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) escudida* Perrilliat and Vega, 1993 (Figure 4.1 – 4.10) crop at the top of the formation. *Ostrea (Turkostrea) escudida* was also reported from the 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...
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 Peru. 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 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 (Turkestrea) 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 Chiaapas (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 Demetrion (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 overlie Maastrichtian deposits of the Escondido Formation containing Sphenodiscus pleurisepata. 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
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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