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A Stratigraphical Section through the Tertiary of Toluviejo, Columbia.

By A. Werenfels (Basle)

With 2 Figures.

During 1921 the writer undertook a series of geological investigations in the surroundings of Toluviejo (see Fig. 1), Bolivar Department, coastal area of the Republic of Colombia, South America¹). The author found a foraminiferous limestone of which he sent some specimens to the Museum of Natural History of Basle (Switzerland). Dr. Aug. Tobler investigated the samples and found the foraminifera genus Helicolepidina identical with that already described by him2) of the Upper Eocene of Trinidad and Venezuela. Therefore the stratigraphical position of this limestone may be of some interest.

For the purpose of this article the formations are named after the type locality or region where they outcrop. Although the writer agrees in general with the stratigraphical section given by Elfred Beck 3) it is impossible to use his stage names as his units are from 2 to 3 times too small (see page 81 and Fig. 2). The map (scale 1:50,000) upon which the author's measurments are based, was checked by transit, therefore there is little doubt about its correctness.

The formations exposed in the surroundings of Toluviejo are all sedimentary and of Tertiary age.

1. The deepest formation exposed is a black, shale horizon with interbedded black limestone and sandstone. Slickensides are very common throughout the whole series. The thickness of the formation as well as the underlying strata are unknown.

H. Douvillé: Quelques observations sur le sous-genre Helicolepidina Eclogae geol. Helv. 1923. Vol. XVII, p. 566-569.

¹⁾ We are indebted to the Bataafsche Petroleum Maatschappij for the permission to publish this article.

²⁾ A. Tobler: Helicolepidina, ein neues Subgenus von Lepidocyclina. Eclogae geol. Helv. 1922. Vol. XVII, p. 380-384.

TH. W. VAUGHAN: American and European Tertiary Larger Foraminifera. Bull. Geol. Soc. of America. Vol. 35, p. 802. Published December

³⁾ Elfred Beck: Geology and Oil Resources of Colombia: The Coastal Plain, Economic Geology. Vol. XVI 1921, p. 463, Fig. 33.

These black shales are overlain by the *Arroyo Seco-Formation*, consisting of a conglomerate and yellow sandstone. The Arroyo Seco Conglomerate is made up of loose Diorite pebbles of a

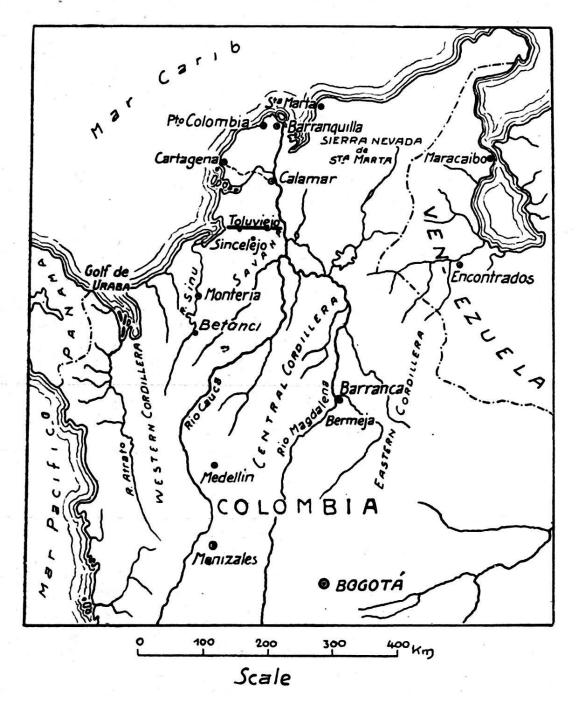


Fig. 1. Key-Map.

diameter of 1 meter and more which changes in lateral extension to a coarse-grained and poorly consolidated sandstone. No fossil evidence is proved neither for the Arroyo Seco formation nor the black shale horizon. 2. The Arroyo Seco formation underlies the *Toluviejo-Series* consisting of limestone and sandstone.

Beck's Denomin	Litholog & Paleontol Charact.	Columnar Section	Formations	Яде
San Antonio Sandstone Formation 1500 feet Huertas Limestone Series 1000 feet	yellow and gray Conglomerate and sona stone - lenses of sona		Sincelejo Sandstone 200m	Plio- cene
	gray coarse cross-bedded sandstone		Savana Sandstone	7 /
	yellow, fine grained sandstone, with big gray bowiders of desintegration		1200 m	0
	some lenses of gravels			7
	yellow fine grained sandstone with gray shale and sandy clay gray hard sands! silicified wood			E
	Deas of gray sanay limestone remains of Lamellibranchiae		Cerrito Formation	>
	brown sandst with marine Gastropods brown sandy shales and clays with some sandstone, Turitella Pyramidella			F
	gray sandy limestone with Ostrea " yellow sandy limest with marine Gastro Contact not determined			-\$-
Shales soof Tofeme Formation 1500 feet	rea shale with inter - bedded black limestone and sandstone Pacini sandstone Contact not getermined		Pacini Shales co. 1000m	OLIGOCENE
Palmito Limestone 200 feet	snow white , massive Limestone with Helicolepidina, Lepidocyclina et., Limestone changing in lateral extension to sondst coarse, Diorite peobled Conglomerate black shales		Toluviejo Series a 400 m Arroyo Seco Formation 20-40 m	EOCENE
,	Scale •	500		S 5.10

Fig. 2. Stratigraphical Section through the Tertiary of Toluviejo, Columbia, South America.

a. The *Toluviejo-Limestone* is the predominent and most important member of the series. The colour of the limestone varies from snow white to brown, although in the whole hard and compact and without any bedding planes it is sometimes

interspersed by cavities and spores. Foraminifera occur (Helicolepidina spiralis Tbl., Lepidocyclina of the Isolepidina type, small Nummulits and Operculina) in some places in rather large quantities.

The Toluviejo-Limestone with the same fauna is also found at different places of the Sinu valley e.g. at Betanci, (see Fig. 1) from where samples are in the Museum of Natural History at Basle.

The age of the Toluviejo-Limestone is uncertain, up to now however Helicolepidina is only known to occur in beds of Upper-Eocene of Trinidad and Venezuela¹), therefore we may presume the Toluviejo-Limestone to be of Upper-Eocene age also. Nevertheless it must be stated that no Discocyclina (Orthophragmina) was found, which would back up this presumption. Within a very short lateral distance the Toluviejo-Limestone changes to a

b. Sandstone. It is of a brown colour, fine grained and contains for a minifera, but no genera was identified. The thickness of Toluviejo-Series is certainly not less than 400 meters.

- 3. The Toluviejo-Series underly the Pacini-Shales, which are overlain by limestones and sandstones of Miocene age. The Pacini-Shales consist of red, gray and blue shales with interbedded limestone and sandstone near the bottom and of compact gray shale at the top. The latter contains gypsiferous clays in parts. The thickness of the whole Pacini-Shales is estimated at about 1000 meters, but this thickness may vary considerably. The few exposures of the formation gave no fossil evidence. The Oligocene age of this system is suggested for the following reasons:
 - a. There is a considerable lithological difference as regards the underlying Toluviejo-Limestone of Upper-Eocene age on one hand and the overlying stratas of the Miocene system on the other hand.
 - b. there is no evidence for a regressive overlap of the Toluviejo-Series by Miocene stratas, furthermore the Oligocene is not known to be missing in any of the areas bordering the Caribbean Sea²).
- 4, 5. The rocks of established Miocene age are the Cerrito-Formation overlain by the Savana-Sandstone. The bulk of

A. Tobler: op. cit., p. 380.
 Th. W. Vaughan: Criteria and Status of Correlation and Classification of Tertiary Deposits. Bull. Geol. Soc. of America. Vol. 35, 1924, p. 677-742, Table 3.

these sediments are sandstones, varying in colour from gray to yellow and brown. Limestone and shale members are interbedded in this sandstone. The whole Cerrito-Formation is highly fossiliferous, whilst in the Savana-Sandstone no fossils could be found. The Cerrito-Formation contains large quantities of Lamellibranchiats and marine Gastropods. Although only very few have been ascertained by names, there can be little doubt as to the Miocene age of the system to which period all geologists point, who worked in this region1). The most important fossiliferous bed of the series is the sandy limestone with a large Ostrea near the base of the Cerrito-Formation. The bed extends over a large area and can be used as key horizon. Turitella and Pyramidella were identified at different horizons of the series (see Fig. 2); besides this silicified wood was found near its top, but no specimen could be determined. The thickness of the whole Miocene system is estimated at about 2400 meters. According to Emmons²) the Miocene of the coast of Colombia has a thickness of at least 8000 feet. This shows a striking difference to the estimate of Beck1), who indicates an aggregate thickness of the whole Tertiary (including the writer's Eocene and Oligocene) of 5000 feet only.

6. The poorly consolidated sediments of the *Sincelejo Sandstone*, which overlies unconformably the Savana Sandstone is believed by most geologists^{1, 2}) to be of *Pliocene* age, but no fossil proving this statement was found by the author. The thickness is roughly estimated at 200 meters.

Conclusions.

The Tertiary formations, with a thickness of about 4000 meters, encountered in the surroundings of Toluviejo, coastal Area of Colombia S. A., are Upper-Eocene or Oligocene to Pliocene. The formations are made up of conglomerates, sandstones, shales and limestones. The main part of the latter is found as Toluviejo-Limestone at a thickness of 400 meters near the base of the group. The Toluviejo-Limestone contains foraminifera: Lepidocyclina, Nummulits, Operculina and Heliolepidina. The latter points towards an Upper-Eocene age of the limestone, but as no Discocyclina (Orthophragmina) is present Oligocene age is also possible.

Elfred Beck: op. cit. page 464.
 W. H. Emmons: Geology of Petroleum, p. 582. Mac Gran Hill Book Co. New York 1921.