

ARTICULO

REVIEW OF THE CRETACEOUS STRATIGRAPHY OF THE
SOUTHWEST BARINAS MOUNTAIN FRONT¹

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ABSTRACT

The Cretaceous stratigraphy of a part of the mountain front in the states of Barinas and Táchira, Venezuela, is examined with a view to correcting certain errors and reconciling some marked differences of opinion which have appeared in the geological literature.

The area selected, between the Río Uribante and the Río Socopó, is characterized by a relatively thin Cretaceous section, poor exposures, and rapid lateral changes in lithologic facies which are markedly different from those of surrounding areas. Stratigraphic studies are further complicated by the scarcity of well preserved, diagnostic fossils.

The basal Cretaceous clastics of the area have received several different names (Uribante, Río Negro, Peñas Altas), none of which are completely suitable. It is suggested that detailed field studies are required to clarify the stratigraphy of these clastics, after which a suitable name and a new type locality and section will probably be established.

The overlying sediments, divisible into the Tibú, Peñas Altas, and Escandalosa formations in the deeper parts of the Uribante trough, cannot be so divided over the Santa Bárbara arch, where it is suggested that the entire interval temporarily be given the name Escandalosa.

The Upper Cretaceous sediments may be separated into a lower shale unit and an upper siliceous unit for which the names La Morita and Quevedo formations are suitable. The name Navay should be discarded since it includes both previously named formations and lacks precedence over those names. The Burgúita formation requires additional field study to establish its age, limits, and correlation.

The contact between the Cretaceous and Tertiary sediments requires additional field work and careful paleontological studies to determine its exact nature. Pollen and spore studies may provide valuable data for such a study.

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RESUMEN

La estratigrafía del Cretáceo, en la parte correspondiente al frente de montaña en los estados Barinas y Táchira en Venezuela, es examinada con el objeto de corregir ciertos errores y reconciliar ciertas diferencias de opinión que han aparecido en la literatura.

El área seleccionada, entre los ríos Uribante y Socopó, se caracteriza por una sección cretácica relativamente delgada, de aplanamientos deficientes y de cambios laterales rápidos en las fases litológicas, las que registran una gran diferencia con aquellas de las regiones adyacentes. Los estudios estratigráficos se complican aún más por la ausencia de fósiles diagnósticos bien preservados.

Los sedimentos clásticos basales del Cretáceo en este área han recibido varios nombres tales como Uribante, Río Negro y Peñas Altas, ninguno de los cuales es apropiado. Se sugiere que estudios de superficie en detalle son necesarios para aclarar la estratigrafía de estos sedimentos, después de lo cual una sección tipo con un nombre apropiado puede ser establecida.

Los sedimentos suprayacentes, en la parte más profunda de la cuenca, incluyen las formaciones Tibú, Peñas Altas y Escandalosa. Esta división no se puede aplicar en el arco de Santa Bárbara, en donde se sugiere que al intervalo completo se le dé el nombre de Escandalosa con carácter temporal.

Los sedimentos del Cretáceo Superior pueden ser divididos así: La parte inferior o lutítica se le puede llamar formación La Morita, mientras que a la parte superior silícea formación Quevedo, siendo ambos términos bastante apropiados. El nombre de Navay debe de ser descartado ya que incluye a ambas formaciones, al mismo tiempo que le falta prioridad. La formación Burgúita requiere estudios de campo adicionales para determinar su edad, sus límites y su correlación con otras unidades.

El contacto entre el Cretáceo y el Terciario requiere también estudio detallado en el campo, lo mismo que análisis paleontológico a fondo con el propósito de determinar con exactitud su naturaleza. Análisis palinológicos pueden ayudar enormemente a solucionar este problema.

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INTRODUCTION

The stratigraphic sequence exposed along the Barinas mountain front has acquired a number of new, conflicting names as a result of the increased petroleum exploration in the Barinas basin by various oil companies during the past few years. The present lull in exploratory activity in the basin affords a chance to review its stratigraphy with an end to eliminating some of the confusion and perhaps aiding future geologic exploration.

This paper treats primarily the Cretaceous stratigraphy of the basin as known from surface geologic exploration, since little has been published concerning its subsurface geology. The area of discussion is confined primarily to the piedmont zone extending from the Río Socopó in Barinas to the Río Uribante in Táchira.

This discussion is based on the excellent papers of Renz (1959, pp. 3-48) and Pierce (1960, pp. 214-276), and amplified by the writer's limited experience in the area. No attempt is made to propose new stratigraphic names, but deficiencies are pointed out in those areas where the present nomenclature is incomplete.

GENERAL

The Barinas mountain front contains a relatively thin, compressed Cretaceous section, which thickens southwestward from a feather edge near the Río Socopó to more than 2500 meters near the Río Uribante. Northwestward, between the Río Socopó and the Río Santo Domingo, a distance of some 75 kilometers, the Cretaceous is practically unknown in outcrop, whereas the Tertiary is well exposed in a broad, folded band. Near the Río Santo Domingo, the Cretaceous again appears, but its facies is different. Pronounced facies changes over short distances are characteristic of the Cretaceous sediments throughout the area of discussion.

4. A thin interval of glauconitic siltstones, sandstones, and locally developed crystalline limestones. This interval grades laterally towards Río Uribante into thick glauconitic sandstones and limestones divisible into three different formations.
5. An interval of fossiliferous clay shales containing fish remains.
6. A sequence of fossiliferous siliceous shales, siliceous limestones, cherts and sandstones locally containing large concretions of limestone.
7. A locally developed massive sandstone overlain by carbonaceous, sandy shales and shaly sandstones with lignite seams.
8. A sequence of light colored massive clays, sandstones and conglomerates containing reworked siliceous material and abundant leaf imprints.

Units (3) through (6) are of definite Cretaceous age; unit (7) is probably of Eocene age; unit (8) is of younger Tertiary age, possibly Oligocene and/or Miocene.

REVIEW OF STRATIGRAPHIC TERMS

A brief review of the stratigraphic terms used in the area of the Barinas mountain front provides a background for this discussion. Many of the terms used in the area by previous workers were brought from the Maracaibo basin and even from eastern Venezuela because of apparent or supposed lithologic and faunal similarities.

Uribante Sandstone, Formation

Author of name: W. Sievers, 1888
 Original reference: W. Sievers, 1888, p. 19
 Original description: *ibid.*

Sievers applied the name Uribante to the basal Cretaceous sandstones and conglomerates exposed along the Río Uribante in Táchira. By his definition the formation includes all of the strata from the base of the Cretaceous up to the base of the "blue limestone of Táchira and Barbacoas" (Capacho formation).

Liddle (1946, p. 165) preferred not to use the term Uribante, stating that the type locality includes "lithologically similar sandstones of both Barremien and Cenomanien ages."

Notestein, Hubman and Bowler (1944, pp. 1173-1178) re-defined the Uribante formation in the Barco Concession of Colombia by dividing it into the Tibú, Mercedes and Aguardiente members, from older to younger. The basal clastics form but a small part (5 to 12 meters) of the Tibú member.

Pierce (1960, pp. 242-246) retained the term Uribante for all of the basal Cretaceous sandstones and conglomerates along the Barinas mountain front from Río Uribante to Río Socopó. He included within his Uribante formation the crystalline limestone locally developed above the sandstone section.

Curito Formation

Author of name: R.A. Terry, 1930 (private report)
 Original reference: A.N. MacKenzie, 1937 (pp. 262-263)
 Original description: R.A. Terry, 1930 (private report)

Misspelled by both Terry and MacKenzie as "Corritos", the name derives from the Río Curito, located between the Río Capitanejo and the Río Pedraza la Vieja about 25 kilometers northeast of Santa Bárbara de Barinas, according to Alberding (1959, unpublished discussion of the Curito formation for the *Léxico Estratigráfico de Venezuela*). Alberding further clarified the origin of the name: R.A. Terry (1930, private report), geologist for the Sinclair Oil Corporation, described the formation as the "lowest sedimentary rock exposed from Río Zapa to the southern limit of the area", and mentions a maximum thickness of 130 meters on the Río Quiú. Terry incorrectly identified the formation as Eocene in age and correlated it with the Misoa-Trujillo formation of Liddle. MacKenzie, apparently without realizing Terry's error, correlated the Eocene sandstones of the Río Santo Domingo area with those reported to be Eocene by Terry on the Río Quiú. From Terry's description it is evident that his Curito formation includes what are known to be the Cretaceous basal sandstones of the Santa Bárbara de Barinas area. Because of MacKenzie's miscorrelation and Terry's erroneous age assignment, the name has been discarded.

Río Negro Formation

Author of name: H.D. Hedberg, 1931
 Original reference: H.D. Hedberg, 1931, p. 230
 Original description: *ibid.*

The name Río Negro formation, as applied to Barinas, was first used by Renz (1959, pp. 4-6), who extended the use of the name from the type locality in the Perijá mountains to the Río Uribante area of Táchira and into Barinas. Renz considered the Río Negro formation to underlie the Uribante formation of Notestein, et al., and followed these authors' usage by including the basal clastics of the Barco Concession in the Tibú member of the Uribante formation. Renz restricted the use of the name Río Negro to the Machiques and Uribante troughs. Sutton (1946, p. 1641) restricted the use of the name to the Machiques trough only, but correlated the Río Negro formation "with the other sandstones and conglomerates which initiated the Cretaceous deposition throughout the entire Maracaibo basin"; such a correlation includes the basal clastics of the Tibú limestone of Notestein, et al.

Tomón Sandstone, Formation, Group, Facies

Author of name: L. Kehrler, 1937
 Original reference: L. Kehrler, 1937, p. 54
 Original description: *ibid.*

Kehrler (1937, p. 66) brought the name Tomón from the type locality in the state of Trujillo to the Barinas mountain front where he applied it to the basal Cretaceous sandstones of the Santa Bárbara de Barinas area. The use of this term was fully discussed by Rod (1954, p. 219) and Maync (1956, p. 647), who recommended that the name be abandoned since it includes sediments of both Eocene and Cretaceous age at the type locality.

Calderas Formation

Author of name: R.L. Collins, 1937

Original reference: A.N. MacKenzie, 1937, p. 260

Original description: *ibid.*

MacKenzie used the name to describe the basal Cretaceous sandstones in the Río Santo Domingo area. Pierce (1960, pp. 234-236) followed MacKenzie's usage and restricted the use of the name to the area between Barinas-Barinitas and Guanare-Biscucúy. Southwest of the Barinas-Barinitas area, Pierce preferred the name *Uribante* for approximately the same sequence.

Santa Bárbara "Series"

Author of name: P. Christ, 1927

Original reference: P. Christ, 1927, p. 406

Original description: *ibid.*

According to Alberding (1956, p. 603), Christ described the entire sedimentary sequence of the Santa Bárbara de Barinas area as the Santa Bárbara "series" of Tertiary age. Since the "series" includes formations of different ages the name has been discarded for use, in this area.

Zapa Formation

Author of name: R.A. Terry, 1930 (private report)

Original reference: A.N. MacKenzie, 1937, p. 263

Original description: *ibid.*

Alberding (1959, unpublished discussion of the Zapa formation for the *Léxico Estratigráfico de Venezuela*) clarified the origin of this name as follows: R.A. Terry (1930, private report) described the Zapa shales from outcrops overlying his "Corritos" formation along the Río Zapa, about 95 kilometers southwest of the town of Barinas. He mentioned fish scales, foraminifera, and finely divided vegetable matter in the shales, and correlated it with the Eocene "Dark Shale" of Darton and the Paují shale of Liddle. It is obvious from Terry's description that the Zapa shale of the Santa Bárbara de Barinas area is the "Quiú facies" of Kehrer, the Navay formation of Pierce, and the combined La Morita and Quevedo formations of Renz. MacKenzie erroneously correlated these Cretaceous shales with lithologically similar Eocene shales in the Río Santo Domingo area. Because of the subsequent confusion the name has been dropped from usage.

Ortiza, Navay, Santa Bárbara, and Quiú Facies

Author of names: L. Kehrer, 1938

Original reference: L. Kehrer, 1938, p. 49

Original description: *ibid.*

Kehrer recognized that the Cretaceous sediments of the Barinas mountain front present distinctive lithologic facies as compared to the Cretaceous of other parts of western Venezuela, and separated them into the Ortiza facies (predominantly calcareous), the Navay facies (predominantly clayey-cherty), the Santa Bárbara facies (predominantly cherty-sandy), and the Quiú facies (predominantly sandy-clayey), according to supposed facies changes along the mountain front. Pierce (1960, pp. 246-247) refuted Kehrer's descriptions as being unrecognizable at the localities named, and included all of the in his Navay formation.

CONCESSION
1940-1942, Notes
1944, Fig. 4 & 5

QDA ESCANDALOSA
Qda. Upr. 7
Renz, 1959, Fig. 14 & 6

RIO MUCUPATI
Qda. Agua Fria
Renz, 1959, Fig. 20

RIO PEDRAZA LA VIEJA

RIO CAPITANEJO

RIO QUIU

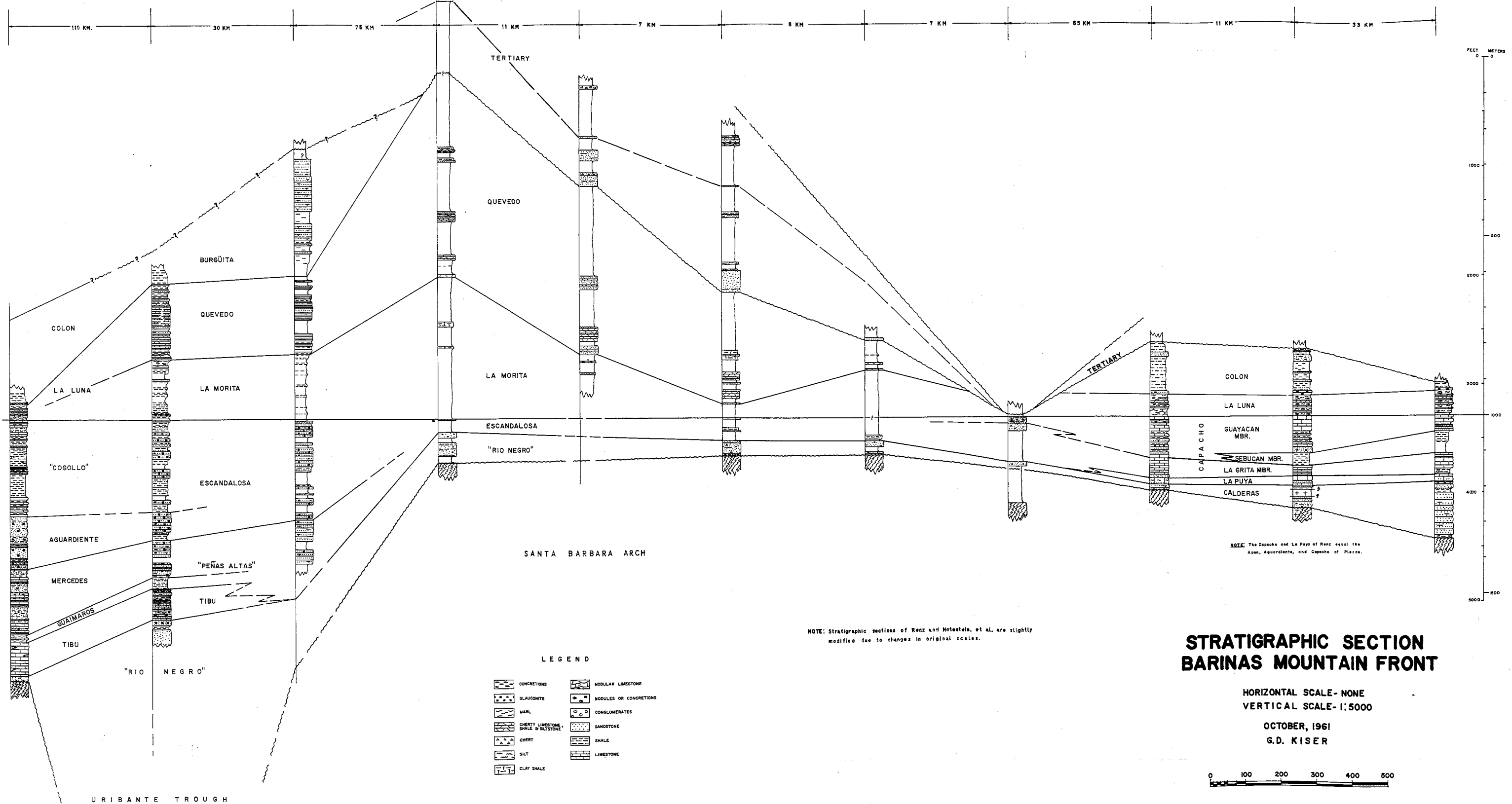
RIO ZAPA

RIO MICHAY

QDA. BELLACA
Renz, 1959, Fig. 11

RIO SANTO DOMINGO
Renz, 1959, Fig. 11

QDA. EL MOLINO, NIQUITAO
Renz, 1959, Fig. 11



STRATIGRAPHIC SECTION BARINAS MOUNTAIN FRONT

HORIZONTAL SCALE- NONE
VERTICAL SCALE- 1:5000

OCTOBER, 1961
G.D. KISER

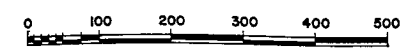


FIG. 2

BARCO CONCESSION
Wells Petro. No. 1-22. Notes
Volin, et al, 1944, Fig. 4 & 6

QDA, ESCANDALOSA
Qda. 1940
Renz, 1959, Fig. 14 & 6

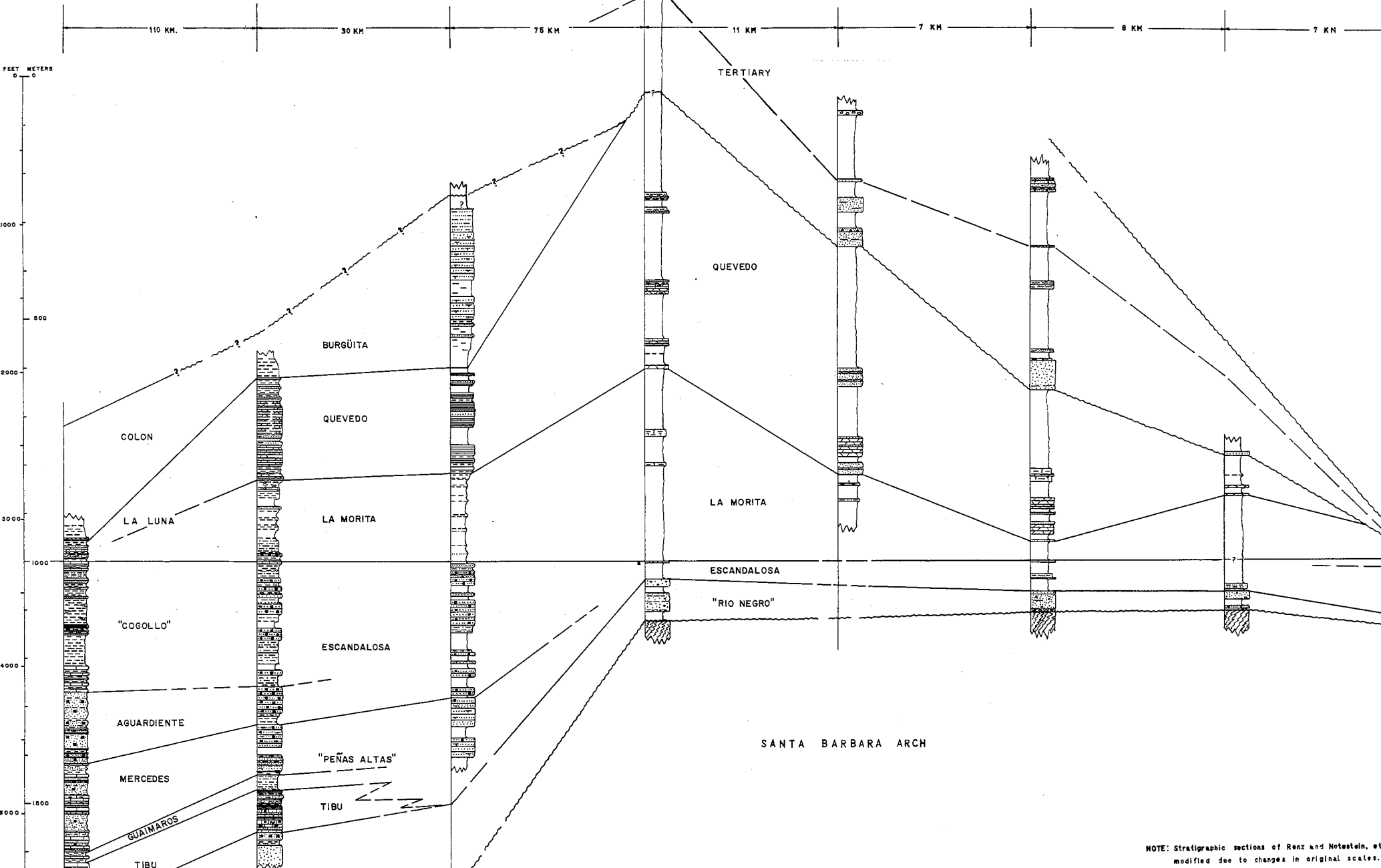
RIO MUCUPATI
Qda. 1940
Renz, 1959, Fig. 20

RIO PEDRAZA LA VIEJA

RIO CAPITANEJO

RIO QUIU

RIO ZAPA



SANTA BARBARA ARCH

NOTE: Stratigraphic sections of Renz and Notestein, et al modified due to changes in original scales.

El Mene Formation

Author of name: A.N. MacKenzie, 1937
Original reference: A.N. MacKenzie, 1937, p. 264
Original description: *ibid.*

MacKenzie applied the name to Eocene carbonaceous sandstones and dark gray sandy shales in the Río Santo Domingo area, and correlated them with the Cerro Pelado and Agua Clara formations. Sutton (1946, p. 1686) correlated the Mene Grande formation with the El Mene formation of MacKenzie, stating that the name El Mene derived from the Río El Mene (Río Quiú) in the state of Barinas. Sutton added: "Since MacKenzie's paper was written, numerous specimens of Raetomya have been discovered in the El Mene, which is therefore now considered Upper Eocene instead of Lower Miocene." The El Mene formation was renamed the Altamira formation by geologists of the Sinclair Oil Company to avoid confusion with similar names elsewhere in Venezuela. Although the writer has no proof at hand, it seems probable, in view of similar errors involving the Curito and Zapa formations, that MacKenzie erroneously correlated the asphalt-impregnated sandstones on the Río Quiú with lithologically similar sandstones in the Río Santo Domingo area, and assigned them a lower Miocene age (following Terry's usage?). The name El Mene is no longer used in the Barinas area.

Altamira Formation

Author of name: R.L. Collins, 1937 (private report)
Original reference: F.A. Sutton, 1946, p. 1686
Original description: none published

According to Sutton, the name Altamira was used by Sinclair geologists to replace the name El Mene. Through correlations with the El Mene formation on the Río Quiú, some confusion has arisen. Alberding (1959, unpublished discussion of the Altamira formation for the Léxico Estratigráfico de Venezuela) states that the Altamira formation of the Río Santo Domingo and the El Mene formation of Río Quiú are "decidedly different in lithology as well as age."

Santa Bárbara de Zamora "Beds"

Author of name: W.G. Argabrite, 1924
Original reference: R.A. Liddle, 1928, pp. 354-355
Original description: *ibid.*

The name originally proposed by Argabrite was Santa Bárbara beds. Liddle modified the name to Santa Bárbara de Zamora beds from the town of Santa Bárbara in the state of Zamora (now Barinas). The name included, according to Liddle, "Quaternary lacustrine or deltaic deposits" from the area of Río Quiú to San Antonio de Caparo, a distance of 120 kilometers. Liddle later assigned the sequence a Miocene and/or Pliocene age. The beds contain reworked siliceous material and reworked fish remains. Alberding (1956, pp. 604-605) includes all of the strata above the Cretaceous siliceous beds (Quevedo formation) of Río Quiú in the Santa Bárbara de Zamora beds. Because the name undoubtedly includes sediments of different ages and different lithology, it is not recommendable for use in this area.

Various Other Names

Aside from the above mentioned names, various authors have used the names La Luna, Luna-Cogollo, Cogollo, Colón, Barranquín, and others, in the area under dis-

cussion to describe the Cretaceous sediments. None of these terms are recommendable because of lithologic differences and faulty correlations between the Santa Bárbara de Barinas area and the areas of their type localities. New names recently introduced by Renz (1959, pp. 3-48) and Pierce (1960, pp. 214-276) will be discussed in the following pages. Some names (e.g. Fortuna formation) used by individual oil companies, have never been formally published, but appear occasionally in the literature.

LOWER CRETACEOUS

Throughout the area discussed, and throughout western Venezuela, with a few exceptions, the Cretaceous period was initiated by the deposition of fine to coarse clastics characterized by sandstones and conglomerates of continental origin. These basal clastics vary in thickness from a few feet to nearly 10,000 feet, depending on whether they were deposited over the then structurally high areas or in the depositional troughs. The deposition of these clastics may have begun as early as the Hauterivian in the deeper parts of the troughs, and apparently continued until about the beginning of the Aptian; by that time most of the structurally high areas within the limits of the sedimentary basin were covered with a thin veneer of conglomerates or coarse sands, and the troughs were filled. Then the environment became definitely marine, favoring the deposition of marine shales and calcareous sediments, including appreciable amounts of biohermal and biostromal limestone, but thick sections of marine sandstones and even conglomerates are found in some areas. The basal clastics are called by most geologists the Río Negro formation in the Machiques trough and the Uribante formation in the Uribante trough. Outside of the trough areas, where the clastics are thin, most geologists have included them in the overlying formation (Tibú or Apón).

Basal Clastics

Sutton (1946, p. 1641) intimated there was a correlation between the Río Negro formation and the basal clastics of the Tibú member of the Uribante formation of Notestein, et al., but considered the Apón and Aguardiente formations of the Perijá mountains to be equivalent to the Uribante formation, thus placing the Río Negro formation below the basal Tibú clastics.

Renz (1959, pp. 4-6) followed the usage of Notestein, et al. and Sutton by including the basal clastics of the Barco Concession in the Tibú member of the Uribante formation. Renz extended the use of the name Río Negro to the Uribante trough, but ignored the transgressive nature of these sediments by calling the basal clastics of the Santa Bárbara de Barinas area the Peñas Altas formation. Renz apparently followed chronostratigraphic criteria in his correlations, since the Peñas Altas overlies the Tibú in the area of Río Uribante. Renz thus interpreted (1959, figs. 2,3, and 4) the Río Negro, Tibú, Guáimaras, and Peñas Altas formations as successively overlapping the basement complex from Río Uribante towards Santa Bárbara de Barinas. The fact that lithologic units may transgress time lines is ignored. Renz thus correlated the basal sandstones (his Peñas Altas formation) of the Santa Bárbara de Barinas area with the combined Mercedes and Tibú formations of the Barco Concession, though the latter formations are stratigraphically much higher than basal sands of that area. The basal sandstones of the Santa Bárbara de Barinas area may be traced on aerial photographs and in the field from Río Micháy to, at least, the area of the Río Navay, where they appear to correlate directly with the Río Negro formation.

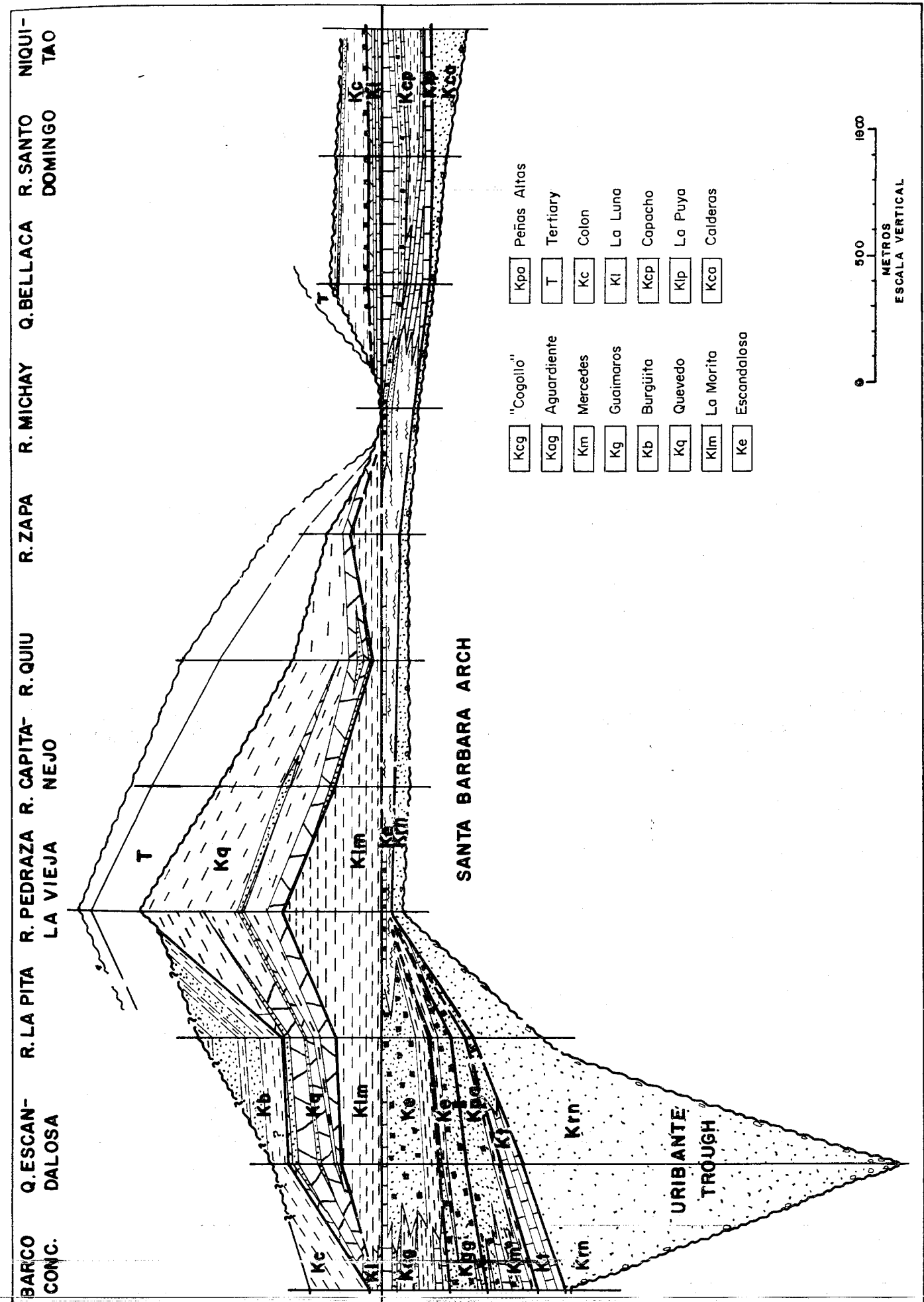


Fig. 3. Kiser. Schematic Diagram of Cretaceous Facies Along the Barinas Mountain Front

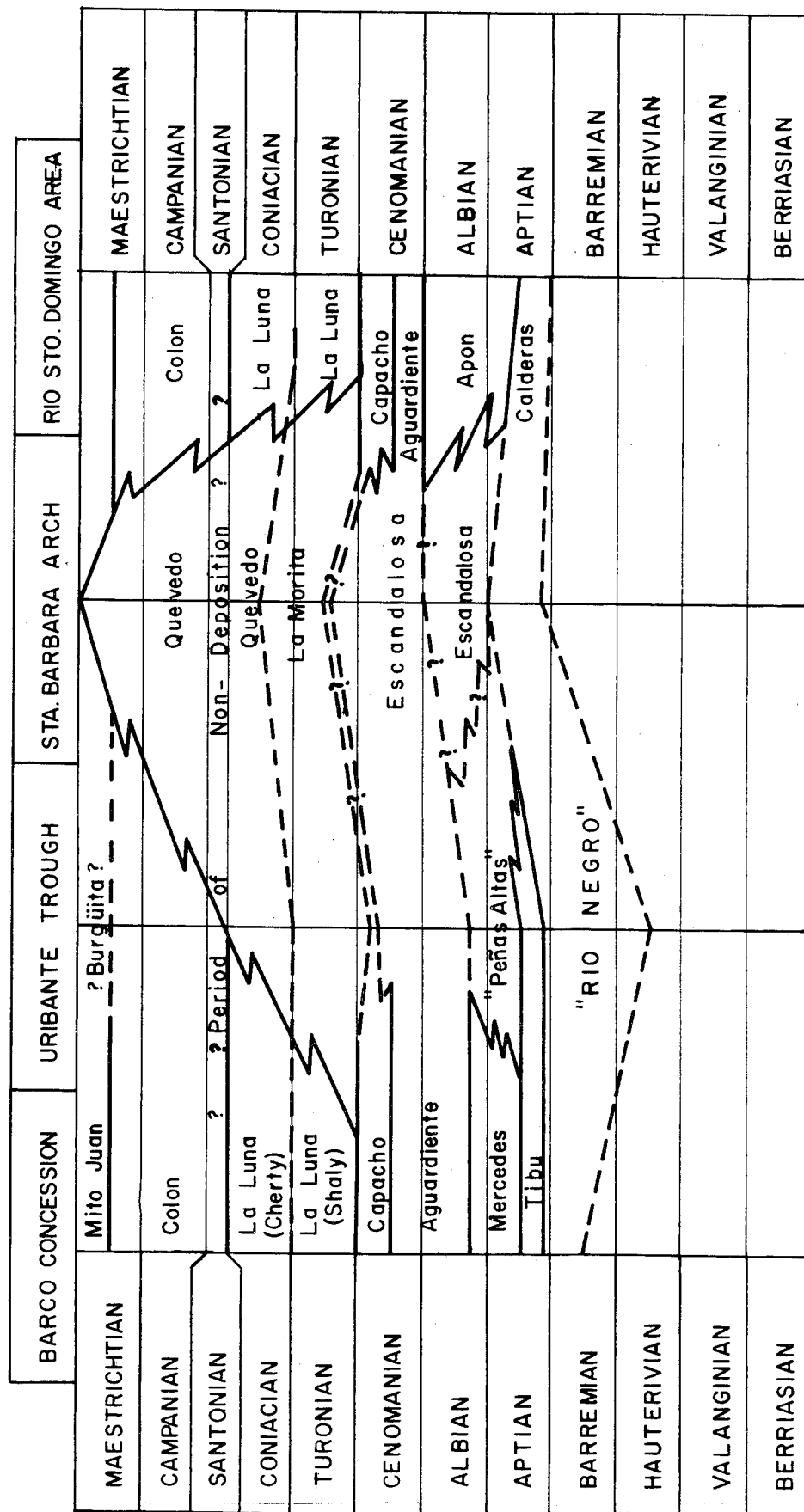


Fig. 4. Kiser. Cretaceous Stratigraphic-Time Relationships Along the Barinas Mountain Front

A theoretical unconformity at the base of the Peñas Altas formation, truncating the Tibú and Río Negro formations in the Santa Bárbara de Barinas area, would make Renz' interpretation more plausible. However, such an unconformity is, as yet purely theoretical, with no basis in fact. The stratigraphic relationships between the deeper parts of the Uribante trough (Río Uribante area) and the Santa Bárbara arch of Pierce (1960, p. 236), or the edges of the sedimentary basin, probably resemble more the classic example of the relationship of transgressive facies to time lines (Figs. 3 and 4).

Pierce (1960, pp. 242-246) followed lithostratigraphic concepts in defining his Uribante formation: "Como la formación Uribante definida por el presente autor es una unidad litogenética que cruce líneas de tiempo, la correlación (to the Uribante, Tomón and Río Negro formations) puede ser válida por lo menos hasta cierto punto." However, the Uribante formation of Pierce includes "lenses" of fossiliferous crystalline limestone exposed on the Ríos Patagallina, Curito, and Piscurí. The writer observed similar limestones on the Río Pedraza la Vieja (very sandy limestone) and the Río Quiú (crystalline limestone), where they occupy a position between the basal sandstones and conglomerates, and the overlying clay shales with fish remains. This limestone interval is included in the "Calcareous Interval" of this paper.

Northeast of the Río Socopó, Pierce applied the name Calderas to the basal Cretaceous sandstone. Although the two formations are lithologically and stratigraphically equivalent, except for the above mentioned limestones, Pierce correlates them differently. His Uribante formation (Barremian-Cenomanian) is correlated with the entire Cretaceous section up to the base of the La Luna formation, whereas his Calderas formation (Barremian? - Aptian) is correlated with the Cretaceous section only up to the base of the Apón formation. He thus insinuated that the calcareous interval of his Uribante formation is equivalent to the combined Apón, Aguardiente and Capacho formations of the Maracaibo basin. Although Pierce correlated the Uribante of the Santa Bárbara de Barinas area with the Uribante, Tomón, and Río Negro formations, he makes no mention of a correlative in the Barinas area, of the Capacho formation.

The writer agrees with Maync (1956, pp. 558-560), who explained that the basal clastics of the Cretaceous in western Venezuela should be separated from the overlying marine limestones and shales, whether the clastics form 10,000 feet or only 5 feet of the sedimentary section. Maync preferred to include the 16 to 40-foot thick basal sandstones of the Tibú member of the Uribante formation of the Barco Concession, as well as the 10 to 60 feet of basal grits of the La Paz-Mara fields, in the Río Negro formation. Only in those areas where a definitely marine facies rests directly above the pre-Cretaceous should the Río Negro be considered absent. The possibility that some marine strata (e.g. glauconitic sandstone) may be present near the top of the Río Negro formation, especially in the deeper parts of the trough, should not detract from the above definition.

The term Uribante has become firmly established in the geologic literature of Venezuela, but no agreement has been reached as to its proper use, and several authors have proposed dropping the name from use. Renz (1959, p. 7) noted the inclusion in the term of two strongly contrasting lithologic types, the fluvial clastics and the marine sediments; for this reason Renz preferred the name Río Negro rather than Uribante for the thick continental clastics of the Uribante trough.

However, this usage also presents objections. As Van Andel (1958, p. 747 and fig. 6) pointed out, major differences exist between the clastics of the Machiques trough and those of the Uribante trough. According to the investigations of this

author, the two troughs had partially different source areas. A common source area for both troughs was the Maracaibo platform which was subjected to erosion until about the end of the Barremian. However, most of the clastics of the Machiques trough came from the destruction of the pre-Cretaceous complex to the northwest and west (Perijá mountains), whereas the major part of the clastics of the Uribante trough came from the Guayana Shield. This difference of source area resulted in at least one major lithologic difference. Van Andel (1958, p. 747) stated: "The pre-Aptian (Río Negro) sandstones are feldspathic and most belong to the arkoses", in reference to the clastics of the Machiques trough and the northern part of the Uribante trough. In the next paragraph, Van Andel added: "Sands of a different composition which consist of more than 95 per cent quartz are found only along the southern edge of the Uribante trough."

Although the basal Cretaceous clastics of the two troughs are lithologically similar in many respects, the writer prefers to assign them different names in the two areas for the following reasons:

1. Two distinct geosynclinal areas exist, represented by thousands of feet of clastics in each, and separated by a structurally high area represented by only a few tens of feet of clastics.
2. The clastics of the two troughs were derived from at least partially different source areas.
3. The clastics of the two troughs present at least one major lithological difference - one is predominantly arkose; the other is, in large part, quartzose.
4. The name Río Negro is firmly established in the area of the Perijá mountains, whereas the name Uribante is usually associated with the Barco Concession and Táchira.

No objections have been raised against the use of the name Río Negro in the area of its type locality; on the other hand, the name Uribante has received severe criticism and has been re-defined by various authors. In view of the many differences of opinion it seems preferable that the name be dropped from usage altogether, and that a new name be designated for the basal Cretaceous clastics of the Uribante trough up to the base of the Tibú limestone or its equivalent.

Calcareous Interval

Overlying the basal clastics along the Barinas mountain front is an interval characterized by sporadic exposures of bluish-gray crystalline fossiliferous limestone. Also present in this interval are locally glauconitic, calcareous sandstones, siltstones, and clay shales. This calcareous interval appears to have a persistent development along the Barinas mountain front. Its sporadic exposure may be more due to the thinness of the interval and the ease with which it is eroded than to supposed lenticularity of the limestones.

Most previous workers in the area referred to these limestones as "Cogollo" because of their lithologic similarity to that formation. Pierce (1960, p. 244) included the interval in his Uribante formation, of which he stated: "Las litologías típicas descritas por Notestein, Hubman y Bowler (1944, pp. 1176-1177) para los miembros Tibú, Mercedes y Aguardiente de la formación Uribante en la Concesión Barco,

no se identifican en la cuenca Barinas-Apure", thus insinuating a correlation between the calcareous interval and these formations.

Renz' ideas concerning the discontinuous limestones are not entirely clear. Discussing the Peñas Altas formation (1959, p. 12), he stated: "En Táchira y a lo largo de las colinas piemontinas suroccidentales de los Andes, las intercalaciones de caliza son menos frecuentes en la formación Peñas Altas." Later in the same paper (1959, pp. 19-20) Renz stated: "El contacto superior con la lutita de La Morita está bien definido tan solo cuando afloran calizas en el tope de la formación." His correlation chart (1959, fig. 2) shows both formations to be present in the area "sureste de Táchira y Mérida". Renz correlated the Peñas Altas formation with the Aguardiente, Mercedes and La Puya formations, and his Escandalosa formation with the Capacho formation, the discontinuous limestone of Barinas being equivalent to the Guayacan limestone of the Capacho formation.

Since only one limestone interval is present below the La Morita shale of the Santa Bárbara area, Renz apparently tried to include the same interval in two different formations.

Various authors have recognized this interval to be of Cretaceous age, but only Pierce (1960, p. 245) attempted a more definite age determination. He indicated a Cenomanian age for the upper part of his Uribante formation, based on Exogyra africana peruana from limestones in the Río Canaguá (Libertad?) section. Exogyra species were reported by Kehrer (1938, p. 50) from "Cogollo type" limestone in his "Santa Bárbara facies", and Engleman (1935, p. 785) referred to "Cogollo limestones with their characteristic Exogyra" throughout the Barinas area. Renz (1959, pp. 13 and 20), on the basis of regional correlations (chronostratigraphic?), assumed the Peñas Altas to be of lower to middle Aptian age, and the Escandalosa to be Cenomanian-Turonian.

The present author believes that the "calcareous interval" is a compressed stratigraphic section representing the combined Tibú, Mercedes, Aguardiente and Capacho formations of the Barco Concession. As previously stated, after the trough areas were finally filled with clastics during Hauterivian? - Barremian time, the Cretaceous seas encroached upon the Maracaibo platform in late Barremian or early Aptian time. The Santa Bárbara arch appears to have been structurally higher than the Maracaibo platform; consequently, Cretaceous deposition began much later in the Santa Bárbara area than in the Barco Concession. The oldest definitely dated sediments of the Santa Bárbara area are the Cenomanian limestones mentioned by Pierce. The underlying clastics contain only the well preserved plant remains reported by Pierce (1960, p. 243). Therefore, without proof to the contrary, these basal clastics may be no older than Aptian, or even Albian, in age in the Santa Bárbara area.

Although regional correlations are hampered by the distance between the Barco Concession and the Río Uribante area (some 130 kilometers), and by the fact that Renz' descriptions and stratigraphic sections are somewhat generalized (Pierce's paper lacks stratigraphic maps), some idea of the correlation can be attained, using the above assumption as to the time lag between the Cretaceous transgression over the Maracaibo platform and over the Santa Bárbara arch.

The Tibú formation, recognized as such by Renz (1959, pp. 7-9) as far east as the Río Uribante area (center of the Uribante trough), suffers pronounced changes in its lithology and thickness towards the Santa Bárbara arch. In the Río Navay -

Río La Pita area, the Tibú is replaced by the sparsely glauconitic sandstones of the lower part of Renz' Peñas Altas formation. The lithologic identity of the Mercedes formation is lost before reaching the Río Uribante area, where it is replaced by the upper part of the Peñas Altas formation. The combined Capacho and Aguardiente formations are replaced by the sandy, glauconitic Escandalosa formation of Renz.

These correlations, in disagreement with those of Renz, are supported to some extent by the relative amounts of glauconite in the formations. The Mercedes of the Barco Concession and the Peñas Altas of the Río La Pita-Río Uribante area are both sparsely glauconitic, whereas the Aguardiente and Escandalosa both contain abundant glauconite. The non-glauconitic facies (Capacho formation) of the Barco Concession grades laterally into the glauconitic facies (upper part of the Escandalosa formation) of the Uribante trough. The Guayacan limestone member of the Capacho formation of the Barco Concession, and the thin limestones at the top of the Escandalosa formation appear to be lithologic equivalents, although the latter (Cenomanian) may be somewhat younger than the former (Albian-Cenomanian?).

From the Río La Pita towards Santa Bárbara de Barinas, approaching the structurally highest part of the Santa Bárbara arch, the pre-"La Luna" section is further compressed and its lithology again changes. In this area, the Tibú, Mercedes, Aguardiente and Capacho (and their equivalents, the Peñas Altas and Escandalosa) cannot be distinguished, except for the possible equivalent of the Guayacan limestone. Here, the sediments are composed of dark shales and locally calcareous siltstones. Glauconite, locally abundant ("greensands" of the Río Micháy), occurs in a few fine-grained sandstones and siltstones. As previously discussed, the writer correlates the Peñas Altas formation of the Río Uribante with the "calcareous interval" of the Santa Bárbara area, and not with the basal clastics as does Renz.

The lithology of the "calcareous interval" of the Santa Bárbara area is not readily identifiable with the descriptions of any of the established formations of nearby areas. Nevertheless, rather than introduce still another name into the literature for a lithologic unit of such restricted areal extent, it seems preferable to retain temporarily the name Escandalosa for this unit. It is recognized that this usage is somewhat awkward and improper, inasmuch as the lateral equivalents of the formation (Santa Bárbara area) include not only the Escandalosa formation of the Uribante trough, as defined by Renz, but also the Peñas Altas formation; thus, the Escandalosa formation of the Santa Bárbara area is equivalent to the Capacho, Aguardiente, Mercedes and Tibú formations of the Barco Concession.

Assuming the basal clastics to be of Aptian age, the "calcareous interval" would be of Albian-Cenomanian age, the upper limit being indicated by the presence of Exogyra africana peruana.

Brief mention should be made of the pronounced difference between the stratigraphic sections of Renz (1959, pp. 3-48) and Pierce (1960, pp. 214-276) in the Río Santo Domingo area. These authors interpret the stratigraphy of the area as follows:

<u>Renz</u>	<u>Pierce</u>
La Luna -----	La Luna
Capacho	Capacho
La Puya	Aguardiente
Peñas Altas -----	Apón
	Calderas

Thus, what Renz calls La Puya and Capacho, Pierce calls Apón, Aguardiente, and Capacho. Pierce presents rather detailed lithologic descriptions but no graphic stratigraphic sections. Both the lithologic descriptions and the graphic sections of Renz are generalized. Thus, it is difficult for the un-informed reader to decide which of the two authors is correct. Obviously, such a marked difference of opinion concerning this important stratigraphic section should be reconciled by additional stratigraphic data.

UPPER CRETACEOUS

During the Lower Cretaceous the facies type of the sediments along the Barinas mountain front was controlled largely by a continental environment and the transgressive nature of the seas; the facies reflects the distance from shore at which the sediments were deposited. During the Upper Cretaceous, facies type depended more upon depth of the seas, irregularities of the sea floor, and basin position relative to the mouths of the sediment-laden rivers. In other words, the type of facies was controlled by local depositional environment whereas previously the facies was controlled by the regional environment.

Clay Shale Interval

Pierce (1960, pp. 246-247) found it impossible to delineate the various Upper Cretaceous "facies" suggested by Kehrer (1938, pp. 48-49) and included all of them in his Navay formation. Pierce added: "Las cuatro facies mencionadas por Kehrer ... pasan gradualmente de una a otra dentro del vecindario de cualquiera de las áreas tipo que ese autor designa", thus recognizing that the formation does present a wide variety of facies, although not in the well-defined manner suggested by Kehrer.

The writer prefers to separate from the lower part of Pierce's Navay formation a section of light to dark gray or tan, soft clay shales containing locally abundant fish remains along the lamina. This shale was traced by the author from the Río Zapa to the Río Pedraza la Vieja, and Renz (1959, pp. 26-27) considered it to be sufficiently distinctive further to the southwest to name it the La Morita formation. Renz' description of the upper stratigraphic limit is vague. The writer would place the upper limit at the base of the lowermost prominent hard, brittle siliceous limestone, shale or siltstone of the overlying Quevedo formation. Poor exposures throughout the area make even this definition arbitrary. From 400 meters thickness on the Río Pedraza la Vieja, the formation thins northeastward and disappears before reaching Río Micháy, where it may be absent as a result of erosion. Southwest of Río Pedraza la Vieja, Renz reports 180 meters in the type section on the Quebrada Agua Fría.

The La Morita formation is a lithologically homogeneous and easily mappable stratigraphic unit.

Kehrer (1938, p. 50) assigned the "Quiú facies" a Turonian age. Renz (1959, p. 26) placed the La Morita formation in the Cenomanian, based on the ammonite *Barroisiceras* from the lower part of the formation on Quebrada Escandalosa. Pierce (1960, p. 251) believed the lower part of his Navay formation to be no older than Coniacian. Alberding (1959, unpublished discussion of the Zapa formation for the *Léxico Estratigráfico de Venezuela*) suggests an Albian to Coniacian age for the lower part of the "Zapa shale" (La Morita).

The age of the La Morita thus appears to range at least from Cenomanian to Coniacian in age, being somewhat older in the Uribante trough than over the Santa Bárbara arch. It is essentially a shaly facies of the lower part of the La Luna formation, although in the areas of thicker development it is probably equivalent in time to the entire La Luna.

Siliceous Interval

The beds which overlie the La Morita formation are characterized by distinctive siliceous shales, siliceous limestones and cherts, with interbedded sandstones, clay shales and siltstones. The peculiar lithology of the siliceous strata, a result of deep weathering and leaching during an extended period of time, has been competently discussed by Pierce (1960, pp. 246-252). Although the siliceous strata form its salient feature, this interval is also characterized by rapid lateral variations in the stratigraphic position and percentage of its various lithologic components. The formation is composed of a series of overlapping and interfingering lenses of various lithologic types which makes detailed correlations almost impossible, even over short distances.

These beds comprise the upper part of Pierce's Navay formation. The Navay, however, can be readily divided into a lower shaly, and an upper siliceous interval, called respectively the La Morita and Quevedo formations by Renz (1959, pp. 25-27). Since these terms are more descriptive and have precedence over the term Navay, the writer suggests that the name Navay be discarded. Furthermore, the name Navay was not introduced in a formal manner, in that the type locality and type section are vaguely described, and neither location map nor stratigraphic section are presented.

The Quevedo formation is thickest (about 550 meters) on the Río Pedraza la Vieja, and thins to the northeast, disappearing before reaching the Río Macháy. Renz measured 180 meters of Quevedo at the type locality near Santa Bárbara de Barinas and indicated a slight thickening southwestward from this point.

The Quevedo formation is a lithologic facies development which cuts strongly across time lines. Its facies equivalent in the Barco Concession, the Maracaibo basin and the Mérida Andes is the La Luna formation, specifically the upper cherty part of the La Luna, which is well developed in Táchira, where it is known as the Táchira chert. The time equivalent of the Quevedo, however, includes the Colón and Mito Juan, as well as the La Luna formations. Pierce (1960, pp. 251-252) presented sufficient evidence that his Navay formation is of Coniacian to Maestrichtian age, possibly extending into the Paleocene. In the Uribante trough, the Quevedo undoubtedly merges with the Táchira chert of Turonian to Coniacian age.

Renz and Pierce disagree as to the nature of the contact between the Quevedo (Navay) and the overlying sediments. Pierce says that south of the Colorado massif the formation is discordant below younger Tertiary sediments or alluvium. Renz says that the formation is overlain normally by his Burgüita formation of Upper Cretaceous age, or the Colón formation in the area between Santa Bárbara de Barinas and Río Uribante. Whether both authors are wrong, whether only one is correct, or whether both are partially correct will require more information than is available to the present writer.

Along most of the streams of the Santa Bárbara-Río Micháy sector, the top of the Quevedo formation is placed at the base of a massive, locally asphalt-saturated, poorly sorted, pebbly sandstone, which in turn is overlain by sandy shales, shaly sandstones, and carbonaceous shales containing thin lignite seams. According to Alberding (1956, p. 605), these beds "contienen foraminíferos removidos del Eoceno superior (formación Paují) (y) restos removidos de peces, derivados de la facies Santa Bárbara, del Cretáceo, de Kehrer (1938, p. 49)." However, some doubt exists in the present author's mind as to whether the beds containing reworked fauna are correlative with the massive sandstones and lignitic shales, or with a stratigraphically higher interval of light-colored clays, sandstones, and conglomerates containing abundant leaf imprints.

"Burgüita" Formation

Renz assigns his Burgüita formation to the Cretaceous on the basis of *Siphogenerinoides*, *Rotalia*, *Clavulina*, and *Bolivina* (species not given) and fish remains found only in well Burgua-3. For several reasons, a Cretaceous age for this section, as exposed in the surface section, is problematical. The correlation between the Burgua-3 well and the outcrop area of the Burgüita formation has not been demonstrated. Renz' lithologic description of the Burgüita formation on the Río Mucupatí (1959, fig. 20) is markedly similar to sequence of light-colored massive clays, sandstones, and conglomerates containing reworked siliceous material and abundant leaf imprints; on the other hand, Renz' description of the Burgüita is decidedly different from the characteristic lithology of the Colón formation, which he considers to be a correlative. The abundant reworked fauna and siliceous material found in the Tertiary beds of the Santa Bárbara area suggest the possibility of a mistaken identity in the Burgua-3 well of reworked Cretaceous fauna for indigenous fauna. In view of these considerations, a Cretaceous age for the Burgüita formation should be accepted with caution.

CRETACEOUS-TERTIARY RELATIONSHIP

In the Santa Bárbara area, the upper limit of the Quevedo formation is abrupt and well-defined even though the uppermost Quevedo shales are not everywhere well exposed. The overlying beds are called "younger Tertiary" by Pierce, and "at least post-Middle Eocene" by Alberding. These data indicate a hiatus comprising the Paleocene and Lower and Middle Eocene. Sutton's tentative assignment of an Upper Eocene age to the sandy, lignitic beds which overlie the Quevedo formation on the Río Quiú, based on *Raetomya* species, strengthens this interpretation.

Strong proof of Eocene erosion of the Cretaceous sediments is the rapid north-eastward thinning and disappearance of the Quevedo formation from Santa Bárbara towards the Río Micháy, although some part of this thinning is undoubtedly the result of depositional thinning over the structurally high area of Santa Bárbara.

The magnitude of the Cretaceous-Tertiary time-gap may be subject to slight revision when the age of the Tertiary beds is better known, but the presence of a pronounced unconformity must be acknowledged. The Trujillo, Gobernador, and part of the Pagüey formations of Pierce (1960, pp. 253-261), well exposed in great thicknesses eastward of the Río Socopó, are absent to the southwest of that stream, at least in the area of this discussion. A strong onlap of the Eocene sediments over the Santa Bárbara arch is suggested.

TERTIARY

The sediments which occur above the Quevedo formation are excluded from further discussion herein because of lack of sufficient information regarding their lithology, extent, stratigraphic limits and fauna. However, the writer recognizes at least two distinct lithologic units in the Santa Bárbara area: the brown sandstones, dark carbonaceous shales and lignites, well exposed on the Río Quiú, and the overlying white to light gray sandstones, clays, and conglomerates, exposed on the Ríos Quiú and Pedraza la Vieja.

CONCLUSIONS

In view of the above considerations, the stratigraphic terms used in the area are reviewed briefly, and reasons presented for their retention or discard.

Uribante - Complete discard recommended

1. Type locality includes strata of different ages.
2. Different authors define the formation differently, especially its stratigraphic limits.
3. The definition of the term has changed several times.
4. The term may possibly serve as a group name, but Rod's (1954, fig. 4) Cogollo group appears more practical.

Río Negro - Restrict to the Machiques trough and the Maracaibo basin.

1. Name well established in the Machiques trough but used for the first time in the Uribante trough by Renz.
2. Basal clastics of the Uribante and Machiques troughs present important differences of lithology and source areas.
3. The clastics of the two troughs were deposited in separate geosynclinal areas.
4. The clastics of the two troughs were derived from partially different sources.

Peñas Altas - Restrict to type locality.

1. In the type locality the Peñas Altas is equivalent to the Aguardiente and Mercedes formations; in the Uribante trough it is equivalent to

the Mercedes formations; in the Uribante trough it is equivalent to the Mercedes formation only; over the Santa Bárbara arch, it comprises the basal clastics, and is thus equivalent to the Río Negro formation of Renz.

2. A new name and type locality should be sought for the sparsely glauconitic sandstones overlying the Tibú formation and underlying the Escandalosa formation in the Uribante trough.
3. A new name and type locality should be established for the basal clastics of the Uribante trough and the Santa Bárbara arch.

Escandalosa - Tentatively useful term, with reservations.

1. Represents an abundantly glauconitic sandstone unit traceable in the field.
2. In the Uribante trough, is equivalent to the Aguardiente plus Capacho formations; over the Santa Bárbara arch, is equivalent to the combined Tibú, Mercedes, Aguardiente, and Capacho formations.
3. Requires some further study to better define its stratigraphic limits and relationships with equivalent and adjacent formations.

La Morita - Useful term.

1. Designates a homogeneous shale unit traceable throughout the area.
2. Name properly introduced with type locality, type section, stratigraphic limits, and lithology clearly described.
3. Takes precedence over the name Navay, to which it is partly equivalent.

Quevedo - Useful term.

1. Designates a shale, sandstone, limestone lithologic unit characterized by siliceous content and bedded chert.
2. Name properly introduced, as in the case of the term La Morita.
3. Lithologic unit traceable throughout the area.
4. Takes precedence over the name Navay, to which it is partly equivalent.

Navay - Recommended for discard.

1. Name includes two distinctive, separable lithologic units.
2. Name informally introduced. Introduction lacks well defined type locality or type section, location maps, graphic section.

Burgüita - Doubtful term.

1. Age of formation may be based on reworked fauna.
2. Correlation from Burgua well to surface section unproved.
3. Unit requires further field work to establish its age, stratigraphic limits, and relation to subsurface.

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