

RUDISTS FROM THE PEÑA COLORADA IRON MINE AND LA MINITA SULFIDE DEPOSIT, STATES OF COLIMA AND MICHOACÁN, SW MEXICO

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ABSTRACT

A geological study of the principal mining areas along the Pacific coast in the states of Colima and Michoacán was carried out with the purpose of understanding the origin of the mineral deposits in southwestern Mexico.

Rudists were found in some of the stratigraphic units. The age indicated by these fossils has been helpful in establishing the sequence of the processes involved. Peña Colorada mine, in the State of Colima, contains the rudists *Texicaprina vivari* (Palmer), *Immanitas* sp., *Mexicaprina minuta* Coogan, *Mexicaprina cornuta* Coogan, *Toucasia* sp., *Eoradiolites davidsoni* (Hill) and *Radiolites costata* Scott. All of them are Albian-Cenomanian in age.

La Minita mine, in the State of Michoacán, contains very poorly preserved rudists, which are *Caprina* sp. and *Amphitriscoelus* sp., of early Aptian age.

The difference in age between these two sites suggests that there were at least two important mineralization events in this region. The first, in the Early Cretaceous, gave rise to the volcanogenic sulfide deposits, and the second, post-Late Cretaceous, event is associated mainly with Fe-bearing metasomatic and hydrothermal deposits.

Key words: Rudists, Peña Colorada mine, La Minita mine, volcanogenic sulfides, iron, Michoacán, Mexico.

RESUMEN

Se realizó un estudio geológico de las principales zonas mineras a lo largo de la costa del Pacífico, en los estados de Colima y Michoacán, con el propósito de comprender el origen de los depósitos minerales en la parte sudoccidental de México.

En algunas de las unidades estratigráficas, se encontró rudistas. La edad indicada por estos fósiles ha sido útil para establecer la secuencia de los procesos involucrados. La mina Peña Colorada, en el Estado de Colima, contiene los rudistas *Texicaprina vivari* (Palmer), *Immanitas* sp., *Mexicaprina minuta* Coogan, *Mexicaprina cornuta* Coogan, *Toucasia* sp., *Eoradiolites davidsoni* (Hill) y *Radiolites costata* Scott. Todos ellos son del Albiano-Cenomaniano.

La mina La Minita, en el Estado de Michoacán, contiene rudistas en un estado pobre de conservación. Éstos son *Caprina* sp. and *Amphitriscoelus* sp., del Aptiano temprano.

La diferencia en edad entre estos dos sitios sugiere que hubo al menos dos eventos de mineralización importantes en esta región. El primero, en el Cretácico Temprano, dio lugar a los depósitos de sulfuros volcanogénicos, y el segundo, en el Cretácico Tardío, está asociado principalmente con depósitos metasomáticos de hierro e hidrotermales.

Palabras clave: Rudistas, mina Peña Colorada, mina La Minita, sulfuros volcanogénicos, hierro, Michoacán, México.

INTRODUCTION

The outcrops in the region located between the Peña Colorada and La Minita ore deposits range from Early to Late Cretaceous in age and include the Tecalitlán, Madrid, El Encino and Vallecitos formations. Previous papers have described the origin and lithology in detail (Gaytán-Rueda *et al.*, 1979; Ortigosa-Cruz *et al.*, 1994; Pineda-Ramírez *et al.*, 1969) but do not give the precise age of these formations nor mention which formations host the mineralization.

In the present study, the rudists found associated with each ore deposit are identified and stratigraphic correlation is established, thereby contributing to the knowledge of the age and depositional environment of these deposits. The La Minita

deposit formed during Aptian time and is distributed in the upper part of the Tecalitlán Formation and the base of the Tepalcatepec Formation, whereas the post-Albian Peña Colorada deposit was emplaced in limestones and volcanic rocks belonging to the upper part of the Tepalcatepec Formation.

LOCATION

The studied area is located at 18°45'-19°30'N and 102°50'-104°20'W, in the states of Colima and Michoacán. This area pertains to the physiographical province of the Sierra Madre del Sur (Raisz, 1964) (Figure 1).

Peña Colorada is in the NW part of the State of Colima in the municipality of Minatitlán and northwest of the village of Minatitlán. From the city of Colima, it is located at Km 54 of the road that leads west and continues on to the port of Manzanillo.

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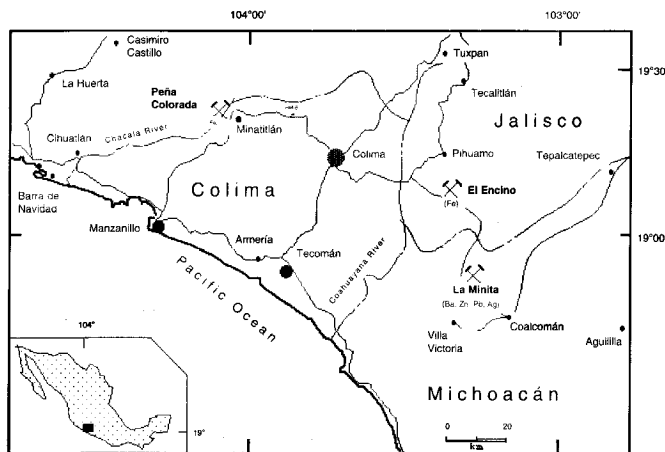


Figure 1. Location map of the Peña Colorada-La Minita area.

The fossiliferous site of La Minita is located in the municipality of Coalcomán, 60 km SE of the city of Colima, in the SW part of the State of Michoacán. The main access is by federal highway 54, from Mexico to Colima; federal highway 110 is taken from the city of Colima toward Pihuamo, Jalisco, and at Km 42 an unpaved road leads to El Encino and La Minita, passing through the villages of Trojes and Juana María (Figure 1).

PREVIOUS STUDIES

The following papers are concerned with the stratigraphy of this region and have a regional approach: Vivar (1926), Pano (1975), Pimentel (1979), Rodríguez (1980), Cuevas-Sánchez (1981), Goveia and Ordóñez (1981), Sánchez (1983), Salazar (1983), Pantoja-Alor and Estrada-Barraza (1986), Bermúdez-Santana (1994) and Bustamante-Bermejo (1994). From 1974 to 1984, Petróleos Mexicanos drilled the wells Colima and Tepames, which provided key stratigraphic information. Several regional studies that focus on understanding the tectonic evolution of Mexico have been carried out, such as Campa-Uranga and Coney (1983), Campa-Uranga and Ramírez (1979), Guerrero-Suástegui and coworkers (1991), Talavera-Mendoza (1993), Centeno-García and coworkers (1993) and Sedlock and coworkers (1993). Since this part of Mexico has mineralized zones, there are several papers that deal with mining geology; for example, Pineda-Ramírez and coworkers (1969), de la Garza-Noriega (1979), Gaytán-Rueda and coworkers (1979), Mérida-Cruz (1978), de la Campa (1988), Corona-Esquivel and coworkers (1991) and Ortigoza-Cruz and coworkers (1994).

STRATIGRAPHY

The stratigraphy of the region includes intrusive igneous rocks, volcanic marine rocks, marine and continental sedi-

ments, with ages ranging from Early Cretaceous to Quaternary time. These rocks correspond to the geologic province "Guerrero-Colima orogenic complex" (Ortega-Gutiérrez *et al.*, 1992) and belong to the "Jalisco-Colima Basin". The fossiliferous localities of this paper comprise the upper part of the Tecalitlán Formation and most of the Tepalcatepec Formation.

TECALITLÁN FORMATION

Rodríguez (1980) informally proposed the name Tecalitlán to designate a pyroclastic sequence constituted of tuff, volcanic sandstone, volcanic conglomerate, andesitic lava flows and isolated intercalations of siltstone beds of probable Barremian-Aptian age. The type locality is from the outcrop located on federal highway 110, between the village of Tecalitlán and the Carrizalillo Ranch, in the State of Jalisco. Pantoja-Alor and Estrada-Barraza (1986) formally named the Tecalitlán Formation, extending it to include the outcrops of volcanic rocks exposed to the west of El Encino mine where the lithology and stratigraphic position are similar to the rocks cropping out around Tecalitlán.

Between La Minita and Coalcomán this formation outcrops in the core of the anticlinal structure and the mineralization is located in the upper part of the Tecalitlán Formation.

In a section north of Coalcomán, Bermúdez-Santana (1994) obtained a K-Ar date on hornblende of 118.5 ± 2.5 Ma, from andesite in the upper part of the Tecalitlán Formation. This isotopic age corresponds to the early Aptian, which agrees with the paleontologic determinations of the present study.

TEPALCATEPEC FORMATION

The Tepalcatepec Formation was informally named by Pimentel (1980) in the Tepalcatepec area, State of Michoacán. It consists of a volcano-sedimentary sequence of thick to massive beds of limestone, argillaceous limestone, siltstone, sandstone, shale, tuff, conglomerate and andesitic flows. An Albian-Cenomanian age is assumed for this formation based on the faunistic assemblage, mainly rudists. It is the widest distributed unit in the area and is 2,500 to 3,000 m thick; there is interdigitation between reefal limestones and the volcano-sedimentary sequence. At the base of both facies, there are sandstone, conglomerate, shale and siltstone interlayered.

The bank facies is formed by thick to massive beds of platform limestone including a great thickness of conglomerate with a calcareous matrix.

The volcano-sedimentary sequence is composed of andesitic to latitic breccias with intercalations of thin calcareous horizons.

Along the road between La Minita and Trojes, rudists of the genus *Immanitas* and ostreids of the genus *Rastellum* (Corona-Esquivel and Alencáster, 1993) were collected, indicating a shallow warm-water environment and confirming an Albian age. In the Peña Colorada area there are extensive

outcrops of the Tepalcatepec Formation with a great diversity of rudists in the calcareous layers. This formation conformably overlies the Tecalitlán Formation, and is interbedded with the Madrid Formation due to lateral variations and underlies the Cerro de la Vieja Formation in angular unconformity (Corona-Esquivel, 1993).

FOSSILIFEROUS LOCALITIES

PEÑA COLORADA AREA

The sampled fossiliferous localities are included in a sequence, approximately 600 m thick, which comprises three

distinct lithologic units of the Tepalcatepec Formation; these units are, from bottom to top: (1) limestone, (2) tuffs and microbreccias, and (3) conglomerate (Figure 2).

The fossiliferous horizons are found principally in Unit 1 and are less abundant in the limestone lenses intercalated in Unit 2.

The fossils of Peña Colorada area were found mainly in two localities. The first one is a 150 m thick sequence at Cerro Los Copales, located to the SE of Minatitlán (Figure 3). The bottom of this sequence consists of 30 to 35 cm thick beds of medium-grained reddish sandstone intercalated with beds of the same thickness of conglomeratic sandstone with round fragments of andesite from 1 to 3 cm in diameter. Toward the

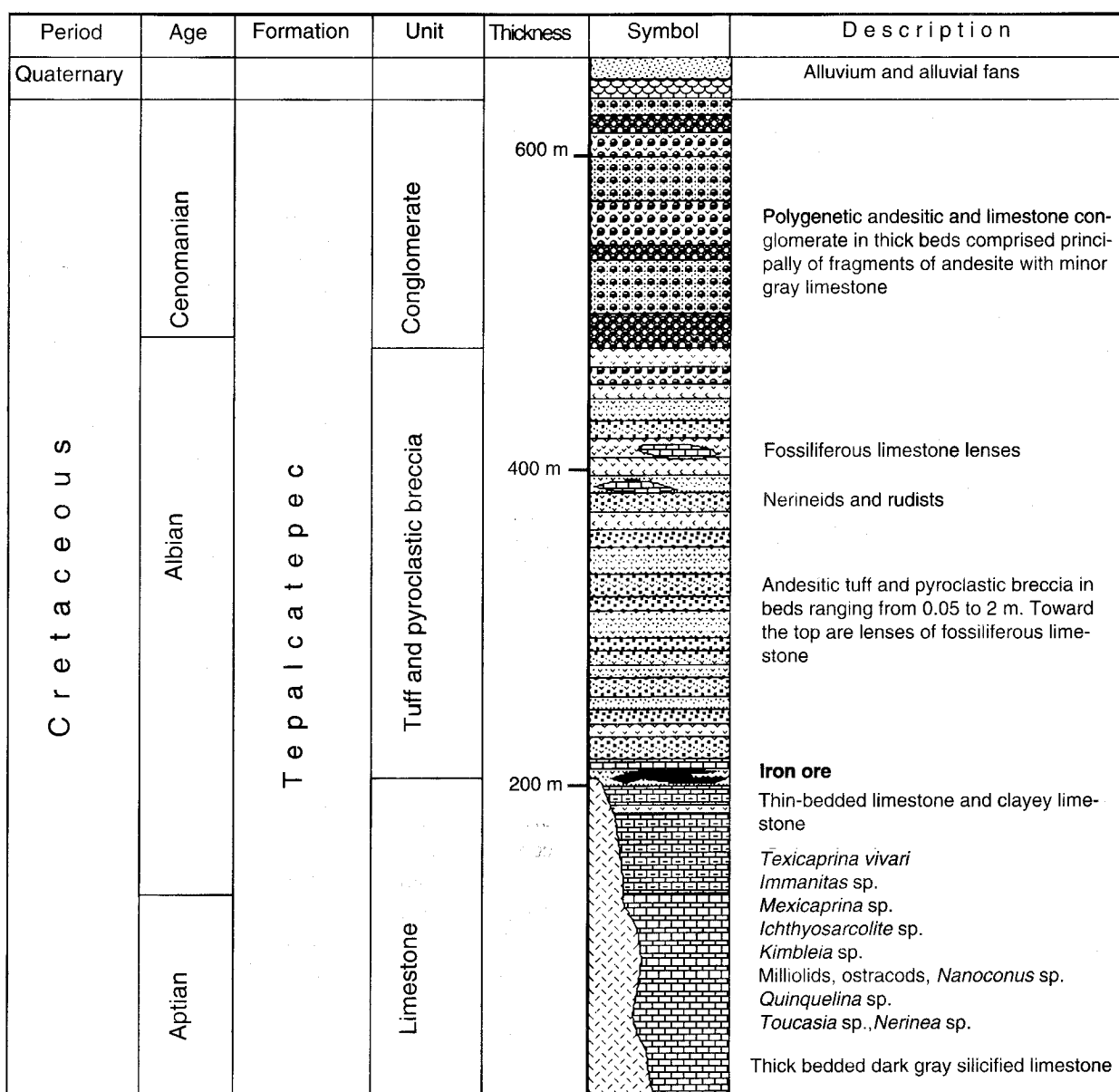


Figure 2. Stratigraphic column of the Minatitlán-Peña Colorada region.

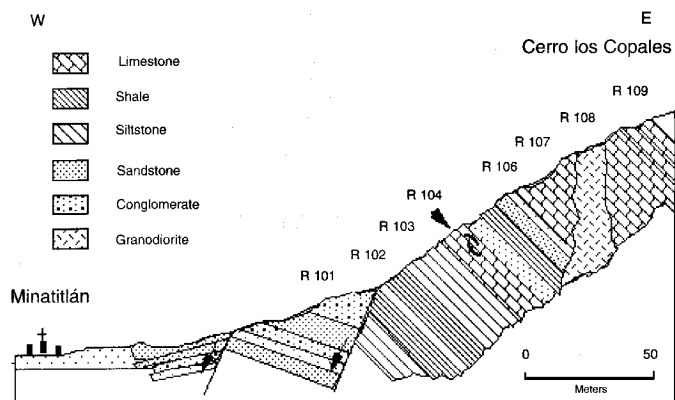


Figure 3. Structural section to the southeast of Minatitlán, Colima. R 104—Caprinid rudists: *Texiacaprina vivari* (Palmer), *Immanitas* sp., *Mexicaprina* sp. Ostreid bivalve: *Rastellum* sp.

middle part of the section, there is gray calcareous sandy siltstone in beds about 20 cm thick, black limestone in beds of 60 to 80 cm, and highly fossiliferous limestone in beds of 40 to 50 cm containing rudists and ostreids, which were collected at locality R-104 (Figure 3).

The upper part of the section consists of alternating beds, 15 to 20 cm thick, of dark gray limestone and gray siltstone having nodular structures.

The second locality corresponds to the metamorphosed limestone lenses interlayered in Unit 2 (tuffs and microbreccias) from the open pits of the Peña Colorada deposit, where nerineid gastropods and rudists bivalves are deformed and recrystallized by the effect of the intrusion (Figure 4). At Peña Colorada locality HM-5 at Juluapan, Colima, beds of algae, the requienid rudist *Toucasia* sp. and the radiolitid rudists *Eoradiolites davidsoni* Hill and *Radiolites costata* Scott were collected (Figure 1).

LA MINITA AREA

In La Minita area the thickness of the sedimentary sequence is about 1,600 m, and includes the Tecalitlán and the Tepalcatepec formations, the latter being distinguished by abundant horizons of limestone and calcareous siltstone (Figure 5). In this area, samples R-45 and R-45B are derived from the reefal limestone, which overlies a manto of barite and sulfides in the main pit of the La Minita area (Vulcano mineral deposit). The caprinid rudists *Amphitriscoelus* and *Caprina* were identified in these samples. The limestone has a thickness of about 30 m and is comprised of thick to massive beds of gray limestone with abundant macrofossils (Figure 6) that are frequently bordered by pyrite. The limestone is conformably covered by 10 m of green tuff that is, in turn, conformably overlain by 70 m of thin-bedded black marls.

Locality R-57 is located 2 km to the NNW of the "Vulcano" deposit. The lithology consists of alternating thin-bedded gray shales and calcareous siltstones. This lithology is similar to that of the Mexcala Formation in the State of Gue-

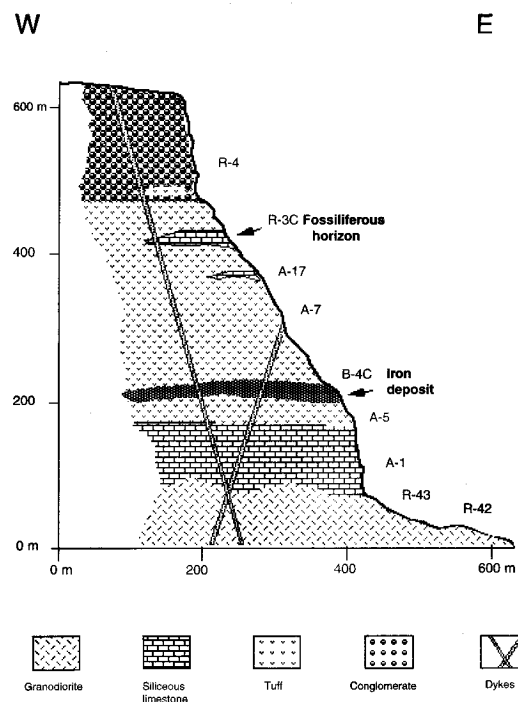


Figure 4. Schematic cross section of the Peña Colorada iron deposit.

rrero. Toward the upper part of the section, there are intercalated fossiliferous horizons with abundant specimens of the rudist *Immanitas* sp. and the bivalve *Rastellum* sp.

CONCLUSIONS

The fossils found in the Peña Colorada area are Albian-Cenomanian in age, while those from the lower part of the La Minita section are indicative of an early Aptian age. The difference in age between these two sites supports the model proposed by Corona-Esquivel (1993), in which at least two important mineralization events are recognized. During the first event in the Early Cretaceous, volcanogenic sulfide deposits formed at La Minita, whereas the Peña Colorada iron ore deposit is associated with the second, post-Late Cretaceous, event.

The association of the rudists with the syngenetic volcanogenic sulfide deposit in the La Minita area suggests that the deposition of the ore minerals was carried out in shallow warm water. However, for the Peña Colorada deposit the same inference cannot be made due to the fact that the mineralization of the rudist-bearing limestone was subsequent.

ACKNOWLEDGMENTS

This project was supported by CONACYT grant 1318-T9206 and the Instituto de Geología of the Universidad Na-

Period	Age	Formation	Thickness	Symbol	Description						
Quaternary			1,600 m		Alluvium and alluvial fans						
Cretaceous	Cenomanian	Tepalcatepec	1,400 m		Shale, siltstone, argillaceous limestone and fine-grained sandstone in thin beds ranging from 1 to 10 cm. Toward the top, local layers of tuff alternating with terrigenous sediments. <i>Polyptyxis schiosensis</i> (Pirona), <i>Plesioptyxis olisiponensis</i> (Sharpe)						
					Coarse-grained tuffaceous sandstones, fragments of quartz and chalcedony. Toward the top, grades into coarse-grained poorly-consolidated felsic tuffs in beds of 20 to 30 cm						
					Fine-grained sandstones interstratified with layers of black argillaceous limestones. Interstratified with calcareous conglomerate 1 to 3 m thick <i>Caprinuloidea perfecta</i> Palmer						
					Alternating shales and fine- to coarse- grained fossiliferous sandstones. Calcuridites present in beds 1 m thick. Conglomerates made up of fragments of fossiliferous limestone <i>Caprinuloidea</i> sp.						
					Black shale Green tuff R-45 R-45 B Reef limestone and jasper at base Barite and Cu, Zn, Pb, Ag sulfides Rhyolitic tuff	<i>Chondrodonta</i> sp. <i>Caprina</i> sp. <i>Amphitriscoelus</i> sp.					
	Albion		600 m		400 m		Andesitic tuffs and breccias, lapilli tuffs, dark green ash tuffs with silicification and chloritization, locally impregnated with manganese and iron oxides. Slightly magnetic				
								Barremian	200 m		Andesitic tuffs, pseudostratification in medium, thick and massive beds, brown to reddish, and dark green to brown in color, with spheroidal weathering. Breccia and fragments of magnetite in some zones

Figure 5. Stratigraphic column of the La Minita region.

cional Autónoma de México. The authors are sincerely grateful to Barbara Martiny from the Instituto de Geología, for constructively reviewing the English manuscript.

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Figure 6. Reefal limestone of the La Minita area.

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Manuscript received: July 3, 1995.

Corrected manuscript received: December 4, 1995.

Manuscript accepted: December 11, 1995.