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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 BECK³) 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 measurements 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.

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.

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

TH. W. VAUGHAN: American and European Tertiary Larger Foraminifera. *Bull. Geol. Soc. of America*. Vol. 35, p. 802. Published December 30, 1924.

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

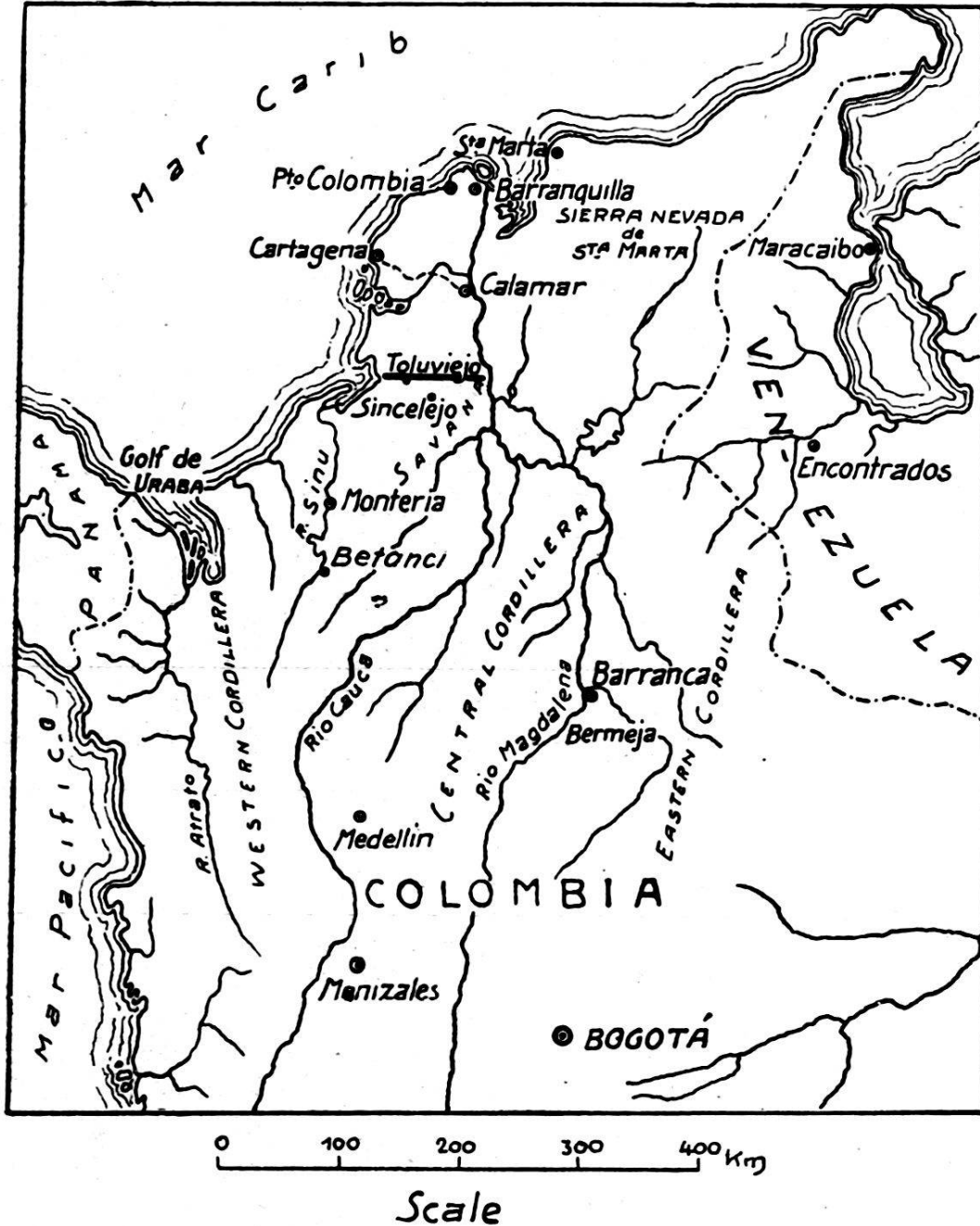


Fig. 1. Key-Map.

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.

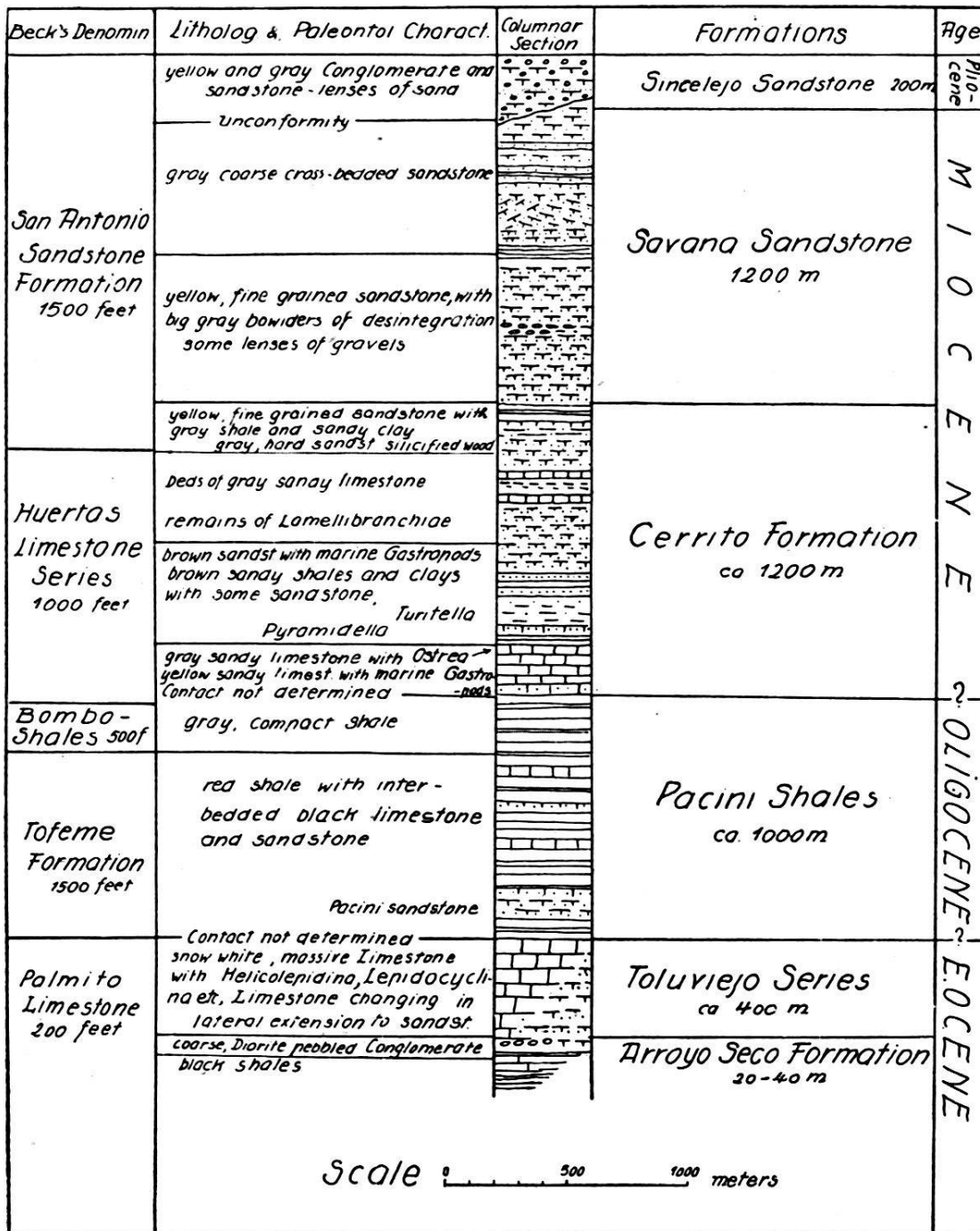


Fig. 2. Stratigraphical Section through the Tertiary of Toluviejo, Columbia, South America.

a. The *Toluviejo-Limestone* is the predominant 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 Tolviejo-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 Tolviejo-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 Tolviejo-Limestone to be of Upper-Eocene age also. Nevertheless it must be stated that no *Discoyclina* (*Orthophragma*) was found, which would back up this presumption. Within a very short lateral distance the Tolviejo-Limestone changes to a

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

3. The Tolviejo-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 Tolviejo-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 Tolviejo-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

¹⁾ A. TOBLER: op. cit., p. 380.

²⁾ 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 Toluvejo, 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 Toluvejo-Limestone at a thickness of 400 meters near the base of the group. The Toluvejo-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.

¹⁾ ELFRED BECK: op. cit. page 464.

²⁾ W. H. EMMONS: *Geology of Petroleum*, p. 582. Mac Gran Hill Book Co. New York 1921.