezuela.

The large seepages and particularly Mene Grande with its suggestion of geological structures in the Maracaibo district of western Venezuela were convincing that the Maracaibo basin might be very prolific in petroleum.

The geological survey during 1912, while hurriedly accomplished over a wide area, was sufficient to start the selection of exploitation areas and direct further geological investigations toward the most promising parts of Venezuela.

The entrance of the Shell Group as a partner provided able finances, techniques and experience so badly needed in a project of this size.

Geological operations in Trinidad during 1913 were left to Dan Nolan who guided the geological development of Vessigny Oilfield and held the wells close to the producing area which was of limited extent. In spite of the prolific gushers, he discouraged an over-expansion such as occurred at the Brighton Oilfield. Vessigny was the first oilfield in Trinidad to make an operating profit.

In June 1913 Well No. 1, Lot 1 was started to test the large anticlinal amphitheater in Morne L'Enfer Forest. Oil shows between 400 and 700 feet depth showed salt water, and in November 1913, when 1,145 feet deep, the well blew out gas and salt water and wrecked itself.

In the meantime, Nolan had selected another location in the amphitheater where No. 2, Lot 1 was started in August 1913 and completed at 510 feet in October for a fifty barrel pumper as the discovery well for Lot 1 Oilfield.

Fred Feisthammel had left the Asphalt Company in June 1912 and Wm. C. McKnight was brought from Coalinga as superintendent for petroleum operations at Trinidad and eastern Venezuela. Wm. D. Fowler remained as General Manager. McKnight surely had his hands full with high gas pressure wells in those days before blowout preventers had been perfected. Among the drillers aiding him were George Barber, W. D. Owsley, Wm. M. Keck, D. E. O'Brien, Oscar Wolverton, "Slim" Chambles, Fred Wimberly, Joe Smith and Jim Gilchrist. Adam Fulton and "Windy Bill" McElwee were rig builders. At Port of Spain, Carlos Dominguez, who had been

with the Asphalt organization almost since its beginning, had all the pesky jobs of getting oil men out of escapades, untangling customs disputes, recruiting labor, finding silver coin for payrolls, and getting shipments routed correctly.

In eastern Venezuela a very hectic development program was carried out by the Bermudez Company in the first half of 1913. General Asphalt organization had spent enormous sums in developing a market for the peculiar virtues of Bermudez Lake Asphalt. Their volume of business on Trinidad and Venezuelan asphalts exceeded $15,000,000 annually. But after 1910 severe competition appeared from Mexican petroleum asphalt. There were differences between Mexican and Venezuelan asphalt by which competition could be resisted. Discovery of heavy asphaltic oil late in 1912 by Bababui #1 suggested that a large supply of petroleum asphalt of the same origin and quality as Bermudez Lake asphalt might underly their own sacred deposit.

It was therefore urgent that General Asphalt Co. take prompt action to gain control of all possible petroleum under or near Bermudez Lake. Obviously they could not endure having a competitor burrow under their Bermudez Lake and market petroleum asphalt of the same origin and quality but cleaner than their own Bermudez asphalt.

The Bermudez Company concession under which Bababui #1 was drilled was to expire in July 1913 and its terms required that a well equipped to produce oil should be in actual operation on each 500 hectare exploitation area before the July expiration date. The Bermudez Asphalt Lake was 1,100 acres in area. To cover the lake and its margin, eighteen 500 hectare areas were laid out and, in addition, ten more 500 hectare areas selected around asphalt deposits at Pedernales, Pauji and Maremare.

That meant 28 wells had to be in operation between January and July of 1913 in a rainy, tropical swamp, with no drilling crews or supply houses within 2,000 miles, except the limited facilities at Trinidad barely adequate for Vessigny development.

Surveying of areas was started in December 1912. To save surveying costs, the 500 hectare areas were laid out in long, parallel shoestrings 666 meters wide by 7,500 meters long (about 0.4 mile by 5 miles), which brought in some problems of accuracy to be sure each well was on its proper area. Wherever possible, wells were located near the end corners to avoid errors.

In addition to Bababui #1, which had been drilled with cable tools and standard derrick, three additional standard derricks were erected and wells drilled to considerable depth in the Guanoco group, and a fourth derrick erected at Pedernales.

Baboso #1 was drilled on the Asphalt Lake about a half mile south of Bababui #1 to a depth of 1,316 feet, encountering large quantities of similar heavy oil. This well was the second one drilled in the Guanoco group and started March 1913. It was drilled with cable tools and standard derrick.

Bacante #1 was started in June 1913 near the west end of the Asphalt Lake and carried by Charlie Dore and John Lotton to a depth of 4,247 feet in September 1914, when drilling stopped. This was by far the deepest well ever drilled in Venezuela and remained the deepest for more than ten years. The well was drilled with cable tools and carried a 10-inch hole when

discontinued. It was primarily stopped as a result of war breaking out in Europe. Formation was blue and yellow clay with gravel to 670 feet, after which formation was entirely hard black Guanoco shale. A few oil shows of non-economic interest were encountered.

Badajo #1 was also started in June 1913 on Guanoco River bank about 4 miles west from the Asphalt Lake and 1 mile northeast from Guanoco as a test of the axis of the anticline visible in Guanoco hills and heading toward the Asphalt Lake. Black Guanoco shale was encountered from surface to 2,206 feet, with no showings of oil. This well was drilled with cable tools and standard derrick.

Baca #1 was drilled with a portable Star 23 machine near the west edge of the Asphalt Lake about a half mile north of Bacante #1 to a depth of 651 feet. Well started June 1913 and stopped October 1913 when heavy oil became too abundant for progress. Alluvial clays were encountered to 360 feet and from then on hard black Guanoco shale with oil.

Bacelar #1 was drilled with a Columbia portable #3 machine on Cicaino Creek in the swamp about 4 miles northwest from Guanoco and nearly 7 miles west from the Asphalt Lake. It was started June 1913 and stopped February 1914 at a depth of 907 feet, with formation all soft alluvial clay with no oil.

Bacara #1 was drilled with a Columbia portable #3 machine near the west edge of the Asphalt Lake about a quarter of a mile north of Baca #1. It started in June 1913 and stopped February 1914 at a depth of 368 feet. The well penetrated alluvial clay to 120 feet and then black shales to the bottom with some heavy oil encountered.

The following wells were drilled with portable machines in June 1913 to shallow depths as follows:

Bactris #1 to 55 feet. On San Juan River ten miles west of Guanoco.
Badan #1 to 79 feet. South edge of Asphalt Lake.
Badiana #1 to 100 feet. South of Asphalt Lake and Badan #1.
Babor #1 to 85 feet. North edge of Asphalt Lake.
Baden #1 to 150 feet. On Guanoco River near Guanoco.
Bagre #1 to 136 feet. On Guanoco River near Guanoco.
Baquio #1 to 174 feet. On Guanoco River near dock at Guanoco.
Badeo #1 to 50 feet. On Cicaino Creek above Guanoco river.
Bache #1 to 55 feet. On Cicaino Creek above Badeo #1.
Bacinete *#1* to 55 feet. On Cicaino Creek between Bacelar #1 and Bache #1.
Baciga #1 to 60 feet. On Cicaino Creek above Bacelar #1.
Baculo to 35 feet. On San Juan River ten miles west of Guanoco.
Bactris #1 to 55 feet. On San Juan River one mile above Baculo #1.

All of these wells ended in alluvial clay except Babor, Baden, Bagre and Baquio which drilled into Guanoco shale.

In addition to the Guanoco district, exploitation areas were laid out by Bermudez Company in three other districts at Pedernales, Maremare and Pauji.

The Bermudez concession covered certain islands including Pedernales about fifty miles east of Guanoco, between the numerous mouths of the Orinoco River. On one of these, a small hill of approximately ten acres in area, nearly vertical Tertiary oil sands outcropped. This isolated exposure in the swamp was twenty miles from the nearest outcrops at the extreme southwest tip of Trinidad.

Becada #1 was started about May 1913 and finally stopped at about 795 feet by heaving shale and gas pressure. It was drilled with cable tools and standard derrick located on the small Pedernales hill, near the village of Pedernales.

Batuta #1, Batalla #1 and Barril #1 were drilled with portable machines south of Becada #1 along the banks of a branch of the Orinoco to depths of 60, 50 and 44 feet respectively, and stopped in alluvial sand and clay.

Becada #2 was started in August 1913 with a Star portable machine near the Asphalt Lake three miles northeast of Becada #1. The well was abandoned at 750 feet in January 1914 because of gas trouble after penetrating soft sands and shales similar to Trinidad Tertiary.

At Maremare, about 25 miles north of Guanoco, a small seepage of asphalt occurred in the swamp at the base of hills of shale and limestone near Maremare landing. Three areas were taken here, on which the following wells were drilled by portable machines:

Bardo #1 to 52 feet in June 1913 close to the seepage. All in alluvial clay.

Baranda #1 to 136 feet in June 1913, half mile southeast of Bardo #1 in alluvial clay to 75 feet and then harder formation to 136 feet.

Baraja #1 to 65 feet in June 1913, close to Baranda #1, in alluvial clay to 36 feet, and then oyster shells and harder formation to 65 feet.

Bardo #2 to 280 feet in August to December 1913, closer to the seepage. It found alluvial clay to 40 feet, then sea shells at the top of limestone and shale which continued to the bottom.

At Pauji, about forty miles northeast of Guanoco, a small seepage occurred in the swamp close to and south of the base of a high mountain range made up of limestone and schist. This was near a landing at the head of Caño Aruca midway between the towns of Irapa and Yaguaraparo. Three areas were taken here, and the following wells drilled with portable machines:

Baquiana #1 in June 1913 to 76 feet close to the seepage, all in alluvial clay.

Baque #1, to 352 feet, just south of Baquiana #1. This well went through alluvial clay and sand to 273 feet, and then through schist to the final depth of 353 feet. It struck inflammable gas at 215 feet. Started in June 1913, it stopped in October 1913.

Banqueta #1 to 273 feet, a half mile south of the first two, and all in alluvial clay.

A half mile of tramway was laid to transport equipment from the boat landing to the wells which were placed alongside the tramway. The Pauji project was carried out by Joe Smith, driller, and Sam Schrum, rig builder, who did the timber work for roads, etc.

The Bermudez Company drilling program started in charge of Fred Feisthammel who left the company before Bababui #1 was spudded. Wm. D. Fowler was General Manager for both Trinidad and Venezuela operations and Felipe Scott was superintendent of asphalt mining at Guanoco. Bababui #1 was drilled with D. E. "Gene" O'Brien as head driller and Joe Smith as night driller (twelve-hour shifts). Wm. C. McKnight became superintendent of all drilling operations near the end of 1912. Scott was a native of Barbados and had come to Venezuela when a youth. After gold mining near El Callao he had joined the asphalt company during Castro's administration. A man very loyal to his employers, but with no technical training, he had grown up in the colonial methods of cheap, unskilled labor and was not accustomed to the skilled, mechanized operations of oil drilling. His principal aim was to get out asphalt as cheaply as possible without any interference, and he resented any interruption of his routine by oil drilling. After the fiasco of 1911, most of the asphalt men regarded the oil operations as a useless waste of money, and interference with asphalt mining; none of them knew of the severe competition petroleum asphalt was causing the Asphalt Company. This attitude occasioned frequent friction between oil and asphalt operations.

When the 1913 exploitation program was commenced, the Asphalt Company made a wise move in placing Fred R. Bartlett in charge of both oil and asphalt operations it Guanoco. He was a high caliber man with long experience in Venezuela and a great factor in eliminating friction between the various groups.

Wm. C. McKnight, as head of drilling operations at Trinidad and Venezuela, was kept very busy with developing the Vessigny and Lot One fields at Trinidad. George Barbour was made tool pusher at Trinidad, Ed McKnight, tool pusher at Guanoco, and D. E. "Gene" O'Brien, pusher for the Maremare, Pauji and Pedernales districts. Drillers were largely recruited from Pennsylvania, and some regarded the expedition as a short-time holiday. Anyway, we all had a very busy year with the Bermudez Company in 1913. The Vessigny wells kept Barbour very busy in Trinidad. Ed McKnight was a brother of the superintendent, and had been many years an army sergeant in the Philippines and may have worked some in the oilfields. Some of the drillers regarded him as overbearing toward them, as one not having had extensive oil experience. O'Brien had had many years of cable tool experience, but not so much rotary experience. To my way of thinking, he was the most level-headed of any of the pushers.

Conkling was sent to Guanoco to keep the drilling records geologically straight. Nolan paid occasional visits to Guanoco to aid him.

Drilling equipment was shipped from the United States usually to Trinidad, where it was loaded into sailboat lighters for transshipment to Venezuela. Lighters sailed across the open Gulf of Paria, but in the rivers and caños it was customary to tow them with launches. A few shipments were made direct to Guanoco by asphalt steamers, but usually these were tramps which came to Guanoco from other ports to load asphalt for New Jersey. Equipment for the wells at Bermudez Asphalt Lake was transported by the company railroad and then by corduroy road

short distances to location. Wells on Guanoco, Cicaino, San Juan and Maremare rivers were at tidewater. At Pauji and Pedernales corduroy roads or a tramway were used to carry equipment from lighter to location.

Although the Guanoco drilling program of 1913 did not result in a large quantity of petroleum, it was of vital interest to the General Asphalt Company as a defensive operation to forestall disastrous competition to their asphalt market.

Bababui #1 and neighboring wells demonstrated the presence of prolific potential oil production primarily suitable for use as an asphalt flux and source of petroleum asphalt. The General Asphalt Company was able to acquire complete control of this deposit and thus prevent it being dumped on the market by a competitor with disastrous results to their business.

During the early part of 1913 I was kept tied down to the development program at Guanoco. B. Bryan was delegated to the Maracaibo exploration. In Monagas it was decided to survey and file large areas around Quiriquiri, Caripito, Pirital, Chapopotal and Aragua de Maturin to cover a wide belt south from the base of the mountains for miles into the plains and extending from the Bermudez Company areas at San Juan River into Anzoategui. In addition, a strip was surveyed from Maturin to Guanipa to cover an area of mud volcanoes. Boyd and Garner were in charge of the Monagas work and were assisted by Wallace Gordon and Charles Eckes as geologists and by Louis Pacheco, Raphael Torres and others as surveyors. Geologically, they did not have much to go on, except that the numerous seepages out in the plain meant some kind of subsurface structure which at the time could be found only by drilling. Approximately 200,000 acres were selected in Monagas.

Boyd and Garner investigated the plains of Monagas south to the Orinoco, where they found crystalline basement rocks outcropping. Around Cumana and Margarita Island, Prout and Henley laid out about 35,000 acres of area selections.

When the drilling program at Guanoco eased enough to release a launch, Conkling, accompanied by Charles Eckes and Martin Tovar, explored the Orinoco Delta and Guanipa River, finding mostly alluvial swamp, except for crystalline rocks along the south edge of the delta. They found numerous mud volcanoes and a few seepages in the northern part of the delta lining up with the southwest peninsula of Trinidad.

They surveyed about 40,000 acres of area selections near Pedernales and Guanipa.

When the drilling program eased at Guanoco, I made an excursion into southern Anzoategui and through Anzoategui and Guarico to Caracas. I found the flat, freshwater deposits of the Llanos lapping up against the mountains of folded shales, similar to Guanoco shale, which extended almost to the core of crystalline basement rocks forming the mountains near Caracas. No asphalt seepages were found.

Dr. Arnold's first examination in 1912 determined that greatly increased geological investigation of the Maracaibo Basin was urgent for 1913. Exploitation areas were to be staked and a test well was to be started at Mene Grande. In addition, the areas south and west of Maracaibo had not been investigated at all, but work had to be initiated at once. Merritt, Joslin,

Bryan, Eckes and Hasbrouck continued their operations from 1912, and many additional geologists were engaged for the Maracaibo Basin.

Floyd Merritt and Joslin continued their survey southward along the east side of Lake Maracaibo, finding additional districts for acquiring areas at Onia and Zoa. Both returned to the United States in September 1913.

Hasbrouck and Eckes continued their investigations near Valera until Hasbrouck returned to the United States in February. Eckes then worked around Mene Grande and El Menito until July 1913, when he was transferred to eastern Venezuela.

Bryan made additional surveys in the Merida, Trujillo and Coro districts until March 1913, when he was assigned to supervision of the numerous geologists in the Maracaibo Basin.

In December 1912 the following geologists came to the Maracaibo Basin: McKee, Burnett, Wilson, Hammer, Bjorge, Taylor, R. W. Merritt, White, Dagenais and Donnelly. In January 1913 they were followed by Dixon, dark, Nash and Herold.

McKee and Burnett were teamed together to investigate the northwest part of Falcon until April 1913.

Wilson and Hammer were assigned to the Tachira area, where they made a thorough investigation of the "One well" oilfield, which had been producing about thirty or forty gallons of oil daily since 1880, and started the surveying of 6,000 acres of exploitation areas. Both returned to the United States about September 1913.

Bjorge and Taylor made an examination of the properties of the Colon Development Company concession in the extreme southeast corner of Zulia, mostly along and south of the Catatumbo River. Commencing in December 1912. their work was carried on well into 1913. during which time they had numerous conflicts and fights with the Motilone Indians who have always resisted the encroachment of white people into their domain which covers a large area in both Colombia and Venezuela. This examination was separate from the Caribbean Company program and more of a collateral investigation by the Asphalt Company. No exploitation areas were staked out because the District of Colon was in a concession separate from the Caribbean concession.

Elliott and Jeffreys, at Caracas, got out summaries of the reports and correlating the field work of all of the geologists.

Donnelly and White were the first geologists assigned to investigate the west side of Lake Maracaibo to the Colombian border, and very soon found interesting geological structures and seepages along the foothills of Perijá Mountains, which ultimately resulted in surveying a large area for exploitation. White returned to the United States about November 1913, but Donnelly continued his investigation until the war began in 1914.

Dagenais was assigned to detailed geological surveys around the Mene Grande seepages. His work turned out to be most valuable as a guide to subsequent drilling developments.

R. W. Merritt was also assigned to Mene Grande and aided Nash in surveying concession areas. Later, in 1913, he moved to the area northwest of Maracaibo.

Dixon and dark were assigned to explore the Goagira Peninsula, inhabited by Indians who, while independent, were not hostile to whites who behaved themselves. Completing that district, they covered the area between Goagira, the Perijá region, and Maracaibo in which there were several seepages and an asphalt mine. Clark returned to the United States in November 1913, but Dixon remained much longer.

Nash and Herold were first assigned to the foothills in Trujillo southeast of Mene Grande, and in April moved to Mene Grande where they surveyed most of the exploitation areas, about 50,000 acres. Thence they moved to the region northwest of Maracaibo to survey areas in the Limon and Inciarte districts.

In February 1913 the following additional geologists went to Venezuela: McCullough, Noehl, Gehrmann, Nobs, Wilde and Lewis.

McCullough and Noehl were teamed together and assigned to the Tachira area, but quickly transferred to the area east of Maracaibo on the east side of the lake, and then in May to the area west of Maracaibo, where they

made an interesting investigation of the northern fringe of the Motilone Indian district. McCullough returned to the United States in October 1913. Noehl continued in the Perijá district until late in 1914.

Gehrmann and Nobs were teamed together and assigned to the southeast margin of Lake Maracaibo, where they investigated the geology until September 1913. Nobs died in Maracaibo in September 1913. Gehrmann continued the remainder of 1913 in the various areas east of Maracaibo.

Wilde and Lewis were teamed together and started in by investigating geology near Mene Grande, then made a traverse from Coro to Barquisimeto. In May and June 1913 they examined the geologic conditions in Onia and Merida, after which they separated, with Lewis working with Nash in exploitation area surveys and Wilde joining the exploration of the Perijá district.

In March and April, Andresen, Sinclair and Packard went to Venezuela.

Andresen and Sinclair worked the area near La Vigia and Onia while exploitation areas were surveyed. Then they were moved to the Limon region northwest of Maracaibo for similar duties. Both returned to the United States in November 1913.

Packard was also assigned to the Onia and Rio Chama area, where he remained until September 1913, when he was transferred to Guanoco in eastern Venezuela; there he looked after development geology of the Bermudez, drilling wells until 1914.

Jeffreys came to Venezuela in May 1913, from extended experience in Mexico. After about three months in the Perijá district he was moved to Caracas to replace Elliott who had resigned.

Elliott had been at Caracas receiving field reports and assimilating them for a general report. It was Elliott who compiled the only map available for exploration parties.

By the end of 1913 Bermudez Company operations had perfected title to 28 exploitation areas of 500 hectares each, or a total of 27,000 acres. Of these, 10. were near Guanoco, 4 near Pedernales, 3 near Maremare, and 3 near Pauji. A well was drilled on each of the areas, with the result that Guanoco field was discovered around Bermudez Asphalt Lake, with thefirst well, Bababui No. 1, yielding 1,000 barrels per day on test. Oil and gas were encountered at Pedernales, and information at Maremare and Pauji resulted in the abandonmentof the six areas there.

Without the guidance of any wells drilled in the remainder of Venezuela, Caribbean geological exploration resulted in title being perfected to 789 areas of 500 hectares each in western Venezuela and 211 areas in eastern Venezuela. This totals 1,028 areas, or about 1,259,580 acres acquired for exploitation.

CHAPTER 12

WESTERN AND EASTERN VENEZUELA-1913

Macready has just given a complete summary of our operations during 1913 in Venezuela and Trinidad. It could clearly be seen that our operations there were becoming a success.

In the introduction to this book, mention was made of the author's experience in London with the Admiralty of the British Navy, when it was being decided if it would be worth while to change their ships from coal to oil. From 1911, when this conference was held in London, until 1913, the British Navy built a class of fast pursuit ships which could only bum oil. By this time gasoline had replaced kerosene as the most important petroleum product.

Middle East production commenced in 1913 with about two million barrels from Iran. The next largest oil producer was Russia with 19% of the world's total. Smaller quantities were contributed by Rumania, Indonesia, and Mexico. Around 1913, the world was consuming and producing about a million barrels of oil per day. Of this figure, the United States was producing about 63% and consuming about 54%. It was thus one of the principal oil exporting centers. Venezuela was rapidly taking shape in this world's picture of the oil industry.

During 1913 I made two trips to Venezuela and Trinidad to check on our operations. The first trip was from April 10 to June 15, and the second trip from October 15 to December 16. On this first trip I covered western Venezuela and Maracaibo Basin. I arrived at Curacao on April 17. On the 18th, Sinclair and Elliott joined me and we went from Caracas to Maracaibo on the steamer "Raum." Sinclair left our party at Maracaibo, but we were joined by Bryan. On April 21 we left on mules for the interior.

April 22: Crossed Palmar River in dugout, the mules being led across by our helpers. Noticed corn being ground in metates, or mortars, and baked in outdoor ovens. Thrushes build oven-shaped mud nests on limbs. Country flat and dry, scattered trees. Big pyramid-shaped black ants' nests not uncommon. Ranchers put poles across cattle to keep them on trails. First town we came

to southwest of Maracaibo was Villa del Rosario, which may be used later as, Company headquarters for Perijá region. A good-looking church, neat thatched-roof, plastered dwellings and a girls' school comprise the village.

April 23: Two miles south of Rio Palmar, near El León, Donnelly and White had a camp with tent, canvas floor, cots, mosquito netting, etc. Cooking was done in the open. Two and one-half miles southwest of our camp is the junction between the Great Plains and the Perijá Mountains. The vegetation becomes more dense toward the mountains. South of El León, a short distance, we saw our first oil, the Monte Verde seepages. The oil here comes from vertical quartzite beds, which have been thrust over the younger (Tertiary) oil-bearing beds to the east by the Perijá fault at the base of the mountains. The oil forms small cones. Shortly after we reached the seepages a heavy storm struck us, requiring ponchos to protect us.

April 24: We were joined by Donnelly and White at Villa del Rosario. A fracture zone in the igneous rocks of Totumo Canyon yields traces of oil and indicates possible migration of oil along cracks. One of the impressive sights along the Totumo trail are large curtains of night blooming epiphyllum, or flat-leaved "cacti" which hang down from the tree limbs forming beautiful curtains 20 feet long and 10 feet wide. Thorny, corrugated, tall, slender cacti grow in the open spaces in the forest, particularly around seepages. We visited beautiful La Luna Canyon, 12 miles west of Villa del Rosario, where a fine section of oil sand is exposed, associated with Cretaceous limestone, called the La Luna limestone, which lies with moderate east dips.

April 25: Going south from Villa del Rosario we crossed peculiarly vertical-jointed horizontal sandstone, characteristic of the Maracaibo series in the plains region in front of the Perijá Range. Weathered-out iron concretions and iron-hardened sandstone follow joint cracks, and are also common throughout the entire series. Small ponds stud the grass-covered country in front of the mountains. Scattered trees and tree cacti, some 30 feet high, complete the vista. Andreas Valbuena, a large landowner near Villa del Rosario, and his nice looking family were most hospitable to our men.

We visited the seepage at Macoa, near Machiques, which, though small, has a most important bearing on the oil possibilities of this area. It appears to come from the crest of ananticline in the Maracaibo beds.

April 25: We reached Machiques today and stayed all night. This town lies on the eastern edge of the Motilone Indian country. It is claimed by the Venezuelans, but the Indians have never given it up, and more than once the city has been razed by a raid and fire set by the Indians, The Motilones were friendly to our men, due to Dixon's diplomacy, but they are a bad bunch if you impose on them as the Venezuelans probably have done along their eastern boundary.

April 26: Between Machiques and Playitas we crossed the Rio Apon on a ferry which carries passengers and horses. After crossing the Rio Apon, the road becomes very good and is passable for ox teams during the dry season. Tree monkeys inhabit the forests in this part of the country. Ants also are abundant and build remarkable-looking mud nests in the forests, sometimes along the sides of trees. From Playitas, the trail turns south to the coast at Macana. Here we took the power-sloop "Joven Panchito," which carried us to Boca del Catatumbo, which means mouth of the Catatumbo River. This is a characteristic lake boat with a dugout canoe as an auxiliary.

Going through this country west of Lake Maracaibo, one is attacked by millions of ticks. They are characteristically belligerent and offer a serious menace to health and comfort. It is often necessary to strip two or three times a day and remove the ticks by scraping the skin with machetes in order to avoid more serious consequences of their boring a hole under the skin and causing sores. We had a solution called "creoline" (a creosote derivative) that we put on, which discouraged the ticks, but we didn't find this out until we had been in the field for some time. The Venezuelans use home-made "tobacco juice" for the same purpose.

April 27: Today found us going up the Rio Catatumbo, the largest river emptying into Lake Maracaibo. The Catatumbo branches into two forks as it approaches the lake. The larger, or North Fork, is used by the boats. A great lagoon lies south of the river a few miles south of Lake Maracaibo. This is a very beautiful country. Going up the river we see trees with beautiful foliage, palms, bamboo, and down near the water, vegetation that apparently is related to the canna. Log jams along the river are inhabited by great alligators which stretch out on the logs, but roll into the water as one approaches in a boat. On account of the vegetation on the banks of the Catatumbo, it is difficult to land at any point unless the vegetation has been removed. One of the most beautiful trees is the ceiba, which looks like a great umbrella. The Venezuelans have cultivated high spots on the river bank and grow fine crops of corn and bananas.

April 28: We left the Catatumbo at Encontrados and took the railroad to Uracá, the end of the line at the base of the Andes. We again resumed mules from Uracá to Colon. A fine old Spanish road extends between these two points. These old roads are more like stairs than mountain trails in some places. Vegetation is very dense along the base of the mountains through which this road goes. The new roads are under a four percent grade, while the old ones made by the Spaniards 300 years ago, have inclines up to twenty-five percent. Parts of the road between Uracá and Colon are passable for automobiles. The mountain huts in this region are made of horizontal bamboo stalks reinforcing mud walls and are covered with various types of thatching, mostly palms. Some fine exposures showing the character and structure of the Coal Series are found along this road and in the streams which are crossed by it. Colon is an important town and has some fairly wide streets, although much of the transporting in this part of the country is done by mules.

April 29: The structure becomes quite complex as one gets into the edge of the mountains. It is not unusual to find beds with dips as high as 60 to 70 degrees and even vertical on the San Pedro del Rio. The type section of the Colon shale is exposed 1 mile south of the town. The cemeteries in some of these old towns are walled and rather elaborate, and the graves within are marked by some impressive mausoleums. Lobatera and Palmira are towns south of Colon. Between the two is a station where the mules are unpacked, allowed to rest, and then repacked for the second stage of the trip from Uracá to San Cristobal.

April 30: Arrived in San Cristobal, which is another fine old town up in the mountains with narrow rock-paved streets and tile-roofed houses. While waiting in the hotel, I heard a noise that sounded like the honk of an automobile. I questioned one of the boys about it and he said it *was* an automobile. We looked out and saw a Ford. It had been carried up the mountain in parts on muleback and put together and used in the town. The streets were just wide enough for one automobile to pass, so, when the horn blew, everything and everybody scattered into the

driveways or into side streets to get out of the way. At San Cristobal we were joined by Hammer and drove over to Petrolia, near Rubio, which is a most interesting point in this part of Venezuela, as here we found the only producing oil well in the country. It penetrates the oil-bearing shales which are overlain by the Coal Series. A refinery here converts the crude oil into kerosene and gasoline and a residual. The refinery is about thirty years old, and although the well produces only about 40 gallons of oil per day, nevertheless it has been a commercial proposition for several years. This was the first and only commercial oil well in Venezuela prior to 1912. Oil is collected in 600-gallon lots before being run through the refining plant. Three products are separated: benzine 2.7%, kerosene 53%, and carbolene or road oil 44%. A windlass is used to raise a baler, which is run once a day. The residual from the operation is taken in drums to San Cristobal and other towns within a radius of 25 to 40 miles, and used on the roads. The operating company is Compania Petrolia del Tachira and has a headquarters house at Petrolia.

The Rio Quinimari rises among peaks over 12,000 feet in altitude and flows out of the mountains through this part of the country. Rubio is the center of a coffee growing district. From Rubio we rode to Cordero, or Quebrada Blanca, where a number of oil seepages are found at an elevation of 4,700 feet, the highest known in Venezuela.

May 1: Among the sights along the trails are piles of rocks marking the graves of some wayfarers who died beside the trail. The stones are reverential offerings of passers-by. This habit of putting stones on the graves is one that is common throughout Latin American countries.

May 2: Oyster-bearing beds are found on the trail between Tariba and Colon. It is rather unusual to find fossils in the formations in this part of Tachira.

ZULIA

May 3: From the mountains of Tachira we descended to the Rio Catatumbo at Encontrados, where we boarded a riverboat, the "Villamizar," which took us across the lake to the
town of San Timoteo, built on piling over the lake, opposite the big seepages at Mene Grande. Landing at night, Elliott made a misstep and slipped into five feet of water, stopping only when he struck the mud.

May 5 and 6: We went from San Timoteo up the Rio Motatan to the Mene Grande country. This was covered carefully, checking the work of the men who had been doing the details in this important area. Joslin, Nash, F. C. Merritt and Dagenais, all of whom accompanied us over the territory, did the work here. The seepages throughout this district are so numerous and so fabulous that a book could be written about them. The details will be given elsewhere.

The American Mission at Maracaibo has trained nurses and, in the case of Eckes, his life was saved through the care of one of the nurses in the local hospital. The same Mission and same nurses carried ice, furnished by our Company (by boat and rail), to Dagenais when he was stricken with typhoid fever at Valera. It was the work of this nurse and the attention given by the Company in seeing that ice was furnished that saved Dagenais's life.

May 7: We headed toward Maracaibo, where we busied ourselves that day and the next day.

May 9: We left on the "San Elias" for the Rio Limon and the Sinamaica Lagoon north of Maracaibo. Jardine and Dixon joined us on this trip.

On the west side of the Sinamaica Lagoon are villages built on piles above the water, the same as those on the east side of Lake Maracaibo. Here they are thatched with a peculiar reed. The Rio Limon (meaning "alligator") flows into the Sinamaica Lagoon from the west, and the river and the lagoon itself are inhabited by myriads of large alligators.

While we were crossing the lagoon in our gasoline launch, we were often stuck on sandbars and it was not uncommon for us to have an audience of several large alligators in a circle around our boat, as we got out to pull or push it off the sandbars. You can estimate the length of a submerged alligator by multiplying the distance from its eyes to the tip of its nose by six. In other words, if you have three feet between the nose and the eyes, you have an alligator eighteen feet long. Usually, only the eyes and tip of the nose are visible.

We reached Carrasquero, at the end of the Inciarte Railroad, in the evening and made arrangements for a handcar to take us to Inciarte the next day. We found the car incapable of being propelled by the "pump handles" and so arranged for two men to push the car, on which we placed our baggage. Bryan, Elliott, Dixon and I walked.

May 10: We left Carrasquero at 4 A.M. and reached Inciarte, 27 miles distant, at 1 P.M. Three miles an hour is a pretty good pace, especially along ties, and in the enervating tropical heat. A short distance from the end of our journey was an enticing but muddy pool of cool water. We all had the same idea—let's see who can strip and get into the pool first. We all landed in the water about the same time —and we all got out quicker than we went in. The cause of our hurried exit was myriads of small "man-eating" fish, three to six inches long, which are partial to white meat and don't care from what part of the victim they secure their tidbit. These fish are doubtless a pint-sized edition of the man-eating fish made famous by Teddy Roosevelt on his trip through the Brazilian jungle several years before we began our work in Venezuela. There just isn't anything akin to the "ole swimmin' hole" in Venezuela!

May 11 and 12: With the camp of Dixon and dark on the Rio Socuy as our headquarters, we examined the great Inciarte seepage, El Mene Grande de Cachiri, Rio Tulé and other seepages in the same region. The oil seepages are usually associated with limestones. An enormous vein of coal 25 to 35 feet thick, in the sandstone and shale of the Coal Series, is found on the Rio Tulé and also 20 miles to the northwest. This is the largest vein so far found in this part of South America. Hardwood trees 10 to 12 feet in diameter are found in the same general region.

On the evening of May 12th dark, Bryan, Elliott and I started down the Rio Socuy from dark and Dixon's camp, for Carrasquero, sixty miles downstream to its junction with the Rio Limon. We were in a large dugout canoe loaded to within six inches of the gunwales. The moon shone the early part of the night and although the river was in flood, we had an interesting and safe trip as long as the moonlight lasted. About midnight the moon went down, then it was a different story. All we could see were the dark bamboo walls of the forest. Our two boatmen knew the river well and handled the canoe as befitted expert river men. The danger spots were the whirlpools at bends in the river. The low roar of the water was not reassuring to us landlubbers. We were going with the current about five or six miles per hour. Once in the river, there is no

landing on the banks—it is the "line of no return." The sharp-pronged bamboo lines the banks down into the water. Anyone who has ever endeavored to negotiate landing on a bamboo-covered bank will confirm every word I have said.

Suddenly we began to hear a louder and more boisterous roar. Our boatmen said it was a big jam ahead, something dangerous to approach in the daylight, and much more so in the dark. Did any of us have a light? One after another said "No," till they reached dark. He said he had a flashlight, and produced it, and it was loaded. So he got in the bow and was our sun and moon and our salvation, all in one.

Our boatmen steered us up the side of a large floating tree in the center of the jam. Then we were ordered out into the maze of trunks, limbs and debris and admonished to look out for snakes. Snakes patronize such jams, looking for stranded deer and other animals. Some of the smaller snakes are poisonous; the larger ones are boas and just squeeze their victims to death. Take your choice. But the Lord was good to us. We portaged the canoe across the jam, lowered it into a relatively quiet spot under the jam, and everybody got aboard safely. Our journey the rest of the way was without incident. We landed at Carrasquero shortly after sunup, a very thankful bunch of geologists. Clark's flashlight was the lifesaver.

May 13: An old asphalt refinery is located at Carrasquero, which lies at the head of tidewater on the Rio Limon. It was formerly used by a company which mined the asphalt at the Inciarte deposits, brought it down on the little narrow gauge railroad up which we walked, and after refining, shipped it abroad. We returned to Maracaibo by launch, noting the huts on piles and fishing nets in the fishing village of Boca del Caño del Sinamaica.

May 14: We saw a considerable number of Goagira Indians in the market at Maracaibo. These cousins of the Motilones are much more civilized than the latter—at least they wear clothes — are peaceful, and acknowledge the sovereignty of the Venezuelan Government. We loaded our mules and equipment into a sloop, but we were taken to Altagracia in the Company's gasoline launch, "Elite." Altagracia is a good-sized town directly east, across the lake from Maracaibo. From here, Bryan, Elliott and I started out east for Coro along the flat desert strip that lies between the mountains of northwestern Venezuela and the Caribbean Sea.

May 14 to 18: Five days of pretty rugged riding were taken up in making the trip from Altagracia to Coro. The living conditions, food and water were not the best in the country. It rains frequently in the mountains south of the desert, while some places in the latter have droughts up to a year or so in length. Rivers flowing from the mountains to the sea may be raging torrents one day and the next day nearly dry. Pools or water holes in the river beds hold water the year around and are the homes of solitary alligators and the watering places for the few animals and birds that inhabit the inhospitable terrain. Efforts have been made in the past to dam up the intermittent streams, and although the natural conditions are often favorable, lack of money and initiative have precluded the building of any successful storage project.

STATE **OF FALCON**

In going east we passed into the State of Falcon, through Quisiro, San Felix, across the Rio Maticora, through Casigua, Dabajuro, Potrero, Lagarto, up Donahita Canyon, through San

Francisco, to Pedregal, Cardon, thence to Cieneguita, Agua Clara, along the Rio Mitare, through Agua Viva and thence to Coro.

East of Altagracia, as far as Dabajuro, the country is flat with few rock exposures. In the vicinity of the latter place and eastward to Coro, are wonderful exposures of the rocks and structures, largely in the Coal Series. The finest outcrops are in the canyons that extend back into the mountains from the plains country. Donahita Canyon, Cardon (type locality of the Cordon series), Cienegita, Agua Clara, the canyon of the Rio Mitare and thence along the foothills to Coro, offer a paradise to the geologist. Anticlines and fault blocks are not uncommon. Hot springs are common near Cordon and occasionally elsewhere.

An oil seepage occurs at Lagarto. It is the easternmost seepage west of the oil pool six miles west of Coro. The paucity of any direct evidence of oil is one of the discouraging factors in the search for oil in this part of Venezuela.

The vegetation is typical of the deserts of all of northern Venezuela. It consists of giant solitary *tuna* or tree cacti, or forests of the same plant. These cactus patches are the home of countless parakeets and the pears, or fruit, furnish food for birds and humans alike.

The scattered, thorny trees are sometimes the host to a small white orchid with small, round, tough, spike-ended leaves that entirely cover some of the larger horizontal limbs of the trees. These orchids are common between Altagracia and Quisiro. A peculiarity of these beautiful white flowers is their emitting strong, sweet perfume at night, but being odorless in the daytime. They retained this habit when transplanted to my hothouse in San Marino, California.

The houses are usually made of adobe, some times mixed with grass. The strong inside fibres of the cacti are also used extensively in house and roof construction. There are no palms in the desert. Goats are the principal product of the desert region. The water for domestic and other purposes comes from a common source—a tank or small reservoir. These are used by humans and animals alike and are an example of unsanitary conditions. No wonder the people, are not healthy, especially when famine is of common occurrence.

FALCON DISTRICT

Pedregal is one of the most important towns in Falcon. The principal hotel is the Nuevo, which was our abode. Guests and animals alike are taken through the front door into the patio at the rear of the hotel. The guest rooms are on either side of the entrance hallway. This is the custom in most abodes in this part of Venezuela. The country being arid, there is much poverty, and many old men and women are seen who have weathered the years but have not had much to eat in the latter part of their lives.

May 18-20: We reached Coro on May 18 and looked over the country to the north, which is occupied by vast expanses of drifting sand dunes.

May 20: Went to La Vela where we boarded the large sloop "Virginia" for Curaçao, using a small sailboat lighter.

May 21: We reached Curaçao and immediately tried to get a large sailboat to take us over to Porto Cabello 90 miles distant. We were unable to find one, as most of these larger sailboats' owners are afraid to venture into Venezuelan waters because at one time or another they have been involved in smuggling operations and are subject to seizure.

May 22: The best we could do was to rent a little sailboat called the "Mita" owned by two colored men who had never sailed outside the waters of Curaçao. This boat was 27 feet long, homemade, the frame from local tree limbs. We finally boarded it late in the afternoon with the hopes of getting to Porto Cabello the next day. We had been out only a short time when the lantern, our only light, was washed overboard. Then a little later, the only hatch went the way of the lantern. Things began to look serious. We had no regular compass, but used our Bruntons to direct the ship. After nightfall, we devised a means of locating directions by noting the trend of the waves, which is very uniform because of the trade winds. We tacked back and forth against the trade winds for the entire trip. I might add that the "Mita's" usual cargo was dried goat skins, which gave the inside of the boat an odor easily differentiated from attar of roses. In fact, the stench made all three of us landlubbers very sick, as we necessarily had to spend part of our time below decks.

STATE OF CARABOBO

May 24: Forty-eight hours after leaving Curaçao, we sighted Porto Cabello and sailed in close to the land. We were halted by a police boat which took us in tow and escorted us to the immigration headquarters on shore. We were a sorry-looking bunch, not having shaved for two or three days, and not being overfed. The officials were suspicious that we might be smugglers or something. However, it occurred to us to contact the American Consul. When he showed up, he was a fine, big colored man, very apologetic, and very much an American. He immediately began to sympathize with us and tried to help us out of our predicament. Some chance remark led him to learn that I was from Marshalltown, Iowa. He said that he was born in Marshalltown. When he found out my name, he said that his father had worked for my father at one time. From that time on, we practically owned Porto Cabello. He apparently was a popular and influential man in that port.

May 25; Then came the problem of getting transportation from Porto Cabello to Valencia. Only a narrow gauge railroad with a train which ran intermittently connected the two towns. However, we learned the name of the manager and he happened to be the father of the girl whom Jeffreys later married. We communicated with him and he sent a motor handcar down to pick us up. The Governor of the State of Falcon happened to be a guest in the hotel and was desirous of getting back to Valencia himself. He conceived the idea of attaching himself to our party. This would have overloaded the car. We had to devise means of shaking the Governor. We took a buggy and ostensibly drove out to look at some geology along the coast west of Porto Cabello. After getting out a mile or two, we swung back and came into the railroad at a certain point agreed upon with the fellow who ran the car, and found him waiting for us. We boarded the car and started off. However, we had just started when we saw the Governor come dashing up in an automobile. He couldn't catch up with us and the last we saw of him, he was gesticulating wildly and giving us his blessing in reverse because of our disregard for his authority and dignity.

We made connections with the Valencia-Caracas train and arrived in Caracas the same afternoon. We stayed all night, and the next morning Mrs. Arnold and I went to La Guaira and took the French liner "Venezuela," which carried us from La Guaira to Colon, Panama Canal Zone.

Unfortunately, the boat had stopped at a Colombian port where there had been yellow fever, so we were put in quarantine at Colon. We used every pull known to science to secure our release, but to no avail. We were four days in the quarantine station. There were quarters for first-class passengers, barracks for the second- and third-class passengers. We were practically the only passengers in the first-class building. I spent my time while we were there in hunting for sea shells along the beach, which the quarantine station faced.

As soon as we were out of quarantine, we contacted MacDonald, an old friend of mine, who was chief geologist for the Panama Canal Commission. He took us over and we spent three very pleasant days in going over and through the Canal just three weeks before the water was let into this great project.

On one of our trips through the Canal we passed by a spot where one of the big boas that inhabit this country had tangled with a freight engine and had emerged in three parts—the head on one side of the rails, the tail on the other, and a big middle section between the rails. I casually remarked to MacDonald that now I understood how the name "Culebra Cut" got its name. To fully appreciate this joke, one must know that "culebra" means snake.

We returned to New York on the "Alianza" the middle of June, 1913.

The summer of 1913 was a busy one for me. Many new men were sent to Venezuela and some returned. On October 15, I left Los Angeles with' my wife and we stopped in the Philadelphia office of the Company. While there, I had a conference with Mr. Sewall, Mr. Seamans and Mr. Rake of the General Asphalt Company. On October 25 we sailed from New York and arrived in Curaçao on the 30th. We were joined here by Jeffreys and left on the "Merida" that afternoon for Maracaibo. (Mrs. Arnold remained in Curaçao.) In Maracaibo we were met by Bryan.

From the inception of the work in Venezuela, I had a plan of having parties working in certain areas, and when it came to checking the work of these parties, I would start at one point in the Lake area, usually Maracaibo, and go around the Lake, passing from one party to another.

STATE OF ZULIA

A typical trip was the one taken in November 1913, starting out with Bryan, Jeffreys and Donnelly. Our equipment consisted of four mules with our hammocks and a small amount of clothing strapped on the back of these animals. We had no peons to guide us in this territory, as our men were all more or less familiar with the country traversed.

Oct. 31: Arnold, Bryan, Jeffreys and Donnelly left Maracaibo at 2 P.M. and rode till suppertime. We traveled light, using horses and mules and carrying our hammocks back of the saddles. After a lunch-supper we kept on going and rode until 2 A.M. Then the boys lifted me out of the saddle. Was I stiff: hadn't been on a horse for months. We pitched camp along the road,

that is, we hung our hammocks between trees and slept until 4:30. Got up, ate a cold breakfast and started on toward the La Paz country.

November 1: Water is a principal item to contend with in this region. There are no streams on the flat, arid country, except for a river or two, and the rainwater is collected in little reservoirs or tanks. These are usually fenced, but openings are usually present which permit the ingress of goats, hogs and other animals. The people use this water for washing and drinking; the animals use it for everything. When I started the men on their work, I cautioned them against drinking any but boiled water, because of the chance of getting amoebic dysentery and other diseases from these polluted pools. After traveling the country for a few days one forgets all about these necessary precautions, and I used to find myself riding out into the middle of one of these pools, dipping my canteen into it, and then taking a good strong drink from it. For some reason or other, I never had any bad effects from this type of water. Possibly it was because we perspired constantly and were very active, and so threw off the impurities that were likely to collect in the system. Some of the boys were not as fortunate as I, and several contracted amoebic dysentery and had to suspend work temporarily or go back to the United States. Malaria also took its toll where the mosquitoes were bad.

The people who inhabit this part of the country between Maracaibo and the Perijá Mountains are isolated groups of native Venezuelans and some Guajira Indians.

At certain localities hills rise out of the flat country. These usually mark some type of structure lying beneath the surface. The rocks are largely sandstone hardened by iron and there are some conglomerate beds. The dips are usually questionable. The only way the people can raise any vegetables is to plant their gardens on elevated platforms erected to protect the vegetables from the goats. They do no irrigating as far as I was able to notice in this part of the country.

At the Ebanos Ranch, 14 miles west of Maracaibo, we found large spineless cacti such as Luther Burbank developed. These are used for fodder for the goats, and the fruit for the people. The fact that Burbank developed a spineless cactus similar in every way to this native form is purely a coincidence. Also near Ebanos Ranch we found a grouping of the formations which showed lines of stress at right angles to each other. One had a strike of N60°W, dip N30°E. The other strike was N30º, S30°W.

Donnelly, who did the spade work in the La Paz region, led us to the big La Paz seepage. It is 1/2 mile long and 1/8 mile wide and it extends in the direction of N30°E. The surface is bare and mostly hard, except for a place near the center where there is a live seepage. No cones are present and the surface is only slightly arched; it is very soft locally. It is one of the largest seepages in Venezuela and suggests great possibilities for oil in that part of the country.

It was at this point that we nearly had an accident. Donnelly and I were investigating the soft place, or "mother" of the seepage, when Donnelly slipped off one of the boards which had been laid out across the softer asphalt, and became mired in the asphalt. He gradually began to sink. I was panic-stricken, but realized that we had to do something and do -it quickly. I yelled at him to lie down and bend over so that he could carry part of the weight of his body on his hands and knees or stomach. I obtained several boards and put them out toward him until he could reach them. Then I went out carefully on the boards my self and got hold of his hands and gradually

pulled him back out of the mire. If he had been alone there would have been no chance whatever of his ever getting out, as the material becomes softer and softer as one sinks down, and in soft asphalt a man or animal sinks fast. A photo shows Donnelly with the asphalt up over his high boot tops, nearly to his knees. The episode reminds me of the Brea Pit at Los Angeles, California, where myriads of extinct animals had been caught in asphalt and sank below the surface to furnish us with the record of a long past epoch.

We camped at Cieneguita de Papina at six o'clock. The La Paz seepage is 27.5 kilometers south 62° east of the great asphalt deposit at Inciarte or 25 kilometers east, and 11 kilometers south of Inciarte. La Paz is about 25 miles west of Lake Maracaibo.

The La Paz seepage and the oil springs are all around, and within its periphery are the burying ground of many animals and birds which have been caught in the asphalt, particularly where it is soft.

As we get nearer to the mountains, the river beds are filled with tropical vegetation, and it is here that the orchids are abundant. Tree cacti up to 30 feet or more in height also grow in bare spots in the forest, particularly near seepages. It was my hobby to collect orchids and bring them back to the States for my hothouse. The boys were unkind enough to say they thought I spent more time hunting for orchids than I did doing geology. I deny the allegation, but I will admit that every trip I made to Venezuela found me returning home with three or four crates of the native orchids. In my six trips to Venezuela and Trinidad I brought home over sixty varieties of orchids.

Nov. 2: The Palmar River is the principal stream between Maracaibo and the mountains. In low water it is not difficult to cross as there are fords at various places along its course. In high water it is practically impassable.

Seepages found in the region we covered on this trip were La Paz, Monte Verdi and Dos Manantiales. They occurred on the flat areas, and generally on the edge of the forests and |were sometimes accompanied by sulphur water. Numbers of photographs were taken showing **these** seepages with the animals such as cattle, birds and turtles caught in the asphalt. These deposits would eventually develop into deposits like the Brea Pit mentioned previously. Some of the seepages take the form of little cones in the midst of a forested patch, or build up terraces as the heavy asphalt and oil flow down the gradual slope of the hills.

The trails through the wooded country in this part of Zulia are generally pretty good, as there are no swamps or marshes to impede progress. It is just a question of keeping the trails cut open. The brush and trees grow up rapidly where trails are abandoned. Spanish moss grows in parts of the wooded country and some beautiful palms are found in others.

The Rio Cogollo yields one of the finest geologic sections in western Venezuela and this section is described in another part of this report.

Nov. 2: We rode as far as Totumo and examined several seepages in its vicinity, which will be described later.

Nov. 3: Arnold, Donnelly, Jeffreys and Bryan went as far as Arimpia, passing the big seepage one-half mile north of Totumo Canyon. We located the first well 300 or 400 feet east of the source of this seepage. Little seepages occur nearly all the way to the canyon. Outcrops of red oil sand are found near the little seepages, with igneous rocks back of the hill.

Nov. 4: Our same party rode from Arimpia to Tintini and thence to Villa del Rosario. Found seepages in the fossil-bearing layers of the grey limestone, oysters, worm borings, gastropods, etc. The grey limestone is thick and heavy-bedded and most of the strata show good oil saturation. Grey limestone is the source of the oil beyond all doubt. Oil occurs in the lower 500 feet of the Frontal sandstone which underlies the shaley sandstone, and in the upper 500 feet of the grey limestone mentioned above. Fresh water comes out of the two Tintini seepages. Large quantities of water are associated with the Frimole seepages, with little activity of oil. The seepages are rather inert, with little or no gas.

Nov. 5: Bryan, Donnelly, Jeffreys and Arnold rode from Villa del Rosario to Putal.

Nov. 6: Our same party crossed Lake Maracaibo to Motatan de Lago where we were joined by Noehl, dark, Gehrmann and Dagenais. We rode from Motatan to Mene Grande, the largest seepage in Venezuela, if not in the world, and re-examined it.

Nov. 7: We rode to El Menito and Ultimo Menito and thence to Motatan del Lago. From Motatan we went by boat to Maracaibo.

Nov. 8: Arnold, Jeffreys and Noehl went across the lake to Santa Isabel in Altagracia and rode into the back country to see the seepage.

Nov. 9: Arnold, Jeffreys and Noehl stayed in Santa Ysabel and then rode out to the important Las Tablosas seepage and returned to Santa Ysabel, where we saw another seepage.

Nov. 10: We went from Santa Ysabel and Altagracia to Maracaibo.

Nov. 11: Spent the day in Maracaibo getting things together, holding conferences, etc. Winninette came to Maracaibo on the Red D steamship "Maracaibo."

Nov. 12: Winninette, Donnelly, Jeffreys and Arnold sailed from Maracaibo at 11 A.M. on the "Maracaibo."

Nov. 13: Arrived at Curaçao at 9 A.M. Visited the Cheneys (American Consul) and took in the sights. Winninette had been staying there at the Hotel Americano while I was in Venezuela. Sailed on the Red D Liner at six o'clock for Caracas via La Guaira.

Nov. 14: Arrived at La Guaira at 7:30 and with the aid of Consul Voetter and our geologist, Burton W. dark, and by leaving McKee and Hammer to look after baggage, Winninette and Messrs. Sinclair, Donnelly, Jeffreys, Merritt, Andresen and Arnold got the 8:30 train for Caracas, where we arrived at 10:30. Conference all day until 12 o'clock at night. Met Bartlett and Doyle.

Nov. 15: Left on 8:30 train with Jeffreys and Sewall and caught the "Filantia" which sailed at noon.

Nov. 16: Reached Pampatar, Santa Margarita Island, at 8:30 and stayed one hour. Reached Carbuano at 2:00 and stayed until 5:00. Macready came aboard here.

Nov. 17: Arrived at Port of Spain at 6:00 A.M. Went aboard the *Viking* for breakfast, then up to the Queens Park Hotel and left for Brighton shortly after.

STATE OF MONAGAS

Nov. 18: Guanoco Pitch Lake.
Nov. 19: Guanoco to Maremare.
Nov. 20: Maremare to Pedernales (Territorio Delta Amacuro).
Nov. 21: Pedernales to Guanipa to Guanoco.

Found a fine camp established at Becada Well No. 1 on the banks of the Pedernales River. The rig was first-class. The boiler house and the equipment were similar to rigs used in the States. The protective covering for the men and houses was palm thatching. Batalla Well No. 1 used a Star rig and drilled to 50 feet. It was put down in the middle of the forest on the edge of the Caño on the Pedernales River, a short distance above Pedernales Point.

Varril Well No. 1 used a Columbia rig and drilled to 44 feet on the banks of the Pedernales River.

At Guanipa, in the State of Monagas, there is an asphalt plant belonging to the Travers Asphalt Co., E. A. Brown, Manager. They haul the asphalt to the plant in barrels on small cars.

The Guarajun Indians live in the vicinity of Guanipa. They are typical Indians, with the women wearing long hair and long skirts and engaged in weaving baskets. The men are scantily clad and work in the asphalt deposits. During the rainy season, the railroad, over a mile long, is submerged from a few inches to a foot below the level of the water, which covers the entire country.

Large amounts of asphalt have been taken out of the lake near the refinery, which is now filled with an emulsion of oil and water coming from the seepages.

Nov. 22: Arnold, Jeffreys and Macready went from Guanoco to Caripito to Sabanilla.

The Company's center for operations at Baculo and Bactris has a fine house built on piles on the edge of the San Juan River, instead of building the house on the ground in the jungle near the river.

The Bactris Well No. 1 has a Star rig and has been drilled to a depth of 55 feet. It has a thatch-covered building adjacent to the rig for the protection of the men. The country along the river is mango swamps.

Nov. 23: The same party went from Sabanilla to Punceres. The trails through this country penetrate dense forests and the territory is practically water-covered during the rainy season. The people live on little elevations in the forest. The town of La Cruz has interesting features. A big

sulphur spring at Los Baños is a mecca for people who go there for the curative properties of the springs. North of the town of Punceres the mountains rise gradually and the country is covered with less vegetation and is more easily traversed by a man on horseback.

Nov. 24: Rode from Punceres via Aragua de Maturin to Chaguaramal. One-fourth mile above the trail on the Guayuta River east of Aragua de Maturin are oil sands in the Llanos formation. We had considerable trouble crossing the rivers in this country, especially the Guayuta River, which was partly swollen and would have been impassable if it had been much higher.

The stakes used to mark the Company's concessions are hardwood and about 6 inches square.

Nov. 25: We rode from Chaguaramal to El Breal to Caicara.

Nov. 26: Caicara to Pirital. At Pirital we stayed at the Posada del Sol. It was a well organized little hotel, but the room we occupied had formerly been used as a chicken house and by the next morning we were all covered with lice, which took us several days to eliminate. Henceforth we were careful to find out the former occupants of our bedrooms. The lice attack you in the hotels; the wood ticks in the forests. Woe be to the pioneer geologist!

Caicara is on the Guarapiche River, one of the larger rivers which were hard to cross. The men in the party were ferried over in a dugout canoe by the Venezuelans, while another group swam our horses across the river. The latter procedure was quite dangerous, as the river was at high flood and the current was very swift.

Nov. 27: One of the native fruits in the Caicara district is the *lechoso*, which is unlike any of our fruits. Also in this district many of the women weave hammocks which were used as beds in our travels. People grind their corn in rock mortars. In some places we had to cross the river, like the Amana River, on the overhanging limbs of large trees. It was rather a difficult proposition and somewhat dangerous. In some cases we had to carry our blankets and possessions on our shoulders and swim across the river.

Nov. 28: We went from Pirital to Paso del Rio Santa Barbara to Maturin.

Nov. 29: We went from Maturin to La Bomba-Hervidero and return. This is one of the largest and finest mud volcanoes in eastern Venezuela. It is about 120 feet wide at the base and 12 feet high. The surface is hard enough to walk upon where the mud has become dried out. Mud flows out intermittently from the little cone at the top of the large, flat cone. The hole from which the mud, water, gas and oil come is well defined and is about a foot or more in diameter. It has built up a little elevated, hardened mud cone at the top of the larger cone.

The country around Maturin is typical Llanos and one's eye can see for many miles with just an occasional bunch of trees growing above the top of the grass. These trees mark slight water-filled depressions in the Llanos country. The buildings around here are made of mud and are thatch-covered.

Nov. 30: We went from Maturin to Caño Colorado to Guanoco. The trails through this country are very swampy and during the rainy season travel is rather difficult in places. It seemed good to

get back to Guanoco where we had a touch of civilization in connection with the Company's fine headquarters house and the activities of the crew who were taking asphalt from the Guanoco Lake. The three boats used by the Company in their work at the mouth of the Orinoco are "La Neva," "Sucre" and "Monagas."

Dec. 1 and 2: We spent these two days at Guanoco, and on the third day packed up and went down to the "Viking," the Company's largest steamer, which sailed at five o'clock in the afternoon, arriving at Port of Spain at six o'clock on the morning of December 4th. We went to San Fernando on December 5th at nine, and met Colonel and Mrs. Carroll, the Superintendent and his wife, and Winninette. Conferences were held with Mr. Sewall, who was staying there also. Nolan came back while we were at Brighton.

Dec. 6: We went down to Moruga where Nolan, Boyd and Macready showed us around the southern anticline, which was very interesting, especially in the quarries. Then we returned to Port of Spain.

Dec. 7: We held several conferences with the Company officials. Winninette and I packed up on December 8 and boarded the Royal Dutch steamer "Commewijne," which sailed at 9:00 P.M. for New York, arriving there December 16, 1913.

CHAPTER 13
OPERATIONS IN 1914
By George A. Macready

The time for filing exploitation areas under the Caribbean Company concession expired January 2, 1914.

At the commencement of 1914 the Caribbean Company had filed selections for 789 areas in western Venezuela and 239 areas in eastern Venezuela, or a total of 1,028 areas. This is equivalent to 1,259,580 acres selected. This included Bermudez Company selections of 28 areas, or approximately 7,000 acres.

Bermudez Company's Bababui #1, with 900 barrels daily, had discovered the Guanoco oil-field and had selected enough areas to control all future production in the immediate vicinity of the Bermudez Asphalt Lake. Although this field was not so important from an actual oil production standpoint, its discovery and control relieved General Asphalt Company from one of its greatest worries: that is, disastrous competition if a competitor should acquire a supply of petroleum asphalt from under their Guanoco asphalt mine.

Geological examinations of the prospective areas had been completed only far enough to guide in their selection, but not enough in detail for test well locations.

As a matter of policy, no drilling had been started on the Caribbean Petroleum Company properties until after the time limit for filing selections had expired.

A remarkable feature of the Caribbean exploration was that all the areas selected were made on geological examinations without aid of drilling any wells. Ordinarily this would have been

bad practice, but with only two years from scratch, and half of that gone before the potentialities of the project were known, it was physically impossible to complete wells in time to be a guide in area selections.

Equipment was shipped into the Maracaibo district so that drilling could be started immediately after all Caribbean selections had been filed.

At Mene Grande, Zumaque #1 was commenced on January 12, 1914 with a #3 Star drilling machine and completed on April 15, 1914 as a 250 barrel-per-day oil producer and discovery well for Mene Grande Oilfield.

Also, at Mene Grande, Zumba #1 was commenced in February, 1914 with cable tools. The rig caught fire and burned in November. In December, 1914 the well was repaired and flowed 1,000 barrels of oil per day. This well produced 43,000 barrels of oil in 1919.

A deeper test for Mene Grande was commenced March 16, 1914 as Zumaya #1, with standard derrick and cable tools. In November, 1914, at a depth of 1,670 feet, the well flowed at the rate of 20,000 to 40,000 barrels of oil per day and created quite a sensation and plenty of trouble, as expressed by Harry Maddren in his description of the well. Although an oil well was expected, the large flow was a surprise and created difficulties in handling and storing the oil. Later, the well settled down to a steady flow of 2,500 barrels per day under control. This well produced 19,000 barrels of oil in 1919.

Zumacaya #1 was started October 14, 1914. By February, 1915 depth was 800 feet. The well produced 500 barrels of oil in 1919.

Caribbean Petroleum Company started drilling at Perijá field with Zambapala #1, started May 1914 with a portable machine. The well was abandoned at 556 feet in August, 1914 because of mechanical trouble.

Zambapala #2 was immediately started August 21, 1914 with a standard rig and stopped work that year at 803 feet.

Zambapala #3 was started about October, 1914 and was shut down when war broke out in Europe.

Drilling operations of Caribbean Petroleum Company and other General Asphalt affiliates in the Caribbean region were under the management of Harry Maddren. General Asphalt was very fortunate in obtaining his services because, from my observations, he was the only manager of their development with whom I came in contact in eight years with General Asphalt who had had any experience with or understood the development of a large-scale oil exploration program. Other managers whom I met were good as tool pushers or head drillers, but few of them had had experience coordinating a complex, large-sized petroleum organization.

Assisting Harry Maddren was Jack Stokes, at Mene Grande, on whom much of the detail and trouble shooting devolved as the wells increased in number. Rig builders Jim Putney and Sam Schrum were very important in a new project because it fell to them to get out into the woods

before the drillers and find suitable timber for rigs and houses before the drillers moved in. Roy Merritt attended to engineering and liaison detail with the Venezuelans because he spoke Spanish fluently, although I do not know what his oil experience was. Harry Maddren has described his experiences in the Maracaibo operations, including a smack of yellow fever, in a very interesting and enlightening manner. His story will be found further on in this book.

By November, 1914 war in Europe had become so involved that all drilling operations in the Maracaibo district were shut down and skeleton crews left to maintain production and equipment. Drilling was not resumed on any scale until 1919.

In eastern Venezuela the Bermudez Company had four wells drilling in the Guanoco field during the early part of the year. Babosa #1 continued drilling to June, 1914 when it stopped drilling at 1,306 feet with much heavy oil.

Badajo #1 stopped drilling April, 1914 at depth of 2,206 feet with no oil.

Bacelar #1 stopped drilling February, 1914 at depth of 907 feet with no oil.

Bacante #1 continued drilling until September, 1914 when it stopped at 4,247 as the deepest well in Venezuela.

Drilling operations were under the management of Harry Maddren with Charles A. Bostaph as superintendent for Trinidad and eastern Venezuela. McManus was tool pusher most of the time for the Bermudez Company. Henry J. Packard served as resident geologist at Guanoco.

Results of drilling in the Guanoco district resulted in heavy oil being found in abundance in a limited area under the Asphalt Lake by the following wells: Bababui #1, Babosa #1, Baca #1, Bacara #1. The quantity of oil discovered was sufficient to justify the Bermudez Company exploration for its protection against competitors.

At Pedernales, Becada #3, #3A were drilled to 280 and 744 feet respectively, encountering oil shows and troublesome gas pressure. These wells were near the asphalt lake northeast from the village. Late in the year Becada #4 was started near the village of Pedernales. Operations were slowed noticeably by the isolation of Pedernales from other operations.

At Trinidad, twenty wells, nearly all producers, were drilled in the Lot One field. They were very shallow, but prolific, with gushers at only 500 feet deep in some instances.

Drilling operations during the early part of the year were in charge of Wm. McKnight, Lee Scott, J. W. McPherson; and W. D. Owsley, and later quieted down under the more efficient management of Charles A. Bostaph. Macready was in charge of geology.

During 1914 the following geologists continued in the field, studying geological conditions with the view of aiding in development, choice of future locations for drill sites, and selections to discard: Boyd, Bryan, Dagenais, Dixon, Donnelly, Eckes, Garner, Hammer, Herold, Jeffreys, McKee, R. W. Merritt and Prout.

Boyd remained in eastern Venezuela a short time and after returning from a vacation went to western Venezuela.

Around Mene Grande district Dagenais and Eckes spent considerable time studying detailed geology.

In the Perijá district Boyd, Dagenais, Garner, Herold and Prout made detailed studies of the geology.

Dixon, Donnelly and McKee spent some time in the Catatumbo and Rio de Oro region.

Dixon, Herold and R. W. Merritt were occupied part of their time in the region northwest of Maracaibo.

Jeffreys, at Caracas, attended to the compilation of summaries of field reports.

In Maracaibo Basin, two development projects were carried on by Shell separate from the General Asphalt management, although basing their operations on geological information obtained by General Asphalt.

One project was operated by Venezuelan Oil Concessions, Ltd. in the District of Bolivar, State of Zulia, a part of the Aranguren Concession. Well #1 was started on the shore of Lake Maracaibo $1^{3/4}$ miles south of La Rosa on November 24, 1913 and shut down on August 26, 1914 at a depth of 1,430 feet after producing some oil. Well #2 was started in February, 1914 on the shore of Lake Maracaibo, at El Mene de Santa Rita, and stopped drilling in June, 1915. Both wells were drilled with Galician rigs. Operations were in charge of Mr. George B. Reynolds and Mr. Cecil R. dark.

Another project was operated by Colon Development Company in District of Colon, State of Zulia, on the Rivas Concession. A. F. Dixon was transferred to this firm about April, 1914 and attended to geological operations and selection and preparation of well sites. The first well was started at Rio de Oro about July, 1914, and, with the outbreak of war in 1914, was shut down until 1915.

CHAPTER 14

ARNOLD'S FOURTH TRIP TO VENEZUELA
OCTOBER 9 TO DECEMBER 9, 1914

A year had passed since I made my last trip to Venezuela in 1913. We arrived in Maracaibo on October 13, 1914. Mr. Arthur W. Sewall, president of the company, was with us on this trip. He wanted to see the conditions existing in Venezuela and Trinidad, but before the examination was completed, we could not have dragged him over the same territory with a log chain. He expected to find a de luxe condition, but on the contrary, he found and experienced in a small way what our boys had gone through from the beginning of the survey. It was most gratifying to me, however, to see the wonderful improvements made in living conditions and in the development

work in general. I realized more fully than ever before just what kind of men we had with us and what an outstanding program they were carrying on in this South American country.

Left New York on September 30th on the steamer "Maracaibo," reaching La Guaira on October 9th. Visited Macuto, lying east of "the port of Guaira, a neat little village on the seacoast, then went west of La Guaira along the coast, as far as Cabo Blanco. Oligocene fossiliferous series outcrops along this part of the coast.

Oct. 11-12. Went from La Guaira to Curaçao and from there to Maracaibo.

Oct. 13-16. Proceeded across Lake Maracaibo and up the Rio Motatan Viejo to Zapatire landing at Mene Grande. Our party consisted of Sewall, Proctor, Bartlett, Bryan and myself. We visited Zumaque No. 1, the first well brought in at Mene Grande, showing the sand which accompanied the oil during the initial flow. Dagenais and Jeffreys joined the party at Mene Grande and accompanied us over the district. Mr. John A. Stokes, Superintendent, and his wife were stationed at Mene Grande.

Visited the fine camp and office at wells Zumaya and Zumba. The country begins to look like an honest-to-goodness oilfield with a steel derrick which was erected at Zumaya. The office building and casing yard added to the reality of the scene. The equipment and building were covered by corrugated iron roofs instead of the thatching. A large sump filled with oil at Zumaya gave it still more of an oil-producing aspect. A hospital building added to the comforts of the camp, and the men lived in cabins made of wood with regulation roof.

The vegetables in the camp are raised in a rather elaborate garden on stilts. The gardeners claim that it is necessary to keep the vegetables off the ground on account of the extreme moisture and temperature, but I believe it was to keep them away from the goats and other animals. Bullocks are still used in transporting pipe about the oilfield, and the Venezuelans live in the usual thatch-roofed houses scattered among the modern wooden and screened houses of the Americans. Messrs. Proctor, Sewall, Jeffreys, Bartlett and Warren were among the party at this camp. A small canoe was used from the "Minmo" (Captain Morris) to navigate the shallow edges of the lake.

Oct. 17. From Mene Grande we went to Punta Iguana in Perijá, where we started the trip inland. The Punta Iguana landing and wharf have fine facilities for handling freight. Inland from here a Ford automobile was used to good advantage on the roads which had been developed. Some of the tractors had trouble in mudholes, but such is liable to happen in any place in the tropics. The Ford automobile sometimes got stuck.

Oct. 18-19. At Arimpia the party slept the night of October 17th on the floor and tables, and some in hammocks in the Red Star Saloon. Some fine exposures of the black limestone were found in the Caño de Agua south of La Luna. We had a fine camp at Petroleo, which included an office, dining room, store house and combination of mosquito-proof structure with palm thatching. Ceilings of the rooms were lined with muslin. The shelter tents were provided for the laborers at Petroleo. Among the wells visited was Zambapalo No. 2, showing the steel derrick construction and corrugated iron and belt houses, very modern in its style and operation.

Oct. 19. At the Petrolea headquarters the wood for some of the construction is cut out of the logs of hard wood and is done by hand with a whipsaw. Going north, we passed Totumo Canyon, where some extremely interesting geology is exposed along the stream bed. The Petrolea camp is up-to-date in many ways, with cookhouses and fine quarters for the men. The important seepage of Dos Manantiales, north of Totumo Canyon, was passed going north from Petrolea.

Oct. 20. The Canon of the Rio La Ge offers some fine exposures of the Coal Series which skirt along the base of the mountains. The rugged topography discloses some of the harder formations in the ridges. Rio Quebrada and Rio Palmar were crossed north of Petrolea. Boyd had a fine camp between the Rio Palmar and Inciarte.

The afternoon of Oct. 20, we rode from Rio Palmar toward Inciarte. We were caught by a terrific rainstorm, and had to make camp before reaching our Inciarte headquarters. This camp was an old deserted hacienda with thatched-roof houses and outbuildings. We hung our hammocks in the best of the buildings and were just getting ready to eat a little supper with the rain coming down in torrents on the outside, when someone looked up in the eaves, or roof, and saw a big hornets' nest with some of the hornets ominously wandering around near the entrance to the nest. It looked as if we were in for a bad night. One of the Venezuelans suggested our getting some dry palm leaves, lighting them, holding them under the nest, then cutting the nest down and letting it fall in the blazing palm leaves. The operation proved very successful; no one was stung.

We had no more than cut down the hornets’nest than we looked up on the inside of the roof and saw a big black snake sticking its head out and looking us over. Those of us who were familiar with the country knew that it was a harmless snake and infested nearly all of the native houses, living in the roof and eating rats and other vermin, and keeping the place cleaned up from such pests. However, Mr. Sewall, who was not as familiar with the country as we were, insisted on having the snake dispatched before he would try to rest. One of the Venezuelans hauled off with his machete and cut the snake's head off with a single blow. We all felt as if we had lost a friend. This did not relieve Mr. Sewall from troubles in sleeping. He had contracted some lumbago in the rain, and with the ticks which infest this country—the worst of any place in Venezuela—he had a most uncomfortable night in his hammock. He was used to a bed. It pays to be used to almost anything before you undertake these trips. Our party in this part of the country consisted of Bryan, Proctor, Boyd, Sewall, Jeffreys, Warren, and Bartlett.

Oct. 21. We reached Inciarte the next morning and after an examination of our fine camp, and Zambapalo Well No. 2, which was quite gassy at the time, we crossed the Rio Palmar, which was swollen and hard to cross, and passed on to Cañoncito.

This is a great orchid country and I filled up my sacks and equipage with all I could carry on my mule. We examined the principal seepages at Caracolial and Los Longos en route.

Oct. 23. The La Paz seepage was visited and carefully examined. We stayed all night near this, the second largest seepage in Venezuela, and the largest one west of the lake.

Oct. 24. We camped at Las Flores the night after leaving La Paz. This was a good native camp and we enjoyed our stay.

Oct. 25. We had lunch under a big tree between La Paz and Maracaibo. It was a hot trail and we were glad to get any shade. We reached Maracaibo on October 25th, delighted to get back to town. The people there, when we arrived, included in our party were Messrs: Proctor, Aguerrevere, Dixon, Bryan, Goldsborough, Warren, Sewall, Maddren, Liermont, Keller, Jeffreys, Martlett, and myself.

Oct. 25-26. The Company has a fine old mansion for an office building in Maracaibo. It has outside stairs, a fine kitchen and dining room, drafting room, secretary's room, manager's office and several bedrooms equipped with wardrobe, beds covered with mosquito netting, wash basins, etc. It is a fine place in which to work in the tropics.

In front of the Company's house was a landing wharf which the "Minmo" and other boats used. A bathhouse and windmill also were a part of our equipment. The windmill furnished all the water needed, except water for drinking purposes.

Oct. 27. Proceeded to Motatan de Tierra on the "Minmo" and thence by a smaller launch to Mene Grande. Dagenais and Roy Merritt were the geologists here at the time of our visit. Zumba and Zumaya were two wells finished in the Mene Grande district

prior to our visit in 1914. They were both producers and yielded considerable quantities of sand with the oil. Open sumpholes provided storage for the oil as produced. Stokes was the head driller, working under Maddren, general development manager. The first drilling equipment used on Zumaya No. 1 was a tripod derrick. It was replaced later by a steel derrick. We used as many Venezuelans as possible in our operations; they lived with their families in the native village of Mene Grande. The office building at Mene Grande was comfortable. Returned to Maracaibo on Oct. 27th.

Oct. 28-29. Our party left Maracaibo on the tramp steamer "Progreso." Was joined
here by Mrs. Arnold.

Oct. 30. From Curaçao we went to La Guaira on the "Philadelphia."

Nov. 1-8. Stayed in Caracas. While there, we explored the city. The most interesting points to me were the orchids in the Plaza Bolivar, mostly Cattleyas. Also, we saw some fine orchids at the home of Mathilde and Rosa Heney, Sur 4, Caracas. We also saw a fine exhibit of the orchids at Mr. Murray's house. They all grow out-of-doors in this area. Mr. Murray and his daughter occupy a fine home. He is representative of some British oil interests in South America. One of the most impressive pictures I ever took was at Mr. Murray's home. The subject was a little girl holding her baby brother in front of a bamboo screen. I called it the "Venezuela Madonna." I learned that my little Madonna died of tuberculosis a year or two later. The Murrays were very kind to us, as were other people who had beautiful gardens in Caracas.

Most of my time in Caracas was taken with conferences with Proctor, Sewall, Doyle and Spencer on company business. Our office force at Caracas consisted of about eleven men besides Proctor and Doyle.

November 12th and November 13th we spent in the vicinity of Brighton at the camp of the Asphalt Company. They have a fine camp here with the machine shops, etc., connected with the

asphalt work and also connected with the operation of the wells adjacent to the pitch lake. Among the equipment is a fine hospital with apothecary's shop, surgical ward, trained nurse and patients' room with plenty of mosquito netting to protect them during periods of convalescence. Many of the diseases of the tropics are borne by mosquitoes, so it is necessary to keep all patients isolated to prevent them from communicating disease to the others.

Nov. 14. The conditions in Trinidad are very different from those in Venezuela, except those around Guanoco. The country is all heavily timbered and is populated in spots. Good, but narrow, roads go from the principal towns out into the country districts. These roads are made of burnt clay pounded up into fragments one-half inch to an inch in diameter. The work is all done by hand; the material is carted on the backs of men and women, and material is pounded into the roadbed by hand. Three or four areas in Trinidad are outstanding, such as Lot 1, Rossant; Stahlmeiers, Lot 5, etc.

The derricks used in the development in this part of the Trinidad oil belt are wood and the standard size, about 56 feet. The oil is collected in sumps which are made by damming up the small ravines that cut the country.

Once in a while a fire starts in the oil on drainage lines and follows up the drainage until it comes to a reservoir, when there is a destructive conflagration, sometimes resulting in the burning of a well. The people are careless in throwing their hot ashes into the ravines back of their houses and in this way the fires may be transmitted for many hundreds of yards up into the oilfields. The fields have been under development long enough so that the area has been drilled according to a set program of spacing and the open areas really look like established oilfields anywhere.

Nearly all the wells flow and a good many of them produce a certain amount of sand. The Vessigny field is one of the new fields discovered since I took over the work in Trinidad and Venezuela for the Bermudez Company and the Trinidad Lake Petroleum Company. Equipment in the Vessigny field is up-to-date, there being good camp buildings and roads connecting headquarters houses with the wells in various parts of the field. Some of the seepages are formed where the roads cut outcropping oil sands. The Lot 1 Camp is a very good one and a good many wells have been drilled in this Lot. They are productive and it has been one of the paying propositions.

Dec. 1. Mrs. Arnold and I sailed from Port of Spain on the British steamer "Scottish Prince" (Capt. E. Naylor). At the time we left the notorious "Karlsruhe," a German raider, was creating havoc among English shipping in the Caribbean Sea. Not only were we fearful of being captured and taken on board the "Karlsruhe," if we were lucky enough not to have our boat sunk with all on board, but we stood a good chance of being on the "Karlsruhe" when the latter was run down and destroyed by British cruisers which were feverishly hunting for it at that time.

We traveled with all lights out at night. No one was even allowed to light a match outside the closely battened ship. A ship's lights at night or the smoke of a steamer by day gave every one the jitters. But we came through without incident. Later we learned the "Karlsruhe" was destroyed.

Dec. 9. We reached New York.

CHAPTER 15

OPERATIONS DURING 1915 and 1916
By George A. Macready

Operations were almost at a standstill during 1915 because of the war in Europe.

Caribbean Petroleum Company did not drill any new wells and confined their operations to finishing up more important geological mapping and maintaining production at Mene Grande. Dagenais, Dixon, Donnelly, Garner and McKee remained in the field and Jeffreys, at Caracas, attended to routine reports.

At Guanoco, Bababui #2 was started not far from Bababui #1 in January 1915, and carried to final depth of 2,665 feet in March 1916. Large quantities of heavy oil were encountered. No other wells were drilled by Bermudez Company.

In Trinidad, two wells were drilled at Lot 1 and remedial work done on others. A wildcat well on Lot 5 was completed as a small non-commercial producer.

Venezuelan Oil Concessions, Ltd. Started three wells near La Rosa in 1915. Well #3 started on April 20, 1915 and was drilling to 1,966 feet in July 1916. Well #4 started on June 18, 1915 and was suspended at 1,220 feet in July 1916. Well #5 started November 13, 1915 and was finished as a producer at 1,112 feet on March 16, 1916. All used a mixup of Galician and Canadian tools.

Colon Development Co. resumed work on its first Rio de Oro well which blew out at 1,000 feet in 1915. Operations still under A. F. Dixon and Mr. Ivenson were then moved to Tarra where, after building a four-mile tram, the first well was commenced late in 1915.

Practically all drilling operations ceased in Venezuela. No geological work was done in eastern Venezuela, but in the Maracaibo basin Dagenais and Garner remained in the field, while Jeffreys attended to reports at Caracas.

On Trinidad, drafts on storage and availability of tanker transport resulted in five additional wells on Lot #1 field, and subsurface work by Macready resulted in five more producing wells in the old Brighton field.

Geological work during the early part of the year, while Macready was on vacation, was handled by Tom W. Barrington, whose interesting articles describe his point of view.

CHAPTER 16
ARNOLD'S TRIP IN 1915

The trip which I made to Venezuela and Trinidad in 1915 was to check the progress of some of the principal oilfields which had been discovered during the past year. On October 8th we left New York on the Red D liner "Caracas."

Oct. 12. We stopped at San Juan, Puerto Rico, where we visited the old Fort Cristobal. I was arrested for taking pictures, but after I had a talk with the commandant, he let me off. He said he didn't want me to see what little guns they had on this fort. At the time they had a German vessel "in storage" in the bay and they did not know when she would try to break out. They were supposed to stop her with gunfire if she made any move.

Oct. 14. We stayed in Curaçao. I was out among the cacti collecting cerions, a small land snail, with the aid of two or three Venezuelans. We collected about a half barley sack full. These living shells were for Dr. Paul Bartsch, of the U. S. National Museum. He was to have them "planted" on another island west of Key West, to see what change in environment, climate, moisture, etc., would have on the characteristics of the shells after several years' residence in their new home. I do not know how the experiment came out.

Curaçao is strictly a coral island and the vegetation is confined to cacti and a few other thorny, hardy plants that can live with practically no water. The domestic water for the island sometimes has to be distilled from sea water, as there is not enough rainfall to collect a supply from the housetops. The "Caracas" was not as good a boat as her sister ship, the Red D liner "Philadelphia," but rode the waves very well, and she had a good commander, Captain Furst.

Oct. 15. Left Curaçao and sailed to Maracaibo.

Oct. 16-21. Went to Mene Grande for another examination of this wonderful field. Jeffreys, Garner and Dagenais were with me. Steel tanks had been erected throughout the field, mostly by Venezuelan helpers under the supervision of one or two white men. A railroad had been put in connecting San Lorenzo with the Mene Grande field. Bridges were put acioss the creeks. A mastodon's remains had been taken from a point on Mene Grande Hill; the spot shows that the remains were enclosed in the secondary sand by exuding oil and surface erosion of the outcropping Maracaibo beds at this point. The mastodon must have become mired in the oil spring at this spot and his remains preserved by the liquid.

Among some of the good wells were Zambel No. 1, Zambador No. 1, and Zumacaya No. 1. Seepage No. 2 on the point of Misoa Ridge comes from the Menito formation in the upper part of the Misoa Sandstone Series. Good exposures of the sandstones were found on the south side of Misoa Ridge. Some of the seepages in the Menito line are almost as large as those in the Mene Grande field proper. The grass in the Quebrada Arenesa is ten feet high and completely covers the country.

The region about Zambel No. 1 well is heavily wooded with trees covered by numerous orchids. Garner and I collected two mule-back loads as we worked around this little well area. Oxen are used tor pulling up cars on the Mene Grande railroad.

Oct. 21. We went across the lake to Punta Iguana and Arimpia.

Oct. 22. Left Arimpia. Where the surface soil breaks down, there is a "basalt column" effect of the clay formed by shrinking and drying. Ferns grow in the sandstone of the Rodeo Series, but it is very seldom exposed in stream beds.

The cabema tree is one of the beautiful symmetrical trees growing in the scattered vegetation of the Llanos country around Los Ranchos east of the Perijá Mountains. The Coal Series and a thick oil sand outcrop in Tinacoa Canyon. The oil sand dips in an easterly direction and is fairly well saturated with oil.

Oct. 23. Coruba to Pueblito on Rio Cogollo.

Oct. 24. In the Canyon of the Rio Piche many fine outcrops of Frontal sandstone, stream conglomerates and oil sands. La Luna limestones, and Cretaceous limestones carrying Trigonias occur. Boyd, Garner and Jeffreys accompanied me on the trip, Rio Piche to Camp at Petrolea, to Maracaibo.

Oct. 25-29. Totumo Canon yields many interesting geological and other features, among which is a very well-defined fault crack down which the water falls. This porphyry shows slickensides on the left wall. The Petrolea-Maracaibo trail contains many trees with various types of orchids. These were collected by me at various times.

Oct. 30. The launch "Minmo" took us to the Island of Toas on the west side of Lake Maracaibo. It yields some very interesting geology. Here we have granite and Cretaceous and Eocene faulted into various relationships along the great Trinidad-Venezuela fault lines. Another island near Maracaibo is Araho, formerly used to house the old pest camp. It is an interesting island, just a piece of flat low-lying land, barren of any but desert vegetation. Pajaro Island, also near Maracaibo, is similar to Araho.

Nov. 1, 1915. Returned to Maracaibo.

Nov. 2. Left Maracaibo for Curasao and I made another raid on the cerions for my friend, Paul Bartsch. I had nine men helping me in this search and I got another large batch of these wonderful little coiled snails. The old famous Hato Ranch House nine miles north-west of Willemstad, Curaçao, was the center of the cerion snail colony.

The quarantine station, the boulders of limestone on the shore, and the remains of an old fort are interesting points on the north shore of Curaçao Island.

Nov. 7. Left Curaçao with Mrs. Arnold on the "Fauna" for Porto Cabello, where we transferred to the "Niagara" for La Guaira. Arrived in Curaçao on November 8. Among the boats which we patronized in our trips along the north shore side of Venezuela in early November 1915 were the French liner "Niagara," on which Mrs. Arnold and I came from Porto Cabello to La Guaira; the Royal Dutch "Fauna," on which we went from Curaçao to Porto Cabello; the Norwegian steamer "Stavengeren," on which I made a trip between Maracaibo and Curaçao; the Italian ship "Bologna," of the La Valatia Line, in which Mrs. Arnold and I came from La Guaira to Port of Spain; and the Trinidad Shipping and Trading Company's steamer "Mayaro," in which we sailed from Trinidad to New York in November, 1915. One of the most beautiful pictures I took in Trinidad was looking east at the sunrise across Port of Spain Harbor from the lighthouse jetty. Another exceptionally good picture was of Supt. Fowler's house at Brighton, with one of the finest furnished porches that I ever remember having seen in the tropics.

Nov. 9-15. Stayed at the Company's house in Caracas for conferences with officials of the Company.

Nov. 15-17. In the oilfields of Trinidad noting improvements and developments since my last visit. The Brighton field was being systematically developed. Also Lot 1, which turned out to be a good field. The Trinidad Oil Fields, Ltd., well No. 66 was brought in for an initial production of 25,000 barrels per day in the middle of November, but on November 19, after producing 40,000 or 50,000 barrels, it sanded up. I was fortunate in getting some good pictures of it when it was gushing over the crown block. That well was not far from Petroleum Development Company's Lot 1 field.

The Devil's Woodpile, one of the largest of the famous mud volcanoes, was visited. This crater blew up with explosive violence severals years ago, sending material for several hundred yards in all directions and destroying vegetation for a radius of many feet on each side of the rims. The Tabaquite oilfield belonging to the Trinidad Central Oil Fields, Ltd., an English company, was examined. The oil from this field is high grade and refined on the premises. Small, stubby, steel derricks are used in drilling the shallow wells.

Nov. 18. Sailed for New York via Grenada on the "Mayaro," Captain Vaughn. Arrived in New York on November 24, 1915.

CHAPTER 17

THE FINAL TRIP TO VENEZUELA AND TRINIDAD

Our South American survey was coming to a close in 1916. The oil industry everywhere was feeling the effects of the war. I left on my final trip on June 25, sailing from New York on the steamer "Caracas," with Capt. Hitchcock, the American Consul at Curaçao, Mr. Work and his wife, and Mrs. Arnold. We arrived at Curaçao on June 28. I left Mrs. Arnold at the Hotel Americano. On June 29 I sailed for Maracaibo on the steamer "Merida," with Captain Johannsen.

July 1. Jeffreys and I took the lake boat, "Nuevo Mara," to La Ceiba, a port at the southeast corner of Lake Maracaibo. The accommodations on these boats are fairly comfortable and the food good, of its kind.

July 2. We continued our trip south along the southeast edge of the lake to Bobures, the terminus of a little railroad that runs from the south end of the lake to the base of the Andes. The town of La Ceiba is built half on the ground and half on stilts over the lake. There is a good wharf here with loading facilities for freight between boat and railroad.

July 3. Continued our trip on the sidewheeler, "Nuevo Mara," westward across the south end of the lake to the Rio Escalante to Santa Barbara and Maracaibo. Coconuts and sugar are the principal products along the river.

[El] Castillo, the terminus of the railroad from Santa Barbara, is an important headquarters for pack animals which carry freight back into the country and products down to the railroad.

July 4. La Chama is one of the towns which we pass through after starting on muleback from the end of the railroad. Although the Rio Chama is impassable in high water, we crossed it in low water. The trail from La Chama to Onia shows good geological outcrops along the Rio Onia, a short distance above the village of El Vigia.

July 5-8. Arrived at Jeffreys' temporary camp south of Caño Frio which he used in protecting himself against the torrential rains which occur in these regions almost daily. He had two good guides in this work, who helped in accomplishing our survey.

July 6-7. We stayed at Jeffreys' main camp in the Onia District on the Caño Colorado. Fine exposures are found along this river. Part of the Rodeo, or La Villa Series may be seen and the Coal Series outcrops farther up the river. The steep beds in this area mark the fault zones and possible unconformity between the lower hard series and the upper soft beds. Landslides are common where steep dips occur.

Two small seepages occur in branch canons of the Caño Colorado above our camp. The largest seepage in the Onia region, Mene Colorado, is found on the hill, fifty feet above the bottom of the second cano above Jeffreys' camp. The second one flows into Caño Colorado just above Jeffreys' camp. The oil in this latter pool is hard in the morning, becoming liquid during the heat of the day, showing its high paraffin content. There is a twenty-foot outcrop of oil sand just above the seepage, which shows the source of the oil. East-dipping conglomerates underlie the oil sands on the river near the seepage.

The vegetation in the Caño Colorado is beautiful, being a combination of the foot-of-the-mountain type and the jungle. The country was full of beautiful butterflies and I caught many of them with my hat. At one place, where they had settled on the wet sand, I caught over 40 at one swing of my hat. This is a great parrot country. I made friends with a pretty tame one, "Lora," which is the Venezuelan name for parrot. Oranges grow in the La Chama country, as do bananas, which are one of the exports.

July 8-9. Went from Santa Barbara to Boca de Catatumbo on the tub "Orion." We were delayed in reaching the mouth of the Catatumbo River, until dark. Like all other large rivers that flow into the oceans, bays, or lakes in the tropics, the deltas are crossed by several branches or mouths of the river. This is very true of the Catatumbo. It is practically impossible to find one's way into the right branch at night, because of the similarity of the topography and vegetation in the entrances of each of these mouths. At this particular time we decided to anchor a short distance up one of the branches and wait for daylight. We were in one of the smaller launches, but expected to have as comfortable a night as can be had sleeping on the benches in the smaller boats. Shortly after midnight one of the most terrific thunderstorms I have ever seen came across the mouth of the river, and we were subjected to the bombardment of the lightning which was really terrifying even to the two Venezuelans who were on the boat with us. As we were the tallest object on the landscape, we of course realized the danger of being struck by lightning, and as a consequence we all peeled oft our clothes and sat around, so that in case we were struck we could get away from the exploding gasoline which might be set off by the lightning. We sat out the storm, and fortunately were not hit, but a more uncomfortable night could not be imagined. As the storm passed, the first light of dawn began to appear in the east, and then began a serenade of small birds, the like of which I have never heard in all my life. I am not familiar with the

details of the bird life of Venezuela, but I concluded that they were large finches living in the vegetation, the roots of which were probably under water a great part of the time. At any rate, there must have been thousands of these birds, each trying to outdo the others in the height of shrillness and joy of its songs. I have often wanted to go back down into that country and would gladly make the trip just to be there during the first hour of daylight. We started up the river shortly after it became light enough to see, and I do not know what time of the morning the serenade ceased, but this was one of my outstanding memories of
Venezuela.

From Boca de Catatumbo to Encontrados we used the lake steamer "Nuevo Feliz." Stayed all night at our camp at Encontrados. The mouth of the Rio Catatumbo has various channels which were formed when an effort was made to jetty the mouth of the channel. This blocked up the river, forcing the water out into the channels toward the north.

The bird life in these delta swamps is most remarkable, finches and other small birds making a beautiful chorus, especially in the early morning. The vegetation on the sides of the Rio Catatumbo from its mouth up to Encontrados simply beggars description. Its variation is from cannas and bamboo trees to various types of water vegetation.

July 10. We sailed up the Rio Tarra, a tributary of Rio Catatumbo, on the launch "Colon." This is the means of reaching our camp at La Paloma, at the terminus of the narrow gauge railroad servicing the Tarra oilfield. Between La Paloma and the Tarra field is Casigua, where the grade steepens up the west flank of the fold. Mules are used for power on the railroad. Caño Cubo extends along the east flank of the anticline, exposing sandstone. An oil seepage known as "Agua Caliente," from which two or three barrels of oil and considerable water flow every day, occurs on the Tarra anticline. The Tarra anticline is a near perfect elongated structure east if and parallel to the Rio Tarra.

July 11-12. The Rio Tarra camp, called "Cubo," was designed, built and managed by Dixon, and reflects great credit to his ability as an architect. The walls of the building are vertical bamboo, with the roof thatched with palms. Dixon gave fantastic names to some of his architectural styles, such as "early Cubo, "late Cubo," etc. We found we got better work out of the Venezuelans in isolated camps, such as La Paloma or Cubo, than we did from the men in camps near native villages.

The boat traversing the Rio Tarra from the Encontrados supply station to La Paloma is the "La Paloma" made for the shallow water. Another boat used here and on the Rio del Oro was the "Colon." It has an elevated wheel house, which gives a good view of the river, often filled with dangerous obstructions. The small cabin and engine room were below, and the culinary department and stove were at the extreme stern. Wood was used for fuel. Gasoline launches and *bongos,* or native dugouts, were also used on the Rio Tarra and Rio de Oro.

While at Tarra I had a native haircut and shave by the camp barber. Venezuelans around the camp are likely to have pets. One of the women at the Tarra camp had parrots and a yonng peccary or wild pig. While at the Tarra camp I busied myself trying to catch the big blue Emperor butterflies which live in the forests. I had poor luck. One of the villagers saw me futilely chasing the big beauties and told me he could take me to a place where I could catch these butterflies by

the hundreds. I didn't believe him. I followed his suggestion, however, and we went back to camp and down to the garbage disposal dump of the camp kitchen. I could hardly believe my eyes. There on the garbage were hundreds of butterflies, mostly Emperors, gorging themselves. I caught all I wanted without any effort whatsoever. It usually pays to follow the suggestions of these Venezuelans.

At the camp were Jeffreys, Terry, the local Jefe, Cole, Avinson, Nixon, Pete Coop-Crank and Mott. We left Tarra on July 12.

July 13-16. Puerto Palo, the Company's deposit on the Rio Catatumbo near Encontrados, was a beautiful camp with bananas and platanos and other fruits growing on the bank of the river. It had been an old ranch.

The Rio de Oro is a branch of the Catatumbo, and one of the former's large branches is the Caño la Necesidad. In this cano were some good exposures of the formations, which are very hard to find in the jungle country.

The unconformity between the Rodeo and the soft, horizontal conglomerates are found near the mouth of La Necesidad. The Maracaibo sandstones also occur here. The camp at the site of the Rio de Oro well is on a sloping bank, and the camp buildings of palms, thatched with the same material, are built on this slope. The well was drilled toward the edge of the river with a wooden derrick fifty feet high. Among the unpleasant experiences in the Rio de Oro country were the visits of the Motilone Indians to our camp. They picked out the cook's camp as the best target and used to shoot their arrows into it nearly every night. Although they raise bananas, sugar cane and casabes, they used to take delight in swiping our bananas and vegetables. We would find their tracks in the morning, but no one was ever able to see the Motilones themselves. Nobody was ever hurt. Can you blame them? We were uninvited guests in their country.

The Sunday afternoon when I was at the Rio de Oro camp, the men were practicing shooting their .38-calibre revolvers at a tree across the Rio de Oro, probably not less than 200 to 300 feet away. Nobody hit it. They finally induced me to take a shot. Although I had no idea that I could even hit the bank, I pulled my gun out in a nonchalant way and lowered it to a quick aim, like a true western cowboy, and let fly. A large block of bark fell off the tree. My marksmanship was proven. I put the gun back into my holster and stood around just as if this were a common occurrence. I was urged to take another shot, but I refused, preferring to quit while my credit was good. When we returned to our deposits just above Encontrados, I decided to take in the sights of Encontrados late in the afternoon and had one of the native boys go with me. We had no more than entered the town when people began to look at me and point their fingers at me, and finally quite a crowd of boys and some men began to follow us. I was quite disturbed because the town had a reputation of being the toughest in Venezuela. I thought they were picking me out as a tenderfoot fit for slaughter. The crowd developed to such a size that I decided to have my man take me back to our camp. We lost no time going home. When we arrived, I asked one of our guides why this crowd had gathered. He replied that they wanted to see and do honor to the great American pistolaro. Encontrados being a rough frontier town, inhabited largely by mule-skinners, who drove burros from the interior, was noted as the toughest in Venezuela. The one thing that they respected more than anything else was somebody who could shoot. I had established a reputation as a real, honest-to-goodness gunman. I let it stop at that and never shot that gun again

as long as I was in Venezuela. I never even confessed to my men that it was purely an accidental shot and that I probably could not have hit the broadside of a barn with the door shut if I had gone into competition with them.

A fossiliferous La Luna limestone outcrop occurs on the Rio de Oro. One of the best exposures is a short distance above the mouth of the Rio Tomas. Caño del Isla and Cano Eusebio are narrow tributaries of the Rio de Oro west and above our camp. These yield good exposures of the La Luna limestone and the sandstones and shales of the Coal Series. Rocky playas along the Rio de Oro are the gathering places for myriads of the most beautiful butterflies that come down to get water. I had devised an amateur butterfly net and secured some fine specimens. So my natural history collecting was not confined entirely to orchids. A small waterfall is formed where the Rio de Oro anticline, which comes down out of the thickly forested region of the north, crosses the river.

July 14. From Rio de Oro camp Dixon took me up the Caño Eusebio about ten miles into the heart of the Motilone country. The launch "Colon" and a canoe were used on this trip. I was a little bit nervous all the time we were on this trip, as it was made up a very narrow cano, with vertical banks ten to fifteen feet high. Occasionally we would find a fallen tree which was used as a bridge by the Indians in crossing the cano along their trail. At the mouth of Caño Eusebio we saw a bejuco or vine line across the caño, placed there by the Indians to steady themselves on a log which formerly extended across the cano, but which at the time of our visit had been washed away. We never got up as far as one of the big Indian houses or camps, but these were not far from where we turned around. Dixon states the big house is fifty feet long or more, and almost as wide. It was used as a communal storehouse. The buildings in which the Indians lived surrounded this big community house. Dixon visited some of these camps. He always found the fires burning in their ovens, but never saw an Indian during his visit. He had provided himself with beads and other things that the Indians like, and left them and taken in return bows and arrows, which we wanted as souvenirs of our work in the country. I had a fine bow stolen out of my New York office, but I still have two arrows.

The Venezuelans use rafts going from one point to another on rivers that have no rapids. All of their household goods sometimes are transferred in this way. We left the Rio del Oro region on July 16 and headed down the Rio Catatumbo in one of the lake boats. The lights of the steamers going down the Rio Catatumbo at night attracted large numbers of moths and insects into the cabin. I captured all I wanted of these moths, squeezed out their insides and pressed them between newspaper pages and sealed the package airtight with tape, then sent the packages home to California. They were in fine shape when I returned home and Mrs. Arnold and I began to prepare them for cabinet specimens. In the midst of this work we were called out of town for several days. When we came back the moths had gotten into the packages which had been mothproofed until we opened them up for airing, and had completely destroyed all these wonderful moths which I had brought back with me. Among the specimens were a large number of fine butterflies I had captured on this same trip. They, too, were destroyed.

July 17. At the mouth of the Catatumbo there are three houses occupied by sentinels who transfer people from one mouth of the river to the other in rowboats. One of the impressive sights on Lake Maracaibo is the clouds of gnats over the lake. These clouds, of which I have seen as

many as fourteen at one time, look like the smoke from a coal-burning steamer. Millions of these small mosquito larvae are included in each cloud.

July 18-19. The Venezuelan Oil Concessions Company has a fine camp at La Rosa, southeast of Maracaibo in Bolivar, which Jeffreys and I used while we were in this part of the country. Here they have storehouses, blacksmith shop, stables for horses and mules, etc.

The wells of the company are six miles east of La Rosa, near Majuga Hill. Good sized seepages are found three miles from the wells and six miles east of La Rosa. Well No. 5 was 1,112 feet deep and produced oil of forty degree gravity. Well No. 1, at the south end of the lagoon one-half mile south of La Rosa, was 1,432 feet deep. Well No. 4, one mile south of La Rosa, was 1,220 feet deep.

Coconut husks were used in construction work on the houses which had horizontal rods along the outside, with the husks as filling in between. In the garden of Mrs. dark at La Rosa, on account of the insect pests, it is necessary to have many of the plants grown in pots which are insulated from the ground by oil. Night blooming cereus are found on the trail east of Escondido. The large buds, which were seen at various points on the plant, had all bloomed during the period between this date and my return from El Consejo.

July 20. We stayed all night at one of the houses at El Consejo. The construction here is horizontal beams with mud filling and palm-thatched roofs.

July 21-22. Hills encircle Los Tablazos seepages which occur in an eroded out dome. In this part of Bolivar the country is hilly, the hills being associated with the structure. Galmata is in this hilly belt. Our camp was in a clump of bamboos on the Rio Churuguara near Los Tablazos. Dagenais dug trenches through the seepages to ascertain the dip of the beds from which the oil was coming. One of Dagenais's peons was murdered for his money by another of his peons on the trail west of Los Tablazos. They were hunting for the culprit when I was there. The Saladillo seepage exposes thoroughly saturated oil sand. In the semi-arid region near Los Tablazos are many varieties of orchids growing on the trees. The region of Saladillo seepage is also peculiarly rich in the commoner varieties of orchids. I obtained some fine pictures and many specimens of these beautiful plants, some of them in bloom. They grow largely on the trunks and limbs of the trees.

July 23. We spent in the vicinity of El Consejo.

July 24. The region about Molotal furnished some encouraging geological features, especially on a hill called Gamelotal. There are cienagas throughout this country, but they are few and far between, and water is very scarce. Jeffreys and I came back from the Escondido-Molotal trip with one mule completely loaded down with the orchids I had collected in this interesting region. We ended our trip at Santa Rita, the capitol of Bolivar, and took a boat for Maracaibo. Santa Rita has some fine buildings, and graceful and remunerative coconut palms grow throughout the town and along the shore of the lake.

July 25. Took the "Merida" to Curaçao, where I was joined by Mrs. Arnold, and we proceeded to New York. I have a fine view of the wharf and customs house at Maracaibo taken from the

stern of the "Merida." It is said that the most beautiful view of Maracaibo is that seen from the stern of a departing vessel.

On our return trip we were not allowed to land at Puerto Rico on account of the quarantine against smallpox. Part of our passengers was a group of circus people who had been playing in Venezuela and Colombia. They disembarked at San Juan. We arrived in New York on August 30, 1916, and this ended my field work in Venezuela.

The war had materially changed all the conditions, not only in Europe, but in other parts of the world. The Company had practically come to a standstill in Venezuela. Furthermore, they had gradually switched the responsibility of its exploration from my supervision to that of the Hague. Most of my boys had come home to the States and I felt this was an opportune time for me to sever my connections with the Company.

PART III
CHAPTER 18

BARRINGTON'S ENTRY INTO TRINIDAD
By Thomas W. Barrington

My work in the South American Oil Exploration began in 1916. I was sent to Trinidad. Storm warnings were posted and we were loaded to the gunwales, but we sailed on schedule. I well remember the empty oil drums lashed to the deck. My cabin mate was Bill Brookover, a driller from the southern part of the country. He had never been to sea. Soon after we left New York we were in the midst of a great Caribbean storm. We were lucky, at least I thought so, to pull through safely.

I wrote what I thought would be my last letter home and sealed it in a pickle bottle, to be turned loose in case we foundered. I was not seasick, but my fellow traveler was dead to the world. In our flooded cabin, suitcases were sloshing about with every movement of the boat. Some days after, hundreds of miles off our course, in a calm and placid sea. Bill staggered on deck and demanded to see "the guy that runs this thing." He said, "If the so-and-so doesn't know any more about where we are than I do, we're lost." However, we arrived safely at Port of Spain, and I soon got into my job.

In connection with my geological work, I soon became initiated into public relations activities. It was my pleasure to meet Teddy Roosevelt and his charming wife while they were visiting Port of Spain. What an experience it was to meet and be with that virile and vigorous American.

My informal and casual assignment was "to do anything I could for Theodore Roosevelt while he and his wife were visiting Trinidad." I considered this one of my most valuable experiences. I suppose it came about because we were both Harvard men. It was rather a fateful time in our country's history. Wilson, our President, and Teddy were not cast from the same mold. Wilson's actions, which for a time put him in the role of one "who kept us out of war," irked Teddy. He felt that Wilson's continued notes to Germany were not worth the paper they were written on. In his opinion, Germany's policies were driving the United States closer and closer to war. People

were full of our neutrality; the invasion of Belgium; the sinking of the "Lusitania," and Germany's submarine policy.

In the few visits I had with Roosevelt I had the awesome feeling of his greatness. He was such a virile, enthusiastic and forthright man, and a great believer in taking action when it was necessary. Those were the days of the Bull Moose and the Progressives. Bryan was our Secretary of State. Roosevelt had an idea that he should organize a Division and take it to the European front, like his Rough Riders in Cuba. However, no one seemed to be overly enthusiastic about it.

He had a tremendous knowledge of South and Central American affairs and often referred to the great value of our Monroe Doctrine. I got snatches of his South African trip and also of his South American experiences on the River of Doubt. I also gathered that his tenure as Police Commissioner of New York was of particular political value. I believe this great American gave me something of inestimable value. My pictures and notes were destroyed in the Berkeley fire of 1923, but I wrote Mrs. Roosevelt after Teddy's death, and she was good enough to send me a picture which I had presented to Teddy.

CHAPTER 19

GENERAL STATEMENT
By Thomas W. Barrington

Observations of a Geologist

On preliminary surveys a geologist must, of necessity, see whatever there is to see and report it all. Some things are vital, some are not, but they all have to be set down. In the final checkup and evaluation they will be sifted out; some utilized; others discarded. Avenues and methods of transportation, food possibilities, animals and birds, etc.; everything at first is important.

The occurrence of oil or asphalt impregnated strata is more often than not indicated by the type and kind of verdure present; streams and water courses expose under-the-surface structure and its characteristics. Also, kind of strata, inclination, thickness, tell-tale fossils, etc., all accomplish what no other natural agency can possibly achieve.

It was all these detailed preliminary observations by the geologists working with him under all sorts of handicaps, natural and otherwise, that enabled Ralph Arnold, the Chief, to bring to light the enormous petroleum resources in Venezuela, and to apply the knowledge gained to the successful development of these resources.

There was no single place reported upon as worth looking into from the standpoint of oil possibility that Mr. Arnold did not personally visit and examine. Also, from haphazard guessing as to where well locations would be successful, as in the early days of Trinidad production, to success in the developments. The application of the knowledge gained from geological surveys and studies, was the program which cut down dry holes and enormous expense in Trinidad and made Venezuela what is now the second largest petroleum production area in the world.

Trinidad

Trinidad is the largest and wealthiest of the British West Indian colonies. Port of Spain is the major city and seaport. The island was discovered by Columbus in 1498, but was not colonized until the 16th century by the Spaniards, and later, in 1802, became British by the treaty of Amiens. It is today one of the most important oil-producing areas of the British Commonwealth. Evidence indicates that the island was at one time a part of South America. It lies off the coast of Venezuela, being separated from this mainland by the Gulf of Paria, a shallow, almost inland sea. Roughly rectangular, with an area of 1,862 square miles, Trinidad has two peninsulas; one on the northwest corner, and one on the southwest corner, both pointing toward Venezuela. The sea opening from the Gulf of Paria, into the Caribbean on the northwest, is called the Dragon's Mouth; that into the Atlantic, on the southwest, the Serpent's Mouth—both of these being outlets of the mighty Orinoco River. Perhaps the Gulf of Paria between these outlets is merely a great eddy at the mouth of this huge river. Port of Spain is on the south side of the above noted northwest peninsula. Brighton, where our headquarters were located, is on the north side of the southwest peninsula—both Brighton and Port of Spain facing one another across the Gulf of Paria. San Fernando is an important town on the east side of the Gulf of Paria, south of Port of Spain.

There are three ranges of uplift running across the island from west to east. The ones on the north and south border the sea; the third roughly bisects the island. None of this mountainous country rises much over 3,000 feet in altitude, and between the three higher areas referred to, run two depressions or valleys called basins. It is in the southern basin where the oil deposits of any consequence are found. In view of the fact that Trinidad's profuse indications of oil, in the shape of seepages, etc., were a forerunner of the development of oil on the island, just so has been the consequent development on the mainland of Venezuela.

Trinidad is densely covered with tropical vegetation. The rainfall is heavy during the so-called rainy season—June to December—averaging seven to ten inches a month and one to three inches during the dry season December to June. When downpours occur, they appear to inundate everything, coming suddenly but are over as quickly, to be followed by bright sunshine, making the jungle growth steamy and humid. As a result, tropical verdure is dense and beautiful, and flowers are brilliant and profuse. The temperature ranges from 65° to 95° Fahrenheit.

One of the beautiful characteristics of the island is the fine white sandy beaches, unbroken for miles, of which Manzanilla Beach on the eastern coast is famous. Another is the curving, miles-long beach on the way from Port of Spain to Brighton.

The white population of Trinidad is English, French, Spanish and Portuguese. The colored people are natives of the West Indies, largely of African descent. Here and there one meets East Indians. English is the universal language with a local "patois" prevalent in the villages and markets. Trinidadians are a very happy people, easy-going and full of music, as for instance, Calypso music, which originated in Trinidad. There are many festivals, one of which is at Easter-time, and getting to be quite as famous as the Mardi Gras at New Orleans. The people get together a lot, one of their colorful meeting places being the open-air markets, where native fruits and vegetables, trinkets and handwork are seen in profusion.

As with all cities of any age, Port of Spain has an old section, Marine Square and Charlotte Street, much like the French Quarter in New Orleans, full of history and tradition.

Venezuela

Venezuela covers the northern end of South America, bounded on the west by Colombia, on the south by Brazil, and on the east by British Guiana.

The chief topographic features of this country are: the northern mountains and the Guiana Massif or Highlands, the Orinoco valley and delta, and its eastern coastal swamps. The northern coast is highly mountainous, apparently an eastern spur of the Cordillera, dropping abruptly to the Caribbean except for the Maracaibo basin, and interrupted by a low break near Barcelona. These mountainous areas reach an altitude of 8,000 feet. The Guiana highlands extend into British, Dutch and French Guiana as well as Brazil, and these highlands have the determining influence on drainage into the Orinoco and the Amazon. The Orinoco rises in the southern part of Venezuela, flows north along the Colombian border, and then swings east around the Guiana Massif, taking its drainage from the northern slopes of these highlands and the southern slopes of the Andean spur referred to above. The Orinoco delta is a huge, triangular region, approximately 150 miles from one extreme point to the other, through which flow its various outlets into the Atlantic. On the Atlantic edge of this delta is a strip of tidal swamp often fifty miles wide. The great Llanos or plains of the Orinoco basin are

> almost flat, grass-covered sabanas, interrupted here and there by densely wooded water courses.

Caracas is the capital and the largest city of Venezuela. It is the important business, political and social center of the country, and La Guaira is its port of entry. Ciudad Bolivar, on the Orinoco, is a trading center for rubber and cattle from the Llanos. Barcelona, Cumana, Guanta, Carupano and Cristobal Colon are important coast shipping points, and Maracaibo is the chief outlet for petroleum.

Except for the few arid areas referred to previously, the rainfall is heavy in most of the region, reaching 60 inches annually in the areas bordering the west side of the Gulf of Paria, and 80 to 100 inches in the swamps to the south. There is not a great seasonal difference in climate throughout the year. The temperature ranges from excessive heat at sea level to perpetual snow on the high peaks near the Colombian border.

The early settlers were Spanish and they chose the highlands of the Andes, in the main, as the most pleasant places to live. They settled several towns along the northern coast—Cumana in 1520 and Coro about the same time—and in the years following extended their occupation inland into the mountains, establishing towns at frequent intervals. These towns were systematically laid out with a central plaza surrounded by church, civil and military buildings. Surrounding the plaza, streets were laid out for shops and residences, all more or less on the order of Old Spain. The upland climate was cool; there were no swamps; crops were good, and the people were active and progressive, more so than in the low altitudes where cocoa, rubber and coconut growing attracted some of the early arrivals. There were no large-scale farms, most of the cultivation being casava, plantains, corn, yams, okra, etc., with fruits such as oranges, mangoes, limes and bananas—all for local use. Most of Venezuela's important products, such as asphalt,

coal, oil, rubber, cocoa, coffee, iron ore, and cattle are exported in exchange for manufactured articles.

In Venezuela the white population is Spanish, French, American, and Dutch. The preponderant native population is of American Indian origin, these being the original inhabitants of Venezuela and its adjacent islands. The only pure Indians remaining are the Caribs in the interior, the Guaraunos who live in the dense swamps, and the Motilones, an unfriendly and warlike tribe in the mountains. The American population has increased with the increase in oil production. Spanish is the universal language, and here, as in Trinidad, one meets with a pigeon mixture of all the languages present, this one called "Papiamento," among the fishermen, traders, etc. Portuguese is also a frequent method of communication almost anywhere.

Vegetation

Plant life is abundant throughout this Central American region. Plenty of rainfall and tropical temperatures foster a natural growth which is phenomenal. Trails through the underbrush, cut one day, seem almost to need recutting the next. Growing things everywhere testify to these lush conditions. One would think the lumber possibilities tremendous because of the many varieties and large growth, the estimated tree height in innumerable places being 100 feet, but in general the product is soft and commercially undesirable. Any occurrences of hardwood are associated with the mountainous sections and are consequently not too accessible. In fact, early requirements for drilling-rig timbers were such that they had to be shipped from the United States, this being better all-around and far more economical than to attempt to furnish them from local sources. Many kinds of palms and mangroves grow in abundance along the coastal sections, the exposed roots of the last named, at tidal level, being an ever-present source for masses of oysters. Cocoa and rubber trees occur back from the coast and at higher elevations. Where the rainfall is heavy, the timber is practically impenetrable. Large areas of the Orinoco lowlands, sabanas, have few trees, but are covered with a heavy growth of saw-grass, often five feet high. To pentrate this is to have one's clothes ripped to ribbons. Coconuts grow in the sandy coves along the coast.

Flowers grow everywhere. The bougainvillaea and royal poinciana or flame-bush are rampant in Trinidad. Once, while watching a gathering of monkeys in Venezuela, immediately after a heavy rain, I heard splashing water and upon investigation it turned out to be a fairly large bird, pigeon size, taking a bath in the upturned petals of a huge flower, not unlike a magnolia blossom. One sees orchids, large and beautiful blossoms, in many places. Cattleya Mossaie and other species are plentiful. In one place, on the side of a small stream bed in Trinidad, I saw a mass of pink and lavender orchids which must have been at least one hundred square feet in area, a sight never to be forgotten. Orchids from Venezuela have been the quest of plant hunters for years.

Arnold tells of orchids at Guanoco; that one of the interesting experiences he had in collecting orchids around the lake there involved the finding of a number of rare specimens in the tops of big trees. One time he went back to camp and got a couple of peons with axes and they chopped the complete trees down, collecting the orchids out of the branches, which otherwise would have been impossible to get. From one of those big trees alone he collected about fifteen kinds. Some of them were in bloom and were gorgeous, a single stalk with forty or fifty beautiful flowers waving out among the branches of the trees.

Transportation, in its many different phases, is of considerable interest. Trinidad has an excellent rail system, the main line running out of Port of Spain and fanning out in three general directions—east to Sangre Grande, south to San Fernando and Siparia, with a main branch from this line southwest to Rio Clara, and a smaller branch east from San Fernando to Princes Town. An asphalt paved road system joins all the cities and towns on the island.

In Venezuela the contrast is noticeable in both rail and highway lines of communication. A few short railroads exist, those around Caracas being best, but wagon roads were not plentiful and the favorite and general method of travel away from the coast or waterways was by burro. The original transportation system being laid out primarily for animal travel, the result was that pack-trails were very direct from point to point, and as grades were not too objectionable, the trails went pretty straight up and down hill. In a few places, as on the flat plains, and near a few of the less mountainous towns, provision was made for two-wheel cart travel. Macready gives the burro or donkey the distinction of being the most important domestic animal in Venezuela, an undisputed position established by him, in the freight and passenger picture in many other parts of the world. There are very few places, trail or no trail, that a burro and his load cannot negotiate, and in Venezuela this has been true since the fourteenth [sic] century. It is interesting, there, to note how eggs are transported. They are wrapped in banana leaves to form a long string, tied closely between each egg and the ends of the string tied together in a ring, which is hung around the burro's neck. A burro will seldom bump his head or neck, so his necklace arrives intact. As a riding animal, the burro is a trustworthy method for non-walking humans to get around. Surefooted and sensible, when the going gets rough he can be relied on to keep going. It almost has to be quicksand to stump him, and if our four-footed friend gets into trouble he merely waits for help. No thrashing around like a mule or a horse; he is the epitome of sublime faith in the arrival of assistance. In Venezuela he travels with the load on his back, because the trail is his path; in Trinidad he is usually hitched to two-wheeled carts, because of the good roads.

The mule was used in Trinidad during the early days for hauling heavy equipment, until it was replaced by motor vehicles. For passenger travel, they were hitched into surreys. In Venezuela they were used as saddle animals and occasionally as pack animals. For well-to-do people, the horse was the usual mode of travel both in Trinidad and Venezuela. Quaint old horse-drawn cabs driven by sleepy Negroes were a familiar sight in Trinidad, and planters used a two-wheeled trap on the side roads and from home to town. "Overlookers," as foremen were called, used saddle horses for going about the fields. There were very few wheel-drawn vehicles in any Venezuelan town, nor roads suitable for their use, to any distance. In Trinidad both racing and riding were pleasurable pastimes. In the Llanos country of Venezuela Macready observed the practice of riding inside shops on horseback to make purchases. Quote: "Local retail stores in small villages have a high entrance, with shelves around the wall for merchandise. Walls are adobe or palm-thatched like the roof; floors are dirt, slightly higher than the ground outside, so that water will not run inside. A customer rides through the door and up to the counter to make his purchase without dismounting." Horses are small and "rat-like" at best, in all tropical countries, and little attention is given to breeding.

Navigable water travel is by canoe or boat. Rubber gatherers, outfitting at Ciudad Bolivar, use large dugout canoes or flat-bottomed boats fitted for sailing, rowing or poling. These flat-bottomed boats usually have a small hut on board to accommodate the whole family—pigs,

chickens and all. Some shallow draft paddle boats are operated on the Orinoco and also sailboats and small steamers. Boats fitted for poling in the upstream shallows are built with planks about 18 inches wide for gunwales. The crew work in pairs, one on either side. They start poling from the bow and keep walking to the stern, returning to the bow to start poling again, with a third crew member always at the bow to fend the boat away from the bank or to keep clear of snags.

Of the rivers which flow out of the Perijá Mountains, many are navigable for canoes upinto the mountains for a short distance, and for canoes and light draft boats in the lowerreaches of the river. One of the greatest dangers of navigation, especially in high water, lies in the fact that if you are thrown into the water and away from the canoe or boat, it is almost impossible for you to find a place to escape from the river. Bamboo thickets grow down into the water on the banks, and it is not possible to find an opening in these thickets. One might hang on to the vegetation along the river, but he would starve to death before he would be able to get help. This, of course, does not apply to cases where there are two or three people in the party who can be of mutual assistance. Some people fear snakes and alligators in the rivers. In addition, there are those little man-eating fish that bite like a dog. An account of this is given in another part.

Railroads in Venezuela approximated a total of about 500 miles in 1912. Macready has very clearly enumerated these, as follows:

1. A short line near Imataca for transporting iron ore.
2. A seven mile Asphalt Company railroad from Guanoco to Bermudez Lake, in Sucre.
3. Twenty miles of railroad from Guanta to Naricual coal mines, in Anzoategui.
4. An excellently equipped rail line from La Guaira to Caracas, about 25 miles in length, in Distrito Federal.
5. A well equipped railroad from Caracas to Valencia, about 100 miles in length, through Distrito Federal, Miranda, Aragua and Carabobo.
6. A well equipped railroad, about 30 miles long, from Valencia to Porto Cabello, through Carabobo.
7. A crooked narrow-gauge line, about 100 miles in length, from Tucacas to Barquisimeto, through Falcon, Yaracuy and Lara.
8. A poorly equipped railroad, 75 miles long, from La Ceiba on Lake Maracaibo, to Valera, through Trujillo.
9. A 50 mile railroad from Lake Maracaibo to Merida, through Zulia and Merida.
10. A short railroad from Catatumbo River into Tachira. Local maps showed a railroad also across the State of Miranda. Animal life is varied. Pigs share the honor as scavengers with the vulture. This is of course a generally controlled situation in Trinidad, except for native villages away from cities and towns, while in Venezuela the pig is depended upon to clean up everything. Garbage and other refuse there are ordinarily thrown into the street or on the trail, and sewage deposited among bushes behind dwellings, where it is all hunted out and consumed by pigs. As Macready related, "In spite of all this foul food, the pig is a main source, among the people here, for edible meat. A pig, once killed, can be eaten before it starts to spoil, unlike a beef which provides too much meat at one time, without refrigeration facilities."

Goats are everywhere, like the pig, but more fastidious. They are also used for food, and for milk and some cheese, and from a sanitary standpoint more acceptable. Wherever one finds a

native village, whether in Trinidad or Venezuela, the goats wander at will about the streets and into houses.

Dairy cattle are a source of milk and cheese, and beef cattle for meat. A lot of beef cattle are raised on the Orinoco plains, but it is just fair range beef. Shipment of these cattle is an interesting operation. They are driven down from the mesas to the river bank and there loaded into small sloops or schooners of up to 25 tons capacity, which anchor 50 to 100 feet out. A rope is tied to the animal's horns and it is coaxed or pushed into the water until it is pulled alongside, then a block and tackle is attached to the horns and it is hoisted aboard. As soon as the animal clears the water, the boat lists in the other direction and it is dropped to the deck and penned or tied up. Oxen are used for hauling carts and dragging loads on the Orinoco plains and in those sections boasting natural cart roads near Lake Maracaibo.

Dogs and cats, especially the former, are of universal occurrence wherever human beings live, and are usually half-starved and hungry specimens at all times. They both have their purpose—the dog as an alarm when strangers appear; the cat as a rodent destroyer.

Wherever a few people live, there one sees a flock of chickens which are a source of eggs, and are also something for the table. In some places, eggs are almost like legal tender. Gamecocks are a prized possession. On Sundays, holidays and at local fiestas the game-cock puts on the show. While waiting to go through customs formalities at Cristobal Colon, the writer spent two hot, sultry days watching the local fortunes change hands in the cock-fighting ring. A prize cock seems to get more attention from his owner than the man's wife or children.

Ducks and pigeons do not appear to be domesticated to any great extent in either Trinidad or Venezuela, but the wild varieties are plentiful on the Orinoco plains. The pauji, or wild turkey, abounds in the forrested areas; parrots are everywhere, and with the other birds mentioned, make good eating game.

Flamingoes and ibis are spectacular birds of the tropics. Out on a trip in the Company launch one day, not far from Pedernales, I saw what I thought were trees in blossom, their tops a brilliant red. I asked Captain Westcott, the pilot, what the flowers were. Westcott said, "I'll show you," and pulled the whistle cord. The blossoms at once arose en masse and floated off into the distance, thousands of ibis which had congregated together on the treetops. The trees were instantly denuded of their "blossoms." The same thing occurred many times along the river banks in remote spots, only here, closer to the water, the red was a beautiful pink, the plumage of the flamingo.

Butterflies are one of the sights of the tropics. Like all tropical countries, Venezuela is populated by very large and beautiful butterflies. The best known is the purple Emperor butterfly which has a beautiful iridescent color on the top of the wings, but underneath the wings are very somber colored, simulating the color of the bark of most trees. When it folds its wings, the beautiful coloration disappears from sight and the somber color is the predominating feature. You see these butterflies winging slowly through the forest and start to follow one of them with the idea of catching him. If you could only get one to light, you know that the dark color would make it almost impossible to see him, and Arnold found that they do not light when you follow them—

they keep on going. He tried time and again to catch one of these butterflies and finally managed to get one which was resting on a tree.

There is another beautiful butterfly, the name of which was not known, which stays in the upper branches of the trees and is very hard to catch. It is much larger and light colored, and is evidently quite rare, as it was only on a few occasions that one of these big fellows was seen in flight, and none was caught.

Another beautiful butterfly, light yellow in color, is quite abundant on the rivers, where they congregate on the sand bars. By stealthily approaching them and using his hat as a butterfly net, Arnold was able to catch a great many of them.

Arnold made notes of a large garden spider on his second trip to Trinidad in 1911. In the Company house where he and his wife stayed near Brighton, a large spider had built a web from the railing of the steps to the side of the house at a point which could be easily observed from inside the porch. Mrs. Arnold watched this spider for several days and noted that there were two spiders involved in the project; the large one and a smaller one, which seemed to be a kind of servant. The large one would spin a portion of web and the smaller one would immediately come from his domicile on the edge of the big web and perform certain tasks, and then return to his station. This happened many times and seemed to indicate that the spiders had the idea of the employment of other spiders to help do their work. These spiders were rather fearsome looking because of their size, but were harmless. They apparently are not uncommon in Trinidad. From the standpoint of wild life, the monkey deserves attention. Not encountered too much in Trinidad, the monkey is common in Venezuela. One kind seemed to be of a reddish hue and was plentiful around Guanoco. The writer was invited to attend a monkey camp-meeting while there, and what seemed to be a joke turned out to be a very serious gathering of the clans. It was out in the forest a short distance and I was told of a certain banyan grove where they usually assembled during the latter part of the afternoon. I was lucky. Hardly had I become safely secreted when I heard them coming through the trees. From every direction, even over my head, they swung through the branches into a chattering group in one particular tree. It seemed to be that they had an agreed-upon place in which to assemble and talk to one another, and once they settled down they remained in that spot, talking incessantly. About the time I decided to count the gathering, the noise suddenly ceased and I saw what looked to be an old patriarch approaching. His face was fringed with gray and when he took position in the midst of the group, all the others became quiet and it was he that did the talking. He chattered on for quite a few minutes and when he stopped, the assembled ones faded off into the jungle, like fog before the sun, without a word. Captain Westcott, my companion, and I sat there and wondered just what had been going on. Monkeys can frequently be seen picking oysters off the mangrove roots at low tide. Young monkeys, especially the green or "spider" monkey, are good eating, their diet being mainly fruit and nuts. Humans have little excuse for going hungry in the tropics.

Arnold had a rather disquieting experience with the Red monkeys, called Red Howlers, encountering a herd of these animals while on a trip alone along the edge of Guanoco Lake. These animals are harmless if there are only one or two together, but when there is a whole herd and they become disturbed by a human being, they are dangerous. He was walking too close to the forest and apparently enraged the group, as they began clambering out of the trees and coming toward him. He didn't spend too much time arguing with them, but made a hasty retreat

out to the open, hard asphalt of the lake. They apparently are very much afraid of getting away from the trees which they inhabit. One seldom sees these monkeys on the ground.

Iguanas are plentiful. They are a huge lizard about three feet long with bright colored scales and taste like the finest chicken. Drillers in the jungle, once they become acquainted with this delicacy, avidly watch for iguanas for which they keep a .22 rifle handy. One place to look for them is on the lintel over the door of an abandoned or unoccupied hut. One time the writer was going from the hotel to the boat in Panama, in an open coach behind a pair of horses, when the Negro driver suddenly stopped, pulled a club that looked like a sledge handle from under the seat, and which he apparently kept there for just such a purpose, went off into the brush and after a few minutes returned dragging a huge iguana, my first iguana experience. Lizard, eel and rattlesnake aren't so far apart, after all.

Trinidad is the home of some very large members of the iguana family. The common variety looks like a tentative form of some of the earliest animals which roamed the earth in early ages. Since they seem ordinarily to be rather slow moving, it was Arnold's ambition to catch one, and he thought that maybe he could run one down in some way. In working along the shore of the Gulf of Paria on the southwest side of Trinidad, he happened to spy one of these big iguanas on the bank. Right near him was a tree which extended out over the water, there being a straight drop from the edge of the bank into the shallow water. Arnold walked up toward the iguana, which evidently didn't like his looks, and streaked up the tree, Arnold after him. When the iguana went out on the end of the limb over the water, it was thought that he was cornered, but when Arnold got within five or six feet of him, the iguana took off like a flying bird, landed on the water and began to run on the surface. Arnold immediately lost all interest, as he figured that any animal which could climb trees, fly, and run on the surface of the water was beyond his capabilities.

Jaguars and tapirs are not commonly observed. One of our parties in the country west of Porto Cabello was going down a *quebrada* when one of the men lingered behind. In trying to overtake the party he noticed tracks of a jaguar and was impressed with the fact that these tracks were later than the footprints of his partners. He did not try to track down the big cat. None of our men ever saw a jaguar in the field. Arnold once saw a tapir that had been killed, but this was as close as anyone came to this animal.

Snakes are common, especially in Venezuela. Boas grow up to four inches in diameter and many feet in length, but they are generally sluggish and harmless. On the way to the Lot 1 field, in Trinidad one morning, while riding with Bostaph, the drilling superintendent, we came across a big boa, head in the underbrush on one side of the road and tail

out of sight on the other. The road was of about forest reserve width, so that one wasn't too large, but it looked like a fire hose across the road. After that experience, the writer had a vague idea that his wife, never having seen anything larger than a garter snake in the garden at home, might like to get one of these boas. So, just before leaving the island for home, I remembered to give one of the colored boys at Brighton a dollar and he brought one in about fifteen feet long. We dried the skin and rolled it up into a compact package. After I presented it at home I never saw it again. Presumably my type of mirth did not go over too well.

In Venezuela there are many snakes. One long, thin, green snake is unpleasant to meet because of the possibility in heavy growth of brushing one's face into one, unwarned in advance. They are hard to see until they make themselves known. Climbers after orchid plants encounter them frequently. Macready told of seeing a rattlesnake in the Trinidad museum, known as the "Cascabel," which was eight feet long. He also encountered the "Cribo" in Venezuela, a big blue racer with a bright yellow tail that makes a startling noise, crashing off into the brush when surprised. Bosworth, the English geologist, killed a ten-foot bushmaster in Trinidad, with fangs an inch and a half long. While Arnold was making an examination of the Trinidad Petroleum Company's properties at Brighton, on his second trip to the island, he and Mrs. Arnold had quarters in a house belonging to the Company. These houses are built up on piles or pillars resting on cement blocks. They are entered by steps from the outside and are completely protected from mosquitoes by netting which is at every opening. Shortly prior to the beginning of the examination, a clearing had been made in the forest to permit the erection of a well derrick, and the brush and trees from this clearing were piled in a large heap in one corner. As soon as it was dry enough to burn, several weeks after cutting, because of the daily rains, it was decided to burn the brush and clear the debris away. Shortly after the brush started to burn, the men noticed a large boa coming out from under the brushpile and proceeded to kill it. A little later another boa came out and it me a similar fate. Then a third boa came out from under the pile and it was also dispatched. These boas were 17 feet, 19 feet and 22 feet in length respectively. They were skinned and the skins were tacked on the beams under the house where the Arnolds were staying. The thought of living in a house, the underpinning of which was adorned with boa constrictor skins, wasn't too pleasurable to Mrs. Arnold.

These boas are common in Trinidad and all over the Orinoco River delta region, and attain a very considerable length. On one trip from Trinidad to New York, Arnold saw a 33-foot boa in a cage, which was being shipped to the New York Zoological Gardens.

Alligators are common in the swamp lagoons of the Orinoco. They are not too large, but one has an uncomfortable feeling when he realizes what is under those two knobby eyes squinting at him from the lily pads. At a distance they can be seen in the mornings, stretched out on the muddy shore, basking in the sun or floating in the water with forelegs or arms and snout exposed on the surface.

One of the outstanding bodies of water in the Maracaibo Basin is the Sinamaica Lagoon, which lies at the mouth of the Rio Limon in the northeast corner of the Maracaibo area. This lagoon is surrounded by the usual type of vegetation in that part of Venezuela and it has a shallow sandy bottom. The depth of the water does not average more than four or five feet, and in many places the sand bars lie just under the water and make navigation with even shallow draft boats rather difficult. The point of interest for the tenderfoot in Venezuela is the fact that this lagoon seems to be the center of distribution for the alligators of this part of South America. One does not start across the lagoon without seeing numerous snouts and eyes sticking out of the water, and one of the interesting experiences is to have the boat get stuck on a submerged sand bar. Then all of the passengers get into the water and push the boat off. In this event there was always a very curious addition to the party; in every direction there would be seen countless noses and eyes of alligators taking in what was going on, an audience not too quieting for the nerves. This was a frequent experience crossing the lagoon to the rivers and streams which flow into it.

Small land turtles are caught by the Guarauno Indians on the llanos, by setting fire to the sabanas in the dry season. Large sea turtles are plentiful in the Caribbean, and a large fresh water turtle, a species of the leather-back or soft shell variety, is found in the delta of the Orinoco. These and the Caribbean turtles weigh several hundred pounds apiece.

Frogs are commonly encountered both in Trinidad and Venezuela. One known as sapo in Venezuela grows to enormous size, said to be a foot or so in diameter when hunched up. The very first evening at Guanoco, when I was walking up to headquarters from the dock, I heard something clumping down the path toward me, and suddenly, in the half light, I saw that it was a huge frog. I must have jumped six feet, because I had been told about them and that they exuded a viscous fluid from their pores which was poisonous. Whether true or not, dogs keep away from them, and that fellow had the trail all to himself that evening. The mate of a Norwegian tanker encountered a sapo in the toilet bowl at Guanoco and decided right then and there it was safer to stay on board

ship. Macready relates finding sky-blue frogs embedded in the clay five feet below the surface in geological test holes at Pedernales.

Bats and little owls are a problem to man and beast in both Trinidad and Venezuela. In caves and heavy jungle, one has to watch out for bats, although they fly unerringly in the dark without collision. When disturbed, they take wing in droves, in an eerie whir and squeaking flight. It is the practice, where dairy cows are kept for milk, to hang a lighted lantern beside each cow at night to keep the bats from swarming over the cow and sucking its blood until it dies. The caves near Caripe del Guacharo in the mountains west of Guanoco are filled with thousands of bats.

On one of Arnold's trips down the eastern side of Lake Maracaibo, he rode a gray horse, and one morning when the animal was saddled it was noted that there was a streak of blood down from the shoulder. Upon asking one of the peons what caused the wound, it was explained that it was from the bite of a vampire bat. The bat had bitten and sucked considerable blood, but much more had flowed down from the wound, so that the horse was quite groggy during the day. It was also explained that if the party had stayed at the same location, the bats would have returned, bitten the same horse and taken out another batch of blood. A similar experience on a third night would probably have laid the horse completely out, whereupon the vultures would have attacked him, picked his eyes out, and he would have died a terrible death.

This vampire bat is of small size, but it is feared by the Venezuelans because it can bite and one does not feel it. They seem to anesthetize the bite by fanning with their wings. They can be scared away at night by keeping a light burning. If you sleep under a mosquito net, you are fairly safe providing you do not let a toe or other part of your body rest against the net. Any part of you that a bat can reach at night will invite attack, with result that you will not feel it and, like the horse described above, you will undoubtedly lose a lot of blood. There is also a distinct danger of infection.

Little owls, two or three inches over all, nest in the foliage on the verandas of houses. The writer had been invited to dinner at the Siegert's, the maker of Angostura Bitters in Port of Spain; as he walked up the lighted drive to the house, two of these small owls, apparently nesting and

disturbed by the intrusion, flew out and into his face, pretty nearly knocking him off balance. My host told me that he should have warned me because the birds were quite a problem.

There is a wild deer in both Trinidad and Venezuela, but it is very small and for some reason or other has very little endurance. Drilling crews often flush a deer in the brush and then run it down on foot until it is exhausted. This is often called the swamp deer and is not unlike in size and color the small deer found in Scotch forests.

Seagulls, pelicans and cormorants are of general occurrence throughout the tropics, and buzzards are the usual scavengers. When one sees a number of any of these birds it is a sign of a fishing village or town. The forests are full of parrots, parakeets, beautiful hummingbirds and toucans, the fruit eater with a beak or bill so large and heavy that he seems to almost fly upside-down. With the bright colored birds and flowers and the huge, brilliantly colored butterflies and moths, the jungle areas of Trinidad and Venezuela are a veritable paradise of plant, bird, and insect life. However, no such wonderful places exist without their deterrent features. Mosquitoes infest all the low, swamp areas, and are especially bad in the cocoa plantations, where they swarm in clouds. Carriers of malaria and jungle fevers, the mosquito, in spite of preventive measures, is a constant menace to health and happiness. Also the *ant, niguas* and *gusanos,* tiny insects, are extremely troublesome. The first is a small flea that gets into one's feet, laying a sack of eggs the size of a grain of wheat, just under the outer skin, and usually produces a festering sore. The villagers extract them by pricking with a sharp instrument and squeezing out the unbroken sack, but it leaves a pock mark in the skin. Care has to be exercised to prevent infection. The *gusano* lays its eggs anywhere on the body and also causes a festering sore if not attended to at once.

Cockroaches are a particular nuisance in the tropics and they are many times larger than the waterbug of civilization, as we know them. They are a repugnant sight around eating places where they seem to be an accepted evil. The clothes closet, where garments have the slightest amount of spilled food on them, is a certain magnet, and in the drafting room, the starch on tracing cloth or even ink is also an attraction. Lice, beetles, ants and termites prosper under tropical conditions. Lice are carried by people in the poorer localities, and prevention does not seem to be considered necessary. A Hindu coolie squatting in the street gives his passengers visible attention when they become particularly troublesome; a native mother with a child on her lap instinctively searches its hair.

Ants are present in all kinds and sizes, but none draw more attention than the leaf-carrying type, with their century-old channels of travel. Build something like a house or stable

across one of these arteries and you merely divert the horde in through a window and out through a door of the edifice. They pick up again somewhere along the old established route. The amazing feature about their trails is that, in spite of the comparatively small size of this insect, their channels of travel are well defined depressions covered with a mat of tiny leaf pieces formerly carried by individuals who died on the march and whose bodies were pushed out of the way.

Termites are of frequent occurrence and all wooden structures have to be inspected frequently or built to prevent their intrusion. There is a black beetle, called the "Moriche" beetle, which swarms over the freshly cut stumps of the Meriche palm, and they are gathered by the Guarauno

Indians who cook and eat them as a delicacy. Ants, termites, cockroaches, etc. — what attention these millions require in order to ward off their daily depredations in the tropics.

Fish are found to be plentiful, both the salt and the fresh water types. Sharks are frequently seen in the Gulf of Paria, and porpoises occasionally. It is said that one of the old-time sports was spearing sharks from horseback in shallow water. Good sport fishing is always available and the fishing enthusiast can catch a number of kinds in the swamp lagoons of eastern Venezuela. One fish affording much sport off the dock at Brighton is called poua. Anyone familiar with Central American waters and streams knows or has heard of the piranha. This is probably one of the most vicious fish anywhere. Particular care has to be taken in fording streams, and let anyone fall overboard where the piranha exists and it is a ten-to-one chance that he will be attacked in minutes. If an injured person, with a fresh flesh wound, is unfortunate enough to find himself in such waters, these fish are incited at once; blood seems to infuriate them. It is not a large fish, but it is equipped with razor teeth, and it operates in schools. The writer was told of a deck-hand who was lacerated from a fall during loading operations on a branch of the Magdalena River, slipped overboard, and before he could be pulled back aboard his leg was stripped to the bone and he died very soon afterward. Macready tells of how the natives fish during the dry season near Guanoco. They dig a hole a few feet deep until they reach water below the dried out swamp, then beat and slap the water with sticks and branches, thus coaxing the fish out of the mud and then they dip the fish out of the puddle. These fish are small and bony and not good eating, but it is an illustration of how some fish will go into the mud when their usual medium dries up.

Oysters mentioned previously are found by the millions. They are small, not more than an inch or so across, but very toothsome.

CHAPTER 20
GEOLOGY

Supplementary data discovered after the report of November 27,1912

In outlining the status of our knowledge of the geology of northern Venezuela as of 1916, it has been deemed desirable to describe the western parts of the country separately. It is logical to do this, as there is a break in the possible oil-bearing formations in a wide belt from Caracas southward. Of course several of the formations or their equivalents extend all through the northern part of the country, but the two important areas are quite widely separated and their stratigraphy and structure often decidedly different.

Eastern Venezuela

Location and topography

That part of eastern Venezuela which is included in this discussion covers in general the great delta of the Rio Orinoco lying north of the main river channel and the sharply denned, thickly timbered ridges which merge farther west into the prominent range lying north of the great Maturin Mesa region. In addition, the Island of Margarita and the mainland opposite this island, including the Paria Peninsula which bounds the Gulf of Paria on the north, is also included. Most

of the good looking oil territory lies in or adjacent to the swampy lowlands near the mountains. An exception to this is the Pedernales

field which covers parts of three islands lying at the mouth of Pedernales river. The streams or canos draining the area, except those flowing out of the mountains, are sinuous and sluggish and are often affected by the tides.

The area includes the states of Nueva Esparta, Monagas, Sucre and part of the Territorio Delta Amacuro. Guanoco and the greatest asphalt lake in the world, bearing the same name, lie at the point of two of the salient ridges on the edge of the swamp lands; Maremare lies north of still a third salient ridge; while Pauji is situated just south of the base of the outlying hills of the Parian Peninsula range. All of the above are in the State of Sucre.

Transportation in the drier areas is pack train over trails, which are often impassable in the rainy season, while the branches of the Orinoco are navigated by boats of medium draft. The tides determine the period of navigation of some of the canos such as Caño Guanoco. The principal towns are Pampatar (Margarita), Maturin (Monagas) and Cumana (Sucre).

Structure

North of the great Trinidad-Venezuelan fault on Santa Margarita Island the Eocene beds lie steeply tilted against the schist and granite core. Along this fault the beds (one oil sand) near Manicuare stand vertical. In fact, on both sides of this fault the strata are usually highly folded and faulted. The schists at the western end of the Peninsula of Araya are flanked at their western extremity by sandstones which are folded into a low southwesterly trending anticline southwest of Manicuare and lie as a northwest dipping monocline north of Salinas [de Araya]. A low arched anticline in beds containing oil is found on

Cubagua Island. South of Cumana is an asymmetric anticline with steep dips on the coastal (north) side. The beds in the top of the range south of Cumana lie flat, suggesting the crest of a major anticline.

At the junction of the base of the mountains and the Llanos country southeast of Aragua de Maturin, orogenic movements produce structures and seepages. In fact, many oilfields of eastern Venezuela will probably be found in front of the mountain ranges bordering the Llanos and out under the flat-lying Llanos beds which mask the structures in the vast expanses of the Llanos. El Breal and Chapopotal are good illustrations.

The structure at Guanoco Pitch Lake revolves around a major anticline, faulted near the crest with minor faults associated with the major line of disturbance. The possible productive area is confined to the area adjacent to the fault and not extending more than one half to three-fourths of a mile on either side of the apex. The longitudinal extent of the oil-yielding fault system does not extend far beyond the limits of the two parts of the pitch lake. The dips on the flanks of the anticline are of the order of 20°.

The structure in the Pedernales and Capure Island asphalt deposits is a faulted anticline which lines up with the so-called east-west Southern Anticline of Trinidad. From the eastern Capure Island deposits, the line of disturbances swings from N. 80° East more toward N. 45°.

In the region a short distance east of Aragua de Maturin there begins a belt extending to Caripito, a distance of some thirty miles in which the numerous seepages suggest the outcropping of a south-dipping monocline.

In the region of Quiriquire and Sabaneta the limestone beds in the outcrop are steep dipping to vertical. In the El Breal, Chapopotal, Maria near Cantura and Hato Pirital seepage areas, simple or faulted anticlines are believed to exist in the underlying Cretaceous beds.

From Pedernales, near the Gulf of Paria, inland westward to Maturin and beyond for an undetermined long distance, mud volcanoes and other phenomena indicate an anticlinal line of disturbance.

Composition of the Guanoco Shale

Samples of the Guanoco shale from Bababui No. 1 were examined microscopically in thin sections by Dr. Clifford Richardson and the writer. The shale was found to consist of minute grains of quartz and minor quantities of other rock-forming minerals with which were associated considerable quantities of black organic matter not of a soluble nature. About 1% of the rock consists of well preserved remains of foraminifera, a minute form of marine animal with a calcareous test or shell. These foraminifera, together with the other organic remains found in the shale, may contribute to the supply of oil in the region. The adequacy of the foraminifera remains alone, to account for commercial quantities of the oil, are shown by the following:

One percent of the shale (total thickness 3,000 feet) would be 30 feet, the thickness of the foraminifera if they were segregated. If one-third of the animal matter by volume were composed of hydrocarbons, this hydrocarbon material—the supposed source of oil—would occupy a thickness of 10 feet in the series. Or, roughly, the oil that might be derived from the foraminifera would occupy a thickness of 10 feet over the whole Guanoco shale area.

As 1 acre-foot contains 7,768 barrels, 10 acre-feet would contain 77,680 barrels. Or in other words, the forminifera alone could account for 77,680 barrels per acre through the Guanoco shale area.

In zones of concentration, like fault zones or the crests of anticlines, the column per acre would be much more. However, as indicated many times elsewhere, the main sources of oil is believed to be the Punceres limestone Series lying below the Guanoco shale. The writer, however, wishes to call attention to the possibility of the organic remains of the shale having contributed to the supply, and the above discussion is given to prove the possibility of the theory. The absence of any soluble hydrocarbons in the shale at the present time is one argument against their ever having been petroliferous.

The following is a physical and chemical analysis of the shale as made by Mr. C. W. Forrest of the New York Testing Laboratory:

Chemical Analysis of Shale from Bababui Well No. 1—Guanoco
Test ..127574 127575
Specimen ... "A" "B"

Silica Calculated as SiO_2 69.02% 73.03%
Lime Calculated as CaO ... 9.81% 10.80%
Iron Calculated as FeO .. 70% .63%
Alumina Calculated as Al_2O_3.... 3.14% 3.22%
Sulphur Calculated as SO_2 1.16% .97%
Carbonates Calculated as CO_2 .... 8.93% 7.96%
Volatile matter including carbonates.. 12.00% 10.75%
Bitumen soluble in CS_2 .. None None
Magnesia calculated MgO.. 54% .46%
Phosphates calculated P_2O_5 ....17% .16% Ranchos

The Guanoco shale yields small specks of oil from the calcite veins in limestone concretions Guayuta. Otherwise, it has not been found oil-bearing at the surface.

In the region from Aragua de Maturin to Guanoco and at Pauji and Maremare the asphaltum and oil seepages in most instances occur at a certain quite readily identifiable zone including the lower 500 feet of the Guanoco shale and the upper part of the immediately underlying sandstones and limestones of the Punceres Series, both of Cretaceous age. The discovery of this fact simplifies the geologic work, as it now resolves itself into the location of the oil zone throughout the region under investigation. Of determination by actual test drilling of the particular conditions in this zone which tend to the accumulation of commercial quantities of petroleum, without going into details, it can be said that many new seepages and some new information regarding the relation between the seepages and the probable occurrence of the oil have been discovered.

Actual drilling at certain spots can solve the question as to the mode of occurrence of the oil. The drilling of Bababui Well No. 1 has furnished some favorable evidence indicating the presence of oil under tremendous gas pressure, this leading to the conclusion that when oil of a lesser viscosity is encountered commercially productive wells will be developed. The drilling in the Guanoco shale has not proven successful wells, and the conclusion is being reached that only in faulted zones will development prove satisfactory.

Location and Transportation

Under this heading the country from Bobures, State of Zulia, to Coro, State of Falcon, will be described. The principal towns are La Ceiba, San Timoteo, Lagunillas, Santa Ritaand Altagracia, all located on the east shore of Lake Maracaibo. Lake boats from Maracaibo to the lake ports and roads, or short rivers from the ports inland, furnish transportation. A survey had been made from San Lorenzo to Mene Grande by June 1915.

Topography and Physical Conditions

The southern part of the district from the edge of the lake to the foot of the encompassing mountains is occupied by lowlands which rise but slightly from the level of the lake to the foot of the mountains. Isolated hills may rise from the lowlands here, but if so, they have not as yet been discovered. So slight is the gradient of this plain, and so nearly level is its surface, that huge swamps are found at least as far inland as 12 miles from the edge of the lake. The sluggish meandering streams running through these swamps periodically overflow their banks, where the

heavy vegetation checks the flow, and flood the surrounding territory for weeks at a time. The suspended matter which is carried in large quantities by the streams is deposited in these swamps until the adjacent country becomes below grade and the streams are forced to split or select another channel. The process of filling them recommences with the result that another alluvial fan is built up and the channel again shifts.

As a result of the repetition of the overflow and change of channel, practically all of the streams which flow into the lake of this region have two or more courses when they reach the graded belt, and these empty into the lake through various mouths.

Hill Region

The region toward the base of the mountains from 15 to 30 miles inland is made up of a series of alternating ridges and valleys which owe their existence largely to structure modified by erosion. A topographic mapping of this region will doubtless throw much light on the geology of the district.

Mountains

The eastern portion of the district is dominated by the great mountain mass which has its culmination in Mt. Chimborazo, a peak rising to at least 7,000 or 8,000 feet, and visible from everywhere in the eastern part of the Lake Maracaibo region. This mountain mass has received little attention from the geologists, but is believed to be a series of ranges more or less complex in structure, which lie at the point of change in strike from the northeast-southwest structures of Falcon to the north-south structures of Falcon to the north-south structures of eastern Zulia.

Near the easternmost point on the lake is a small but important range known as the Misoa Range. This range is typically anticlinal and forms a secondary but still very important ridge, extending for about 20 miles north from the Mene Grande field. It is separated from the main Trujillo range, a part of the main mountain mass, by a valley varying in width from 2 to 5 miles. Reflecting the north rise of the anticline, the ridge appears out of the plain about 3 miles north of Mene Grande and gradually slopes upward to an elevation of approximately 2,500 feet. The average width of the ridge is about 3 miles. The surface of the range corresponds quite closely to the underlying structure and has been dissected but little. What streams do trench its flanks expose beds which dip from the crest on both sides of the range. Immediately south of the Misoa ridge and genetically related to it is Mene Grande Hill, the dominant topographic feature in the immediate vicinity of Mene Grande.

The Misoa and Trujillo ranges are connected by a lower ridge about 20 miles north of Mene Grande. The low elevation of this connecting ridge is undoubtedly due to its structural position in the syncline which separates the two ranges.

Stratigraphic Geology

The formations involved in the geology of the District of Bolivar are the same as those occurring in the Mene Grande district on the south and the Los Tablazos district on the east and include the Misoa pink sandstone and shale, 2,500 feet in thickness, of Eocene or Oligocene age;

the Paujil dark-colored sandstone 3,700 feet thick, probably of lower Oligocene age; the unconformably overlying Maracaibo Series 400 feet in thickness, of Oligocene or Miocene age, or the Llanos or Quaternary beds up to 200 feet in thickness.

General Statement

The formations involved in the geology east of Lake Maracaibo and along the coast to Coro are similar in general to those described as occurring west and south of the lake, butthere are some major differences in the later formations of important economic values. Misoa formation: this formation consists of alternating beds of sandstone and shale, theformer being white, gray or pinkish, fine-grained, slightly micaceous, laminated and much of it so indurated as to resemble quartzite. The sandy shale phases are thinly bedded gray to reddish brown in color and contain much white mica. The other shale phases are fissile, dark gray in color, and contain relatively small quantities of mica.

The upper 700 feet of the Misoa formation, in the region of Misoa ridge and the Menito and the Ultimo seepages, have been called the "Menito Shale." It consists largely of thedark fissile shale and thin sandy shale and thin quartzitic sandstone phases and is oil-bearing on the western flank of the Misoa anticline, especially near the plunging southern end where it yields important oil seepages. Paujil shale: lying above and closely associated with the Misoa formation is the Paujil shale approximately 3,700 feet in thickness

and consisting largely of shale with some interbedded sandstones at various points, especially toward the top. In fact, it seems likely that toward the northwest the formation becomes more sandy and the alternating sandstones and shales underlying the Maracaibo Series in the region of Mene Grande Hill are probably equivalent to the more dominantly shaly phase of the series found along the flanks of the Trujillo range.

Dagenais states that the upper part of this shale is made up of a succession of thinly-bedded, dark gray sandstone and black shale. Although thinly bedded, this formation is not thinly laminated like the Maracaibo. The approximate thickness of this sandy phase of the Paujil is about 328 feet. It was termed "La Fortuna" by Eckes and later named the "Mene Grande" formation on account of its presence in the highest part of the Mene Grande Hill. This sand phase of the Paujil is oil bearing where it has been found in the Mene Grande ridge, and its outcrops correspond to a line of little seepages extending as far north as the Santa Barbara-Los Barrosos trail. It strikes north and has an average dip of 45º to the east, but locally the dips go as high as 75'. This upper member of the Paujil shale is overlapped unconformably by the Maracaibo and their line of contact marks the northern limit of the seepages in the northern part of the Mene Grande seepage

area.

Below the sandy phase is the massive part of the Paujil, which is hard and almost black when fresh, but weathers into a soft, dark, flaky mass when it is exposed to the air for a few weeks. It is usually very massive and has no apparent bedding, except for a few lenses of concretions and a few streaks of limestone. The concretions are more generally oval or spherical in shape and are made up of a very fine-grained dark brown cherty mass which is much more resistant to the weathering than the enclosing shale. The center of these concretions is very often composed of iron pyrites and c.alcite. This shale is not a relief-forming rock and consequently its outcrops

usually correspond to the valleys. The formation is best exposed in Quebrada Maximiliana, where it has a thickness of about 3,608 feet. It has never been found to the west of the Misoa Range, but its absence there is readily explained by the probable overlapping of the Maracaibo formation. The relation existing between the Paujil shale and the Maracaibo Series on the east slope of the Misoa Range has not as yet been satisfactorily worked out. Along the Trujillo Range the Maracaibo and the Paujil are separated by an unconformity which is shown by the gradual overlapping of the Maracaibo, beginning at Quebrada Maximiliana and extending to Quebrada Arenosa, where the Maracaibo is in contact with the Misoa.

Fossils are not numerous in the Paujil formation, but some have been found indicating the lower Tertiary age (probably lower Oligocene). The most numerous and characteristic form is an echinoid or "sea biscuit" probably belonging in or related to the genus Cassidulus. Maracaibo Series: The name "Maracaibo Series" was first applied to the shale and sandstone marl which are so well exposed in the vicinity of Maracaibo. Here it shows considerable deformation, and although no fossils were found in it, it is believed to be of Tertiary age. A fairly thorough reconnaissance of the great Maracaibo basin leads to the belief that this formation is extensively developed over the whole region, and beds at various other points have been correlated with those originally described from Maracaibo.

The series consists essentially of alternating colored clays, light colored sandstone, and a conglomeratic zone at the top. The coherency and hardness of the formation vary greatly from point to point, the difference in particular cases leading to a belief that two entirely distinct formations are represented when in reality both are part of the same series.

East Side of Lake Maracaibo

In the vicinity of Mene Grande the Maracaibo Series consists of a basal zone approximately 800 feet in thickness, made up of light colored, medium to coarse-grained sands, alternating with pink, green, and various colored clays. Above this comes about 600 feet of hard, fine-grained, usually thoroughly oxidized sandstone, and then about 2,000 feet of a somewhat softer series of alternating sandy shale and sandstone, light yellowish and brown in color. At the top is a coarse conglomerate, practically 700 feet in thickness.

This conglomerate is formed by sandstone, gravel and boulders up to ten inches in size, and in places is deeply oxidized. Some streaks of finer sands are interbedded, and accentuate the rather imperfect bedding. Exposed to the air, this conglomerate turns deep brown, and the pebbles, which are less oxidized than the matrix, will weather out, leaving cavities of their exact moulds. Instead of being removed like the pebbles, the matrix is hardened until it has all the characters of a typical quartzite.

The conglomerate is believed to be the equivalent of one found in the region of Coro, which rests unconformably on top of the Coro Series, the supposed equivalent of the main part of the Maracaibo Series. Although no angular unconformity has been discovered between this conglomerate and the underlying sandstone and sandy shale in the Mene Grande region, it is possible that such a line does exist. This unconformity is suggested by the occurrence of the Rio Raya seepages near the conglomerate, whereas in the Mene Grande field the conglomerate lies 2,500 feet above the seepages. The change in sedimentation between the underlying sandstone

and conglomerate is very pronounced. This conglomerate forms the five-mile escarpment which bounds the Mene Grande hill and terrace on the east, and also the ridge east of Rio Raya.

The most unique characteristic of the series found on both the east and west sides of the lake is a type of jointing perpendicular to the bedding planes. The weathering of these joint cracks give the exposure an aspect which the writer has never seen duplicated in any other series of rocks. In the region of Mene Grande the basal 800 feet of varicolored clays and sands form the oil zone, the fluid being practically confined to the coarser layers. This is the series from which the wells in the Mene Grande field secure their oil and from which it is expected the great bulk of the oil will be secured in future development.

The basal portion of the Maracaibo Series is the main reservoir of the oil for the Mene Grande region, and it is believed that it will also be found to be oil-bearing along the western flank of the Trujillo range, and northward across the District of Bolivar and westward to the lake. Descriptions of the surface evidences of petroleum emanating from this

series will be given in another paragraph. In a general way, the lower Maracaibo beds are believed to be the equivalent of the upper part of the Coal Series and Coro formation.

The correlation of the sandstone and shale series, forming the outcrops in the District of Bolivar from the hills region to the lake shore with the Maracaibo Series, as exposed in the Mene Grande region, can be only approximate at the present time. The sandstones forming the first ridge south of the summit of Gamelotal Hill are very similar to the oil bearing beds at Mene Grande. The red clay reported in the La Rosa wells, Nos. 4 and 5, just above the oil zone is the exact counterpart of that found interbedded in the oil zone at Mene Grande. This, together with other points of similarity, suggests the possible equivalence of the Mene Grande and La Rosa oil zones.

Llanos Formations

Overlying the Maracaibo Series, throughout a portion of the plains region of the District of Bolivar, are soft, practically horizontal clays, sandstones, and gravels, which have been correlated with the Llanos formation of eastern Venezuela. They were spread out by the periodical floods which washed material down from the adjacent hillsides and mountains. This formation is probably not over 150 to 200 feet in thickness in the region under discussion, but may possibly be thicker than this in the old valley of the Misoa River between Mene Grande hill and the Misoa range. The Llanos formation is of little economic significance, except that it may act as a cover for a possible extension of the oil sands under the flats.

Oil-Bearing Zones

Summarizing the information on hand, it can be pretty definitely stated that the oil-bearing zones of the region east of the lake, including the District of Bolivar and Mene Grande district, are confined to the following:

1. Basal Paujil and upper Misoa formations (locally called the Menito formation) Menito seepages at the southern end of Misoa ridge.

2. Upper Paujil (locally called Mene Grande formation): outcropping oil sands, and possibly also in wells at Mene Grande.

3. Basal Maracaibo: Mene Grande, Paujil and Ultimo Menito seepages and 1,100 to 1,500 feet of petroliferous strata in the Mene Grande wells; seepages at San Geronimo, Cachimbo, Los Tablazos and Lagunillas, also the oil zone in the La Rosa field, including the Juncalito seepage area, possibly also the El Mene de Santa Rita seepages. The lighter oil in the La Rosa field; as compared with that from Mene Grande, is probably due to the fact that oil-bearing beds at La Rosa are sealed, instead of open as at Mene Grande.

Structure of Falcon

The structure of Falcon from the Zulia Falcon boundary line to Coro, especially in the lowlands along the coast, is dominated by small asymmetric folds, mostly sharp or overturned. The surface formations are Miocene sands and shales overlain by later gravels and sands, which are easily wrinkled up by the forces developed in the earth's crust along the coast.

To mention a few structural features, we can begin at La Soledad, 55 miles due east, where one low-domed anticline and several outcrops with dips up to 70º in the Coal Series, indicated conditions seemingly good for oil accumulation. At Lagarto, 20 miles west-northwest of Pedregal, a sharp overturned and probably faulted anticline yields oil. The region around Coro is folded into overturned anticlines, in one of which an oil seepage occurs. Far to the east of Coro on the coast, near San Juan, the same types of structure are still in evidence.

West and South of Lake Maracaibo

Location—Settlement—Transportation

Maracaibo, the second largest city in Venezuela, with a population of about 40,000 inhabitants, is situated at the northwestern end of the lake. It is the capital of Zulia and the port of entry for all of the region under discussion, with the exception of Carabobo, Yaracuy, Lara and the eastern part of Falcon. Other cities of importance are San Cristobal in Tachira, Merida in Merida, Valera and Trujillo in Trujillo, Barquisimeto in Lara, Coro in Falcon, and Puerto Cabello and Valencia in Carabobo. Towns and villages of varying degrees of importance are scattered through the productive regions in the mountains, at the edge of the mountains, and on the edge of the lake. The flats, except along the rivers, and the mountains both to the east and west of the lake are only sparsely inhabited. Indians live in the mountains west of the lake and in some instances are unfriendly to the extent of rendering work in their hunting grounds exceedingly hazardous. In those cases where supposed favorable territory within the Company's concession comes within the Indians' danger zone, armed parties only can be utilized for exploration work.

The bar at the mouth of Lake Maracaibo is passable for vessels drawing up to 11 feet, and a channel deeper than this passes to Maracaibo and-the main part of the lake. The rivers Limon, Catatumbo, Zulia and Escalante are navigable for light draft lake craft and are utilized as channels of transportation. Some of the other rivers are navigable for canoes. Railroads extend from Encontrados to Uracá, Santa Barbara to El Vigia, La Ceiba to Valera, Tucacas to Barquisimeto, and Porto Cabello to Caracas. Otherwise, the transportation of passengers and

supplies is entirely by animals over roads and trails, which often wind through the very roughest kind of mountains or the boggiest of swamps.

With some construction work and by strenuous efforts, it will be possible to transport the necessary machinery and casing for test drilling over the present roads and trails, but with the commencement of development work on a large scale, it will be necessary to construct one or more railroads and many miles of corduroy or surfaced roadway. The problems incident to transportation are going to be among the hardest and most expensive to solve of any that will come up in the course of the development of the oil resources of the concession.

Lake boats carry freight as far as Encontrados, about 50 miles up the Rio Catatumbo. The Tarra field is reached by gasoline launch and bongo from Encontrados to La Paloma, 46 miles by the rios Catatumbo and Tarra, From La Paloma a 7 kilometer (4 $^{1/2}$ mile) narrow gauge tramway runs to the field at Cubo. The [Rio de] Oro field is reached by launch and bongo from Encontrados to the camp, about 45 miles by the rios Catatumbo and Oro. The Catatumbo will float vessels of 4-foot draft below the mouth of the Rio [de] Oro. The rios Oro and Tarra float 3-foot vessels most of the year, but the latter is not navigable for freight bongos for a few weeks in the dry season. The best method of transporting supplies into the region north of the Rio [de] Oro is still an open question. Transport along the ridge formed by the [Rio de] Oro anticline might do for a part of the area, while the rios Santa Ana and Lora might offer advantages for the remaining territory. The Company is provided with ample transportation facilities consisting of the gasoline launch "Colon" (speed 10 miles per hour—draft 2 feet), two other smaller gasoline launches, and several bongos and canoes.

Topography

The western portion of Venezuela is occupied by an immense structural basin surrounded on the east, south and west by mountain ranges and including in its center the great fresh water Lake of Maracaibo. This body of water is about 100 miles long, north and south, and from 40 to 60 miles wide, and is connected with the Gulf of Maracaibo by a strait of fresh to brackish water, about 35 miles long and 4 to 10 miles wide. Many large rivers, some of these being navigable for light draft vessels, flow into the lake from the adjacent mountains. The mountains on the east rise to elevations of 4,000 feet or more; those on the south—a spur of the Andes—to 14,000 feet, and those on the west-separating Venezuela and Colombia—to possibly 7,000 feet or more. Plains, from 10 to 50 miles across, fringe the lake and separate it from the mountain ranges, which usually rise abruptly from them. Much of this flat country is dry during the dry season and swampy during the rainy season, while portions are always under water. The mountains are largely covered with timber and underbrush, the dryer portion of the flats with scattered trees, cacti and open grassy spots or sabanas, while the swamps support the usual dense growth of mangrove and aquatic types of vegetation.

The rainy seasons include May, June and July, and October, November and December. During these months, especially the latter three, work in the forest and swamp regions is practically impossible, and even under the most advantageous circumstances work in the lowland swamp region is rendered disagreeable and sometimes hazardous by the moisture and insect pests. Insects, such as ticks (garrapatas), mosquitoes and botflies (gusanos), which are disagreeable to

say the least, when found in moderate numbers, become a menace of serious moment when occurring in the hordes which have been encountered by the men in certain regions.

The animal life of the region includes the jaguar, tapir, peccary, wild boar, deer, monkey and smaller animals, the wild turkey, pauji (a small wild turkey), parrot, pigeon, dove, etc. The edible animals and birds have been almost indispensable to our men in these regions, where it has been impossible to obtain other fresh meat.

Lowlands

Beginning at the edge of Lake Maracaibo, a great plain stretches out to the west until it reaches the base of the Frontal Range, which rises abruptly 50 miles or more from the western edge of the lake. This great plain varies in character in different parts. The coast at the northern end, from near the entrance of the lake at Castillo San Carlos around to the mouth of the Rio Limon, is very low and swampy, and is overgrown with a dense jungle of mangrove trees, except on the ocean-facing side of the Island of San Carlos, which is bordered by sand dunes. Out in the lake, opposite the mouth of the Rio Limon, are several small islands, all of which, except the Island of Toas, are level and scarcely reach above the surface of the water. The Island of Toas, however, stands out prominently, consisting of rocky islands of different heights joined together by a low isthmus. Beginning at the town of El Mojan, located just south of the mouth of the Rio Limon, and reaching beyond the bend of the lake to the south of the town of Maracaibo, the coast is marked by low cliffs of soft yellow sandstone and clays, varying slightly in height from place to place, being highest where the lake is narrowed. South of this narrow part the coast again becomes low and swampy.

Passing westward across the plains, one is impressed by the monotony of level land that is broken only by a few isolated hills scattered over the region. Some of the hills may be the remnants left by erosion; others may be of structural origin and of much importance as showing the direction of lines favorable for oil accumulation. In the region just west of Maracaibo the plains are somewhat higher and have been eroded into series of low hills and valleys. This high region is probably to be associated with the structural "Maracaibo uplift" described in a later paragraph.

North of the Rio Palmar, one does not see the mountains until almost reaching their foot. Here erosion in places has cut small valleys, leaving low hills to the eastward which overlook the mountains and these intervening valleys. In Perijá these hills begin farther to the east in the region of La Villa, being part of a higher plain cut up into low rolling hills and valleys covered with but few trees, but with a good growth of grass. The trees begin again to the west of Arimpia and also off to the sides near the rivers. These rolling plains are crossed in places by low ridges of white sandstone, which are more or less parallel with the mountains and die out as they approach the Rio Palmar.

The Mountains

The Frontal Range of mountains in Perijá rises abruptly out of the plains 30 to 60 miles back from the lake front. It is highest opposite the southern end of the district, that is, opposite Machiques, dropping off northward toward the Rio Palmar and southward toward the Rio de Oro.

North of the Palmar the range divides, the western extension trending almost due north, while the eastern one continues the trend of N 25º E. of the main range. Certain portions of the eastern range have been so eroded as to suggest an east-west trending range. In the District of Mara the eastern ridge continues from the southwest corner of the claims, running roughly parallel to them and extending on in the same general direction of N 25º E. It consists of a series of low limestone hills, decreasing in size northward until it dies out at the Rio Socuy. From here on north, there is a low sandstone ridge continuing to Puerto Rosas, located on the Rio Guasare, which is the boundary between the districts of Mara and Paez. A short distance to the northwest in the latter district, a high limestone ridge begins and extends on to the west. This is a structural ridge owing its existence to the system of forces producing the great east-west Trinidad-Venezuela fault zone. The northern edge of this ridge runs approximately N 75º W. and forms the southwestern boundary of a great plain that extends from the ridge and the Guasare and Limon rivers north to the mountains of the Guajira peninsula, and across the Colombian line from coast to coast. This is conveniently called the Paraguaipoa plain from the small town of that name situated upon it near the coast north of Sinamaica, from which there can be obtained an excellent view of the plain in all directions and of the mountains of Guana beyond.

Beyond the Frontal Range of the mountains in Perijá little is known. Part of the ridge has been crossed just north of Petroleo at Totumo, where the trail leads across to the Rio Lajas and the upper Rio Palmar. However, this region is in the midst of the range and not beyond it. In Mara, the region beyond the limestone hills consists of more or less parallel sandstone ridges, varying considerably in height, and flanked on the west by another limestone ridge, which corresponds in height to the Perijá Frontal Range, into which it seems to run just north of the Rio Palmar. This ridge appears to trend nearly north and south. It either ends at the north against the Guana east-and-west limestone ridge, or else it bends around and continues on to the east as the Guana ridge, which corresponds to it in height.

Drainage

The drainage lines are due largely to the structure and to the difference in lithology of the rocks, the latter cause is especially evident in certain localities back of the Frontal Range and in the hilly country east of the range. The drainage of the different areas can best be seen by reference to the maps. No further comments here are necessary other than to say that absence of stress on the map does not necessarily mean that no streams exist there. This is especially true of the region along the coast between the mouths of the Rio Limon and of the Rio Palmar, where many small but commonly dry canyons are found. It might also be well to add that the only streams that flow all along their courses the year round are the Rio Limon and its tributaries, the Guasare, Socuy and Tulé; the Rio Palmar with its branches, Rio Lajas and Rio Pescado, and in the south of the region, the Macoíta, Aponcito and Apon rivers, and the Rio Negro beyond. Some others flow only in their upper courses the year round. Thus the water supply is very limited in the dry season.

The oilfields lie in the region of ridges and hills caused by the crumpling up of the strata in a belt 10 to 20 miles wide in front of the main Perijá range. The ridges, for the most part, strike north and south and rise to altitudes of 1,500 to 2,000 feet in extreme cases, though they are usually less than 1,000 feet in height. The slopes are moderately steep and grade into valleys drained by canos which flow into the main river. The country is heavily timbered and uninhabited

except for the wild, shy Motilone Indians, whose camps and cultivated areas have been encountered in the western part of the district. The usual wild animals of northern South America are found in the forests, and the rivers are full of fish.

Geology

Enough field work is now being completed in the region west of Lake Maracaibo to give a general idea of the sequence and distribution of the principal geologic formations, their important characteristics and major structural features, and, in a tentative way, the relations which they bear to the occurrence of the oil and asphaltum. There will be presented in this report a brief outline of the formations and of the principal structural features, after which will be given a more detailed discussion of both the stratigraphy and structure of the most important localities, as they relate to the consequent rock deposits of all parts of the Maracaibo basin and adjacent territory are not the same, it has been deemed advisable to present a correlation table illustrating the geologic column for the principal districts in the basin region, together with a generalized section covering all of the formations represented in this geologic province. These columns are drawn roughly to scale and are intended to show the relative importance of each stratigraphic unit as regards the others in the same column and as regards the same units in the other columns. The horizons of the occurrence of oil in these regions are shown to the left of each column, the supposed importance of the occurrence being roughly indicated by the thickness of the black band.

Stratigraphic Geology

The following general divisions have been recognized in the Maracaibo basin:

(A) A group of pre-Jurassic schists, quartzites, metamorphosed limestone and granite

(B) A group of supposed Jurassic reddish and purple conglomerates, sandstones, shales and quartzite derived largely from and intruded by igneous rocks

(C) A group of limestones, shales, sandstones and conglomerates of Cretaceous age

(D) A group of Tertiary conglomerates, sandstones, shales and clays locally coal-bearing

(E) Quaternary deposits of gravel, sand and clay

(F) Igneous rocks.

The total thickness of the sedimentary rocks in the region under discussion ranges between 9,000 and 35,000 feet. These rocks are affected by several folds and numerous faults, and in some instances by igneous intrusions. The oil, for the main part, comes from the beds at the top of the Cretaceous and the lower part of the Tertiary.

A. Pre-Jurassic Group

Relation to Petroleum. The occurrence of petroleum in this group is inconsequential, except as it is found in fault zones in localities where these old rocks are associated with some of the later oil-bearing horizons. The principal occurrence of this character is at the Caracolial seepage on the Rio Palmar.

Palmar Granite. This group which, as a whole, is known as the "basement complex" is represented in the region under discussion by what may be termed the "Palmar granite." This rock occurs on the Rio Palmar, just west of the Caracolial seepage, extends northeast to the

Riecito de Tulé, Caño Sucio and Los Longos occurrences, and southwest through the heart of the Perijá Range to the Rio de Oro country. The rock is coarsely crystalline, showing characteristic rounded exposures, and in all ways resembles a true granite. Its exact mineralogic character has never been determined. It is possible that this Palmar granite may intrude the Perijá Series and therefore be younger than the latter. No definite evidence as to its age has been adduced up to date.

B. Jurassic Group

Relation to Petroleum. This group, like the above, is important economically only where fault zones which affect it also cut the younger oil-bearing horizons. .It carries commercial quantities of petroleum at Petroleo and also, probably, from there north along the Perijá fault to near the Rio Palmar. Oil seepages are directly with the series at Petroleo, Totumo and Monte Verde.

Perijá Series. This series, locally known as the "old red series," varying in exposed thickness from 2,000 to 4,000 feet and prominent in outcrop over considerable areas south and west of Lake Maracaibo, consists of red to purple conglomerate, tuff, breccia, sandstone and sandy shale, largely derived from and intruded by basic and, possibly, even fairly acid igneous rocks. It is a most complex series as regards the structure of its beds, and the origin and field relations of several of its members, especially when weathered, are most obscure and often impossible of determination. According to the evidence in hand, this series is the last in this region to be intruded by igneous rocks. A marked unconformity is known to exist between it and the overlying Cretaceous Cogollo gray limestone, the region back of Petroleo being an admirable one in which to observe this phenomenon. The relation of the Perijá Series to the Palmar granite is not definitely known, and although the granite is considered the older rock, it is possible that the latter is the younger and is the metamorphizing agent of the Monte Verde quartzite, which is certainly a part of the Perijá Series. No fossils have been found in the series by which its age can be definitely determined, but owing to its peculiar color—a color, quite characteristic of the Jurassic throughout many parts of the world —and its unconformable position below the known Cretaceous, it has been tentatively placed in the Jurassic.

Among some of the local phases of the Perijá Series which are worthy of note are coarse, hard, purple, quartzitic conglomerates, found throughout the entire range of the series from the Rio Palmar to Tachira. Then there is the "Monte Verde quartzite" found from the region of Totumo north to near the Rio Palmar. This rock varies from white, through gray and purple to black, and in compactness from that of quartzite to that of a true sandstone. In one place, at least, it is slaty in structure, and at another has been recorded as a schist. A fine-grained, light green sandstone, interbedded with thin limestone layers, is also reported by dark at the base of the series in Rio Cuiba. The northernmost exposure of the series is reported by dark in Caño Inciarte. It is abundantly developed as far south as Tachira and undoubtedly extends eastward into Merida.

C. Cretaceous Group

Relation to Petroleum. The limestones of this group are believed to be the ultimate source of much of the oil in western as well as eastern Venezuela and Trinidad, and the limestones, sandstone and fracture or fault zones in the group the reservoir for many commercial deposits. For these reasons the group is one of the most important, if not the most important, of any west of the lake. Oil seepages are found in or associated with the Cretaceous rocks on the Rio Cogollo, La Luna, at Cachiri, north of Inciarte, and in the limestone ridge at Los Ochos near the Rio

Socuy. Much, if not most, of the oil from the limestone has escaped to the overlying porous sandstone formatio ns lying above it or to the fault zones which cut the Cretaceous, and is now retained in them in commercial quantities.

Cogollo Formation. This formation, characterized principally by a series of gray massive and bedded limestone strata, 1,600 to 3,000 feet in thickness, is found outcropping in most of the river sections throughout the region under discussion. Moderately thick sandstones are found at a few horizons throughout the series. The basal portion of the formation usually consists of a coarse green conglomerate or coarse sandstone made up essentially of pebbles of quartzite and igneous rocks derived from the underlying Perijá rocks. In places the basal beds grade into the overlying limestones; elsewhere there is a sharp line of demarcation between the two. The probability that the gray limestone facies of the Cretaceous grades, at least locally, into sandstones as one goes south and southeast from Perijá, is suggested by the evidence. The compact limestone beds sometimes contain irregular nodules of black chert and are interbedded with very thin layers of argillaceous to sandy shales in places represented by layers of sandstone a few inches thick. Locally, the top layers contain nodules of pyrites or reddish brown shale. Many fossiliferous beds are found in the series, especially on the Rio Cogollo, and small inclusions of petroleum are also to be found in the compact rock in the same section. The fossils indicate the Cretaceous age of the formation, and it and the overlying darker limestones have been correlated in a general way with the Cretaceous oil-producing limestones of Mexico.

La Luna Limestone. Beginning near Quebrada La Ge and extending southward into Tachira is a formation 50 to 700 feet thick, consisting principally of black to dark gray concretionary limestone, locally fossiliferous and interbedded with more or less crinkled and contorted light and dark colored calcareous and siliceous to sandy shale. In Tachira this series grades above into flinty and calcareous shale members, while to the north (Cañada de Agua), according to dark, it is replaced near the base by thin-bedded, yellow to gray sandstone, splitting into thin sheets. The black limestone is known to extend eastward into Merida as far as Torondoy. The formation shows direct evidences of petroleum in most exposures, the petroliferous members usually being black and the oil sometimes occurring in the beds and sometimes in joint cracks. The formation yields well preserved fossils at several localities and these have been correlated with those from the Guanoco shale and Punceres of eastern Venezuela.

D. Tertiary Formation

Relation to Petroleum. Wherever the porous Tertiary beds are associated directly, or even in some cases indirectly, with the Cogollo or La Luna oil-bearing limestones, the Tertiary beds usually show local impregnation. Furthermore, certain horizons in the Coal Series (Tertiary), apparently far removed from the influence of the limestones, also carry commercial quantities of oil. These latter occurrences make one cautious in ascribing the source of all of the fluid hydrocarbons to the Cretaceous. At any rate, the Tertiary beds of the Perijá-Limon region are known to yield large seepages and are believed to carry important deposits of oil, not only in the vicinity of the fault zones, but in structurally favorable positions in the plains region in front of the mountains.

Among the localities where the Tertiary yields seepages, or is impregnated with oil, are Macoa, Rio Cogollo, La Luna, Totumo and Caracolial. The Tertiary may possibly be the source

of La Paz, Los Longos, Inciarte, and Cachiri as well. The great deposits of oil at Mene Grande are in the Tertiary, and, although the oil recovered here and in the recently recorded strike at Petroleo is of a rather heavy asphalt grade, it will not be surprising to meet with a better grade at depth as development takes place more remote from active seepages.

The sequence of the Tertiary sediments and their relation to the underlying Cretaceous are easily worked out in Tachira and also, in a measure, in the District of Colon, south of the region under discussion. Here the formations, in ascending order, are:

(1) A series of black to gray sandy shales, 800 to 4,000 feet thick
(2) The Coal Series carrying oil sands, 1,200 to 2,400 feet thick
(3) A cliff-forming sandstone, 200 to 700 feet thick
(4) Sandstone, shale and clay (Maracaibo), 1,500 to 2,500 feet thick.

The sequence of the same series in the Perijá-Limon region is not as well understood, owing to the fact that at nearly every locality where the Tertiary and Cretaceous come together there is a fault contact, and even at those places where there is no direct evidence of faulting at the contact, there are indications of the possible presence of a fault, or of an overlap. The geologic sections accompanying this report will indicate better than a wordy discussion the various relations that are believed to exist at the principal localities. The great bulk of the evidence seems to indicate that between the Coal Series and the Cretaceous there is a preponderantly shaly formation up to 4,000 feet thick, developed between the Coal Series and the Cretaceous as one goes south from La Luna; that in the Limon district and to the northwest there is also a thick series of sand and shale lying below the Coal Series; and that in the region from La Luna north to the Rio Palmar the beds underlying the Coal Series are either absent through the result of overlap or are faulted down out of sight on the east of the Perijá a fault zone.

Colon Shale Zone. This zone is represented in the Limon district by a thick series (reported by dark) of light brown to gray sandstone, locally conglomeratic, interbedded with soft shales, which occur on the west side of the Rio Socuy syncline. The relation between this formation and the supposed underlying Cretaceous limestone is unknown. Beginning south of La Luna and showing greater and greater development as one goes south along the mountain front to the Rio de Oro country, this formation is represented by nearly pure shales. A maximum thickness of nearly 3,000 feet is found in the last mentioned region. The Colon shale is well developed in the Merida foothill belt.

Coal Series. Wherever workable or important deposits of coal occur in western Venezuela, all have been found to occupy approximately the same position in the geologic column, that is, between the Colon shale zone below and the soft vari-colored, barren Maracaibo beds above. The coal-bearing zone has become known as the Coal Series. It consists largely of plainly-bedded sandstones of various textures, dark, usually more or less carbonaceous, thinly laminated shale, and coal beds from "stringers" up to 30 feet or more in thickness. The series attains its maximum thickness in the Limon district where it contains between 3,000 and 4,000 feet of strata, including thick beds of good coal and a few scattered oil sands. In the District of Colon it is 2,775 feet thick and carries important deposits of coal and oil sands. In Tachira the series thins to less than 2,000 feet and contains but minor quantities of good coal and one or two small oil horizons. Eastward the Coal Series blends into Merida (and possibly Trujillo) where it carries coal and is 10,000 feet thick, mostly sand. As previously mentioned, the occurrence of coal in the Tertiary along the

Perija fault zone is rare, the Rio La Ge outcrop being the only one so far recorded, but sandstone and shale beds, which may belong to it or to the associated Frontal Sandstone Series, are sometimes in evidence at the surface and are believed to form the country rock and, incidentally, a good oil reservoir, along the easternside of the fault. The best exposure of what may be a part of this series is found above the limestone on Rio La Ge.

Frontal Sandstone. This name has been applied to a persistent, ridge-and-cliff-forming sandstone zone, from 250 to 750 feet in thickness, which is found along the Perijá front from La Luna at least as far south as the Faroles seepages south of the Rio Cogollo and possibly also to the Rio Negro. Throughout this region the sandstone usually stands with a steep southeastern dip, and much of the sand is heavily impregnated with oil, and several of the important seepages are believed to come from it. The writer has been inclined to correlate this zone with the great cliff-forming sandstone beds found above the Coal Series in the Tachira country. It is also possible, and indeed quite probable, that the oil sands outcropping east of the fault zone at Totumo, Caracolial and elsewhere belong to this zone. The oil sand beds on Rio La Ge may also belong in this zone. At La Luna the Frontal Sandstone, heavily charged with oil, appears to rest practically conformably upon the La Luna (black) limestone, both dipping southeast 30º. If it does, it probably marks an overlap of this sandstone zone over the top of the Coal Series, both from the north and south. A fault, however, might separate the Frontal Sandstone and La Luna limestone, as suggested by Jeffreys, in which case the Coal Series could be lying below the former. In the region at the base of the mountains south of Rio Palmar it will be difficult to separate the Coal Series Frontal Sandstone and Maracaibo beds, except locally, owing to the similarity of certain members of the formations mentioned.

Maracaibo Series. The Maracaibo Series, locally called the Rodeo, etc., consists of interbedded yellow to gray and white sandstones and white, gray, purple and pinkish soft clay shales grading into very fine, resistant, white to pinkish sandstone, dark mentions a coarse conglomerate overlying the pink sandstone of the Maracaibo Series on the Rio Guasare. This may be the equivalent of that found at the top of the Maracaibo Series at Mene Grande, at Coro, and possibly also in Tachira. The formation is poorly consolidated in places, is commonly crossbedded, and contains much yellow to reddish brown clay ironstone, either in concretions or as thin seams along the joint planes. In many localities, notably around Villa del Rosario, the sandstones are affected by a unique type of jointing and weathering, not duplicated in any other formation, so far as the writer's knowledge goes. The Maracaibo Series ranges in thickness from 2,000 feet (dark) in the Rio Limon district, to 10,000 feet in the region between the mountains and Villa del Rosario and Arimpia. The formation is barren of coal, but yields oil seepages at Macoa and supposedly at La Paz. The writer is inclined to believe that oil in commercial quantities will be found in the Maracaibo Series only in those places where local faults have permitted the oil to reach its upper portions or where overlap or folding has brought the contact between the Maracaibo and the underlying formations near to the surface. Localities offering such conditions are probably few, and most of them will be hard to discover owing to the paucity of evidence in the plains country.

E. Quaternary Deposits

Relation to Petroleum. Many of the important seepages come from secondary detrital deposits or beds of recent origin. For that reason the Quaternary is important as yielding much surface

evidence of petroleum. It is hardly possible that economic deposits of oil will be found in these beds.

Llanos Formation. This name has been given to the flat-lying deposits of gravel, sand and clay usually carrying abundant ironstone as concretions and seams, which cover the terraces and Llanos or plains of eastern Venezuela. Since deposits of a similar nature are found lying horizontally over the older formations in the Maracaibo Lake region, the name has been applied here also. The Llanos beds vary from 10 to 200 feet thick. Some of the best exposures are found in the cliffs along the shore of Lake Maracaibo, and on the banks of deep quebradas or canyons cutting the plains region. The great seepage or asphalt deposit of Inciarte is believed to consist largely of fine-grained, horizontal Llanos beds saturated with heavy oil.

Recent Deposits. The recent deposits consist of river and swamp clays, sands and gravels, and detrital and terrace deposits. They occur throughout the entire region under discussion, and in places are saturated with seepage oil and asphalt.

F. Igneous Rocks

Relation to Petroleum. Oil is found associated with the igneous rocks only in the vicinity of fault zones, and under these conditions only when some fault cuts the oil-bearing sedimentary strata. Among the localities where seepages are found associated with igneous
rocks are Petroleo, Totumo and Cachiri.

Character and Distribution. As previously mentioned, the evidence so far secured leads to the conclusion that igneous activity ceased in this region before the Cretaceous beds were deposited. For that reason, all of the igneous occurrences are to be found associated with the supposed Jurassic strata. Many true intrusions are found in the region north of Rio La Ge; the most important are in the region of Petroleo, Totumo, mouth of the Rio Laja, Sierra Guineo and Cachiri. Some fine-grained igneous rocks are reported from the Perijá Series in the Rio Oro region. No careful determinations or analyses have as yet been made of any of the igneous rocks because the lithologic problems presented by these rocks are not of importance in connection with the oil deposits.

The Totumo porphyry or andesite outcrops in Totumo canyon and at many places in the trail here to Laja; also in several of the canyons on the east side of the Frontal Range.

The Palmar granite was discussed under the heading of pre-Jurassic rocks. Fine-grained, dark-colored dike rocks occur in the Perijá formation in several of the canyons of the Perijá range.

Structure

The dominant structural feature of western Venezuela is the great synclinal Maracaibo basin, a structural spoon with the formations dipping into it from all sides. Forces acting in two almost perpendicular directions, north and south (in the region east and west of the lake) have combined to produce this great trough or sink and to develop a series of dominant east-west folds or faults north and south of the lake, and north-south folds east and west of the lake. As might be expected in a region subjected to two sets of forces, the folds in the angles between the resultant dominant

ranges—the Andes on the south and the Venezuelan-Colombian range on the west—at one place have one trend and nearby have an entirely different one. This has resulted in cross folds, plunging folds, and folds with sinuous axes northwest, southwest, southeast and northeast of the lake, and it is along the axes of these folds that important deposits of petroleum have been accumulated. In the region west of the lake, especially toward the north, and in the region southeast of the lake, faulting has played a prominent part, not only in the development of structural features, but also in the distribution and accumulation of the oil. It is therefore not surprising to find the seepages in the last two regions mentioned associated with fault zones or zones of fracture produced by intrusive rocks.

Although little definite information is at hand concerning the westward continuation of the great Trinidad-Venezuelan fault or disturbance zone mentioned as running about due west from Trinidad to west of Porto Cabello, it is the writer's belief that this same line extends southwestward from Porto Cabello, in a general way coincident with the line marking the northern limit of the main area of the granite and metamorphic series, and passes into the disturbed zone along the north front of the great Andes uplift, and that the movements along this line have been dominant in determining the distribution of the metamorphic series and the development of several of the later sedimentary series. If this theory is correct, the line is a most important one as viewed from an economic standpoint, as it determines the southern limit of those rock formations in which the oil originated and in which it is now conserved. A further study of this great structural feature should answer many of the questions regarding the geologic history of the region which now confront the men in the field.

A branch or offset continuation of the line just described again appears at the Island of Toas, where the granite of the basement complex is brought up in juxtaposition with the recent deposits. This Toas fault apparently continues due westward, determining the course of the Rio Limon and abruptly truncating the great range of mountains which marks the boundary between Colombia and Venezuela west of Lake Maracaibo.

The structure of the Perijá-Limon region is dominated by the forces acting in an east-west direction, but the effect of the other system of forces is to be noticed in the deflection of the structure lines from a true north-south to a general direction of N.25º E. In general, the stresses were relieved by folding, with minor faulting, in the Tachira and Colon districts, and as far north as the La Luna region, north of the latter locality, faulting appears to predominate, and as one reaches the Limon district complex along lines followed by the old intrusions is the salient feature of the structure.

Perijá Anticline. The Perijá anticline is the dominant structural feature of the Perijá-Limon area, extending entirely through the district in a general N.25º E. direction from at least as far south as the Rio de Oro region. From a point somewhere back of Machiques the anticline plunges in either direction, the node or high point on the axis probably being coincident with the highest point in this part of the range. In the region drained by the Rio Cogollo, and southward to at least the Rio Oro, the anticline is practically normal, its more or less -regular eastern flank underlying the entire region from the crest of the range to the plains and even out under the latter. The eastern face of the mountains is formed by the Cogollo limestone of the eastern limb of the anticline as far north as La Quebrada, from where, due to plunge, greater erosion, faulting overlap and cross structure, the eastern slope is formed successively by the Perijá formation (first

intrusion, then Monte Verde quartzite), Palmar granite, then again Perijá intrusion, and, finally, Cogollo limestone, the last two on the west flank of the original Perijá anticline. In other words, the northeast trending fold is truncated diagonally by the Perijá fault, which trends more nearly north than the axis of the anticline. At the foot of the mountains on the east side of the fault zone is the Frontal Sandstone or Coal Series, striking in general parallel with the fault, and, at most points where visible, saturated with petroleum and yielding seepages.

The western flank of the Perijá anticline passes off into a faulted syncline north of the Rio Palmar, the western flank of this syncline, in turn, being the eastern flank of another anticline in the Cogollo limestone to the west of the rios Socuy and Riocito. The Perijá anticline and the syncline and anticline west of it are abruptly truncated, along with the mountain range, by the Toas-Rio Limon east-west fault, north of which lies the Paraguaipoa plains.

Perijá Fault. A fault zone, in general paralleling the axis of the Perijá anticline, and two or three miles east of it in the region of Rio La Ge, but still so trending toward it going north as to cut the same axis somewhere in the region between the Rio Palmar and Sierra Guineo, is the dominant structural features in the Perija district as regards the accumulation of petroleum. The downthrow of this fault is always on the east, its hade is toward the east in the vicinity of Petroleo, according to the evidence offered by Zambapala Well No. 2, but elsewhere the hade is uncertain, though in the Monte Verde area the evidence points toward a westward hade. As mentioned in a preceding paragraph, the Tertiary sediments on the east side of the fault are brought in contact with the La Luna limestone, Cogollo limestone, Perijá sediments and igneous rocks, Palmar granite, igneous rocks, and, finally, the Cogollo limestone, successively, as one goes north from Rio La Ge. The fault is not a continuous line of displacement, but is as the term "zone" implies, a series of faults all closely associated and extending in the same general direction, each section having a strike of its own. The variation in strikes along the zone ranges from N 34º E. to N 13º W. The zone has served as a channel of migration which the oil has traversed from depths to the surface. It is also believed that at many points the zone is sealed either through the action or gouge or of asphalt, in such a way as to render it a reservoir for oil under pressure sufficient to render the accumulation of economic importance.

Maracaibo Uplift. A glance at the map of the Maracaibo basin discloses the fact that the lake narrows opposite Maracaibo; furthermore, the territory west of Maracaibo and east of it on the opposite side of the lake rises appreciably above the average elevation of the plains country. Both of these conditions are believed to be due to an arching of the underlying beds along an east-west line through Maracaibo. In fact, a well-defined zone of folding can be seen within the confines of the town itself. The same line of uplift is reflected in the bringing to the surface of the granite of the basement complex along the Rio Palmar, where it debouches from the Frontal Range. It would be natural to expect that such a prominent structural uplift would affect the accumulation of petroleum in beds influenced, and such is the case, for without doubt the great deposits of Petroleo, Monte Verdi, Los Longos, Inciarte and La Paz on the west side of the lake, and Santa Rita on the east side, are due, in part at least, to the favorable conditions of accumulation offered by this great arch or geoanticline. The Macoa seepage is due to another cross fold, called the Cogillo anticline, which plunges in a southeasterly direction from the mountains toward the lake, and has resulted in a structural "terrace" or "half dome," a type found abundantly in such oilfields as the Appalachian and Mid-Continent of North

America, and which has proved favorable for oil accumulation.

Structure

[Rio de] Oro Anticline. The structure in the Rio [de] Oro region is very simple and well understood. The Perijá anticline brings up the older Perijá Series and Cretaceous limestones in the higher range on the west; these beds dipping off toward the lake at angles varying from 10º to 30º, with sometimes local steepening, especially in the region of the sandstones, which appear to locally relieve the stresses through the development of minor faults. In the region of the Colon shale and Coal Series, the beds dip fairly steeply toward the east, and are folded into an asymmetric anticline (called the [Rio de] Oro anticline), in the area where drilling is now taking place. The strike of this anticline is N 29º E and near the Rio [de] Oro the flanks yield dips of 25º to 70º on the east and 10º to 25º on the west. It extends south into Colombia for 4 or 5 kilometers south of the Rio Oro, and north at least to the Rio Lora, which is 25 to 30 kilometers north of the Rio Oro. The fold flattens toward the north, until in the region of Rio Cinco de Julio, 10 kilometers north of the Rio Oro, it is one kilometer wide, with a broad symmetrical crest. In the region of the Rio Lora, the anticline has flattened until is it nothing more than a "terrace" on the east flank of the great Perijá anticline. The crest of the fold is flat from Rio Oro to Rio Cinco de Julio; north of the latter it plunges slightly toward the north. It is similar in all respects to most folds of this character developed on the flanks of a great monocline. The syncline between the axis of the Oro anticline and the east-dipping beds to the west is also asymmetric, the beds having low dips on the eastern flank and steep dips on the west, with a broad, flat bottom.

Tarra Anticline. The main structural features of the Tarra region, the Tarra anticline, dominates the topography, forming a long ridge coincident with the anticline which strikes approximately N 7º E. and plunges toward the north.

Near "La Paloma" the east leg of the anticline is represented by beds which dip east at very steep angles (75º to 90º). The west line dips from 10º to 25º. Going south there is a small fold on the main fold on the east. Each leg of the small fold dips about 10º and is very wide. The west line of this fold has an average dip of about 45º.

Still farther south, the anticline is much steeper and the west leg is overturned dipping on the average of 75º east. The east leg dips about 75º east also. From this locality the east leg dips about twenty degrees and the west leg is very steep (seventy-five to ninety degrees), this condition continuing south for a considerable distance.

Other Folds and Faults. Among other folds, faults or lines of disturbance, which are interesting not only from a scientific standpoint, but from an economic one as well, are the cross-faults of the Los Longos region, which drop the oil-impregnated sands down against the granite at this locality, and the important El Indio-La Paz-El Padre line of disturbance striking N 38º E., the character of which has not as yet been worked out, but along which the great La Paz seepage occurs and on which the supposed dome or quaquaversal of El Padre has been developed. Mr. Garner has recently found a west or reverse dip of 15º on the Perijá monocline about 18 kilometers east of Inciarte on the old Inciarte-Maracaibo road, which probably indicates another line of disturbance similar to, and possibly of as great importance as, that last described.

At least one, and possibly two, well-defined anticlines exist in the region of Maracaibo, and surface evidence such as that offered by the hill of San Andreas, which rises so prominently west of the lake between Maracaibo and Rio Limon and other similar hills, suggests the presence, even to the eastern edges of the plains country, of folds which may be of great commercial importance. It is the writer's belief that most, if not all, of these folds will be found to have the general trend of the Perijá structure which is a little north of northeast. Only a detailed geologic examination of this plains country will disclose its possibilities, and it is hoped that such an examination will soon be authorized. South of the lake the beds dip from the mountains toward the lake, the dips being steeper toward the mountains. The base of the mountains forms a line of weakness along which faulting and folding take place.

Relation of Topography to Structure

The main streams in the region have their present sources as a result of structural movements. In many places the study of the drainage indicates the structures upon which it is dependent, as, for instance, the case of Limon-Palmar and Palmar-Apon divides or the ponding of the Rio Tulé and the splitting of its mouth by the small anticline in the Rio Socuy. At other places antecedent drainage, or drainage courses determined prior to the development of the structure, are suggested by the conditions. The peculiar character of the Socuy River in certain parts of its course, where it flows at right angles to the strike opposite the ends of the limestone hills and even crosses the center of the syncline at such a point, are examples of antecedent drainage. The larger relationships of the drainage are brought out by noting the lack of large streams flowing into the lake between the Rios Palmar and Limon, due to the divergence of the drainage back in the mountains by the plunging of the folds northward and by a low divide, the Maracaibo uplift, running westward from the narrow part of the lake to a point not far from Valledupar in Colombia. The smaller streams are largely dependent on the lithology of the rocks through which they cut. This is well illustrated in the hills in front of the range, which are made up of the Tertiary beds. The ridges in this region are largely resistant sandstones, while the small valleys parallel with the strike mark the presence of dominantly shaly zones.

Relation of Structure to Oil Accumulation.

The relation between the structure and oil accumulation has been touched upon briefly in several of the paragraphs. To summarize, it may be said that the Maracaibo uplift and the Perijá anticline and fault are the dominant causes of accumulation, the last two being the most potent locally, while the former apparently has more of a regional effect. The Perijá anticline has elevated the beds into an east-dipping monocline or limb, in which the tendency of the oil has been to rise from the gathering grounds under the great Maracaibo basin and migrate westward to the rim of the basin. Here the Perijá fault zone exerts its influence by acting at one place as a channel of migration along which the oil escapes to the surface; at another as a porous reservoir for the retention of the oil under pressure, and at still others as a barrier against which the oil collects in porous strata on the downdip or eastern side of the fault. The presence of the first two conditions is amply proven by the surface evidence and the drilling of Zambapalo No. 2; the existence of the third condition is as yet only hypothetical, but is certainly to be expected. If it exists, the area affected by it should yield wells at least as large as, if not larger, than either of the other two.

Another type of structure which acts as a collector of petroleum is that of which the El Indio-La Paz-El Padre line of disturbance is an example. Along such lines and along true anticlines, of which there may be several in the district, commercial quantities of oil doubtless exist.

Origin of the Oil. A word here as to the probable source of the oil will help to explain some of the deductions made as to best locations for test wells, etc. The Cogollo and La Luna limestones are believed to be the source of much of the oil found in the Perijá and Limon districts, for the reason that they are of organic origin, show evidences of petroleum at many localities both in pores in the rock and in the cracks of the same, and are associated with some of the larger seepages of the region. This idea fits in with that accounting for the oil in eastern Venezuela, Mexico and several other regions of the earth where limestones are the only rocks of organic origin found associated with commercialdeposits of oil. A study of the conditions existing in Mene Grande, in the Colon district, and in Tachira, where oil exists in greater or less quantities, but where the limestones are absent or, if present, are not deemed adequate to account for the oil, leads to the conclusion that another source must exist. The organic character of the Coal Series, taken in connection with our knowledge of the possibilities of certain types of plant remains to yield petroleum, leads to the conclusion that those beds may be a source of some of the oil. In sizing up the possibilities of any particular area, therefore, the geologist must find one or the other of these sources before giving the territory serious consideration as a source of commercial deposits.

CHAPTER 21
SEEPAGES

The discovery and interpretation of the seepages were the most important parts of our work, as we had less than two years in which to make our denouncements. Not having geophysical instruments, we had to depend on the interpretation of the geology as disclosed by the seepages and their relation to the adjacent formations.

About fifty seepages were found, and these were described and photographed in as much detail as time and the surrounding surface conditions would permit. It is well known that the oil developments in a country begin around the seepages and extend farther away as the structure becomes better known. This was the rule in our program of recommending the areas selected for denouncement. Two stratigraphic correlation tables accompany the geologic discussions.

In the book the three districts covered are each divided into separate areas designated by some stream or river where the formations are well exposed. Geologic names were given the principal stratigraphic units depending on the area in which they were first discovered or where they were best exposed. Sometimes the conclusions as to oil possibilities are given for a particular area surrounding a seepage or for a general area in which two or more seepages can be correlated.

Eastern Venezuela

Distribution of Seepages and Prospective Oilfields

Most of the oilfields of the world have been discovered through prospect drilling in areas where surface evidences have led to the conclusion that oil and/or gas exist underground.

Venezuela and Trinidad are no exceptions to this rule. In fact, some of the most important surface manifestations are found in both countries: Trinidad, Pitch Lake, Guanoco Pitch Lake and the Mene Grande seepages and asphalt deposits are world renowned for their size and activity.

In the following paragraphs will be given a summary of the principal seepages in eastern Venezuela, discovered or brought to the attention of the oil industry by the members of the General Asphalt Survey, 1911 to 1916. It may be said that many of the seepages in remote or forested regions were shown to our men by observant inhabitants of the country. From the start we let it be known to the Venezuelan people that we would pay a bonus to anyone showing us a bona fide oil or mene (asphalt) occurrence. Through the ignorance of some of our guides who mistook mineral-stained rock or iron oxide or sulphur scum on water for oil, we were led on several wild goose chases. But, all in all, we found the people in Venezuela good observers and reliable guides, and much credit should go to them for finding many important prospective areas.

Chapopotal and El Breal. These two localities, the names of which both mean asphaltum or an asphalt seepage, lie about six miles east of Chaguaramal and 15 miles south of Punceres. The Llanos beds form the principal exposures in the vicinity lying horizontal and being cut by the stream trenches.

El Breal is characterized by several important seepages, the main one of which is quite active, covers over an acre, and rises about 6 or 8 feet above the surface of the ground. It is surrounded by numerous lesser seepages, some of which attain considerable size. The sides of the ravines which drain the area of the seepages are often covered with asphaltum which has flowed down their courses at former periods. No evidences of beds older than the Llanos are found at El Breal.

Chapopotal is the name given to some live seepages occurring on the banks of a creek one and one-half miles south of El Breal. These seepages line up along a course having a general east-west direction as do also those at El Breal. A horizontal oil-impregnated sand between two clay layers occurs along the creek. Furthermore, some large angular blocks of hard sandstone closely resembling certain sandstones of the Punceres Series occur at the main seepage of Chapopotal. One or more zones in the Llanos beds exposed in the ravines between El Breal and Chapopotal are strongly impregnated with oil.

Pirital or Hato Pirital. The seepages of Pirital are located a short distance south of the Rio Amana, about 32 miles slightly south of west of Maturin. Mention was made of the locality in the report of November, 1912, but was not examined by the writer until the present trip. There were two seepages seen by the writer, a third seepage reported in a swamp east of the Rio Amana, but not seen by any of our geologists, and a gas spring in the Rio Amana. The geology of the district is obscure owing to the blanket of Llanos beds which covers the mesa country south and north of the Rio Amana. A quebrada, or ravine, which trenches the hilly region between the mesa land and south bank of the river, and which passes 400 meters north of the western seepage and 800 meters north of the eastern seepage, discloses a series of moderately soft, alternating sand and shale zones, the beds of which dip in a general north to northeast direction at angles from 10' to 20º. This series of sands and shales is believed to be of Tertiary age and to correspond in a general way with the oil-bearing series at Pedernales and Guanipa, which in turn are correlated with the lower oil-bearing zones of Trinidad. The Pirital seepages and gas spring line up in an east-west direction approximating the trend of the Guanipa-La Bomba seepages and mud

volcanoes, and may be a continuation of this line or a closely related line of disturbance. Beginning on the west, the first Pirital seepage lies 150 meters west of the road from Urica to Santa Barbara. This is a small occurrence of asphaltum covering about 75 square feet in the bed of a small ravine. Eight hundred meters almost due east of the first seepage is the second, which is included in an area of some 500 square feet. Here the oil appears to come from a practically horizontal oil sand in the banks of a quebrada, or ravine. It is the belief that these horizontal beds are Llanos locally impregnated from some underlying series, but it is equally possible that the horizontal beds are to be correlated with the supposed Tertiary beds mentioned as occurring in the ravine to the north of the seepages. In the latter case they may represent the arch of a domed anticline of which the north dips secured may be on the north flank. The presence of the seepages and gas spring is indicative of the occurrence of petroleum at depths in this locality, but the small size of the deposits and weakness of the gas pressure does not inspire one with much optimism as to the results to be expected by drilling.

La Bomba-Hervidero. This mud volcano is situated on top of a low hill about 12 miles slightly south of east of Maturin on the continuation of the line of disturbance which extends in a slightly south of west direction from Guanipa and along the course of which occur the asphalt desposits of Guanipa, the mud volcanoes and asphalt lake west of these, and the La Bomba Grande volcanoes still farther west and about 27 miles east of Maturin. This line is to be compared with the Southern Anticline of Trinidad, on the continuation of which are located the Pedernales oil sand outcrops and asphalt deposits, and may possibly be a continuation of the same general zone of disturbance. The Hervidero cone is 120 feet across at the base, 12 feet high, and is surmounted by a beautiful!) proportioned crater, about 10 by 12 inches across, which rises two feet above the normal slope of the sides. The crater is 6 inches deep and full of liquid mud, from which gas bubbles (some of which cover nearly the entire surface) are intermittently escaping with a flow of muddy water stained with an oil film. It was estimated that from four to six barrels of water per day escaped at the time of our visit The small grains of solid material ejected with the fluid consisted of rounded, soft, gray clay fragments, and grains of quartz and other material. The oil was of an excellent light gravity, probably above 30º Baumé, but was in very small quantities. Asphalt was found during the past dry season in the marsh near the cone by one of the geologists, but none was seen by the writer owing to the covering of water at the time of our visit. No oil was seen coming from the crater during the dry season, so that the rains may have something to do with its appearance at this time. Two miles east of La Bomba Hervidero cone is an extinct cone which our guide (who was 23 years old) told us was active at the time of his birth and for several years afterwards, but which became quiescent on the beginning of activity of Hervidero, which is only about 15 years old. The writer is willing to believe the first part of this statement, but the mound at Heberdero is too conclusive evidence of the long continued activity of this cone to be overcome by the evidence of the guide. At any rate, the two cones are certainly genetically related, and their resemblance to the mud volcanoes of Trinidad is most striking. The presence of the oil and petroleum gas leads to optimistic conclusions concerning the presence of oil at depth in their immediate vicinity.

La Bomba Grande. La Bomba Grande is a group of mud volcanoes of the same type as La Bomba-Hervidero, just described, situated about 27 miles east of Maturin and 15 miles east of La Bomba-Hervidero, on the line of disturbance which runs from Guanipa westward at least as far as the last mentioned mud cone. There are said to be seven cones in the group. Of these, Mr. Boyd has seen three and Mr. Eckes two. The cones are each located on top of a low knoll which rises

out of the flat sabana, and vary in size from 100 to 200 feet in diameter at the base and up to 25 feet in height. La Bomba Grande proper, the largest of the cones, has an active vent or crater at the summit over three feet in diameter. The explosion of the gas bubbles as they reach the surface of the mud in this crater can be heard for over half a mile. The gas and other emanations from these cones are similar to those at La Bomba-Hervidero, although no oil was noted as coming with the gas and water. This may be because the craters were examined in the dry season and the oil may show only in the wet season, or be intermittent in its occurrence, as in La Bomba Heberdero. In any event, the occurrence of the mud volcanoes here offers evidence of the presence of petroleum at depth, and a bank of claims extending from Guanipa westward to La Bomba-Hervidero has been surveyed and staked.

Location for Test Wells. The location for test wells at La Bomba Grande will depend on the results obtained in the experimental drilling at Guanipa and La Bomba Herberdero.

Guanipa. The village of Guanipa lies on the mainland near Caño La Brea, about two miles north of the mouth of the Rio Guanipa, the first important river north of the Orinoco. There is a large oil spring and asphaltum deposit near the village, and from here, almost due westward for over a mile, is a row of similar deposits. All of them have been worked for their asphaltum for several years by the Val de Travers Asphalt Paving Company, Ltd. About a mile westward from the westernmost asphalt deposit are a group of extinct mud volcanoes, and still farther westward active mud volcanoes emitting gas, water and oil are found. About a mile or two farther on is found an asphalt lake covering several thousand square feet. The deposits near Guanipa, the mud volcanoes and the asphalt lake all occur on a line running slightly south of west, and this line continued westward strikes La Bomba Grande, La Bomba-Hervidero, and making a slight deflection on the present map, the asphalt seepage at Pirital. Owing to the fact that the evidence of petroleum and gas along this line closely resembles those at Pedernales and the Southern Anticline of Trinidad, the theory has been advanced that the geologic conditions along the Guanipa-La Bomba Grande line are similar in a general way to those at Pedernales and are therefore favorable for the accumulation of a high gravity oil. With this theory as a guide, fifteen areas have been staked at Guanipa to include all of the seepages and mud volcanoes, and two more areas have been suggested for the region immediately south of the most favorable looking territory. Mr. Macready is of the opinion that the surface manifestations occur along the outcrop of north-dipping beds which are supposed to represent the north flank of an anticline, on the south flank of which occur the south-dipping oil sands at Pedernales. There are some grounds for such a theory, and apparently no direct evidence controverting it. However, the seepage and mud volcanoes may occur along the crest of an anticline or along a fault zone, so that in locating the wells to test the possibilities of the region, it has been deemed advisable to choose sites extending entirely across the strike of the surface emanations in order to test all possibilities.

State of Falcon

The seepages in Falcon come from the Coal Series or associated Tertiary rocks and are in general of little importance and offer little evidence of important deposits of petroleum.

La Soledad. Three seepages occur near the town of La Soledad, about 35 miles due east of Altagracia. The first comes from a soft, fossiliferous limestone overlying a lignite bed, probably of the Coal Series. Little structure is in evidence at this seepage. The second lies 2 miles

southwest of the first, the most active vent being in a 2-foot bed of limestone. Above this is 30 feet of sandy shale and sandstone and under it is 20 feet of sandy shale, both being saturated with oil. The beds dip S. 45° E. 45°. Two thin beds of oil sand outcrop a few hundred feet northwest of the main seepage. All of these occurrences and one or two others in the same vicinity are associated with a low-domed anticline under conditions which apparently indicate possibilities of commercial quantities of oil. At the third important locality, 32 feet of oil-impregnated sandstone dipping N. 20° W. 70° outcrops, accompanied by a small seepage of oil. This steep dip almost precludes any but small wells. Taking the region as a whole. La Soledad offers the best evidence of commercial quantities of oil of any locality in Falcon. These seepages are covered by the Barnabe Planas concession. (Joslin and F. C. Merritt.)

Lagarto. (Mina El Menito on map.) The seepage 2 miles west of Lagarto and 20 miles west-northwest of Pedregal consists of some high-grade greenish oil coming from a sandy shale of the Coal Series at the crest of a sharp overturned and probably faulted anticline. Judging by the quantity of oil escaping and the structural conditions surrounding its occurrence, it is extremely hazardous to predict oil in commercial quantities in the region. Furthermore, the immediate region of the seepage is covered by the Tregelles concession.

Coro. The seepage 6 miles west of Coro was visited. It consists of a very insignificant showing of a high-grade oil coming from some impure, sandy limestone of the Coal Series in the crest of an overturned anticline. The size of the seepage apparently precludes the occurrence of oil in commercial quantities in this region, and for this reason the retention of the area is recommended only as a precautionary measure.

Salto, near San Juan. The seepages of Salto, situated 10 or 12 miles south of San Juan, are three in number, occurring together in a sandy bed that dips S. 30° E. 30°. Two are 3 feet long, while the third spreads over an area of 15 by 20 feet. The oil is very fluid and is accompanied by some gas. Another seepage is reported 6 miles west along the strike of the formations. Owing to the isolated position and small size of these seepages, it is not deemed probable that commercial quantities of oil can be economically recovered in this region. These seepages all fall within the limits covered by the Francisco Jiménez Arráiz concession. (Macready.)

At the Caño Cubo, on the "La Paloma" end line, there are eight or ten seepages of medium to light oil. The largest seepages are at the crest of the anticline, and oil is floating off on the surface of the stream here continuously. There are also smaller seepages in both flanks of the anticline.

At the Caño Caiman there are numerous large seepages of heavier asphaltic oil apparently at the crest of the anticline.

At the Caño de Agua Caliente and on the first end line south of "La Paloma," there are numerous seepages of heavy oil similar to that at Caño Caiman. The writer, who saw the principal one of these seepages, estimated that from three to five barrels of oil escape daily from this single vent. The hot water in the Caño de Agua Caliente carries oil out to a distance of more than three kilometers from the seepages, where it spreads it over the flat along the stream. These seepages are at the crest of the smaller fold, in a zone of steep dips. At the crest of the main fold at this end line, there is one very small seepage in a small tributary of Caño Las Piedras.

At the second end line south of "La Paloma," there are hundreds of active seepages. The Rio de Agua Caliente at this point carries out a large amount of light oil daily on its surface and flows in banks of asphaltic residue, as does also Caño San Rafael, nearby. There are many seepages of asphalt here, as well as of light oil; there is a large amount of dry asphalt on the surface near the headwaters of Caño San Rafael.

At the Caño Mapurito (half-way to the next end line), there are scores of asphalt seepages at the crest of the anticline. Light oil is less abundant here, but there are large open spaces in the woods kept bare of vegetation by the asphalt.

Near the south end line, in the valley between the ranges, there are several seepages of light oil. There has been some primitive development work here by Colombians, and four oil wells have been dug. These oil wells are holes in the ground about fifteen feet deep, in which there is considerable gas pressure and oil seepage. This oil seeps through the Colon shales, and this may account for its low specific gravity. At least one of these seepages is surely in Venezuela; the others are in disputed territory. There is a small and primitive refinery located nearby, where kerosene has been produced recently. It was not in operation at the time of this investigation.

There are springs of hot water in the Caño de Agua Caliente, the Rio de Agua Caliente, Caño Mapurito, and Caño Carbon. All of this hot water is more or less chalybeate, but does not contain enough salt to be disagreeable to the taste. The water probably comes from great depths; it issues under pressure. Except at the Caño de Agua Caliente, the springs are located well over on one leg of the anticline.

Eastern Zulia

The surface evidence of petroleum in the Mene Grande district is probably as impressive as in any other oil region in the world.

This statement applies particularly to Mene Grande hill, which in itself is practically one great oil seepage, two miles long by one-half to one mile in width. In addition to this, there are large seepages at Menito and Ultimo Menito, on the west side of the Rio Misoa and a large seep at Paujil, adjoining properties of the Caribbean Petroleum Company. Minor seepages are found near the edge of the Sierra Trujillo on the Rio Raya and Quebrada Casadora, and also some near the Rio San Pedro. Most of these seepages are believed to be emanations from outcropping oil sands, although in some instances the actual sands themselves are covered with alluvium or swamp material.

General Statement: The oil seepages of Zulia east of Lake Maracaibo are among the largest in Venezuela, but because of their obscure occurrence are the least understood from a geologic standpoint. With one or two exceptions, they occur in beds younger than the Cretaceous, usually under conditions suggesting a source in the beds immediately underlying the ones furnishing the surface seepages. The structure in the region of the seepages is usually anticlinal. It is confidently believed that the territory will prove to be among the most productive of oil of any in Venezuela.

Rio Pauji or Paujil. The first seepage north of the Valera region is that at the Rio Pauji about 2 miles west of the foot of the mountains. Here is found a seepage and asphalt deposit one-half

mile long by 100 to 200 yards wide, extending in a direction a little west of north. The northern end only is active, the southern two-thirds of the deposit apparently being flowage from the north. The principal vent is a pool of oil-covered water near the north end which is continually agitated by escaping gas and oil. A few minor vents occur adjacent to the main one. No rocks areexposed in the immediate vicinity of the seepage, but from a study of the surrounding region, the conclusion is reached that the oil comes from a series of alternating sandstones and shales, probably Cretaceous in age, underlying the great 4,000 foot series of Pauji shale, at the nose of a great northwesterly plunging anticline. Although the seepage is covered by the Tregelles concession, it is believed that the most favorable territory is outside of this. This locality should yield wells with good production and heavy gas pressure.

Rio San Pedro and Rio Raya Seepages. About seven miles northwest of the Paujil seepage on the Rio San Pedro is another large seepage, similar in occurrence to the Paujil, both in type of surface phenomena and gee logic and structural position. It consists of an active seepage with patches of dry asphaltum scattered along the line from the Rio San Joaquin to practically the Rio San Pedro. No details have been worked out in connection with this seepage, although it is probable thatit comes from the lower part of the Maracaibo seepage.

The Rio Raya seepages are two in number, separated by about a mile in which extinct cones and other minor evidences of oil are found. The seepages occur in basal Maracaibo beds or possibly upper Paujil shale, which along here dip at angles of 30° to 40° south-west. These seepages are the usual type coming from oil sands. In the northern group, which includes several active vents and numerous extinct asphaltum cones and flows, the oilsands are not exposed, but in the group to the south, the sands, especially toward the east, appear at the surface. Here the beds dip about 40° toward the west. West of this seepage and higher up in the series are a number of more or less important flows and extinct cones. There is very little activity indicated by the seepages in this southern group.

Summarizing: the surface evidences of petroleum throughout the Mene Grande region are confined largely to the basal portion of the Maracaibo Series. Where this series is affected by the anticlinal conditions, the seepages are large and active and indicate probable deposits of commercial importance in the outlying beds. Along the base of the Sierra Trujillo the seepages are not so important, and it is more questionable whether commercial deposits of oil will be secured by drilling. As regards the Company's properties in this district, those near the Paujil seepage should be considered as second only in importance to those around Mene Grande.

Mene Grande Seepage. Mene Grande hill consists of a scimitar-shaped ridge which strikes practically east and west at its southern end and north and south at its northern end. The area of active seepages extends from the southwestern edge of the hill around its eastern and western face, and northward to just east of the highest point on the main part the northward-striking ridge. The area covered by active seepages includes about two square miles. Within this area occur hundreds of individual seepages, pitch cones, and asphalt deposits. Standing in the cirque like basin north of the west end of the hill, the eye can follow down the inside of the ridge for two miles, noting a surface practically entirely covered with asphalt and fresh oil seepages for the entire distance. This scimitar-shaped hill marks the outcrop of the lower part of the Maracaibo Series, which is the source of the major portion of the oil in this field. As described above, these sands vary from white to pink and green and are interbedded with even more brilliant clays. The

seepages take the form of exudations from cracks in the sand or exude direct from the sand itself. Again, the oil may break up through the more or less incoherent surface material. Certain areas seem to show more activity than others, and the activity of the seepages varies from time to time over different portions of the seepage area.

The most impressive of the phenomena are the pitch cones, which in some instances rise to a height of 2 to 3 feet and are 10 to 25 feet in diameter at their base. The slope of the sides of these "pitch volcanoes," as they are called, varies greatly in the individual cones, depending upon the viscosity of the exuded oil. The best development of the cones is around the southern and western ends of the Mene Grande hill. The largest cone, "Mene Grandissimo," is situated a short distance east of Zumba Well No. 1. Oil and gas continually ooze from these cones during their active periods. Sometimes they become quiescent and the sides are broken and eroded away, after which they may again show activity. The asphalt deposits are simply old, hardened exudations. These sometimes coalesce, forming large sheets over the surface. In many instances the surface of the ground is covered with hard fragments of asphalt which have been weathered out of the sandstone or broken up on the surface. The seepages occur in various beds, indicating a varying saturation for the whole series which outcrops along the southern part of the Mene Grande ridge. Several streams of asphalt run down from the flanks of Mene Grande ridge, the two most important being that which starts down in the vicinity of Zumacaya No. 1 and another large stream which flows off from the southwestern edge of the hill. The latter extends down into the forest, making a stream from 50 to 100 feet wide which is completely devoid of vegetation. This stream and, in fact, the whole surface of Mene Grande hill, is some times burnt off by grass fires, the burning process coking the asphalt and thus reducing its quantity and rendering it valueless. No accurate estimate can be made of the amount of oil that has exuded from this great seepage, but, in general, it can be said that it is measurable in millions of barrels. The movement of some of the exuded asphaltum is too slow to be noted by the eye, but its crumpled surface shows that it obeys the laws of fluids. All the 485 principal seepages uniting in a single stream produce 10 barrels of oil per day. Associated water produces the illusion of hundreds of barrels run off.

North of Mene Grande there are outcrops of oil sands in the upper part of the Paujil shale or possibly the lower part of the Maracaibo, which yield small quantities of oil. The seepage farthest north breaks up through the Llanos or Maracaibo conglomerate near the trail which runs east from Los Barrosos. This seepage apparently comes from pretty well down in the Maracaibo Series, or possibly the upper Paujil. It is unimportant, except as indicating the probably northern limit of impregnation.

Menito (Ultimo Menito) Seepage. The Menito seepage lies on the point of the west flank of the plunging Misoa anticline, a short distance west of the Misoa River, and occupies an elliptical-shaped area approximately one-half mile long and three-eighths of a mile wide, with extensions of asphalt flows at least a mile northwest down the drainage lines. The seepages occur on the sides of a hill, in some instances quite steep, and are without question due to outcropping oil sands in the Maracaibo Series. The beds here dip southwest at fairly steep angles and are somewhat harder than those of Mene Grande hill, the difference in hardness possibly being due to greater structural stresses. Small cones and open seepages are the principal type of occurrence. In one instance a pipe is said to have been forced down into one of the cones for 20 or 30 feet, and this particular cone is now producing a very fluid oil.

Near the north end of the seepage area is an amphitheatre of seepages from which the oil runs down into a basin at the bottom. In the bottom of this basin is a spring yielding thousands of barrels of hot water daily. Another hot spring is found south of the seepage. It is the belief of the writer that the big spring and the one south of the seepage comes from a fault line which, in general, parallels the strike of the beds, and it is questionable whether or not, in the ordinary process of drilling, this water will give any trouble. If it came from a particularly well-defined water sand, it could probably be counted a very material menace to development of this part of the field, but, occurring as it does along a fault, it seems reasonable that damage from it can be avoided by locating the wells a reasonable distance from the fault.

About a mile north-northwest of Menito is the Ultimo Menito area, a group of seepages occurring along the outcrop of steeply dipping oil sands in the Maracaibo Series. As in the case of Menito, the seepages here occur in the form of cones and also in open springs of oil emanating from the sands. Flows of asphaltum extend downward from these seepages, as in the others previously mentioned. East of the Ultimo Menito seepage outcrops of oil sand yielding small amounts of oil are found in the canyons on the side of the Misoa range, indicating a source in beds lower down in the series than those yielding the main seepage.

Los Barrosos is about 2 miles southeast of Menito and on the eastern and southeastern flank of the same anticline, but apparently farther away from the axis.

Comparison of Mene Crande Area to Coalinga District, California: One of the most striking characteristics of the Mene Grande district, speaking of it in its larger sense as including Menito, Ultimo Menito, and the Rio Raya region, is the similarity, structurally and lithologically, to the Coalinga district of California. As at Coalinga, there is a great monocline of the oil-bearing series, composed of beds and lenses of true oil sand separated by shales and clays, off which a prominent subsidiary anticline (Misoa anticline) plunges. The similarity is carried even to the dip of the strata; the thickness of the oil zone, which is practically 700 to 800 feet in each field, and to the quality of the oil, which ranges from 10º to 19º Baumé (1.0000 to 0.9395 sp. gr.) in the Mene Grande and Westside Coalinga fields. The Eastside Coalinga field yields oil as high as 30º Baumé in gravity (0.8750 sp. gr.), and it is not only possible but probable that oil of much better quality than that already encountered will be struck in the Mene Grande field in the deeper wells away from the outcrop. Fortunately for the Mene Grande field, there is apparently a dissimilarity in the two as regards the occurrence of water above, and associated with, the oil zone, for up to the present time no water-bearing strata have been encountered in the drilling at Mene Grande, whereas water above, and associated with, the oil sands in the Coalinga field has always been its greatest menace. (Water was erroneously reported in the Mene Grande wells in one of the statements sent out by the resident geologist, the latter having been misinformed by one of the drillers.) The importance of the similarity of Mene Grande to a well-known field like that at Coalinga lies largely in the fact that it is possible to obtain a fairly accurate estimate of the future productivity of the wells at Mene Grande by comparison with the Coalinga wells. Most of the wells at Coalinga situated in an analogous position to those at Mene Grande, but in general probably farther from the outcrop than the latter, flow when the richer sands are first tapped. The period during which the wells flow varies from well to well, according to the local gas pressure and also according to the period of the field's history in which they are drilled.

Cachimbo. The Cachimbo seepage is located about 30 miles east of Santa Rita, 6 miles south of Los Tablazos, and 8 or 10 miles west-northwest of San Geronimo. It resembles the occurrence at the last mentioned locality and consists of petroleum seeping from a shattered zone of medium grained sandstone, two to three feet in thickness, which apparently dips N.70º E., at an angle of about 45°. The commercial importance of this locality is questionable.

Lagunillas. The deposit known as El Mene de Lagunillas lies about 6 miles east of Lagunillas, or about 32 miles southeast of Santa Rita, at the edge of a swamp and small sabana, and covers an area 300 feet long by 30 feet wide. The main axis running in a north-south direction. Other small deposits extend along the strike for half a mile, and still another is known to occur half a mile east of the main one. No rocks or other evidences of the geology or structure are visible in the entire region, which is covered with flat-lying Llanos beds. The occurrence, however, is so similar to these at Santa Rita and La Rosa, where the geology is better known, that it seems likely that the Lagunillas seepages are the result of beds folded in a manner and similar to those at Santa Rita and La Rosa.

It is the belief of the writer that careful testing of the region with a portable rig would soon furnish evidence enabling one to work out the underground structure. The evidence in general favors the idea that there is a fold or dome in the region of the seepages and that exploratory drilling will result in securing results comparable with those obtained in the La Rosa wells.

La Rosa or Santa Rosa. La Rosa is a small village on the east shore of Lake Maracaibo about 20 miles southeast of Maracaibo. Certain surface evidences of petroleum, combined with the natural advantages of transportation, led the management of the Venezuelan Oil Concessions, Limited, to drill its first well here.

The surface evidence consists of emanations of gas at the following localities: in and adjacent to the lagoon or ciénaga at Santa Barbara, $1^{1/2}$; miles southeast of La Rosa; at Cienaga Pelada, 2 miles north of La Rosa; at Barros, one mile north of La Rosa; at Curraria, $2^{1/2}$ miles northeast of La Rosa; at Sabana Grande, 5 miles northeast of La Rosa; and Sibucara-Gorda, 3 miles east-northeast of La Rosa; deposits of asphalt of considerable size at Juncalito, $6^{1/2}$ miles slightly south of east of La Rosa; and at a point one mile southeast of Loma de San Diego. The most important of these emanations are those of Santa Barbara and Juncalito. All of the occurrences are believed to come from the Maracaibo Series, the oil-bearing series of the Mene Grande field. With the possible exceptions of the gas emanations at Santa Barbara and Sibucara Gorda, which occur along the axis of the Santa Barbara anticline, all are believed to represent outcropping petroliferous beds or oil sands.

El Mene de Santa Rita. Santa Rita is a small village on the shore of Lake Maracaibo, 15 miles southeast of the city of Maracaibo. Some small oil seepages occur on the shore of the lake at this point, and oil bubbles up from the lake at a point immediately off the shore from the village. Inland for a distance of about two miles are other seepages, two of which—El Mene and Temblador—are quite important. The line of seepages extends in a general east-west direction, but the lines of activity in the two principal groups are N.48º W. for the eastern or Temblador seepage and N.42º W. for the El Mene or western seepage. This N-W alignment of the local points of activity is probably due to faults which cut diagonally across the major structure, which extends in a general direction slightly south of east. Minor seepages occur between the two larger

groups. The large seepages are of such size and activity as to indicate commercial quantities of petroleum in the district.

The seepages break up through the horizontal Llanos beds and in some instances spread out through the bedding planes of this formation. The Maracaibo formation is exposed on the lake shore just north of the village of El Mene de Santa Rita, dipping south and slightly west at an angle of about 15°. This surface evidence leads to the conclusion that the seepages are the result of oil escaping from the oil sands in the Maracaibo, which are covered by a thin veneer of the Llanos. The structure is clearly that of a broad anticline, on the south side of which these oil-bearing beds occur.

San Geronimo. The oil seepage at San Geronimo, which is about 35 miles almost due east of Santa Rita, occurs in a small quebrada and comes from an oil-soaked sandstone. Up the stream, or south 100 yards, is a deposit of asphalt. The sandstone has the general appearance of that exposed at El Venado and is believed to be a part of the Maracaibo Series. No dip or strike could be determined. North of this quebrada, and over the ridge into the next one, is another asphalt deposit containing boulders of the same sandstone as seen at the San Geronimo seepage.

Los Tablazos. This, the most important of the three localities which include the San Geronimo and Cachimbo, is located a little over 30 miles east of Santa Rita. Numerous active seepages occur over an area of asphalt 300 by 500 feet. A very sandy shale outcrops in the asphalt area, and nearby structure indicates dips for the formation of N.10º to 30º, W.25º to 30º, with the major axis of the seepages paralleling the strike. In addition to this, there appear to be three lines of activity cutting diagonally across the strike. The whole occurrence suggests that El Mene de Santa Rita, and in the absence of other evidence, may be classed as one of the deposits suggesting commercial deposits of petroleum in either the Maracaibo Series or Cretaceous. The seepages lie within the Aranguren concession. (Joslin, F. C. Merritt and Bryan.)

San Felix. This seepage is 32 miles N.60º E. of Santa Rita and consists of a patch of asphalt 200 by 300 feet with oil oozing out of rocks of the Maracaibo or Coal Series at the crest of a structural dome. The conditions here suggest the possibility of small wells of a good quality of oil. (Joslin and F. C. Merritt.)

West of Lake Maracaibo

Rio Socuy. Beginning at the north end of the eastern flank of the Perijá range and coming south, the first evidence of oil is found on the Rio Socuy, a branch of the Rio Limon, which empties into the Sinamaica Lagoon north of Maracaibo.

An intermittently active, heavy asphalt seepage, 10 by 20 feet in dimension, occurs in vertical white limestone 12 miles north-north-west of Inciarte and 6 miles northeast of the Cachiri seepage. This seepage, although it indicates poor structural conditions for the accumulation of commercial quantities of oil at this particular locality, shows the oil-bearing character of the Cretaceous limestone series this far north. This is the northernmost seepage of which there is definite evidence.

An isolated patch of asphalt associated with the limestone beds occurs 10 miles north-northwest of Inciarte. The structural relations of this seepage are not clear, but the occurrence strengthens the belief in the presence of commercial quantities of oil in the limestone series of this region. (Clark and Dixon.)

Cachiri-Los Ochos Area. Surface evidences of petroleum are numerous in the region under discussion. They are found in three different forms, viz., seepages, outcropping oil sands, and outcrops of "asphaltic coal," of which the first mentioned is by far the most important and significant.

The principal seepages are those of Cachiri, which begin at a point not over a quarter of a mile north of where the Rio Tulé passes outof the trench between Sierra Guineo and Sierra de Mene, and extend in a line N. 25° to 30° E. for at least $2^{1/4}$ miles along the southeastern base of the latter ridge. The seepages increase in size and activity as one goes south along this line, the largest being opposite the village of Cachiri and covering an area of over two acres. Oil flows from several vents in this area and also from many of the seepages to the north and south. Toward the north end of the Cachiri line the seepages become small and inactive, and between the northernmost one and the seepage of Sierra Los Ochos no evidences of petroleum occur. The geologic relations of most of the seepages are obscure, but in some instances they have been found in such association with old greenstones or basalt as to suggest their occurrence along a fault, as in the Perijá country. Their linear occurrence supports this idea.

About six miles northeast of the Cachiri seepage is one found in the gray Cogollo limestone at the south end of Sierra Los Ochos. This occurrence covers an area 10 by 12 feet, the oil oozing intermittently from the vertical bedded and jointed white limestone strata.

Outcropping Oil Sands. Boyd reports a total of about 17 feet of oil sand interbedded withshale at one place, and 2 feet in another, in the upper part of the Coal Series on the Rio Tulé, just below the mouth of Caño Salado. These sands lie just below the upper coal- bearing zone of the Coal Series as exposed in this region, and although their occurrence is probably of little economic importance, due to the poor structural conditions surrounding them, their presence at this horizon in the geologic column is significant as suggesting a possible origin of at least some of the oil in the Coal Series.

Asphaltic Coal. A rather unusual occurrence of asphalt, somewhat resembling an impure coal in appearance, is found on the main road about one mile south of El Dibujo. In the opinion of the writer the phenomenon represents an impregnation of porous, possibly carbonaceous shale by heavy oil, to the extent of saturating and blackening the shale so that it resembles coal. The material gives a reaction for soluble hydrocarbons in the chloroform. Little significance is attached to the occurrence, except that it is an indication of the presence of oil in the sandstone formations of the region. A similar outcrop occurs some distance northeast of this one, and still others in the region west of Sierra del Mene. The latter occurrences represent the impregnation of outcropping coal with asphalt. Another occurrence located to the east of the Riecito is said by dark to be a mass of brittle asphalt on the outcrop of a coal bed.

Inciarte Seepage. This, the largest of the seepages so far examined west of Lake Maracaibo, is in Mara and is situated about 50 miles northwest of Maracaibo at the end of a railroad 27 miles

long, connecting it with Carrasquero on the Rio Limon. The asphalt rights were formerly the property of an American company, which lost them through confiscation by the Castro government; the Gomez government paid the owner $400,000. The oil rights of the main seepage area are a part of the Tregelles concession. The Inciarte seepage is an elevated terraced knoll of asphalt-impregnated horizontal Llanos beds about 1 mile long and one-half mile wide. Active seepages of oil and gas occur at various points over the knoll, the most active area appearing to be that at the north and south ends where small streams of oil are constantly flowing away. These flows extend for some distance east of the main area, and are of such size as to have been worked for asphalt at one time. One of the notable facts in connection with this seepage, and in fact all of the seepages west of the lake, is that the oil is of such low viscosity as to render the formation of any but the most insignificant of asphalt cones impossible. In this, it resembles the Guanoco seepages and is in direct contrast with the great seepages of Trinidad and San Timoteo. The oil at Inciarte is believed to come from a fault zone in the Cretaceous, and the activity and extent of the seepage is certainly an indication of important deposits of oil in the immediate region.

South of Inciarte. Beginning a mile or so south of Inciarte and extending southward for about 4 miles is a line of important seepages which is believed to mark the trace of the fault zone along which the oil accumulation of this region occurs. At the south end of this line the oil is associated with what is reported to be granite. A careful examination of the rock may prove it to be the same as that reported as "acid igneous rock" in the region farther south. At any rate, the line of seepages denotes the probable presence of important deposits of oil and ties up the Inciarte and associated occurrences with those in the region south of the Rio Palmar. This 4-mile line of seepages is in the Aranguren concession, but is mentioned because of its bearing on the region north and south of this concession. (Clark and Dixon.)

La Paz or Las Flores. Situation and topography: The La Paz or Las Flores seepage, probably the second largest west of Lake Maracaibo, lies on the plain or Llanos about 28 miles slightly north of west of the city of Maracaibo and 18.6 miles S. 53° 30’ E. of Rio Viejo reference post. The country for several miles around the seepage is practically flat and covered with the usual type of forest found on the semi-arid plains west of the lake. The seepage can be reached by trail from Maracaibo or Inciarte. As the plains of the District of Maracaibo to the east of La Paz are probably underlain by formations similar to those at La Paz, and also possibly similarly affected structurally, a brief discussion of the region will be given in the following paragraphs.

Geology and Structure. There is little evidence regarding the geology in the region of the seepage. The most suggestive feature is the strike of the line of active vents which trends N. 38° 2’ E. This trend is in general parallel with the fault zones of the Perijá
and Rio Limon districts to the west, and suggests that the seepages emanate from a fault
line. In line with this trend and 10 or 11 miles northeast of La Paz is Sierra El Padre, supposed to be a structural dome, while to the southwest and also in line with the same trend is Sierra El Indio. This suggests a continuous line of disturbance from La Paz, both to the northeast and southwest, along which the conditions for the accumulation of oil are believed to be excellent. This same line may possibly continue still farther to the northeast and have some connection with the origin of the Toas Island uplift.

Surface Evidence of Asphaltum. The main asphaltum area is one solid bed of asphaltum, almost entirely free from vegetation and with a very slightly arched surface. It is about one-half

mile long in the northeast-southwest direction and from 200 to 500 feet across. From each end of this main bed extend lines of smaller seepages or tar springs. Active seepages and soft areas occur at many points within the asphaltum zone, the most active being near the northeastern end and at the southwestern end of the main area. The smaller deposits are sometimes 100 feet long, parallel with the general strike of the deposit, but are seldom over 20 feet across. Active vents also accompany many of these small deposits.

Conclusions. As mentioned before, the seepage lies on the axis of a disturbance (fault or fold) which passes through two of the most prominent topographic features of the plains region west of the lake, viz., Sierras El Padre and El Indio. Such a line is believed to be suitable for the accumulation of oil. The large amount of oil which has escaped and is escaping at this locality clearly indicates the presence of commercial quantities of oil in the underlying formations. There is every reason to believe that other deposits of oil similar to those undoubtedly underlying the La Paz region are to be found at other points along the El Padre-El Indio line and probably also at other locally structurally advantageous positions throughout the plains or Llanos region in the District of Maracaibo between the Perijá-Rio Limon line of seepages and Lake Maracaibo.

Near Rio Palmar. The next known seepage to the south of those last mentioned is that of Los Ranchos, within 2 miles of the Rio Palmar. It is variously estimated at from 5 to 15 miles from the southernmost seepage described in the last paragraph. It occurs near the foot of the mountains and is believed to be on a continuation of the zone of faulting to which the seepages described in the next paragraph are assigned. It is significant in indicating the northward extent of this important structural line. (Donnelly and White.)

Los Longos or Emboscado Area

Situation and Topography. About $13^{1/2}$ miles northeast of the mouth of the canyon of the Rio Palmar, and 3 miles south-southwest of Inciarte, is a group of seepages known as the Los Longos or Emboscado. Although these are believed to be within the limits of the Aranguren concession, they will be described because they pertain to the problems affecting the Caribbean Petroleum Company's property.

The region is one of rather gentle relief, the seepages being located around the northeastern end of a hill which is part of a group extending southwestward from Emboscado.

Surface Evidence of Petroleum. Those of the Los Longos seepages visited by the writer consisted of hardened asphalt deposits which had flowed down a low slope, indicating that the source had been active over a considerable period. In the case of the deposit farthest west, the seepage was still active. In the deposit near the trail to Emboscado, no activity was apparent. This latter deposit may have been part of an old flow. Clark is authority for the statement that the larger seepages are those toward the north end of the area.

Caracolial

Surface Evidence of Petroleum. The surface evidence of petroleum at Caracolial consists of an exposure of coarse Tertiary sandstone, dipping S. 40° E. 30' or steeper, thoroughly saturated with a heavy asphalt oil, which exudes from the surface along a line 100 yards or more in length,

striking N. 50° E. The oil can be seen exuding from the exposed sandstone. A fair amount of activity was evidenced by the seepages at the time of the writer's visit (October 22, 1914), but no cones have formed and the oil seems to be oozing out very gradually, as is usually the case in exudations from exposed sandstones. The oil is heavy and asphaltic.

Monte Verde-Rio Palmar Region

The Monte Verde region occupies the front of the range from a point $1^{1/2}$ miles north of Totumo canyon to the Rio Palmar. The mountains here are characterized by a steep slope where they meet the plains. The rocks of the mountains consist of the unique Monte Verde quartzite which is complexly folded, the beds generally standing nearly vertical. The Perijá fault zone passes along the base of the mountains and is believed to bring down the east-dipping Tertiary beds on the east side of the fault against the older rocks on the west. Several important oil seepages occur along the fault zone, and the locations for drilling sites have been made to tap the fault zone, and possibly the porous beds which lie east of it. The geology is almost a counterpart of that at Petroleo, and good results are expected from test drilling.

Perijd or Petroleo Seepages. These seepages, which cover more than 25 acres, rank next to La Paz and are probably the third largest in the region west of Lake Maracaibo. The seepages form four or five divisions, the active vents lining up in general along a trend of N. 34° E. to N. 13° W. The oil seeps out and flows down toward the east, forming several more or less distinct tongues of asphaltum, which are partially covered with vegetation. The oil is supposed to emanate from a fault zone which dips eastward at an angle variously estimated at from 70° to the vertical. To obtain the best results, this zone should be tapped at a depth of from 1,500 to 2,500 feet. As these seepages appeared to offer the best inducements of any in undisputed possession of the Company in the region west of Lake Maracaibo, the first test wells were located here.

Totumo or Dos Manantiales Seepages. An important seepage occurs at the foot of the mountain slope in a small canyon about 2,000 feet north and slightly west of the mouth of Totumo Canyon. It consists of two active vents about 20 feet apart, from which oil is continually flowing. For this reason, and to distinguish it from the other seepages in the same general region, it was named "Dos Manantiales," meaning "two sources or springs." The asphalt deposit in front of the vents is from 20 to 50 feet wide and extends for at least a quarter of a mile down the shallow ravine in which the seepage occurs, and indicates the escape of large quantities of oil. In fact, the seepage left the impression of being one of the most active of any found in the region south of the Rio Palmar. A line of small seepages extends in a direction S. 13° W. from this main one toward Totumo Canyon, and an isolated seepage is also found along the same line on the southern side of the canyon, near the mouth. Fragments of a coarse, true oil sand are fond at several points between Dos Manantiales and the mouth of Totumo Canyon. This evidence led to the digging of a trench about half-way between the seepage and the canyon, to discover, if possible, the absolute contact between the igneous rocks on the west of the fault and the sandstones on the east. This trench disclosed a series of impregnated sands with interbedded barren clays lying against a zone of gouge or clay, back of which the igneous rocks were found in place on the hill. The sedimentary series did not come in direct contact with the older rocks as was to be expected along a line of faulting. The sandstones dip N. 77° E. 52°. It is the belief of the writer that this steep dip does not continue very far in the formations as one goes away from the fault.

Tintini-Rio Cogollo-Rio La Ge-La Luna-Finoles

Surface Evidence of Petroleum. Active seepages from joint cracks, seepages at the surface where no structural relations can be made out, and oil-impregnated sandstones are the three principal forms in which petroleum indicates its presence throughout the region. Beginning at the north, the first evidence of petroleum is found in the oil-saturated sandstone at La Luna. This canyon lies about $10^{1/2}$ miles west-northwest of La Villa del Rosario.

The oil comes from a saturated, medium-grained oil sand approximating 250 feet in exposed thickness, which appears to lie conformably on the fossiliferous, black, concretionary La Luna limestone beds. The sandstone dips about 30° southeast; the dip in the black limestones is the same, but steeper dips were noted in the gray Cogollo limestone lying under the latter. This is one of the few instances in Venezuela of a true oil sand occurring on a monoclinal slope under conditions which appear favorable to its exploration on a commercial scale. Some seepages of oil are also found in the black limestone below the oil sand, but these are of minor importance.

The next seepages of importance are those at Tintini, within the canyon of the Rio Cogollo below the Frontal Sandstone outcrop, which forms the first ridge of the mountain slope. These seepages may be described as follows:

A small seepage occurs in sandstone near the river and two large ones on a side hill in joint cracks of the limestone. These last two are known as the main Tintini seepages. A little fresh water comes out with the oil from both vents. The asphalt which has come from them coalesces to form a sheet 750 by 300 feet or more in area on the side hill. Farther down, and not far from its base, is another active seepage from which sulphur water and heavy oil exude. A short distance down in the gray limestone there is an impregnated bed of true oil sand.

About a mile south of the Tintini seepages and apparently occupying a somewhat analogous structural and stratigraphic position, are three closely associated seepages known as the Finoles. Here a great quantity of oil has escaped from either the top of the black La Luna limestone or the rocks above the limestone as far as the base of the Frontal Sandstone, and has spread out over several acres, forming an impressive sheet of asphaltum, most of which is at present overgrown with vegetation. The three vents from which the fluid has come lie in a north-south line about one-fourth mile long. They were not exceptionally active at the time of the writer's visit, although considerable quantities of sulphur water were escaping with what little oil was coming out. There was apparently little gas coming from the vents, which is not a particularly favorable sign. However, the size of the asphalt deposits is such that test wells should be put down here if favorable results are obtained at Tintini or La Luna.

El Fausto and Coruba-Rios Tinacoa and Cuiba

Surface Evidence of Petroleum. In the hilly country south of El Fausto there is an asphalt seepage, occurring in the middle of the Rodeo formation. No outcroppings occur right at the spot, so that the structure in the immediate vicinity cannot be worked out. At Coruba a large mud hole of considerable depth floats up asphalt on the water periodically. Again, the sandstone exposed along the rios Tinacoa and Cuiba, which is in the Coal Series or Frontal Sandstone, gives positive tests for petroleum with chloroform, and in this same connection, as occurring under similar

structural conditions, might be mentioned the Macoa seepage which occurs farther east, down the axis of the Cogollo anticline.

Macoa

Situation and Topography. The Macoa area, a continuation of that described in the preceding paragraphs, is located between Rio Cogollo and Rio Apon, about 6 or 7 miles northeast of Machiques and 8 miles east of the foot of the Frontal Range. The topography is dominated by the valleys of the two rivers mentioned and consists of rolling sabanas cut by quebradas.

Surface Evidence of Petroleum. Only one seepage has been found in the Macoa area, this consisting of an area of dry asphalt 20 square meters in extent, situated in the bottom of a small quebrada in the southern part of the mapped area. It shows no evidence of recent 0activity, but its general appearance indicates that it cannot be many years old. Its origin is clearly from some joint cracks in the crest of the terrace fold, and the source from which it came may be at almost any depth below the surface.

Rio Negro-Caño del Mene-Rio Aponcito-Rio Santa Ana Region

This area includes the hilly country in front of the main mountain ridges from the Cogollo region south to the northern line of the Vigas concession, which is approximately coincident with the course of the Rio Santa Ana. In the Caño del Mene, a branch of the Rio Negro, five miles southwest of Machiques and just inside the Frontal Range of hills, is a seepage coming from saturated oil sand. This occurrence possibly indicates the same conditions as those occurring at La Luna, although Donnelly and White, who made the observations, were inclined to believe that the impregated sand represents a lower horizon than that one which is exposed at La Luna. Judging by the evidence offered by the Rio Oro region, their conclusion is probably right, as the Colon shale and Coal Series come in below what is known as the Frontal Sandstone of La Luna in the region south from La Luna, the two series being developed to the maximum in the Rio Oro-Rio Tarra region. The Rio Negro sand may therefore represent one of the zones of impregnation in the Coal Series, such as are found in the Rio Oro-Rio Tarra region.

Another seepage reported by Donnelly and White occurs in a fault crack at the contact between the La Luna and Cogollo limestone series on the Rio Aponcito, near the base of the mountains. This occurrence is rather to be likened to those in the limestone on the Rio Cogollo to the north, than to the Rio Negro occurrence. It simply shows the petroliferous character of the limestones, believed to be the source of much of the oil of this entire district, in the region of the Rio Negro, and is believed to be the point farthest south at which oil is found in the limestones in Zulia.

Large asphalt deposits were reported as occurring up the Rio Santa Rosa de Aguas Negras, but these could not be located in the short time at the command of the exploring party.

From Rio Negro southward for 30 miles to the northern limit of the Vigas concession, no explorations have been carried on, owing to the hostility of the Indians, but enough is known of the region to warrant the recommendation that an armed expedition be sent in to locate seepages of which creditable witnesses report.

Oro Anticline

The natural surface evidence of the presence of petroleum in the Oro anticline is confined to four or five seepages along the crest of the anticline on the south or Colombian side of the Rio Oro. The seepages are all small, the exuding oil being of medium grade. The occurrence of these seepages along the crest of the fold follows the usual rule for closed anticlines. A poorly exposed oil of unknown thickness is exposed near the seepages.

Tarra Anticline

Oil seepages were found at the crest of the anticline in every section made from "La Paloma" south.

State of Tachira

About 4 miles southwest of El Petroleo, and apparently on the same flank of the same anticline and at about the same geologic horizon as the seepages at the latter locality, are the two seepages at Quebrada Blanca. They occur at an elevation of about 4,700 feet and are, so far as known, the highest seepages in Venezuela. They are probably not important economically.

Rio Quinimari

Ten miles south of San Cristobal, on the Rio Quinimari, are some small seepages of heavy oil coming from the joint cracks of the fossiliferous black limestone. Similar seepages are known to occur about 3 miles southeast of San Cristobal and at one or two other localities in this same general region. In both cases the structure in the limestone is monoclinal. Not of economic importance.

Quebrada Cope

At Quebrada Cope, 16 miles south-southeast of San Cristobal, and very difficult of access, is a tar or asphaltic seepage in conglomerate (possibly of Tertiary or Quaternary age) and siliceous sand strata interbedded with the latter. The impregnated zone is over 100 feet square and is believed to overlie a petroliferous zone in the limestone series. Owing to the poor structural conditions tor oil accumulation and the difficulties of exploitation, it is not believed that this locality will ever yield oil in commercial quantities.

Caño Azul

A light oil seepage, covered by the Tregelles concession, occurs on the east side of the railroad between La Fria and Uracá. The rocks here are sands and clays, probably of Oligocene age (Maracaibo Series) and dip south-east at an angle of 30 degrees. The seepage was first located by a film of oil on the water, but by digging in the clay beside the creek a strong odor of kerosene was given off. The clay is impregnated with a light oil resembling kerosene, while a slightly heavier and darker oil is found in a more solid formation deeper down. These indications occurring under the structural conditions offer little hope of commercial oil in the vicinity.

State of Merida

It is known that a pretty continuous line of seepages occurs along a northeast-south- west line at the base of the Andes and at some considerable distance inland from the lake. Judging by the size of the seepages and the structural conditions which surround most of those which have so far been studied, it seems likely that only a few of the areas selected around these seepages will ever prove to be of commercial importance. The known seepages from west to east are:

Quebrada El Oro. Two miles west-northwest of Tovar, on the Quebrada El Oro, is a small seepage of light oil with some local impregnation of the Colon shale, which here dips at angles of over 30º and is overlain by the Coal Series dipping at much steeper angles. The conditions do not favor commercial deposits of oil.

Quebrada Olla. At Quebrada Olla, 3 miles northeast of Quebrada El Oro, is a live seepage of light oil coming from alternating thin-bedded sandstone and shale. This is probably similar to the last, and is in general to be compared to the El Petroleo occurrence in Tachira, which offers little hope of important commercial deposits.

Quebrada Agua Caliente. A sandstone dipping 50º to the northwest in the bank at Quebrada Agua Caliente yields some light green oil and water which collect in pools in the gulch below. Downstream are some hot sulphur springs flowing from sandstones which dip 50º to 80º northwest. The oil is coming from beds believed to be in the base of the Coal Series, and because of its quantity and structural position, is probably not in commercial amounts in this vicinity.

Mina Onia. Oil sand fully 16 feet thick, capped with mottled clay and dipping at angles less than 30º, was noted in Caño Frío near Mina Onia, the Tregelles concession. Two other seepages of light oil occurring in the same horizon as the sand at Caño Frío, and within 12 miles of the latter, are known, but the oil sands do not show at the surface as at Caño Frío. These occurrences of oil are believed tobelong somewhere above the Coal Series. The conditions are believed to be quite favorable for the accumulation of possibly commercial quantities of oil. (Bryan.)

Between Mina Onia and Torondoy. Two seepages are reported by a peon between Mina Onia and Torondoy. One is apparently similar to the light oil seepages at Mina Onia, while the other is said to be an asphalt seepage on the flat. (Bryan.)

Torondoy. In the vicinity of Torondoy are a series of seepages of light greenish oil coming from the black limestone series and from the schist associated with the limestone in a fault zone which is plainly seen at one or more places and has been traced for several miles in a northwesterly-southeasterly direction. Although the presence of seepages of oil in schist is not common, they are still known to occur in certain localities, always, however, in the region of faulted or disturbed zones. The conditions for accumulation in commercial quantities in such zones are usually not good, and it is the writer's belief that little chance exists for the development of any but small producers in this particular region. Furthermore, the conditions governing transportation and development work in this region are exceedingly adverse. (Eckes and Bryan.)

Near Torondoy. A big seepage with a good sized deposit of asphalt is reported by outside parties as occurring 8 miles west of Tabacal. Another asphalt seepage 12 miles southwest of Torondoy has been reported by Nobs and Gehrmann.

[El] Caraño. At [El] Caraño, 13 miles north of west of Valera, in the Rio Caus, are 7 seepages in a shale which underlies the Coal Series and is believed to be the equivalent of the Colon shale. The dip of the beds is about 50º and the structure more or less questionable, but probably monoclinal. Five gallons of light oil are collected here daily and sold in Valera for forty cents per gallon for lubricating purposes. The occurrence here is not under conditions conducive to much production, but owing to the good quality of the oil, it may be found profitable to exploit certain areas with shallow wells. (Eckes, Hasbrouck, Jackson, Macready and Bryan.)

Region between Rios Chiruri and Culebra, States' of Merida and Zulia

San Cristobal Seepage. This is the most eastwardly seepage. Its location is about 3 miles north of San Cristobal near a hacienda known as La Virtudes. The seepage, a small one, is of black, fairly flashy oil, and occurs in a drain by the Rio Chiruri. Occasional gas
bubbles ooze from the oil. No exposures occur near the seepage, the surface being covered with metamorphic float.

Tabacal Seepage. The second seepage going westward is located on the mountainside by the Rio Torondoy six miles southeast from Caja Seca. Here there are several small seepages which appear to come directly from the metamorphics. In one place it oozes from the joint planes of schist, which is apparently in place.

Rio Mujaca Seepage. This is by far the largest seepage between the Rios Chiruri and Culebra. Its location is high up on the Rio Mujaca. The oil, which is black and very heavy, issues from the bedding planes of sandstone standing on end. There appears to be slip faulting along the bedding.

San Pedro Seepage. The next seepage going west is on the Rio San Pedro. Here oil was found in the Rio San Pedro and traced to certain sandstone beds above which it was lacking.

Rio Culebra Seepage. The next seepage was that found in the Rio Culebra. The dips of the beds exposed in the Rio Culebra are much less. The seepage is small and the oil, which is heavy, apparently issues from the contact between a sandy shale and a 4' bed of hard, black limestone.

PART IV
CHAPTER 22

Contributions by the Men on the Survey

This section is devoted to some of the written contributions from those men taking part in the pioneering for petroleum in Venezuela. They show firsthand some of the difficulties encountered in those early days. They are heroic stories of "Our Boys" writing the records of their findings, in their respective assigned areas.

They came to Venezuela out of the classrooms, but when they left the country most of them were seasoned petroleum geologists. None escaped the gnawing ravages of nature in this rugged land. To contemplate bringing to light the oil possibilities of such virgin country was a task in itself. The fact that they completed their assignment successfully is a credit to their courage and fortitude.

The country was investigated in detail firsthand by the pioneers, and the knowledge gained utilized in making known the hazards and the rewards. An investigative trip to the Venezuelan jungle today would be totally different from such an experience during those early times. The jungle and its resources are still there, but better known and more available and accessible now than then, because of this early work.

One feature of interest throughout those contributions from the pioneers is the friendliness of the people, cooperative and interested at all times. This was in itself of tremendous value. Had our men experienced opposition or unfriendliness (witness the experience with the Motilone Indians), the task would have been infinitely more difficult and the results would have been incomplete and of little value.

Each man will be introduced, whether he has written a contribution or not. The reason that the writing of this book was not started was because all of our crew, including myself, felt under obligations to the company to withhold the dissemination of any valuable material until it had become economically valueless.

In my original arrangement with John Mack, when I undertook the direction of the survey, it was distinctly understood that we had the right to publish scientific or other articles regarding our work only when we felt that such publication would not hurt the interests of our employer. By waiting until 1953, 35 years after we finished the job, we feel that we have carried out our obligations to the General Asphalt Company and the Shell Oil Company interests.

Ralph Arnold—Senior Author

Ralph Arnold came from Pasadena, California. He was graduated from the Pasadena High School in 1894, Throop Polytechnic Institute in 1896, Stanford University in 1899; A.M. 1900; Ph.D. in 1902. He taught Physics and Chemistry at Hoitt's School, Menlo Park, California, 1899-1900. Lectured on Petroleum Geology and Engineering, University of Chicago, 1914, Harvard and Mass. Inst. Tech., 1915. Member United States Geological Survey, 1900-1909; in charge of oil investigations in California for the Survey, 1905-1909. Organized Petroleum Division of U. S. Bureau of Mines in 1910; Consulting Geologist and Petroleum Engineer, 1909.

George Alexander Macready—Co-author

George Alexander Macready came from Los Angeles, California. Attended Throop Polytechnic Institute and was graduated in Geology and Mining, Stanford University, 1906. Was instructor in Geology, Stanford. Was the first man employed by Arnold in Trinidad; served as Chief Geologist 1911 to 1913, and later served as Resident Geologist through the entire program. He left the employment of the General Asphalt Company in 1919, after which he was with the Shell Oil Company. His death came November 10, 1955.

Thomas W. Barrington—Co-author

Thomas W. Barrington was born at Cambridge, Massachusetts, and educated in the public schools, Cambridge. He was graduated from Harvard University in 1910 and given an S.B. Degree in Mining and Metallurgy. In 1912 he received M.E. in Mining Engineering. After spending two years in Chile for the Chile Copper Company in getting the mine started at Chuquicamata, he went to Trinidad early in 1916. After leaving the General Asphalt Company, Barrington was engaged in copper mining at Kennecott, Alaska. He became interested in heavy equipment and took additional studies at the University of California. Later he joined the purchasing department of Standard Oil Company of California from which he retired in 1958.

Our group had such close contact with the initial development operations that their opinion was dominant as to location of wells and the underground geology as disclosed by the drilling. In addition to the geologists employed, the names of the Venezuelan civil engineers, superintendents, tool-pushers, drillers and helpers have been given as far as possible. Much of the work was soon learned by the local people and they were employed whenever possible. They ofttimes turned out to be apt pupils and many times showed ingenuity in doing things their way, which was sometimes superior to our way of accomplishing the same thing.

E. D. "Dan" Nolan-Deceased

E. D. "Dan" Nolan came from San Luis Obispo County, California. He majored in Geology and Mining at Stanford University with the class of 1912. His college work was interrupted by his appointment as Resident Geologist at Brighton, Trinidad. Returning to the United States in 1914, he completed university training and received his A.B. from Stanford in 1917.

Clarence J. Peterson—Deceased

Clarence J. Peterson was born in Hawaii while it was still an independent kingdom. He attended Stanford where he majored in Geology and Mining and was graduated in 1910. Feb. 5, 1912 he went to Guanoco, Venezuela, for the Bermudez Company, where he took part in the field work resulting in the location of Bababui #1 as the first discovery well in eastern Venezuela.

John E. Elliott

John E. Elliott was graduated from Stanford in January 1912 with an A.B. degree in Geology and Mining. His employment with Caribbean Petroleum Company began about February 1, 1912. His outstanding work in Venezuela was the assembly and compilation of the first complete map for geological use ever made of northern Venezuela.

Early in 1912, I was employed by Mr. Ralph Arnold to act as Assistant Chief Geologist for the Caribbean Petroleum Company. Their main office was in Caracas, Venezuela. The equipment of the geological department consisted of a desk, a couple of chairs, a drafting table, a blueprinting machine and a few books on geology which I had brought with me from the States. This was the first blueprinting machine in Caracas. I made the first geological map in Venezuela and it is still on file at the Caribbean Petroleum Office in Caracas. The over-all plan as outlined by Mr. Arnold

was to employ as many geologists as possible and to scatter them over the parts of the concession in pairs, which was necessary as a protective measure in the event one man might have an accident or become ill. So far as I know, this group was the largest group of geologists ever assembled on an oil finding project.

Early in 1913, George A. Macready was taken from Trinidad into Venezuela to make a reconnaissance survey of eastern Venezuela and later of the area around Lake Maracaibo. George was the most experienced field geologist that we had in the entire group at that time. He had a keen eye in the field and had the remarkable ability of expressing what he found in very few words. George traveled alone—lived off the country the best he could, and got along extremely well with the Venezuelans wherever he went. He was very courteous to the Venezuelans and made no pretense of being more than one of them at any time.

I will relate briefly my great inspection trip over western Venezuela, with Ralph Arnold, during March, April and May of 1913. Mr. Arnold insisted on moving at the greatest speed possible and yet it required from seven to eight weeks of hard, continuous travel with few comforts. We left Caracas by the little narrow gauge railroad for La Guaira, where we took a tramp steamer to Maracaibo. Our steamer anchored offshore; we went ashore in a rowboat and walked a short way to the center of the town. The following morning we took off on horseback. During the afternoon we heard a loud roar from the forest. It was brown monkeys. Our guide stopped us and told us to remain quiet. Soon they came to the ground, to inspect us, one coming to inspect my shoe in the stirrup of the saddle. Soon we made camp and I noticed our guide scrutinizing his trousers. Looking down, I found I was fairly covered with ticks. We stripped down, scraped off the ticks and held our clothes over the fire so that those we missed would burn off. We covered the spots with creoline—the only antiseptic we had with us.

The next morning we took off at dawn and headed towards Inciarte, where we found some large seepages of petroleum. From there, we went overland and arrived at Machiques late the second night. The Motilone Indians had driven the Venezuelans eastward and this was as far as we could go at that time. Early the next morning we headed for Lake Maracaibo at Playitas. This took one day's travel on horseback. Here a native schooner was awaiting us. We were glad to go aboard and get a few hours rest from the ticks. We sailed all that night off the southwest shore of Lake Maracaibo. The next day we transferred to an ancient stern wheel steamer which had served its early days on the Mississippi River. We stopped often to pick up wood, and the passengers amused themselves shooting at the alligators. At Encontrados we disembarked from the river steamer and took a narrow gauge wood-burning railroad train to Tachira. From here we had horses and mules ready to continue southward to San Cristobal. Here we had rooms in a hotel and even had a shower. We heard a noise and found a Model T Ford making its way along the street. This was the first automobile in this part of Venezuela. It was also the only spot in Venezuela to have a local source of gasoline. From here, we made our way to Rubio on horseback to visit some dug wells and inspect a crude-oil refinery. The oil was bailed out into cans from the wells, carried by man power (Chinese fashion), to the nearby refinery. The products from the refinery were all sold locally.

We went by horseback to San Timoteo, a small village on the eastern shore of Lake Maracaibo. These small villages were built on piles out in the lake. This had been found to be the only means of getting away from the terrible scourge of mosquitoes that plagued the onshore

lowlands. The next morning we headed for shore along the narrow board walks. Our guide told me to take the "white horse." I could see no white horse, but as I approached the animals I could see that they were so completely blanketed with mosquitoes that they all appeared dark colored only a few feet away. Now, we had no ticks, but we had to contend with the vicious mosquitoes. Mounting our horses we headed in an easterly direction. It was past noon when we arrived at the geologists' camp on the border of Mene Grande. After a quick and scanty lunch, we rode over the large oil and tar seepages of Los Barrosos which are now surrounded by the Mene Grande oil field.

We returned to our camp in the early afternoon for an early supper and retired long before dark in order to beat the mosquitoes under the nets. The following morning we got off to an early start, heading southward, and crossed the Rio Motatan in a native dugout. We finally wound up at Sabana de Mendoza in time to board a small wood-burning train which took us back to the coast at La Cieba. Here we found another sailboat waiting for us and we made a slow return to the town of Maracaibo. The next day we went in a small motor boat to the area west of Sinamaica. We traveled most of one day, arriving at Mojan well after dark, where we put up for the night. Then we had a small, narrow gauge railway line to Carrasquero. We intended to spend a couple of days in this area, but a torrential cloudburst kept us in camp.

During this storm the Rio Socuy had risen some twenty feet. Arnold was too impatient to wait until the next day, so we took a big dugout canoe, with two native polers each, and they took us down the Rio Socuy that same night. There was little enthusiasm among the rest of the party for making the trip during the dark, overcast night, as we all were aware of the dangers that lurked in that river full of floating logs and other debris which had been brought down by the recent storm. Even the native polers were reluctant to hazard the trip, but finally agreed when offered double pay. The canoe contained four members of our party; each sat between the outstretched legs of the man behind, with each one packed as close as possible. An Indian poler was stationed fore and aft on the boat and with only three inches of free-board, we headed down the river. We passed numbers of floating logs and trees and every now and then we would hear a mighty splash and the natives would mutter, *"Caimanes"* (alligators). We were forced to portage over three or four log jams. Finally, at early dawn, we reached Sinamaica, weary and travel worn and very glad to disembark and stretch our cramped legs and bodies from the sitting position which we had maintained during most of the night. We returned to Maracaibo by motor boat the same day. We crossed Lake Maracaibo in a native schooner, then with mules and horses headed eastward toward Altagracia, then on to El Mene.

This part of Venezuela is flat, semi-desert country, and water is a problem. Our liquid diet consisted mainly of lukewarm beer which we had gotten along the trail.

We finally arrived at Coro, tired and saddle sore. Here we had good food and drink and sheets to sleep between and even a much needed shower bath.

Mr. Arnold, indefatigable, insisted on traveling with the utmost speed possible. While he was checking the reports of the local geologists, another was busy chartering a boat which would take us to the Island of Curaçao. This time we had a fairly large schooner which made a pleasant trip to Curaçao, and upon arrival we found it would be several days before we could get a ship for Venezuela. This time we had a 27-foot sail boat to make the trip to Puerto Cabello and we took

off the same night. There were four of us in our party, in addition to three in the crew, and there was barely space for half that number. This was a rough, wet and miserable trip, and inasmuch as I am not a very good sailor, I recall that I threatened never to repeat such a trip, even if it meant deserting my profession. We arrived safely at Puerto Cabello and immediately took a railroad train into Caracas. We had been traveling as fast as the conditions would then allow; we were traveling as light as possible, with barely enough clothes to keep us dry and warm; we had lived off the country as we traveled; carrying almost no provisions of any sort, and yet, this trip had taken some two months of time which today would be easily and comfortably made in not over a week. This is about all I can remember of those forty years ago.

Arthur S. "Pike" Henley

Arthur S. "Pike" Henley entered Geology and Mining Department, Stanford University from Mendocino County, California, in 1901, remaining there until 1905. Was in Alaska and in coal mine investigations for the United States Geological Survey. He went to Venezuela in February 1912, and left early in 1913.

Franklin S. Prout

Franklin S. Prout came from Sonoma County, California and was graduated from Stanford University in January 1912. He came to Venezuela in February 1912 and remained until July 1914. Prout was considerably over six feet in height and a strenuous walker. He was conspicuous on account of his height and well liked by the Venezuelan people.

Harold E. Boyd

Harold E. Boyd was graduated by Stanford University in January 1912. He came from Santa Clara County, California. He was engaged for the Venezuelan exploration February 24, 1912. One of the great disappointments of Boyd's was the fact that after all the work he and Garner did in laying out the potentially rich oil concession areas at Quiriquiri, the Shell let them lapse and they finally fell into the hands of the Standard Oil Company of New Jersey. Boyd was one of our outstanding geologists.

A. H. Garner

A. H. Garner came to Stanford University from Astoria, Oregon, and was graduated in Geology and Mining, January 1912, in the same class with Harold Boyd. They came to Venezuela together and worked together for two years. Garner remained in Venezuela until late 1916. After war services he joined the consulting geologists' firm of Brokaw, Dixon, Garner, Donnelly and McKee with which he remained until his death in 1952.

Richard A. Conkling

Richard A. Conkling left New York on April 29, 1912, for Venezuela. He was born in Texas, raised in Oklahoma; graduated from University of Oklahoma in 1911 with **B.A.** Degree in Geology. Then followed a year of graduate work at University of Chicago and two summers with United States Geological Survey before going to Venezuela. After leaving Venezuela he returned

to the University of Chicago to complete his year of graduate work. He organized the geological department of the Roxana Petroleum Company where he remained until 1922, after which time he was engaged in consulting geology at Oklahoma City until his death on June 21, 1952.

I went from New York to Port of Spain, Trinidad, on a Dutch Line ship and from Port of Spain to Guanoco on the company's big tugboat. I was sent to Venezuela to work as an assistant to a Mr. Peterson who was working in the State of Sucre. I left Guanoco in the dry season and met Peterson at El Pilar. We then started reconnaissance work and worked around the Gulf of Paria for thirty days, to Yaguaraparo, where we met our District Geologist, Mr. George A. Macready. He spent three days with us, checking the work we had done, and outlining another thirty days' work until he was to meet us again. At the end of this three days' conference Macready and Peterson had a disagreement and Peterson resigned, as of that moment, and left Guanoco. Macready then spent two more days in outlining work for me and said that he would get me an assistant from the States as soon as possible. In the meantime, I worked alone with only hired Venezuelans to help me. After working for about two and a half months on the peninsula of Paria, I received word that my assistant would arrive in Carupano on the north coast of Sucre on a certain date. Accordingly I made my way through the jungles over the trails to meet him, and met the boat from Port of Spain on which there was no one from the U. S. A. Learning that there would be a United Fruit boat in from the opposite direction the next day, I stayed over and met it, with the same result. I then wired to the Company Office in Caracas for instruction. After they had gotten in touch with Port of Spain, they wired me that something had gone wrong and to go ahead with the work alone for a while. Later I learned that the Company had sent me a man whom they had hired from the U.S.G.S., who got as far as Port of Spain. There he was told of the terrible jungles where I was working and he said that it was no place for a white man, so he packed his bag and sailed back to New York. I accordingly worked another two months alone, and finished the peninsula of Paria. I made the maps on which I put the general geology, running the traverse much of the time by sound and pacing. I would send a man ahead through the jungle and we would call to each other and I would take a bearing on him with a Brunton compass, then pace up to him and again repeat this performance. There were no maps at all, except poor ones, along the coast. Whenever we reached the coast with our traverse, I would tie my map into the little towns. Occasionally I would climb to the top of the ridge at the north edge of the peninsula and take bearings on the little towns along the coast.

All during this work I would inquire at plantations and little villages as to whether there were any oil or gas seepages or asphalt deposits in the area. If there were any I would get a guide to take me to them and make an investigation and spot them on my traverse map.

After having taken malarial fever, due to disobeying one of the orders given us, not to overwork, when I had climbed a 2,000 foot ridge and made a traverse to the north coast of the peninsula of Paria and then on back to a little village 17 miles inland from the Gulf of Paria, I made my way by mule-back to Irapa, a village on the coast, where I was sick for seven days. Then I took a sloop down to Yaguaraparo. Here I received word that I was to put my burros in a pasture, pack up my maps, instruments and belongings, and come to Guanoco to meet my big chief, Ralph Arnold, whom I had never met.

Although I was so weak that I could hardly travel, I hired a *curiara* with two Venezuelans to paddle me to Guariquen. The native canoe was so small that I had to lie on my back in the

bottom, careful not to move, or it would dip water. We arrived at Gueriguen at about 11:00 P.M. and I slept on the wharf until daylight. Then I hired a small boy with a burro to carry my war-bag across country to the asphalt lake, a distance of about 15 miles, where the Company had a railroad to Guanoco. When we came to the slough surrounding the lake, which had been perfectly dry when going out five months earlier, I found that it was full of water. The burro could not cross this, so in spite of my weakened condition, I decided to try to carry my own war-bag across to the edge of the asphalt diggings and then call one of the men working there to get me over to the train. I found, after I had started across on the log trail, that some of the logs were partially afloat and would roll when walked on. I fell off three times in the mud and water up to my armpits and almost didn't make it across. Finally I arrived at Guanoco and met Mr. Arnold three days later.

Instead of being fired, we had a conference and it was decided that I was to examine the cuttings and watch a well which was being drilled in between the two asphalt lakes until another geologist could be engaged for that work. During the time I was on that well they drilled into a fault and the well started flowing liquid asphalt at several hundred barrels per day. They were never able to complete this well because the drill would not work in this asphalt. I was here almost a month and during that time I measured the thickness of the Cretaceous section of that area.

Then I began working from a launch along the coast of the Gulf of Paria in the State of Monagas. I examined the asphalt deposits at Guanoco and the oil lakes farther back in the interior, which were reached only by trail afoot. I had to go through extensive salt marshes, in the middle of one of which, on a little island not far from the oil lakes, I found white sand beneath the rotten vegetation, filled with wonderfully fresh, clear water, which was surely some find for men suffering with thirst.

I then worked my way around the coast to Pedernales, which was at the east end of the Gulf and which was in Territory Delta Amacuro. Here I worked out a faulted structure, as far as was possible, on which the Company drilled the first oil well in eastern Venezuela. When the Company was drilling its first well about a quarter of a mile from the fault, it went through a few feet of sand rock at about 1,600 feet depth. Every time the drill-stem was pulled out of the hole and left out a few hours, this rock would slip across the hole so that a new hole would to be drilled through it when they went back in. This lasted for several weeks and then we had an earthquake which came near to shaking down the rig and buildings, and which I felt sharply some 250 miles up the Delta. We found that the ground along the fault which I had mapped had dropped some three or four feet. They never had any more trouble about that rock sliding across the hole after that earthquake.

After the geological work had been completed around the Gulf of Paria, and of course before any drilling was started, I received a new transit all crated, which never had been set up or tested, with instructions that I was to survey all of the areas that I had recom mended around the Gulf, and put up proper markings at the corners of each concession. Having never run a transit, I had to stick my nose into a book on surveying for three days and nights before starting off on that job. I had also received a nineteen year old Venezuelan named Tovar Lange, who was a graduate of the University of Caracas in engineering. He was to assist me and *sign all the notes and sketches for recording.* Tovar proved to be an exceptionally studious and ambitious young man who was also

very likable and easy to work with. In this I was very fortunate, as some of the other geologists did not fare so well. Tovar Lange and I became very fast friends and never had any difficulties in our work. He later went on to Columbia University for postgraduate work on my recommendation.

All of this latest geological work and the surveying was done from an old catboat, 34 feet long, as living quarters, in which a two cylinder engine had been installed for motor power. This had to be used because the 44 foot launch on which I was to have done this work caught fire and was burned the night before we were to leave Guanoco. We called this boat on which we worked "The Battleship," because it was almost as broad as it was long. We were only able to make four or five knots per hour out in the Gulf of Paria if there was any wind at all.

By the time we had finished the land survey, the Company had shipped us a 62 foot launch named the "Minmo," which had been a private yacht. This was exceedingly comfortable for living quarters while we were working the Delta of the Orinoco River, which task was now assigned to us. I was also told to meet my assistant whom they were sending me at last at Guanoco. I went to meet the Company's big tug coming from Port of Spain, and to my surprise, whom should I see but a geologist with whom I had done undergraduate work at Oklahoma University and also postgraduate work at University of Chicago, named Charles R. Eckes. Upon my asking what in the world he was doing there, he said that he had come to assist some geologist whose name they had not told him. I told him that I was supposed to meet an assistant and asked if any other geologists were aboard. He told me that there were no others on board, and then we knew that we were to work together.

After filling all the gasoline tanks on the "Minmo" and lashing 60 gallon drums of gasoline to the stern deck, our Captain Morris of the "Minmo" started out through the Gulf of Paria and up one of the distributaries of the Orinoco River. Up this river, which flowed into the Gulf at Pedernales, we went to the town of Tucupita which was the capital of Territorio Delta Amacuro. I had orders from the Company to stop here and meet the Governor and establish cordial relations with the territorial officials. After an hour's conversation with the Governor, during which I met the Attorney General and the Secretary of State, and had several drinks, I invited all three officials to dinner on board the yacht that evening. It was a very pleasant occasion, as Capt. Morris took us for a two-hour moonlight ride after dinner, and we had two señoritas, the nieces of the Secretary of State, on board with us. I also succeeded in getting the Governor to give me a letter permitting me to go anywhere in the Delta with the assistance, rather than the hindrance, of the Guarda Costa, which proved to be very helpful. I learned later that we had established very cordial relations with the Government officials.

We then spent two or three months mapping many of the seventy-two mouths of the Orinoco river. The only maps we had of this area was one of the main mouth of the river, made by the Coast and Geodetic Survey boats, "Wilmington" and "Curasarge," in 1900, and a poor map of the Atlantic coast around the Delta. We had to make our maps by running compass directions with the launch at a certain speed and then sketching in details as we went along. I did this by sitting in the pilothouse with the Captain and timing our run on each course, with the Captain giving me directions from the boat's compass. I sketched the entrance of each caño as we went along, many of which we had to map out later by the same method so that we could locate any asphalt deposits, oil seeps or mud volcanoes. In making the final map all of these traverses were fitted

into the map of the main river and that of the Coast. It was remarkable with what ease they all were fitted in together.

In parts of our work we had to find a Guarauno Indian to act as a guide to show where there were asphalt deposits in the area. At first it was exceedingly hard to get one, as they would run into the jungle and hide. This was due to the Venezuelans having rounded up numbers of them and forced them to labor as slaves gathering rubber in the jungle. After we had employed one or two and given them canned goods and cigarettes as well as paying for their labor, we were overwhelmed by them. In one caño along which we came, they had heard that we would pass that way and some forty or fifty canoe loads had gathered to meet us. They tried to get us to go up a side stream to their village and said that they would give us anything that they had. We had to refuse this invitation, however, because of our shortness of time.

Having finished the work in the Delta, we returned to headquarters at Guanoco where we finished making up our maps. I was then taken to Port of Spain where I had a conference with the President of the Company, Mr. Arthur W. Sewall of Philadelphia. After this conference I promised Mr. Sewall that when I had finished another year's postgraduate work at the University of Chicago I would contact him in regard to further work for his Company. In the meantime Captain Morris and Charles Eckes had reprovisioned the "Minmo" and started out through the Caribbean Sea for further work over at Maracaibo. I sailed for New York the first of September, 1913.

In May of the following year Mr. Sewall asked me to come to see him in Philadelphia over a week end, where I agreed to go to the Hague, Holland, for a tryout with the Royal Dutch/Shell as soon as school was out. The Royal Dutch/Shell in the meantime had purchased the controlling interest in the General Asphalt's concessions in Venezuela.

At the end of my six months' tryout in the Hague I took a three years' contract with the Royal Dutch/Shell to organize a geological department for their subsidiary in the Mid-Continent area of the U. S. A., then called the Roxana Petroleum Corporation. After this organizational work I was supposed to go back to Venezuela for the Royal Dutch/Shell as exploration engineer, but due to World War I was never sent there, and continued on for seven and a half years as chief geologist for the Roxana and Shell companies in the U.S.A.

I think that this covers the general facts that you wished to have brought out. Although most of my work was in the swamps and jungles where there was very little geology to be seen, I am quite sure that it would have been much more enjoyable had I had another American geologist with me during all that time I was all alone in the jungles, except for the Venezuelans. I never at any time met any American geologists, only those that I have mentioned herein.

I was to have met Boyd and Garner at Barcelona about the time that I went up toCarupano to meet my assistant geologist who never came, but I learned that they were over non the Island of Margarita doing some work at that time. Again I was supposed to meet them for a conference at Ciudad Bolivar on the Orinoco River, but just at that time our launches burned which I was to have used for that trip, and I was delayed two or three months, and by that time they had moved to some place else, so we never met.

Joseph E. Pogue

Joseph E. Pogue received his Ph.D. in geology from Yale University in 1909, and after three years as curator of mineralogy at the United States National Museum, went to Trinidad in 1912. On his way down to Trinidad he conferred with several people who were familiar with the tropics and he reached the conclusion that it would be foolish for him to try to overcome the rigors of the tropics, with the slender physique which Mother Nature had allotted to him. He turned around and went back to the United States. By doing so, he probably saved his life. He devoted his time to studying the economics of petroleum, rising to the top of this branch of the industry. His is a fine illustration of a man who fitted himself to do that for which he was best equipped to do, both physically and mentally. He is the author of numerous books, papers and discussions of the economics of petroleum.

Emile Huguenin

Emile Huguenin went to Venezuela in June 1912. He was born in Geneva, Switzerland, and was graduated from University of California with a B.A. Degree. In December 1912 he fell victim to malaria, after which he returned to the United States. After leaving Venezuela he joined the Oil and Gas Division of the State Mining Bureau of which he became the head. He remained in this position until he retired in 1950.

My arrival in Caracas was interesting and colorful. As a number of transatlantic steamships call at La Guaira, many tourists stop off to visit Caracas. Then, too, it was the custom for the more affluent Venezuelans to educate their children in European schools; therefore, the arrival of the boat train was treated as a gala occasion, the women being decked out in their afternoon finery and all carrying colorful bouquets of tropical flowers to be presented to the new arrivals.

Our group was lodged at the Grand Hotel Klindt on the Plaza Bolivar, the center of the city. This has since been removed, but at that time was the city's finest. It was more like a European than an American Hotel, with spacious bedrooms, minus baths, I might add, heavy with gilt and upholstered furniture. Two of us shared a room. We had been warned by Mr. Proctor not to tip, as tipping was then an unknown nuisance in that country. Not being familiar with continental service, my roommate and I went down to the dining room for breakfast on the first morning, but found the room in great disorder, with chairs piled on tables. After a while a waiter appeared and made us understand that if we would return to our room breakfast would be sent up. We did not repeat that offense, but did cause considerable consternation among the help by insisting on having hot showers every morning. There were only a couple of showers on each floor of this reasonably large hotel, and methods of heating the water were primitive.

Life in Caracas was delightful and we had a full week to enjoy it before going our various paths. The city boasts not only the usual bullring, at which I saw my first and only bullfight, but also a fine race track. The ordinary day's routine was coffee, fruit and rolls in one's bedroom before 8, then work until 11. *El almuerzo* (breakfast) was served at 11. This consisted of at least three courses, always including fruit, meat, beans and rice. Siesta 12 to 2, all places of business beingclosed. Work 2 to 4:30, followed by a walk or, if one could afford it, a drive in El Paraiso, a beautiful park containing much statuary. Dinner was served at 8. Military band concerts were given a couple of nights a week, in the Plaza Bolivar. One could hire a folding chair for a few

pennies or sit in one of the sidewalk cafes adjoining the plaza where a litre of imported German beer would be served for 1 *real* (10 cents).

During our week at the Caracas headquarters we met John E. "Brick" Elliott who later invented the Elliott Core Drill, as he was employed there. George A. Macready also came into the office to make a report on his eastern assignment, and told us something of his experiences.

The six of us new arrivals were divided into three groups and to each group was assigned a large area to be roughly geologically mapped. Bryan and I were assigned to cover the area east of Puerto Cabello and extending to Coro. We were provided with tents, unfortunately not mosquito proof, cots, a few pots and pans, and were authorized to buy mules or burros and hire such native help as we needed. After getting our equipment together, we returned to La Guaira and boarded a Venezuelan coastal steamer for Puerto Cabello. This was a paddle wheel boat resembling our river steamers and probably built originally for that purpose. Sailing in the late afternoon, we were quite ready when the dinner call came, but one whiff of the codfish stew being served was sufficient to drive us back to the upper deck where we contented ourselves by munching on chocolate bars.

Upon arrival at Puerto Cabello the next day we called upon our Consul. He was most courteous and gave us much assistance in acquiring further supplies and securing reliable native guides for us. I am sorry that I have forgotten his name, as he more than did his duty in assisting and advising us of conditions that we would encounter.

At Tucacas we purchased a half dozen burros and started out with our two guides. They agreed to accompany us only as far as San Felipe, claiming that they did not know the country beyond. We had been warned by the Consul that we would have to make frequent changes of guides, as Venezuelans generally would not go more than a couple of weeks' distance by trail from their homes. Those living in the coastal areas were afraid of the interior mountainous area, and the interior men, mostly Indians, would not go to the coastal areas. Therefore, we were forced to hire new guides frequently. None of them spoke or understood English. Fortunately, both Bryan and I spoke Spanish, I might add, as spoken in Mexico, so had no trouble with them.

The only maps we had of the region that we were to traverse were some blueprint copies made by the Army. It was necessary that we walk, so the entire trip was made on foot. After carefully checking the length of pace, we were able to measure the distance within a reasonable degree of accuracy. Hand tallies were also used as a check. We found the Army maps in several cases extremely accurate. In one case an error of about 20 kilometers was noted between two villages. These inaccuracies caused us some hardship, as we would plan on reaching a certain village where we hoped to get water and supplies, only to find that it was probably two to three leagues (four to six miles) beyond. This made trouble with our guides, as they did not like to make camp in the jungle or at any distance from a native village, which we occasionally had to do. Our practice was to establish camp at the outskirts of a village or town whenever possible. This often caused us annoyance as well as embarrassment, as the minute we were spotted walking into a village, every boy, man and dog would immediately follow us, and many remarks were made on our appearance, equipment, etc. They could not understand our walking when we had burros to ride. A number of the small interior villages had never been visited by a *Norte Americano* and were habited only by the native Indians, who were friendly. The women showed great curiosity in

our tents and cooking utensils. They would squat around our camp watching us prepare our evening meal, usually remaining until we retired. Most of them had never seen a canvas tent before. The poverty in these villages was appalling. They lived in flimsy grass-roofed huts, sleeping in hammocks slung from the rafters, and many were suffering with malaria. It was impossible to buy food supplies in these villages other than an occasional egg or two which they sold for a few pennies. Apparently little use was made of them as they subsided almost entirely on beans and corn.

The whole trip was rugged but interesting. One day we saw a female jaguar with a couple of cubs basking in a patch of sunlight on the opposite bank of a small river that we had been following for some time. Then, too, for a whole day while we were hacking a trail through a swampy jungle area, a number of monkeys followed us through the treetops. Our guides took a couple of shots at them with their antiquated muzzle loader type gun, but failed to scare them away. We saw but few snakes, but in one muddy stream alongside which we were camped and in which we were about to bathe, two small alligators stuck their ugly heads out of the water. We decided to have sponge baths instead.

At San Felipe we were met on the outskirts of the town, which is the capital of the State of Yaracuy, by a very officious Venezuelan who insisted that we lodge at his hotel which he claimed was the only clean one in town. Through the grapevine circuit he had heard that the *ingenieros americanos* were coming and assured us that we would be well fed and housed. We had subsisted mostly on boiled beans and rice for the previous weeks, and by that time a motley crew of boys and dogs had joined the party, so we meekly allowed him to guide us to his hotel. This proved to be nothing more than a private dwelling with us the only guests. We ate with the family and slept in a spare bedroom. It was here the Governor of the state sent word that he would like us to to call. As we knew the Latin American's formality, this posed a problem for us, as the only clothes we had with us were our khaki field clothes, by then much in need of cleaning. We went, however, as we were, and spent a couple of pleasant hours with him. He was most interested in our work and asked many questions pertaining to petroleum exploration. Later at San Felipe our host took us to visit a large coffee and cacao plantation not far out of town. It was interesting to learn that both trees were grown on the same plantation, one used to give shade to the other. I believe the cacao trees were grown under the coffee trees. We were told that this cacao was all shipped to Switzerland, it being the finest variety for use in making Swiss chocolates. Several days later, on preparing to resume our journey, our host presented us with a bill far in excess of what we had expected. After telling him what we thought of him in our best Spanish we paid up and left, and as usual were escortedto the town limit by all the small boys and dogs which took delight in snapping at the legs of our burros.

After leaving San Felipe we continued southwesterly toward Barquisimeto. The topography, as I remember, was more mountainous and open, with quite a little land under cultivation. The trails always went straight over a hill rather than around its base, the reason being that the Indians usually had their corn or bean patches on the top of a hill where they could see whoever approached.

Barquisimeto, capital of the State of Lara, was the largest and most attractive of the cities that we visited, having a population of about 25,060. Its central plaza was a particularly lovely one with its avenues of Royal Palms. It also boasted an elaborate theatre, uncompleted for lack of

funds, but in which moving pictures were shown. The films shown were all made in Europe, mostly French and German, and some of those we saw would not have passed U. S. censorship. The people took it all very seriously, loudly cursing the villains and commenting freely on the charms of the heroine. As these were the days of the silent movies, we were more highly entertained by the audience than by the pictures.

In Barquisimeto we were able to purchase a few canned goods, all imports from England and mostly Crosse and Blackwell products.

Leaving Barquisimeto we turned north, heading for Coro. It was surprising how quickly the physical appearance of the country changed. Most of the country from Puerto Cabello was tropical with lush vegetation and we had sudden showers almost every day.

One day we came upon a large hacienda that looked unusually prosperous. On approaching the neat adobe houses we were most surprised to be greeted in English by a very blond young man. He was the first English speaking person that we had met in almost four months, it then being late November. The plantation was owned by an English company and he was manager. He told us that his wife and two children were in England, where he expected to return the following summer. We were the first "white people" that he had seen in over a year, and he was most insistent that we stop off there a few days. As it was then near Thanksgiving, he said that he would take us parrot hunting for a Thanksgiving "parrot pie." As is the custom of most Englishmen living in foreign lands, he lived very well. His dinner table was equipped with linen and silver, and excellent meals were served by an attractive young Venezuelan woman. He even had a small piano which had been hauled in by mule. The following morning we went out in a wood a short distance from the houses and literally hundreds of small parrots were noisily flying about. We shot about thirty in a short time. They are suitable for eating only if they are boiled for five or six hours. They were then baked into a meat pie which was very good. We pulled out on the third morning and thereby another embarrassing incident occurred. After going on our way a short distance, I realized that I had left my Brunton (pocket transit) on the bedroom bureau. I told Bryan to keep on slowly; I would return alone. As I entered the house, what was my surprise to see our host dangling a blond baby on his knees, while the attractive young native servant was leaning fondly over both. Much embarrassment on both sides, and a hasty adieu.

After crossing the Tocuyo River about halfway to Coro, we traversed a desert very similar to that of southeastern California, but even more arid. At that time we were told that there had been no rain for two years. The only animals that we saw were occasionally a goat or two nibbling cactus leaves. The few villages that we passed through were impoverished and mostly deserted. People that we met on the trails were emaciated and dressed in rags, but at that we were ill prepared for the gruesome sights that we saw upon our arrival in Coro. This city, capital of the State of Falcon, is among the oldest in South America, its church having been built in 1530. Due to the long drought with the resultant failure of the crops, the people were impoverished and many were starving. No attempt, as far as we could ascertain, had been made by the federal government to help them.

Many of the small children were in the last stages of starvation, with swollen limbs and distended bellies. We actually saw mothers sitting in doorways with their already dead infants clasped in their arms. The dead wagon made the rounds every evening picking up those who had

died during the day. We were told that the population had declined 25% in six months; this is a town of over 10,000 people.

In order to help some of the most needy, our Company allotted us a sum of money—I have since forgotten the amount, but probably a couple of hundred dollars—instructing us to spread it where it would do the most good. Upon the advice of our kind landlady at the Hotel Coriano, we had it changed into *reales* and word was sent out that the *Norte Americanos* would distribute alms at the hotel that afternoon. We had met Del Arrell at the hotel. He had been working in the area northeast of Coro and was there recuperating from an attack of dysentery.

By afternoon a large group of the poor unfortunates had gathered at the hotel entrance and the three of us tried to give each one enough to sustain his or her family a week; they could buy a cornmeal cake for a *real* and could actually exist on one a day. It was hoped that government aid would be received any day. This was the most depressing task that I believe any of us ever experienced, as, practically all who came were in rags and various degrees of starvation. We stood it for several hours, then turned over the remainder of the money to the landlady whom all the people revered for her great kindness and humanity.

From Coro we turned east following the coast to Cumarebo. Thus far we had not been molested particularly by mosquitoes. A few days later, as we camped along a dry river bed, a heavy rain fell during the night and the next morning the mosquitoes appeared in great clouds. They were so thick that they even got into our eyes. One of our burros, maddened by them, jumped over a cliff into the sea with a lot of our personal belongings on him, which we were unable to recover.

As I had lost considerable weight in our thousand mile trek, my resistance had been lowered so that I was a ready victim for the malaria which ensued. Upon notification to our Caracas office of my condition, Mr. Proctor ordered me to return there as soon as possible.

President Juan V. Gomez had placed his private yacht at the disposal of the Governor of Falcon to return to Coro from a visit to Caracas. The yacht was in La Vela, seaport for Coro, and due to return to La Guaira within a couple of days. The Governor, whom we had also met, kindly arranged for my passage on that ship. This was quite an experience. The yacht had been built some years before for one of our eastern industrialists and sold to President Gomez only the year before. While a crew of only four Americans brought it down from New York, a crew of twenty Venezuelans then manned it. The only other passengers were a Venezuelan family returning to their home in the capital. I don't believe that any of the brass had been polished, nor the decks thoroughly cleaned since it was purchased. As it was not a regular passenger ship, no provision was made to feed us, which I did not know until I arrived on board. Fortunately I had bought a few cornmeal cakes and tinned fruit preserves before leaving La Vela. During the night the engine stopped and we spent all the next day anchored a few hundred yards off the coast. The only information I could get was that the machinery broke down. It finally developed that due to some leaky flues it was impossible to generate sufficient steam to run the engines. Some cementing material was finally located, the flues were patched up; we proceeded on our way, arriving forty-eight hours later at LaGuaira than we had expected.

After resting a week in Caracas and upon advice of the doctor, I sailed for home and health.

Byron Jackson

Byron Jackson graduated from Stanford University in Geology in May 1901. He was in Venezuela from June to November 1912. Most of his activities prior to coming to Venezuela, and after he left, appear to have been in mining. He joined the A.I.M.E. in 1923. We have been unable to locate Jackson in the last several years.

Bernard Hasbrouck

Bernard Hasbrouck was graduated from Princeton University and later attended Houghton School of Mines in Michigan and McGill University in Canada. He was in Venezuela from June 1912 to February 1913. Later, he was with the Sinclair Oil organization. He passed away in Panama about 1948.

Thomas A. Bendrat

Thomas A. Bendrat took part in the Venezuela project from June 1912 to September 1912. In 1953 he was teaching in Beckley, West Virginia. At one time he wrote a paper on the laterites of the Orinoco River. He became a member of AAPG in 1921.

Floyd C. Merritt

Floyd C. Merritt originally came from San Luis Obispo County, California. He was graduated in 1910 from Stanford University with degree of A.B. in Geology and Mining. He arrived in Venezuela in July 1912, was teamed with Garnett A. Joslin, and they formed the first geological party sent into the Maracaibo Basin. In August 1913, after continuing attacks of malaria, they both returned to the United States.

The first geological exploration of the Maracaibo Basin was started in the summer of 1912 by the late Garnett A. Joslin and the writer, Floyd C. Merritt, under the direction of Ralph Arnold. After an intensive instruction course conducted by J. L. Proctor and J. E. "Brick" Elliott in Caracas, we two exmining engineers proceeded to Coro via the picturesque railroad from Caracas to Puerto Cabello, thence by schooner bearing an odoriferous cargo of *platanos* and goats.

Coro and the entire northern coast of Venezuela was suffering from a drought which had continued unabated for eighteen months. Death by starvation was a common occurrence. The government had just started a soup kitchen. *La Cocina Economica,* but the photographs we took will evidence the meager nutrition furnished. Señora Ana Roz, proprietress of the Coriano Hotel, was a noticeable contrast to the extremely emaciated "woman on the street."

Having outfitted in Coro, we started for Altagracia on August 3rd along the so-called *Camino Real* (King's Highway), a trail which had never seen a wheeled vehicle. Our day's journeys were governed by the location of water holes—small tanques covered by green slime and open to the herds of goats which were the only domestic animals of the area. And such goats! They subsisted on the only vegetation—scrub trees, the leaves of which they gathered by standing on their hind legs and sometimes by climbing well-branched specimens. Not a spear of grass existed in the entire region, but cactus was plentiful.

Our route took us through extremely small poverty stricken villages of from three to twenty houses clustered around a water supply. Our first day's trek ended at Sabaneta, a distance of nearly twenty-four miles. After that we camped at Cabecera, Corubo, Caramabure, Dabajuro, Casigua, Quisiro and Los Quemados, and finally arrived at Maracaibo on August 12th.

Maps, stated to have been made by the military, had been supplied us, but they were highly inaccurate, as we found out later when we were supplied with a transit equipped with an attachment for solar observation. Errors of as much as fifteen miles were observed and verified.

Our instructions were to proceed from Coro to Maracaibo as rapidly as possible, reporting only such geological observations as we could make on the most direct route. At intervals we marked on our maps outcrops of sedimentary material, and, not far from Coro, were tempted out of our course by an obvious anticlinal structure of textbook regularity. Our notes were sent to Caracas for the benefit of those who might be assigned to that area.

At Coro we had met an old friend, Dell Arrell, and his partner, T. A. Bendrat. I saw Dell only once after that—on his leaving for New York about six months later, a victim of severe tropical dysentery. On that occasion he was followed to the dock by two gigantic Barbados Negroes carrying immense loads of bottled water and "Zephyr" biscuits. He remarked that the doctors had him on a diet of "wind and water." Del never recovered from the effects of his tropic illness and diedin the early part of 1920. The oil industry lost a brilliant geologist, and his associates lost a wonderfully sincere and lovable friend. Bendrat was reported to have suffered another affliction, not confined to the tropics, and shipped home not long after I first met him.

At Coro we also met General Leon Jurado, President of Estado Falcon, who was friendly and later very helpful in arranging contacts with *Jefes Civile* and others who were in position to aid us. I wonder what he thought of a company that would entrust the exploration of his country to youths of twenty-three. Whatever he thought, he appreciated the necessity of foreign exploitation of the mineral resources of his country and did everything he could to smooth our path.

As I recall the Maracaibo of 1912, it was a country town with a few poorly paved streets and others completely unpaved. A statue consisting of the bust of Columbus surmounting a six-foot globe adorned the small park near the waterfront. The American Consul, Mr. J. A. Ray, Joslin and I constituted the entire contingent from the U. S., although Mr. Phelps, an American business man, owned a store which sold American products such as safety razors, typewriters and other mechanical devices, and occasionally paid a visit from his headquarters in Caracas. I remember his telling about the early days when he traveled by horseback and would dismount in the late afternoon, wrap himself in a blanket after tying the horse's reins to his wrist, and proceed to suffer the rigorous chill and the enervating fever of his regular daily attack of *paludismo,* after which he would make camp. We were later to undergo the same routine when we were on the march.

Ray enjoyed telling the story of his predecessor, a political hack who insured his tenure in office by a clever maneuver. He had been fired several times by the State Department. He would meet his successor at the dock, start to embrace him in the Spanish manner, then draw back and gasp, "No, I must not. My best friend died in my arms of yellow fever this morning." On showing the successor the consulate, he would stumble over the end of a coffin, protruding from under the

bed. When the newcomer inquired about the coffin, he would reply, casually, that everybody kept a coffin handy because of the prevalence of yellow fever and the necessity of immediate burial. Until Ray arrived, each successor had returned by the same boat on which he had arrived. The irony of the situation was that about two months after we met him, Ray almost succumbed to yellow fever and had to return to the States.

Jos and I enjoyed the comparative luxury of the town's leading hotel while assembling a crew, equipment and supplies. There were several large stores, owned by Germans, which carried such luxuries as American canned goods, but the article I remember best was canned Westphalia bacon. I have never tasted better. The German-owned stores were actually trading posts belonging to firms in Hamburg. They purchased the products of the country—coffee, cacao and hides and, in exchange, supplied the Venezuelans with German products on terms as long as thirty months. German youths were indentured at a wage of a few dollars a month, housed in living quarters above the stores, taught the Spanish language and Spanish social and business customs.

Three days after arriving in Maracaibo we crossed the bay to Altagracia and camped on the shore at the home of one of the most intelligent and forward-looking men I met during my stay in Venezulea, Señor Jesus Maria Nava. He was acquainted with the gas and oil seepages to the south and predicted the economic prosperity of western Venezuela.

In another three days we started on our first reconnaissance—a reported oil seepage at Los Tablazos, some thirty miles easterly of Altagracia and south of the Camino Real, near the village of Santa Ysabel. We found it to be a basin of about four hundred feet in diameter, paved with asphalt, and containing live seepages of petroleum which contaminated the stream flowing through the basin. It was an impressive sight in that it definitely proved the presence of significant deposits of petroleum. We made such observations in the vicinity as the heavy brush would permit, gathered typical specimens and sketched the deposit and surrounding area.

From Los Tablazos we returned to Santa Isabel and proceeded to La Rosa, on Maracaibo Lake via Consejo, La Plata and Punta Gorda, noting outcrops and taking samples on the way. At La Rosa we were informed that a gas well existed about a mile east of the village. We found the location, an excavation about seven feet deep, emitting a foul smelling gas which readily ignited. It was in a dense soil cover with no outcrops discoverable in any direction. It burned with a flame perhaps fifteen feet high, evidencing again the economic possibilities. Later we were to hear that we had been severely condemned by the *Jefe Civil* for not extinguishing the flame.

We next proceeded along the shore to La Rita, visiting two asphalt deposits along the way, smaller than we had seen at Los Tablazos, but, together with the gas seep at La Rosa, evidencing a line of weakness that permitted the escape of hydrocarbons over a long span. Such evidence was good news for seekers of petroleum, but we were frustrated by the absolute flatness of the terrain, the thick soil and the heavy vegetation, in our attempts to discover structure.

This first trip was typical of the terrain we would encounter in the area on the east side of Maracaibo Lake from the plain along the Caribbean Sea to the foothills of the Andes. Areas of no relief, bisected by swamps, bordered the Lake. These gave way to rolling sabana country which

in turn was merged into low hills. The trip was also typical of many we would make, in the methods of travel and of gathering information. We walked, accompanied by a train of burros carrying our camp equipment, food and belongings, chaperoned by young Venezuelans picked for their intelligence and physique. Every step was counted, every course was measured by Brunton compass so that our traverse could be located with some degree of accuracy on the very sketchy maps with which we had been furnished. As our natural paces were different, we walked at some distance from each other so that we would not unconsciously compromise our strides and thus fail to register a correct measure of distance. At intervals of a few days we would camp for a day, plot our traverse by averaging our separate courses and bearings, and enter the locations and descriptions of outcrops or topographic details of interest encountered. Most of our traverses were open ended—starting at one point on the lake and ending at another, so we had no good measure of the accuracy of our work. However, we made one traverse, from Altagracia into Distrito Buchivacoa and return to Altagracia by another route, of slightly over a hundred miles, which closed with an error of six thousand feet. As part of the journey was through pretty rugged terrain, we didn't know whether we were good or just lucky.

It was on this traverse that we had two experiences that linger in my memory. Having reached well into the hills, we turned north towards the Caribbean, following a stream. It was necessary to clear a trail for the burros and consequently progress was so slow that we could afford to take side trips up the small streams entering the main one. On one of these expeditions we found a series of steeply north dipping, heavy bedded, coarse grained sandstones, one of which constantly oozed a waxy petroleum. A side stream had exposed this bed for a distance of over three hundred feet and a height of perhaps twenty feet. Apparently the face was attractive to insects, and, as a result, thousands of them, including gorgeous butterflies with a wingspread up to eight inches were trapped in the sticky seep. To us it was a unique sight—to an entomologist, it would have been a short cut to a complete collection of the insects of Venezuela.

The other experience is amusing to me, even now. In the *Engineering and Mining Journal,* which we received once in a while, I had seen a review of a book, *Oil Finding,* by one E. H. Cunningham-Craig, a British geologist, and had sent for it. I sent for it because both Jos and I were trained as mining engineers and our education in oil exploration was limited. As a student at Stanford University, my instruction in petroleum geology was limited to one lecture by Ralph Arnold on Tertiary fossils and two lectures by Valentin Garfias on structure. As I recall, only two types of possible oil bearing structure were recognized at that time—the anticline and the "arrested" monocline. Cunningham-Craig's book would be primer stuff to the geologists of today, but to us it was extremely helpful.

One of the last chapters of *Oil Finding* consisted of advice as to what the well-dressed geologist should wear in the tropics. A cork helmet and high laced boots were essential. (We wore native hats and shoes, for comfort.) But the prime requirement was a stout walking cane with a crooked handle. It could be carried on the arm while riding and, when walking, was a defense against snakes. Jos and I had just finished reading the book and having a good laugh about the cane at a camp in Buchivacoa, when we became aware of the arrival of a large party led by a blond man riding a horse and carrying a crooked handled cane—E. H. Cunningham-Craig in person. He was somewhat stuffy to find us camped on a concession that did not belong to the company we represented, but we explained we knew we were off bounds but were there only to

try to find a structural key to the area to the west. That satisfied him, and we became friends when we showed him the copy of his book and thanked him for writing it.

On one traverse inland from San Timoteo, on the lake, we explored the asphalt seeps near the village of Los Barrosos. There were two of them—Mene Grande and El Menito—lying slightly north of east, about twelve miles from San Timoteo. I have never seen larger swarms of mosquitoes than existed here. They worked in shifts and were so numerous that it was impossible to read a stadia rod at a distance of 300 feet. Our animals were attacked at night by vampire bats to the extent that we had to send them back to the Lake to preserve them. Later, when I escorted George Macready to the district, he pronounced Mene Grande the largest seep he had seen, except the Trinidad deposit and Guanoco Lake.

In late October of 1912, Ralph Arnold, L. J. Proctor and George Macready paid us a visit and we showed them the highlights of our discoveries. A few days later J. E. Elliott arrived with a Hollander whose name I do not remember.

It was at this meeting that we urged the need for additional personnel and suggested that we should start laying out claims in the flat country bordering the lake. It was impossible to discover evidence of structure in this terrain, but the numerous brea deposits, gas seeps and mud volcanoes were sufficient evidence of the presence of petroleum. Our contract with the Venezuelan government permitted us to denounce as many claims as we wished, 667 meters by $7^{1/2}$ kilometers each, by mapping and paying one hundred bolivars for each claim. It was much cheaper to run the boundaries of a claim and to pay twenty dollars for it, than to explore it. And in the flat country, the soil mantle and the vegetation practically precluded intelligent exploration.

In December Jos and I went to Curaçao in the hope of getting good treatment for both malaria and threatened blood poisoning occasioned by bites of the hordes of garrapatas we had encountered, particularly in the Sabana country. The Dutch doctor quickly cleared up the garrapatas situation and did alleviate the misery of the malaria. I went on to Caracas and met B. Bryan and Emil Huguenin. Emil had been working in the east and was overcome by malaria. He left for home about Christmas.

Several new men arrived about the same time. I met Burnett, Hammer, Wilson, McKee and R. W. Merritt. A few days later White and Dagenais arrived, and still later, Donnelly.

On returning to Maracaibo about the first of January 1913, we got White and Donnelly outfitted and on their way to Perijá. dark and Dixon showed up soon after this and Jos and I went up into the Andes as far as Tovar. We worked the foothills of the Andes along the southeast end of Lake Maracaibo, and in April, B. Bryan, Andresen and Dr. S. Aguerrevere arrived with orders to start laying out claims in the general vicinity of Onia.

All claims had to be certified by a Venezuelan engineer. We were fortunate in having Dr. Aguerrevere assigned to us. He had been one of the Venezuelan representatives on the Venezuela-British Guiana boundary dispute, and was a lovable character. He was a stocky individual, apparently impervious to mosquitoes. He was the father of three sons who were educated in geology at Stanford and later played a prominent part in the Venezuelan government's control of the oil business.

In May E. G. Sinclair and Packard arrived. Sinclair and Andresen teamed up to further exploration in the foothills, and Packard joined us in surveying. Not long after, both Packard and Dr. Aguerrevere had to be sent to Maracaibo for the removal of several *gusanos de monte* from various parts of their bodies. These irritating worms are the result of the bite of a fly which lays eggs in the victim. Surgery is required, although the Venezuelans remove them by holding a lighted cigarette on the wormhole and waiting for the festering wound to slough off the worm. I still bear a scar resulting from such a treatment. Packard later went to the East to help Macready.

By August we were both suffering constantly from malaria, taking as much as forty-eight grains of quinine per day in twelve grain bread pills and decided to go to Curaçao for treatment. In Maracaibo we met Frank Wilde and Stan Herold, just arrived, and in the hospital in Curaçao, Burnett and A. S. McCullough. We got some relief from the Dutch doctor, but not enough to justify a further bout in the jungles, and shortly left for Caracas to turn in our final reports and to take our departure for home.

In retrospect, I can honestly say that the adventure was worthwhile in spite of the many extremely disagreeable living and working conditions. I weighed 140 pounds when I left New York and 114 when I returned, as a result of malaria, which remained with me for a few years. I can recall that we used to scrape ticks off our bodies with a knife and bathe in sheep dip to sterilize their bites. I remember that in some areas, with the thermometer at 95° and humidity at 100, we had to work with head nets and wear two shirts to combat the mosquitoes. I will never forget the discomfort of sleeping in a tent in that atmosphere, under a mosquito net which never quite succeeded in excluding the mosquitoes.

But, on the credit side, I will never forget the unfailing kindness, courtesy, helpfulness and honesty of the Venezuelan people with whom we came in contact. I know that such a statement would come as a surprise to oil company representatives of the present era. I can only say that perhaps we have spoiled the fine people I knew.

In the north country there is a disease known as "cabin fever," born of boredom and personal antagonism when two men are forced to endure each other's continual presence. The same disease can occur in a tent, and I saw a few cases of it among our associates. Two of them visited our camp in the foothills of . the Andes and it soon became obvious that they were speaking to each other only through us. One of them I had known in Stanford, and when I could detach him, he explained that he had run out of shoes and borrowed a pair from his partner. After wearing them a day, he remarked that they hurt his feet, and the battle was on. We got them straightened out. That's a perfect example of "cabin fever."

We lived in seven by nine tents, lined with mosquito netting, when we were in the field. We saw no other English speaking person for weeks on end. We lived under extremely uncomfortable conditions and it is no wonder that personal feuds broke out. To account for the fact that my partner Jos and I never succumbed to bloodshed, I give the credit to Jos. He was a completely well-balanced, considerate person, and we remained friends then and thereafter.

Also on the credit side, I remember scenes of beauty that defy my poor power of description. I remember a night ride down the Catatumbo River. We had slung our hammocks under the pilot's cabin where the breeze kept us cool and free of insects. The ship's headlight pried into the high

forest jungle at every bend of the river, awakening the monkeys and parrots to a chattering and screaming protest. The caymans slithered off the mud banks with surprising agility. The entire forest was alive and we stayed awake the whole night, watching the ever-changing panorama and luxuriating in the first cool breeze we had encountered in a month.

Further, the adventure was worthwhile because we can look back and say to ourselves, "We were fortunate in being assigned to explore the 'Maracaibo Basin.' We saw it first and recognized and reported its prospective worth."

Barnabas Bryan

Barnabas Bryan came to Stanford from Washington, D.C., and was graduated in Geology and Mining in May 1909. After two years of mining geology in Chile, he came to Venezuela in June 1912. Most of his work was in northern Venezuela. Bryan returned to the United States and engaged in consulting work which took him to many parts of the world. He was one of our most energetic and talented men. He was second in command of most of our crew.

Dell B. Arrell

Dell B. Arrell was graduated from Stanford University in Geology and Mining in January 1912. He took part in the Venezuelan project from June 1912 to December 1912. After returning from Venezuela, he devoted his time to oil geology. With Arnold, he was the first to write a favorable report on the famous Cuyama Field in California.

Because of ill health, Barnabas Bryan was unable to contribute an account of his experience in the field. However, the following report on the irrigation project at Coro, by Bryan and Arrell, covers a phase of our investigations which is not treated in any other reports. The developing of water supplies in the desert regions of Venezuela is just as important as the opening of new oil fields, if not more so. For that reason, the report is included herewith.

Report of B. Bryan and D. B. Arrell on Irrigation at Coro

In view of the fact that we were instructed to take note of things of economic value aside from the geology, we have seen fit to spend a few hours looking up the facts and a little time on this report on the subject of irrigation.

The whole of the coastal plain, from the sand dunes to the conglomerate hills, is very suitable for irrigation due to its flatness and evenness of grade. This plain is some four miles wide and as long as can be desired. Most of it is vacant or covered with tree cactus, Cuji and leaf cactus. Most of it is also government land.

There is no doubt of the fertility of this land, for it supports such a luxuriant growth of cactus and it is also farmed in some places where water can be gotten. Thus, along the city water main, there are several small, and one or two large gardens, where grass, bananas, mangoes, grapes and various sorts of garden truck are doing finely. The squares and patios about town all bear witness to the fertility of the soil. We are also informed that in good years some corn is planted on the flat and does well.

Water Supply

If properly conserved, there is quite a plentiful supply of water in the Coro or Caujarao River. From what has been seen by Arrell since coming here and from what we have heard in talking about town, it seems that even though the river did go dry for a while last summer, still it is safe to assume the minimum flow as $12^{1/2}$ cubic feet per second. At present it is flowing some 18 feet per second. And so, since the water comes from the three thousand foot lime hills to the south where it rains much more than in Coro, it seems safe to assume *12 1/2*cubic feet per second as the minimum flow.

There is also a very desirable dam site for a medium sized dam which could make a lake about a mile long and a quarter mile wide and only about a mile from the land that is to be irrigated. The low gradient of the stream which makes such a good dam site spoils the location for use as a town site.

Rainfall at Coro is very irregular. The recent drought of two years is the worst for a long time, but failure of the crops from lack of water is a well-known thing here. As far as one can tell, about every third year is a good one, while during the other two the crops are part or total failures, according to chance.

The proofs of a dry climate are the cactus and Cuji growths, which are the principal vegetation, and the old abandoned irrigation works, which necessity is causing them to attempt to repair. At Laton is an old dam that was underwashed some twenty-five years ago, while from there to the flats back of Coro there is an old ditch line with its old brick pillars that supported the flume across the gulches. And so, since it is very dry and shows only dry country growth all the way south and west to Siquisique, Carora and Pedregal, it is quite certain that this country does not get water enough even in average years.

The people of the country do not understand proper methods of agriculture or the storage of crops. The result is that in a good year prices go to pieces and the whole crop is consumed or wasted, with the result that it takes but one real bad year to make the country as it is now. The reports of the famine, which are available in Caracas, are not exaggerated, for one sees hundreds of hungry people on the street every day, many with the swollen feet and legs that mean starvation. The hospital here reports a death rate of fifteen per day.

Suitability of the Locality for Irrigation

When one sees this state of affairs and at the same time the ideal location of things for irrigation here in some areas, the situation becomes pitiable indeed.

The dam site is formed by a 20 foot ledge of hard, fossiliferous limestone which has an almost vertical dip and from the geology must go very deep. The dip of the strata here has made erosion so hard that the valley is very narrow at Laton for the first 100 feet above the stream bed. On the upstream side of the lime there is a lot of sandy shale that, while probably a fair conductor of water, is so well bound in by the lime that seepage would probably be relatively very small.

This site at Laton had an old dam 35 feet above stream level which made the Coro water supply in years past, until it was spoiled about 25 years ago by underwashing. The dam was built forward of the lime ledge so that it is probable that when the protection of the spillway was neglected a pot hole was formed and the wall caved in due to the weakening of the probably careless joint between the dam and ledge. The ledge at center is said to be 40 feet below water, but I doubt its being more than 20 feet.

After the failure of the dam they went upstream about 2 miles and put in a dam in a mixture of sandstone and shale without trenching into it enough for a foundation. As a result they are trying to put a foundation under it at present. The city pipe line from here would be through the proposed reservoir.

Engineering Features

The ledge of limestone spoken of at Laton forms a foundation 20 feet thick upon which to put a watertight reinforced wall that would be easy to construct and efficient in use. The old dam is fitted onto the lime ledge apparently very well at the sides, and there is only a width of 200 feet where the ledge is not outcropping. And so, with the exception of the break in the old dam with its base 20 to 40 feet below water, the work would all be dry and perfectly simple.

The break at the bottom is as given by the engineer. Seventy-five feet above water level is the size of the dam, that is suggested by the site itself, though 100 feet is practicable.

The materials for the work are all excellently located. The rise of the hill on the east end of the dam gives a good quarry site, both for rock and shale, and sandy shale for the filling. This would make the work noticeably cheaper than would otherwise be the case.

Aside from this, there is to the south a good ledge of hard lime, some 6 feet thick, that has weathered in big slabs which are suitable for masonry work and are readily quarried. This material would have to be loaded and hauled 600 paces to the end of the dam. There is an excellent supply of good clean cement sand at the dam site. Labor here is about as usual and will cost from three to six *reales* (30¢ *to* 60¢) for shovel
work, according to circumstances.

Probable Types of Construction

Dam. The fact that the dam site is formed by such a thin section of hard rock and that this is surrounded by shale and sandy shale makes it unsafe to try to build the ordinary type of cement dam for a height much greater than the present dam, but the presence of a hill of filling material so conveniently located suggests at once the other type of dam with a water-tight center and a dirt filling for stiffness. The center core would best be made of cement or masonry, but for cheaper work could be made of wood. This type of dam would be reasonable in cost and perfectly safe here with careful construction of the overflow. But in whatever case, it should be made of cement to the top of the present dam.

Distribution

On account of the probable high seepage through the cement, gravel, sand and sandstone in the valley between the dam and the land, the distribution system should include a pipe line or else a cement-lined ditch for the mile between the dam and the land to be irrigated. It would then be advisable to count on a couple of miles of cement-lined ditch.

Estimate of Cost

Dam. Assuming the height of the dam as 75 feet and the average thickness of the cement center wall as 12 feet, there would be 12,000 yards of cement in the center wall. Assume 500 yards as overflow work and 100 as outlet pipe head and we have a total of 12,600 yards which, at the excessive figure of $8.00, would come to $100,000.00. A liberal figure of the dirt fill would be 120,000 yards, which, figured at 25¢, gives $30,000.00. With $10,000.00 for value pipe and extras, the dam would cost $140,000.00. As a matter of fact, by using masonry in place of straight cement, the cost would figure to $100,000.00, due to the presence of such a convenient quantity of rock.

Ditches. Figure on five miles of cement-lined ditch, one mile from the dam to the land, and four miles of distributing ditch with an excavation of one cubic yard per foot length and one cubic yard cement per 10 foot length. With the dirt at 25¢ and the cement at $12.00, the cost will be $37,600.00. For safety's sake, figure on 10 miles of distributing ditch with $^{1/3}$ yard excavation per foot and at 25c we have a total of $42,000.00. Allow for house and incidentals $18,000.00 and we have a total cost of $200,000.00 for absolutely first class construction throughout.

Probable Acreage

For safety's sake, take the reservoir lake as averaging 4,000 feet long by 1,300 feet wide and 30 feet deep and we have a capacity of 156,000,000 cubic feet. Assuming the minimum average flow as 12.5 cubic feet per second, we have 338,800,000 cubic feet per year. Thus we have 388,800,000 cubic feet with a five months' reserve—minus evaporation.

Unless we are mistaken in the amount of water necessary for irrigation in this climate, this quantity of water is sufficient for 10,000 acres of land, with a possible cut to 5,000 acres in excessively dry times such as the past year.

The irrigation of such an acreage would entirely revolutionize life in this entire section of the country, and the cost would be entirely within reason. Assuming a minimum acreage of 5,000 and a maximum cost of $250,000.00, the cost would then be $50.00 per acre for land that at present is without value.

Conclusions

The present repair work on the Laton Dam has but a very small chance of success. They are at present trying to shovel enough sand out of the river below the dam, so that they can see the bottom of the hole. If the advance steps were taken now, it should be quite easy to get a concession here when this work fails, and it should be possible now.

The advantages to the company in doing this work would be several. The percentage of profit would be sure and could be made to equal anything within reason. The company could also strengthen its position in this section by taking credit for such a good work for the benefit of the country. If there is to be oil development here, as conditions would indicate, it would be advantageous in many other ways.

Concession

If it were decided to try to do something with the project, the concession should be made to include all the land in the reservoir site within an elevation of 120 feet above the stream level at the dam site, such room for ditches as may be needed between the dam and Coro, and all the government land about Coro which the Company might decide to irrigate.

Garnett A. Joslin

Garnett A. Joslin was born in Fargo, North Dakota, and was graduated from Massachusetts Institute of Technology in 1909 as Mining Engineer. Was employed by Porcupine Gold Mines Company, Porcupine, Canada, until he went to Venezuela. After leaving Venezuela, Joslin returned to mining geology and for many years was a leading consultant mining engineer in Los Angeles, California. He passed away in Mexico City in 1952.

Charles R. Eckes

Charles R. Eckes came from Oklahoma where he was graduated from the University of Oklahoma. He sailed from New York in August 1912 for Trinidad, but was immediately transferred to western Venezuela. He commenced work with Bernard Hasbrouck and Byron Jackson. Jackson returned to the United States in November, and shortly afterward Hasbrouck also became ill and left for Caracas. This left Eckes alone. He returned to the United States in 1914, when war broke out in Europe and operations were suspended.

After returning from Venezuela, Eckes engaged in geological and other work in Oklahoma, and now resides at Tulsa, Oklahoma.

Below is a letter written by Charles R. Eckes to his Company dated Sept. 29,1913.

The jungle is a bad one, and if it gets much worse I think I will leave it for a better man in a month or two. As it is now, it takes five days to make a trip with burros to Maturin and return. There are also about ten rivers to swim, but so far the burros and mules have been able to swim all of them, but the men have to carry the cargoes across the river on a log. That is not the worst part. The thousands of mosquito bites that each of us gets daily are a little monotonous and sometimes a little unpleasant. Of all the places I have ever seen, this jungle has at least 100 times as many mosquitoes and I have been in the Orinoco region, the San Juan and Pedernales jungles where there are supposed to be mosquitoes. Well, I wear two suits of clothes. One suit just sharpens their appetites. Then I wear a head net and two socks on each hand for gloves. In this way I manage to get along. I crawl under my net at night, before dark, in all the smoke I can stand, but never can get under it without taking a dozen or more mosquitoes under too. I tried to kill them two nights and set my net on fire, but since then I try to take as few mosquitoes to bed

with me as possible and let them stay. The men work with undershirts tied over their heads and around their necks, with just their faces sticking out. They also have a palm leaf mosquito swatter in their hands all the time. Then it rains several times a day and they are always wet. I have a slicker, but am always wet from perspiration if not from rain. About two men are sick all the time, but I have not been sick at all. My bad leg is entirely well now. I have taken up two holes in my belt and am as strong as ever.

H. Harper McKee

H. Harper McKee received his Master's degree from the University of Chicago in

June 1912. He taught geology at Drury College, Missouri, and was then engaged by the General Asphalt Company for the Venezuelan exploration. In July 1915 he discontinued his connection with the Company to become a member of the consulting firm in New York where he is still located.

Note: Although Harper McKee was not among the first to go to Venezuela for the General Asphalt Company, nevertheless, through a series of fortunate circumstances, he had opportunities of examining several areas during his employment by the company. His yen for writing led him to cover several experiences in the course of his work, which were not afforded most of the other geologists. Therefore, it has been desirable to publish three of his contributions in this book.

* * * * *

I

Sometime in the middle of 1912 I received an inquiry as to my availability to go to Venezuela as a geologist for the General Asphalt Company. I went to Philadelphia where I met Mr. Sewall and others of the Company. They sent me on to New York and in a day or so I found myself on board the S.S. of the Red D line for Caracas. We were met here by Mr. Lewis J. Proctor and driven in coaches to the Grand Hotel Klindt at the Esquina Torre on the Plaza Bolivar. The streets in Caracas have no names—simply the corners. The next trick is to find where those corners are.

Coro

The way to get to Coro from Caracas, it seemed, was to take the German railroad to Valencia, then the English railroad to Puerto Cabello, where we got back on the good ship Caracas again and went back to Curaçao. From Curaçao to La Vela de Coro (the port for Coro) was just overnight in a schooner.

We did all that, but we had to stay in Curaçao a couple of days until the schooner got ready to sail. The Captain was a very black man who spoke Papamiento and a little Spanish and English—probably Dutch too, and perhaps other languages.

We enjoyed our stay in Curaçao at the Hotel Americano very much and we got across to La Vela all right, but after we anchored offshore waiting for immigration officers, port doctor and pilot to come aboard, the boat started rocking very badly and we had another attack of seasickness. When we finally got ashore, Christmas morning, the streets were literally crowded

with people who were very hungry. There hadn't been any rain in Paraguana for 18 months. The water ponds had all dried up, the goats had died and the people went to La Vela. It was a very discouraging situation.

We had missed the train that went once a day from La Vela to Coro so we employed the services of a coach, coachman and one decrepit horse to drive us the eight or nine miles to Coro where we did find the Hotel Coriano, owned and operated by the good señora Anita Roz.

The ceilings in the bedrooms were high, the beds were canvas cots, but cool and comfortable. We found our camping equipment, telegraphed to Pedro and Rufo to bring on the burros and then took a bath. The bathhouse was a fine brick building in the patio of the hotel, four feet square and seven feet high with a tank on top which was reached by a stepladder outside the bathhouse and filled by one of the servants, from a pail. Inside there were sprinklers from the top, the bottom and three sides, so the shower facilities were excellent. We found by experience, though, that the quantity of water in the tank should be verified before one got oneself covered with soapsuds.

So about December 30 or 31, 1912, we started out, on foot. The first day's journey was short—about seven or eight miles, I think, but we couldn't get Pedro and Rufo to go any farther, so we made camp alongside a water hole, boiled some drinking water and Rufo went hunting for rabbits in the cactus with a .22 rifle. In those days Rufo could almost be counted on to get a rabbit or two and maybe a parrot which he boiled for the main course of the main meal. Later, and from time to time, we had chickens and eggs, but they had to be bought and paid for. Inexperienced as we were with the expense account, we were sure the farmers were robbing us and I am sure no oil company's expense account has ever since been treated so carefully as ours was during the first six weeks.

Next day we made Sabaneta, where we put up at an inn which regularly catered to travelers. Next day was Agua Clara, where we made camp and investigated an anticline and a gas seepage. Then Pecaya, which is quite a little village. We stayed around there several days and started making some cross sections. We were of great interest to the village people who had never seen anyone like us, but that was all right too, because we had never seen anything like them. Between Agua Clara and Pecaya there is a spring of clear water seeping right out of a cliff of sandstone. We ventured to drink some of it without boiling. We didn't get sick at all.

When we got to our next camp or two after Pecaya, our funds were beginning to run low, but we sent Pedro to Pedregal with a telegram to Mr. Lewis J. Proctor at Salas a Caja de Agua 26, asking for two hundred dollars. The next day the answer came back in Spanish to come and get the money. Our Spanish was beginning to pick up and it was agreed that Jerry should go on one of the burros to Pedregal accompanied by Pedro on another burro, to get the one thousand and forty *bolivares.*(You can only get about 650 *bolivares* for $200 now.) Jerry had bought himself a wide leather money belt and a holster for his revolver, so away they went. It turned out that the telegraph office in Pedregal dealt only in silver, no gold or paper money, so Jerry was pretty well loaded down with his two hundred silver five *bolivar* pieces, each the same size as a United States silver dollar. He had no trouble, even with his rudimentary Spanish, in identifying himself at the telegraph office, and of course no one made any trouble for him, although everyone must have known that he had all that money on his person. He thought that his conspicuous revolver

acted as a deterrent, but we were to come to 259 know that in General Gomez' times the penalties for molesting or stealing from a foreigner were serious.

After six weeks of camping around the State of Falcon, we decided to go back to Coro and make use of the Hotel Coriano's bathhouse. We made up our minds to do this rather hurriedly while we were camped at Agua Clara. We decided to get up early and try to make it in one day, and did. It is about forty miles and we had taken three days for it six weeks before, so that makes it my longest day's walk before, since, or in the future.

When we got to Coro, Jerry decided he'd best go to Caracas as he had been bothered by fever of one kind or another, so I was told to stay at Coro and get acquainted with Enrique Jorge Aguerrevere. Enrique (he later became Minister of Public Works and also Minister of Development under the Lopez Contreras and Medina regimes) had had some training at the University of Caracas and probably also from his father, Don Santiago Aguerrevere, who was the Dean of Venezuelan civil engineers. Enrique was two or three years younger than I was, which made him pretty young, but he knew how to run a transit. He knew slightly less English than I did Spanish—and I knew nothing about running a transit. He knew more about some other things than I did too. He knew that if he rented a horse to ride to work on from Coro and put the cost on his expense account the item would not be questioned, so about that time I bought a riding mule for myself and a great satisfaction it was, too. We surveyed some parcels out around Coro (I never quite knew why), and then we were told to go, on horse and muleback, to Maracaibo. I went a day or two ahead because I, being the geologist, was supposed to do a little local exporting on an oil prospect back of a place called Dabajuro. That distance is about 150 miles and I spent several days on muleback traveling alone. The telegraph line was my guide. My Spanish continued to improve so that I could ask questions about distances and places to stop at night. Sometimes the answers were not very intelligible. There were no maps except some small scale sketches of the country put together by men like Don Santiago Aguerrevere and Doctor Pedro Torres Arnaez who made determinations of latitude and longitude with a transit and chronometer. There were twenty-five or fifty of these points scattered around the republic and the rest were just sort of filled in. Anyway, I was told even though the number of leagues from Zazarida to Maracaibo was greater than the number from Coro to Zazarida, that the leagues beyond Zazarida were much shorter than those east of that town.

I got into Los Puertos de Altagracia in the late afternoon and took passage in a hurry on a little sailboat, mule and all, with a fine wind at our back, and made it across to Maracaibo in forty-five minutes. I don't think the modern steam ferryboats do much better.

Enrique Jorge and I parted company at that time and I was sorry. We had become good friends, improving each other's languages and we have remained good friends
ever since.

Perijá

I went out to Perijá to a place called Totumo where I met a geologist by the name of Noehl working around some seepages at the foot of the mountain. Later we called the place Petroleo—some wells were drilled and some oil obtained, but it never amounted to much and I think it has been abandoned. A year later I was assigned to a drilling well which had been located close to the

seepages at Petroleo. We had two very interesting people there at that time. One was a driller by the name of Smitty who had a bad finger. I had nothing to do with it, but a road was hacked out from Petroleo to a lake port at Punta Iguana on the shore of Lake Maracaibo. The Model T Ford which Smitty drove was sent in over the road to Petroleo. The bad finger—one over which we had no control—would every now and then strike the gas throttle and cause the Model T to leap forward. My other interesting friend was John Cheney of Anniston, Alabama. He and several others had just finished building the Panama Canal, so now he had come to Venezuela to help build the oil industry. The Philadelphia office, on whom was blamed everything that went wrong, had brought two big steam tractors to move material in to the well site. They were powerful machines, burned a lot of wood, but they were not mudders, so when the rainy season came along they were immobilized. One day a messenger came, on foot, with burros and supplies from John, who was in charge of the tractors where they were stuck in the mud half-way between Petroleo and Lake Maracaibo. (I think the drilling well was shut down for water at the time.) The messenger bore a challenge from John to Smitty. He wanted to get up a polo game. He would ride a tractor and Smitty would ride his leaping Model T and the game would be played on an asphalt polo court to be constructed at Petroleo as soon as John could get his tractors out of the mud and come to Petroleo to build it.

I did not stay at Petroleo long on my first visit because I was encouraged to volunteer for an exploration trip into southern Perijá. The area south from the Rio Negro to the Rio de Oro, the boundary line between the Districts of Perijá and Colon, was even less well known than the part of Perijá to the north. There were, and are, two towns of some importance in Perijá; the capital of the District, La Villa del Rosario, and the larger town of Machiques to the south and within a few miles of the southern limit of the Spanish speaking population. Machiques is an old town, founded in the early part of the sixteenth century, but what settlements had been made to the south in the intervening centuries had been abandoned because of the hostile attitude of the aborigines, the Motilone Indians. The Company's Valladares Concession covered the area and I presume the Company officials thought they ought to find out what they could about it within the relatively brief period of time allotted. L. G. Donnelly and K. D. White had started out from Maracaibo about the same time Jerry Burnett and I started out at Coro, with the intention of going straight through to the Rio de Oro, but by the time they got to Machiques they had learned enough Spanish to understand that a small party such as theirs would be notably unsafe in the Indian country. A party was made up led by Donnelly and including Stanley Herold, Frank Wilde and myself together with Dr. Pedro Torres Arnaez and some sixty Venezuelan laborers to see what we could do about it. We assembled at La Villa del Rosario in the latter part of June and proceeded with all kinds of equipment to the Rio Yasa—just south of Machiques where we camped. At that point, Faison Dixon turned up and then and there started a lifelong partnership which was resumed in 1919 and still continues today. He had been working in the Guajira, northwest of Maracaibo with Dr. Burton Clark. The prospect of exploring some dangerous country intrigued him greatly and he simply attached himself to the party.

We had rifles and revolvers—everyone in the party was supposed to carry arms at all times. Our objective was to cut a trail S. 30° W. through the jungle along the foot of the mountains in a straight line to the Rio de Oro, to explore the streams we crossed, upstream, to study the geological section and to run cross lines every $7^{1/2}$ kilometers and set parcel corner posts every 666.67 meters at right angles to the main trail.

At night we set kerosene lamps, with reflectors back of them, all the way around our camp and maintained armed watch at all times. I never did see any Indians, although I think some of the party did. We saw signs of them constantly.

At the Rio Santa Rosa de Aguas Claras [Blancas] it became necessary to send back to Machiques for supplies. Faison Dixon led the party which undertook that task. He came back with plenty of groceries, but had the bad luck to lose a bag of salt in fording one of the rivers. The meals were very tasteless thereafter, but at least we did eat. Tinned dried beef was fairly salty, so we flavored everything with that.

The rainy season was coming on and so we decided that there could be no more sending back for supplies. We would go as far as we could, set a stake and get out. On the last day along in the late afternoon—we still had to get back to our camp and leave for Machiques next day—we came upon a well-traveled path; obviously the Indians lived nearby. Dixon was all for taking off down the path to see where it went, but the rest of us talked him out of it and we went back. Dixon has always regretted that retreat, but the chances are he wouldn't have gotten back at all if he hadn't turned back when he did.

As soon as we got back to Machiques I started having chills and fever. They were intermittent and I made it on horseback as far as a point about nine or ten miles from Maracaibo where I stopped at a house along the road and hung up my hammock. The others went on to Maracaibo and after a while a coach drawn by two horses turned up; Stanley Herold had very thoughtfully provided a cake of ice, so I rode into Maracaibo in comfort.

Then we all went to Caracas and were sent home to the United States for a month's vacation. I think everybody was invited to come back after the holiday at an increased salary, but not all did—some had had enough of that kind of business.

Colon

After the vacation Donnelly, Dixon and I, with Dr. Torres and Martin Tovar, now a leading industrialist of Caracas, were asked if we would like to try it again, so we went back into the Motilone country with another large party, this time in the District of Colon.

The Philadelphia office, I suppose it was, authorized the chartering of a steamship this time. It was an old Mississippi River sternwheeler which was supposed to be oar living quarters. The company really was anxious to make us comfortable and spared no expense. The theory was that the Tarra River paralleled the north-south trail we were to cut at no great distance, and that we could go to and from our work each day on foot and sleep on the boat. The main trouble with that idea was the *tatucales.* I don't know the English word for that one, but it is a type of topography resembling nothing so much as acres and acres of bushel baskets, top side up. It was hard country to get over, though the total relief was only a couple of feet. The result was that we could only get to the place the work started in time to start back, so we had to resort to camping again without even burros to carry the camp equipment.

After moving the camp several times we sent back to the steamer for supplies. The steamer had moved on upstream several miles in order to keep even with us, but the trouble was that the

river wasn't where it appeared to be on the map and the party had a much longer trip to and fro than was anticipated. We really did run out of groceries this time. There had been plenty of wild game, turkeys and wild pigs, right up to that point, but suddenly they all disappeared and the hunter came back with not even a monkey or a parrot. While we were waiting for the party to return, we didn't exercise ourselves very much because we were hungry, but in exploring around we came to a big, wide-open, new road. It wasn't really a road, but it was a wide, long, open place through the jungle which we investigated and found that we were in Colombia. A Colombian engineer was opening up a road from Villamizar to the Sardinata River. The Colombian engineer was not too pleased to have some Americans from Venezuela trespassing on his territory and he gave us quite a lecture on the subject of Theodore Roosevelt and the Panama Canal, but he did give us some beans and explained that it was not too far to town, where we could replenish our supplies.

We decided that we had probably reached the southern limit of our concession—at least another foreign government seemed to be occupying the territory, so we pulled out.

The exploration work in Colon was much more interesting than anything I had done theretofore in Venezuela. We crossed the Tarra anticline at five or six points and saw lots of seepages of light oil, gas seepages and hot water springs. At one point on a narrow piece of land between a hot stream on one side and a cold stream on the other, we came on the abandoned camp of Bjorge and Taylor. It was all packed up as though they had expected to return soon.

Getting back out to Encontrados was not as simple on the steamer as coming in had been. We had come in at high water and had had several weeks of dry weather during which the river went down, leaving the steamboat stuck on a series of sand bars. This situation was no novelty to the captain, however, and he would put lines to trees on the river bank, pull off from the sand bars, one after another, and we finally made it downstream to the mouth of the Rio de Oro. From there on down, the Catatumbo had plenty of water in it, but we had to go up the Rio de Oro to investigate a reported seepage. We did that, and noted the reversed dips in the sandstone at the river bank. This was really the place we were headed for several months before when we were coming southwest through southern Perijá. An oil well was drilled at this point some time later. I have always understood that Faison and Tom Ivenson drilled it single-handed, but I will let Faison tell that part of the story as I wasn't there.

Before we returned to our headquarters on the steamer we spent two days going up the river in dugout canoes which carried us to the head of that type of navigation at a point where three streams came together to make the Rio de Oro. As I remember it, we saw a tiger (jaguar) and some Cretaceous La Luna and Cogollo limestone and also some pre-Cretaceous rocks.

When we got back to Caracas we spent several weeks at Salas a Caja de Agua 26 writing up our notes and reports. It was at that time that I became well acquainted with Geoffrey Jeffreys and W. T. S. Doyle. They were great good company.

Perijá Again

I then returned to Petroleo in northern Perijá where Smitty was driving his leaping Model T. Sometime in the summer of 1914 I went to Mene Grande where several of us tried to decipher the

surface geology of that area—at any rate we all agreed that the seepages were phenomenal. They still were when I visited the area in 1949.

I was back at Petroleo in August, 1914. One evening Jack Lewis rode up on a little mule from Maracaibo with the news that hell was popping in Europe. We were all sent back to the States. Jack Lewis, Al Hammer, Jim Wilde and I went on the Dutch steamer "Prinz der Nederlanden," Captain Van Baaren. He had a square cut red beard the shape of those worn by the ancient Egyptians. We made a very thorough trip around the Republic of Haiti, calling at all the ports. At Port au Prince there was French Line steamer loaded with Frenchmen headed for World War I. They sang the "Marseillaise" with great enthusiasm.

After leaving Haiti for New York, our ship was stopped by a British cruiser. We were allowed to proceed when Captain Van Baaren assured the British that we had only one German, a chemist from a sugar plantation in Trinidad, on board.

When we got to New York we were all put up at the Hotel Wallach, then at the corner of 43d Street and Broadway across from the Astor. It was there that Shorty Prout created quite a stir. Shorty was 5 feet 19 inches tall. I remember asking the telephone operator at the Wallach to ring his room for me, but she leaned over from her switchboard, which was alongside the window, and pointing out the window said, "There he is, standing right over there by the Times Building."

After a delay of two or three days, Louis Dagenais and I were sent back to Venezuela, and we made all those Haitian ports again on the same "Prinz der Nederlanden." By the time we arrived at Curaçao we had run out of money. The trip took so long that our bar bill got ahead of us, so we cabled to Mr. Doyle for a hundred dollars. Mr. Doyle later told me he had sized up the situation exactly and had sent S. L. Maduro of the Curaçaosche Handel Maatschaapij a cable saying, "Find and pay to Harper McKee one hundred dollars." That got us back to Caracas.

From Caracas I went back to Perijá and spent most of the next year geologizing and mapping out in the flat. Ham Garner and I worked together part of the time. Once Mr. Doyle came out from Caracas and we led him on an expedition up the Cogollo River to the beautiful waterfall in the Perijá Mountains which is visible from all over the sabana in which La Villa del Rosario is located, but which is very hard to reach on foot. Another time Ham and I entertained a geologist from Holland. What I remember most about him was that he often upset our plans by taking an hour off for taking a bath when we came to a stream that offered what he thought were suitable bathing facilities, and he scolded Ham and me for smoking because he said it kept us from smelling petroleum odors in the rocks.

Leaving Venezuela

When I came to leave Venezuela in July 1915, I was working with Louis Dagenais from a camp at the Pauji River east of Mene Grande. When I first got there, Louis had already been on that job for some time. He took me out for a walk over some of the trails he had cut. They were mostly up and down, but every now and then he would strive to keep my courage up by assuring me that "from now on, it's mostly downhill."

My lifelong college friend, J. Elmer Thomas, who does not otherwise figure in this narrative, had written suggesting that I come back and join him in the practice of petroleum geology in Oklahoma. I didn't have too much confidence in that prospect, so I wrote him that I would come to Oklahoma when he could assure me of a year's employment at a fixed salary. He fooled me and did just that, so I left Louis at his camp on the Pauji River and proceeded to Mene Grande, Maracaibo, New York and Tulsa. To my surprise and chagrin, the management of the Caribbean Petroleum Company expressed only mild regret at losing my services. Had I stayed on with them, I might have reached the age of retirement some years ago and by now would be living on my pension. I can only say that I do not regret those early years in Venezuela nor do I regret having left when I did.

When I returned to Maracaibo in the fall of, 1921 to lay out parcels for Creole Syndicate, after six years' absence, I called on my old "friends at the Caribbean. Mac, the cashier, greeted me cordially and said he was delighted to see me as he still had seven burros charged to me!

II

Transportation in Southern Perijá

The problem of transportation on the Indian trip divided itself into three parts; first, the problem of moving the camp equipment and supplies on hand from one camping place to another; second, the problem of bringing in from the outside sufficient food supplies to last from time to time; and third, the problem of getting out of the country at the end of the trip.

Except for the last camp, where we resorted to man-packing, all of the transportation was accomplished by packing on mules, horses, and burros. The animals which we had to work with were not selected with any special reference to the task at hand, nor did we find it possible to estimate in advance what the proper number of animals should have been. There were three horses, which had been used for riding purposes and which we continued to use for that purpose at first. We had also eight mules, all of which had been used for packing purposes, and fifteen burros, some of which were in very good condition and others not so good. We were careful, however, to take no animals which were in bad condition.

At Camp Yasita, our first camp in the jungle, it was discovered that we had insufficient camp equipment and food supplies, so that practically two full burro trains were brought in at this point. The move from Camp Yasita to Camp Yasa was accomplished in one day by making two trips. The road was nothing more than the trail cut by Dr. Torres for surveying the base line and was not very satisfactory. However, this country is not very hilly and the trip was made without undue difficulty.

At this point it was found necessary to split the camp into two sections and so we gave five burros to Dr. Torres and he moved his camp ahead some two or three kilometers. It should be understood that in all cases the problem of transportation belonged to the party behind. The party ahead had no moves over three kilometers long. When Dr. Torres was

ahead, working on the base line; he kept his camp close to his work, even when this necessitated carrying water from a distance. His camp equipment was small and he did not carry more than a few days' supply of food so'that he needed no more than five or six of the burros.

From Camp Yasa, burro trains were sent out twice, one immediately after the other, along the old trail past the deserted ranch on the Rio Yasa to Machiques, for food supplies. On one of these trips Herold went with the train and on the other trip one of the peons was in charge. It was found much better to have an American in charge on account of the fact that when such was the case the trip was completed much more rapidly, supplies were obtained more economically and to better advantage, and the animals were treated better than when one of the peons was in charge. These trips out from the Yasa were accomplished with comparative ease as the rivers were not yet serious obstructions—there had not yet been many heavy rains. The trip from the camp to the outside was made in less than a day.

The next move was from the Rio Yasa to the Cañada Gil Blas, a distance of $7^{1/2}$ kilometers. This move was accomplished by making two trips in one day. A few days later we moved again, this time to the Rio Tucuco. On this trip it was discovered that the little trails made for the purpose of surveying were unsatisfactory when used as burro trails for bringing in large quantities of material. These trails, of course, pay no attention to topography, except in extreme cases, and are likely to be very hilly. From this time on, about ten men were detailed to go along with the party, surveying the base line to cut a burro trail which should omit as many of the hills as possible. It was found that although this practically doubled the work of the base line party, still it was very necessary. The trails north of the Rio Yasa were not made in this way and they were very unsatisfactory. Between the Yasa and Tucuco, this method was employed to a certain extent, but that country is mostly in slopes and the trail is not good. 269

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Our first camp on the Rio Tucuco was located close to an old trail which formerly led down to Los Ranchos Tucucos, a deserted rubber ranch. One of our first duties at this camp was to clear out this old trail in order that it might be used on the next trip out. It was anticipated that this trail would be considerably out of our way, but the trail by which we came in was so poor and especially so hilly that it was deemed advisable to go to the extra effort for the sake of the better trail. The wisdom of this course was fully realized later on. It took Herold, with seven or eight peons, two days to get this

trail cleared out so that it was usable to the Ranchos Tucucos and by the time this work was completed the other work of the party had gone so far that it was necessary to move the camp some $6^{1/2}$ kilometers upstream on the Tucuco for the sake of further geologic study. This move was made in two stages and immediately thereafter Dixon started in to Machiques with the burro train for more supplies. He followed the trail which we had cut nearly to the first Tucuco camp and then he turned off east on the trail to the rubber ranch—from there he followed on in to Los Cañitos by the old trail which had been used in former times by the Tucuco ranchers. This trip was the one which brought us to our first real difficulties in the matter of transportation. The first day out two of the good pack mules had to be abandoned because they were too weak from lack of food to go ahead. The first night out this party camped at the Ranchos Tucucos and the next morning Dixon went back on the trail and found that the mules were able to come ahead, but one of them had to be abandoned permanently later in the day. Dixon found that the trail from

Los Ranchos Tucucos to Los Cañitos was thickly overgrown and although it is only about nine miles from the Tucuco to the Yasa, time had been lost in crossing the Tucuco and he was unable to make the Yasa in one day and was obliged to make a camp that night without any water. The next day was one of considerable hardship as no water was discovered until the trail had been cleared out almost to the Yasa—this was at three o'clock in the afternoon. This dry camp and the work the next day was probably the

most serious hardship which any of the party ran up against during the entire trip. Camp was made that night at the Rio Yasa and the next day they went on in to Los Cañitos. The trip was slow on account of losing time in crossing both the Yasa and the Negro. The next day the party went on in to Machiques and got the business done in time to start back in the afternoon of the next day. Arrangements were made with a burro driver in

Machiques to bring out 17 burros with cargo at the rate of Bs 21.00 per cargo, we to furnish a guard for the party. These and our own burros (28 in all, because some of our burros were left in Machiques in bad condition) arrived at Los Cañitos on the Rio Negro the first night. Most of the next day was spent in crossing the Rio Yasa, which was very

high. The men built a raft of logs for transferring the cargo. About 40 passages were

required because the raft was made of heavy logs and was not a good floater. The next day the party was able to reach the Rio Tucuco in spite of the fact that the Rio Yasa and

the Rio Tucuco bottoms were both flooded and a great deal of time was lost in manpacking the cargo at both of these places. This trail from the Rio Yasa to the Rio Tucuco is a perfectly satisfactory trail in dry weather, but in wet weather the flats are so muddy as to make the passage extremely difficult. The next day, the last of the trip, was spent in reaching the last Rio Tucuco camp. Nine days in all had been used on this trip which we had anticipated could be made in four or five, and the party arrived in camp just before the last of the food gave out. Dr. Torres had reached and gone beyond the next end line, but had not done any work for the last two or three days because of the shortage of the food supply; the back party had been ready to move for three days, but was unable to do so for lack of animals. At this point it appeared clear that we would have to make every effort to get all that we could possibly get out of the animals for the rest of the trip. One mule had died at this camp, apparently mainly from lack of food. Dixon had brought out nine cargoes of corn, $6^{1/2}$ of which were fed to the best of the animals in small rations.

We thought that the best thing to do was to take as good care as we could of our best animals and let the others go. We bought thirteen burros from the burro man who had come in from Machiques and although they were not very good burros, still they helped us out at a time when such help was very necessary.

At this point, too, we sent back to Machiques two riding horses which were in bad condition and all the saddles except two which we saved for an emergency. Although the members of the party are not all agreed, still some of us think that it was a very good plan to use animals for riding as much as possible. As far in as the Rio Tucuco, it had been fairly easy to get corn and considerable green feed for the animals and, such being the case, it was thought quite proper to conserve personal energy at the expense of horse energy. South of the Rio Tucuco, however, animal feed is at such a premium that we believed animal effort should be conserved even at the expense of man energy.

The trip from the Rio Tucuco to the Rio Santa Rosa de Aguas Negras was made with considerable difficulty. The move was the longest of any yet undertaken and the trail, for about $4^{1/2}$ kilometers, is very hilly and generally bad. We had the misfortune on more than half of our moves to have rain the night before. At about this time, to be sure, the rains were coming every night. The trip occupied six days, beginning on September 13. The animals were too weak to make a trip on the second day, but on the third the men were sent back to the old camp where they spent the night and came forward on the fourth. But even at this, they were not able to bring along everything, and so some of them were sent back again on the fifth day and on the sixth they brought up everything remaining. This move was the worst that we had had and if we had not bought the thirteen burros at the Rio Tucuco the trip would have been seriously curtailed.

Before all of the material had been brought forward to the Rio Agua Negra, a party consisting of three Americans and the ten best peons had gone forward to push the work-on the base line. This party had a few of the best animals and worked forward by three stages to the next end line which came at the Rio Santa Rosa de Aguas Blancas. Dr. Torres was making the burro trail and later Herold and Wilde who had stayed behind came onto this, which was the last main camp. They had cached six days' supplies at the Agua Negra for the trip out. A good mule was lost at one of the camps between the Tucuco and the Agua Blanca. This mule, however, seemed to have been bitten by a snake or a spider and probably did not die from lack of feed. By this time all of the animals were in bad condition. There had been no real green feed south of the Rio Yasa, where there is abundant good grass, and only a few of the animals seemed to like jungle feed. This jungle feed is valuable, but it does not have the strength-giving powers of good grass. Those things which are most favored are the leaves of a tree called guaima, and the leaves of a small palm known as macanilla. Those animals which ate these things fared better, but this stuff is not very good feed at best. The amount of corn which we had was small and part of it had to be fed to the men, and so for the last three weeks the animals had practically no feed except the wild stuff.

The last camp at Caño Dificultad was a man-pack camp. The base line had been going in country which was so rough that the making of a burro trail was out of the question in the very short time at our disposal, and in order to make the most of our provisions it was decided to take out a man-pack camp in a last effort to reach the next end line or at least to reach a point for reference on some of the waters of the Rio Aricuaisá. The party consisted of fifteen men, three Americans and twelve peons. This party reached the point where the work began, about 3 kilometers out at 11:30 A.M., and was then split into two parts, one of which made trail and the other carried the baggage. At 12:30 Herold came along with ten more men, each carrying about 35 pounds of cargo. This was left on the bank of the Caño and these ten men went back to the Agua Blanca camp in the afternoon. The party continued with its work in the afternoon and was

able to reach a main tributary of the Rio Ariguaisa. There had been enough food brought over for two days, but as it rained heavily the first night and as it was obviously impossible to reach the end line, it was decided to go back on the second day although this involved each man's packing back an extra day's rations. This little experiment in man-packing was found to be quite satisfactory, probably on account of the fact that we had the extra ten men to help. The country was mountainous, all in very steep slopes, so that the rate of travel was reduced to no more than $^{2/3}$ of a kilometer per hour, but the men did the work cheerfully.

The retreat from the Rio Aguas Blancas commenced on September 25. As a matter of fact, Dixon and Herold had gone back to the Agua Negra the day before and had arranged a camp on the north bank in order to guard against a rise of the river. Between the Agua Blanca and the Agua Negra five burros were left along the road and parts of their cargoes discarded. The trip from the Agua Negra to the Santa Rosita, a distance of about $5^{1/2}$ kilometers, was made on September 26 and was the hardest day's trip of all. At the start on the Agua Negra plans were arranged for the trip. In the first place, less valuable articles were discarded until the cargo was reduced to a minimum. There were twenty-two animals in all and these were divided up among the members of the party with one American in charge of each squad and Dr. Torres in charge of a squad. Each squad had from eight to ten peons and the arrangement was that when it became necessary to leave any of the animals, the cargo was to be carried on the other animals or by the peons, or was to be judiciously discarded. The rule was made that no squad should pass any other squad, and squads behind should always make an effort to carry cargo which had to be discarded by those ahead. This arrangement worked excellently, To be sure, it was found necessary to leave some of the burros and also to leave some of the cargo, but this was reduced to a minimum. The trip on this day was so hard on account of the fact that it had rained heavily the night before and the road was very hilly. That night we were fortunate in that it did not rain, and the next day we had a very successful trip to the Ranchos Tucucos. There is only one hill on the trail between the Santa Rosita and the Tucuco and we took precaution to unload all the cargo and man-pack it at this point. We arrived at the Ranchos Tucucos in good time and found the river fairly low. On September 28 we exceeded all expectations and were able to make Los Cañitos. This was due to the fact that the places along the rivers where Dixon had had trouble were dry. We found we had lost fourteen burros and three mules. We think that if we were to take a trip of this kind again we would do some things differently, but the main changes which we would make in the matter of transportation are as follows: First, we would use no animals except burros, which should be selected with care so that only strong burros and those in excellent condition would be taken. It seems that mules and horses require much more feed than do the burros, and when feed is so hard to get it is advisable to use those animals which need the least of it. Second, we think that it would be advisable and economical to have two trains of burros whose only work would be that of bringing in supplies. In this way it would be possible to leave one train at the base of supplies where the animals could get plenty of good feed, while the other train would be at work. In this way all the animals would be getting good feed half of the time. We think that it was proven beyond a doubt that it is not successful to try to feed the animals mainly on the wild green stuff and expect them to do good work.

In going back again into this same country, we think that it would be advisable to cut a trail southwest from Los Ranchos Tucucos to the Rio Agua Blanca or, in case it was desired to explore farther south, to cut this trail clear through to the Rio Loro. Such a trail could be kept in

the flat country east of the hills and side trails could be cut up the stream valleys from it for purposes of exploration.

CHAPTER 23

DEFENSE IN THE INDIAN COUNTRY OF PERIJA

By H. Harper McKee

The conditions which have to be met in considering defense in carrying on work in the Indian country of southern Perijá are as follows:

The boundary of the Indian country is roughly the Rio Negro about ten miles south of the town of Machiques. The Ranchos along the northern bank of the river are in a constant state of defense and men are occasionally picked off, generally while they are asleep. It is supposed that the Indians watch them Ranchos carefully for months until they have learned the habits of the ranchers and make an attack when there are only one or two there. This makes it safer for a party constantly on the move than it might otherwise be. In one case, last March at the ranch El Capitán, Indians came in force and tried to storm the place, but were driven back. The last man to be killed by the Indians was during last July at a ranch on the north bank of the Rio Negro near El Capitan. Mr. Donnelly was near there at the time. The man was alone at the ranch, asleep in a hammock at three o'clock in the afternoon, when he was shot with arrows. Aside from a natural and apparently justifiable desire for revenge on the Venezuelans, the object in attacking the Ranchos is to get machetes and salt. The Indians use machetes, as can be seen where they have made cuttings in the woods, and one of the arrows in the dead man was pointed with a piece of steel from a machete; the others were pointed with hard wood.

There were formerly Ranchos along the Rio Yasa, but they are all deserted; all that is left of them now is large fields of grass. The Indians have no communications with the whites except possibly through other friendly tribes in the hills to the west.

We had no trouble in getting all the men that we needed for the trip at Bs 6.00 per day when they knew that it was to be a large party, but at Ranchos Los Cañitos on the Rio Negro three men would not go for Bs 6.00 each two miles into the woods to bring in a burro.

We started with 50 peons. We had for arms 12 Mauser military rifles from the government. They were in very poor shape, uncertain and practically useless; also 36 .38-caliber Colt Police Positive revolvers. We procured 10 more later in the trip—2 Winchester .405, 1 Winchester .33, 1 Winchester .44, 1 Mauser sporting rifle and miscellaneous revolvers and automatic pistols which belonged to members of the party. If it had been possible, it would have been far better to have had all revolvers of the same caliber.

At the start we took over all revolvers and cartridges belonging to the men, on condition that they were to buy them back at a reduced price at the. end of the trip. We thus had complete control over all weapons. Every man had either a revolver or a rifle. The men carried their revolvers all the time. Each man was given 16 cartridges and the orders were never to shoot at an Indian in the daytime except in self-defense. They were to be fined Bs 1.00 for each shot unless they had good reason to shoot.

The camps were made as small as possible and an open space cleared around the camp, which was well lighted at night with reflector oil lamps.

The first day south of the Rio Negro Dr. Torres saw three Indians for a moment. That evening at dusk eight men went about 200 yards to get water; they saw something which they took to be Indians and began to shoot. Some of the men rushed out from camp and started shooting in every direction. We called them back, counted cartridges, and fined all except those who had gone for water Bs 1.00 for each cartridge fired. We had no more trouble with foolish shooting.

Sentinels were put out every night, four or less, depending on the natural conditions around the camp—they changed every hour. The men were divided into four squads, each under a *jefe* who saw to the placing of his men. The original plan was to always have but one camp as that appeared easier and safer, but we soon found that we could not run the base and end lines from the same camp. Dr. Torres took 25 or 30 men and part of the time was camped separately, using the same general plan as we did.

We tried never to have less than five or six men together; generally six or seven stayed in camp. As we had men to attend to the burros, to cook, etc., and a few of the men were usually sick or injured, it practically took no extra men to guard the camp. In working on the line nine or ten was the average party—one with a rifle went ahead of the machete men, another with a rifle stayed with either the back rod man or the transit man, whichever was farthest in the rear. We continually saw signs of Indians, small palm leaf huts, footprints, trails, and places where they had made fires. Aside from the first day out, Indians were only seen once when Dr. Torres saw them in the pica. We found a place where several had slept in our trail, and several times found where they had been but a short time before. Often the sentinels would shoot at something they took to be Indians in the dark. Toward the end of the trip we were forced to make a cache of several days of our provisions and they were not disturbed. From the Rio Negro to the Rio Tucuco Indian signs were frequent; near the Rio Agua Negra we saw no indications of the Indians having ever been there, but five miles farther south near the Rio Agua Blanca there were evidently many Indians living nearby; we saw the smoke of their campfires and one well-traveled trail. In this trail was found a piece of cut sugar cane and we were told that they cultivated platanos. As far as we went we saw where men many years before had cut *cabima* trees, and one of our men had come through this part of the country ten years before, with twelve others hunting *cabima.* He said that as long as they did not disturb the Indians' Ranchos the Indians did not trouble them, but this same man had two of his brothers killed by the Indians on another trip.

It is said that the Indians of the Rio Agua Blanca are of a different tribe from those farther to the north, and evidently the territory along the Rio Agua Negra is neutral land between the two tribes. The Ranchos and the trails north of the Rio Agua Blanca were of a temporary character, evidently used only by fishing or hunting parties whose permanent homes are farther up in the hills. Luis Paris, in telling of his father's lumbering operations on the Rio Tucuco twenty years ago, speaks of many Ranchos and platano groves of the Indians farther up the river than we went. South of the Rio Agua Blanca we were practically in the hills, which may explain the difference of indications we saw.

These Indians show signs of not being low savages. Twenty or thirty years ago they were at peace with the Venezuelans and had communications with them, but the barbarous treatment they

have received, according to the stories which are told, has driven them into their present state of perpetual hostility. They seem to be more than holding their own in the conflict as they have been slowly driving the Venezuelans from their Ranchos, and we saw no signs younger than three or four years old of the *cabima* hunters.

Considering the character of the country which is open to attack and would deter the Indians from a permanent settlement, mosquitoes in the rainy season and the lack of game except for a few birds, it is not surprising that the Indians do not stay in the low country in which most of our work was confined.

Our most unguarded moments were when we were moving camp or going out with burro trains for supplies. Often the party would be scattered over miles of trail and we had to leave burros and loads in the trail overnight several times, but they were never molested. The animals were tethered outside of the camp guard and were never troubled.

Concerning further work in this country, the Indians should not be considered a detriment if the following precautions are observed:

1. A sufficient number of men in the party.
2. The party should be properly armed; each man should have a revolver, and there should be one rifle for every five or six men. The Winchester .33 rifle is a suitable arm.
3. Proper vigilance, especially at night, when reflector lights are almost invaluable.
4. Indians or their property should never be molested, and after a time, it seems that friendly relations could be established with them.

Jerome B. Burnett

Jerome B. Burnett came to the Caribbean project from the University of Nebraska, shortly before receiving his Bachelor degree. He left for Venezuela December 4, 1912, and returned to the United States October 14,1913. He completed his undergraduate work and took his Master and Doctor degrees at University of Nebraska in 1921. Later he became Chief Geologist for Lago Petroleum Company at Maracaibo and passed away January 4, 1953.

My records indicate that early in November 1912 Dr. Barbour received a telegram from Dr. Arnold asking for a young geologist in good health. While I had not completed my academic work, I had had three summers on the state survey with Professor Schramm. Dr. Barbour's recommendation was accepted and promptly I was off for New York.

We arrived at La Guaira Friday morning, December 13th. The evening before, the ship's doctor, Dr. Blanchard, said, "Well, boys, this is traditionally an unlucky day for you to land in this country, but if you have not seen the Southern Cross, get up early and you will see it over the mountains south of La Guaira." We did. It was an impressive sight.

We took the narrow gauge railway across the mountains to Caracas. We stopped for a few minutes at Curucutí where most of the male passengers got out to get a drink of rum. In Caracas we took coaches to Salas a Caja de Agua No, 34 where we reported to Louis J. Proctor, General Manager. We lodged at the Grand Hotel Klindt. After a few days in Caracas, we (Harper McKee and myself), returned to La Guaira and left for Curaçao, Dutch West Indies, on the Red D, "Maracaibo." There we took the schooner "Canna" for La Vela de Coro. We dropped anchor in

the roadstead and waited (time is easy in the tropics) for the oar propelled boats to take us ashore—December 25th. We got ashore and went through the formalities.

Most of our luggage was dispatched by burro caravan to Coro. We traveled in a *cache*, a horse-drawn conveyance similar to the droshky of Russia and the Near East. About half-way to Coro one of those violent tropical rainstorms broke loose. The old rack of bones which drew our carriage struggled on until we were within a half block of the Hotel Coreano, where he dropped dead. Three boys rushed to get our luggage, and we got to the hotel and registered. The rain was reported to be the first in thirteen months. A five gallon can of water sold for one real—about ten cents in U. S. currency. That was a lot of money when three reals per day was considered an exceptionally good wage. At the hotel we were greeted by Ana Roz, owner and operator. She was of dusky brown color but had a heart of gold. As a matter of fact, the famine had been so severe that I saw two losses—one in La Vela and the other in Coro, where emaciated women dropped dead in the street. They did not have energy left even to struggle. In Coro the government was distributing corn. It was tossed out into the street and I saw a fist fight develop over a single grain.

Immediately we sent a telegram to Pedro Ouvert to come along with the burros. We did not know enough Spanish to compose the message, but a native came to our assistance.

Next morning we received the answer: "Leaving tomorrow with seven burros." In the meantime, we looked over some supplies which a previous party had left. Among them was a case of deviled ham—possibly one of the worst things that could be taken into that hot, dry country when potable water was scarce.

Pedro arrived with the burros two days later and we started out. After getting several cases of dried prunes, to provide some fruit, we took off—Harper, myself, Pedro and Rufo Diaz, the black cook. All human transportation was by foot. The first day we went to el Rio Seco. The next day we went to Sabaneta; the following day to Agua Clara where we viewed the Agua Clara Anticline which had probably been studied by every geologist who had passed that way.

We went on from there to Pecaya. Some several miles west of Pecaya we crossed an unusual meandering ridge. I used a hand level and the ridge came out to be about 30 feet higher than the terrain on either side. It was composed of boulders, pebbles and gravel, with lime. Well, we were out looking for oil and did not stop to study physiography. But this feature always intrigued me. (Fifteen years later I drove over that ridge and recognized it immediately.) I gave it about two hours' examination and we drove on to Pecaya. But I was not satisfied and decided to take a couple of days off from oil. The feature turned out to be the relic of an old river channel developed under different climatic conditions.

Now let us get back to the end of 1912. We pitched our tent on the east side of Pecaya. For some reason Pedro and Rufo put their covvos squarely in front of the entrance to the tent, with their sharpened machetes. Inasmuch as they were loyal and faithful, they may have heard it rumored that someone was laying for us. The next day Harper and I ran a traverse up the south side of the mountains and measured a section to the San Luis limestone. (Oligocene?)

By this time we were getting hungry for fresh meat. I went out with a .22 rifle—the largest the government would permit us to use. Well (and here is one on Harp) I shot two parrots — they

were called cotos. One. was only wounded. Harp grabbed him and the parrot grabbed Harp's fingers.

Well, we worked both north and south and then moved on west. A few miles to the west we passed by a low mountain. To the side of the trail I noticed a beautiful pink calcite. I long regretted, and still do, that I did not make a private collection of the crystals. We moved on westward, stopped at a little place shortly after noon. After camp was pitched and we were working on notes and maps, I heard two shots from my .22 caliber rifle. Ruflo frequently would go and get a rabbit or two. This time it was not a rabbit. After some little time I saw him dragging something in. It was a boa constrictor, a little less than ten feet long. Ruflo had shot him twice in the head.

We worked north and south from here—north to what was termed the Nassue sandstone, tentatively called Pliocene. By this time our collection of fossil and rock samples had reached the point where our heavily laden burros could take no more, so we had to dispatch them by another burro train to Coro for transportation to Caracas.

Our next stop was Pedregal. We went through the regular routine: south to the massive sandstone and north as far as we could go. A couple of days after we arrived, the telegraph operator, drunk, came into the little pension (posada) and started a rumpus. He evidently considered us persona non grataand started to raise a commotion. I pulled out my pistol and fired one shot into the floor. The intruder took off and did not return.

From Pedregal we went to Lagarto, also called Bruzual. Upon arrival here we had developed such a strong hunger for fresh meat that even our fear of spending a little money did not stop us from buying a young goat. If I remember correctly, we paid three bolivares (60c U. S. currency) for him.

I had some alum and arsenic on hand and cured the skin. I believe we sold the skin for the equivalent of fifty cents US. Well, Harp and I went after the liver and heart like a pair of hungry wolves. Of course we had no refrigeration, so we gave the peasant from whom we had bought the goat, one half of it. Before the meat became tainted we had our fill. We took off north across the mountains "Los Cerros" (common parlance, skimmed or barren mountain). We camped once en route where there was water for our animals and for us. The next day we went on to a ranch called Pozos Azules. This place was so nice and the people so hospitable that we decided to stay for a couple of days. Before we left Pozos Azules I asked the owner of the place how far it was to Agua Clara. We had a map showing a carefully surveyed traverse of the mule trail. We had scaled off the distance on the map and we knew very closely what the measurement was. The owner of the ranch told me it was nearly twice the actual distance. I told him we had a map showing the trail and the distance and he said, "Well, but it's a very bad road." In this part of Falcon a league was considered to be the equivalent of about 2.6 miles of the distance a good saddle mule with rider can walk in one hour. Later I encountered the same type of distance reckoning in the "out back" in other countries.

After doing geological work farther afield, we wanted to review some of the locations in that locality. We finished the review and prepared to leave for Coro. The night before we left I began to run a high fever, so I called Rufo, the cook, at about 3 A.M. This was the middle of February

and the heat of the day would get unpleasantly high. We had about thirty-three miles to walk. We stopped at noon for a brief rest. I lay down in what shade a tree cactus could make. After about a half hour old Ruflo came and called me to tell me we would have to get on in order to make Coro by nightfall. But when we were about three to four miles from Coro I felt I would have to have a riding burro. Pedro, our burro boy, went to a nearby peasant cottage and got the saddle burro and the owner. We arrived in Coro before dark. Our two faithful boys came in a couple of times to see how I was getting along. Ruflo finally insisted that I have a doctor and two nurses. The next morning at dawn the doctor and one nurse arrived. The doctor's name was Smith. He was a native Venezuelan, but his grandfather was an Englishman of that name. He always walked along the street reading a book. The day nurse was as black as ink and she smoked stogies that were as black as she was.

My case was diagnosed as typhoid, but it did not time according to typhoid schedule. My impression was that it was dengue. However, it got around that there was a typhoid patient in the hospital. One of the priests from the Catholic Cathedral across the street came to remonstrate the presence of a supposed typhoid patient. Anita Roz very promptly told him that she was running this hotel and he could very well stay on his side of the street. Some days later, while I was still running a fairly high fever but was improving rapidly, I wakened in the morning to see a galvanized bathtub. I asked the nurse what that was for. She said they were going to give me an ice bath. As mentioned above, I was improving, but with the vision of an ice bath, I improved more rapidly. I did not get the ice bath.

All that I had to consume during my sickness were orange juice and boiled potatoes. Finally, when Dr. Smith told me I could leave, I took a sailboat from La Vela to Curaçao. At Willemstad I took a side wheeler called the "Venezuela." It creaked in every joint. I believe if we had encountered heavy seas we would not have reached La Guaira. I went through the lounge room. There was one man there. Well, I had studied some French, some German, and had studied Spanish since we left New York. I tried all three on him. Then, in a soft voice and in perfect English, he said, "What language do you speak. Sir?" That certainly took the wind out of my sails. We got to La Guaira and I went on to Caracas. Stopped again at the Grand Hotel Klindt. The next day I reported to the office.

Proctor had Dr. Machado give me a very thorough examination. The next day he came back and said, "You seem to be in good condition." Then he sat down and asked me some questions, among which were, "Do you drink beer, whisky, brandy or wine?" Mr. Proctor smiled and said, "Mr. Burnett, he is trying to make a drunkard out of you." I spent about two weeks in Caracas, then I went back to Coro via La Guaira and Curaçao. While I prepared for a reconnaissance of the peninsula of Paraguana, a telegram from Mr. Proctor arrived, which said, "Arnold arriving, wait for him." This telegram was dated May 14, 1913 in Caracas. Dr. Arnold and those who accompanied him, including Harp McKee, arrived around 5 P.M. that day. I had arranged for their accommodations and the care of the animals.

The next morning we started out. Dr. Arnold and I led the cavalcade. We both were interested in birds and they took up most of our conversation. After we got in from the day, one of the boys said, "I thought we were here to study geology—all you and Dr. Arnold talked about was birds." Two days later Dr. Arnold and his retinue moved on eastward and I took off northward to the Peninsula of Paraguana. We left the hotel at 2 A.M. in order to cover a substantial part of the

fiery hot isthmus during the hours of darkness. We stopped at about noon for a small lunch. I think I ate more sand that day than before or since. The trade winds were blowing. We stopped that night at a little peasant's place bn the east coast of the isthmus. This little place was called *El Faro*, (the lighthouse). We slept in the peasant's little house and became acquainted with the local fleas. The next morning we took off north. Before I left Caracas, Proctor asked me to investigate a chromite prospect on a mountain called El Rodeo. I looked over the drift about fifteen feet long and saw a few thin veins, but nothing that would justify developments, and I telegraphed Proctor accordingly.

That night I stopped at a small ranch, (about three houses). As I was sitting on a camp chair studying Spanish by lantern light, a small snake about two feet long slipped through my feet and under my chair. I jumped up and called Ruflo who came running with his machete. The snake had made his getaway. I knew some tropical snakes were harmless, but others were highly venomous. I did not want to make companions of either.

We continued northward arriving at the north coast of San Francisco. Then we turned southwestward and nothing of interest showed up. Our next stop was at a moderate-sized village called Jadacaquiva. The next day we went eastward, passing through a small village where we had a little coffee.

On June 13 we were in the camp of Gehrmann and Nobs. K. D. White was also there. The following day we all returned to Bobures. Then next day Gehrmann and Nobs accompanied us (White and myself) as far as the Culebra River. It did not take us long to survey to the basement here. Our next stop was at Playa Grande where we camped on the west side of the river. We worked to the basement again and stopped for a lunch of sardines and crude sugar. All at once I heard a rumble and what I saw was frightening. It was a wall of water descending upon us. It was about seven feet high. I called to White and asked him to get to the top of the hill as fast as he could. We climbed up the vines with only a few moments to spare before the water came. We waited there until nearly dark. Our two boys were on the opposite side of the river with our equipment and food. Finally, after some maneuvering, we got across, where we had another meager meal. In the morning we took off for our camp. When we made camp here, both White and I had examined the river bank to ascertain the high water line and placed our tents and supplies two to three feet above that line. That was not enough. Our instruments and clothing were wet when we arrived back in camp. I was cleaning my instrument and pistol when I heard another sound. Here came the water again. I hurriedly took my instrument and pistol to White's tent, but it was too late to get anything else. My tent, cot, clothing and one burro went downstream.

After a day of drying out and resting, White decided to do a little reconnaissance to the west. I wanted to check up on some of the first work we had done in the locality. This could have easily been a fatal mistake. I got along all right until I came to a fallen tree. We had to do the work from the river. At the fallen tree, the eddying effect of the river had developed a pool which was too deep for one to get through. So I looked around and decided I would crawl through the roots of the tree. Suddenly I looked at a fer-de-lance. It was coiled and within striking distance. I looked away and then pulled my automatic, took careful aim and fired. He thrashed for a moment and then lay still. I backed out carefully lest the dead one might have a companion. After retracing the path I had taken, I cut a thin branch with a fork on it and drew the snake into the clear. Promptly I

cut off its head with my machete and buried it. Then, in order to be sure of my identification, I made a sketch of the markings. This sketch I took to New York. The curator at the Museum of Natural History said it was lucky I had got the first shot, for it was a fer-de- lance.

That afternoon I was running an uncomfortable temperature. I checked with my clinical thermometer and it was 103 degrees. I decided I needed medical attention and rode to Santa Maria on a burro and there caught a small sailing vessel to Bobures, where I had to wait five days for a schooner to Maracaibo. We arrived there about midnight, July 22. The next morning I went to a local doctor and he pronounced it malaria. He sent me to Curaçao where I could get care in the St. Elizabeth Hospital. There I found four of the other geologists. Dr. Gearst gave me liquid quinine and later a daily injection of arsenic. This routine continued until August 30 when he told me I could leave. Before we paid our bills (which were ridiculously low), he gave us a lecture in which he said, "If you fellows keep going back to that country you are going to die there." Despite this admonition, we all went back.

In Maracaibo I received instructions to proceed to Villa del Rosario in Perijá. I had three pack burros, but I needed a good riding animal. I let out word that I wanted a good tame saddle mule. The next day three Guajiro Indians brought four nice looking mules. Obviously these had not just come down from the Guajira Peninsula. One was a fine looking animal and very gentle. I bought it for three *morocota* (sixty dollars USC). I arrived at Villa del Rosario where I again met Garner and White. They had additional burros and a good crew of machete and axe men. White went with me to the starting-off point, gave me a sketch showing the distance and bearings (Magnetic).

The concessions to be surveyed belonged to the Caribbean Petroleum Company and were located near the foothills south-southeast of Villa del Rosario. I had that block about three-fourths laid out when White came by again. He stayed overnight. He was ready to go when I looked through the transit and the middle horizontal cross-hair was broken. We searched around to find a very fine spider web. I thought he was more deft than I, so I asked him to place it on the cross-hair ring. We had to wait for the glue to dry and in the meantime White felt it necessary to proceed to other work. The next morning I looked through the transit and the spider web looked about the size of a ship's hawser. On this last side of the concession an amusing incident occurred. I was just about to make a station reading of distance when a group of wild hogs (which had been flushed possibly by a jaguar or mountain lion) came racing into the line and headed toward my rodman. Well, naturally the man dropped the rod and climbed the first tree available. After some fifteen minutes he got down and we proceeded. We closed in at starting point with a two point error. In those days we were allowed ten percent. The next morning a telegram arrived saying it had been decided to not survey the adjoining concession and I should return to Caracas. There I told them that I could just barely get back to resume my academic studies where I had left *off* the preceding year, and then I offered my resignation. I left on the S.S. "Philadelphia" in October and this closed my first trip to South America.

Trevett H. Wilson

Trevett H. Wilson left New York December 4, 1912 for Caracas on the same steamer with McKee and Burnett. From January to August 1913 Wilson and Hammer worked in Tachira and the south end of Merida.

Alva A. Hammer

Alva A. Hammer left New York December 4, 1912 for Caracas on the same steamer with McKee, Burnett and Wilson. From January to August 1913 Wilson and Hammer worked in Tachira and the south end of Merida. Later Hammer worked west of Maracaibo.

Guy N. Bjorge

Guy N. Bjorge left New York December 4, 1912 for Caracas with McKee, Burnett, Wilson and Hammer. With Taylor, Bjorge was sent down by Mr. James Clark Curtin to investigate the District of Colon, south of Lake Maracaibo. January, February and March were spent in the field. Excellent oil seepages and geological outcrops were found, but the party was driven out early in March by hostile Motilone Indians. Bjorge's arm was seriously infected by blood poisoning. He returned to New York in April 1913. Bjorge is now General Manager of Homestake Mine at San Francisco, California.

Roy W. Merritt

Roy W. Merritt left New York for Caracas

December 10, 1912. Most of his work was surveying and field engineering, first, at Mene Grande, and last, west of Maracaibo. He left in August 1914 when war broke out in Europe. Later he was agent for Socony-Vacuum at Bogota.

W. L. Taylor

W. L. Taylor left New York with Bjorge and others December 4,1912. He worked with Bjorge in District Colon, State of Zulia, and returned to New York with Bjorge. He has been a member of AIME since 1920. He is Consultant Mining Engineer and General Manager for the Mesabi Service & Supply Company, Hibbing, Minnesota.

CHAPTER 24

JUNGLE EXPERIENCE
By W. L. Taylor

On Thanksgiving Day, 1912, two enthusiastic young engineers left the Midwest for New York to confer with a London capitalist, Mr. F. J. Curtin, in regard to a concession he held on a large tract of oil land in Venezuela. They also met Señor J. J. Paris, a native Venezuelan, who was the owner of this concession. The outcome of these conferences was that these two boys, G. N. Bjorge and W. L. Taylor, sailed for Maracaibo on what promised to be a pleasant and mildly adventurous assignment of making a geological reconnaissance of this area. Señor Paris vividly described for them a trip he had made two years before into the foothills of the Andes to visit this property.

He had been accompanied by several Venezuelans, two of whom were Copaiba balsam hunters who had first told him of the "oil springs" they had seen. He had arranged with one of these men to act as guide for any party he might be able to interest in this proposition.

There were no reliable maps of the interior and very little information was available.

During the voyage these young men made the acquaintance of the chief engineer of the steamship company on whose boat they sailed, the Red D Line. He was a man named Jarchow and was en route to Rio de Janeiro and gave them much good advice about the difficulties they would encounter. They subsequently learned by painful experience that many of his seemingly fantastic tales were the literal truth, told with a sincere desire
to be of assistance.

He spoke of the myriads of insect pests-flies, mosquitoes, chiggers, ticks, scorpions, centipedes, tarantulas and, lastly, of an insect parasite which deposits an egg in the body of the person bitten. The egg hatches in about a week's time into a worm, very closely resembling the common white pine borer, and soon attains a length of more than an inch.

Arriving in Maracaibo, the engineers called at once upon the American Consul, Mr. John A. Ray. When informed of their business and destination, he replied that his advice would be to take the next boat back to the States. He immediately communicated with the governor of the State of Zulia and this dignitary flatly refused to allow them to depart into the interior unless accompanied by a regiment of soldiers. After several lengthy conferences, it was decided to send for Adolfo, the native guide previously mentioned, and after hearing his story the governor would decide about the necessity of the armed escort. When Adolfo arrived he gave such a glowing account of the ease and safety of the contemplated trip that the governor finally consented to let them leave, provided they would take fifteen soldiers as a guard. They ultimately persuaded him to furnish them with fifteen army rifles and an adequate supply of ammunition, and said they would hire fifteen natives who were accustomed to jungle travel to do the soldiering.

The last night they were in Maracaibo before leaving for the interior, they and Mr. Ray were entertained at dinner by Herr Von Jess, the German Consul. As they bade their host farewell after an exceptionally pleasant evening, he laconically said, "It is too bad. You are nice boys, but you will not return."

The next evening they left on a river steamer, going up Lake Maracaibo to the mouth of the river Catatumbo, a distance of about seventy-five miles. Near the mouth of this wide, swiftly flowing river were a large number of lake dwellers—Indians who depended almost entirely upon fishing tor a livelihood. Their huts consisted of a rather sketchy framework of poles with a platform about six or eight feet above the water. These structures were covered on sides and roof with a thatch made of grass and palm fronds. A dugout canoe, a couple of mangy dogs and a flock of children completed the family possessions. Their location on this submerged delta gave them good fishing grounds and a certain degree of protection from insects and snakes.

The lower reaches of the Catatumbo were ill-defined as the surrounding territory for miles was so low and swampy that large branches of the river were continually leaving or re-entering the main channel. The banks of this main stream were little more than low mud flats or islands

covered with a dense jungle growth of cane, vines and small trees. Occasionally one would see a ceiba tree rising in stately grandeur from its wonderfully buttressed root system through a limbless trunk of six to ten feet in diameter to a smoothly rounded top like a giant umbrella. The trees were alive with all the various brightly plumaged birds of the tropics; also large flocks of wild turkeys. Groups of white-faced monkeys quietly gazed at the world with round-eyed solemnity, or scampered madly through the trees and vines with great chattering. The rear of such processions was composed of a number of matrons that tightly clasped their babies to their breasts.

Ever present were lazily circling buzzards looking for some jungle casualty. On the bars and in the shallow water could be seen the ugly snouts of alligators looking for any unwary victim. These alligators provided fine target practice and our friends soon discovered that their army rifles were accurate only as to general vicinity and that most of the cartridges contained no powder. It had been extracted by the soldiers in the garrison by removing the bullets, pouring out the powder,and reseating them. The powder could be traded for cigarettes or tobacco, or an occasional bottle of wine or rum.

The score with Colts, Remingtons and Winchesters was decidedly better. The native guns and ammunition were left with the station master at the little station of El Guayabo, on a narrow gauge coffee railroad running from Encontrados to La Fria. They are likely there yet.

The river steamer was left at Encontrados, which is located about sixty miles up the Catatumbo and just below the mouth of the river Zulia. The Zulia is a link in one of the main channels of river trade from interior Colombia to the coast, but on account of its swift current and many shifting bars, travel upstream is slow and tedious, being
confined to shallow-draft boats.

It was not an uncommon sight to see a dugout canoe up to thirty-five or forty feet in length and filled to capacity with shelled corn or coffee, glide swiftly downstream with a Venezuelan seated on either end comfortably puffing on a good Colombian cigar.

At Encontrados a day was spent recruiting a party consisting of the guide, his brother, a cook and six Venezuelan packers. The most important member of the party was the interpreter. He was a Scotsman named Andrew Muir, fully five feet four, of Kentucky colonel type, and the embodiment of pomposity and dignity. He had been the Admiral of the Venezuelan navy under the Castro regime and was continually trying to drown his sorrow over the exile of the former dictator. His duties were to teach Spanish to Bjorge and Taylor, and to act as interpreter for a requested $15.00 a day and expenses and a gladly accepted $3.00 a day. It became necessary to discharge him ten days after reaching El Guayabo as he obstinately refused to transmit orders except as he saw fit, and he did not have the physique required for jungle travel.

It had been the intention of the party to strike directly west into the jungle from El Guayabo, with a territory approximately fifteen hundred square miles in extent as their first objective. This area was bounded on the north by the Catatumbo and on the south by the Colombian boundary. It lay between the rivers Zulia and Tarra, which are roughly parallel and about thirty miles apart. It was somewhere in the middle of this area that Adolfo had taken señor Paris to show him the "oil springs."

Due, however, to excessive rainfall in a district of nearly daily downpours, even in the dry season, and where it often rains continuously for ten days, there was a strip of swamp land about four miles wide lying along the west shore of the river Zulia. Here were great areas of mud flats and cane-brakes swarming with flies and mosquitoes. The mud and slime were from five to fifteen feet deep, so it was decided to move up the river about three miles to a plantation known as "El Manguito." It was owned by Señor Neptali Soto, who proved to be of great assistance to the party, acting as their agent in getting supplies and provisions. He and his good wife treated the engineers with every courtesy. They were repaid, however, as one of their sons, a handsome boy of about twelve, had a very badly infected ulcer on one leg and unquestionably would have died had not their guests been able to treat this infection successfully. Before the party left the interior, Juan was restored to normal good health.

The Sotos asked Bjorge and Taylor to hang their hammocks in the family sleeping quarters where they and their nine children slept. This was an act of the greatest hospitality and confidence in their guests.

The jungle west of El Manguito was so dense that a trail had to be cut through the tangle of vines and underbrush to gain passage. The first camp was set up about eight miles west of the river at the edge of a large swamp. This swamp was later identified on a rough military map of the interior as la ciénaga de Motilones, or swamp of the Motilones.

One must see a tropical jungle to appreciate the number of thorny vines and bushes which catch the traveler's clothing and make progress impossible until a trail is cut through them. The greatest advance the party was able to make was about a mile a day with six men cutting trail.

Señor Soto told the party that eight Venezuelans from this district had gone up the Catatumbo the previous year hunting alligator eggs. Their destination was given as the mouth of the river Tarra, but they had never returned. Adolfo did his best to minimize the danger of Indians, saying he had hunted in this area repeatedly and had never seen a sign of Indians.

Having spent several days trying to reach high ground beyond the swamp, Taylor tried to obtain a view over the surrounding swamp by climbing a tall tree by means of the network of vines growing on its trunk and thus had his first experience with termite ants.

In jumping for a vine slightly above his reach, his hand closed through the bark, which was all that remained of the vine, and he fell a distance of about forty-five feet. Fortunately, he struck in soft ground, and the most serious effect, at the time, was the dislocation of two bones in the right ankle. Subsequently, X rays showed that he had also suffered two broken vertebrae which caused him no little annoyance and pain for the next twenty-five years. He was carried out to El Manguito in a hammock tied to a pole and forced to remain there several days.

This event enabled the party to participate in a rather unique New Year's Eve celebration. About thirty guests began assembling about seven o'clock. It was soon necessary to dispatch one of the boys to El Guayabo on a mule to get another demijohn of rum. At midnight the party went to the river bank where a large scarecrow representing the devil had been prepared. Each one took a shot at this effigy. A hit assures good luck for the ensuing year, but a miss spells disaster. A feast was then served by the women. There was a great abundance of all the common native

foods and drinks, and in addition, alligator eggs and monkey meat, which was the flesh of a fairly large and somewhat rare black monkey. This was the real treat of the occasion.

Higher ground was found some six miles to the north and camp moved to this new site, which was on a high bank overlooking a creek. The first night in the new camp was somewhat unusual. Shortly after dark a terrific tropical storm broke out and the little creek, normally about twenty feet wide, became a raging torrent over a hundred yards wide within three hours. About ten P.M. a large jaguar swam across the creek, landed in the midst of camp, but left without ceremony after emitting a bloodcurdling scream which sent the Venezuelans into paroxysms of fear. They greatly fear "El Tigre," as they call the jaguar.

Just before moving to this new camp, the expedition was visited by a German engineer named Charles Heller. He was on his way to do assessment work on some mining claims he held in Colombia. On his way up river he had met Muir in Encontrados. He thought he might be able to act as interpreter so came into the jungle.

By this time work was progressing smoothly. The engineers and their men could communicate readily with a mixture of Spanish, English and signs. It was remarkable how soon the Venezuelans learned the correct usage of English expletives. As Bjorge and Taylor were very glad to see someone who spoke English, they asked Heller to spend Sunday with them. As they were to move camp on Monday morning, the men were all busy and there was no one to accompany Heller to El Manguito. When camp had been moved and the packers made their first trip to El Manguito, Señor Soto asked about Heller and was much surprised to learn that he had left camp for the river several days previous. He disappeared completely and a careful search along both sides of the trail failed to throw any light on the manner of his death. It seems most likely that he was picked up by a large python or boa. He was a powerfully built man, in excellent health, and armed with a Mauser pistol.

Shortly after the establishment of the second camp Bjorge developed malaria, and also a very bad infection in the back of his left hand. While he was thus incapacitated, Taylor and the men spent several days exploring the adjoining territory and found traces of the trail made two years before when Señor Paris had been in the jungle. Four days later, Bjorge still being unable to travel, Taylor set out with three men to follow the old Paris trail which led over very rough rolling country, somewhat more open, however. The following afternoon, after covering some eight miles, the party was surprised to come out into an open valley of considerable extent, the floor of which looked like an asphalt pavement. This asphaltic residue was too soft to walk upon during the heat of the day, consequently the edge was skirted for a distance of about half a mile to a ridge some three hundred feet high. Near the crest of this ridge was a huge hot spring, the waters of which carried large quantities of oil.

The party immediately returned to camp, which they reached twenty-four hours later, to find Bjorge very ill. He was delirious, had a high fever, and had developed dysentery. He grew steadily worse, and it became necessary to operate on his hand three days later. The skin was bursting on his fingers and his arm badly inflamed and swollen to the shoulder. Taylor gave him a drink of Scotch, carefully sterilized the infected area and set to work with a first-aid kit. By good fortune the spread of the infection was checked. Two days later, when Bjorge had regained a little strength, he was carried the fourteen miles to El Manguito in a hammock suspended to a

pole. This took nineteen hours of traveling time. The only nourishment Bjorge was able to retain for a period of ten days was a mixture of olive oil and whiskey, given in small quantities every three hours.

When Bjorge's condition had improved to the extent that it looked as though he could take a little food and retain it, Taylor went to a neighboring plantation to get some chicken and oranges.

As soon as Bjorge began to mend, Taylor returned to the jungle, the men having preceded him to cut a good trail to the edgeof the asphalt filled valley and to move camp to this site, which was so ideal as to be a story in itself.

In the meantime, four men had been building a pole bridge from the edge of the swamp on señor Paris's old trail to El Guayabo, thus shortening the distance necessary to pack provisions by more than ten miles.

When Taylor returned to camp, provisions were low, but the packers were daily expected with a fresh supply. A week later, having been entirely out of provisions except for two small wild turkeys in five days, the party started for El Manguito. When about five miles had been covered they met Bjorge coming into the woods with the rest of the men and a supply of food. After a hearty meal the engineers and three men started for camp. The rest of the party returned to work on the pole bridge, except for two men who were dispatched for more provisions.

The next couple of weeks were spent in mapping the various points of geologic interest within a radius of two or three miles of camp.

Taylor now experienced his only illness —a three-day siege of malaria. It was his first attack and during moments when not delirious he felt sure he was about to join the celestial choir. The cook would just laugh and give him another dose of quinine and a hot drink.

A three-day trip was then made to the mouth of the river Tarra, A really amusing incident occurred on this trip when we camped in a particularly wild, lonely spot. Adolfo asked Taylor if he knew "La Paloma" and if so, to please sing it to frighten away the evil spirits.

Upon returning to camp the boys wrote several letters to their friends in the States telling them that during two months no sign of Indians had been seen, so it was thought safe to say there was little danger from this source.

The following morning a trip was started straight west from camp, a distance of perhaps five miles to the river Tarra. The engineers took two men and sufficient food for a three-day trip. After going, perhaps, two miles, Bjorge was taken with a severe attack of malaria. Taylor first built a fire and then started down a dry canyon looking for water to make a hot drink. He soon saw a large outcrop of unusual interest, and on rounding it, his attention was drawn to the movements of a dying monkey. About a dozen others already dead were lying beside it. Just beyond were a number of bows and arrows which had been dropped by five naked Indians who were drinking from a pool. They were immediately recognized from Jarchow's description as Motilones. As they had seen Taylor almost instantly, he decided his best move would be to advance in a bold, friendly manner, which he did. The Indians at once grabbed their bows and

began to shoot arrows at him. He had left his Winchester at the fire and had only his Colt automatic. He shot the nearest three and then started to run. Halfway back to where he had left Bjorge one of the Indians stepped from behind a tree and let go an arrow from a distance of about ten feet. Taylor was able to get in a lucky shot and the arrow flew wild. After recovering his rifle he took one shot at the fifth Indian, who was just disappearing in the brush, but did not hit him.

These Indians travel in large bands and it was thus assumed that these five were a hunting party sent out to get meat for camp. It was subsequently learned that this band of approximately 150 had attacked a Colombian oil refinery a month earlier and had
killed a number of well-armed workmen.

Calling the two men who were cutting trail, the party half carried, half dragged Bjorge back to camp. With the cook's assistance, they immediately started for the river Zulia, carrying Bjorge in a hammock tied to a pole. Night overtook them shortly after reaching the edge of the swamp along the river. They crossed the first river at the edge of the swamp, a stream about seventy-five feet wide and alive with alligators. They cut the bridge behind them and camped for the night with the Indians plainly to be heard in the darkness on the other side of the river.

Starting at the first sign of light the following morning, they soon met the rest of the crew coming in over the newly completed pole bridge. At ten they reached the Zulia, crossed, and safely reached El Guayabo. The men, however, feared that the Indians would cross the Zulia, even though it was more than a thousand feet wide. Taylor was taken by a special locomotive to Encontrados, and the government notified by telephone from there. A troop of soldiers was immediately dispatched to the river bank, patrolling it for the next ten days, but the Indians did not make any attempt to cross this river. The guide, Adolfo, had not been in the jungle at the time of the encounter with the Indians and tried to discredit it by saying he would take the packers and recover the equipment and instruments left at camp. This he attempted to do, but on reaching the river in the swamp where the party had stopped for the night during their flight, they attempted to reconstruct the bridge across the river, but were at once attacked by the Indians who were lying in wait at the edge of the swamp. The men retreated at once, but picked up several of the arrows shot at them. These arrows are still kept as souvenirs of the trip.

The Motilones commonly used poisoned arrows which cause swift and certain death. The poison they use is curare.

Bjorge now developed a second bad infection in his right elbow. He was rushed to the hospital in Maracaibo for operation although the surgeon had little hope of saving either his arm or his life.

A month later, assisted by Taylor, he was able to sail for New York where he made complete recovery. After finishing the report covering their explorations, the prospectors decided that distant fields were not so green.

On reaching Maracaibo Bjorge and Taylor were informed by Mr. Ray, the American Consul, that on the Monday morning that they had their encounter with the Indians, a planter from the District Perijá, more than one hundred miles from where the encounter took place, had started for Maracaibo, arriving there on Wednesday. He immediately went to the American Consul and told

him that our party had been attacked by the Indians on Monday morning and that we had all been killed or captured. This word was given to the United Press and was the only information our families had for five days in spite of the fact that upon reaching Encontrados, Taylor had sent a cablegram to his uncle in New York telling him of our safe escape. As all our cablegrams were sent in code, and even though a translation was filed with them in both Spanish and English, the authorities held up this cablegram for five days before sending it.

What no one has been able to understand is how this planter knew our party was in the jungle in the first place, and also how he had the time of our skirmish with the Indians so accurately timed.

At this time Venezuela was full of German agents. They had persuaded the Venezuelan authorities that we were American spies sent to Venezuela to map the country and that as soon as our work was completed the United States was going to take over Venezuela.

While Bjorge was in the hospital in Maracaibo and not expected to live, Señor Paris asked Taylor what he was going to report to Mr. Curtin about his oil concessions. Taylor told Señor Paris he was not at liberty to give Señor Paris any information, that he would have to get his information from Mr. Curtin. Señor Paris evidently mulled this over in his mind and came to the conclusion that Bjorge was going to die anyway and that if Taylor was out of the way his property at least would not get an unfavorable report.

The following day Señor Paris invited Taylor to a dancing party at which he was introduced to a very beautiful and charming young Spanish woman.

The next morning Señor Paris arrived in Taylor's room all smiles and accompanied by a coachman or hack driver.

He told Taylor that the young lady he had met the night before would like to have him come to her home and that the coachman had been scouting and that the young husband was at work.

To try to sidestep this situation, Taylor told Señor Paris that he must finish writing a report so it could go on a steamer leaving port that afternoon. Señor Paris then became very insistent on Taylor's accompanying the coachman. He finally told Señor Paris he was not going to fall for any such "badger game."

Señor Paris then tried to pull his revolver which fortunately was on his hip under a tightly buttoned jacket, so that Taylor had a chance to get the drop on him and told him to go out and cool off.

Taylor immediately went to see Mr. Ray, the American Consul, and told him of this development.

Mr. Ray told him not to venture out of the hotel unless accompanied by himself or William Lightener, the Vice-Consul.

During the rest of the time in Maracaibo, whenever Taylor was on the street, there were two natives following within a block, but they did not dare any attack as Ray or Lightener was always along. This closes an incident in the monotonous lives of mining engineers.

Kessack D. White

Kessack D. White left New York for Caracas December 18, 1912. Most of his work was along the east side of the Perijá Mountains although he and Burnett did some work south- east of Lake Maracaibo. He left Venezuela late in 1913 after nearly a year of service. Since leaving Venezuela he has been with Standard Oil of New Jersey and more recently with Continental Oil Company in the Mid-Continent area.

Louis E. Dagenais

Louis E. Dagenais left New York for Caracas December 18, 1912. He was a Canadian of French ancestry and received his education in Canada. He spent much of his time in a detailed geological study of Mene Grande and surrounding area. In 1914 he spent a short time in Perijá area and in 1916 made an investigation of the area east of Maracaibo. He remained with the Caribbean Company until the latter part of 1916. Later he continued his work including some investigations in Venezuela and Colombia.

A Personal Experience of Mrs. Arnold During an Illness of Mr. Dagenais

By Ralph Arnold

Dagenais contracted typhoid fever during the course of our work in Venezuela. After getting strong enough to travel, he was sent to the Dutch Hospital in Curasao to convalesce. Mrs. Arnold was in Curasao at that time awaiting my return from the interior of Venezuela. As soon as she learned that Dagenais was in the hospital, she went to call on him. She was told by the doctor that it was improper for any woman but intimate family relatives of the patient to see him in bed.

I was told by someone who was present that when she got through talking to the doctor about the difference in regulations between the Dutch and American hospitals, she not only was granted the permission to see Dagenais whenever she wanted to, but her "lecture" also practically revised the code of the hospital regarding women seeing men patients.

As the result of her calls, Dagenais named her the "White Angel," a name by which she was known around the hospital as long as Dagenais was a patient there.

(The reason for publishing the following report is because it is the first detailed account of one of the largest seepages in the world.)

Tentative Report
Menito and Ultimo Seepages, May 27, 1913

By Louis E. Dagenais

At the nose of the Misoa Range is found the Menito and Ultimo Menito, a seep not less than $1^{1/2}$ miles in length. The Mene Grande, which has been visited by Mr. Arnold, Mr. Elliott and Mr. Bryan, is to the southeast of the Menito some two miles. The Mene Grande seems to occur when the structures take their curve to the north, if we assume that the Pauji and Misoa anticlines are parts of one and the same anticline. If the hypothesis is correct, the curvature in the Pauji-Misoa Anticline would form a new anticline superimposed on the original one; this last one would be of a much greater magnitude since the angle between the two limbs would be 60°. Into this broad anticline would be found undisturbed the Pauji-Misoa Anticline, thus giving the most favorable structure possible. This hypothesis is at the mere stage of speculation, although a few facts seem to be there to back it up; more information is necessary to present this view under the form of a report.

What is known up to today is the Misoa Anticline. The Misoa Anticline has been determined by its two limbs, by flat dips on top of ridge or crest, by the curving of the strike at the nose and by the topography.

On the east limb the strike is N. 5 to 15° E. Dip 25-30 E.
On the west limb the strike is N. 25° W. Dip 20-30 W.
On top of the mountain has been found flatlying sandstone of the same nature as on both limbs.
The topography of the east and west slopes are *dip slope.*
The range is gradually slanting to the south, indicating a south dip.
An exposure in the vicinity of the Menito by the structures recorded correlate this pitch.

Strike N. 75° E. dip South 20°. This exposure shows the curving in strike of the beddings curving which is possible only if the anticline is pitching. The lithological character of the rocks is not discussed here, it being one of the arguments for the hypothetical correlation suggested above.

Economical Value of Misoa Anticline. The Misoa Anticline constitutes land of great value; the seeps which are found at the nose and on the western side are over a mile and a half in length and compare well with the seep that Mr. Arnold calls the biggest in the world. This seep, called Menito and Ultimo Menito, forms a ridge 150 feet high of solid asphalt, with thick oil running down the slope. It has a big, boiling hot spring able to supply a six inch pipe; water from the spring is covered with an iridescent film of oil. This seep does not enter the claim of the Venezuelan Oil Fields Company, although it was believed to do so. Their claim was never completely surveyed so that no posts are to be found; only a map tie line to work with, and they exclude this valuable piece of land. We were told by Mr. Samuel Melandos, one of the directors of the Venezuelan Oil Field Company, that they had 900 hectares instead of 300. He was to bring his document to our camp, but failed to do it for unknown reasons. Hence my telegram. Our concession will take in everything around their claim. There will be a few triangles left, one of which we will put into the synclinal area and the others as far southeast as possible.

The Rio Raya Seeps. Three big seeps exist in the vicinity of Rio Raya, two of them on the flat at the foot of a hill some five miles east of Los Barrosos. I made an attempt to visit them, but could not do it on account of the May flood of Rio Raya. The two in the flat enter into our concession. The third seep is in the mountains at the head of Rio Raya some two days from Los

Barrosos, according to our guide. Will have something to say on these in next report. We worked during May under extremely bad conditions, everything under water, had to swim what used to be dry creeks. It rained day and night for a week after the visit of Mr. Arnold. June and July will be dryer—we hope so.

I am still under a pretty slim diet; although I have no more trouble with the liver, am fairly weak. Will be well fast if they only feed me a little. Expect to be in camp next
Sunday.

Leonard G. Donnelly

Leonard G. Donnelly went to Venezuela in December 1912. Practically all his work was done west of Lake Maracaibo, although in 1915 he investigated Mene Grande. He was the first geologist to visit the southern part of the Perijá Range and to call' attention to its great oil potentialities. He was the first also to make a careful study of the great La Paz seepage and oil fields. He nearly lost his life in the "mother" of the La Paz oil seepage.

A. Faison Dixon

A. Faison Dixon arrived in Venezuela January 15,1913. He was graduated from Harvard in 1907 and from the Graduate School of Applied Sciences in 1909. He spent three years investigating the minerals of India. Most of Dixon's work in 1913 was along the flanks of Perijá Range. He resigned from the Company in February 1916 and returned to the United States. After leaving Venezuela he engaged in consulting work which in 1920 again took him to the District of Colon. He is still consulting, with offices in New York, the firm being Brokaw, Dixon & McKee.

CHAPTER 25

THE MOTILONE INDIANS

A. Faison Dixon

I graduated from Harvard College in 1907 and from the Graduate School of Applied Science in 1909. During the summers I had worked as a woodsman for the Cleveland Cliff Iron Company in Michigan or as a miner in Utah and Nevada.

After graduation I went back to Cleveland Cliff as a geologist and then had an offer to go to India to do geological work for Tata Sons & Company who owned many mineral interests and were planning to build a large steel plant there. I had a fine time running around India for about three years and then returned to London where I worked for Herbert Hoover for a few weeks and then left for the States, thinking I had a job as a mining geologist in Mexico, but by the time I arrived in New York there was trouble in Mexico and I had no job.

It looked as if I might starve to death, but my college professor sent me a telegram telling me to call on a Mr. Sewall in Philadelphia who he understood was hunting for geologists. I went there and he said that although there was a Dr. Arnold who was passing on all the geologists, that one of them had recently died in Venezuela and another was coming home sick, so that he

supposed they would be needing several. So Sewall took me on, even giving me an advance on salary.

I left tor Venezuela, as near as I can remember, sometime in the latter part of 1912 on the old steamship "Maracaibo," which did not seem to resemble very closely the Atlantic liners. On reaching Caracas, I met Mr. Proctor and shortly afterward, Dr. Burton Clark arrived. Proctor told us that we were to go to Maracaibo and then up to the Guajira Peninsula and study the geology from Los Castilletes to the Rio Limon. He said the country was in dispute between Venezuela and Colombia and he believed it was inhabited chiefly by the Guajira Indians and "of course, we do not want you boys to take any risks, but there is where we want you to go."

We took an old paddle steamer from La Guaira to Maracaibo which looked to us, when Clark and I saw it, as if it were not fit to go to sea, so after taking one glance at it, we decided to go to Macuto and stay there long enough to miss the boat, but we had no luck. We came back six hours after departure time and the old paddle wheel steamer was still there. We arrived in Maracaibo and made contact with Sr. Juan E. Paris who was the proprietor of one of the large stores in Maracaibo. Neither Clark nor I knew a word of Spanish, but Sr. Paris fixedus up as passengers on a small sailing boat about 40 feet long to take the trip to Castilletes and found some people who knew about the Guajira Peninsula and who told us what to do. We took as baggage two small kegs of rum, two boxes of chewing tobacco, and about $500 in $20 gold pieces and a large bag of silver, our duffle bags and our own provisions. We sailed out of Maracaibo and lay off the entrance of the channel for about a day before we could get through into the gulf, and then we set sail for our destination. It was cloudy that day and the sun was setting and I chanced to look at the compass which I found was broken. We were then out of sight of land and I asked the captain, who was a very black gentleman, as were all the crew, but fortunately spoke English (I think he was from Trinidad), how he knew what direction to steer. He said he steered by the wind, which always blew in the same direction. This seemed to work, for the next morning we were off the little harbor of Castilletes.

The inhabitants of this place consisted of 20 or 30 Venezuelans or Colombians and about one hundred Guajira Indians. Fortunately, there was a Franciscan Father there who spoke good English and he was very kind to us. He told us just what to do and how to do it. We stayed there for several days and the good Father got in contact with an Indian chief by the name of Gonzalez, and made a bargain with him that he should take us as far as Carrasquero. He was to furnish a guard with horses and mules and we were to pay him a $20 gold piece per day and rum and tobacco, and buy supplies in any villages where we were to be.

There was quite a troupe of us when we started off. We knew practically no Spanish and no one in the party knew any English. As a matter of fact, only a few of the Guajira Indians knew even Spanish. The Franciscan Father had explained to us that Gonzalez could only go to the Indian villages where he had a wife, as the other villages would be hostile. We found that this was not any great inconvenience, for he seemed to have a wife practically everywhere.

The Guajira is an open desert country with fairly good grazing land in places and a small number of Indians live by keeping sheep, goats and cattle. When we came near a village which ordinarily consisted of a dozen small grass huts, Gonzalez would ride ahead holding both hands in the air. We would follow him about 100 yards behind. There would be only one or two old

women in the place when we arrived, but when they saw that we were friends, thirty or forty people would seem to come from nowhere. There were then signs made to us to hand out some money to pay for one or two sheep which were promptly killed and everybody had a feast. We would distribute plugs of chewing tobacco and Gonzalez would distribute some rum, and a good time was had by all.

The geology we did was negligible as there wasn't much to see and what little we saw looked as if there were nothing but sediments dipping at a low angle from the basement to the sea.

I had with me a .405 Winchester rifle which was a relic of my stay in India and I had many opportunities to dispose of it. One offer was a very plump Guajira girl, and when I shook my head they raised the bid by offering in her place a good looking mule!

We eventually reached Carrasquero and wrote up our limited accounts of the geology of the Guajira. We then went up the railroad to the asphalt lake at Inciarte. dark had made good progress in Spanish by this time and we were able to get along pretty well. We sent word by a boat to Maracaibo that we needed some more canned goods. In the course of time they arrived. We opened them up and found that they had sent us six boxes of deviled ham and that was all, but we were able to get plenty of bananas and chickens and even crackers and bread from the store in Carrasquero, so we did not suffer.

We tried to do some geology in this general region for some time. Arnold eventually arrived and I do not think that he will forget that trip. He will remember that Brick Elliott had a lame foot and we had to have him pushed on a hand car from Carrasquero to the asphalt lake while he and I trudged behind, a nice little 23 or 24 mile
walk that day.

After this, Brick and Clark went back to Maracaibo and I stayed and surveyed some claims and then returned to Maracaibo and was sent down to Punta Iguana to cut a road from there into Perijá.

I had received instructions to have a signed receipt for all money expended on construction and to have everything ui triplicate. This seemed unduly complicated, but matters were simplified by adopting a system whereby I laid out a mile or so of road to be cleared, put some men to work on it and after the work was finished, I paid them their wages and then found some one that could sign his name, and had him sign in triplicate a receipted contract for the construction of so many meters of road, the amount being paid being the amount that I had paid out in wages. I was greatly complimented by the Accounting Head, I think for the only time in my life, for the neatness and clarity of my accounts!

While working on this job I heard that an expedition was to start from Machiques to explore the country to the south. I had about finished my work on the road. They sent a Venezuelan engineer to relieve me and so I went back to Maracaibo and found that the party had left for Machiques some days before, but I decided to go anyway, so I started off after them on a mule. I think McKee has described our trip into southern Perija and I will not repeat it.

We then made the trip to the District of Colon which Harper has also described.

On the return from Colon I went to Caracas and was there offered the job as field manager of the Colon Development Company to have charge of field operations. I left for New York with a great list of materials which I was to purchase, including a boat to navigate the Rio de Oro. I was in the States for two or three months and returned to Maracaibo to take up my new duties. Dr. Torres, a very capable Venezuelan engineer, had already gone into the District of Colon and had started to make a large clearing at Tarra and had already arranged for bongos to transport material up the Rio de Oro. He had about 250 peons already at work. Drilling material was on the way. Our instructions were to start one well on the Rio de Oro and another at Tarra. As there was a favorable location on the river's edge on the Rio de Oro, we decided to start there first. We had about 100 men to start work at the Oro and a good fleet of dugout canoes and bongos. We made a clearing of about 30 acres on account of the danger of Indians and started the laborious operation of getting drilling equipment timber for the houses and the continuous flow of supplies and our men up the river. It took about a week from Encontrados to pole one of the bongos or canoes to the well site. We had material to build a good house, and no carpenter. Then the drilling superintendent and two drillers and toolies arrived. They were all men that seemed to be handy at everything and it wasn't long before we had a comfortable place to live, electric lights strung around the edge of the clearing to scare off the Indians, and a big garden started. We needed many men in the camp for the sake of safety. The gardening really cost us nothing, and anything we saved in the line of canned fruit and vegetables was enormous saving. As I figured, counting the inevitable losses, a can of tomatoes or peaches cost us about $2 before it reached camp.

We made a well site right beside the river and started to build a derrick and had that successfully finished. We also located a little coal seam within 100 yards of the derrick and started a little mining operation, which proved to be much better fuel than trying to cut the tropical woods.

After the camp was built and the derrick up, we spudded in, but the isolation was too much for our drillers and they all left excepting Mr. Carpenter, who only stayed a week or two longer. That left me as the only American in camp, but I received word that other drillers were on their way.

When there was nothing else to do, I made trips back into the mountains or south along the crest of a hill which was also the crest of an anticline. Peons would slowly cut a path and we would leave supplies at the end of the clearing and in this way gradually worked our way about 20 miles north. I also made trips up the Rio de Oro and back into the mountains.

One day when I returned from a trip I found some men had paddled up the river from Encontrados with the message that there was a war starting in Europe and a telegram from the Hague telling me to shut down all work and return to Maracaibo. I went to Encontrados and found, due to the disturbed conditions, I could get no money and I had to pay several hundred men their month's wages, so I couldn't very well fire them. I pulled in all the men from Tarra and all those who wanted to quit. I said we would pay them up when we could, and any that wanted tostay we would keep feeding and that they could go on working. Eventually I hoped it would come out all right. It took about 10 days for me to get word by telegram via Caracas to The Hague and back.

Mr. Murray, the general manager of the company, who was in Caracas, was in no better position than I was to help out. After about a month, word came that finances had been arranged and to go ahead drilling the well at Oro and that the new drillers were on their way.

Shortly afterwards, Mr. Tom Ivenson, the new drilling superintendent, arrived and shortly after him, two drillers and also an accountant from Scotland, and we again started drilling the well. Mr. Ivenson was a Canadian as were the two drillers, all from the small town of Petroleo in Ontario. Mr. Ivenson had just come from Borneo, one of the drillers from Burma and one from Persia, but it seems there was a family feud in Petroleo between them all which immediately flared up, and the place was far from having Arcadian peace and quiet. One of the drillers and the accountant had a fight and I had to send the accountant away, and then the two drillers said they were sick of the place and also quit, but Tom Ivenson said that if I would stay and act as his tooly, he would stay and finish the well. My Spanish always was what might be called "imperfect." Tom Ivenson spoke a mixture of English, Spanish, Hindustani and whatever they talk in Borneo, but Venezuelans are very intelligent and we were able to get along. By this time, some of our Venezuelan boys had learned enough so they could do most of the hard work. I received an education in cable tool drilling. We finished jobs after long waits for replacements of broken parts, split casing, crooked holes and all

imaginable kinds of trouble, but we eventually worried the well down about 1,000 feet

and it blew the oil over the top of the derrick. In the meantime we were really getting along very nicely. We now had the "Colon," which was a shallow draft fast boat, and a man by the name of Martin had come with the boat from the States as an engineer. He built, from the native cedar which we cut in the woods, with Venezuelan carpenters, the hulls of two other boats. I ordered the engines for these two boats direct from the States without going to the formality of writing for permission. They came all right, but I had apparently broken all the laws and rules and regulations of the Royal Dutch/Shell. It seemed that I could spend all the money that I wanted, so long as it was in bolivars in Venezuela (I guess that was because they couldn't think of any way to have a check on it), but to send an order for material to the States without permission of The Hague was unthinkable. We then had the fleet of the "Colon," the "Santa Maria" and the "Pinta," and could get our mail once a week from Encontrados, providing the steamer had come to Encontrados from Maracaibo.

While we were in the Rio de Oro camp, we had several visitors. Mr. Murray came to look things over and brought two huge books to show me how to work a double entry book- keeping system! He explained it all to me, but after he left I decided that sending the men to Encontrados and letting the store-keeper pay them off and settle up with him every few months was a far simpler proceeding. I think I did make an honest effort for about a week, to set up some books, and then decided I would take a trip back to the mountains as that would be to the best interest of the company!

About ten miles up the river from camp we found a trail and followed it several miles and came to large Indian house (of which you have many pictures). As I remember it, when Arnold came I brought him up to the start of the trail and wanted to show him my ethnological find and I believe he said he had not lost anything at the end of that trail. In all my work back up country I felt perfectly secure. We always had with us several men and five or six good-sized dogs. Apparently the Indians had a great fear of the dogs. When we had our camp at first on the river, we found that they would come around and take any empty tins that were handy, and one of them

stole several machetes that were left at the edge of the clearing. Once or twice they shot an arrow into the clearing. I saw them twice while we moved up the river and made every effort to be friendly with them by leaving salt, machetes and cloth at their house. On one of my trips we went up the Rio de Oro as far as we could in canoes and then with three other men I tried to cross the Peri j a Range. We crossed the fairly high mountain, following Indian trails which were taking us a very circuitous route, so we tried a straight line through the jungle and came to a river flowing northwest. I think we were on the drainage of the Magdalena. We only had one day's provisions with us and tried to get back to the Rio de Oro. We found the going tough in the two days making the trip back.

On our work up and down the river we used American canoes that I had brought from the States. They proved much better than the heavy dugouts ordinarily used in these waters.

After the well came in at Oro we built a refinery which consisted of a steam coil in a steel barrel. We would heat up the steam and some gasoline would come off the oil in the barrel, and by redistilling the first distillate, we were able to make a gasoline that could run the boats. I think this was the first refinery built in Venezuela. It was crude, even by the standards of a Kentucky moon-shiner, but it worked.

We then moved the base of our operation to Tarra. Some new drillers were sent in and we started the construction of a railroad of about 2-foot gauge. The railroad was about four miles long, and wound around hills to an elevation of about 400 feet. The surveying was simple—all done with a Brunton compass. Oxen were the motive power. In Tarra we built our houses, using very little imported material, and to my mind they were much better than the big bunk houses used in most of the oil fields. Each American and many Venezuelans had their own houses. The only parts that were imported were screening and tongue and groove flooring. We built a flooring on posts with small hewn timbers as a frame work, and stretched wire screen around all sides to a height of about 6 feet with a canvas ceiling, and then a thick thatched roof on top of it all, with canvas curtains to let down for the sake of privacy if anyone wanted it.

I also laid out a village for the Venezuelan workmen. Anyone who wanted it could have his plot of land and we would transport the material for his house, all of which could be cut in the woods, on our little railroad. Then anyone who wished to go to Encontrados and bring up a girl who he said was his wife, had the privilege of doing it. After a little while I found there was great speculation among the citizens of our little town in buying and selling their thatched houses.

In Tarra we had very competent help in the engineers and accountants, and Mr. Ivenson had excellent drillers. Everything went smoothly. I located and started the well here, then left to go to London for instructions from the company, and the well came in while I was away. In London I met Mr. Benjamin and other high dignitaries of the Dutch/Shell. To show how people appreciate conditions elsewhere, I was asked by one of the directors of the Royal Dutch/Shell, after I had given what I thought was a vivid description of Motilone Indians and the general country, if the roads were very good or if I could use only small cars!

I returned to Tarra and stayed a short time, then left for New York, as I thought I had had enough of the jungle for the time being.

The first time I actually had a good view of a Motilone Indian was about 15 miles up river from the Oro camp when I was drifting down the river in a canoe. We turned the bend and about 150 yards ahead of us were four or five Indians on a raft in shallow water near a playa. They jumped off the raft and ran ashore and across the playa. I did not get a very good view of them as I was busy trying to keep the two Venezuelans with me from shooting at them. They were evidently short, stockily built, very dark and apparently naked. I had a few other glimpses of them, but at no time did I get a good view of them again on the Rio de Oro.

The house of the Motilones, of which I have photos, was two or three miles in from the river, with extremely well marked trails coming within a few hundred yards of the river, but the trails never actually reached the river. I made this trip to the house with, I believe, as I remember it, five men and a pack of dogs, following one of these trails. Around the house were planted yucca and cotton. The hearth in the middle of the house still had some embers of a fire left, so evidently theIndians had left just before we arrived. On returning from the house we found the trail had been barricaded, but we never saw or heard any of the Indians. We believe our pack of dogs formed perfect protection.

The next time I saw the Indians was whenI was making a trip up the Rio Ariguaisa with Mr. Grady Kirby and four Venezuelans in two American canoes. About 15 miles from the mouth of the Ariguaisa we found a well defined trail leading from the river bank. We followed this trail for about two miles and found the house. This house had not been occupied apparently for several days. About 5 miles farther up the river I heard the sound of chopping in the woods and climbed the river bank and saw a clearing in which were ten or a dozen Indians, men, women and children. I had an opportunity to watch them for several minutes at a distance of about 100 yards from the nearest men and about only 50 feet from the nearest women. The women were clothed with a short skirt and one of them had what appeared to be a covering over her shoulders. The men were clothed with a sort of girdle or skirt that came down about half-way from their waists to their knees. After a few minutes a little child came by and let out a yell and the women turned and saw me. I stepped out and took the picture of the women jumping over the logs, which is enclosed. The men went to the other side of the clearing, about 150 yards distant, and brandished some of their clubs or agricultural instruments and then disappeared in the woods. We left presents for these Indians, consisting of 2 machetes, salt and a few trinkets, and made a camp a few miles above the clearing. We camped on the playa and the next morning while we were starting to push the canoes into the water, 10 to 20 Indians stepped out in front of the trees on the opposite bank and let loose a flight of arrows, only a few of which could reach near us. We shot at the Indians, but I did not have an opportunity to closely observe them. My mind was on other things!

We proceeded to paddle up the river, but after we had gone about a half mile arrows were shot at us at different times and we decided we had gone far enough, so turned around and started back. For a distance of about 15 miles and during a period from morning till late afternoon, the Indians followed us, cutting across the horseshoe bends of the river and shooting arrows at us as we passed by, and also while we were dragging the boats down through the shallow rapids. A good many times I had a close view of them and at least some were dressed in the same costume that they had worn the day before.

They were men of less than average height, I imagine about 5' 6" tall, very broad in the shoulders and very dark, giving the impression of a rather dark Negro. Their hair was long (about like a boyish bob).

The only time I was able to see their features carefully was when I was looking at the women in the clearing. They seemed to have a distinctly Mongolian type of features. The little children that ran very close to me were of a dark brown color, very chubby and rather pretty.

On the whole, I think they resemble the Guajira Indians, but are stockier and shorter in build.

It is interesting to note that on my trip up the Ariguaisa I had only one small dog, not any larger than a Scotch terrier, who barked vigorously from time to time in the canoe while the fighting was going on, but the Indians seemed to pay no attention to him.

In making many trips, to the top of the Perijá Range, up the Rio de Oro and working south in Colombia and north from the Oro to the Santa Ana, I often had only two or three men with me, but always a pack of dogs and was never molested.

I have heard people mention the disagreeable odor of an Indian camp. I did not find this to be the case. Around and inside the Indian houses there was no disagreeable odor; inside of the houses it was scrupulously clean and neat.

Only one man in Venezuela that I know of ever was actually with the Motilones. He was a Guajiro Indian who was a slave of some Venezuelans making a clearing on the Rio Catatumbo. He had escaped from camp and eventually ended up in our Tarra camp. He knew no Spanish and I had no one with me who knew more than a few words of Guajiro, but from the little of what I could gather, he had met a band of wandering Motilone Indians, traveled with them for a few days, then becoming frightened, left them. The owners of this Guajiro boy came up and got him and I made efforts afterwards to find him, with a man who could speak Guajiro, but never was able to locate him again.

Mr. Kirby, myself and six men, with two American canoes, started up the Ariguaisa River. We were forced to send the launch back to Maracaibo as the dry season had begun. The launch had orders to return to Laguneta at the end of the month. We had to arm the men working up the Lora River, the men at the well site and the men left in camp at the mouth of the river. This left us two rifles, one shotgun and four revolvers. The outfit of men, arms and canoes was the same that I have used in exploring the Indian country, on many previous trips, and have always considered sufficient for protection as long as we were all together, even in such places as the Oro River where we were continually among the Indians. We live and learn! We paddled up the river for four days without incident. After the second day we saw many Indian tracks along the river and, as usual, two men stood guard at night. At the end of the fourth day we discovered a ladder leaning against the bank of the river. From this ladder a good trail led to a large clearing and Indian community house, such as I had found before in the upper part of the Oro River. As far as I know, these are the only two Motilone houses ever discovered in Venezuela. At the house, we were a day's journey farther up the river than anyone had gone before. We had a report of a man having gone up the first twenty-two rapids fifty years ago. We were then at the thirtieth rapids. As I had done before, in finding an Indian camp, I took some of their bows and arrows. We

expected to leave gifts at the house, upon our return trip, as I did when working up the Oro River. The following day, late in the afternoon, while we were examining an outcrop along the river, we heard a baby crying. I took my camera and crept through the cane-brake. I found a clearing of about three acres in which I could see twelve or fifteen Indians working. I came within ten feet of a woman before she noticed me. As she turned and ran, I snapped a picture of her, which I hope will turn out well. The Indians ran to the farther side of the clearing and stopped. There were some men, but most of them were women. A girl of about five and a boy of three trotted past us, apparently very little frightened. We waved to the Indians, as they stood on the other side, and did our best to try to show that we were friends. We also left considerable salt, which is the commodity most prized by the Motilones, and a few little trinkets on a stump in the middle of the clearing.

We paddled up a couple of bends and made camp, as usual, on one of the sand bars along the river and passed a peaceful night. The next morning, just as we were getting into the canoes, about twenty Indians stepped out of the brush on the opposite side, fifty yards distant, and let fly a volley of arrows. We stepped back, as far as we could oh the sand bar, and began to shoot. I saw two of the Indians drop and the rest disappeared. I took a picture of the arrows sticking in the sand around the canoes and told our men that we would keep going on up the river. According to everything I had ever heard, after the Indians had made an unsuccessful attack, they would not return. As we were getting ready to leave again, they began to shoot again. We then realized that we were in for it. The river was full of rapids; in many places the channel was only a few feet wide running beside densely wooded high banks. There were not enough in our party of eight men, with seven arms and limited ammunition, to chase the Indians.

Just below, where we were camping, there were very bad rapids and a favorable spot for the Indians to attack. By great good fortune, just above this point, the river had made a cut-off. Knowing that the cut-off came in two miles below, we took a chance and started down. There was very little water in it and we did not know but that it might prove to be a blind lead. Anything seemed better than trying to work the canoes through bad rapids under fire. One is particularly helpless in a canoe in swift water. When we started down the cut-off the Indians let out their war whoops and began to beat a tom-tom. They came to the bank of the river and shook the trees after the fashion of monkeys. We took a few more shots at them and kept on down the cut-off.

After we traveled along in peace for about a mile, the Indians attacked us again. The cut-off was full of logs, high out of the water, over which we had to lift the canoes. We threw away some of our provisions, to lighten the load, but kept everything else. Upon the uncertain assumption that Indians would attack only from the high bank, some of us would keep to the far side of the river, along which there was always a cane-brake, Mr. Kirby at the rear and I at the front, the men swimming along, protected by the canoes, where they had to go close to the high bank, or dragging them in the shallow water as far away from the high bank as possible. We were attacked three times in the cut-off. If the Indians had shown any sense they could have gotten us easily here, where two high banks came together.

They kept after us below the junction of the cut-off and the river. In one place they did attack us from both sides and made it hot for us for a few minutes. Fortunately, there were no obstructions in the river and, after shooting a volley into the woods, we could be certain of a few

moments free from interruption. A few miles down the main river, we took to the canoes and were only shot at twice. Our canoes were repeatedly hit and arrows fell thick around us upon many occasions, but no one was touched, which was almost miraculous. Had it not been for the fact that the Indians had a fatal curiosity, wewould have been "easy marks." They would shoot from behind big trees, but could notresist looking out to see where their arrows had hit, which gave us a chance to get them.

Naturally, this must have made the others nervous marksmen. Our men calculated that we hit at least twelve. I have to hand it to them, the Motilones are brave men. Their last real attack, when they came at us from both sides, was just as vicious as the others, in spite of the fact that many of them must have been killed. I do not believe that there were more than forty Indians altogether, who took part in driving us out. We kept on down the river, which was swift, and reached our camp at the junction of the Lora and Ariguaisa late at night.

We had marvelous luck in that all of us escaped. I do not believe that even a larger body of men could go up the river again in canoes, in low water, without some being hit. In high water, a high powered launch can bring a party up and work out the geology along the banks of the river, which would be sufficient, with comparative safety. We were far enough up to make it seem improbable that there is favorable structure along this river. In any case, nothing can be done for several months until the water is high. I do not believe it would be worthwhile then. As you can see by the map, the Indians are near the Lora River and the Canon del Norte, and the men working there must be protected. We cabled for some shotguns as they are an effective weapon for such work and can be brought in without government permission.

Captain Dame tells me that in Colombia there is a mission school where Motilones are being educated. It would be worthwhile to go to a very large expense, which might not be required, to get some of these Motilones and try to establish communications and make peace with those of the Ariguaisa. Aside from the danger, difficulty and very large expense of going up into this country and cleaning them out, I do not like the idea of destroying a whole community of men, women and children. But this would be the only thing to do unless peace is made. After three centuries of continuous warfare between the Venezuelans and the Motilones, opening up peaceful relations is a matter of no small difficulty, but it can be done if the problem is attacked in a serious manner. If oil is found up the Lora, peaceful relations with these Indians would be worth several hundred thousand dollars to the company.

We returned to Maracaibo by canoe and sailboat, a five days' trip. I expect to take the first available steamer for New York. The lack of accommodations on the Red D Line and the breaking down of their steamers may force me to try to reach the States by some other route. There is no prospect of my getting away from here for a week or so. I shall use part of that time looking up a possible structure, which is not now taken up by any other company. I reported on this when working for the Caribbean, but no further geological work was done on it.

Maracaibo

We left here about a month ago in a little sailboat, had a day's sail to the mouth of the lake and were held up a day by high winds. When we put out to sea, it was almost a dead calm, but that night it blew hard. To get the real artistic effect of a storm, one should get the impression from the deck of a little sailboat at night. The moon was out and it was really fine to see the big

whitecaps ready to fall on us. Waves were coming over the boat all night; of course we were wet to the skin, and dark was seasick, but it was too interesting and cold for me to notice any of the motion. We got to Castilletes in the early morning; a narrow neck of water runs into the land here and joins the ocean to a big lagoon. The town of Castilletes is a little place of thirty or so houses, most of them built around a patio, making it practically a walled town. The only fresh water nearby is a spring five miles off. The town used to be near it, but was destroyed by Indians a few years ago and they built it nearer the sea. The boundary between Colombia and Venezuela passes through the town, and most of the inhabitants are government officials and a few Indians, chiefly women. We had letters of introduction from the President of the State telling them to give us whatever help we needed, and we spent the day making official calls. We were in hard luck in not having a letter to one of the members; he felt slighted and I think made a lot of trouble for us. These official visits get on my nerves; we go to a house not as good as a Negro's log cabin, shake hands and make a few fool remarks in reply to meaningless polite questions we don't understand, have a drink of fresco, stuff made from kaffir corn that tastes like barley water mixed with mud, or if we are especially unlucky, they bring out rum which has no taste at all—it only burns.

We found that the people in Castilletes were completely buffaloed by the Indians. They did not dare go more than a few miles from town unless they were in big parties and well armed, and no Venezuelan there had ever been back to the hills more than fifteen miles, all across open plains.

We also had a letter to an Indian chief and Venezuelan "General" Lewis Fernando who lived a few miles off. He was away at the time and we had to wait around a few days for him. We made a collection of sea shells, finding about forty distinct species to send in to the company. They ought to be quite a help in any paleontological work that they may want to do. On the fourth day Lewis Fernando showed up. He is a fairly typical Guajiran Indian, dark copper colored skin, well built, heavy, and with a flat nose and rather thick lips. We had been trying to buy mules and horses; they are supposed to be very cheap in Guajira, but the prices they wanted to sell them for were ridiculous, so we saw we had to make some other scheme. Lewis spoke Spanish, but not at all well. We had an interpreter who was supposed to know Guajiran, but we found that it was somewhat on the order of our Spanish—good enough at times, but not reliable. We showed him the letter and he was greatly flattered, had several men read it to him and pretended to understand it, put himself entirely at our order and told us he would furnish us with everything we needed. We had rented a small house of two rooms and while we were talking to him, everybody in town crowded in except the higher officials who did not let their curiosity get the better of their dignity.

The Indian was dressed in a robe, the upper part of his face painted jet black, and it was perfectly evident that the amount of brains he had was small, but the respect paid to him by these Venezuelan white men was extraordinary. They were always whispering little asides to us of what a wealthy and powerful man he was. They were deferential in their manner toward him, which he took as one to the manor born. Sometime before, President Gomez of Venezuela had invited him and some other chiefs to Caracas, given them presents, made them "Generals" and shown them honor. Our talking, incidentally, made the old boy thirsty. He went out and came back in about an hour with the fellow for whom we had not had a letter. Our visitors being all gone, he did not have to pretend any politeness but came right to the point and told us we had to pay him five hundred pesos, $400 a month, to show us around the country. We already knew that

it was practically impossible to buy horses and hire a guard of our own, so we bargained with him.

Finally he agreed to furnish us horses, burros, a sufficient guard, and go with us over the country for 15 pesos a day. We had to give him an advance for four days, and the next morning we started off.

Everything was fine the first day. We had plenty of horses, seven or eight men and lots of burros. We started off to the ranch of General Lewis, had a delightful ride along the beach, and he told us the next day everything would be ready for us to start for the hills.

He had a house of two rooms with a number of Indian huts around it. We took one of the rooms, swung our hammocks and made ourselves comfortable.

The next morning there were no horses around, but he said he was getting some fresh ones, so we spent the day surf bathing. Everywhere in the Guajira trade winds blow strong all the time, which makes it delightful. The next day the horses arrived and we went off to some nearby hills; the day after, we had no more horses, but did a little more work nearby. We were getting impatient and he was always putting us off—everything was going to be all right "tomorrow." He worried us asking for presents, which we refused. Finally he had to have another advance to buy sufficient burros for our baggage. He said the burros we used the first day were not his, but borrowed. We gave him part of what he asked for, everything to be ready sure the next day.

The next morning he came in before day-light and asked me for our bottle of brandy. It always makes me mad to be awakened and I told him no. He then woke up dark and he called to our cook to pour him some. He did. The old boy looked into the cup, said he was no child, he wanted a real drink, and handed it back to be filled, dark told the cook to pour it back into the bottle, then told the chief if he did not like what we gave him, he need not take it. It was out of his range of ideas being treated that way. He humbly took his small portion and went out.

We got up and found no animals were ready for us. We decided to change our manner to the man, not treat him as if he were a "General," and hold him in awe, but to order him around a bit. We called in our interpreter and tried to get him to interpret for us, but our fool interpreter seemed to stand in awe of the chief and it was evident that our Spanish never got into Guajiran, the way we said it. We then talked it up to the chief ourselves and got it into his head that we were not to be fooled with. He had to keep his contract and we were going to stand no more foolishness. I doubt if many of our words got to him, but our manner did, and he rather lost his temper and blustered about expecting to outface us. But we kept at the same thing—that we had to have those horses immediately—we had paid for them—bring them to us. Our interpreter was horrified, but after a little the general got off his high horse and became as meek as a Hindu coolie. He told us it was not his fault, the peons he sent out had not brought them in, but if we wanted it, he would kill them when they got back. Shortly the horses showed up and also "General" Jose Fernando, the half brother of Lewis. He wore trousers and was civilized. He took over the contract from his brother and from then on everything went smoothly.

We got off the next day and made a trip of some 150 miles through the Indian country. We generally had a party of seven or eight on horses and a bunch of burros for the baggage. Jose Fernando went with us, otherwise it would have been impossible to get along.

The laws of Venezuela and Colombia, whatever they may be (this is not a great country for law and order anywhere), have no force at all in the Guajira. As near as I can make out, the Indians have nothing but a very loose clan system. The family of Fernando controls the southern and western part of the Peninsula. Lewis and Jose Fernando had a "rancho" and wives to take care of at nearly every place we stopped after traveling for two weeks—an excellent custom—a man can travel and always be at home. The women here are sold, the girl's mother's brother getting the purchase price. A girl of good family will sell for as much as a dozen mules, a thousand dollars. They are animists in religion, but I saw nothing to indicate any religion, except some women putting a few things for the dead on the grass. They carry on blood feuds, after the manner of Southern mountaineers, except that they have sense enough to have the regulation that when one side gets tired of the feud, it can pay a price in cattle to the other and end it; and also it squares things in general if a relative is killed. To kill anybody else will always settle the matter in the public eye. How much more convenient than trying to get the real culprit.

Our party were all armed, and in coming up to an Indian camp, a "rancho" in which Jose did not have a wife or relative, they would have the rifles out. Generally, unless they had heard we were coming, the rancho would be absolutely deserted, everybody having fled at the approach of a bunch of unknown horsemen. Even at his own Ranchos, men would be out with the horses all night to see they were not stolen. Once our cook was some distance from us with the burros, saw an Indian behind a tree and shot at him four times. He did not hit him and the rest of the men took it as a great joke. One day while we were all riding along a narrow path, we met a bunch of about 35 Indians all armed with rifles or poisoned arrows. I wanted Jose to stop them so that I could get a picture, but I was greatly surprised to see that he was scared. He rode in the middle of the path and made them all get out of the way, but would not stop.

We moved on every day, stopping at the Indian camps. We found no oil indications. We ended at the town of Sinamaica and took a sailboat to Maracaibo.

Rio de Oro

I took seven men and two small canoes and started up the Rio de Oro. The first two days we had good going and got a long way. We saw all sorts of Indian signs, ten rafts tied to the bank, fresh footprints, large fishing weirs built across the shallow places. The country is full of them. The third day we got to rapids. Worked hard at portages and dragging the canoes, but in the afternoon got to rapids we could not even carry around without climbing a hill.

The next day I took three of the men and started off to climb a high hill to the east of camp. We found a good Indian trail leading almost to the top of the hill. To my great surprise, when I got to the top and had a good view to the west, there were no high mountains as are shown on the map. On our way back we shot a big black bear, the first time I knew they were in Venezuela. When we first saw him he stood up on his hind legs and looked as big as an elephant. We all had guns and filled him full of lead, but he rolled down the hill a long way. We skinned him. He weighed well over 300 pounds.

On our way down we evidently took the wrong Indian trail. After a bit we knew we were lost and took to a stream which we expected would take us to the Rio de Oro. We went down this stream until four o'clock, when it joined a river much larger than the Oro, flowing to the

northwest. We had crossed over the watershed and gotten into the waters of the Magdalena River of Colombia.

I then started to run a line with my compass, taking all the canyons and cliffs as they came. Just at sunset we found a tree, the *palo de vaca,* "cow tree," which gives a sap like milk. We cut into it and licked the sap until it would flow no more. It had an extraordinary effect. It took away our hunger, but at the same time we lost all our strength. I started to hunt for water, went about 50 paces and fell down. My men were following me and they dropped down too. We were on a steep hillside. I slid down until a small tree stopped me and I did not move for hours. One of the men rolled into an ant hill, not the stinging kind, and did not move until near morning. I soon dozed off in a sort of stupor. About midnight I got into a more comfortable place and felt much better in the morning.

We climbed the next morning and reached Oro the next afternoon and then had a long walk upstream to camp. We had taken nothing to eat with us and were without food almost two days, working hard all the time. We had a good night's rest and felt fine the next morning.

It was fine slipping down the rapids we had taken so much trouble to come through. We had to let the canoes down with ropes at some spots, but that is easier than making portages. At a sharp bend in the river we came on a bunch of Indians building a raft. I counted ten, including one child. They were almost naked and were not white as they are supposed to be, but very dark, almost black with a tinge of red. They did not see us until we were within 60 yards when I had to shout to stop one of my men from shooting.

I expected Murray and the drillers to be in camp when I got back, but when I arrived there was not even any word from them. I had heard rumors of a revolution starting and I thought they might have been held up. I waited a couple of days and then started up the river to where we had found the good Indian trails. We camped at the river and I hunted the country for the Indians. We finally ran into one of their houses. It was a great surprise. It was 100 feet long, 45 feet high and very well built; it looked like a huge beehive. Inside there were all sorts of utensils and weapons. Everything neat and clean, with two lifts for sleeping. They had big patches of cultivated land (several of two or three acres each) where they were growing nearly all the products that the Venezuelans grow. They also had clothes and spinning jennies and crude pottery. There were also tin cans and an axe that they had evidently picked up near our camps. There were no Indians around but they had probably been there the day before.

I had only seven men with me and as there possibly were many Indians near, the men did not want to go any deeper. We left four machetes and took arrows, bows, baskets, fire sticks, etc. I never was as surprised in my life as when I came to this house. I had asked everybody who ever had known anything at all about the Indians, and everyone here believed that they did not have any settled place of abode. My men were more surprised than I was. The house had only a small door, and I pushed a big dog that we had with us ahead to be sure there was no one waiting there for us. I think that in the course of time we may be able to get into communication with them.

Burton W. Clark

Burton W. Clark was educated at dark University, Worcester, Mass., and came to Venezuela at the same time as Dixon in 1913. He has been engaged in paleontological work for New York

Geological Survey near Utica. He accompanied Dixon on the investigation of Guajira Peninsula and Toas Island, January to July 1913. The remaining part of his stay he was in Maracaibo region. He returned to the United States about, November 1913, after which time he was engaged in teaching geology and paleontology. His whereabouts at present is unknown.

Howard F. Nash

Howard F. Nash arrived in Caracas January 29, 1913. He was graduated from Stanford University in 1910 with the degree of A.B. in geology and mining. Before coming to Venezuela, he had varied experience in western United States and Canada involving railroad, placer and underground surveying. After leaving Venezuela, he spent many years managing explorations in Indonesia, Mexico and South America.

OUTLINE OF MY EXPERIENCE WHILE WORKING FOR THE GENERAL ASPHALT COMPANY, 1913-1914

By Howard F. Nash

The beginning of my employment with the General Asphalt Company was shortly after the first of January, 1913, and ended in September or October, 1914, shortly after the commencement of World War I when operations were greatly curtailed due to the war.

At the end of about a week spent very pleasantly in Caracas, we went on to Maracaibo and in due time to Valera. The ride on the little narrow-gauge railroad from La Ceiba to Motatan was extremely interesting.

After the first few kilometers through fields of sugar cane the train entered the jungle that was so thick and dark that it seemed impenetrable. The branches of the giant trees standing near the edges of the right of way almost met overhead so that we seemed to be traveling through a tunnel extending for a great many kilometers. This illusion was heightened by the brush that had grown up in the original clearing to a height of ten meters or more and almost brushed the sides of the cars.

About noon, after traveling several hours from La Ceiba, the train arrived at the village of Sabana de Mendoza. Besides the station, it consisted of a few adobe thatched-roof houses and many hovels consisting of thatched roofs sustained by posts. In some of these the spaces between the posts were filled with the stalks of wild cane, but most were entirely open to the view of the passers-by and to the passage of chickens, dogs and pigs. Once when I slept in one of these hovels, a dog chased a pig right through the mosquito net hanging to the floor around my sleeping hammock.

The train remained for a long time at the station and finally we were informed that it probably would not proceed that day because of some trouble or revolution that had broken out in the Andes where such upheavals usually started. We were advised to obtain quarters for the night, and assured that if orders to proceed should arrive, we would be notified and that the train would not leave without us. There was no hotel or pension in the place, but we were offered a room in which to sleep, as well as food and drink. This was our first experience of the wonderful

hospitality and friendliness of the people of the country. All of the people were anxious to help us in every way possible, and even the poorest were willing to share their little with us. Nor could we pay them for it, with money.

Apparently the trouble was not as serious as was thought, so the next morning the train proceeded to Motatan where it arrived about noon and, as soon as we arranged for a man to take our burros and baggage to Valera, we rented mules and rode up the trail, arriving at our destination shortly before dusk. It was a pleasant ride for me as I had been raised in the saddle in northwestern Montana, but quite the opposite for Herold who had never ridden before.

At last we were ready to start—five burros, six peons and two geologists. We had no riding animals as we wanted to examine the outcrops on the way, and also because Herold thought walking was easier than riding. This caused a great deal of wonder and amazement when we met other travelers and when passing through villages and populated areas, because in Venezuela all upper class people ride. The word for gentleman in Spanish is *caballero,* which literally means horseman.

Our provisions consisted of such concentrated foods as rice, beans, chick peas, dried beef, dried soup, dried apples, dried fish and, of course, a good supply of coffee for which the Venezuelans and Colombian Andes are famed. We also had flour, salt and corn meal and shelled corn for the burros. At the start the burros were overloaded, but that was soon corrected as they and we ate the provisions.

Herold and I each carried a one-quart canteen of water which had been boiled, and that was all the liquid that we had until camp was made for the night and we were able to boil some more. However, we soon secured some bottles which we sterilized and filled with boiled water, as one quart for the whole day was entirely inadequate in that climate. We found nothing of interest in the Sabana Grande district, and when our supplies were running low and we had decided the area did not warrant the expenditure of more time or effort, we returned on foot to Valera, where we found Eckes ill with typhoid fever. On our last day before arriving at Valera Herold became ill with malaria and that last day's hike must have been terrible for him.

The last night out we camped near a lumber camp that was operated by two brothers named Africano, who were lepers and who hired only lepers in their operations. We were practically out of food and our men wanted to go to the Africanos' camp, but we did not want any food that lepers might have touched. Later on I became more accustomed to leprosy and I actually have shaken hands with men that I believed and still believe were lepers. Not to have shaken hands when meeting or when leaving an acquaintance would have been very impolite and we did not want to give offense. Of course I washed my hands in rum as soon afterwards as possible, especially when the right hand had an open scratch or wound.

We also learned that, contrary to the popular notion in the north, there is practically no food in the jungles either for man or beast, other than game for the former and palm leaves for the burros and horses that will eat them, and most will starve rather than do so. As a consequence we had to feed them corn or *panela,* the crude brown sugar in pound cakes, which of course had to be packed in. It was advisable, therefore, to limit the weight of the equipment and provisions for the men and ourselves to the barest necessities. Folding cots were discarded in favor of sleeping

hammocks, the tents changed for flies just large enough to protect the hammocks from the tropical rains, and the folding table and chairs discarded, as it was easy for the men to make substitutes with their machetes. We purchased mosquito nets for the hammocks, which were made with sleeves to go over the ends of the hammocks and tie tightly over the hammock strings or ropes, and used our waterproof ponchos on the ground under the hammocks for the bottoms of the nets to rest upon.

In a few days after our return to Valera I was instructed to join Louis Dagenais and Roy Merritt at the Pauji seepage where they were investigating the geology and commencing to select land to be covered by concessions. I therefore left Herold to recover and recuperate from the fever and went with my baggage to Motatan and took the railroad to Sabana de Mendoza where I arrived about noon. There I met Dagenais' and Merritt's *arriero* who had come in for provisions and, while I was having lunch, he secured a riding animal for me and an extra burro for my gear. As soon as lunch was over, we started out in a northerly direction and after crossing about twenty kilometers of sabana and some ten kilometers of jungle we arrived at their camp just at dusk.

The following morning, while out on the line, I had a severe attack of malaria and had to return to camp where I began dosing myself with quinine. The next day I remained in camp and felt all right so that the second day after the attack I went to work again and had another hard attack of malaria. I then decided that I had tertian malaria, the every-other-day kind, and that it would be advisable for me to return to Valera tor medical treatment, so started the next day, the day that I should have been free from an attack. Dagenais accompanied me, which was fortunate, because we had hardly reached the edge of the sabana when my temperature began to rise and the remainder of the ride to the railroad with a raging fever under the blazing tropical sun was as near purgatory as I have experienced. I was surprised that the attacks did not commence with a chill as I had been informed, just a fever and severe headache followed by a hard sweat during which the temperature returned about to normal.

That night we slept in a recently completed house, and when I awoke about 9:00 A.M. a religious procession was passing through the room. It consisted of a priest in his vestments and altar boys carrying incense burners, followed by the people of the village in their best going-to-mass clothes. To say that I was surprised is putting it mildly, but it soon became evident that the procession had nothing to do with me or my illness, but was merely the blessing of the new house prior to its occupancy by a priest and his aides who had ridden down from Betijoque that morning for the purpose.

When I awoke my temperature was normal and I felt all right, but soon the fever began again and by the time that Dagenais and I had ridden on the train to Motatan it was so high that I could not continue the journey on horseback to Valera, so Dagenais telegraphed to Valera and arranged for a physician to come to Motatan to treat me. Eventually he arrived and gave me an intramuscular injection of quinine and instructed me to proceed to Valera the same evening. I demurred, as I doubted that I could make it, but he said that I would need another injection in the morning and that I would have to be in Valera for it, as he intended to return there immediately. He added that his health was too important for him to remain in Motatan even a single night. He told Dagenais to obtain riding animals, and when he had secured them the fever had sufficiently abated for me to mount and ride seven miles to Valera, the longest seven miles I have ever experienced.

In the morning I received the second injection and a prescription calling for twenty-five grains of quinine and a like amount of bicarbonate of soda per day for a month. Evidently this treatment was just what I needed, because I did not have a recurrence of malaria for nearly ten years and I had had hundreds of opportunities for reinfection, as much of the time had been spent in jungles and fever ports in the tropics of South America and Mexico.

After a few days, when it seemed that the fever was stopped, I returned to Pauji and got busy surveying the Mene Grande-Pauji block of concessions. Shortly thereafter, Merritt went to Maracaibo and Dagenais and I continued the work, he doing most of the outcrop hunting near the base of the mountains and looking after camp moving, securing supplies, etc., and I practically all of the surveying.

When the survey had progressed to within about ten kilometers of the sabana surrounding the great Mene Grande seepages, Dagenais and I agreed that I would carry the survey as far as I could and then proceed to the sabana and continue several kilometers around a swamp near the edge of the sabana to the point where the trail from Pauji to Mene Grande crossed a little stream, near the edge of the jungle, and he agreed to move the camp to that point and have everything ready for me and the surveying party when we arrived.

When we reached the appointed place shortly before dark there was no sign of the camp. The water in the stream was too deep to ford, but it was a simple matter to fell a couple of trees over the stream, which we did in a few minutes. Then we crossed on them and walked up the trail hoping to find the camp set up and ready for us beside the trail on the higher ground, but were disappointed. We therefore made a hasty palm leaf shelter and fought mosquitoes on empty stomachs all night.

At daylight we started for Mene Grande, where we had heard Jack Lewis and Frank Wilde were camped mapping the seepages, but had gone only a short distance when we met Dagenais and the camp outfit, and were astounded when he told us that the river, which we had crossed and recrossed, was impassable and that consequently they had had to go downstream on the other side to a bridge some kilometers away, and that night had overtaken them before they could come back up the stream to the rendezvous. Needless to say, we were very glad to see them as we were out of matches and had had nothing to eat since noon the preceding day.

We returned to the agreed camp site at the river bank, pitched camp and were having breakfast when Dagenais began to shake with a chill and it was soon apparent that he was having an attack of malaria, his first. By that time I had had considerable experience treating the disease, as of course all of our peons were infected and most of them had occasional attacks. The attacks usually occurred after one had been chilled by rain or exposure or after excessive physical exertion. I, therefore, dosed Dagenais and soon had him back on his feet; then advised him to go in to Maracaibo as the geological reconnaissance was about completed and I did not need him for the surveying, which he was very glad to do. Thenceforth I worked alone, without other foreigners, until the drillers and rig builders arrived after the taking of concessions had ended.

I did, however, have the assistance of several of the Venezuelan engineers who were cooperative and appreciative of the opportunity to learn our methods and acquire valuable experience. The best among them were the Aguerrevere, Enrique, Pedro, and their father

Santiago. All of them had Doctor of Surveying degrees and were always addressed as Doctor. The Aguerrevere boys afterwards went to Stanford and entered as freshmen and graduated; Enrique in Civil Engineering and Pedro in Geology. After graduation, both worked for me in Mexico; Enrique as Civil Engineer and then Terminal Superintendent. Later they returned to Venezuela and are high in the technical councils and diplomatic service of their country.

I continued the survey and soon arrived at Mene Grande, where I met and spent a Sunday with Wilde and Lewis. The former I had known in college. Ordinarily I worked Sundays, as the time for taking concessions was growing short, but the men did not like it because of religious reasons. I also camped for a few days in the vicinity of Mene Grande, but, as the country was mostly sabana, the surveying went quite rapidly and consequently I soon completed all that could be efficiently accomplished from there. So I moved on after thoroughly discussing with them the geology of the area and probable limits of favorable territory.

The rainy season had commenced before we got out of the Pauji jungle, and a considerable area of the flood plain southwest of Mene Grande was under two or three feet

of water, but as all concessions that we were selecting had to be staked and mapped and the maps accepted in Caracas before the end of the year 1913, and it was then May or June, and as much of the most favorable territory was in this flooded area, there was no time to be lost, so we extended the end lines of the concessions on into this flooded area, setting corner posts every two-thirds of a kilometer.

The *Arrieros* brought provisions on the burros from Motatan del Rio, on the Motatan river some ten kilometers from its mouth into Lake Maracaibo where was located still another Motatan, Motatan del Lago, to the edge of the flooded area from which they werepacked by the peons to the camp which usually was on higher ground above the flood, but at times was in water a foot or two deep. The camp of course was moved by manpack. In a considerable portion of the flooded ar ea there were *tatucales,* which made walking very difficult even when not submerged, and almost impossible when hidden by the brackish water. *Tatucales* are very difficult to describe. About half of the area was about twelve to eighteen inches lower than the other half, and neither the depression nor elevation had as a rule more than a square meter of area. In walking over them one could take a couple of short steps and then, with a stick, feel for the next high place that he could reach with a long step and thus usually avoid the deeper places between. The only explanation of them that seems reasonable to me is that the depressions are where large palms have grown and died and been eaten by the ants or rotted away. When working in the flooded *tatucales,* every man of the surveying crew would slip and fall from time to time and was usually wet from head to foot, and it was very difficult to keep the transit in usable condition. On several occasions it was submerged, and onceI had to install new cross hairs, using freshly spun spider webs, and I was surprised how small the spider was that spun a web of the proper diameter.

The camps presented no very difficult problem. We were always able to have a fire even in those that were in the water, when it was made on a crude platform above the water. There were always trees to tie our hammocks and flies to, and the mosquito nets could hang right down in to the water. With a fire we could boil the water that was all around us. Of course it was disagreeable to always be wet and to have all of our clothes mold, even the hats on our heads, but it is a fact that during the several weeks that we worked under these conditions no one became ill

and there was less use for the medicine kit than in any other similar period that I have ever spent in the jungles.

One day the jungle became more open and, as I was anxious to know whether we were approaching a deep swamp or lake, or were about to arrive at a sabana or clearing, I decided to climb ten or fifteen feet up a small dead tree for a look ahead, but before I had climbed very far I was attacked by thousands of small red fire-ants whose bites were very venomous and painful, so I jumped right down and, to the great amusement of the men, ducked under the water to get rid of the pests.

Eventually all of the land that we considered might be productive was surveyed and we moved the outfit to Motatan del Rio where the men were paid off and told that they would be sent for if I had need for them again. Several of them did work for me in the survey of concessions north and west of Maracaibo, and also were given preference when operations started at Mene Grande three or four months later.

While I was waiting for a boat on which I could take passage to Maracaibo, one of my men came to me and stated that Don Samuel wished to talk to me, but that he could not come to me because he was ill. I immediately went with the messenger to a little store where a rather fleshy, swarthy, young man in ordinary peon clothes was lying in a hammock, suffering from a high fever. I inquired in Spanish what he wanted and he replied, also in Spanish, that he was ill and, having heard that I was going to charter a boat to take me and my outfit to Maracaibo, wanted to know if he could arrange to accompany me as he was in need of medical attention and possibly hospitalization. I noticed that he used very correct Spanish and realized at once that he was not an ordinary peon. I replied that it would be all right providing there was sufficient room on the boat, and then informed him that I was well supplied with medicines for the treatment of ordinary tropical diseases and had had considerable experience in their use so that I might be able to help him if he would tell me what was his trouble or describe the symptoms to me. To this he replied, *"Estoy mal del higado."* As I did not know the meaning of the last word, I took out my pocket dictionary and was trying to find it under the I's, not thinking that the word might start with an "h" which is always silent in Spanish, when he spoke up and informed me in perfect English that it begins with "h" and means liver. When I asked him why he had let me struggle with Spanish when his English was so much better, he replied that my Spanish was all right and that it was a pleasure for him to speak Spanish to an American. I afterwards learned that no educated Venezuelan who spoke English well would reply in English if spoken to in Spanish, unless the conversation reached a complete impasse.

Having learned the trouble, I immediately started to treat the patient with quinine, calomel and castor oil and before we arrived in Maracaibo a couple of days later he apparently had recovered completely. As he was the most important man in all the Mene Grande area, owned considerable land, was in the business of cutting and exporting hard woods, and had adequate transportation equipment for hauling drilling machinery and casing, i.e., bull teams and lumbering trucks, he was a great help when operations were started in the autumn.

In Maracaibo I met many geologists who were vacationing or convalescing from illnesses contracted in the jungles. I did not have long, however, to enjoy their company, as almost immediately upon my arrival I was ordered to proceed to Carrasquero on the Rio Limon, some

sixty kilometers northwest of Maracaibo, and then take the narrow gauge railroad southwest to the great Inciarte seepages.

The nature of the country was very different from that I had previously worked. It was covered with a desert flora, thorny brush, small, twisted hardwood trees, pipe organ cactus, and maya, a plant similar to yucca in the southwestern part of the United States. The principal pest was wood ticks instead of mosquitoes, and poisonous snakes were numerous, whereas I had seen not more than a half dozen all the time I had been in the jungles. Instead of an excess of water there was so little that practically every camp was dry. It was located where water had to be brought to it in cans on the backs of the burros. Instead of being able to avoid the bad places by traversing around them, the whole area was difficult and it was necessary to cut with machetes almost every foot of the line. As this was very slow work, I ran three crews, each on a different line with a separate camp to work from. I instructed the head lineman how to continue a straight line by using a number of straight poles. I would sight in with the transit four of these poles stuck in the ground at about forty meter intervals and then, as the cutting of the line progressed, show him how to move the rear poles ahead, sighting them in on the leading two poles. I also taught the lineman how to offset the larger trees and other obstructions. After I had everything organized I divided my time among the three camps. Each day I traversed the line that had been cut on at least one of the lines and set posts each two-thirds of a kilometer, cutting offsets from the main line when necessary. When I overtook the cutters I corrected their directions and moved them back on line when necessary, and then went on to the next line. The instrument crew accompanied me, of course, and used machetes to clear the way if necessary.

As the lines neared Lake Maracaibo the country became more open, suitable for goat grazing, and in a few weeks' time I had covered all of the territory that seemed desirable between Inciarte and the lake, having taken a fifteen kilometer strip clear to the lake. By that time I was very tired as I had been working hard for several months, with very little rest. While on this last job I had never been 'able to have a good night's sleep due to the continuous itching of the tick bites. I 'was literally covered with them, as the thorny brush tore our clothes and the ticks entered by the hundreds. Every night I would wake up scratching the bites raw and then would rub myself with rum, which would sting like fire, but would stop the itching for a while until I would fall asleep only to awake scratching again in an hour or so, and repeat the process.

On the night after completing the survey we camped on the beach and I had the first good bath in weeks and almost a continuous night's sleep. I was planning to remain there a few days to rest and heal the sores, but about noon the first day a messenger arrived from Maracaibo with an order for me to return to Inciarte and start cutting a line or trail southward to El Rosario in Perijá. The message explained that Dr. Arnold had arrived in Maracaibo and wished to visit Inciarte and then go as directly as possible to El Rosario.

It was necessary for me to return to Carrasquero and, as there was a pretty good trail and the distance was only about thirty-two kilometers, and the owner of the only riding animal in the neighborhood wanted an exorbitant price for its rental, I decided to walk with the men, so we made a very early start by moonlight and arrived in Carrasquero about 9:00 A.M. There I learned that Dr. Aguerrevere was in Inciarte and I joined him there the same afternoon.

I discussed the whole work with him, and as he had accurately located the northern boundary of the District of Maracaibo, we found that the concessions I had already surveyed left no gap between our block in the District of Mara and the District of Maracaibo, so I supplied him surveying data from which to prepare the concession maps and descriptions and immediately started preparations to locate and cut a trail to Perijá. Later that day, however, another messenger arrived from Maracaibo with a letter informing me that the plans had been changed and instructing me to return to Maracaibo as soon as the survey was finished, which I did the next day.

I believe this concluded the selection of concessions in the Maracaibo Basin under the grant of the General Asphalt Company. Other concessions had been selected and surveyed by others of the score or more geologists assigned to the area, but I doubt that the area of the concessions taken by all of them equaled the area of those I had taken. Most of the other men did a great deal more geological work whereas I spent practically all| of my time blanketing large areas basinward from the large seepages where the significant geology and structure were hidden by alluvium and Quaternary strata and, consequently, undecipherable in those days before the development of geophysical methods. I might add that the last time I was in Maracaibo, thirty years afterwards, all of the petroleum production of the General Asphalt Company in the Maracaibo Basin had been, and was being, obtained from concessions I had taken, and no other production had been obtained in the Basin by any company except that from lands already under concession prior to the grant to the General Asphalt Company, viz., the Districts of Colon, Bolivar and Maracaibo, and from Lake Maracaibo itself. Incidentally, in 1917 I tried unsuccessfully to induce a client to take a concession covering a width of five kilometers of the lake along the shore of the District of Bolivar from which the greater portion of the lake production had been obtained.

Almost immediately after returning to Maracaibo from Inciarte I was sent to Motatan del Rio with instructions to prepare for the arrival of men and equipment and materials for the drilling of three exploratory wells at Mene Grande. This material would be sent in small boats from Maracaibo to Motatan del Rio.

The first task was to locate and clear a road through the jungle to Mene Grande some twelve kilometers distant. The next was to prepare temporary living quarters for the Americans, who were coming, to use while building the living quarters and mess house which were to be constructed from lumber, etc., which were being sent from the States with the drilling material. Another very urgent task was to cut firewood for the boilers, as no other fuel was available.

Soon Dr. Arnold arrived with several members of the exploratory crew, and Dr. Arnold made the locations as we stood on the top of the ridge above the seepages; the first location near the top of the ridge to be drilled by a Keystone portable; the second, one kilometer down the dip from the first; and the third, five hundred meters beyond the second and about one kilometer out on the flat—all three in a straight line. The second and third locations were to be drilled with cable tools, using combination steel rigs. Even the walking beams were of steel truss construction, but so poorly designed that they buckled almost immediately and had to be replaced with hardwood timbers. When I made the locations on the ground I saw that each location was in a separate concession so as to satisfy drilling requirements on three concessions instead of only one or two.

The first location was in Zumaque, the second in Zumaya, and the third was Zumba No. 1, which I believe was the first gusher ever drilled in Venezuela.

Only one bridge was needed on the road to Mene Grande and that only about ten meters long. It was made only of hewed stringers cut near the location. After the drillers and rig builders arrived they insisted that it was too light and would not take the boilers over it until I put a bent under the middle of it. Their misapprehension was due, of course, to their lack of knowledge of the great strength of these hard woods compared to that of the lumber that they were accustomed to use.

The wells had hardly been located when the rig builders, cable tool drillers and tool dressers, about twenty men altogether, arrived and soon the wife of one of them. Most of these men were willing and were a great helpn in unloading and transporting of the rigs, equipment and material, the building of a warehouse to protect the material from the weather as the fall rainy season had commenced, the cutting of rig timbers, the supervision of the laborers, and in many other ways.

We hired quite a large number of laborers, of course, and many of them brought their families, so that soon there was quite a thriving native village with little stores that carried provisions, peon clothing, rum, and beer, and before long we could dispense with boarding these men, but paid them an extra bolivar per day instead. One of the men who came to work as a peon had had a little education and I used him as a timekeeper.

Several months passed before a physician was sent to us; in the meanwhile it was necessary for me to treat the illnesses and injuries not only of the Americans and the laborers but also of their families and the other inhabitants of the village. I just could not stand by and allow people to die for lack of treatment that only I could supply. This alone took two or three hours of my time each day, but I had the great satisfaction of not losing a patient in the four or five months until the physician arrived, and this in a district where normally the death rate, including infant mortality, was over five per cent per year and ordinarily five or ten deaths would have occurred in that time. My fame as a healer spread and mothers brought their sick children long distances for treatment. One poor woman brought her clubfooted child about forty kilometers hoping that I could straighten its feet.

In addition to my first aid duties, my work consisted of everything necessary to the operation of a three well drilling operation in an isolated location, with no telephone, telegraph of even regular mail communication with headquarters in Maracaibo, except the actual rig building and drilling of the wells. A launch brought cash and supplies and provisions from Maracaibo to Motatan del Rio three or four times a month, delivered the cargo and cash to the Venezuelans in charge of the river station, and often went back before we were informed of its arrival, of course, taking the mail, orders, drilling reports, etc., that were waiting at the river station. All personal transportation was still by muleback and supplies were brought out on the backs of burros or hauled in two-wheeled carts, each drawn by a single mule. The cash also was brought out by the *Arriero* as part of the cargo of one of the burros. Once the *Arriero* arrived without it, some five thousand bolivares, but it was soon brought to me by one of the original surveying crew, who found it on the road where it had fallen, and who was going to Motatan del Rio for a short vacation. He

actually ran a good share of the way, trying to overtake the *Arriero* before he arrived at camp, so that I would not worry about its loss.

Among my duties were those of transportation superintendent, camp and commissary, warehouseman, engineer, subsurface geologist, cashier, paymaster and order clerk. While attending to these few chores I received an order from headquarters to make a location for a railroad from Mene Grande to San Lorenzo, a little village on the shore of Lake Maracaibo a few kilometers north of Motatan del Lago, which could be reached without crossing a swamp which was almost impassable farther south. I replied that I could not do it unless I received some help, which I requested again and again, and eventually Dr. Santiago Aguerrevere was sent to do the job. Shortly after, Charles R. Eckes came to take over the subsurface work, and then a warehouseman, and a bookkeeper and cashier, and then a Venezuelan physician and Venezuelan woman, a practical nurse.

In April, 1914, all of the other men having returned from their vacations, and my vacation being three months overdue, I insisted on relief so that I could take mine, so Roy Merritt was sent to relieve me while I returned to Palo Alto for a month's vacation. At the end of the vacation I returned to Mene Grande, where the drilling had been successful, and remained in charge there until the outbreak of World War I, when operations were practically shut down and I was returned home, together with most of the other geologists and engineers.

It was a great experience and invaluable in my later professional life which included management of explorations in Indonesia and South America and of producing oil companies in Mexico and Colombia.

Stanley C. Herold

Stanley C. Herold left New York for Caracas on the same steamer with Howard Nash, January 29, 1913. Previously he had been graduated from Stanford University in 1909, with an A.B. in geology and mining, after which he was engaged in mining engineering in Nevada and Alaska. After leaving Venezuela, he spent several years in geological work in various countries until he returned to Stanford to take his Doctor's degree in 1926.

CHAPTER 26

THE COMMISSARY DEPARTMENT OF THE EXPEDITION TO SOUTHERN PERIJA

By Stanley C. Herold

The greater bulk of food supplies for the expedition was obtained in the town of Maracaibo. Some canned goods, however, were purchased in Maracaibo and some of the beans, rice, and panela were obtained in La Villa.

Fortunately for us, Perijá is a very fertile country, thereby simplifying to a great extent the food problem.

We arrived at the first camp near El Capitan without a great supply of food on hand, but kept the burros occupied while the line work was going on by bringing in supplies. When we arrived we had 15 cargoes of food and 15 cargoes of camp equipment. Here we increased our food supply by 33 cargoes and we also brought in 5 cargoes of equipment. At Camp Yasita we increased our food supply by 43 cargoes and 2 cows on the hoof.

At the Rio Yasa we reinforced by 25 cargoes of food and 4 cows on the hoof.

Again on the Rio Tucuco we brought in 27 cargoes of food and 2 cows on the hoof.

In all, 143 cargoes of food and 8 cows were eaten in the 57 days we were in camp. This gives approximately 2.5 cargoes consumption daily, exclusive of meat. That is to say, 2.5 cargoes less to transport for each day passed.

It must be considered that of these 143 cargoes, 26 were cargoes of corn for the animals, netting 117 cargoes of food for the men, exclusive of meat.

Variety of Food: In general, the men were fed with as great variety as was convenient. Up to and including the camp Yasita, we were able to give them platanos and yuca, but this was calculated impracticable at the later camps as their weights per amount of actual food value is prohibitive on the longer trips. For them, corn meal cooked into a hard mush with lard and salt was substituted. This so-called *funche* proved to be a very valuable article of food on account of its light weight, although when platanos and Iluca were not eaten the amount of cheese and panela were increased as will be shown below.

Other main articles of food were cheese, panela, beans, rice, meat, and of course, coffee.

Occasionally crude corn, cooked and ground, formed into cakes or rolls, and roasted, afforded a change welcomed by the men. Peas also were served occasionally, but were not favored by the men, which fact we surmised previously by not being able to purchase any in Machiques.

Consumption of Food Data: We herewith discuss the actual amount of food consumed by the men. At all times they were allowed to eat all they desired, three times per day, except on one day during the retreat when it was considered advisable to secure ourselves on a half-ration, which was found on the next day to have been unnecessary as the roads permitted a longer journey than would have been possible under worse conditions.

The men were capable of eating almost any number of meals per day so that instructions were given and adhered to on that point, or results might have been disastrous.

Data will be given on each article enumerated above separately.

The average number of men on hand during the entire trip was 60.

Yuca—a vegetable something like a cross between a potato and a turnip. During 13 days, Iluca formed a part of the daily ration. In all, 1,154 pounds were used. As there were 60 men to be fed, there were 180 man-days. This gives 1.48 pounds per man per day.

Platanos— bananas. 4,750 platanos were used during the first 13 days. This gives 6.09 plátanos per man per day.

Rice. 600 pounds of rice were consumed in the 57 days. This gives 0.175 pounds per man per day.

Meat. 3,025 pounds of meat were consumed during 57 days. This gives 3.88 pounds per man per day. The fact that this is greater than the actual amount eaten must not be overlooked. Most of the meat was taken in on the hoof and after the hard trip on palm leaf feed, often the weight would decrease considerably. Each cow was carefully watched and those failing most were killed first.

This figure must stand, however, as it represents the amount purchased to net the proper amount to the men.

Corn and Cornmeal. 65 pounds of crude corn and 900 pounds of cornmeal were consumed in 44 days. This gives 0.365 pounds per man per day.

Panela. Of panela, or crude sugar, 1,850 pounds were used. During the first 13 days 354 pounds were used, and during the other 44 days, 1,496 pounds. This commodity was eaten at a greater rate during the second period, as before stated. This is at the rate of 0.454 pounds per man per day for the first period, and at the date of 0.567 pounds per man for the second period.

Cheese. 1,122 pounds of cheese were consumed during the entire period of 57 days. 214 pounds were used during the first period and 910 pounds during the second. The rate was also greater during the second period on account of there not being platanos and yuca. This gives the rates of 0.275 pounds and 0.344 pounds per man for the first 13
days and the second 44 days respectively.

Peas and Beans. The supply of peas and beans was limited, as they could not be purchased. 384 pounds were consumed. This gives 0.11 pounds per man per day.

Manteca. Manteca, or lard, is a very important food for the Venezuelans. 330 pounds were consumed. This gives 0.097 pounds per man per day.

Salt. Taking our meat in on the hoof necessitated the use of considerable salt, to preserve the meat for a few days after killing. 500 pounds were consumed. This gives 0.146 pounds per man per day.

While this amount of salt was not actually eaten, it must be considered in our calculations. Much of it was lost by first washing the meat and discarding the wash water, but this amount is necessary with meat as we handled it.

This also includes salt used for ordinary cooking purposes.

Coffee. 230 pounds of coffee were consumed. This gives .067 pounds per man per day.

Summary of Data

The foregoing data are summed up in the following.
Consumption Per Man Per Day

Yuca	1.48 pounds	Corn and	
Platanos	6.09 "	or Cornmeal	0.365 pounds
Panela	0.454 "	Panela	0.567 "
Cheese	0.275 "	Cheese	0.344 "
		and	
Rice	0.175 pounds		
Meat	3.88		
Peas and Beans	0.11		
Manteca	0.097 "		
Salt	0.146 "		
Coffee	0.067 "		

Game. The amount of game obtained was small for the number of men to be fed. That obtained consisted principally of turkeys and pigs. Also, one tapir was killed and partly eaten. On account of a shortage of salt at that particular time (a sack having been recently lost in a river), all of the meat could not be preserved. The total amount of game killed was of insufficient amount to enter into our calculations.

Cooking Operations, Equipment, Etc. As the camp generally worked in two divisions, one pushing the base line and the other the end line and the geology, two sets of cooks and equipment were necessary.

The professional men in either division had their own first and second cooks, with equipment separate from those of the peons. They also had two cooks. This required four cooks in each part, eight in all. Their duties included nothing but cooking and personally supervising the packing and transportation of their particular equipment to the next camp.

The equipment consisted of a good supply of pots and kettles of sufficient size to meet the demands, a few large cooking spoons and a plate and cup for each peon, the latter being cared for by each individual.

To mount the kettles, one camp had a sheet iron stove and the other used simple forked sticks with a green wood bar across, from which the kettles were hung. There is no advantage in the stove.

The equipment of the kitchen of the professional man was a little new, yet practicably simple.

If the day's journey to the next camping place was long, food for the evening meal for the peons was cooked in the morning and carried ready prepared, hot coffee being served with this when the men returned hungry after the day's work.

The best way to get a good day's work out of a good peon is to feed him well. Rarely will they become discontented on a full stomach.

Wallace Gordon

Wallace Gordon arrived in eastern Venezuela in February 1913. Just prior to this, he graduated from the University of California. His first assignment was to work with Boyd and Garner in Monagas. In April and May of 1913 he accompanied Garner in an investigation of the Orinoco River area below Ciudad Bolivar. He left Venezuela around the end of 1913. After leaving Venezuela he engaged in geological work and later returned to ranching near Azusa, California.

Frank L. Wilde

Frank L. Wilde left New York for Caracas February 26, 1913 on the same steamer with McCullough and others. He came from New York State and graduated from Stanford in May 1911 with A.B. degree in Geology. After working a short time south of Mene Grande, he was transferred to the area west of Lake Maracaibo, where he took part in the exploration of the Indian country. When the work was curtailed because of war in Europe, he came back to the United States late in 1914. After leaving Venezuela, Wilde was employed as geologist by several oil companies, including Standard, Gulf, and Gypsy.

William C. Gehrmann

William C. Gehrmann arrived in Caracas along with McCullough, Wilde, Lewis, Noehl and Nobs, February 26, 1913. He came from Davenport, Iowa, and graduated from Stanford in January 1913 with degree A.B. in Geology. Teamed with Walter Nobs, they worked the area south of Lake Maracaibo. Nobs became infected with tetanus, which resulted in his death. Gerhmann returned to the United States in September 1914. After leaving Venezuela, he returned to Iowa, where he joined the meat packing business of his family until 1946, when he retired.

A. Stafford McCullough

A. Stafford McCullough arrived in Caracas February 26, 1913. He originally came from Clifton, Ohio, and graduated from Stanford in 1911 with A.B. degree in Chemistry. Teamed with Noehl, they started work near Tachira, but were quickly moved down to investigate the east side of Lake Maracaibo until May 1913. Then they moved west of Maracaibo, but after a severe fever attack, returned to the United States in October 1913. After leaving Venezuela, McCullough was employed by Carter and Sun Oil Companies until 1931. Since then, he has lived at Clifton, Ohio.

My associates in Venezuela were Nobs, White, Bryan, Dixon, Noehl, Dagenais, Nash and Willson. Nobs and I were in Zulia (south of Lake Maracaibo) six months, and White about three months. Together with Willson, Noehl and Dagenais, I was, for the months of August, September and October 1913, in and around Miranda, El Rudal, El Cousje and Rio Coquisa. Early in November (after a delightful visit with Mr. and Mrs. Arnold) I was sent to Motatan to work with Nash in handling transportation of lumber, machinery, etc., for the fields which promised so much. Much of the time until August 1914 was spent on the west coast of Lake Maracaibo.

The company sent down two steam tractors to pull wagons of supplies fifty miles inland through jungle and sand, and that is where I spent my last months in Venezuela. Our commissary was about what we made it. When in Maracaibo we bought plenty of canned food, even butter. When in the field we lived on animals our hunters could shoot; deer, peccary, wild hog, even

iguana and monkey were the meats. Sometimes we could persuade a peon to slaughter a beef, of which we would buy the tenderloin (the only really edible part).

Our first days in Venezuela were exciting. We had just about cleared customs when shots rang out; we ducked behind the big pillars and after a few seconds looked out. Two men were dueling and one was killed. The following day (Sunday) we all went to a bullfight and saw one of the matadors killed by a bull. During the night one of our boys, while cleaning a gun, shot a bullet through about three floors of the hotel. Our first days in Venezuela were interesting, to say the least. At our first job, Valera, we found Eckes sick with typhoid and I was elected to stay with him during the three weeks it took him to recover. This is where I learned Spanish; a priest and I exchanged language education. It was a real experience and one which I have never regretted.

Walter R. Nobs

Walter R. Nobs was in his senior year at Stanford University when he left for Venezuela, February 26,1913. He lived in Redwood City, California. (The following was written by W. C. Gehrmann who worked with Nobs.)

"In Caracas Nobs was assigned as my partner. Early in March we arrived in Valera. After a few weeks we left for Bobures, where we established headquarters. For six months we explored the south shore of Lake Maracaibo, and the Venezuelans there declared we were the first white men they had ever seen. After two months, Bryan came in and brought White who was to work with us. In early September we finished and were ordered back to Maracaibo. The Venezuelan engineer who was to check our work didn't appear, so Nobs was left and White and I went in to Maracaibo.

"Nobs was delayed several days and in this time came down with malaria. Our quinine had run out, so he went to the local doctor for help. This man gave him injections of quinine and either his needle or the quinine was not sterile, for this brought on tetanus. Shortly after this treatment he left for Maracaibo with a high fever. We called a doctor who gave him something for the fever and extracted a few gusanos from his legs. The following morning he was very sick and he was removed to the hospital. The doctor called his illness tetanus and gave me no hope. We called in other doctors, notably an Italian, who was good. About this time Bryan came in. We had Caracas on the phone for hours. They called on the best men there for advice, but gave us nothing that could be or had not been done for him. On Sunday evening, September 14, 1913, Nobs died—Bryan and I were there. He had given his life in the great oil hunt—a real soldier in line of duty.

"Laws which prevented us from moving his body to the States caused us to have his burial in Maracaibo on Tuesday, September 16. Fortunately, some more men came in and services were held, with Willson, McCullough, Hammer, Bryan, Noehl and Gehrmann as pallbearers. I should like to add that everything possible was done for him by everyone concerned."

B. F. Noehl

B. F. Noehl arrived in Caracas February 26, 1913, with McCullough, Wilde, Gehrmann, Nobs and Lewis. He worked in the area east of Maracaibo and later along the Perijá flanks. He returned to the United States late in 1914.

Lewis P. Andresen

Lewis P. Andresen arrived in Caracas March 5, 1913. He graduated from Stanford University in May 1912 with the degree A.B. in Geology and Mining. He worked with E. G. Sinclair south of Lake Maracaibo near El Vigia. Later he took part in the discovery and staking of concessions for the La Paz field. He left Venezuela late in 1913. He later became Chief of the Natural Resources Division of the United States Revenue Bureau. He is now a Christian Science practitioner in Washington, D.C.

SOME NOTES ON MY EXPERIENCES IN VENEZUELA

By Lewis P. Andresen

The earlier part of my stay in Venezuela was in the area south of Lake Maracaibo along the Rio Chama just below Tovar, the mountain town which was the economic center for the trading in that area. This was about 400 miles inland from the coast.

The geology work was inconclusive, but there were a few minor oil seepages, so we laid out a bank of concession claims and then pulled out for Maracaibo.

E. G. Sinclair was my companion during the latter part of this job. He was very bitter because of the way the Caracas office scared his wife into returning to the States. As a result, he was poor company, blowing up over little things and suffering from self-pity and resentment until he came down with a bad case of malaria. He wanted to get back to the seaboard and wanted me to go with him, but I wanted to stay and finish the job. I finally accompanied him out to the railhead and sent him on his way.

That left me with Fr. Aguerrevere as my only companion other than the native crew. A few weeks later I had to send Fr. Aguerrevere out for medical attention. When I finished the job I had a bad case of malaria myself, so I went out to the coast and to the hospital at Auracoa, where I spent a month. Returning to Maracaibo I joined Sinclair on the job of working the area around the La Paz oil seep. Description follows:

Some incidents relating to the discovery of the La Paz Oil Field: It was early in the fall of 1913 that E. G. Sinclair and I went up the Limon River from its mouth to Carrasquero. From this point we had a night ride on a man-propelled flat car to a point about 40 miles south. Here, on instructions from the Caracas office, we established a camp in the vicinity of a reported oil seepage. No one in our party knew the precise location of the oil seep, so we sent out scouts through the forested area along known trails, while we made observations and established a base line for operations. The period during which the Caribbean Petroleum Co. could take up concessions was drawing to a close and we were prepared to survey claims as soon as any favorable information became available. The surface geology was not favorable for structure geology determinations and the area was heavily forested with hardwood. The climate was quite arid and camp water supplies had to be hauled long distances.

After several weeks devoted to preparation work, one of the scouts reported contact with an individual who claimed that he could lead us to the reported oil seepages. Sinclair, who was

always rather timid about his geology, suggested that I follow up the lead. So arrangements were made to hire the guide for the trip. It turned out to be a hot all-day ride over poor trails at a mule's pace. We camped for the night. The following day the guide led me to the first of a series of asphalt cones about 3 feet high. Asked whether there were more, he replied, "Si, señor." I asked him to go ahead to the next cone and put up a flag. I established a bearing on the line. We followed this line to the next cone and others. Then we reached an asphalt lake, covering perhaps 10 acres. Continuing on the same straight line were more cones. Then another asphalt lake, about 20 acres, followed by more cones.

It seemed obvious to me that the seepages were located along a fault line or a buried granite ridge or both, with recent sediments lying unconformably on the top of the oil formation.

Returning from this expedition, Sinclair and I laid out the parallel end lines of a whole bank of concession claims and carried them east until we reached the shore of Lake Maracaibo.

This was the pioneer work leading to the discovery of the La Paz and Concepcion oil fields in the area northwest of Maracaibo.

At this point both Sinclair and I returned to the States on leave. While on the boat returning to New York I enjoyed some very pleasant hours with Mrs. Arnold. She was reading a novel with a Christian Science setting. I asked her what she thought about Christian Science. She said she knew a number of people in Los Angeles who had been greatly benefited by it. The discussion was very appropriate for me because Dr. Gaerste at the hospital in Curaçao had told me frankly he could not guarantee me a cure of malaria.

I had a bad relapse while laying out the lines from La Paz to the Lake. The conversation with Mrs. Arnold set me to thinking seriously. My mother was a Christian Scientist. I knew that she had been greatly benefited by it. When I reached my home on the Pacific Coast I began my study of Christian Science. A few weeks later I had another bad relapse. I said to myself, here goes, here is where I try Christian Science. I threw the quinine and arsenic tonics away. It seemed like a tough battle. For two days I had a very high fever; on the third day the chills and fever resumed. I kept on with Christian Science. In an hour's time I was completely healed—completely and permanently. There were complications with the malaria, liver complaint, jaundice, etc. But they all dis appeared at the same time. I felt like the blind man whom Jesus healed—"one thing I know, that whereas I was blind, now I see." It was like being reborn instantaneously.

I am now engaged in a full time public practice of Christian Science healing.

J. Whitney Lewis

J. Whitney Lewis left New York for Caracas February 26, 1913. He graduated from the University of Minnesota in 1912 with the degree of Engineer of Mines. He was teamed with Frank Wilde, and after mapping topography and seeps at Mene Grande, he made a foot traverse from Coro to Barquisimeto. He was making locations for a railroad when operations were suspended because of war in Europe, after which he returned to the United States. Since leaving Venezuela, he has engaged as a consultant in Petroleum Geology with offices in New York City.

I went to Venezuela in February 1913 on the old wooden S.S. "Caracas." On the trip were Frank L. Wilde, George Macready, Gehrmann, B. F. Noehl (deceased) and Nobs (deceased). On the second night out we had such a severe storm that the waves filled the floors of our deck cabins and we were moved into the quarters of the crew below deck.

In the customs house in La Guaira, during our first hour ashore, we witnessed a pistol duel between two Venezuelans in which one was killed. Immediately the place was swarming with policemen dressed in plain uniforms with sandaled feet and forage caps, armed with sawed-off single shot bolt-action Mausers. It looked like a revolution and was quite an impressive introduction into the country. It took months for me to learn that there was no need for carrying a gun.

Frank Wilde and I were assigned to measure a section between Coro and Barquisimeto. We walked all the way there and back, making a pace and Brunton compass survey. We then made a detailed transit survey of the Mene Grande seep, mapping more than 6,000 separate flowing vents.

I then worked with Howard F. Nash, stadia surveying concession lines in the Mene Grande region and later did similar work alone in the Rio Limon area.

My last work was construction road and running a railroad location survey in Perija.

I remember Nobs as a quiet, competent, fine young man, although I did not know him intimately. I did not meet Garner until years later.

We traveled on the lake by sailboat until the arrival of the company launch, the "Minmo." I remember that the captain had been commodore of a yacht club and was a stickler for maritime etiquette and discipline. He never ate with the crew and was formal and precise in his dealings with them. I remember his story of being ordered to take the "Minmo" from the States to Venezuela. When he reminded the officers of the company that the Caribbean was dangerous for a small boat and the "Minmo" might be lost, he was told that they did not mind taking the risk, because the boat was insured. Then he really blew up.

Our sailboat trips were made at night as a rule. Supper would be cooked over a fire built on a dirt-filled box. We slept on the deck under the stars and came into Maracaibo in the cool, beautiful tropical dawn.

The only automobile in the Maracaibo basin was a Ford which the company importe sometime after our arrival. Horses, mules and shanks' mare were our means of travel, and the burro our beast of burden.

When drilling operations commenced in Mene Grande and in Perijá, the machinery and casing were brought in on trains of five or six farm wagons pulled by a wood-burning steam-driven tractor. At that time gasoline-driven tractors were in the experimental stage.

We had poor and delayed mail service and no long-distance telephones; however, the national telegraph system connected most of the towns of any size. Our principal need to communicate

with the Caracas office was to ask for money. We eventually got all that we asked for and were never restricted as to expenses. We used gold and silver coin to pay the native employees and to purchase supplies locally. It was quite a task to carry all of that metal in our saddlebags. Of necessity, our parties worked independently and our only dependable link with the rest of the organization was Barnabas Bryan, who dropped in every month or so to give instructions and to collect information. We had little opportunity to discuss geology with members of other parties.

Our food was varied and very good. Hunters brought in deer, turkey and paujil, and the plantains and native vegetables and fruits gave us a well balanced and palatable diet. Canned peaches and Huntley-Palmer tea biscuits, deviled ham and sardines were also on the menu.

Though several members of field parties were taken with malaria or dysentery, most of us kept healthy the greater portion of the time. We were careful not to drink unboiled water and to get under a mosquito net after dark. We had no Flit, and seeking out that mosquito in the hammock net and destroying him was a hand-to-hand battle. Quinine, castor oil, ipecac, Eno's Fruit Salts and iodine were the principal items in the medicine chest. None of us got to use our anti-snake-venom kit, though some of the burros developed ulcered swollen noses, which the peons said were due to snake bites.

I made no important contributions to the over-all report. Perhaps the detailed map of the Mene Grande seep was useful, but I was not one of the principal actors. However, I did have a lot of fun "carrying a spear in the chorus."

Jungle animals and birds were plentiful and the jaguar and puma tracks in the muddy trails were common sights. I shall always remember the parrots flying westward at evening in pairs, making short shrill cries. I will never forget the friendly, hospitable natives.

One joke on myself may merit inclusion in the record. One night a number of the boys in the company house in Maracaibo were robbed of money and watches by a sneak thief who had entered through an unlocked door. He missed two hundred dollars that I had locked in my cedar trunk and I foolishly boasted about my good luck. The following night the thief returned and took my trunk, money and all. We found the trunk in the yard the next morning. It was broken open, but he had failed to find the money which had been placed in envelopes and which he had mistaken for correspondence. I was given some well deserved kidding.

Sneak thieves were not uncommon in Maracaibo and unless the board shutters of the windows were closed each night, some urchin, using a fishing pole, would lift the sleeper's trousers and coat out the window. This happened several times to some of the boys.

Through the years I have managed to keep in touch with several of the geologists who were in Venezuela in those early days. I count them among my best friends. I also remember that period as one of the happiest in my life.

Ewart G. Sinclair

Ewart G. Sinclair left New York for Caracas in April 9, 1913. He graduated from Stanford University January 1912 with a degree of A.B. in Geology and Mining. He worked with

Andresen south of Lake Maracaibo and later took part in the discovery and staking of concession areas for the La Paz field. He left Venezuela late in 1913, after which he was geologist for the Midwest Refining Company. He passed away June 25, 1927 at Kalispel, Montana.

Henry J. Packard

Henry J. Packard came direct to Venezuela from Nicaragua about April 1, 1913. He was graduated from Stanford University in May 1911 with the degree of A.B. in Geology and Mining. He first worked south of Lake Maracaibo and then was moved to Guanoco to look after the geology of wells drilled there. He remained at Guanoco until late in 1914 when he returned to the United States. After leaving Venezuela he was a consultant in petroleum geology and passed away sometime after 1930.

Geoffrey Jeffreys

Geoffrey Jeffreys came to Venezuela from Mexico in April 1913. He was educated in England and had engaged in petroleum geology in Mexico. He worked in the Perijá and Arimpia regions from May to August 1913, after which he went to Caracas to replace Elliott. He remained in Caracas, handling field reports until late 1916. He passed away in Jackson, Mississippi, in November 1953.

Paul Weaver

Paul Weaver was engaged by the General Asphalt Company in October 1910 and resigned November 1911. He majored in Mathematics and Geology at Columbia University and was graduated with an A.B. degree. His work was mostly in Trinidad, but he was in Venezuela from May to August 1911. His work in Venezuela was cut short by an attack of black water fever and he was sent to the hospital at Port of Spain.

My work in Venezuela started with running a plane table with Artie Reeds. We worked several of the streams coming off the mountains northeast of Guanoco and also in the area of the seepages next to Pedernales. This work was all carried on with camp on a boat. Our most interesting experience was a fire in the galley of our boat, where we were using a kerosene stove primed with gasoline by mistake. The cook jumped through the screen, leaving Archie and me the job of putting out the fire with blankets. We also had an experience with a squall on the Gulf, which washed our canoes overboard and grounded us. We had to swim to recover the canoes. The novelty which we introduced into the Venezuela area was the American canoes which were, of course, much more ticklish to handle than the native dugouts. We were also in trouble because the Venezuelan assistant would try to stand up in the canoe and tip it over, so we were always prepared for a dunking.

My duties in Trinidad were to cooperate with the drilling department and to do surface mapping around the Trinidad Lake; also on leases which the company held from the Trinidad Government.

A shallow water-well rig was used to drill a well right on the edge of the Bermudez Lake in Venezuela. I believe the well went down to. about 200 feet. Several other wells were drilled which showed that the asphalt lake had flowed out over recent formations.

Ingeniero Don Santiago Aguerrevere

It was a law in Venezuela at this time that all the surveying should be done by the Venezuelan engineers. The most outstanding of these men whom we employed was Ing. Don Santiago Aguerrevere, Dean of the Venezuelan Civil Engineers. He was official engineer for the company and was in charge of all the other surveyors. It was his duty to furnish the legal knowledge concerning the surveying of all the concession lines. Also the kind of monuments for the boundary lines which would satisfy the government regulations.

Dr. Aguerrevere was one of the chief elements in establishing the fine relations between the company and the land owners. This was because of his intimate knowledge of the Venezuelan people and the boys who made up the geologic staff. Dr. Aguerrevere had three fine sons who later were graduated from Stanford University: Enrique—1919, A.B. degree in Civil Engineering; Pedro Ignacio—1921, A.B. in Geology, and Santiago Emigdio—1925, A.B. in Geology.

Enrique J. Aguerrevere

Enrique J. Aguerrevere is a native Venezuelan and gives interesting history of his country in his article. He is now an important member of the government of that country. He shared in the early exploration for oil, and accredited himself well in all of his work. Since his graduation from Stanford he has been successively Secretary of Public Works in Venezuela, Secretary of Development, Minister to Mexico, Ambassador to Ecuador and to Panama—all for his country. He has helped greatly in the development of his country's vast oil resources.

MY GENERAL EXPERIENCE IN THE PIONEERING FOR OIL IN MY OWN COUNTRY, VENEZUELA

By Enrique J. Aguerrevere

The angle, or point of view, in this story is that of myself, the Venezuelan young fellow who, for the first time in his life, looked with keen interest through a narrow opening into the world at large, full of mysteries to him, when he became acquainted way back in 1913 with the group of clean, wholesome boys who had come down from the northern part of the hemisphere to help in the search for the "black gold." Very much like a new discovery —in a way like a mock re-enactment of 1492— I don't know which of the two groups, the Venezuelan or the American boys, were more bewildered in that new meeting of two civilizations, two points of view, two traditions, two systems.

Venezuela had been bled white in the long effort to bring about its own independence from Spain and that of its neighboring sister colonies, down to and including Peru, and this condition together with the handicaps of climate, health and lack of known natural resources, led my

country into a series of internal disturbances and continued civil wars and revolts of all sorts that sapped away most of the vitality left in it.

It is not surprising that we took to each other keenly and that no friction ever developed between men looking at the facts of life from such different, if not opposite, points of view. The fact is that we both, American and Venezuelan, were anxious to learn from each other what the other had to offer, most particularly the language. Friendships developed then that are today as firm as ever. With great fondness, I recall the names of Proctor, Doyle, Elliott, Herold, Nash, Sinclair, Hammer, Donnelly, Dagenais, Bryan, Garner, Prout, McKee, and the unfortunate Nobs. I met this fine boy shortly before his death, in the village of Bobures. He had been infected by what we think is a fly that lays an egg under the skin of its victim, and this egg develops later into quite a large worm, with the usual sequence of swelling of the part affected, and fever. Besides that, he had his usual share of malaria. No doctors were available in that far-away place, and one fellow who pretended to be so, and had only a grammar school education, gave him a quinine injection which developed later into tetanus. When Nobs and I met in Bobures, we were scheduled to go over and survey together some claims in the extreme southeastern part of Lake Maracaibo and close to the shore villages of San Antonio and Santa Maria. He was a hard-working, strong young chap and wanted to go along with me in spite of the fact that he was obviously feeling very bad and low. I finally convinced him that he should go back to Maracaibo where he could get some medical help. His trip must have been a terrible ordeal for him, judging from his physical condition when I saw him last. In 1915, I found the same quack doctor practicing in a nearby sugar
mill.

While Mr. Proctor is by far one of the most distinguished American figures in my own recollection, and the only one among the pioneers who married a Venezuelan lady, he didn't stay long, and the piloting of the only large oil company then existing, the Caribbean Petroleum Company, was taken over by Mr. W. T. S. Doyle, one of the most able, intelligent men, and richly endowed with human sympathy, that I have ever known. One anecdote is quite typical of Mr. Doyle's ability in the handling of men. The company was for some reason extremely interested in the mapping of the land around the Cerro San Andres and Cerro del Cochino, west of Salina Rica, and formed a party made up of Drs. Badillo and Tovar and myself, and we worked very hard at it for four months. The hurry was such that we had a special man from Maracaibo sent to our camp just to copy at nights our field notes, which were then sent to the office by messenger. When this last was finished we men rushed to Maracaibo for the final computations and plotting.

We arrived in town at dusk and felt so happy to be in the city again that we fired a volley of shots with our pistols, a most dangerous undertaking in the days of Gomez. Tovar and I were in our early twenties and Dr. Badillo, though about forty at the time, acted like a boy of our age. We got into the building that was at the same time office and home, which the company maintained in Los Haticos, the then elegant suburb of Maracaibo, had the old maid, Rita, bring out our clean suits, had supper in the established family style of those days with Mr. Doyle presiding, and with our pockets full of money we were ready for the big night in town. Mr. Doyle well knew that next morning our brains would be in a fog and our hands too shaky for the fine drafting that was expected of us. He also knew that we could not be stopped by force or reason from going out. So, he just simply entertained us after supper with the most wonderful and spicy collection of tales,

expressed in his wonderful Spanish, until the last streetcar Maracaibo-bound was gone. There was no other way to reach the city, so we went to bed without even realizing what the old man had done to stop us.

After leaving the company, I attended Stanford University. The impressions of the two years I spent there can be summed up in very few words: the anticipations which had been built up in my active, youthful imagination were fulfilled to the utmost. Graduating in 1919, I went to Mexico where I remained, mostly in the Tampico area, until the end of 1929. Production of oil there reached its maximum in 1922 when the encroachment of salt water in the southern fields started the decline. By that time, with the early success in the field of Mene Grande and the famous La Rosa well which came in the year before, Venezuela was on the map as a very promising prospect.

I returned to Venezuela in 1930. The American pioneers were all gone and in their place were men who had not gone through the hardships of the pioneering days. They had no other thoughts except securing quick and large returns for the investments of their employers.

Pedro I. Aguerrevere

Pedro I. Aguerrevere has contributed a most interesting article giving his experience in the Venezuela work. Following his graduation from Stanford, he has been one of Venezuela's outstanding engineers. He was in charge of dredging out the channel between Lake Maracaibo and the Caribbean Sea, which was the largest engineering project ever undertaken in Venezuela.

CERTAIN ASPECTS OF THE BEGINNING AND GROWTH OF THE OIL BUSINESS IN VENEZUELA AND ITS INFLUENCE ON THE LIFE OF ONE VENEZUELAN

By Pedro I. Aguerrevere

I came into this world on the ninth day of May in the year 1896 in the City of Caracas, capital of Venezuela. Caracas was then a quiet, colonial—one might even say provincial —capital of one of the most under-developed of the American nations and almost of the world. For Venezuela, after blazing up like a nova star to the highest possible brightness in the period of the wars of independence (1810-1824) had moved down the political grade through the remaining years of the nineteenth century to reach the lowest in the last years of the Gomez dictatorship, well into the twentieth. Economically, the curve had also gone down the incline, and the Lord only knows where the combination of these two depressive forces would have brought us if it had not been for the discovery in July, 1914, of oil in commercial quantities. From then on, as far as economics is concerned, Venezuela acquired the characteristics which, although now to a much lesser extent, it still retains, namely, a poor people with a very rich government.

In spite of our Spanish ancestry and undoubted affection for the mother country, our closest spiritual ties with the outside world used to be with France. When I say this, I mean it in a one-sided way, as really our relations with France were those of a poor boy contemplating a rich display in a store window. Everything seemed to be under French influence; even our textbooks were in' French, and as we early became familiar with that language, French science, French art in all its forms, and French material wealth made France appear to our young eyes as Paradise on

earth. Two world wars and Venezuelan oil production were to change all that so completely that I had the unique experience of being told in 1947 by a high international banking official' that his organization was contemplating a rather risky loan to a European country and would like to make one to Venezuela in order to have our good credit position balance the other; and later I learned he was referring to a French loan. *Sic transit gloria mundi!*

In 1908, President Castro, who had been ruling the country with an iron hand, took a trip to Europe to have some medical treatment he could not get at home, and left his trusted *"compadre,"* General Juan Vicente Gomez, to stand guard over the job. Gomez, promptly, and with full support of all the people who believed as usual in his promises, put Castro out and kept power for himself. Afterwards, he held the reins of power until his death in 1935. During the twenty-seven years of Gomez's regime, the oil business grew from nothing to a position of world prominence, and the revenue from this business, according to many, provided the necessary wherewithal for his political machine.

On January 2, 1912, while I took the second year of engineering, the original contract of the Caribbean Petroleum Company was signed between the government and Dr. Ralph Max Valladares. Several months later, a quarrel between the students and the President of the University, which had been smoldering for quite a while, broke into the open and wound up with the closing of the University. For the rest of the year we wandered around hoping for a reopening, but the old dictator wanted nothing of us. In February, 1913, the Caribbean Petroleum Company looked for surveyors to prepare the maps of the concessions that were to cover the areas already explored and thought to contain oil, and several of the ex-students of engineering hired out. I was one of them and this fact completely changed the course of my life.

My first surveying assignment took me to eastern Venezuela in an area along the coast that was practically a desert. The change from the mild climate of Caracas was very hard to stand at first, and only pride kept me there; later the charm of the desert and the sea, and the awakening interest in that mysterious science that allowed men to look under the surface of the earth, made the work seem very attractive. There came also the proud feeling of being connected with something quite new in Venezuela, and every time I came to Caracas I felt like a very important person in spite of being still in my teens.

In the first survey and in the next job I was attached to the party of the late Franklin S. Prout, Stanford geologist. At first Frank simply awed me; I had practically known no strangers before, and then, he was so big! For I am only five feet six inches tall, and Frank was exactly six feet six. After a while we found our differences really were a source of fun and we got along beautifully. He took good-naturedly the constant kidding about his size, which followed everywhere we went, and to which my small, frail figure added comical contrast.

The year 1914 began full of promise for all of us. We had filed our maps on time and the company was going to start a program of drilling for oil, with the corresponding transportation and housing projects. Everyone had his salary raised; my original four hundred bolivars monthly (slightly less than $80) received a boost to five hundred and sixty ($113) and I felt I was well on the road to fame and riches.

I was sent in January of that year on a railroad survey party to eastern Venezuela. This time we were to find the way to reach an area where very important seepages had been located two years before while exploring the plains that drain eastwards into the Gulf of Paria. In this area, by the way, the Caripito oil field was developed several years later. The party was headed by Harold E. Boyd, one of the finest men it has been my pleasure to meet, and to whom I am mostly indebted for my going to Stanford. We were several months in the jungles strictly by ourselves, and as we were rapidly becoming jungle-wise, we enjoyed our work immensely. Our only connection with the outside world was when our burro train, driven by a quaint old character called "Caraqueño" (the Caracas man), would go to town, often more than one day's ride away, for our supplies. Caraqueno was not only a good, careful driver of animals on the trail, but in his long life and travels had acquired the greatest line of stories from episodes on the various civil wars he had been in (or so at least he claimed) to spicy and comical adventures in which he always seemed to have played an important part.

Towards the middle of the year, and having just reached the ripe old age of eighteen, I was sent alone with a party of men to set a line of corner stakes, starting where the work had been stopped the year before, near the mouth of the Guanipa River (just north of the Delta of the Orinoco). I was proud as Punch about this and started full of hope of showing how good I was by finishing what another man had been unable to do. We cut our way through the jungle all right, camped on the edge of what looked like a wide grass plain, and started our work, thinking that success was in our grasp. What a mistake! The plain was merely a grass-covered swamp, and we couldn't get across. We set all the corner stakes we could and pulled out.

After returning to Maturin, my new orders were to join another surveying party headed by Ham Garner, another Stanford geologist, further inland. I had been in his camp but two or three days when I came down with malaria. It must have gotten into me in the camp near the mouth of the Orinoco, and after the proper number of days for the thing to grow and spread through my system, I came down with it.

Malaria hit me very hard. The high fever would make me go clear off my head so that Ham Garner, who unexpectedly had received orders to go to Caracas, sent me a doctor when he rode through the nearest town on his way out. The doctor came to our camp, but he had barely gotten off his horse, and had not even begun to examine me, when he broke the news that war had started in Europe! This was the first week of August, 1914, and it was not long before we realized why Garner had been called; the company had decided on a general shutdown and we were told to stop our work and come home. But it took us so long to reach Caracas (we had to go east to Trinidad and there wait for a boat west to La Guaira) that when we finally reached home the panic was over and we were back on our jobs again.

Now, we were sent to Maracaibo, the biggest city of western Venezuela, to start working from the local office there. The company had already found commercial production in the Mene Grande field, in that fateful July of 1914, and the rush for oil was on. Meanwhile, during our stay in Trinidad, Harold Boyd had taken seriously my suggestion that he write Stanford to see if I could be admitted as a student of geology, and a favorable reply from Jack McDowell reached him in our camp out of Maracaibo. I was indeed quite surprised, for I must now admit I had made the first move with the subconscious hope that the answer would be vague, difficult, or just plainly negative. Instead it was favorable, friendly, and simply opened all doors possible to my

going there. There was no backing out now; I was scared to death, but too proud to show it, and then our Caracas University was still closed with not even a hint as to when we could resume our studies. I decided to stick to my job until the middle of 1916 to save up enough money and go to Stanford.

In the latter part of 1915, I think, all these plans were nearly stopped. Boyd and I had been escorting a visiting Dutch geologist, whose name I cannot recollect, through the area we had been exploring, when the young mule I was riding, tired of the slow pace of our distinguished Dutch friend, or scared by something on the trail, ran away. I was pretty tired too, and was not sitting properly on the saddle when the animal bolted through the trees like a flash of lightning. All I can recollect is seeing before me the thick branch of a tree, under which the mule was going to pass, and ducking my head but hitting with my shoulder. The next moment I was on the ground trying to breathe, but not seeming quite able to. Well, no bones were broken, thank God, but I was black and blue all over and sore for weeks. If I had hit with my head, I am afraid I would not be here now.

We did not know it at the time, but the Dutch geologist was looking over the properties of the Caribbean Petroleum Company as a preliminary to the deal by which the oil empire that General Asphalt had founded and begun to develop was to pass over to the Shell interests.

Before finally deciding on my trip to the States, I had a long talk with my father to tell him of the plans I had made and that if I tried to wait until I saved enough for the whole four years, it would take too long; that I understood one could earn his way through school, but I wanted to ask him if I could count on his lending me the necessary money if I ran out of funds. With that understanding I left for California a few days after my twentieth birthday and, after all, I never needed to ask for money.

I was deeply moved upon leaving Caracas on my great adventure. Behind me were to stay family, friends, and a way of life that did not differ much from Spanish colonial days. Ahead of me was the modern world of great achievements in industry, in science, in transportation, and I was to live with a people incredibly free in its institutions and enjoying the highest standard of living. So, with my funny little trunk, containing still funnier European-cut clothes, and some books, I took off on the little toy train to La Guaira, caught a French boat as far as Colon on the Canal Zone, then a boat of the United Fruit Line to New Orleans, and the Sunset Limited train to California. My mental baggage was even more strange; three years of experience in the service of the Caribbean had matured me beyond my years in some ways; in others I was still the romantic boy with an old-fashioned Spanish education and full of fancy ideas from Spanish writers and poets like Becquer, French like Victor Hugo, and the lessons in chivalry from *Ivanhoe.*

With that makeup, my freshman year at Stanford was pretty much like that of a returning soldier after World War II, with the difficulty of the language on top of it all. For while I thought I had a good knowledge of English when I left Caracas, I soon found out differently! I still remember a kind, elderly lady on the train to California trying to show me and explain the scenery through the deserts of Arizona, or at least I suppose that was what she was saying, for I understood not one word!

Stanford took me into its fold with all the natural ease of people who are born friendly. With Dr. J. P. Smith, the grand old man of the Geology School, the boys could discuss anything from geology or philosophy to their personal troubles, and always be certain of a kind word and sound advice; and he, with Dr. B. Willis, the great teacher and traveler, and C. F. Tolman, a thorough investigator and great friend, were three of my professors who have long since departed, but to whom my most grateful memories will go as long as I live.

My return to Venezuela in 1921 was in the employ of Cities Service Company, then holding the Barco Concession across the border line into Colombia. I was to work for the Foreign Department for thirteen years and visit many countries of the world. The rush in which I left Stanford to get started on my job was quite typical of business in those days; I could not stay until commencement and my diploma was mailed to me, together with my nomination to Phi Beta Kappa. I regret to this day that I did not stay over, and I advise no one to be so foolishly businesslike as I was in sacrificing the ceremonies that wound up the best four years of my life. I realized this better in 1929 when, after one year of postgraduate work at the Colorado School of Mines, I received my Master of Science degree in the regular way.

Between 1921 and 1934 I was in Venezuela several times, but always as a visitor, for I was not roaming the world of oil. (Although never active in politics, I disliked profoundly, however, the Gomez dictatorship and worried about the way the oil interests seemed to rely too much upon him instead of upon the goodwill and understanding of the people.)

In 1934, the depression terminated what might be called my training wanderings and I decided to return home, in spite of the fact that Venezuelan technical men of experience did not seem to be wanted either by the government or by the oil companies. Nevertheless, home is sweet regardless, so my wife, three children and I settled ourselves to live the best we could in Caracas.

The death of President Gomez ended his twenty-seven-year period of dictatorship. Those 1 of us who had seen the Mexican Revolution were afraid of the worst for the period after his passing away. Venezuela was, however, most fortunate in having General Lopez Contreras as Minister of War at that critical; moment, for he steered the country so well that the awakening of a national conscience and the formation of strong labor unions were done without causing armed conflict.

In a matter of a few days after the death of Gomez, the oil companies found themselves in the center of quite a storm. In our newfound freedom, every other man in the country seemed to have an axe to grind, and the oil companies were the best targets for criticism. Anyone capable of writing a letter to a newspaper claimed to have a solution for all
our problems, whether oil or anything else; naturally, some of the solutions were sober, some drastic, some simply insane. Here was the time to bring into play, for the benefit of Venezuela, the lessons we had learned in foreign lands. We counseled revision of all past arrangements in a spirit of practical understanding, and I put all this in a memo-
randum which I privately gave the managers of the three largest companies in 1938, shortly after Mexican expropriation, but which was not well received by them. Nevertheless, after five years, the idea involved in that memo was the basis for the new Petroleum Law of 1943, which really saved the Venezuelan oil industry, avoiding the crises which have been the lot of the oil business in many parts of the world.

As a climax to this somewhat eventful and certainly not dull life, I was a member of the first cabinet named by the present government of Venezuela when it came to power on the 25th of November of 1948. My post was that of Minister of *Fomento,* and in that capacity I tried again the policy of finding the solution to matters of national interest with oil and mining companies in a spirit of reciprocal fair play and practical understanding. It was, in a way, what we might call the Stanford spirit applied to political administration.

July 2, 1951

Martin Tovar Lange

Martin Tovar Lange was a young Venezuelan engineer and was graduated from the University of Caracas. While working on this exploration survey, he met and worked with Richard M. Conkling,. a geologist from the States. Through this friendship, and suggestions of Conkling, Lange came to the United States and took post-graduate work at Columbia University.

P. J. Torres and L. J. Pacheco are two Venezuelan engineers who worked on our survey, but unfortunately we have no record of them in detail.

The article that forms the next chapter was written by Harry Maddren, Drilling Superintendent, of whom we have no history.

CHAPTER 27

Pioneer Drilling and Development of the Oil Fields of Trinidad, B.W.I, and Venezuela, S.A.

Before I joined the General Asphalt Company, which controlled immense concessions in Trinidad and Venezuela, my experience in the oil branch of the business had been quite extensive.

I was not born and brought up in the oil country, but in Washington, D.C., where I attended grade school. Not being able to continue school, due to straitened circumstances, and not being disposed to work my way through school for an education, I chose to follow various lines of work of an outdoor nature in the eastern states. While in Boston, Massachusetts, working for the Postal Telegraph Company as a lineman, I got the gold fever and went to Alaska following the Klondike gold strike. I followed placer mining for a few years, without much success, and then decided to try the oil game. I liked boom towns, and was what you might call a boomer.

There had been quite an oil boom in Texas, so I went to Beaumont which had been quite active due to Lucas Gusher coming in at "Spindle Top." However, the boom was over when I appeared on the scene, and oil was selling for only ten cents a barrel. In spite of this, there was considerable activity in Louisiana, and, later on, the Jennings field came in and was very prolific.

After that I worked in Oklahoma and \ Kansas, and finally California, where I covered nearly all the fields which were active at that time. Eventually I located in Coalinga, California, in 1906, which was having quite a boom as crude oil had gone up in price from forty cents to nearly a dollar a barrel for certain grades. I worked for various companies as a driller, and later for the Kern Trading and Oil Company which was the crude oil department of the Southern Pacific

Railway in Coalinga and Midway. After several years in their employ I became General Field Superintendent with regard to drilling and production in the Midway District; this developed into a big operation, as they had vast holdings.

It was then that I joined the General Asphalt Company. I think it was early in 1914. This also was to become an extensive operation in South America, and I was quite well fitted for the job since my past experience had given me a good training in both cable-tool and rotary drilling methods, which were necessary, and in the control and handling of gusher production.

Upon arriving at the home office in Philadelphia I found the management to be wonderful people. However, they were not what you would call oil men, although they had spent a lot of money in Trinidad and some in Venezuela trying to develop their concessions. Their field managers were mostly engineers from the Panama Canal Zone and were totally inexperienced insofar as the development of oil properties was concerned. They had been used to mining asphalt from the asphalt lakes and shipping it in bulk to all parts of the world, there to be used as paving material.

Although some good oil men had been there prior to my time, they had soon become disgusted and left for the States, due principally to the management, climate, and various other reasons.

There had been a very thorough geological study made of the most promising areas by outstanding geologists, but it was not until Dr. Ralph Arnold and his organization had made a new report and recommendations that it was used, with the result that about two-thirds of the wells drilled prior to my time were dry holes. After I joined the company, and with the aid of Dr. Arnold's organization, not a dry hole, I believe, was drilled, and we soon commenced to fill a million-barrel tank farm at Brighton, Trinidad, which had been built by the former management but stood idle and nearly empty for a couple of years.

The one redeeming feature of the layout was that the Canal Zone engineers had built a wonderful camp in a beautiful setting; they had paved roads and installed modern improvements, tennis courts, and fine bungalows all screened for protection against mosquitoes and various other kinds of insects. These of course were for the key men. Then there was a fine staff house much like a small hotel for housing the drillers and the rest of the personnel. However, the commissary was very poor, especially for men from the States—the food was there, but nobody to prepare it, and as the management ran their own establishment and got what they wanted, they were not much interested in the boys from the States in the drilling department, whom they seemed to consider just a necessary evil; socially they were outcasts, as you just can't make oil men adopt British customs. This of course was at Brighton, Trinidad. There was no such layout in Venezuela.

One of the main drawbacks to the operation was the obsolete equipment which the purchasing department had shipped in there. I think the supply men unloaded everything they had in the way of obsolescence, due to an inexperienced purchasing agent being in charge of purchases in Philadelphia, the men in the field who had to use the stuff being three thousand miles away. Fortunately they had a fairly good machine shop for the up-keep of the asphalt equipment, so after installing a steam hammer, joint lathes, and other equipment for oil country tools, and with the services of a fine oil country shop superintendent, Denny Driscoll (who has long since passed

on), and a crew of mechanics such as a heavy blacksmith for forging, joint turners, etc., we got our drilling equipment in pretty good shape.

Steel derricks had not come into general use yet, but we were able to get rig timbers and dimension lumber from the States, the native timber not being suitable. We had a fine rig builder—Jim Putney, from Olean, New York—who knew his stuff and could frame a rig right out of the woods if the timber was suitable; also, an equally good drilling superintendent by the name of Charlie Bostaph, an old-timer with a world of experience, and Johnnie Augsburger from California as superintendent of production. These men made a fine team and things were rolling good, so I felt free now to go to Guanoco and Pedernales, across the Gulf of Paria in eastern Venezuela, where we were drilling two wells. The one at Guanoco was a cable-tool job; at Pedernales it was a rotary rig.

I left Port of Spain on the company steamer, the "Viking." She was a converted tug boat with passenger accommodations, about 125 feet over all. We always liked to travel on the "Viking," for Captain Haberstraw ran a trim ship, had a good steward and served the best food on the circuit, so to speak, and as soon as the boat got offshore you were free from mosquitoes. The "Viking's" principal use was to pilot the pitch boats through the delta and up the Guanoco River. This was quite an interesting operation, as the ships, which were four to five thousand ton capacity, had to be turned around in a natural turning basin and then backed up the Guanoco River on flood tide to her mooring. The captain was quite expert at this, though the channel was narrow and crooked, having sharp bends to maneuver around, and tall mango trees in the swampy jungle on each side of the channel, scraping the ships from stem to stern. It was unlike anything I had ever seen.

After the ship was made fast at the wharf, there was usually a trainload of asphalt from the lake, which was about seven miles inland, mostly through swamps and jungle, ready to be dumped into the ship. The asphalt came down on the railroad in huge dump boxes which were lined with liquid mud to prevent sticking, as the asphalt adhered readily to anything, especially in the warmth of the sun. The inside of the ship's hull also was coated with mud. To prevent the cargo from shifting at sea in case the ship listed for any length of time, wooden bulkheads had been installed both lengthwise and transversely, as the asphalt, although not liquid, would crawl to the low side in warm temperatures. Upon arrival at its destination it was usually unloaded with clamshell buckets.

We now had our first view of Guanoco, and of all the Godforsaken places I ever saw, this was the worst, and it sure made newcomers feel like going back to the States. It was situated on the river and was made up of a cluttered group of shacks and huts. There was no street, not even for an oxcart, their only means of transportation being by pack animal or small skiffs or canoes. The occupants were mostly employees of the asphalt company who worked at the lake mining the asphalt or on the railroad and dock. The place was filthy, with no sanitary facilities at all, depending for sanitation entirely on scavenger pigs and buzzards, and disease ran rampant. This condition prevailed in nearly all the small communities, and, to a great extent, in the larger cities. Water and sewage facilities were very poor almost everywhere, resulting in soil pollution and breeding grounds for mosquitoes, mostly of the malarial species. Yellow fever in some areas, and hookworm, were quite common. These were things you had to guard against constantly, but most of our camps were good, and well screened. It was advisable

to boil all drinking water unless you could obtain bottled mineral water, and all living quarters had to be fumigated regularly in order to exterminate the vermin, such as flies, mosquitoes, fleas, bedbugs, lice and ants, as they would get in somehow. Even our camp at Brighton, Trinidad, which was one of the finest you could possibly have in the tropics, was sealed up and fumigated regularly. The buildings there were set on concrete piers with a receptacle at the top of each one which was kept filled with insecticide to prevent insects from entering from below. Even then they would get in.

We had one producer at the Lake that had produced at the rate of nearly a thousand barrels per day, and we had facilities for handling a 35,000-barrel tanker. At this time we were drilling another well and were down about 4,000 feet in hard black shale.

The drillers in the crew (I'll name only the drillers, as the balance of the crew were Venezuelans, six or eight of them on each shift) were Charlie Dore and Johnnie Lotton. They

traveled to and from the well mostly on a railroad motor car as the train schedule was controlled by the asphalt shipments. I frequently made the trip with them. The track and right of way was only about eighteen feet wide, with a swamp on either side lined with tall mango trees and other jungle growth, all of which had thorns, stickers, or sharp cutting edges on them. On one occasion, returning from the lake, we saw what appeared to be the trunk of a tree lying across the track, but as we came closer we discovered that it was a boa constrictor. We came to a sudden stop, as a thing like that could derail the car. We were then within fifty feet of the reptile, which was sliding across the track at its ease and had started down into the swamp on the other side. I was in favor of letting him go, but Charlie Dore wanted to capture or kill him, and ordered his crew to make a rope fast to the snake's tail which was gradually sliding into the swamp. They did so, but could not hold him and were slowly but surely being pulled closer to the edge of the swamp. They were just about ready to give up when the snake's head appeared out of

the swamp about three feet from where his tail was going in—apparently he had hair-pinned down in the swamp. That was the big moment. Charlie grabbed a fish plate off the motor car and beat him on the head until he was dead, we thought, or at any rate

knocked out. The Venezuelans then tied a rope around his neck and pulled him out, coiling him up on the deck of the motor car, and we proceeded to camp. Just as we pulled in and stopped and were getting off the car, the old snake came to and unloaded himself. However, he was kind of groggy and didn't put up much of a struggle, and the Venezuelan boys dragged him away. Charlie had him skinned and had the skin cured. It measured 19' 10" in length and *27"* in width, which made him about *9"* thick when alive. As thedrilling of a well is not too interesting at best, incidents such as these that I relate as I go along help to liven up my story.

Here in Guanoco we used cable tools, but in Trinidad the rotary method was by far the best. Charlie Dore and John Latton, who drilled on these wells, were two of the most capable drillers we had, and both became well known and held positions of responsibility later in the States.

As the pitch boat was about loaded and was to leave the next night at flood tide, we prepared to go aboard the "Viking" for the return trip to Port of Spain. However, we were to make Pedernales the next stop as we were drilling a well there with a rotary. Pedernales is situated in the delta of the Orinoco River, on low flat country not much above tide water. There were numerous asphalt seepages and mud volcanoes thereabouts. We anchored offshore and landed in small boats, and found the village much the same type as Guanoco.

We had a great deal of trouble with lost circulation and quite a few blowouts here. On this particular well the mud came up in such volume that it practically buried the rig. There were several wells drilled here, none of them over 1,000 feet in depth and with poor results, as far as I know.

Upon my return to Trinidad I found our operations were progressing very nicely and the production was increasing steadily, so I decided to go to Maracaibo and inspect the holdings surrounding Lake Maracaibo. This was really a very promising area, especially in the Mene Grande district. One shallow well had already been completed and was capable of producing 250 barrels per day. It had been drilled with cable tools and a portable rig. We decided to drill another well farther out on the structure and endeavor to pick up the oil sand at a greater depth, which of course would require a heavy standard cable-tool rig; we had no rotary equipment in that district.

So here is where a real rig builder by the name of Sam Schrum came in handy.

At that time we had practically no transportation other than small boats on the lake, and bull-teams and pack animals on land. So Sam the rig builder really did his stuff, not being able to secure rig timbers readily. Sam and his crew of axmen went into the forest and hewed out all the heavy timbers, and even whipsawed some of the dimension material for the rig. It was about sixty-five miles from Maracaibo to the slough which extended from the lake shore up toward our location and camp, and all material had to be brought down the lake by sailboats or lighters and then transferred to shallow draft punts to proceed up the slough. It was a common sight to see large alligators sliding off the muddy banks into the water. At the head of the slough, the material had to be unloaded, and from there moved by bull-teams three or four miles to the locations.

The bull-teams were hitched up by lashing a pole about three inches in diameter and six feet long across their horns; to that was fastened a long pole like the tongue of a wagon, which extended between the bulls to a wooden sled they dragged on the ground. They did not use yokes as you would on oxen in this country—we tried that later and found that the bulls wouldn't work with them. After the bullwhackers got the bulls lined up and the load had been put on the sled, the bull-whackers would go to work on the bulls with a blacksnake whip and a long prod stick with a sharp prong on the end of it. After much prodding, whiplashing and jabbering in Spanish, the bulls would move off. They wouldn't go far, though, until their necks would buckle and then they would quit for a while. I've seen it take all day to move a joint of *50#* $12^{1/2}$ casing twenty feet long, three miles. So you can readily see how difficult our transportation problem was.

By the time the rig was up we had moved in the tools and enough material and pipe to rig up and spud in. The casing program called for shutting off water with 10" casing, finishing up with an 8" oil string. We of course planned to cement the 10" casing, as a formation shutoff is never very good, so we had ordered several tons of cement from Maracaibo to be shipped by one of the sailboats to the mouth of the slough and there transferred to the punts. It developed that the punts failed to meet the boat and, as the tide was low and the sandbar at the mouth of the slough was exposed, they unloaded the cement, which was contained in wooden barrels, on the sandbar and by the time the punts arrived I the tide had come in and the cement was submerged and of course ruined. This meant a long delay, but in that country it didn't seem to mean anything—there is always another day tomorrow.

I was fortunate in having an excellent superintendent in charge of the drilling, an old-timer by the name of Jack Stokes who had years of experience in California and was familiar with this type of drilling. I think a great deal of the credit for the successful development of the Mene Grande field, which later became one of the most extensive and productive fields in South America, belongs to him.

With the water shut off we proceeded with the drilling, carrying a string of 8" casing as we drilled, for the formation would not stand up, and at about 1,500' we picked up the top of the oil sand which was rich and gassy, and it became necessary to keep the casing close to bottom. We had penetrated the sand about fifty feet and the well commenced to flow between the 8" and 10" casing. The farther we penetrated the sand, the stronger the flow became and it soon was necessary to place steel plates below the derrick floors to divert the flow into the sump. Not having the facilities at hand to put such a well under control and close it in, we had to provide storage of some kind. There being no tanks, we had to resort to earthen storage. As the well was now producing several hundred barrels per day, we secured the services of a couple of hundred Venezuelans through the *Jefe Grande,* who was the headman among the people. We had no teams or dirt-moving equipment, and the only way the Venezuelans knew how to move dirt was to dig it with wooden forks, put it in wicker baskets, pack it on their heads and dump it where directed, then tamp it down with their feet.

We had cabled the purchasing agent in Philadelphia to ship the necessary control heads and fittings to harness the well up, but that was going to take weeks, as there were only two boats a month on the run. In the meantime, the well got wild and came up inside the 8" casing, blew the crown block off the top of the derrick and became a real gusher, flowing at the rate of 30,000 barrels per day. I think we had over 500 Venezuelans packing dirt, but the oil was gaining on us all the time. So there we were with a wild well flowing like hell, and there was nothing we could do about it. Jack and I were hoping that the well would sand up before it overflowed the levees and went into the lake. Sure enough, it did the next day, and we didn't have room for another barrel. That enabled us to put some temporary fittings on the well and clean up the wreck, repair the derrick and get ready for the control heads and connections which had been shipped. They finally arrived and, much to our disgust, the purchasing department had not sent what we had ordered (they never did), so we had to improvise and make up a Christmas tree as best we could.

There were no flow beams to be had, so we made them out of 4" shafting one foot long, and drilled holes through the center $^{3/4}$", $^{7/8}$" and 1″. After getting this makeshift collection of connections hooked up we were ready for a production test and started off with the $^{3/4}$" beam. In the meantime, the levees had been raised and reinforced and we had quite a lot of room. However, not only was it a big fire hazard, but there was danger of a heavy rain and a washout. But fortunately it was the dry season.

We did not think it would take much agitation to start the flow, as the gas was breaking through. Sure enough, a few trips of the bailer started her off and she flowed at a 3,000-barrel rate through a $^{3/4}$" beam and making very little sand. Jack and I thought that was good enough, as we did not have much room anyway, but the management wanted to see how much more it would do and wanted to open her up. We did this against our better judgment. She cut a 1" beam out to over 2" in just a few hours and was flowing at the rate of 10,000 barrels per day. The storage was

fast filling up, so we closed her in without any ceremony, hoping that the makeshift Christmas tree would hold her down. It did, and what a relief.

I returned to Maracaibo after that and, not feeling well, decided to go to Caracas which was at a 3,000-foot elevation and much cooler. Maracaibo is located just inside the entrance to the Lake at sea level, a large city of about 100,000 population and I think one of the filthiest cities I was ever in. I left by boat for Curasao and thence to La Guaira, the port of entry to Caracas from which there is a good railroad.

By that time I was feeling worse and must have looked bad, as the quarantine officers did not want to let me enter, but through the influence of our agent they let me pass. Upon

reaching Caracas I could hardly walk. I was assigned a room in our headquarters building and a doctor was called. He looked me over and at once had the room screened in. I realized then that I had contracted yellow fever in Maracaibo and that it had been running for a couple of days by then. As it runs its course in five to seven days, it is needless to say that I was very much concerned, since very few white men survive it. In fact, insurance companies double your life insurance rates as soon as you go into the tropics, just on account of the yellow fever risk. About the only consolation to be found in having yellow fever was that you didn't have leprosy. Lepers were allowed to roam at large in Maracaibo as long as they were able to get around and were not dependent.

I had quite a siege of malaria in Trinidad, but had completely recovered. Most of the men had a touch of that, but yellow fever was something to worry about. You either get well in less than a week, or die then and there—you don't linger around. The treatment for it is to remain quiet and keep your kidneys functioning, as you do not perspire. Your temperature is low compared to malaria and there is great danger of hemorrhage of the intestines if you stir around. For that reason you cannot be moved, and of course you are isolated as much as possible and you don't have many visitors.

My fever broke about midnight of the sixth day and I came out of it in good condition, though it takes a couple of weeks to recuperate.

Our next point of operations was at Petroleo on the west side of Lake Maracaibo. It was a "wildcat" in the foothills. We unloaded on a small wharf on the lake shore at a place called Punta Iguana and proceeded inland about 25 miles. The first few miles was through a swampy jungle over a corduroy road, but we soon reached a wide sabana and the going was good to the foothills where the well was located, in the Petroleo district. They had two high-wheeled tractors and some trailers over there, which enabled them to move pipe and equipment in large loads fairly easily, although the tractor would break through the corduroy portion of the road and bog down occasionally. On the sabana, however, the tractor made good time and a lot of material could be moved in a short while.

This was another cable-tool job. It's a good thing it was, as the location was a long way from water—about seven miles—and the only means of getting water to the location was by burro. We had about forty burros and a few saddle horses. The Venezuelans who handled these started out every morning at daybreak and made the trip to the river, taking all day to make the round trip. Each burro had a pack saddle and four five-gallon kerosene cans lashed to it, two on each side, or

else skin bags which would hold the equivalent. The total amount of water for the string of burros was about twenty barrels, and this had to do for domestic use as well as drilling the well. It was hardly enough, and all waste water from the shower bath and the kitchen (which was just a hearth built of stones and mud) was saved and used for drilling purposes. Any water that accumulated in the sump was used over again.

We had just started going good, having spudded as far as practical and had hitched onto the beam, and the drillers were making good time and knocking the hole out pretty fast, when unfortunately one of the gudgeons on the saddle of the beam broke and the beam came down with a crash. It made quite a wreck. That would not have been so bad, but there wasn't another saddle to be had within a thousand miles, so we had to use our ingenuity and fix up a makeshift saddle, as we were too deep to spud further. At that time there were no supply houses, oil country shops, welding outfits, or any other facilities such as we have today in the oil fields. It so happened that there was an old abandoned mine back in the hills where we found a piece of 4" shafting. Taking along a couple of burros and a hacksaw and plenty of hacksaw blades we went up to the mine, sawed off a piece of the shaft the right length and bolted it under the belly of the beam with a couple of heavy "U" bolts which we had to make also. This worked out fine and we got to making hole again in good shape.

In the meantime. World War I had gotten a good start and some German cruisers had been seen in the Caribbean and in the Gulf of Paria. There was a good deal of concern as to what they might do, but of course we had not heard much about the war as we did not get much news out there in the sticks.

One evening a messenger came in on horseback. He had ridden all the way from Maracaibo that day—fifty miles. The message stated the facts briefly, instructing me to shut down all drilling operations as much as possible and send all men out except for a skeleton organization. This made a lot of the men happy as they wanted to get out anyway, but a few wished to remain. In order to get back to Maracaibo I either had to go to Punta Iguana at the shore landing and wait for a launch, or ride horseback a distance of about fifty miles. I chose the latter, although I was a poor horseman, as it seemed an urgent matter. Therefore, I left at daybreak with the messenger as a guide. The horse I had was a pretty good-sized bay mare, with no particular gait. Of course we had to walk most of the time, as the trail went through the forest, dodged around trees and rocks, up hill and down hill, across ditches and gullies, without much open country. I soon found that an English saddle was the most uncomfortable damn thing on earth. However, we made about thirty miles before dark and stopped at a ranch for the night. The people there fed us and let us swing our hammocks under the roof of their open-air kitchen, and put up our horses. I was full of ticks, as the brush along the trail abounds with them, and was very uncomfortable. But having been in the saddle all day I was soon asleep. Sometime during the night

I was disturbed by a swaying motion of my hammock and felt something rubbing the under side of the hammock. Jumping out on the dirt floor, I found that a big razorback hog had been scratching his back. After raising my hammock about a foot to get in the clear, I got back in and finished up a very uncomfortable night.

We were up at daybreak, had our coffee, and went on our way. I was so sore and stiff I could hardly get on the old horse, but I did manage to ride and we arrived in Maracaibo that afternoon. Believe me, I haven't ridden a horse since. We got our orders that evening and I proceeded to

Mene Grande by boat the next morning. We had a good cabin cruiser and made the trip without incident.

Mr. Stokes was left in charge and buttoned things up. He had his wife there with him and had comfortable quarters, so it was a good arrangement. There was no point in continuing operations anyway, as there was no way of marketing the oil at that time, and due to the war there were restrictions on the use of steel. Also, in order to ship the oil to Curaçao where there was a deep-water harbor, it would have been necessary to take the oil out of the lake in shallow-draft barges as there was only twelve feet of water over the bar at the mouth of the lake.

I then left for Port of Spain via Curaçao and took a Dutch steamer. It was the cleanest and neatest ship I was ever aboard—simply immaculate, and quite a contrast to the surroundings I had just left.

We arrived there in due time, were informed of the conditions that had resulted from the war, and were advised that the British Admiralty had ordered certain restrictions put into effect for protection of the oil in storage and of the producing wells, also to evacuate all personnel from the Brighton Camp if necessary.

After this was completed I left for the States on one of the pitch boats; I think it was the "Matura." We sailed without lights and were blacked out at night. The voyage was uneventful, as apparently the Germans were not bothering with a load of asphalt.

I reported to the management, and after closing the details that were necessary I resigned and severed my connection with the company, as I was reluctant to return to the tropics.

Later development resulted in this area becoming one of the largest oil fields in the world.

CHAPTER 28

CONCLUSION

It is difficult to sit here in April, 1959, and take my thoughts back to December, 1916, and say what my conclusions were regarding our work in Venezuela and Trinidad, and what I believed the future held for the oil and gas developments of these countries.

Two things stand out in my mind crystal clear: First, considering the conditions under which our geologists and engineers worked and their lack of experience in a science in which they themselves were then helping lay the foundation stones, I' believe they did an excellent job. Second, I was always exceedingly optimistic regarding both countries from the first trip I made over them. This was particularly true of the Maracaibo Basin because of the many things it had in common with the San Joaquin Valley fields of California, with which I was familiar.

To be a little more specific, I was hopeful or the development of many new minor structures in the southern and eastern part of Trinidad.

I was disappointed in the failure of most of the test wells drilled in the silt-filled Guanoco Basin and did not look for good results in that area.

I was enthusiastic about the possibilities of the Llanos country between the mountains and the rios Orinoco and Capura and westward from Monagas to Tachira because of the findings of Macready, Boyd and Garner. This, it seemed to me, was a series of favorable oil structures buried beneath the blanket of Llanos beds which only exploratory drilling could fathom.

The mountainous country, inland and along the north coast westward as far as Falcon, had shown no important evidence of oil or gas, so this territory was written off as of little value.

The region from Falcon along the east shore of Lake Maracaibo as far south as La Ceiba yielded some of the largest and liveliest oil seepages of any in Venezuela, if not in the world, so naturally this was my first choice of all the Venezuelan districts.

The great La Paz pitch lake, west of Maracaibo, indicated great possibilities for the flat country between the Peri j a Range and Lake Maracaibo, hence I recommended the country around La Paz and the adjoining portions of Mara.

Anything just in front of the Perijá Fault from the Rio Limon and the Inciarte seepage southwards to the south end of the lake seemed to have good possibilities, as did also the Llanos between the mountains and the lake. I was therefore led to recommend taking all of the concessions in this vast area possible. But, of course, there was a limit.

In 1906, I prepared a report on the Summerland oil field on the coast of California. Here commercial oil production was recovered from wells drilled into the off-shore ocean bottom. The first time I saw the seepages along the northeast shore of Lake Maracaibo, I began to think of developing oil underneath the lake. Discussions with officials of the company (and I will say they were very conservative) along the lines of such sub-water drilling did not elicit any enthusiasm, and the subject was dropped. I think the principal reason for the Company's not going into the lake was because it had more concessions on hand than it could handle in the limited time in which we had to operate.

The line of submarine disturbance between the southwestern tip of Trinidad and the mainland of Venezuela also intrigued me, and this zone was given some thought, but was turned down because of too much land available above water.

Thus, when I left the service of the Company at the end of 1916, I felt that our group of 52 geologists had not only given good measure with our services in locating vast areas of practically proven grounds, but had pointed to almost unlimited territory almost as desirable for future exploration and development.

APPENDIX I

DRILLING DEVELOPMENT PERSONNEL

E. Eggleston Smith
Clarence Waring
Arthur C. Veatch
Ralph Soper

Carlos Dominguez, Asphalt Company Agent

Special information given by:

David Donoghue—Historical and other data
R. C. McCurdy—General Manager, Caracas

Office
O. W. Wells-Maps

General Managers:

L. J. Proctor-1911 to 1916
W. D. Fowler-1912 to 1916

Managers of Oil Development:

Fred R. Bartlett, Bermudez Company, 1912 and 1913
H. H. Maddren, 1914 to 1916

Agents and Cashiers:

Alexander Fraser, Cashier, Trinidad
W. H. Kennedy, Cashier, Trinidad
Andrew J. Rock, Cashier, Guanoco
W. T. Doyle, Agent at Caracas

Drilling Superintendents:

F. L. Feisthammel, Guanoco, 1911 to 1912
J. H. McKnight, Trinidad and Guanoco, 1911 to 1912
J. W. McPherson, Trinidad and Guanoco, 1914
C. A. Bostaph, Trinidad and Guanoco, 1914
Jack Stokes, Lake Maracaibo, 1914 to 1916

Production Foremen:

J. H. Augsburger, Trinidad, 1914-1915
Paul Massey, Trinidad, 1915
J. H. Nicholson, Trinidad, 1915-1917

Tool Pushers:

George Barber, Trinidad, 1912

D. E. O'Brien, Trinidad and Guanoco, 1913
Ed McKnight, Guanoco, 1913

W. D. Osley, Guanoco, 1913
McManus, Bermudez Co., 1915
Lee Scott, Trinidad, 1914

Drillers:

Hill, Trinidad, 1913-1915
McBurney, Trinidad, 1913-1915
A. Lea, Trinidad, 1913-1916
S. Watts, Trinidad, 1914-1916
F. Chambles, Trinidad, 1912-1913
F. Winberly, Trinidad, 1912-1913
W. M. Keck, Trinidad, 1912-1913
George Barber, Trinidad, 1912-1913
0. Wolverton, Trinidad, 1913-1915
W. D. Owsley, Trinidad, 1913-1915
D. E. O'Brien, Trinidad and Venezuela,

1913-1915
A. Smith, Trinidad and Venezuela, 1913-1915
C. A. Dore, Trinidad and Venezuela,

1913-1915
J. Lotton, Venezuela, 1913-1915
B. Smith, Trinidad and Venezuela, 1913-1916
Davis, Venezuela, 1913
Lee Scott, Trinidad, 1913-1914
W. Brookover, Trinidad and Venezuela, 1914-1916
C. A. Ingle, Trinidad and Venezuela, 1914-1916
B. Stockton, Trinidad, 1914-1916
G. Stockton, Trinidad, 1914-1916
N. C. Graham, Trinidad, 1914-1916
G. D. Lower, Trinidad, 1915-1916
C. R. Pelton, Trinidad, 1914-1916
C. W. Paterson, Machine Shop, Trinidad, 1916
D. L. Driscoll, Machine Shop, Trinidad, 1916
J. Welch, Blacksmith, Trinidad, 1914-1916
H. Knight, Hammer Driver, Trinidad, 1914-1916
G. Ward, Tank Builder, Trinidad, 1912-1916
J. Hart, Tank Builder, Trinidad, 1912-1916
M. Moran, Mechanic, Trinidad, 1912-1916
Sam Schrum, Rig Builder, 1913-1916
Adam Fulton, Rig Builder, 1911-1914
William McElwee, Rig Builder, 1911-1912
Jim Putney, Rig Builder, 1915-1916
McCrae, Store Keeper

APPENDIX II

Wells which had been drilled up to November 1, 1915—Report
Trinidad Lake Petroleum Company

Field	Well No.	Depth	Completion Date	Daily Production	Total Production
Trinidad					
Brighton	1	790	6/5/1908	Dry	
”	2	858	8/24/1908	40	3,033
”	3	377	2/1/1909	Unfinished	
”	3	725	5/24/1909		2,180
”	4	1,067	5/14/1909	150	158,803
”	5	1,280	10/1/1909	5 ?	1,000
”	6	955	8/20/1910	11	2,350
”	7	915	9/21/1910	500	46,606
”	7-A	832			
”	8	1,250	9/11/1911	166	
”	9	789	8/22/1911	150	117,955
”	10	844	7/1/1911	100	115,335
”	11	921	8/24/1911	50	34,989
”	12	1,050	10/20/1911	Dry	
”	13	903	11/3/1911	100	16,294
”	14	718	1/14/1912	60	21,028
”	15	559	12/11/1911	30	37,696
”	16	1,105	6/21/1912	25	5,261
Levet	17	1,030	10/11/1911	Abandoned	
”	18	1,020	10/13/1911	”	
”	19	950	11/6/1911	”	
”	20	945	11/7/1911	”	
Brighton	21	762	1/8/1912	75	4,121
”	22	1,765	3/4/1912	10	7,368
Levet	23	789	10/21/1912	Abandoned	
”	24	2,188	9/11/1912	”	
Brighton	25	995	4/26/1912	”	
”	26	672	3/28/1912	30	2,519
”	27	711	4/19/1912	Abandoned	
”	28	857	5/16/1912	”	
”	29 to 33	more drilled			
”	34	910	2/15/1912	5	24,895
Vessigny	35	1,418	12/4/1914	12	53,853
	36 ?				
”	37	1,606	1914	20	168,495
”	38-A	2,000	1/3/1915	Abandoned	
”	39	1,468	1915	”	
”	40	1,680	1915	4	19,609
”	41	1,838	10/1915	50	68,901

”	42	1,955	10/1915	50	142,138
”	43	1,571	11/1913	Abandoned	
”	44	1,554	4/1914	”	
”	44-A	1,650		7	5,799
”	45				
”	46				
Brighton	47	906	2/18/1915	63	23,287
”	48	933	5/15/1916	65	23,362
”	49	1,036	9/16/1915	50	2,150
”		1,235			

Petroleum Development Company

Trinidad DailyTotal

Field	Well No.	Depth	Completion Date	Production	Production
Lot 1	1	1,140	1913		
”	2	510	10/7/1914	20	45,495
”	3	576	4/1/1914	16	18,235
”	4	588	3/13/1914	32	146,184
”	5	579	4/1914	33	30,918
”	6	600	4/25/1914	11	9,448
”	7	1,640	4/30/1914		3,811
”	8	538	5/19/1914	62	42,561
”	9	433	8/9/1914	23	25,681
”	10	507	6/13/1914	71/2	17,343
”	11	432	6/25/1914	27	70,181
”	12	1,790	7/20/1914	5	441
”	13	496		26	35,593
”	14	498	8/1914	6	8,327
”	15	665	8/21/1914		
”	16	476	10/12/1914		23,424
”	17	480	9 12/1914	19	22,031
”	18	460	9/24/1914	5	
”	19	460	9/6/1914	16	22,693
”	20	441	9/19/1914	20	21,167
”	21	450	11/17/1914	21	17,585
”	22	550			
”	23	460		19	7,422
”	24	645			
Lot 5	1	2,570		33	5,862
		240	top of Stallmeyer oil zone		
		240-370	oil sand		
		599-623	gray shale trace of oil		
		651-790	”		
		1,950-1,993	heavy oil		
Lot 5	1	460	blue and sandy shales		

495	brown shale with small amount of oil sand
1,234	blue shale
2,455	blue shale with oil sand

Venezuela — Bermudez Company

Field	Well No.		Depth	Completion Date	Daily Production
Guanoco	Babor	1	55	12/1/1913	
”	”	2	2,040	11/11/1915	300 heavy oil
”	Babosa	1	1,315	6/22/1913	
”	Baca	1	651	10/9/1913	50
Pedernales	Becada	1	759	10/13/1913	
”		2	750	1/20/1914	
”		3	275	7/8/1914	
”		4	257	8/13/1914	

Caribbean Petroleum Company — Prior to Nov. 14, 1915

Field	Well No.		Depth	Completion Date	Daily Production
Mene Grande	Zumaque	1	443	4/15/1914	200
99	Zumaya	1	1,670	10/25/1914	2,500 gusher
99	Zumba	1	912	11/26/1914	1,000
99	Zumbador	1	895	10/15/1915	gusher 20 to 40,000
Perijá	Zumbapalo	1	556	8/1914	Abandoned
”		2	803	10/24/1914	*99*
”		3			

Venezuelan Oil Concessions

Field
Well No. 1
0-15 surface soil
15-20 sandy blue shale
20-90 pink shale
90-105 gray sandy shale
105-655 sandy shale
655-660 white sandstone, water, gas and some heavy oil
660-850 sandy gray shale
850-940 darker gray shale
940-943 tar sand zone
943-944 water sand zone
944-1,038 oil sand (heavy oil)
1,038-1,044 blue shale
1,044-1,074 heavy oil zone
1,074-1,105 blue shale
1,105-1,151 sandstone
1,151-1,151 oil sandstone

1,155-1,203 shale and sandstone
1,203-1,228 oil sandstone
1,228-1,424 sticky blue shale
1,424-1,430 light oil
1,430-1,432 water sandstone

El Mene Field
Well No. 2
0-12 surface soil
12-77blue shale
77-140 dark blue shale
140-165 blue shale
165-275 blue shale
…
282-790 blue sandy shale
790-940 black shale
940-1,700 blue sticky shale
1,700-2,570 hard sandstone

La Rosa Field
Well No. 5
0-60 blue sandy shale
60-130 red blue clay
130-202 blue clay
202-400 blue clay
400-465 sandy shale
465-485 water sandstone
485-520 sandy blue clay
520-720 blue clay
720-790 blue layers sandstone
790-805 blue clay
805-885 gas sandstone
885-955 oil sandstone
955-1,088 blue gray clay
1,088-1,112 oil sandstone

Mene Grande Field
Production and History of Zumba Well No. 1

The well commenced in February 1914: steel derrick and cable tools. The main features of the formation encountered were as follows:

From Surface to 92 feet: Conglomeratic material with streaks of tar sands in it.
From 92 feet to 400 feet: Many alternating heavy tar sands and sandy clays.
From 400 feet to 703 feet: A stretch of variegated clays.
From 703 " " 729 ": An oil sand showing much gas.
From 729 " " 784 " :Variegated clay.

From 784 " " 797 ": Oil and gas sand; exceedingly strong gas pressure.
From 797 " " 822 ": Variegated clay.
From 822 " " 835 ": Oil sand.

From 835 " " 882 ": Variegated clay.
From 882 " " 890 ": Oil sand.
From 890 " " 905 ": Variegated clay.
From 905 " " 912 ": Oil sand.
From 912 " " 921 ": Light gray clay.
From 921 not drilled: Apparently hit heavy pressure oil sand.

The oil sands mentioned in the above log of the well merit the following comments:
The oil sand at 703 feet: This sand had considerable pressure on it and made from 500 to 700 barrels per day at a rough estimate.

The oil sand at 784 feet: The pressure of gas was very strong here, blowing hard, and spraying oil. The amount of oil would seem to be about 75 barrels per day and was thought to be about 11.5 degrees Baumé. The gas blew so hard for nearly a week that the work was stopped on account of the pressure.

The oil sand at 822 feet: A well saturated oil sand.

The oil sand at 882 feet: A productive sand, with gas abundant.

The oil sand at 905 feet: Well kept blowing out from here and had to keep circulation to make headway. Strong gas pressure. The production could not be estimated, but was on the increase when the well was struck by lightning on November 10, 1914. The fire was only extinguished December 6, 1914. A test showed that this sand makes about 1,000 barrels per day. A new rig and derrick was now erected and drilling continued at the end of March 1915.

The oil sand at 921 feet: Was just tapped and the well started off at about 5,000 barrels per day. She was capped and completed. The gravity is about 16 B.

Caujarao (Falcón): río
Cazadora, quebrada (cerca del ríos Raya y San Pedro (en las estribaciones de las montanas de Trujillo):
La Ceiba (Trujillo):
Chaguaramal (Monagas, NW de Maturín): pueblo
Chama, río (Mérida y Zulia):
Chapopotal (Monagas): mene; quebrada
Chatham (Trinidad)
Chichiriviche (Falcón):
Chimborazo, cerro (1.200 m de altitud al NE de Bachaquero):
Chiruri, rio (en Mérida y Zulia):
Cicaíno (quebrada a cuatro millas al NW de Guanoco):
Cieneguita (Falcón):
La Cienaguita de Papina (Falcón):
Ciudad Bolívar
Cochino, cerro (S de la laguna Tulé):
Cogollo, río; cañón; sierra; anticlinal (Zulia):
Colón (Panamá):
Colón (Zulia): distrito
Colón, pueblo (Táchira):
Colorado (Monagas): caño; mene
Colorado (Zulia): caño
Colorado (Estados Unidos): río
El Consejo (Zulia):
Copé (Táchira): quebrada
Cordero (Táchira):
Coro (Falcón):
La Coruba (Zulia):
Corubo (Falcón):
Costa, cordillera de la
Cristóbal Colón (hoy Macuro, Sucre):
La Cruz (Monagas):
Cubagua, isla
El Cubo (Zulia): campamento
Cuiba, río (afluente del río Cogollo):
Culebra (Zulia), quebrada; mene
Cumaná (Sucre):
Cumanacoa (Sucre):
Cumarebo (Falcón):
Curraría ($2^{1/2}$ miles northeast of La Rosa)
Curucutí (estación del tren entre Caracas y La Guaira)
Dabajuro (Falcón)
Dibujo, el (Zulia)
La Dificultad (Zulia): caño
Distrito Federal
Dispatch Reef (Trinidad)
Los Dos Manantiales, mene (Zulia)

El Emboscado (Zulia)
Encontrados (Zulia)
Eusebio (Zulia): caño
Falcón
El Fausto (Zulia)
Finoles (Zulia): mene
Las Flores (Zulia): mene
La Fría (Mérida)
Frío (Mérida): caño cerca de mina Onia,
Fyzabad (Trinidad)
Gamelotal (Zulia, distrito Bolívar): cerro
Gaudal (cerca del rio Tulé) Ver foto p. 106
La Ge, cañón del río (Zulia):
Gil Blas (Zulia): cañada
Gran Colombia:
Guaidima (Falcón): caserío
La Guaira (Vargas)
La Guajira, península
Guana (al oeste de Paraiguaipoa): montaña
Guanaguana (Monagas):
Guanipa (Anzoátegui):
Guanaco (Monagas): lago
Guanta (Anzoátegui):
Guariquén (Sucre):
Guasare (Zulia): río
El Guayabo (estación del ferrocarril entre Encontrados y La Fría):
Guayana: macizo guayanés
Guayuta (Monagas): río
Guineo (Zulia): sierra
Güiria (Sucre):
Los Haticos
Higuero[te]
Imataca (Bolívar): sierra
Inciarte (Zulia): caño; mene
El Indio (Zulia): sierra
Irapa (Sucre):
Isla, caño de la (y caño Eusebio tributarios del rio de Oro):
Jadacaquiva (Falcón):
Juncalito (Falcón): mene

Perijá (Zulia): anticlinal; mene; distrito; falla; serranía; falla; sierra frontal
El Pescado (Zulia): quebrada
Petróleo (Zulia): campamento; mene
La Petrolia (Táchira):
Petrolia (Ontario)
Piche (afluente del río Cogollo):
Las Piedras (Zulia): caño
El Pilar (Sucre):
Pirital (Monagas): hato; mene
Píritu (Anzoátegui):
Pitch Lake (Trinidad)
Playitas (Zulia):
La Plata (Zulia):
Playa Grande (sur del lago de Maracaibo):
Potrero (Falcón):
Pozos Azules (Falcón): hacienda
Pueblito (Zulia):
Puerto Cabello (Carabobo):
Puerto Palo (en el río Catatumbo):
Puerto Rosas (sobre el río Guasare, entre los antiguos distritos Mara y Páez):
Punceres (Monagas): pueblo; río
Punta Gorda (Zulia):
Punta Iguana (occidente del lago de Maracaibo):
Putal (en las cercanías de Villa del Rosario):
La Quebrada (Zulia): cerca del río Palmar
Quebrada Blanca (Cordero):
Los Quemados (Falcón):
Quinimarí (Táchira): río
Quiriquire (Monagas):
Quisiro (Falcón):
Los Ranchos (Zulia):
Raya (afluente del río San Pedro): río:
Río Seco (Falcón): Ojo en el original, p. 278, 3ª linea col. A: El Ricseo
La Rita (Zulia):
El Rodeo (Falcón): cerro
El Rodeo (Zulia): caserío; serie
La Rosa (Zulia):
Rubio (Táchira):
Rudal (Zulia y Falcón): El Rudal, El Cousje y río Cocuiza
Sabana de Mendoza (Trujillo):
Sabana Grande (Trujillo):
Sabana Grande (Zulia):
Sabaneta (Monagas):
Sabanilla (Monagas):
Saladillo (Falcón): mene
Salado (Táchira): caño
Salina Rica (Zulia):
Saltenejas
Salto (Falcón): cerca de San Juan
San Andrés (Zulia): cerro
San Antonio (Monagas):
San Antonio (Zulia):
San Carlos (Zulia): isla
San Cristóbal (Táchira): ciudad; mene
San Felipe (Yaracuy):
San Fernando (Trinidad):
San Francisco (California):
San Francisco (Falcón):
San Jerónimo (35 millas al E de Santa Rita): mene
San Joaquin Valley (California):
San Joaquín (Zulia): río
San Juan (Monagas):
San Juan (Puerto Rico):
San Juan de los Morros (Guárico)
San Juan (Falcón): río
San Lorenzo (Zulia)
San Pablo (Trujillo):
San Pedro del Río (Táchira):
San Pedro (cerca del río Paují): mene; río
San Rafael (Zulia): caño
San Timoteo (Zulia):
Santa Ana de Coro (Falcón):
Santa Ana (Zulia): río
Santa Bárbara (Monagas): pueblo; río
Santa Bárbara (Zulia): laguna o ciénaga
Santa Bárbara (hoy San Carlos del Zulia):
Santa Isabel, río
Santa María, puerto al S del lago de Maracaibo
Santa Rita (Zulia): mene; pueblo
Santa Rosa de Aguas Blancas (hoy río Sucumo, Zulia): río
Santa Rosa de Aguas Negras (Zulia): río
Santa Rosa (Zulia): pueblo
Santa Rosita (Zulia): campamento
Sardinata (río Tarra): río
Sibucara Gorda (Falcón):
Sinamaica (Zulia): laguna

Siquisique (Lara):
Socuy (Zulia): río
La Soledad (Falcón):
Soro (Sucre):
Sucio (Zulia): caño
Sucre
Tabacal (cerca de Torondoy): mene
Los Tablazos (Falcón): mene
Táchira
Taft
Táriba (Táchira):
Tarra (Zulia): anticlinal, río Sardinata:
Temblador (Zulia): mene
Tinacoa (Zulia): cañón; río
Tinajitas (Falcón): cañón
Tintini (Zulia):
Toas (Zulia): isla
Tocuyo (Lara): río
Tomás (Colombia): río
Torondoy (Mérida):
Totumo (Zulia): caño; cañón; mene
Tovar (Mérida):
Trujillo (estado); montañas
Tucacas (Falcón):
Tucuco (Zulia): rancho; río
Tucupita (Delta Amacuro)
Tulé (Zulia): río
Último Menito (Zulia):
Uracá (Táchira):
Urica (Anzoátegui)
Valencia (Carabobo):
Valencia (Carabobo): lago
Valera (Trujillo)
La Vela (Falcón):
El Venado (Zulia): quebrada
Viejo (Zulia): río
El Vigía (Mérida):
Villa de San Francisco (hoy Caracas)
Villa del Rosario (Zulia)
Villamizar (Colombia)
Willemstad (Curazao)
Las Virtudes (Táchira): hacienda
Yaguaraparo (Sucre)
Yaracuy
Yasa (Zulia): campamento; río
Yasa (Zulia):
Yasita (Zulia): campamento
Zamora (territorio que comprendía el actual estado Barinas y partes de Apure, Portuguesa y Cojedes):
Zapatire (Zulia): Zapalavo en un croquis
Zazárida (Falcón):
Zulia, río