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A coral-rich unit of Berriasian (Early Cretaceous) age in the Sierra Madre Oriental of northeastern Mexico

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ABSTRACT

A coral-rich Berriasian unit locally known as the San Juan Lentil conforms the basal Taraises Formation in the San Juan canyon located half distance between the cities of Saltillo and Monterrey in northeastern Mexico. Here we document the environmental conditions and discuss its regional distribution of this biostrome unit. Calpionellids are intermittently present and indicate a middle to late Berriasian age for the coral-bearing unit that was deposited during an interval of increased oligotrophic conditions.

1. Introduction

Here we report on the oldest Mesozoic coral-rich buildups known to date from the Sierra Madre Oriental of northeastern Mexico. The unit, termed the San Juan Lentil by Frame and Ward (1987), conformably overlies uppermost Jurassic deltaic sediments of the La Casita Formation (Fig. 1). The occurrence of abundant and relatively diverse corals of earliest Cretaceous age is quite unexpected, as region-wide sedimentation during this time interval is siliciclastic-dominated (e.g., Michalzik and Schumann, 1994). Extended shallow water carbonate platforms are developed in the region during later Early Cretaceous periods and include important reefal build-ups (e.g., the Cupido Formation; Wilson, 1981; Wilson and Ward, 1993; Lehmann et al., 1999), but these are characteristically dominated by rudist bivalves and corals are either completely absent or minor accessory elements. According to present knowledge, rudists first arrive in Mexico during the late Berriasian (e.g., Pantoja-Alor et al., 2004; Scott and Filkorn, 2007; Lara Osorio, 2009).

1.1. Geographic and geologic overview

The coral-rich limestone unit described here is exposed on the northern flank of the overturned WSW–ENE trending Los Muertos anticline (see Wall et al., 1961; Wilson et al., 1984) in the Sierra Madre Oriental, at about half-distance between Saltillo, Coahuila state, and Monterrey, Nuevo León state, in the northernmost Sierra San José de los Nuncios fold and thrust belt (Fig. 2A). In the San Juan canyon, that perpendicularly crosses strata of the Los Muertos anticline in North-South direction, the unit reaches a maximum thickness of about 30 m (Figs. 1 and 2A). Coeval coral-bearing sediment units were also identified in three canyons located on strike to the ENE, at Cortinas at 4 km distance (Michalzik, 1988), at El Ranchero at 11 km distance (Figs. 2A, and 3), and La Huasteca at 21 km distance (Figs. 2A and 4; Adatte et al., 2001). Here we also document on two additional locations to the SE, Potrerillos at 85 km distance from San Juan canyon and Puerto Piñones at 80 km distance (see Fig. 2B), where approximately coeval individual corals (calpionellid subzone D2 or slightly higher; Adatte et al., 1996) were identified in hemipelagic environments. Humphrey (1949) assigned the shallow water coral-bearing limestone to the lowermost Cretaceous basal Taraises Formation; he informally termed the unit "Bryozoan Limestone". Based on correlation with approximately coeval reefal buildups in the subsurface of Texas (e.g., Cregg

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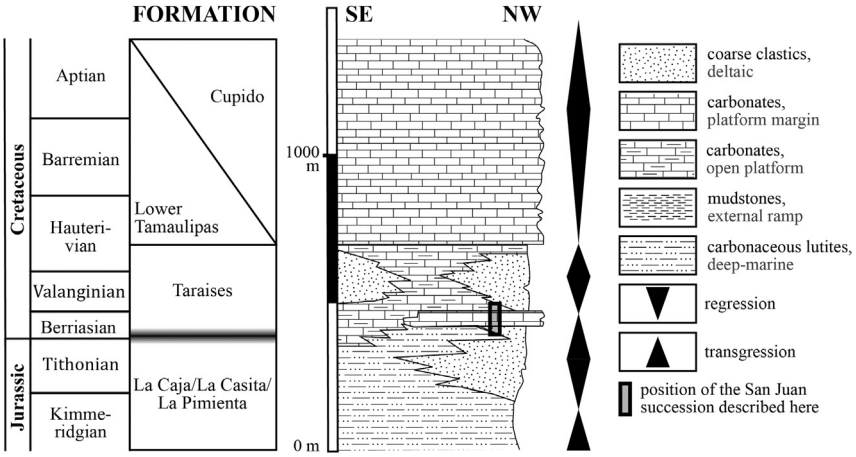

Fig. 1. Simplified stratigraphic column of Upper Jurassic to Lower Cretaceous sediments in northeastern and central Mexico. The position of the San Juan carbonate succession described here is illustrated by the vertical rectangle box (modified after Michalzik, 1988; Goldhammer and Johnson, 2001 and Ocampo-Díaz et al., 2008).

and Ahr, 1984; Finneran et al., 1984; Scott, 1984) and on ammonites detected overlying the San Juan Lentil (Humphrey, 1949), a Berriasian age of the coral-rich unit at San Juan canyon was tentatively proposed by Frame and Ward (1987). Here we refer to the coral-rich limestone as San Juan Limestone Member. Assignation to the base of the Taraises Formation is based on the predominance of limestone (cf. Imlay, 1936) and reduced siliciclastic content as compared to sediments of the underlying La Casita Formation.

The San Juan limestone is a lenticular unit of limestone, sandy limestone and marl, that trends for approximately 15 km in WSW–ENE direction (see Frame and Ward, 1987). At San Juan canyon the unit reaches a thickness of up to 30 m and forms a morphological ridge located at about 100 m south of the vertical cliff of shallow water limestone of the Lower Cretaceous Cupido Formation. This latter unit is easily identified in the field as it forms the high mountain ridge of the Sierra Madre Oriental (Fig. 3A). At its type locality, the San Juan limestone forms part of the northern vertical to slightly overturned limb of the Los Muertos anticline (Fig. 3B).

1.2. Material and methods

Rocks and fossils described here were sampled at San Juan canyon at N25°37.317′/W100°44.231′. 60 rock samples were collected layer-by-layer from a 70 m-thick section. Calpionellids were identified in thin sections to provide biostratigraphic framework. They are rare throughout the section and were only detected in lime-dominated lithologies. All rock samples (including thin-sections) described here are housed in the *Colección de Paleontología de Coahuila* (CPC) at the Museo del Desierto, Saltillo, Coahuila state, Mexico. Collection numbers: CPC-1186 to CPC-1213; CPC-1244 to CPC-1258; CPC-1387 to CPC-1403.

2. Depositional setting

Fig. 3 depicts outcrop conditions in the San Juan canyon, while Fig. 4 illustrates representative microfacies. Fig. 5 presents the sediment column of the San Juan Limestone Member including under- and overlying sediments, interpreted depositional environments (cf. Frame and Ward, 1987), and a stratigraphic distribution of corals and calpionellid taxa. Calpionellids were detected in 8 layers of the San Juan canyon section spanning the upper La Casita to lower Taraises formations. They are sufficiently well-preserved to be identified to species level and indicate early Berriasian to early Valanginian ages for the sediment sequence, as discussed below. Sediments also contain foraminifers, radiolarians, bivalves, gastropods, sponges, stromatoporoids, corals and echinoderms.

The base of the section consists of weathered, thin- to medium-bedded, medium- to coarse-grained sandstone (cf. Michalzik and Schumann, 1994) of the upper La Casita Formation (Figs. 3C and 5, unit I). These sediments are occasionally cross-bedded indicating shallow marine high-energy deltaic environments (e.g., Michalzik, 1988; Adatte et al., 2001). Fossils are rare and include unidentified ammonites, echinoids and bivalves (e.g., trigoniids). The presence of trigoniids in life position characterizes shallow water environments of near-shore habitats (Stanley, 1977). Bioturbation was detected in two layers. The uppermost 3.5 m (Fig. 5, unit II) of the La Casita Formation (Fig. 4.1 and thin section position 1 in Fig. 5) consist of beige-colored and nodular-bedded marl rich in $C_{org.}$, with abundant gastropod, bivalve and echinoderm fragments, suggesting deposition in a slightly less energetic shallow marine environment. This increase in carbonate and decrease in siliciclastic content and grain-size is well known from the uppermost La Casita and more distal La Caja formations of northeastern Mexico and is there interpreted to reflect a rise in relative sea-level, stratigraphically assigned to approximately the Tithonian–Berriasian boundary transition (e.g., Wilson et al., 1984; Adatte et al., 1994, 1996).

The transition between the siliciclastic La Casita Formation and overlying calcareous sediments of the San Juan Limestone Member of the Taraises Formation is approximately 8 m thick and is marked by a gradual increase in lime content, resulting in sandy marl- and limestone. Above, coral-bearing limestone of the San Juan Limestone Member is massive and reaches a thickness of 30 m. A 5 m-thick unit of silty limestone (Fig. 5, unit III) forms the basal San Juan Limestone Member. Deposition on a shallow marine carbonate platform is indicated by an increase in macrofossil abundance (Fig. 4.2 and thin section position 2 in Fig. 5), notably bivalves, gastropods, echinoids, bryozoans and rare benthonic foraminifers. Calpionellids were detected in a single layer at 2 m above the base of the San Juan Limestone unit; they indicate an early or middle Berriasian age.

The silty limestone unit III underlies an approximately 4 m-thick unit (Fig. 5, unit IV) of thin-bedded marl and wackestone rich in $C_{org.}$-matter (Fig. 4.3 and thin section position 3 in Fig. 5). This unit also includes two layers with corals in life position and bryozoan detritus, rare benthonic foraminifers, turriculate gastropods and