



Age and depositional conditions of the marine vertebrate concentration Lagerstätte at Gomez Farías, southern Coahuila, Mexico



Patrick Zell*, Seija Beckmann, Wolfgang Stinnesbeck

Institute for Earth Sciences, Heidelberg University, Im Neuenheimer Feld 234, 69120 Heidelberg, Germany

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ABSTRACT

A 1.5 m thick coquinite discovered in the Upper Jurassic La Casita Formation of the Sierra El Jabalí near Gomez Farías, Coahuila, northeastern Mexico qualifies as a concentration Lagerstätte owing to its richness in marine vertebrates. Ichthyosaurs, pliosaurus and crocodylians were described to some detail, but other taxa remained unstudied and the precise biostratigraphical age, as well as paleoecological conditions that led to the formation of the fossil deposit, are not known in detail. Here we describe ammonites, aptychi, bivalves and radiolarians, which allow for a stratigraphic assignment of the deposit to the uppermost Kimmeridgian Beckeri Zone. The unit under consideration accumulated in a hemipelagic mud bottom environment during a period of time characterized by low oxygen conditions, while a short term benthic colonization phase near the top of the coquinite corresponds to increased oxygen availability. A combination of upwelling, bottom currents, winnowing, offshore winds, storm events, circulatory nutrient traps, low oxygenated bottom waters, and a transgression regime with reduced net sedimentation was crucial factors for the subsequent concentration of fossils, as well as for marine phosphate generation and phosphorus migration.

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1. Introduction

The Upper Jurassic La Casita Formation of the Sierra El Jabalí in the northeastern Mexican state of Coahuila received international attention for the abundance and diversity of marine vertebrate remains (Buchy et al., 2006a; Buchy, 2007, 2010; Stinnesbeck and Frey, 2014; Frey and Stinnesbeck, 2014). Since the discovery of this vertebrate-bearing unit, in 2003, several excavations were carried out close to the village of Gomez Farías, approximately 60 km south of Saltillo, and a vast collection of marine reptilian remains, many of them subarticulated fragments, was excavated, enclosed in a 1.5 m thick coquinite. The horizon is mainly built up by bivalves, but ammonites and aptychi were also recorded. Well preserved ichthyosaur remains (e.g., *Ophthalmosaurus icenicus*) and various thalattosuchians numerically dominate the vertebrate assemblage, while sauropterygians, mainly represented by large pliosaurids of unclear affinities, a few vertebrae attributed to elasmosauridae, and a cryptoclidid, await formal description. Turtles are yet to be reported (Buchy et al., 2006b; Buchy, 2010; Brinkman, 2014). The assemblage of Late Jurassic Gulf of Mexico marine reptiles (e.g., Buchy, 2007), ammonites (e.g., Villaseñor

et al., 2012) and belemnites (Zell et al., 2013), but also the nearly absence of earliest calpionellids in the late Tithonian (e.g., Adatte et al., 1994, 1996), differ from coeval associations in Europe and the Pacific realm and confirm a partial isolation of the area.

1.1. Paleogeographical and geological setting

During Late Jurassic times, the opening of the Gulf of Mexico was accompanied by widespread rifting and continental extension related to sea-floor spreading in the Gulf of Mexico, but the area remained at least temporarily isolated from both the European Realm and the Pacific, with the Florida uplift to the east and the Sinaloa Magmatic Arc to the west forming barriers (e.g., Imlay, 1941; Goldhammer, 1999; Goldhammer and Johnson, 2001; Buchy et al., 2003, 2005, 2006b; Stinnesbeck and Frey, 2014, and references therein).

A prominent paleo-high in northeastern Mexico, the Coahuila Peninsula, existed in the region northwest of Saltillo and shed enormous quantities of terrigenous sediment southward into the epicontinental sea (Fig. 1). The deposition of conglomerate, sandstone and siltstone of the La Casita Formation characterizes deltaic and inner shelf environments proximal to the Coahuila Peninsula (e.g., Michalzik, 1988; Götte, 1990; Goldhammer and Wilson, 1991; Adatte et al., 1994; Goldhammer, 1999; Goldhammer and Johnson,

* Corresponding author. Tel.: +49 (0) 6221 54 6045.

E-mail address: Patrick.Zell@geow.uni-heidelberg.de (P. Zell).

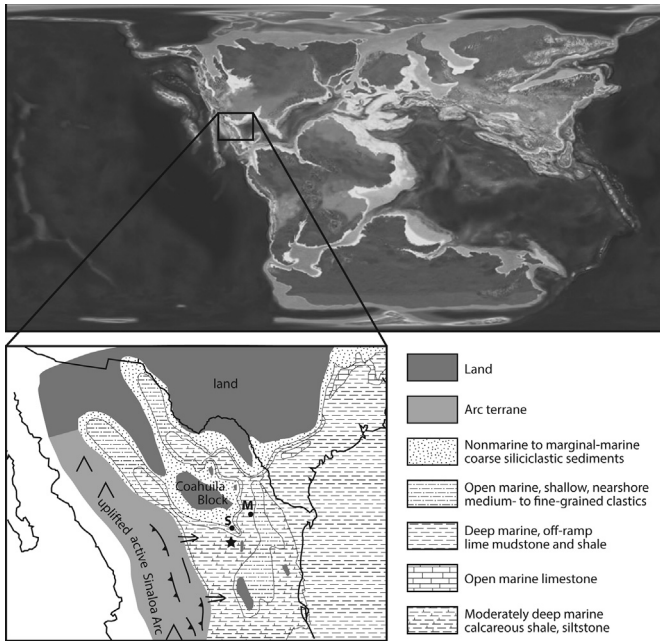


Fig. 1. Paleogeographic map of the Late Jurassic world (Blakey, 2014) with inset of northeastern Mexico (simplified after Goldhammer and Johnson, 2001). An asterisk marks the Gomez Farías site. M = Monterrey, S = Saltillo.

2001), while the coeval deposition of shale, marl, siltstone and phosphorites of the La Caja Formation to the south of Monterrey and Saltillo reflect more distal inner to outer shelf environments (e.g., Michalzik, 1988; Michalzik and Schumann, 1994; Longoria, 1984; Buchy et al., 2006b). Sea floor topography was markedly irregular as a result of rifting in the Gulf of Mexico, leading to block tectonic in northeastern Mexico (Goldhammer, 1999), but also due to sea level fluctuations (Adatte et al., 1996). In consequence, sections show rapid lateral changes in facies and abrupt variations in thickness, from 40 m to >500 m (e.g., Adatte et al., 1994). The irregular sea bottom topography and heterogeneity of eco-sedimentary conditions were used to explain differential ammonite records and endemism (e.g. Olóriz, 1992; Villaseñor et al., 2012).

1.2. The La Casita Formation

The La Casita Formation and its equivalents, the La Caja and Pimienta formations, show an overall transgressive lithostratigraphic sequence (Jenchen, 2007). Lithologies of the La Casita Formation are predominantly siliciclastic, conforming conglomerate, sandstone, shale and marl. Phosphoritic layers are also characteristically present in restricted horizons but increase in abundance in the upper part of the succession (Imlay, 1943; Rogers et al., 1956; Michalzik, 1988; Schumann, 1988a; Adatte et al., 1994).

Fossils are locally abundant and occasionally preserved 3-dimensionally in limestones and calcareous concretions between a few tens of millimeters and >2 m in diameter. Diverse ammonite assemblages have been described (e.g., Burckhardt, 1906, 1930; Imlay, 1938, 1939; Cantú-Chapa, 1963, 1999, 2006; Peña-Muñoz, 1964; Verma and Westermann, 1973; Olóriz et al., 1998, 1999; Villaseñor et al., 2000), but belemnites (e.g., López-Caballero, 2009; Zell et al., 2013), bivalves (e.g., Mora et al., 2000; Zell et al., 2014), brachiopods (Castillo and Aguilera, 1895; Gerwig, 2012) and serpulids as well as radiolarians and calpionellids (e.g., Adatte et al., 1994, 1996) were also recorded. Marine vertebrate remains are occasionally abundant and include fishes, ichthyosaurs,

crocodiles and pliosaurus (Frey et al., 2002; Buchy et al., 2003, 2006a; Buchy, 2007; Stinnesbeck and Frey, 2014; Frey and Stinnesbeck, 2014; Carbot-Chanona, 2014). Based on the faunal contents (e.g., ammonites, calpionellids), an Early Kimmeridgian to lowermost Berriasian age was assigned to the La Caja/La Casita formations (e.g., Adatte et al., 1994, 1996; Villaseñor et al., 2000, 2012; Olóriz et al., 2003b; Zell et al., 2013).

1.3. The Gomez Farías concentration Lagerstätte

The Gomez Farías section is located in the Sierra El Jabalí, approximately 60 km south of Saltillo and approximately 8 km east-southeast of the village of Gomez Farías, in southern Coahuila (N24°56.320'/W100°57.310') (Fig. 2). The La Casita Formation is 126 m thick, with a well exposed erosive contact to the underlying Zuloaga and a gradual transition to the overlying Taraises formations (Velasco Segura, 2005). The layers are subvertically exposed on the southern flank of the Sierra El Jabalí anticline, which trends in northwest-southeast direction (Fig. 3.1). The overall succession is transgressive and ranges from lagoonal (Zuloaga Formation) to pelagic basin (Taraises Formation) environments (Adatte et al., 1994).

The concentration of marine vertebrates in the Gomez Farías coquinite is outstanding and has been investigated to some detail. The invertebrate assemblage of the Gomez Farías section, on the other hand, has not received much attention to date, with the exception of the belemnite record (Zell et al., 2013) and the transition between the La Caja and Taraises formations, which contains the Jurassic–Cretaceous boundary (Adatte et al., 1994, 1996).

Here, we present a collection of ammonites, aptychi and bivalves from the Gomez Farías coquinite with abundant marine vertebrate remains and assign a precise stratigraphic age to this unusual

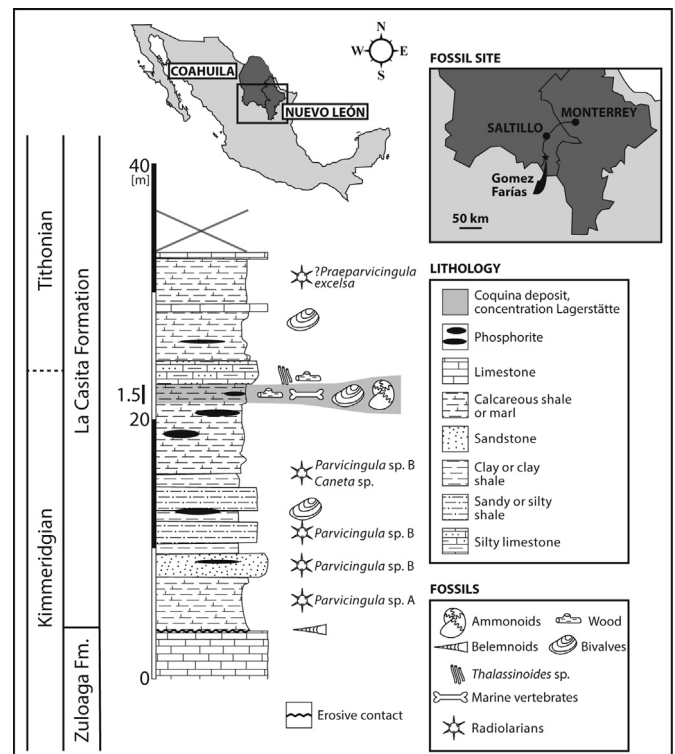


Fig. 2. Map of Mexico showing the location of southern Coahuila and Nuevo León. Below: Lithostratigraphic column of the lower La Casita Formation at Gomez Farías. The vertebrate-rich coquinite is marked in grey. It is situated at approximately 19 m above the base of the La Casita Formation and was assigned here to the uppermost Kimmeridgian Beckeri Zone (section redrawn after Velasco Segura, 2005).

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