ASOCIACION VENEZOLANA DE GEOLOGIA, MINERIA Y PETROLEO

GUIDEBOOK TO THE GEOLOGY OF WESTERN TACHIRA [1]

Por G. W. Trump and Amos Salvador, Creole Petroleum Corporation, Caracas, Venezuela, 24 al 26 de Octubre de 1964.

FIGURE – 2

COMPOSITE COLUMNAR SECTION OF WESTERN TACHIRA

(POST – PALEOZOIC)

AGE	FORMATION	MEMBER	LITHOLOGY	GENERALIZED LITHOLOGIC DESCRIPTION
CENOZOIC – QUAT. – Recent				ALLUVIUM and TERRACES. SAND, GRAVEL and CLAY.
CENOZOIC – QUAT. – Pleistocene				
CENOZOIC – TERTIARY – Pliocene	GUAYABO GROUP – BETIJOQUE			Unconsolidated boulder and cobble CONGLOMERATES, white SANDSTONES and mottled CLAYS.
CENOZOIC – TERTIARY – Miocene	GUAYABO GROUP – ISNOTU			White, massive, fine-grained SANDSTONE & mottled CLAYS.
	GUAYABO GROUP – PALMAR			White to yellow, fine-grained SANDSTONE and gray SHALE.
CENOZOIC – TERTIARY – Oligocene	LEON			Greenish to purplish-gray SHALE.
CENOZOIC – TERTIARY – Eocene	CARBONERA			Alternating gray, carbonaceous SHALE, SILTSTONE and SANDSTONE w/ thin COALS.
	MIRADOR			Clean, white to yellow SANDSTONE w/ some thin beds of mottled CLAYSTONE.
CENOZOIC – TERTIARY – Paleocene	LOS CUERVOS			Alternating carb. SANDSTONE, SILTSTONE, SHALE & COAL
	BARCO			Fine-grained, yellow to white SANDSTONE, & SILTSTONE
MESOZOIC – CRETACEOUS – Maestrichtian	MITO JUAN – COLON	CATATUMBO		Thin bedded, carbonaceous SANDSTONE, SILTSTONE and SHALE. Some thin COALS.
MESOZOIC – CRETACEOUS – Campanian				Dark gray to black, silty SHALE w/ calcareous SANDSTONE developed locally near the top.
MESOZOIC – CRETACEOUS – Santonian				
MESOZOIC – CRETACEOUS – Coniacian	LA LUNA	TRES ESQUINAS		Glauconitic SANDSTONE, locally calcareous.
		TACHIRA CHERT		Dark gray CHERT and siliceous SHALE.
MESOZOIC – CRETACEOUS – Turonian	CAPACHO	GUAYACAN		Black SHALE & thin, uniform beds of concretionary LIMESTONE.
		SEBORUCO		Massive, fossiliferous, gray LIMESTONE & black SH.
MESOZOIC – CRETACEOUS – Ceno-manian				Gray to black SHALE.
		LA GRITA		Black, thin bedded, concretionary LIMESTONE.
MESOZOIC – CRETACEOUS – Albian	MARACA			Arenaceous, fossiliferous LIMESTONE.
	AGUARDIENTE			Light gray to yellow, hard SANDSTONE and SILTSTONE locally glauconitic, and calcareous. Some SHALE.
MESOZOIC – CRETACEOUS – Aptian	APON	GUAIMAROS		Dark gray, sandy SHALE.
		TIBU		Bluish-gray nodular LIMESTONE.
MESOZOIC – CRETACEOUS – Barrimian	RIO NEGRO			White, yellow and red SANDSTONE, often coarse-grained and pebbly. Local beds calcareous. Rare SHALE.
MESOZOIC – CRETACEOUS – Neo-Comian				
MESOZOIC – JURASSIC	LA QUINTA			Red SANDSTONE & SILTSTONE w/ some green and white beds
MESOZOIC – TRIASSIC				

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ILLUSTRATIONS

EXCURSION PROGRAM

FIRST DAY - Saturday, October 24th

7:00 a.m. Depart from Maiquetía Airport.

10:00 a.m. Arrive La Fría Airport.

10:30 a.m. Depart La Fría Airport by chartered bus.

11:15 a.m. Arrive in San Cristóbal, check into Hotel Tamá.

12:00 noon Lunch.

1:00 p.m. Leave hotel by bus and meet at alcabala at junction of Pan-American Highway with San Cristóbal-Rubio Road.

1:15 p.m. Tour Cretaceous-Tertiary exposures along San Cristóbal-Rubio Road.

3:10 p.m. Drive through Rubio Depression to Alquitrana.

3:45 p.m. Visit old refinery and seeps at Alquitrana.

4:05 p.m. Drive from Alquitrana to the Copé asphalt seep.

4:52 p.m. Visit Copé asphalt seep.

5:07 p.m. Drive from the Copé asphalt seep to San Cristóbal, making two stops to study. Exposures of interest.

6:05 p.m. Arrive back at Hotel Tamá.

If due to unexpected circumstances, it is not possible to leave the hotel at 1:00 p.m., or if the field trip falls behind schedule, the side trip to the Copé asphalt seep may be omitted, and the excursion will proceed directly to San Cristóbal from Alquitrana.

SECOND DAY - Sunday, October 25th

7:00 a.m. Breakfast and check out of Hotel Tamá. Baggage will be sent ahead to the Hotel Aguas Calientes in Ureña.

8:30 a.m. Side trip into the mountains east of San Cristóbal for a review of regional geology weather permitting.

9:08 a.m. Return to San Cristóbal and drive to alcabala at junction of Pan-American

9:50 a.m. Highway with San Cristóbal - Rubio Road. Visit type localities of Táchira Chert and Capacho Formation; traverse

12:16 p.m. La Mulera Anticline. Lunch near La Mulera.

1:00 p.m. Tour Tertiary section along Pan-American Highway to San Antonio.

3:25 p.m. Drive to Hotel Aguas Calientes near Ureña. Overnight at Hotel.

THIRD DAY - Monday, October 26th

6:00 a.m. Depart Hotel Aguas Calientes by chartered bus.

7:00 a.m. Depart from La Fría Airport.

10:00 a.m. Arrive Maiquetía Airport.

GUIDEBOOK TO THE GEOLOGY OF WESTERN TACHIRA

Field Trip of October 24, 25 and 26, 1964
by
G. W. Trump and Amos Salvador
Creole Petroleum Corporation

INTRODUCTION

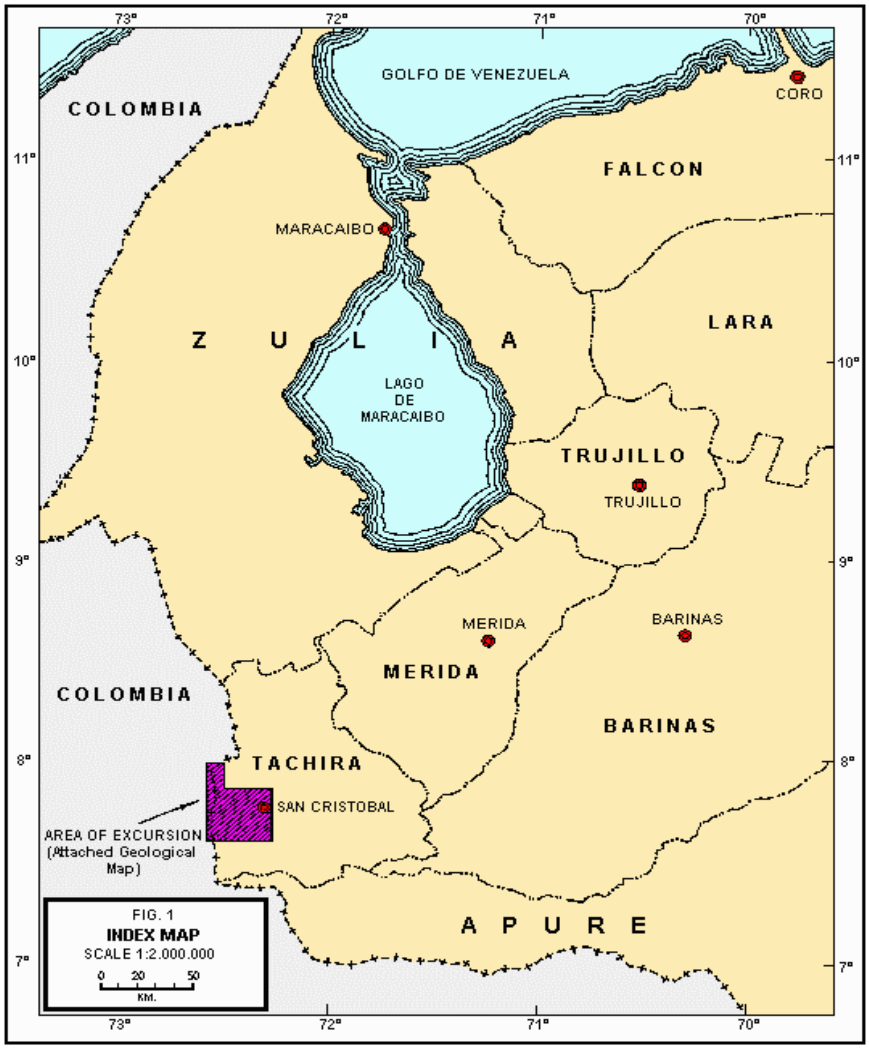
Western Táchira, the heart of the so-called "Táchira Gap", is one of the best areas in which to study the Cretaceous and Tertiary rocks of the Venezuelan Andes. Exposures are excellent, the stratigraphic sequence can be clearly established in spite of the fairly intense tectonic deformation, and the country side is traversed by numerous roads and trails which permit easy access to nearly all parts of the region. For these reasons, western Táchira seemed an obvious choice for the 1964 field trip of the Asociación Venezolana de Geología, Minería y Petróleo.

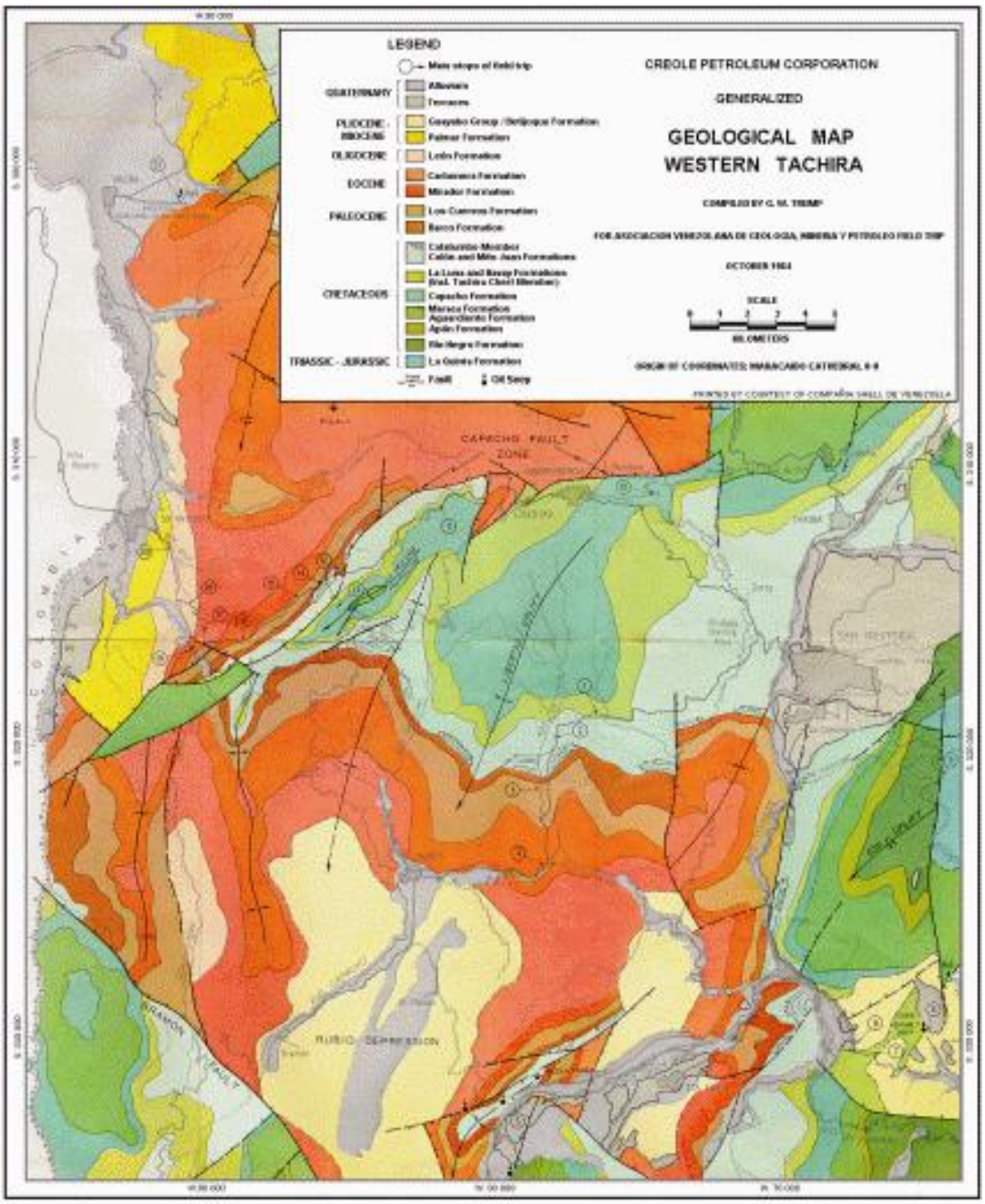
Táchira is the westernmost of the Andean states. It lies southwest of Lake Maracaibo and its western border forms the international frontier with the neighboring Republic of Colombia. Táchira has a surface area of 11,100 square kilometers and a population of 399,163 inhabitants, according to the 1961 census. San Cristóbal, the capital of the State, has a population of 98,777 (1961 census). It is located on a large, elevated fluvial terrace perched along the valley of the Río Torbes, 829 meters above sea level. San Cristóbal, and the State of Táchira in general, are easily accessible from others parts of Venezuela. They can be reached from the northeast by car through either the scenic Trans-Andean Highway or the faster Pan-American Highway. Westward from San Cristóbal, the Pan-American Highway continues to San Antonio, crosses the border to Cúcuta, Colombia, and leads eventually to Bogotá.

Due to its location in the heart of a mountainous area, San Cristóbal has no airport. The Santo Domingo, San Antonio and La Fría airports have been used at various times to reach the Táchira State capital. At present, the SantoDomingo airport is little used and that of San Antonio is temporarily closed. Therefore, air traffic to and from Táchira is now channelled through the La Fría airport, into which commercial airlines have daily flights.

The general itinerary of the field trip is included at the beginning of this guidebook; a detailed road log at the end. The generalized geological map attached to the guidebook is based on surveys by Creole geologists. The limits imposed by scale have made it necessary to omit some geological details. Nevertheless, the map should serve as a useful guide to excursionists wishing to fit individual stops on the road log into the broader geological framework of Táchira.

All outcrops visited during the field trip are either along well-travelled roads, or a short distance from them. A pair of old street shoes is more than adequate footwear for the excursion.





ACKNOWLEDGEMENTS

All members of the Junta Directiva of the Asociación Venezolana de Geología, Minería y Petróleo contributed, in one way or another, to the organization of the field trip, and to the preparation of this guidebook. However, the authors are particular indebted to Dr. R. M. Stainforth who not only helped in the time-consuming preparation of illustrations, but who also edited much of the original manuscript and offered many timely suggestions.

Humberto Espinal and Carlos Vásquez undertook the always difficult task of organizing hotel accommodations, food and transportation. Cía. Shell de Venezuela printed the geological map and made the log of Fila-1 available. Creole Petroleum Corporation printed the guidebook and contributed much private geological information to its preparation. Schlumberger Surenco, S.A. deserves the lasting gratitude of all excursionists for its excellent selection of "en route" beverages.

Finally, the field trip would hardly have been possible without the cooperation of the Venezuelan Air Force which so graciously provided air transport to and from Táchira.

STRATIGRAPHY

The following discussion of the stratigraphy of western Táchira will treat only that portion of the geologic column actually traversed during the field trip; that is, the Mesozoic-Cenozoic sequence. descriptions of individual units will be brief. For those wishing a more detailed treatment of the geology of the region, a list of selected references is included at the end of the guidebook.

Despite the structural complexity of western Táchira, the post-Paleozoic stratigraphic sequence of the region is now well defined, and there is general agreement concerning the selection of lithostratigraphic units and their nomenclature. The exact dating of some units remains in doubt, particularly in the case of the Tertiary non-marine intervals, but there is hope that palynological studies now under way will eventually solve this problem.

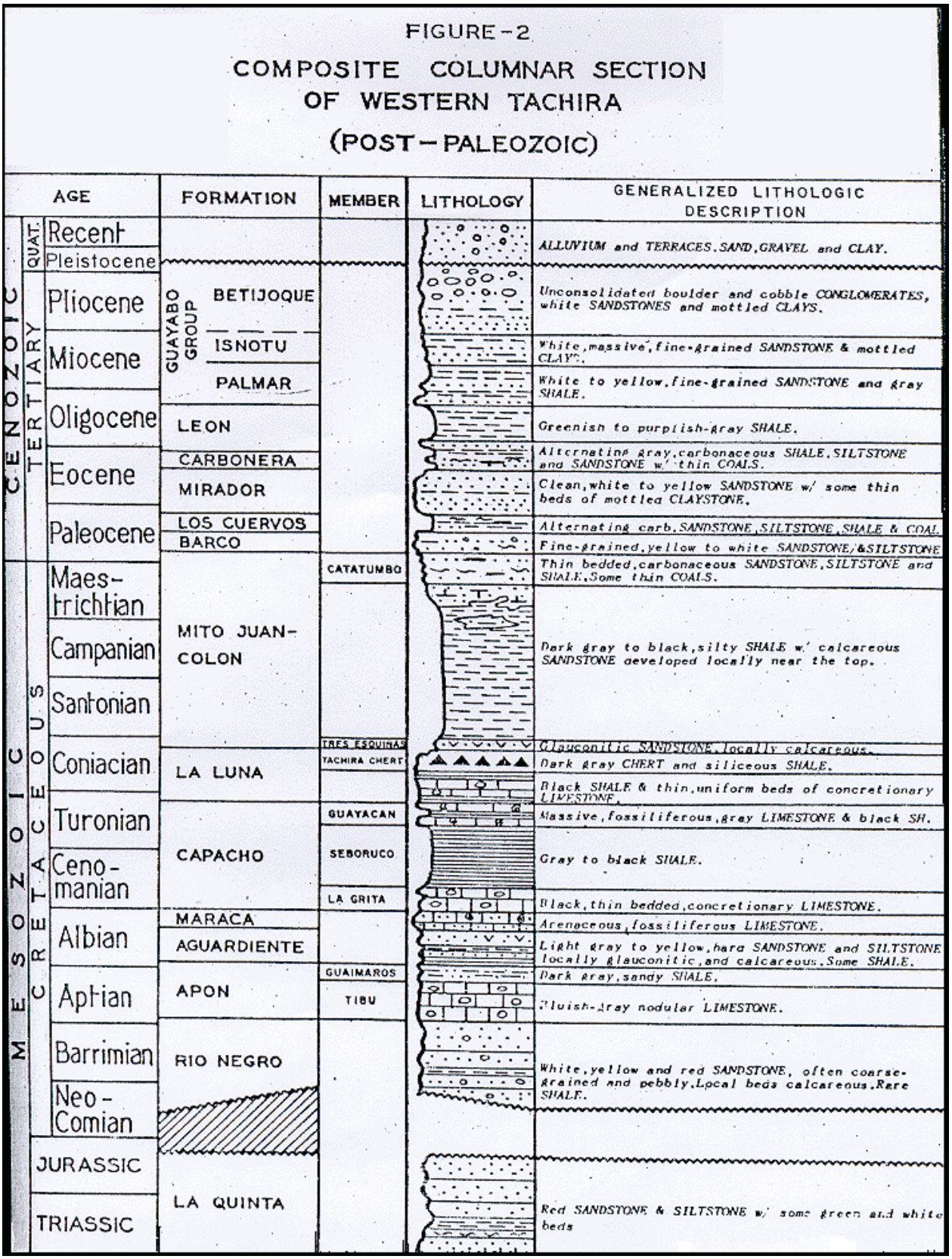
The first attempts to establish a stratigraphic classification and nomenclature for western Táchira were made principally by Garner (1926), Liddle (1928), Kehrer (1937, 1938) and Kündig (1938). These were generalized accounts, and the designation of stratigraphic units was often vague inadequate even though some of the terms persist in the present-day nomenclature. It was not until 1944 that a detailed description of the stratigraphic sequence appeared, applicable to this area and including proper designations of type sections, careful lithologic descriptions, and discussions of the distinguishing features of the named units. This was the now-classic paper of the Notestein, Hubman, and Bowler on the geology of the adjoining Barco Concession area of Colombia, which gained immediate acceptance by geologists familiar with western Venezuela.

The lithostratigraphic breakdown and nomenclature used by Notestein, Hubman and Bowler for the late Cretaceous and Tertiary units is still applied to western Táchira. The older Cretaceous section, however, has been somewhat modified in recent years as a result of the excellent work of O. Renz (1956, 1959, 1960) and regional studies by Creole geologists (see Salvador, 1961). These changes will be discussed in the following pages.

FIGURE-2

COMPOSITE COLUMNAR SECTION OF WESTERN TACHIRA

(POST-PALEOZOIC)



The stratigraphic nomenclature used in this guidebook follows that of the "Correlation Chart of Venezuela and Trinidad" prepared for a first Venezuelan Petroleum Congress, March 1962, and subsequently published in "Aspectos de Industria Petrolera en Venezuela" (Soc. Ven. Ing. de Petróleo, 1963), and in the Boletín Informatívo of the A.V.G.M.P. (vol. 6, N° 11, 1963, and vol. 7, N° 5, 1964). Data on original descriptions and stratigraphic status of almost all the units discussed are readily available in the "Stratigraphic Lexicon of Venezuela" (Min. Minas e Hidroc., 1956). Literature references to the few units introduced since 1956 are provided in the text.

TRIASSIC - JURASSIC

La Quinta Formation

In western Táchira the La Quinta Formation is dominantly composed of bricked, medium -to thick- bedded sandstones which form some of the higher mountains around San Cristóbal. These sandstones are often interbedded with red siltstone and blue-black, red-weathering, arenaceous shale. Thick beds of mottled white and green, medium -to coarse- grained sandstone occur toward the middle of the formation. Although the lower beds of the La Quinta are not exposed in the San Cristóbal area, at the type locality near the village of La Quinta in northern Táchira, the formation contains basal conglomerates composed of granites, phyllite and schist, which area in fault contact with Carboniferous schists. Elsewhere in Táchira, however, the La Quinta rests unconformably on granite. The upper contact, where exposed, is characterized by an angular unconformity with the overlying basal Cretaceous Río Negro Formation. The measured thickness of the La Quinta at type locality is 1517 meters. Estimates of its thickness in other localities range as high as 3500 meters.

Fossils in the La Quinta are extremely rare, and none have been found in the vicinity of San Cristóbal. Based on scant fish remains of probable lower Mesozoic age at the type locality, and on ostracods and phyllopods elsewhere, the La Quinta is generally assigned to the Triassic-Jurassic.

CRETACEOUS

One of the thickest and most complete Cretaceous sections in western Venezuela is found in Táchira. More than 3000 meters of Cretaceous deposits accumulated in the Uribante Trough, the axis of which lies a few kilometers east of San Cristóbal. This cycle of deposition probably began in Neocomian time and appears to have been continuous into the Tertiary.

The Cretaceous section in Táchira has been subdivided, from oldest to youngest, into the Río Negro, Apón, Aguardiente, Maraca, Capacho, La Luna, Colón and Mito Juan formations. Some of these formations are locally subdivided into members.

This terminology differs from that of Notestein, Hubman and Bowler (1944) in the following items:

1. It recognizes the basal Cretaceous sandstones as an individual lithostratigraphic unit, and applies to it the term, "Río Negro Formation", which has been carried into Táchira from its type locality in the Sierra de Perijá.

2. It eliminates the name "Uribante", a term very poorly defined originally, and which has since been used in a rather inconsistent manner.

3. It applies the term "Apón" to the section predominantly composed of limestone which overlies the Río Negro Formation. In the Barco Concession are and in parts of western Venezuela, this interval may be subdivided, on the basis of its sandstone content, into a lower unit where the sandstones are scarce, and an upper unit where the sandstones form an important part of the section. The name "Tibú" is applied to the lower unit, and the name "Mercedes" to the upper unit, both with the rank of members of the Apón Formation. However, to the northeast, it is not possible to establish this lithologic differentiation Whitin the Apón Formation. The Tibú and Mercedes members cannot, therefore, be recognized over most of the Venezuelan Andes (for further discussion see Salvador, 1961).

4. A conspicuous "shale break" is often encountered at or near the top of the Apón Formation. In Táchira this is named to Guaimaros Member, as defined by O. Renz (1959), modified by Salvador (1961), and depicted on the current correlation chart (Soc. Ven. Ing. de Petróleo, 1963).

5. The "Aguardiente member" of Notestein, Hubman, and Bowler is used with the rank of formation because the unit is widespread and very distinctive over the entire area of the Venezuela Andes.

6. A thin, but very persistent, limestone which occurs over most of western Venezuela above the Aguardiente of Lisure formations, and below the La Luna or Capacho formations, has been considered as a separate formation and named "Maraca Formation" (Rod and Maync, 1954). It is one of the best correlation markers in the Cretaceous section of western Venezuela.

7. The interval which was called "Cogollo" by Notestein, Hubman, and Bowler is here assigned the name "Capacho Formation". Notestein *et al.*, while correctly stating that what they called "Cogollo" was equivalent to the Capacho Formation of Táchira, were misled by apparent lithologic similarity of the upper or Guayacán Member of the Capacho with the limestones of the Cogollo in its type area in the Venezuelan foothills of the Sierra de Perijá. They erroneously correlated the two units. The work of O. Renz (1956, 1959) has proven conclusively that the Capacho of Táchira (and the "Cogollo" of Notestein, Hubman, and Bowler) does not correlate with the type Cogollo, but instead grades laterally into the lower part of

the La Luna Formation of the Central Perijá foothills. This is probably the only serious error in the stratigraphic scheme of Notestein *et al.*

Río Negro Formation

Although the Río Negro Formation is not well exposed along the main route of the excursion, it is relatively widespread, throughout the hinterlands east and north of San Cristóbal. The formation is composed largely of light-colored sandstones and conglomerates, with occasional beds of green or red siltstone. Thin, lenticular beds of brownish gray, arenaceous limestone containing *Chofatella*, *Exogyra* and *Trigonia* occur as minor constituents throughout the formation. Dark gray of greenish-gray, fossiliferous shales and siltstones are found in the lower part of the unit. Near the unconformable contact with the La Quinta, the basal Río Negro sandstones and conglomerates become increasingly red, and are often difficult to distinguish from the La Quinta red beds. The upper contact with the Apón is conformble. A faulted section of the Río Negro was measured in Río Chucurí very near Stop 9 of the excursion. Here the formation is 1065 meters thick. However, its thing rapidly northward until it is less than 40 meters thick in northern Táchira.

Fossils indicating an age ranging from Hauterivian to Aptian have been collected from the Río Negro in Táchira. The general lithology of the formation is characteristic of very near shore deposition.

Apón Formation

The Apón is not exposed along the excursion route. The formation consists of a series of light gray to blue gray, hard, often nodular, medium-bedded limestones interbedded with black to dark gray, calcareous shale and, less commonly, calcareous sandstone. As do all the Cretaceous units in Táchira, the Apón becomes sandier to the southeast, approaching the Guayana Shield. The formation is conformable with both the underlying Río Negro and overlying Aguardiente. Its measured thickness near San Cristóbal is 210 meters. Based largely on ammonite faunas, the Apón has been assigned an Aptian-lower Albian age. Its faunal content and lithology suggest deposition in a clear, shallow sea.

Aguardiente Formation

In Táchira, the Guardiente Formation is composed of light colored, hard, medium -to thick-bedded sandstone interbedded with carbonaceous shale and siltstone. The upper portion of the unit, as exposed at Stop 13, is often thin bedded and sparingly glauconitic, and lenses of the sandstone are sometimes calcareous. To the north and west of Táchira, the Aguradiente becomes increasingly calcareous and limestone beds are a distinctive feature of the lithology. Both the upper and lower contacts of the formation are conformable. The thickness of the Aguardiente ranges from 500 meters near San Cristóbal to less than 300 meters in northern Táchira. Fossils are scarce in the Aguardiente of central and southern Táchira. In northern Táchira, however, the well-known *Orbitolina* zone is characteristic of the formation. Based on the occurrence

of *Orbotolina lenticularis* (= "*O. concava texana*" of authors), the Aguardiente has been assigned to the lower and middle Albian. Very shallow marine conditions prevailed during its deposition.

Maraca Formation

Although Rod and Mayng described the Maraca Formation in the Perijá Range in 1954, the unit was not recognized in the Venezuelan Andes until Blazer and Dusenbury (1960) showed in their correlation chart that the Maraca of Perijá was equivalent to the La Puya Formation of the Venezuelan Andes (O. Renz, 1959). For many years the Maraca was mapped in Táchira as part of the basal Capacho. As seen at Stop 13, the formation is composed of gray, thick-bedded, arenaceous limestone containing an abundance of well-preserved, often recrystallized shells. Specimens of *Ostrea scyphax* and *Exogyra* sp. are characteristic of the formation. It is conformable with the underlying Aguardiente and overlying Capacho. At stop 13, the Maraca is less than five meters thick; however, it thickens northward into western Zulia. Fossils collected in the Maraca in Táchira have been dated as upper Albian. The formation was deposited in a shallow marine environment.

Capacho Formation

The name of this unit is one of the oldest in the annals of Venezuelan geology. It was used originally by Wilhem Sievers in 1888 to designate the limestone exposures near the village of Capacho Viejo, which has since been named Libertad. Stop 11, a short distance west of Libertad, is thought to be very near the original type locality. Three members of the Caparo have been recognized in Táchira. From oldest to youngest, they are the La Grita, Seboruco and Guayacán. Only the Guayacán, however, is exposed along the excursion route. It is composed of brownish gray to bluish gray, massive, crystalline limestone interbedded with dark gray to black, orange-weathering shale. Throughout Táchira, the Guayacán Member of the Capacho is conformable beneath the La Luna. The contact is well exposed at Stop 10 (Fig. 5). The Guayacán grades downward into the gray or black micaceous, argillaceous shales of the Seboruco Member which overlie the basal "La Luna-type" limestones of the La Grita Member. These two lower members are particularly well developed in northern Táchira. The measured thickness of the Capacho in Río Chucurí near Stop 9 is 310 meters. Northward toward the Perijá Range and northeastward toward Mérida and Trujillo, the formation grades laterally into the lower part of the La Luna Formation (O. Renz, 1956, 1959; Salvador, 1961). Based on its stratigraphic position and rare ammonites found in Guayacán beds at Río Zorca, the Capacho of Táchira is considered to range in age from Cenomanian to upper Turonian. It was deposited in shallow marine waters.

La Luna and Navay formations

Because of literal equivalence and intimate gradational relationship in the field trip area, the two formations will be treated together. The La Luna is one of the most widespread

and distinctive lithologic units in western Venezuela. It is relatively resistant to erosion and characteristically stands out in sharp ridges along valleys of the Colón shale. Because of its use as a road ballast, it is exposed in numerous quarries throughout the San Cristóbal-San Antonio area.

The lower portion of the La Luna is composed of gray to black, calcareous shales interbedded with grey cryptocrystalline limestones and occasional calcareous cherts. The limestones and cherts emit a petroliferous odor when freshely broken. Dark grey to black limestone concretions, ranging from a few centimeters to more than a meter in diameter is typical of the lower La Luna. The upper portion of the La Luna has been formally maned The Táchira Chert Formation by O. Renz (1959). However, since the unit is confined to a relatively restricted area in central and southern Táchira, it is best considered a member of the La Luna. At Renz's type locality (Stop 10), the Táchira Chert is composed of thin-bedded black chert in uniform layers ranging from about 5 to 20 centimeters in thickness. Siliceous limestone and layers of phosphatic breccacia are commonly interbedded throughout this interval. Elsewhere in southern Táchira, the Táchira Chert is composed of banded dark gray and light brownish gray chert, and siliceous shale. This is particularly true toward the southeast, where the unit grades laterally into the porcellanitic shales of the Navay Formation near the Táchira-Apure border. In this region the Táchira Chert becomes extremely light colored and silty, and the section is composed of a mixed lithology containing typical cherts of the upper La Luna and light tan, chalk-weathering shales and siltstones characteristic of the Navay Formation. The uniform bedding seen in the Táchira Chert is also a distinctive characteristic of the Navay; from a distance, exposures of the two formations look identical. Moreover, both units carry similar Campanian-Maestrichtian microfaunal assemblages. The La Luna of Táchira is conformably overlain by the Colón Formation. The contact at the type locality of the Táchira Chert is marked by the thin glauconitic sandstone bed of the Tres Esquinas Member (Stainforth, 1962), the basal unit of the Colón. In the transitional zone of the La Luna and Navay in southeastern Táchira, the top of the unit has been eroded and is overlain unconformably by conglomeratic beds of the Guayabo Group which are locally rich in asphalt (Stop 6). Near the Táchira-Apure border, the Navay grades upward into glauconitic and calcareous sandstones of the Burgüita Formation, the sandy unit into which the Colón Formation grades southward, toward the Guayana Shield. The thickness of the La Luna is relatively uniform over northern Táchira, ranging from 220 to 250 meters is measured sections, but increases southwestward into the Uribante Trough. At the type locality of the Táchira Chert, O. Renz shows a combined thickness for the La Luna and Táchira Chert of approximately 140 meters. Based on stratigraphic position, the lower La Luna in Táchira is considered to be Turonian in age; foraminifera from both the Táchira Chert Member and the equivalent Navay Formation have been dated as Santonian-Maestrichtian. The La Luna is generally considered to have been deposited under deep marine, euxinic conditions during the period of maximum transgression of the Cretaceous seas. However, the upper part of the formation in southeastern Táchira suggests a rather

shallow marine environment of deposition, relatively close to a source area in the Guayana Shield.

Colón and Mito Juan formations

Although the Colón and Mito Juan appear on the latest correlation chart (Soc. Ven. de Ing. Petróleo, 1963) as separate formations, over most of Táchira (indeed over much of western Venezuela) they are difficult to separate. The contact between them is extremely gradational and cannot be traced with any degree of certainty; hence, they are shown as a single unit on the geological map accompanying this guidebook. The characteristic lithology on the interval is dark gray to black, fissile, locally calcareous shale containing an abundant microfauna (Stop 2). A thin, glauconitic sandstone called the Tres Esquinas Member (op. cit.), occurs at the base of the interval in northern and central Táchira, but cannot be traced south of San Cristobal. The upper part of the Colón-Mito Juan often contains light gray, fine-grained, calcareous sandstones, siltstones and less frequently, lenticular limestones. Over restricted areas, this sandier part of the section can be mapped as the Mito Juan Formation. However, the dominant rock type, even is this upper interval, is the characteristic gray foraminiferal shales.

In western Táchira, carbonaceous sandstones, siltstones and shales occur near the top of the Colón-Mito Juan. These beds become well developed in the Barco Concession area of neighboring Colombia, where they are named the Catatumbo Formation. Over most of Táchira, however, these facies are only locally mappable; hence it is considered to be a member of the Colón.Mito Juan sequence, rather than a formation.

Both the upper and lower contacts of the Colón. Mito Juan interval is conformable. The upper contact with the Barco Formation is usually marked by a sharp topographic break. Such is the case at Stop 3, even though the contact is somewhat gradational. Measured thicknesses of the combined Colón-Mito Juan-Catatumbo interval in Táchira range from from 700 to 1300 meters. The Catatumbo Member along the San Cristóbal-Rubio Road is 400 meters thick. The Colón-Mito Juan sequence yields the most prolific microfauna's known in Táchira. Based on this assemblage, the interval has been assigned an age ranging from Santonian to Maestrichtian. However, since the carbonaceous beds of the Catatumbo contain Paleocene pollen, is generally agreed that the uppermost portion of the Colón-Mito Juan straddles the Cretaceous-Tertiary boundary.

TERTIARY

There is no field evidence in Táchira to suggest any depositional hiatus between the Cretaceous and Tertiary sediments. The sequence of deposition from the upper Cretaceous Colón-Mito Juan through the Cretaceous-Paleocene Catatumbo to the Paleocene Barco is distinctly one of transition from a marine to a brackish or fresh water environment.

Barco Formation

The Braco Formation is composed or yellowish brown or gray-brown fine-to-medium-grained sandstones and siltstones interbedded with lesser amounts of gray shale. The sandstones form the bulk of the section in central and southern Táchira. To the north-east, however, the Barco becomes distinctly siltier and cannot be separated from the overlying Los Cuervos. In northwestern Mérida, the two units are mapped together as the Angostura Group. The Barco typically form prominent ridges and flatirons between the less resistant beds of the Colón-Mito Juan on the one side and Los Cuervos on the other (Stop 3). It is conformable both with the underlying Colón-Mito Juan and the overlying Los Cuervos. The lower contact is clearly exposed at Stop 3 on the Rubio-San Cristóbal road where the Barco grades downward into the Catatumbo. At this exposure, the Barco is 82 meters thick. Elsewhere in Táchira it ranges up to 165 meters in thickness. Except for a few non-diagnostic arenaceous foraminifera, the Barco is barren of fauna. It does, however, contain Paleocene pollen. The formation appears to be largely a fluviatile to brackish water deposit.

Los Cuervos Formation

The Los Cuervos consists of an alternating sequence of gray, carbonaceous shales, siltstones and fine-grained, argillaceous sandstones, with occasional concentrations of low-grade coal beds. In some areas these coals reach a thickness of up to three meters and are worked commercially. Nodular ironstone bands are common throughout the formation and silty, lenticular limestones occur locally. Lithologic similarity between portions of the Los Cuervos, the Carbonera and the Catatumbo has often led to confusion in mapping structurally complicated areas where the order of superposition of the stratigraphic sequence cannot be observed. Despite a somewhat abrupt change in lithology, there is no observable angularity between the Los Cuervos and the overlying Mirador Formation in Táchira, though an angular unconformity has been recognized between the two formations in the Barco Concession (Notestein, Hubman, and Bowler, 1944). The formation ranges in thickness from 420 to 500 meters in measured sections near San Cristóbal. It thins northeastward into Mérida. Although the Los Cuervos is barren of diagnostic fauna, the carbonaceous beds contain abundant Paleocene pollen. The lithology of the formation is characteristic of a paludal environment.

Mirador Formation

The Mirador is typically composed of light-colored, medium- to thick-bedded sandstones with occasional breaks of mottled purplish gray shale or siltstone. The sandstones are quartzose and usually friable. They frequently contain quartz pebble stringers. Cross-bedding and ripple marks are common throughout the formation. Individual sandstones of the Mirador often resemble often resemble those of the Barco: hence, it is sometimes difficult to distinguish between the two formations in isolated outcrops. In the Barco Concession and in the Tarra area, a persistent shale break occurs near the middle of the Mirador. This "intermediate shale" is not widely recognized in outcrops of the formation in

Táchira. It has, however, been distinguished in shell's well, Fila-1 (Fig.6). That contact of the Mirador with overlying Carbonera is conformable and often gradational, as demonstrated at Stop 19. The relationship between the two formations becomes increasingly gradational into northern Táchira where the top of the Mirador cannot be drawn with certainty. The Mirador ranges in thickness from 80 to 190 meters. No diagnostic fossils have been found in the formation, nor have the rare pollen remains yielded any conclusive age determinations. Based on its stratigraphic position, the Mirador may range from Paleocene to upper Eocene. It appears to have been deposited in an essentially fresh water environment.

Carbonera Formation

Throughout Táchira, the Carbonera Formation consists of an alternating sequence of sandstones, siltstones, claystones, shales and coals, with occasional fossiliferous, sandy limestones. The sandstones are brown, fine -to medium- grained, and characteristically contain carbonaceous laminae. Bedding in the lower part of the section is typically massive, with thinner beds and increasing shale content toward the top of the formation. Carbonized plant remains are common throughout the sequence. The coal beds are usually concentrated in the lower two-thirds of the formation. They seldom exceed one meter in thickness. In normal sequence, the upper contact of the Carbonera is conformable with the overlying León Formation. Because the shales of the uppermost Carbonera and those of the León are very similar, the contact is placed rather arbitrarily at the top of the uppermost Carbonera sand. Since the upper Carbonera sands are often lenticular, this contact is likely to wander up or down the section. Complete sections of the Carbonera are rare in the San Cristóbal-San Antonio area. The formation is usually either faulted or unconformably overlain by young Miocene beds. In northern Táchira, the Carbonera is 475 meters thick. The Carbonera is the only Tertiary formation to yield a diagnostic fauna in the Táchira region. This fauna includes the well known *Hannatoma emendorferi* collected from the formation in Quebrada Seca a few kilometers southeast of San Antonio (Durham *et al.*, 1949). Based essentially on this macrofossil assemblage the Carbonera has been placed in the upper Eocene. Both the fauna and the lithology are indicative of a brackish water environment with progressively deeper water conditions toward the top of the formation.

León Formation

The León is composed almost entirely of olive gray to purplish gray shale, which locally becomes very silty. In the semi-arid region around San Antonio (Stop 18), the shales weather red and purple and contain grains of selenite. The formation shows very little resistance to erosion and commonly forms broad valleys. Both the upper and lower contacts are conformable and extremely gradational. The contact relationship between the León and the overlying Palmar is similar to that between the León and the Carbonera. The upper contact of the León is placed at the base of the first prominent sand above the continuous shale sequence. This sand then becomes the basal bed of the Palmar

Formation. The estimated thickness of the León in the San Antonio area is 450 meters. The formation is essentially barren of fauna throughout Táchira. A few arenaceous foraminifera have been found, but they are non-diagnostic for age determination. The León has been dated as upper Eocene to Oligocene on the basis of pollen. The environment of deposition of the unit is still open to conjecture. Notwithstanding the absence of fossils, the shales give the impression of having been deposited in at least moderately deep water. One of the more popular theories is that the León accumulated in a large fresh water lake.

Guayabo Group and Palmar Formation

Over much of Táchira, the post-León Tertiary section cannot be separated into individual units. This is particularly true in the area covered by the field trip, where the interval is mapped as the Guayabo Group. The only locality in which the post-Léon sequence has been assigned a formational name is near San Antonio where the Palmar Formation can be recognized, forming a distinct and mappable unit above the León shales (Stop 20). Here the Palmar is characterized by medium-to thick-bedded, light colored, fine-grained sandstones interbedded with León-type shales. The unit is conformable and gradational with the underlying Léon, and is overlain unconformably by Quaternary alluvium. Elsewhere in Táchira, the Palmar lies conformably beneath the Isnotú Formation. No detailed measurement of the Palmar is available in the San Antonio area. In northern Táchira, however, it attains thicknesses in excess of 1400 meters. Based on faunal assemblages collected in northern Táchira, the Palmar Formation is known to range in age from upper Oligocene to middle Miocene. The fauna suggests a brackish water to shallow marine environment of deposition.

With the exception of the Palmar near San Antonio, the Guayabo Group along the excursion route is composed of massive, light-colored unconsolidated sandstones and claystones. The claystones often weather to a mottled gray and red. The sandstones are usually thick-bedded are rippled marked. South of San Cristóbal, the interval contains thick accumulations of boulder and cobble conglomerates resembling the Betijoque Formation of northern Táchira and Mérida. These conglomerated often contain plant fragments and pebbles or cobbles of reworked Cretaceous rocks. In the Copé area (Stop 6), these conglomerates are unconformable on upper La Luna beds. Asphalt migrating upfit along this unconformable contact has permeated the conglomerates to such an extent that they are mined commercially for road surfacing. In the Rubio Depression, unconsolidated sandstones and claystones of the Guayabo lie unconformably on the Carbonera Formation. Throughout Táchira, the Guayabo is overlain by Quaternary alluvium. The Guayabo contains only rare re-worked Cretaceous fauna in the area of the field trip. The position of the formation above the Palmar, together with pollen remains, indicates a MIocene to Pliocene age range for the interval.

QUATERNARY

Fluvial Terraces

Elevated terraces of both Pleistocene and Recent age are found at various levels along the valleys of the main rivers. San Cristóbal is built on of the largest of these terraces: the town of Santa Ana on another one. They consist or poorly consolidated cobbles, gravels, sands, and clays derived from older formations. Foreset bedding, cross-bedding and great lenticularity is common. In the area of the field trip the Quaternary terraces are essentially horizontal or only slightly tilted.

Alluvium

Alluvial deposits, composed of unconsolidated sands and gravels derived from the surrounding terrain fill the major river valleys. In the area of the excursion, they are widespread along the flood plain of the Río Táchira from San Antonio to Ureña and in the Río Torbes valley near San Cristóbal.

STRUCTURE

The area covered by the field excursion lies in the heart of the so-called Táchira Gap, a marked structural and topographic depression separating the Venezuelan Andes from the Cordillera Oriental of Colombia. The regional axis of this structural depression passes roughly through Rubio Trending in a northwesterly direction.

The Táchira Gap area, as the rest of the Venezuelan Andes, is characteristically a block-faulted area where faults constitute the major tectonic elements. In the are visited during the field trip the main structural feature is a prominent half-graben formed by two large faults, the Capacho and Bramón faults, which intersect each other at nearly a right angle. The structurally depressed part of the half-graben has been called the Rubio Depression.

Superimposed on this broad structural frame is a north to northeast-trending fold system. Within the half-graben area, the most important positive trends are the La Mulera Anticline and its southern extension, which has been named the La Virgen Anticline by O. Renz (1960), the Libertad Uplift, and the Oso Uplift of which the Alquitrana Anticline appears to be an en-echelon continuation.

North of the Capacho Fault, and east of the San Antonio-Ureña Road is a sharp NNE overturned anticline which has been called the La Fila Anticline by O. Renz (1960). west of the Bramón Fault, between it and the Venezuelan-Colombian border, is a large unnamed anticline, trending roughly NNW.

Flanking these major positive elements, several important synclinal areas and clearly discernible. Most prominent is a large low between the Oso and Libertad uplifts which runs in a general NE-SW direction along the valley of the Río Torbes from the northeastern corner of the map, through Táriba and San Cristóbal and finally plunges into the Rubio Depression. Another important syncline, also plunging southward into the Rubio

Depression, trends north-northeastward between the Libertad Uplift and the La Virgen Anticline. Still another sharp, north-trending syncline can be seen paralleling the La Virgen Anticline to the west. Finally, a prominent low area is found parallel and to the north of the Capacho Fault, between it and the bent nose of the La Fila Anticline.

Further, the area is shattered by innumerable smaller faults and is complexly deformed into many folds of secondary importance.

The main structural elements that can be seen during the field trip ae briefly described below in the order in which they appear on the road log.

1. The Libertad Uplift is a broad, nearly domal, southwest-plunging anticline which forms the high hills west of the San Cristóbal. Sandstones of the Aguardiente Formation are locally exposed in the core of the uplift, and limestones and shales of the Capacho, La Luna, and Colón-Mito Juan Formation form the major part of the structure. It terminates to the north against the Capacho Fault and plunges southward into the Rubio Depression.

2. The Rubio Depression is the structurally lowest part of a major half-graben formed on the down dropped side of the Bramón Fault which bounds this low to the southwest. Topographically, it is a fairly flat intermontane depression filled with Mio-Pliocene and Quaternary deposits and rimmed on nearly all sides by prominent basin ward dipping ridges (dip-slopes) of the resistant sandstone's units of the early Tertiary Barco and Mirador formations. Several major folds plunge south-southeastward into the Rubio Depression. The most important of these are the Oso and Libertad uplifts, the la Virgen Anticline and the synclines which flank them.

3. The Bramón Fault is a northwest-southeast trending fault which has been traced southeastward for over twenty-five kilometers from the Venezuelan-Colombian border. There is evidence, such as overturning of beds in the upthrown side, that this fault is a reverse or overturned normal fault, upthrown more than 2500 meters to the west. Along the entire length of the Bramón Fault, Cretaceous sediments are brought in contact with Paleocene, Eocene and Mio-Pliocene beds.

4. The Alquitrana Anticline is a small northeast-southwest trending structure located approximately five kilometers west of the town of Santa Ana. It is the site of the oldest oil field in Venezuela, and several oil seeps are located in its core along small faults. The anticline is approximately eight kilometers long and plunges to the southwest with early Tertiary beds exposed on the flanks and shales of the Colón-Mito Juan in core. The Alquitrana Anticline is sharp and complex with steep dips common along both flanks and several axial and tear faults further complicating the structure (see Fig. 4). It is undoubtedly this very highly complex and fractured condition which favored the seepage of the oil to the surface.

5. The Oso Uplift is a broad northeast-southwest trending nose which forms some of the high hills southeast and east of San Cristóbal. The core is made up of La Quinta

red beds flanked by the complete Cretaceous section. It progressively loses character and plunges southwestward into an essentially homoclinal structure along the eastern rim of the Rubio Depression.

6. The Capacho Fault Zone is a southwest-northeast trending system of normal faults generally upthrown to the southeast, bringing upper Cretaceous rocks in contact with the early Tertiary sequence. Maximum displacement is estimated to be on the order of three thousand meters, but it is probably less along most of the trend of the fault zone. The Capacho fault system has been traced for over 25 kilometers from the Venezuelan-Colombian border to the neighborhood of Copa de Oro, north of San Cristóbal. It undoubtedly extends for a considerable distance into Colombia. This main system is offset in many places by small cross-faults. Some right-lateral strike-slip movement is suspected along the Capacho Fault, since the axes of the folds south of it can be seen to bend eastward as they approach the fault zone.

The Capacho Fault marks the northwestern boundary of the previously described large half-graben which dominates the structural picture of the area visited during the field trip.

7. The La Mulera Anticline is a small, symmetrical, northeast-southwest trending anticline which parallels the Capacho Fault to the southeast. Followed northeastward, the fold terminates against a cross-fault west of the town of Libertad. To the southwest it seems to swing away from the Capacho Fault to take an approximate north-south direction, becoming what has been called the La Virgen Anticline, and plunging into the Rubio Depression. Its credence is given to the previously discussed right-lateral strike-slip movement along the Capacho Fault, the Mulera Anticline could be considered as the dragged part of the La Virgen Anticline in the proximity of the Capacho Fault.

The core of the La Mulera Anticline is made up of the sandstones of the Aguardiente Formation, flanked in turn by the maraca, Capacho, La Luna, and Colón formations. As it plunges, initially southwestward, and then southward to become the La Virgen Anticline, increasingly younger beds crop out along the trend of the structure until, at its southern extremity, the Carbonera Formation forms the plunging nose of the structure.

8. The La Fila Anticline is an essentially north-south trending anticline, overturned to the west. Its east flank dips gently toward the east, but its west flank is vertical to overturned. Thrust faulting toward the west is suspected in places along this west flank. Several cross-faults are known to displace the axis of the structure. The core of the anticline is made up of the resistant sands of the Mirador Formation, which are flanked by the sandstone-shale sequence of the Carbonera. At its southern end, east of San Antonio, the La Fila Anticline swings sharply eastward as it approaches the Caparo Fault and fades into the synclinal area which parallels the fault zone to the north. Quebrada La Capacho crosses the structure where its axis bends eastward, and the Los Cuervos Formation is exposed in the core of the structure along the valley of the quebrada.

In 1955, Compañía Shell de Venezuela drilled their wildcat Fila-1 on the La Fila Anticline. The well was located down the gentle eastern flank, in the hope crossing the axial plane of the fold at the level of the Cretaceous limestones. The well was drilled to basement and abandoned at a total depth of 9030' without encountering any encouraging indications of commercial oil production (see Fig. 6).

ROAD LOG OF EXCURSION

The following road log and time table contains a brief description of the various stops to be made along the excursion route. Each stop on the log corresponds to a numbered reference point on the accompanying geological map. For a detailed discussion of stratigraphy and structure, excursionists can refer to the expanded treatment of these subjects in the early pages of the guidebook.

In order to avoid any confusion that might arise due to road repairs and detours in and out of San Cristóbal, the alcabala at the junction of the Pan-American Highway with the San Cristóbal-Rubio Road has been chosen as the starting point for both excursion days. It should be noted, however, that before starting from this alcabala on the second day, excursionists will be taken on a side trip into the mountains east of San Cristóbal for a panoramic view of the regional geology. Sinc this side trip is optional, depending on the absence of cloud cover, it has been logged as a separate item preceding the main route of the second day.

FIRST DAY

It is expected that, with good luck, the excursionists will be able reach San Cristóbal in time to have an early lunch at the Hotel Tamá and leave on the field trip at 1:00 p.m. If, due to unexpected circumstances, it is not possible to leave the hotel at this time, or, if upon reaching El Corozo, at the junction of the Alquitrana road with San Cristóbal-Santo Domingo Highway, the field trip is behind schedule, the side trip to the Copé asphalt seep may be left off in order nor to arrive back in San Cristóbal after dark.

Time	Kms.	Description
1:00 p.m.		Leave Hotel Tamá and Proceed to the alcabala at the junction of the Pan-American Highway with the San Cristóbal-Rubio Road. Occasional outcrops of Mito Juan sandy limestones and shales can be seen along the road.
1:15 p.m.	0.0	Alcabala at junction of Pan-American Highway with San Cristóbal-Rubio Road. Turn left. The road climbs low hills of Colón-Mito Juan to
1:25	6.8	STOP (1) (10 minutes). Quarry in La Luna limestone shale

		The La Luna in this area is usually very siliceous, especially its Táchira Chert Member. Phosphatic pellets and fish remain are common. The concretions which, on rare occasion, contain ammonites and dead oil in vugs, are characteristically confined to the lower one-third of the formation. As is the case in most of the La Luna throughout Táchira, this exposure shows intense folding are brecciation. It is likely that the formation has undergone several periods of deformation. The road continues trough La Luna crosses the covered contact between the La Luna and overlying Colón-Mito Juan
1:39 p.m. to 1:49	9.5	STOP (2) (10 minutes). Very typical example of dark gray to black Colón shale. This shale is the dominant lithology of the Colón-Mito Juan sequence throughout Táchira. Indeed, over most of the area, the Mito Juan might well, be relegated to member status, since its characteristic sandy limestones are developed only very locally. The road continues up-section through the Colón shale
1:53 to 2:43		STOP (3) (50 minutes). Thin-bedded sandstones and shales of the Catatumbo Member of the Colón-Mito Juan. This outcrop lies at the base of a nearly completely exposed sequence of Catatumbo, Barco and Los Cuervos. By walking along the road, excursionists can trace lithological changes through the sequence and, with the aid of the columnar section (Fig. 3) following this page, can readily place the contacts between formations. The contact between the Barco and Los Cuervos can be located Whitin a few meters along a small stream at the

		curve in the road. Prominent Barco dip slopes can be seen west of the road.
		Vehicles will drive ahead approximately 1.5 Kms. to the end of the Los Cuervos outcrop and await excursionists.
		Road passes over the covered contact between the Los Cuervos and Mirador.
2:45 to 2:55	13.3	STOP (4) (10 minutes). Cliff-face of nearly flat lying Mirador sandstone. The "immediate shale", so characteristic of the Mirador in the Barco Concession region of Colombia, does not seem to be developed in this area. Sandstones of this type form prolific oil reservoirs in the recently discovered Río Zulia Field just west of Cúcuta in Colombia. The road swings west around fault block of Carbonera and then continues along the strike of the Mirador following of valley of the Río Azuero. Approaching Rubio, excursionists can see, north of the road, several prominent south-dipping flatirons of Mirador sandstone, which form the northern rim of the Rubio Depression.
3:10	22.3	Rubio a thriving agricultural center and the locate of several technical schools. The town lies on the northern edge of a broad depression which is filled with unconsolidated sands and mottled clays of the uppermost the Capacho and the La Luna. Excursionists who walk a few hundred meters southward along the road will cross the axial core of the anticline. Thin bedded, glauconitic sandstones of the Aguardiente are exposed in this anticlinal core. These are conformably overlain on the southern flank, by about 3 meters of arenaceous Maraca limestone

		containing *Ostrea scyphax*. The southern flank of the structure is complicated by faulting which cuts out much of the Capacho section.
		The small settlement of the La Mulera, located on a small terrace just south of the road, is reputed to have been the early home of General Juan Vicente Gómez, who ruled Venezuela for 27 years, from 1908 to 1935. Legend places his actual birth site on a spot now occupied by the small white chapel nestled in the hills to the east.
		Vehicles will return to the junction with the Pan-American Highway, turn left to the first bodega and
12:16 to 1:00	35.2	STOP (14) (44 minutes). LUNCH!!! Exposures of Barco and Los Cuervos on north side of road, but excursionists do not have to look at them if they do not want to.
		After lunch vehicles will proceed south along Pan-American Highway which cuts through a nearly continuous section of Los Cuervos to
1:03 to 1:18	36.8	STOP (15) (15 minutes). Excellent outcrop of Paleocene coals, sandstones and siltstones of the Los Cuervos, containing numerous examples of channelling, current ripple marks and other sedimentary structures. Coal seams in the formation occasionally reach thicknesses of two to three meters and are mined commercially elsewhere in Táchira.
		The Tertiary section along the highway is intensely faulted and slumped, and repetition of beds is quite common. Nevertheless, the sequence is relatively complete and the exposures are among the best and most accessible in southwestern Venezuela.
		The highway continuous along outcrops of the Los Cuervos, gradually going up in the section until it crosses the

		slumped-out and covered Los Cuervos-Mirador contact. Slumped area continues to
1:23 to 1:38	38.7	STOP (16) (15 minutes). Typical Mirador sandstone. Massive, pink to white sandstone with occasional pebble stringers, interbedded with purplish gray silty claystone. Cross-bedding and ripple marks occur in several beds. Again, the "intermediate shale" appears to be absent, although it has been recognized in Shell's well, Fila-1, located about 5 Kms. to the north (Fig. 6). The highway cuts through Mirador sandstones for several hundred meters and then crosses the covered contact between the Mirador and Carbonera. The Carbonera section immediately above this contact contains an abundance of thick sandstone beds which often resemble sandstones in the Mirador. The Carbonera gradually becomes shalier up-section.
1:44 to 1:59	41.8	STOP (17) (15 minutes). Sandstones and shales of the Carbonera. Particular note should be taken of the shales in this exposure. they grade up section into very similar shales of the León Formation. The contact between the Carbonera and León is extremely gradational and is usually placed at the top of the uppermost prominent sandstone in the Carbonera. In this general area, the Carbonera carries the controversial *Hannatoma* fauna, once thought to be Oligocene, but now generally placed in the upper Eocene. The original *Hannatoma* collecting locality in Venezuela, Quebrada Seca, lies about 1 Km. east of the road. To the west, excursionists can see the effect of the

		nearly 3000 meters of throw along the Capacho fault zone. The hump-backed mountain just west of the road is composed of Aguardiente sandstone which has been upthrown relative to the gently northwest dipping beds of the upper tertiary Palmar Formation.
		The highway continues through the Carbonera for a short distance then passes down into a broad shale valley to
2:04 to 2:19	43.8	STOP (18) (15 minutes). Typical León shale banks. Purplish and greenish-gray shale which forms a valley between the resistant sandstones of the underlying Carbonera and overlying Palmar. The depositional environment of this non-fossiliferous shale is somewhat controversial, one of the more recent theories being that it collected in a large inland lake. Again, the attention of excursionists is drawn to the similarity between the shales of the León and those of the Palmar and Carbonera.
		The highway cuts through low hills of León to
2:22	44.5	Junction (just before alcabala) with road leading south along Quebrada Dantera. Turn sharp left. Road runs along León shale valley to
2:28 to 2:53	46.6	STOP (19) (25 minutes). Fault block of nearly vertical Carbonera and Mirador. Although somewhat broken and incomplete, this section is an excellent example of the gradational relationship between the sandstones of the lower Carbonera and those of the upper Mirador. Regional geologists are often tempted to extend the pre-Miocene unconformity of Lake Maracaibo south-ward

		into Táchira, placing it between either the Carbonera and León or the Carbonera and Mirador, thus, separating the Eocene from younger Tertiary beds. The apparent absence of any angularity as well as the gradational contacts between the units strongly suggest, however, that there is no unconformity in western Táchira.
		Vehicles will return to the junction with the Pan-American Highway and turn left to the alcabala.
3:00	48.7	Alcabala. León shale valley and low hills to the east; Palmar dip slopes to the west. Road continues north. Excursionists can see the León-palmar contact exposed near crest of hills about 300 meters west of highway. Contact is placed at base of lowermost Palmar sandstone.
3:05 to 3:20	50.8	STOP (20) (15 minutes). Typical Palmar outcrop, very near the contact with the León shale. Shales of the Palmar usually cannot be distinguished from León shales. The Palmar here is a distinctly mappeable unit within the Guayabo Group. It is overlain unconformably by Quaternary alluvium.
		The highway continues north through the alluvial valley of the Río Táchira to
3:28	54.1	San Antonio Airport. Hills of León and Carbonera to east.
3:45	64.6	Ureña
3:50	67.6	STOP (21). Hotel Aguas Calientes. Site of numerous hot sulphur springs, probably emanating along faults in the Carbonera. END OF EXCURSION!!!

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[1] Por G. W. Trump and Amos Salvador, Creole Petroleum Corporation, Caracas, Venezuela, 24 al 26 de Octubre de 1964.