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Eocene strata from the Sabinas Basin and their bearing in sedimentary basin correlation in NE Mexico

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Abstract

The El Arco section, located on the southeast margin of the Sabinas Basin (Adjuntas Sub-basin), includes a succession consisting of Upper Cretaceous formations typical for this unit, as well as Paleogene strata similar to those previously reported from the La Popa Basin, adjacent to the Sabinas Basin. The El Arco carbonate lentil includes microfossils and nautiloids that indicate a middle Eocene age, which is consistent with previous stratigraphic inferences for the La Popa Basin. The presence of the nautiloid *Hercoglossa* sp. cf. *H. peruviana* in the El Arco Lentil and in the upper portion of the Rancho Nuevo Formation of Parras Basin, suggests a new correlation scheme for the Tertiary stratigraphic units of the three basins (Parras, La Popa and Sabinas basins). All three units had sediment input as late as middle Eocene time.

Key words: Middle Eocene, Sabinas Basin, basin correlation, Northeastern Mexico.

Resumen

La sección El Arco, en el margen sureste de la Cuenca de Sabinas (Subcuenca de Adjuntas), incluye una secuencia que abarca formaciones del Cretácico Superior, características de esa unidad, así como estratos del Paleógeno, similares a los previamente reportados para la Cuenca de La Popa, adyacente a la Cuenca de Sabinas. La lente de carbonato El Arco incluye microfósiles y nautiloideos que indican una edad Eoceno medio, lo cual es congruente con inferencias estratigráficas previas para la Cuenca de La Popa. La presencia del nautiloideo *Hercoglossa* sp. cf. *H. peruviana* en la Lente El Arco y en la parte superior de la Formación Rancho Nuevo de la Cuenca de Parras, sugiere un nuevo esquema de correlación entre las unidades terciarias de las tres cuencas (Parras, La Popa y Sabinas), las cuales recibieron aporte sedimentario hasta el Eoceno medio.

Palabras clave: Eoceno medio, Cuenca de Sabinas, correlación de cuencas, Noreste de México.

1. Introduction

Data presented here document the presence of Eocene strata in southeast Sabinas Basin (Adjuntas Sub-basin, *sensu* Flores-Galicia, 1988), and indicate the need for a new correlation scheme between three important Cretaceous – Paleogene depocenters in NE Mexico, known as the Parras, La Popa and Sabinas basins (Figure 1a).

Previously, several authors suggested the presence of Eocene strata in the Sabinas Basin (Chávez-Cabello, 2005; Echánove, 1988; Eguiluz-de Antuñano *et al.*, 2000; Eguiluz-de Antuñano, 2001; 2004; 2007; Eguiluz-de Antuñano and Amezcua, 2003; Gray *et al.*, 2001). Recent field research in the Sierra El Arco on the eastern margin of the Sabinas Basin (Figure 1b) (locality IGM 3599 of the Catálogo de Localidades de la Colección Nacional de Paleontología, UNAM) has revealed the presence of marine Paleogene strata, previously considered as Maastrichtian Hermanas formation by Flores-Espinoza (1989). Flores-Espinoza (1989) studied the area recognizing a vertical succession consisting of the Escondido Formation, which includes a red-beds unit, the Múzquiz member, overlain by the Hermanas formation, represented by the El Arco Lentil. The El Arco Lentil was interpreted as a 15 m thick and 8 km long carbonate biostrome, deposited during a transgressive phase during low rates of terrigenous sedimentation in Maastrichtian times (Flores-Espinoza, 1989). Based on previous regional reports by Laudon (1975) and McBride *et al.* (1975), Flores-Espinoza (1989) suggested a relationship between topographic relief associated with diapirism and the deposit on the El Arco Lentil. The elongate shape of the El Arco Lentil suggests its origin adjacent to a former salt wall since evacuated to form a weld, but more fieldwork is necessary to confirm this inference. Recent reports of La Popa Basin document the relation between carbonate lentils and topographic relief associated with diapirism (Giles and Lawton, 1999; 2002; Lawton *et al.*, 2001).

2. El Arco Section

The sequence at El Arco includes outcrops of the San Miguel, Olmos and Escondido formations, all units typical of the Sabinas Basin, as well as outcrops of the upper Potrerillos and Adjuntas formations, typical of the La Popa Basin. The top of the sequence is represented by the El Arco carbonate lentil (Figure 2). A covered interval stratigraphically above the Escondido Formation may correspond to Paleocene deposits, probably equivalent to the Upper Mudstone and Upper Sandstone Members of the Potrerillos Formation. Red beds crop stratigraphically above the covered interval (Figure 3), and are equivalent to the Adjuntas Formation where oyster banks of the species *Ostrea* (*Turkostrea*) *escondida* Perrilliat and Vega, 1993 (Figure 4.1 – 4.10) crop at the top of the formation. *Ostrea* (*Turkostrea*) *escondida* was also reported from the

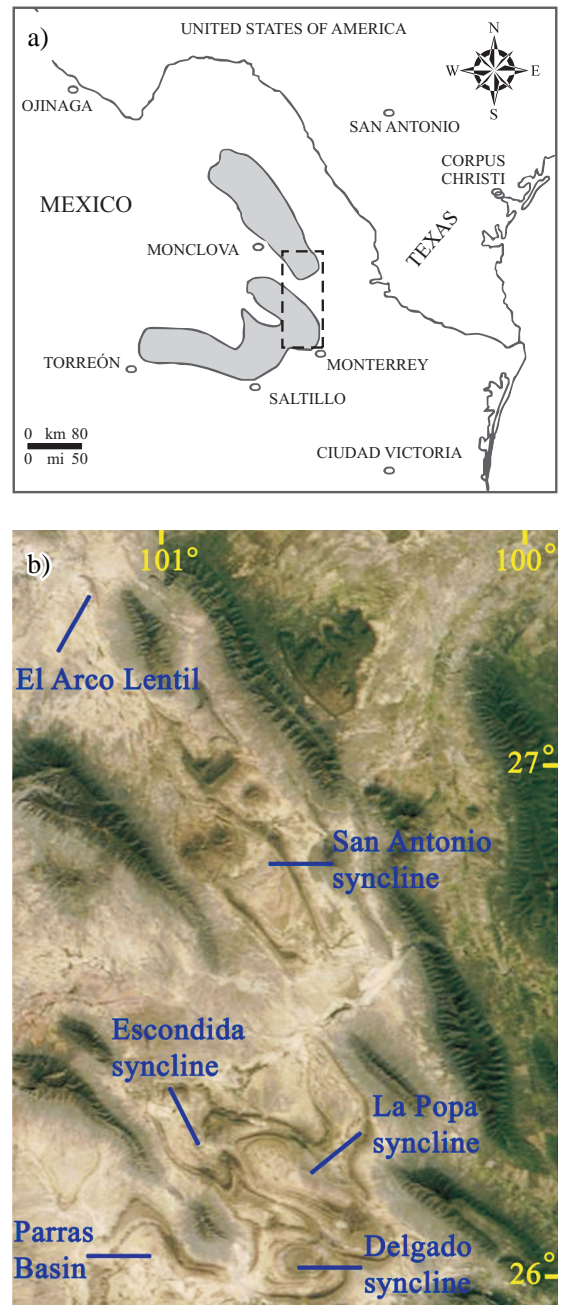


Figure 1. a) Location map of the Parras, La Popa and Sabinas basins. Dashed line rectangle indicates area of figure b) Location map of the El Arco section, southeast margin of the Sabinas Basin and primary synclines of La Popa Basin.

Lower Eocene (Ypresian) of the La Popa Basin (Perrilliat and Vega, 1993) at the La Escondida and San Antonio synclines (Figure 1b). A review of the Múzquiz Member is necessary, as this unit represents, at least in the SE portion of the Sabinas Basin, the Adjuntas Formation, but it is still considered by some, as a Cretaceous unit (Corona-Esquivel

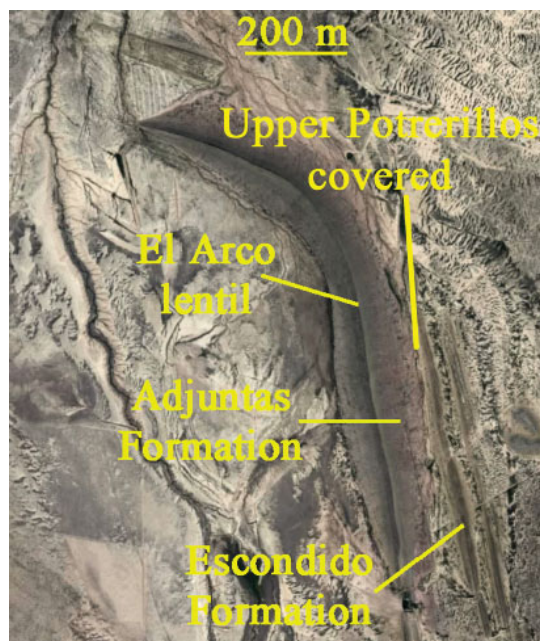


Figure 2. Satellite image of the Sierra El Arco, eastern portion of the Sabinas Basin, with outcrops of the Escondido, upper Potrerillos (covered), Adjuntas and El Arco Lentil.

et al., 2006). Stephenson (1927) reported a new species of *Ostrea* collected from the Múzquiz formation, mentioning they resemble ostreids of Tertiary forms. However, other authors have reported ammonites from the same unit (Robeck *et al.*, 1956; Flores-Espinoza, 1989). On top of the Adjuntas Formation beds, a 10 m thick interval of dark-gray limestone, named by Flores-Espinoza (1989) as the El Arco member (Figure 3) of the Hermanas formation, contains numerous fossils that include foraminifera, sponges, solitary corals *Flabellum* sp. (Figure 5.20 – 5.22), scarce valves of *Venericardia* sp., and complete nautiloids identified as *Hercoglossa* sp. cf. *H. peruviana* Berry, 1923 (Figure 4.11 – 4.14), a species reported from the Middle Eocene of Perú. Additionally, foraminifera found at the El Arco Lentil (Figure 5.1 – 5.19) suggests a Middle Eocene age, with benthic forms such as *Lenticulina jeffersonensis* Garrett, 1939 (Figure 5.19), which is used to recognize middle Eocene beds of the Burgos Basin (Aguilar-Piña, pers. comm.). Forms similar to *Morozovella aragonensis* (Nuttall, 1930) (Figure 5.14, 5.15) also support this interpretation.

3. Biostratigraphy

Maastrichtian beds are present in the Parras, La Popa and Sabinas basins. Occurrence of the ammonite *Sphenodiscus pleurisepta* (Conrad, 1857) indicates an early Maastrichtian age for the Las Imágenes Formation

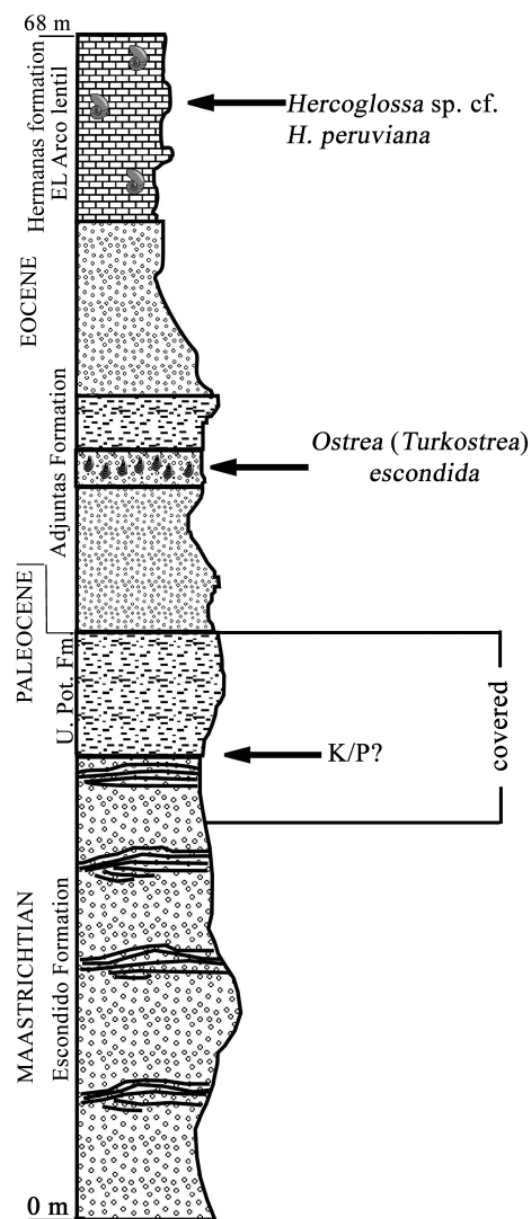


Figure 3. Composite stratigraphic section at El Arco, southeast Sabinas Basin, with Escondido, upper Potrerillos Formation (U. Pot. Fm.), Adjuntas Formation and Hermanas formation, which consists entirely of the El Arco Lentil. Top of section is eroded.

of the Parras Basin (Bermúdez-Santana, 2003; Wolleben, 1977), the Lower Mudstone Member of the Potrerillos Formation of the La Popa Basin (Ifrim, 2005; Vega and Perrilliat, 1989c; Wolleben, 1977), and the Escondido Formation of the Sabinas Basin (Flores-Espinoza, 1989). *Cimomia haltomi* (Aldrich, 1931) is present in the lower Rancho Nuevo Formation of the Parras Basin (Vega and Perrilliat, 1995; Wolleben, 1977), and the Upper Mudstone Member of the Potrerillos Formation, La Popa Basin (Vega

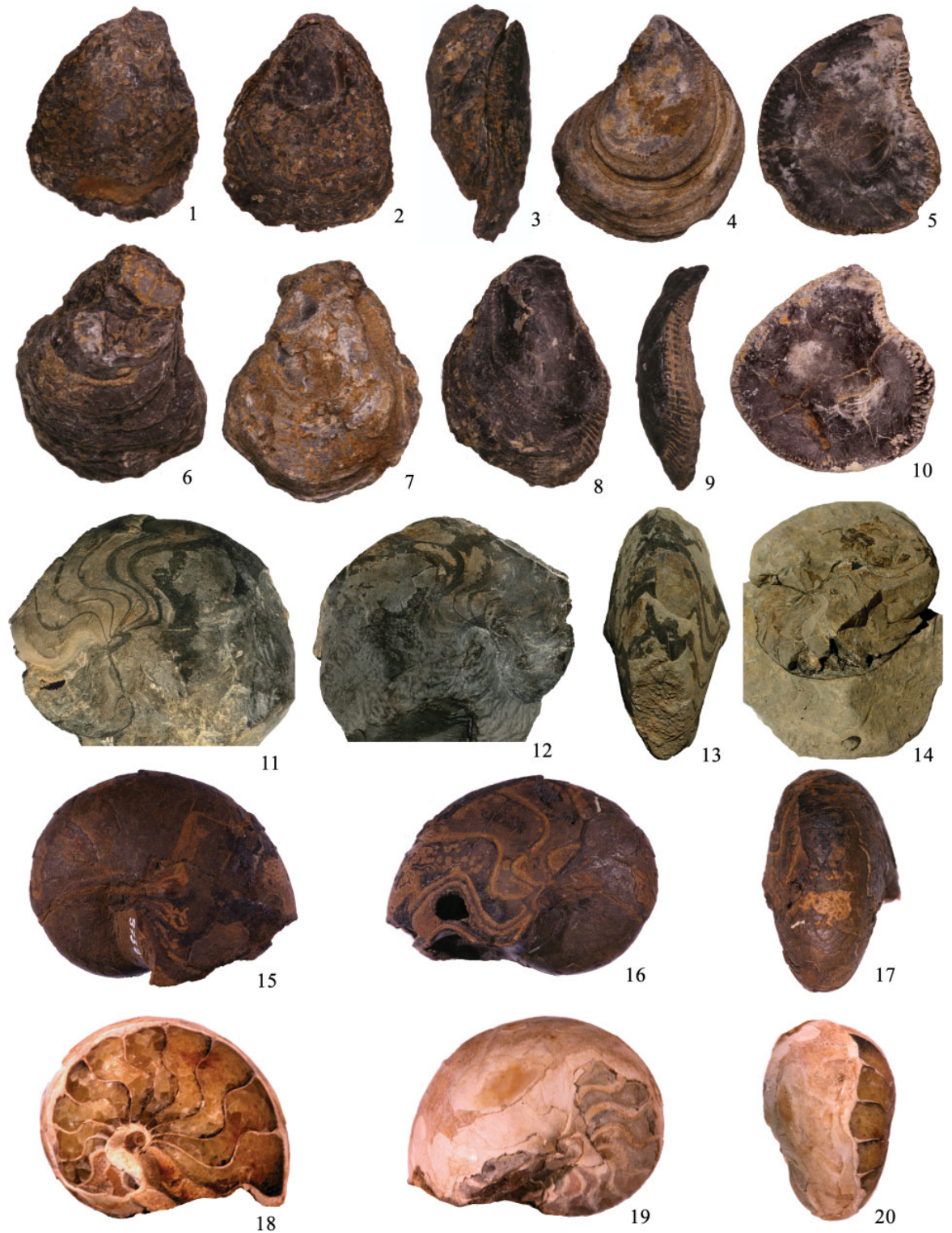


Figure 4. 1 – 10: *Ostrea (Turkostrea) escondida* Perrilliat and Vega, 1993, El Arco section, Adjuntas Formation, Sabinas Basin, Coahuila, Lower Eocene (Ypresian). 1 – 3: Hypotype IGM-7840, articulated specimen, left valve, right valve and left lateral views, X1.2; 4, 5: Hypotype IGM-7841, right valve, outer and inner views, X1.0; 6, 7: Hypotype IGM-7842, articulated specimen, left and right valves, X1.2; 8, 9: Hypotype IGM-7875, outer and left views of left valve, X1.2; 10: Hypotype IGM-7876, inner view of left valve, X0.8. 11 – 16: *Hercoglossa* sp. cf. *H. peruviana* Berry, 1923. 11 – 13: Hypotype IGM-7878, right, left and ventral views, El Arco Lentil (Hermanas formation), Sabinas Basin, Coahuila, Middle Eocene (Lutetian), X0. (Continue on next page).

and Perrilliat, 1995), indicating a Paleocene age for those units. As previously mentioned, no Paleocene strata were recognized at the El Arco section, due to lack of exposure in the upper portion of the Escondido Formation. However, based on a similar stratigraphic sequence observed by Vega *et al.* (1989) at the San Antonio Syncline, we infer that Paleocene strata equivalent to the Upper Mudstone and Upper Sandstone Members of the Potrerillos Formation are present above the Escondido Formation. The Adjuntas Formation in the La Popa Basin, has been considered to be of early Eocene age on the basis of index fossils such as *Venericardia planicosta* (Lamarck, 1801), *Kapalmerella mortoni postmortoni* (Harris, 1894) and turkostreid species, which are closely related to species from other Eocene units in the Tethys Province (Vega and Perrilliat, 1989a; 1989b; 1992; 1995; Vega *et al.*, 1989; Perrilliat and Vega, 1993; 2003; Lawton *et al.*, 2001; Klosterman *et al.*, 2007). *Kapalmerella mortoni postmortoni* (Figure 5.23 – 5.25) is also abundant in the Viento Formation of the La Popa Basin, and although it was formerly considered as an index fossil for the early Eocene, Allmon (1996; 2005) placed this species in the upper Paleocene. However, an important index fossil found in the Adjuntas Formation is *Venericardia planicosta* (Figure 5.26), an early Eocene (Ypresian) bivalve. The presence of the Eocene nautiloid *Hercoglossa* sp. cf. *H. peruviana* above Adjuntas strata at El Arco section seems to confirm that the succession overlying the Adjuntas (Viento and Carroza formations) is of Eocene age. An interesting addition to the data presented here is the occurrence of *Hercoglossa* sp. cf. *H. peruviana* (Figs. 4.15 – 4.17) in the upper part of the Rancho Nuevo Formation (contribution of J. Ventura, locality IGM 3598 of the Catálogo de Localidades de la Colección Nacional de Paleontología, UNAM). Thus a new scheme of correlation is needed for the three main Upper Cretaceous – Paleogene sedimentary basins in Northeastern Mexico. *Hercoglossa* is also present in the lower Eocene of Chiapas (Figure 4.18 – 4.20), shells of which were used to obtain an isotopic age equivalent to 52 Ma (Perrilliat *et al.*, 2006), which corresponds with the Ypresian stage (Steurbaut, 2006). A nautiloid specimen reported by Squires and Demetrios (1992) from the Eocene of Baja California Sur, was reported as being similar to *H. peruviana*.

4. Correlation

Flores-Espinoza (1989) proposed a correlation between the Upper Sandstone Member of the Potrerillos Formation

(La Popa Basin) and the El Arco Lentil of the Hermanas formation. However, the Upper Sandstone Member underlies the Adjuntas Formation at the Delgado, La Popa, La Escondida and San Antonio synclines (Figure 1b). In the hinge of the San Antonio Syncline on the southernmost edge of the Sabinas Basin, Vega *et al.* (1989) recognized Paleocene strata (upper Potrerillos Formation) that overlies Maastrichtian deposits of the Escondido Formation containing *Sphenodiscus pleurisepta*. Although oyster beds of *Ostrea (Turkostrea) escondida* were recognized from the top of the Adjuntas Formation in this section, the calcareous equivalent found at the top of El Arco section is not present. Soegaard *et al.* (2003) also suggested a correlation of the section in the southern part of the Sabinas Basin at the San Antonio Syncline, with the upper portion (Paleocene) of the Parras and La Popa basins. They considered the Rancho Nuevo Formation (Parras Basin) to be correlated with the Paleocene Upper Mudstone Member of the Potrerillos Formation (La Popa Basin), and that the Adjuntas, Viento and Carroza Formations (La Popa Basin) of Eocene age, were deposited during the last stratigraphic cycle in the Difunta Group.

On the basis of previous stratigraphic interpretations and recent findings at El Arco, we suggest a new scheme of correlation between the Paleogene sections of three important sedimentary basins in northeastern Mexico (Figure 6). The Paleogene units at the Sabinas Basin are represented by the upper Potrerillos Formation, the Adjuntas Formation and the El Arco Lentil of the Hermanas formation. These units are equivalent to the Paleocene Upper Mudstone and Upper Sandstone Members of the Potrerillos Formation, and to the Lower Eocene Adjuntas Formation, and the basal middle Eocene Viento and Carroza formations of the La Popa Basin, respectively (Figure 6). Occurrence of the nautiloid *Hercoglossa* sp. cf. *H. peruviana* on the upper part of the Rancho Nuevo Formation in the Parras Basin suggests a direct correlation with strata of the Sabinas Basin, and indirectly with the upper part of the section in La Popa Basin. Sediment was being supplied to the three basins during middle Eocene time, possibly the beginning of the Lutetian, while seas were retreating from W-SW to E-NE in Northeastern Mexico (Figure 7).

5. Conclusions

Presence of marine Eocene strata in the eastern part of the Sabinas Basin, suggests a correlation with the La Popa and the eastern Parras basins. The stratigraphic range of the

Figure 4. (Continued). 3, 14: Hypotype IGM-7879, left side of specimen in a concretion, with a specimen of *Flabellum* sp. included, El Arco Lentil (Hermanas formation), Sabinas Basin, Coahuila, Middle Eocene (Lutetian), X0.3. 15 – 17: Hypotype IGM-7877, right, left and ventral views, locality IGM 3598, Noria Las Ánimas, upper Rancho Nuevo Formation, Parras Basin, Coahuila, Middle Eocene (Lutetian), X0.8. 18 – 20: *Hercoglossa* sp., hypotype IGM-8622, right, left and ventral views, Veinte de Noviembre, El Bosque Formation, Chiapas, Lower Eocene (Ypresian), X1.0.

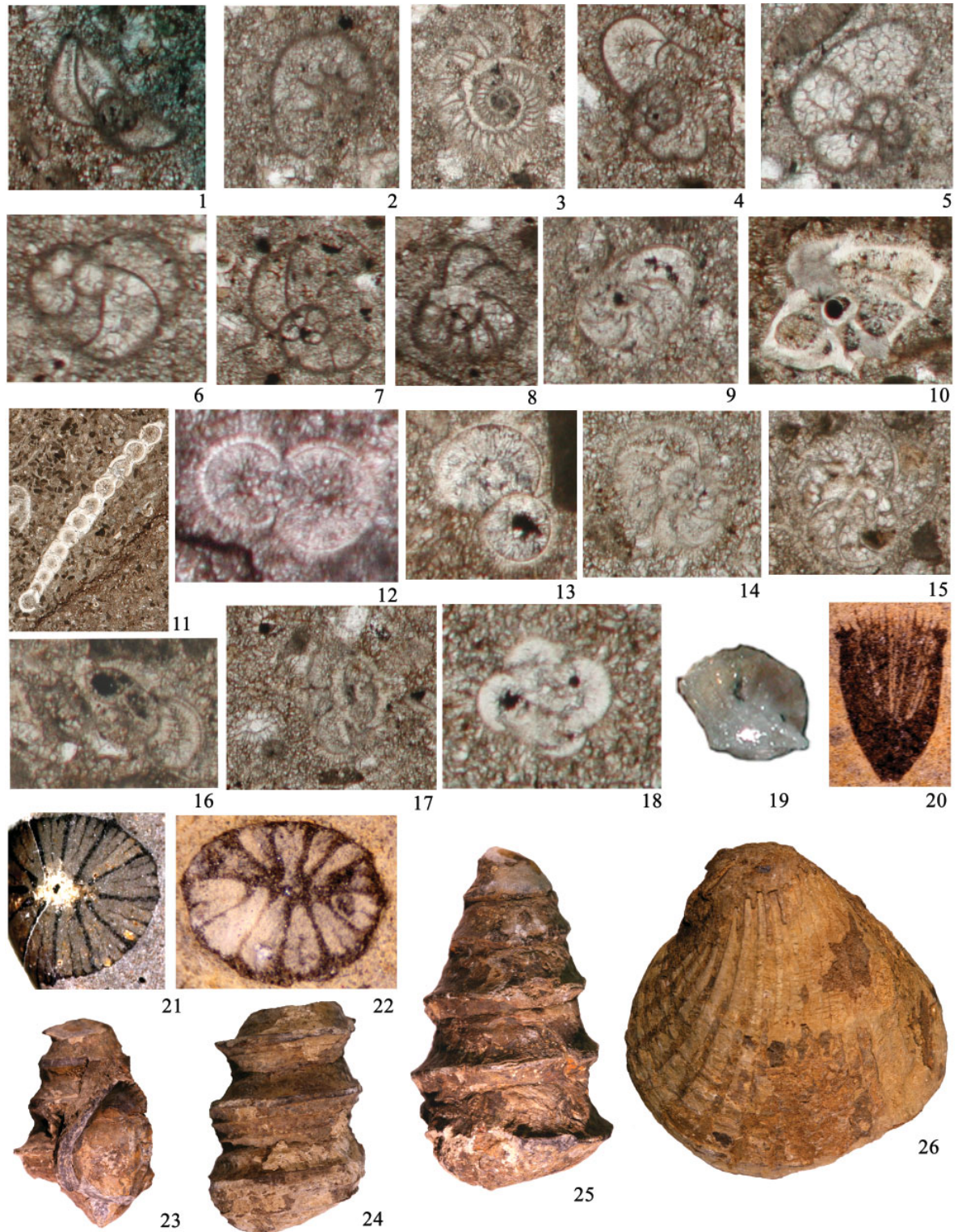


Figure 5. 1 – 19: Foraminifera, locality IGM 3599, El Arco Lentil, Hermanas formation, Sabinas Basin, Coahuila, Middle Eocene (Lutetian). 1, 2: *Gyroidinoides* sp. 1: Axial section, 36X. 2: Equatorial section, 36X. 3: *Cibicidoides* sp., surficial equatorial section, 36X. 4 – 8: Valvulaminidae Loeblich and Tappan, 1986, equatorial section, 48X. 9: *Hanzawaia* sp., equatorial section, 90X. 10: Rotallid, axial section, 48X. 11: *Siphonodosaria* sp., axial section, 10X. 12, 13: *Pseudoglobigerinella* sp. cf. *G. bolivariana*, axial section, 63X. 14, 15: *Morozovella* sp. cf. *M. aragonensis* (Nuttall, 1930), equatorial section, 90X. 16: *Morozovella* sp., axial section, 90X. 17: *Acarinina* sp., axial section, 63X. 18: *Subbotina* sp., equatorial section, 90X. 19: *Lenticulina* sp. cf. *L. jeffersonensis* Garrett, 1939, side view, 30X. (Continue on next page).

Cretaceous				Tertiary	
Campanian		Maastrichtian	Paleocene		Eocene
		Parras Basin	La Popa Basin		Sabinas Basin
	Cerro del Pueblo	Cerro Huerta	Rancho Nuevo	Carroza	Hermanas (El Arco)
				Viento	
				Adjuntas	
				Upper Sandstone	Upper Potrerillos?
		Upper Mudstone			
		Las Encinas	Escondido		
		Cerro Grande		Middle Siltstone	
		Las Imágenes		Lower Mudstone	
	Cañón del Tule	Lower Siltstone			
	Cerro Huerta	Muerto		Olmos	
		Parras	San Miguel		
			Upson		

Figure 6. Stratigraphic correlation between units of the Parras, La Popa and Sabinas basins, based on data here presented and on those of Bermúdez-Santana, 2003; Chávez-Cabello *et al.*, 2004; Eberth *et al.*, 2004; Goldhammer and Johnson, 1999; Kirkland *et al.*, 2000; Lawton *et al.*, 2001; Soegaard *et al.*, 2003; Vega and Perrilliat, 1995.

Rancho Nuevo Formation in the Parras Basin is extended to the Eocene, indicating that the Rancho Nuevo contains strata equivalent to the Adjuntas and Viento formations in the La Popa Basin, and the Adjuntas Formation and El Arco Lentil in the Sabinas Basin. Eustasy and diapirism during Paleocene and Eocene times played important roles in deposition of Tertiary strata in Northeastern Mexico.

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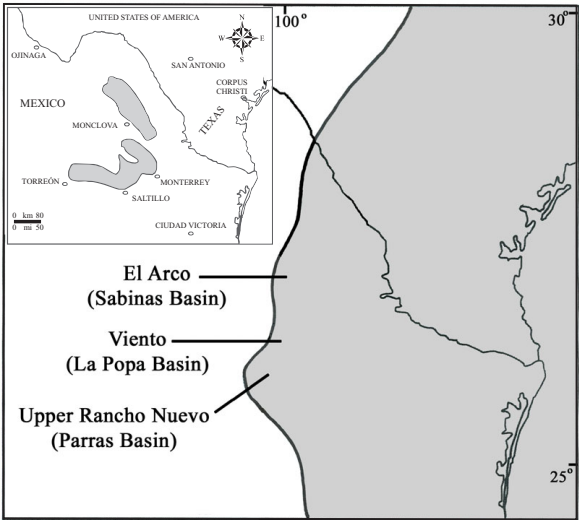


Figure 7. Inferred Eocene shoreline with approximate location of deposits of El Arco Lentil (Hermanas formation), Viento/Carroza and upper Rancho Nuevo formations. See Figure 1.1 for Recent geographic reference.

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Figure 5. (Continued). 20 – 22: *Flabellum* sp., locality IGM 3599, El Arco Lentil, Hermanas formation, Sabinas Basin, Coahuila, Middle Eocene. 20: Hypotype IGM-7833, approximately oblique - longitudinal cross section of a corallum; the upper margins of septa appear to be exsert, 5X; 21: Hypotype IGM-7834, transverse cross section near the calicular margin of a corallum; four complete cycles of septa present (48 septa), columella absent, 10X; 22: Hypotype IGM-7835, transverse cross section near the base of a corallum; three complete cycles of septa present (24 septa), columella absent, 15X. 23 – 25: *Kapalmerella mortoni postmortoni* (Harris, 1894), locality IGM 1973, Cerro La Carroza, Adjuntas Formation, La Popa Basin, Nuevo León, Lower Eocene (Ypresian). 23: Hypotype IGM-7836, with a left valve of *Ostrea* (*Turkostrea*) *escondida* Perrilliat and Vega, 1993 attached, X1.5. 24: Hypotype IGM-7837, X2.0. 25: Hypotype IGM-7838, X0.7. 26: *Venericardia planicosta* (Lamarck, 1801), hypotype IGM-7839, locality IGM 1973, Cerro La Carroza, Adjuntas Formation, La Popa Basin, Nuevo León, Lower Eocene (Ypresian), X0.8.

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