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

Rodolfo Corona-Exquibel* and Gloria Alencáster*

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 Texacaprina vivari (Palmer), Immunitas sp., Mexicaprina minuta Coogan, Mexicaprina cornuta Coogan, Trenacasia 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 Amphitricolea 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 encontraron 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 Texacaprina vivari (Palmer), Immunitas sp., Mexicaprina minuta Coogan, Mexicaprina cornuta Coogan, Trenacasia sp., Eoradiolites davidsoni (Hill) y Radiolites costata Scott. Todos ellos son del Albian-Cenomaniano.

La mina La Minita, en el Estado de Michoacán, contiene rudistas en un estado pobre de conservación. Estos son Caprina sp. y Amphitricolea sp., del Aptano 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 y 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 Tecomitlán, 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 Tecomitlán Formation and the base of the Teplacatepec Formation, whereas the post-Albian Peña Colorada deposit was emplaced in limestones and volcanic rocks belonging to the upper part of the Teplacatepec 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.
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), Gómez and Ordóñez (1981), Sánchez (1983), Salazar (1983), Pantoja-Alor and Estrada-Barraza (1986), Bermúdez-Santana (1991) and Bustamante-Vallejo (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 Cama-Uranga and Coney (1983), Cama-Uranga and Ramírez (1979), Guerrero-Suástegeut 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), Gayán-Rueda and coworkers (1979), Mérida-Cruz (1978), de la Campa (1988), Corona-Esquível 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 sediments, with ages ranging from Early Cretaceous to Quaternary time. These rocks correspond to the geologic province "Guer-

ro- Colima orogenic complex" (Ortega-Gutiérrez et al., 1992) and belong to the "Jalisco-Colima Basin". The fossilifer-

cous 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 Teco-

litlán 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 Tec-

litlán 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 out-

crops in the core of the anticlinal structure and the mineraliza-

tion 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 volcanic-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 volcanic-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 conglom-

erate with a calcareous matrix.

The volcano-sedimentary sequence is composed of an-

desitic to latitic breccias with intercalations of thin calcareous horizons.

Along the road between La Minita and Trojes, rudists of the genus *Immites* and ostreids of the genus *Rastellum* (Corona-Esquível 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-Esquível, 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

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<th>Period</th>
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<th>Unit</th>
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<td>Aptian</td>
<td>Tepalcatepec</td>
<td>Limestone</td>
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<td>Tuff and pyroclastic breccia</td>
<td>200 m</td>
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<td>Polygenetic andesitic and limestone conglomerate in thick beds comprised principally of fragments of andesite with minor gray limestone</td>
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<td>Conglomerate</td>
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<td>Fossiliferous limestone lenses</td>
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**Figure 2.** Stratigraphic column of the Minatitlán-Peña Colorada region.
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 Jalupan, 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 Tecomitlán 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 reeal limestone, which overlies a manto of barite and sulfides in the main pit of the La Minita area (Vulcano mineral deposit). The caprinid rudists *Amphirtriscoelus* and *Caprina* were identified in these samples. The limestone has a thickness of about 30 m and is comprised of thin to massive beds of gray limestone with abundant macrofossils (Figure 6) that are frequently bordered by pyrite. The limestone is conformably overlain 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 Guadalajara. 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-Esquível (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.

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<td>Quaternary</td>
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<td>Tepalcatepec</td>
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<td></td>
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<td>1,400 m</td>
<td></td>
<td>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 tenaceous sediments. Polyptyxis schioersis (Pieona), Plesiptyxis olivonensis (Sharpe)</td>
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<td>1,200 m</td>
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<td>Coarse-grained tuffaceous sandstones, fragments of quartz and clastics. Toward the top, grades into course-grained poorly-consolidated felsic tuffs in beds of 20 to 30 cm.</td>
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<td>1,000 m</td>
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<td>Fine-grained sandstones interstratified with layers of black argillaceous limestones. Interstratified with calcareous conglomerate 1 to 3 m thick. Caprinuloides perfecta Palmer</td>
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<td>800 m</td>
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<td>Alternating shales and fine- to coarse-grained fossiliferous sandstones. Calcirudites present in beds 1 m thick. Conglomerates made up of fragments of fossiliferous limestone Caprinuloides sp.</td>
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<td>400 m</td>
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<td>Andesitic tuffs and breccias, lapilli tuffs, dark green ash tuffs with silification and chloritization, locally impregnated with manganese and iron oxides. Slightly magnetic.</td>
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<td>200 m</td>
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<td>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.</td>
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</table>

Figure 5. Stratigraphic column of the La Minita region.

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