# BIOSTRATIGRAPHY AND DEPOSITIONAL PALEOENVIRONMENT OF THE CHICONTEPEC FORMATION IN THE TAMAZUNCHALE, HUEJUTLA AND CHICONTEPEC AREAS (CENTRAL-EAST MEXICO)

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## ABSTRACT

The foraminiferal fauna has been examined of surface samples from the Chicontepec Formation located in the Tampico-Misantla basin in central-east Mexico. The study of the planktic foraminiferal assemblage allowed an accurate dating of this unit, which includes strata of Early Paleocene to Early Eocene age corresponding to the interval defined by the Praemurica trinidadensis to *Morozovella formosa formosa* Zones. The benthic foraminiferal succession is representative of the Velasco Type Fauna and it comprises the following species: *Osangularia velascoensis, Gavellinella velascoensis, Gavellinella beccariiformis, Nutallinella florealis, Gyroidina globosa* and agglutinated foraminifers. The paleobathymetry of the benthic foraminiferal association, together with the sedimentary patterns, suggest that this was a turbidite deposit occurring on the lower slope.

## INTRODUCTION

The Tampico-Misantla Basin is located in the Gulf Coastal Plain; geographically it is bounded to the north by the Tamaulipas Range, to the south by the Tezuitlan Massif, to the west by the Sierra Madre Oriental and extends east ward beyond the present Gulf Coast shoreline. This basin contains Tertiary deposits, besides outcrops of Late Cretaceous and earliest Tertiary that are exposed in the Sierra Madre Oriental.

The Chicontepec Formation is the main lithostratigraphic unit of this basin. It cropsout along the eastern margin. Exposures of this lithologic unit are easily recognized by the interbedded pattern of sandstone and shale with some conglomerates horizons which developed a thick sequence of flysch deposit. The Chicontepec sequence unconformably overlies the Mendez Formation. It is covered by the Aragon or Guayabal Formations. The Chicontepec deposits appear to grade northward into the Velasco Formation. According to Hay (1960), the Velasco succession is characterized by a monotonous argillaceous lithology. Accordingly, bedding is not generally apparent except when bentonite layers are present.

It is important to point out that the foraminifera are abundant, but only in some levels of the Chicontepec Formation. The foraminiferal biostratigraphy is not well known, Barker and Berggren (1977), and Butterlin *et al.* (1977) studied some samples of this unit; however, the foraminiferal biostratigraphy remains poorly known.

The objective of this paper is the study of the planktic foraminifera, in order to determine the age of the Chicontepec Formation, as well as to established a zonal scheme. In addition, the knowledge of the benthic foraminifera permits interpretation of the paleonenvironments of the studied unit. For this purpose I analyzed samples of eight measured sections of the Tamazunchale, Huejutla and Chicontepec area located in the Tampico-Misantla Basin.

### Geographical Setting

The area is situated in the front of the Sierra Madre Oriental between the cities of Tamazunchale, Huejutla and Chicontepec along the boundary of the states of San Luis Potosi, Hidalgo and Veracruz (Fig.1).

### Material and Methods

The analyzed material was collected by Estanislao Velazquez (1979) geologist of Petroleos Mexicanos. It consisted of several hundred samples from eight stratigraphic sections of the classical sites (type localities) of the Chicontepec Formation.

A total of 40 species of foraminifera have been identified. The taxonomic review proposed by Berggren and Norris (1997) for the planktic foraminifera was utilized in part in this paper.

### Previous work

The name Chicontepec was first introduced with reference to the mountain and the village of the same name located in the western part of Veracruz. It was probably used in unpublished reports, but it was first published by Dumble (1918) without precise definition, included most of the Eocene rocks of the region. Belt (1925) referred to this unit as: "The Chicontepec Formation, of Eocene age, outcropping at the town of the Chicontepec and over the whole area west of Calabozo-

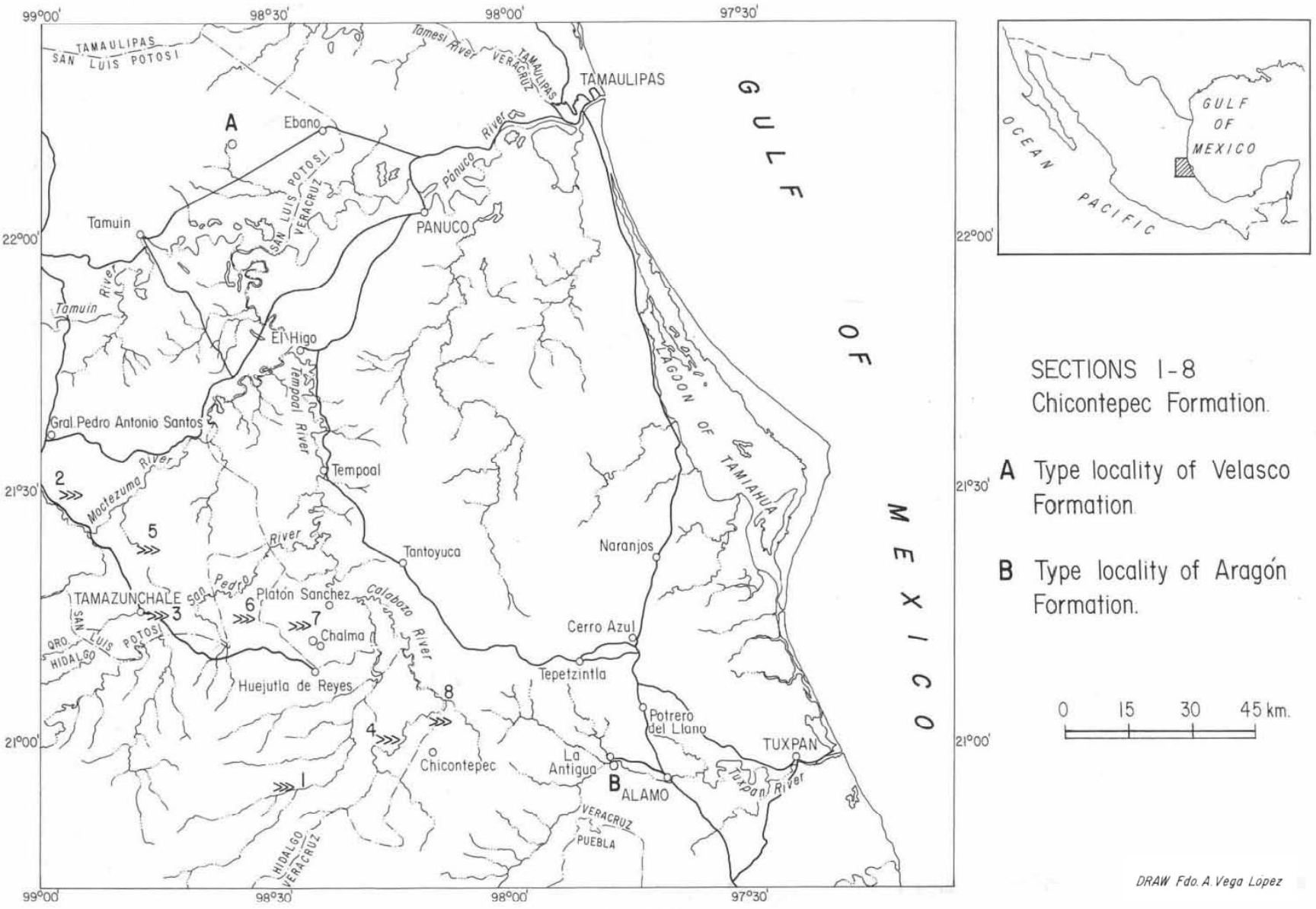


***Figure 1:*** *Geographical setting of the stratigraphic sections*

Platon river and east of Sierra Madre." Krutak *et al.* (1990) reviewed the stratigraphic history of the Chicontepec.

A typical section of this formation is exposed on Platon River just below Platon Sanchez (south-westward across the strike to the foot of Sierra Madre) where this formation lies on the Mendez Formation. Although all the shales and sandstones occurring between Platon and Tamazunchale have been assigned to the Eocene, it is possible that a remnant of Upper Cretaceous is present between the Mendez and the Chicontepec and that the dark shales with occasional sandy beds, which are now assigned to the base of the Chicontepec, may be Cretaceous and properly referable to the Tamesi Formation. Our knowledge of the base of the Chicontepec is incomplete, and it does not seem probable that the Tamesi is missing regionally at the foot of the Sierra Madre. The Chicontepec at its type locality consists of dark shales which weather brown, alternating with bluish, fine grained, brown-weathering sandstones in beds from a few inches to 3 or 4 feet thick. The upper part, which is known to be of Tertiary age, has a maximum thickness of about 4000 feet. Its exact thickness cannot be stated, since key horizons have not been distinguished, and because the structure of its outcrops is complex. Furthermore the entire formation has never been penetrated in a well."

Adkins (1925, in Barker and Berggren, 1977) proposed the use of Chicontepec as a Group made up of three formations: Tanlajas at the base, Chalma Shale and Chicontepec Formation at the top. Several geologists in Mexico used the Chicontepec in a formational sense for the Lower Eocene. However further work showed that Adkins' three formations were of only local significance and graded into one another almost imperceptibly. Also the uppermost division has been termed Jaco Formation, Jaco sandstone (Semmes, 1924 private report in Barker and Blow op.cit.) or Upper Chicontepec.

Nutall (1931, in Barker and Berggren, 1977) proposed a three fold division for the Chicontepec based in smaller foraminifera. His lower Chicontepec contained a large number of species in common with the Velasco and they were regarded at least in part as equivalent facies. The middle Chicontepec also contained many species in common with the Velasco and its was considered to be equivalent to the Velasco Shale. The upper Chicontepec, was regarded as younger, and probably a shallow-water equivalent, at least in part to the Aragon Formation. Barker and Blow (1977) suggested that a basal Velasco Shale occurs throughout the Tampico Embayment and the Burgos Basin. This is followed by a sandier facies in the southern part of the Tampico Embayment (termed Chicontepec). They indicate that the Chicontepec Formation has been mapped in two main areas in the Tampico Embayment, around Magiscatzin, north of Tamesi river and along the Sierra Madre front, from the Panuco river to the Misantla region. Around Tancanhuitz and Tamazunchale just south of the Panuco river, the basal part consists of very regularly bedded sandstone and shale in "flysch facies". On the other hand, the Chalma Shale of the Adkins' report is developed principally between Tamazunchale and Chicontepec. Previously, Muir (1936) indicates that "exposures in the Rio Calabozo, north of Chicontepec show beds that are strongly buckled". In some places contorted beds lie between horizontally bedded shales that are undisturbed. The Chicontepec is severely folded in numerous exposures, vertical limbs occurring in many places. Many faults occur, some of low angle. The Chicontepec is exposed in the foot hills of Sierra Madre in a belt 18-40 kilometres wide, extendended from Tancanhuitz southeastward past Chicontepec.

Velazquez (1979) measured several stratigraphic sections of the Chicontepec Formation from Tamazunchale, Huejutla and Chicontepec. Immediately to the south this lithostratigraphic unit outcrops on the road Villa Juarez-La Ceiba in the State of Puebla (Patiño, 1966).

## BIOSTRATIGRAPHY

A detailed study of planktic foraminifera (Omaña, 1980, 1982) from the eight sections (Figure 1) measured and sampled by Velazquez about 1979 provided the data for the integration of an Early Paleogene zonation of the Chicontepec Formation (Figs. 2,3). The definitions of the zones is based on the planktic foraminiferal zonal scheme proposed by Toumarkine and Luterbacher (1985) and Berggren and Miller (1988).

| SERIES | SUB SERIES | PLANKTIC FORAMINIFERAL ZONES | Surface samples | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Section 1 | Section 2 | Section 3 | Section 4 | Section 5 | Section 6 | Section 7 | Section 8 |
| EOCENE | Lower | *Morozovella formosa formosa* | | | | | | | | • |
| | | *Morozovella subbotinae* | | | | • | | | | |
| PALEOCENE | Upper | *Morozovella velascoensis* | | | | • | | • | | |
| | | *Planorotalites pseudomenardii* | | | | • | • | • | • | |
| | Middle | *Igorina pusilla pusilla* | • | | • | | | | | |
| | | *Morozovella angulata* | • | • | • | | | | | |
| | | *Praemurica uncinata* | | • | | | | | | |
| | Lower | *Praemurica trinidadensis* | • | | | | | | | |

***Figure 2:*** *Planktic foraminiferal zones recognized in the Chicontepec Formation.*

### Early Paleocene

*Praemurica trinidadensis* Zone. Interval between the initial appearance of the nominal taxon and the first occurrence of *Praemurica uncinata*. The assemblage of this zone contains: *Praemurica inconstans* and *Praemurica trinidadensis*. This zone is considered the youngest zone of the *Early Paleocene*, but in the material studied, it is the oldest zone noted. It occurs only in section 1.

### Middle Paleocene

*Praemurica uncinata* Zone. Interval from the first occurrence of *Praemurica uncinata* to the first appearance of *Morozovella angulata*. This zone is characterized by forms with the angular conical chambers in the initial part of the last whorl, such as *Praemurica praecursoria and Praemurica uncinata*.

*Praemurica inconstans* is also present in this interval. The *Praemurica uncinata* Zone is recognized in section 2.

*Morozovella angulata* Zone. Interval from the first occurrence of the nominal taxon to the first appearance of *Igorina pusilla pusilla.* A dominant planktic foraminifera assemblage of this zone includes species of *Morozovella* with conic-angular chambers from the initial part of the coiling, such as *Morozovella angulata* and *Morozovella* conicotruncata. In addition, *Planorotalites compressa* and *Morozovella kolchidica* have been reported. The *Morozovella angulata* Zone is widely distributed in the study area, it occurs in sections 1, 2 and 3.

In section 3 the *Morozovella angulata* Zone is overlying beds with Late Cretaceous (Maastrichtian) foraminiferal assemblages. This fact is important because only this site contains the unconformable boundary between the Cretaceous and Tertiary sediments.

*Igorina pusilla pusilla* Zone. Interval from the first appearance of *Igorina pusilla pusilla* to the first occurrence of *Planorotalites pseudomenardii.* The planktic association of this zone is characterized by *Igorina pusilla pusilla, Igorina pusilla laevigata, Morozovella conicotruncata, Morozovella simulatilis* and *Planorotalites chapmani.* This zone occurs in sections 1 and 3.

## Early Paleocene

*Planorotalites pseudomenardii* Zone. The total range of the nominal taxon defines this zone. The planktic foraminiferal assemblage consists of the heavily ornamented representatives of the genus *Morozovella* such as *Morozovella velascoensis, Morozovella acuta,* and *Morozovella kolchidica.* However, outside of the tropical and subtropical regions, the ornamented *Morozovella* species are absent, in general, and globular forms of the genus *Acarinina* are dominant. Therefore, it may be difficult to separate the Late Paleocene in two zones. This zone is extensively distributed in the material studied, it occurs in sections 4, 5, 6 and 7.

*Morozovella velascoensis* Zone. Interval from the extinction of *Planorotalites pseudomenardii* to the last occurrence of *Morozovella velascoensis.* The typical association of this zone contains coarsely ornamented species of *Morozovella,* such as *Morozovella occlusa, Morozovella velas-coensis, Morozovella acuta* and *Morozovella marginodentata.* Some authors indicate that the nominal taxon may be absent, even in assemblages from the tropical and subtropical realms. For that reason, this zone would be recognized by the co-occurrence of *Morozovella acuta* and *Morozovella occlusa* (Caro *et al.,* 1975, Stainforth *et al.,* 1975). In this interval several species make their first appearance, but become dominant within the basal Early Eocene assemblage, such as *Morozovella subbotinae, Morozovella formosa gracilis* and *Morozovella aequa.* The boundary between the Paleocene and the Eocene is generally placed at the top of the *Morozovella velascoensis* Zone (Toumarkine and Luterbacher,1985; Berggren and Miller, 1988). The *Morozovella velascoensis* Zone occurs in sections 5 and 6.

## Early Eocene

*Morozovella subbotinae* Zone. This zone is defined by the partial range of *Morozovella subbotinae* between the last occurrence of *Morozovella velascoensis* and the first appearance of Morozovella aragonensis. This has been widely recognized, but some authors disagree in the definitions of the boundaries. Here, I utilize the criteria of Stainforth *et al.,* 1975.

The *Morozovella subbotinae* Zone contains besides the nominal taxon, the following species of planktic foraminifers: *Morozovella formosa gracilis, Morozovella marginodentata, Morozovella aequa, Muricoglobigerina soldadoensis soldadoensis* and *Acarinina nitida.* This zone is present in section 4.

*Morozovella formosa formosa* Zone. Partial range of the nominal taxon between the first occurrence of *Morozovella aragonensis* and the first appearance of *Acarina pentacamerata.* The planktic foraminiferal assemblage from the *Morozovella formosa formosa* Zone consists of *Morozovella quetra, Morozovella lensiformis, Morozovella wilcoxensis, Morozovella formosa gracilis, Muricoglo-bigerina soldadoensis soldadoensis and Murico globigerina soldadoensis angulosa.*

Berggren and Miller (1988) used the last occurrence of *Morozovella formosa formosa* rather than the first appearance of Acarinina aspensis (=*pentacamerata*), but these two bioevents are basically equivalent, and mark the top of the *Morozovella formosa formosa* Zone.

## PALEOENVIROMENTS

The benthic foraminifera recovered from the Chicontepec Formation are: *Gavellinella velascoensis, Gavellinella beccariiformis, Nutallinella florealis, Osangularia velascoensis, Gyroidina globosa* and also agglutinated foraminifers. This assemblage was termed by Berggren and Aubert (1975) as "Velasco Type" because it was described and illustrated from the Velasco Formation (Cushman, 1925; Cushman; 1926; White 1928).

These Paleocene-Early Eocene forms are interpreted as deep-water fauna of the lower slope and abyssal plain (Berggren and Aubert, 1975, and Proto-Decima and Bolli, 1978).

On the other hand, the sedimentary pattern was controlled by the emergence of the Sierra Madre Oriental providing the sediments for the accumulation of a thick sequence of flysch sandstones interlayered with shales, which were deposited as turbidite deposits.

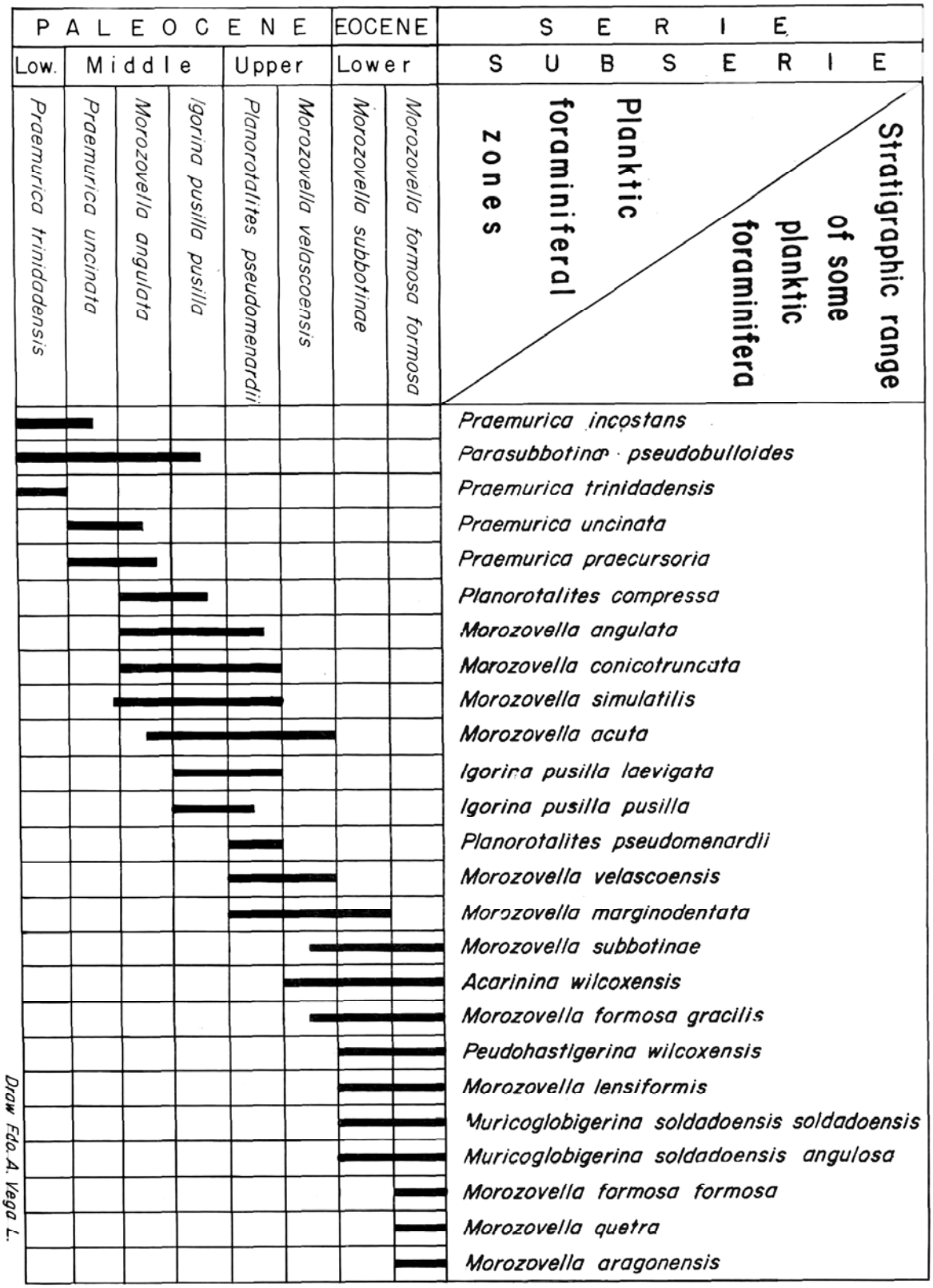


*Figure 3: Stratigraphic range of planktic foraminifera of the Chicontepec Formation*

*Draw Fdo. A. Vega L.*

## CONCLUSIONS

The planktic foraminiferal analysis from the Chicontepec sequence allows establishment of a zonation which define more precisely the chronostratigraphy of this unit. The age assigned to these beds is Early Paleocene to Early Eocene, with 7 interval zones and one range zone.

The Chicontepec deposit was largely controlled by the Laramide Orogeny, resulting in a trend sub-parallel to the coastal plain. The deposits exhibit a west-east distribution, with the older strata to the west and the younger to the east. This has been noted by other authors (Barker and Berggren, 1977 and Longoria, 1993).

The benthic foraminifera and the sedimentological characteristics indicate that the studied sequence accumulated in deep-water of the lower slope as a turbidite deposit.

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