

NEOGENE MARINE DEPOSITS OF CALETA PATILLOS, NORTHERN CHILE: THEIR RELATIONSHIP WITH NEOGENE SEDIMENTS OF THE PENINSULA DE MEJILLONES

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ABSTRACT

A 10 m thick marine sequence of Neogene age composed of terrigenoclastic sediments interbedded with bioclastic grainstones and coquinas and capped by diatomaceous calcareous mudstones has been recently recognized in Caleta Patillos (20°43'S), 80 km south of Iquique. The organic framework of grainstones and coquinas consists of molluscan, balanid and echinoderm fragments and foraminifera. Litho- and biofacies suggest deposition on an open shelf basin next to a moderate coastal upwelling in an Andean forearc domain. This sequence represents the northern extension of similar age deposits previously known from the Península de Mejillones, 250 km further south. This discovery partially confirms that Neogene marine sedimentation, including diatomaceous occurrences, took place along the continental margin of Chile north of Mejillones, which up to now had been considered its northern limit, and probably represents the onland expression of a major depositional basin located mainly offshore as is here demonstrated by the only seismic line available. In addition, it opens up possibilities of finding exposures of similar age between the above mentioned locations and the southern coastal Perú Tertiary sequences, both onshore and offshore.

Key words: Diatomaceous sediments, Neogene, Caleta Patillos, Península de Mejillones, Chile.

RESUMEN

DEPOSITOS NEOGENOS MARINOS DE CALETA PATILLOS, NORTE DE CHILE: SU RELACION CON LOS SEDIMENTOS NEOGENOS DE LA PENINSULA DE MEJILLONES. En Caleta Patillos (20°43'S), 80 km al sur de Iquique, aflora una secuencia marina neógena de 10 m de espesor, compuesta por sedimentos terrígeno-clásticos intercalados con calcarenitas bioclásticas y coquinas y fangolitas calcáreas diatomáceas en su parte más alta. La fracción orgánica de las calcarenitas y coquinas consiste en fragmentos de moluscos, balánidos y equinodermos, además de foraminíferos. Las lito- y biofacies encontradas permiten sugerir que la sedimentación tuvo lugar en una cuenca localizada principalmente en la plataforma externa, cercana al desarrollo de surgencias costaneras moderadas, en el dominio del antearco andino. Esta secuencia representa la extensión más septentrional conocida de unidades contemporáneas, expuestas 250 km al sur, en Península de Mejillones. Este hallazgo confirma, parcialmente, la continuidad en la sedimentación marina neógena que incluye horizontes ricos en diatomeas a lo largo del margen continental del norte de Chile hasta ahora restringida a la latitud de Mejillones. La secuencia se encuentra en el extremo más oriental de una cuenca de sedimentación mayor ubicada, principalmente, mar afuera, como lo demuestra la línea sísmica disponible de este sector. Por otra parte, abre la posibilidad de encontrar nuevos afloramientos, similares a los mencionados, en localidades del norte del país y de establecer un vínculo más directo con las cuencas terciarias del sur del Perú.

Palabras claves: Sedimentos diatomáceos, Neógeno, Caleta Patillos, Península de Mejillones, Chile.

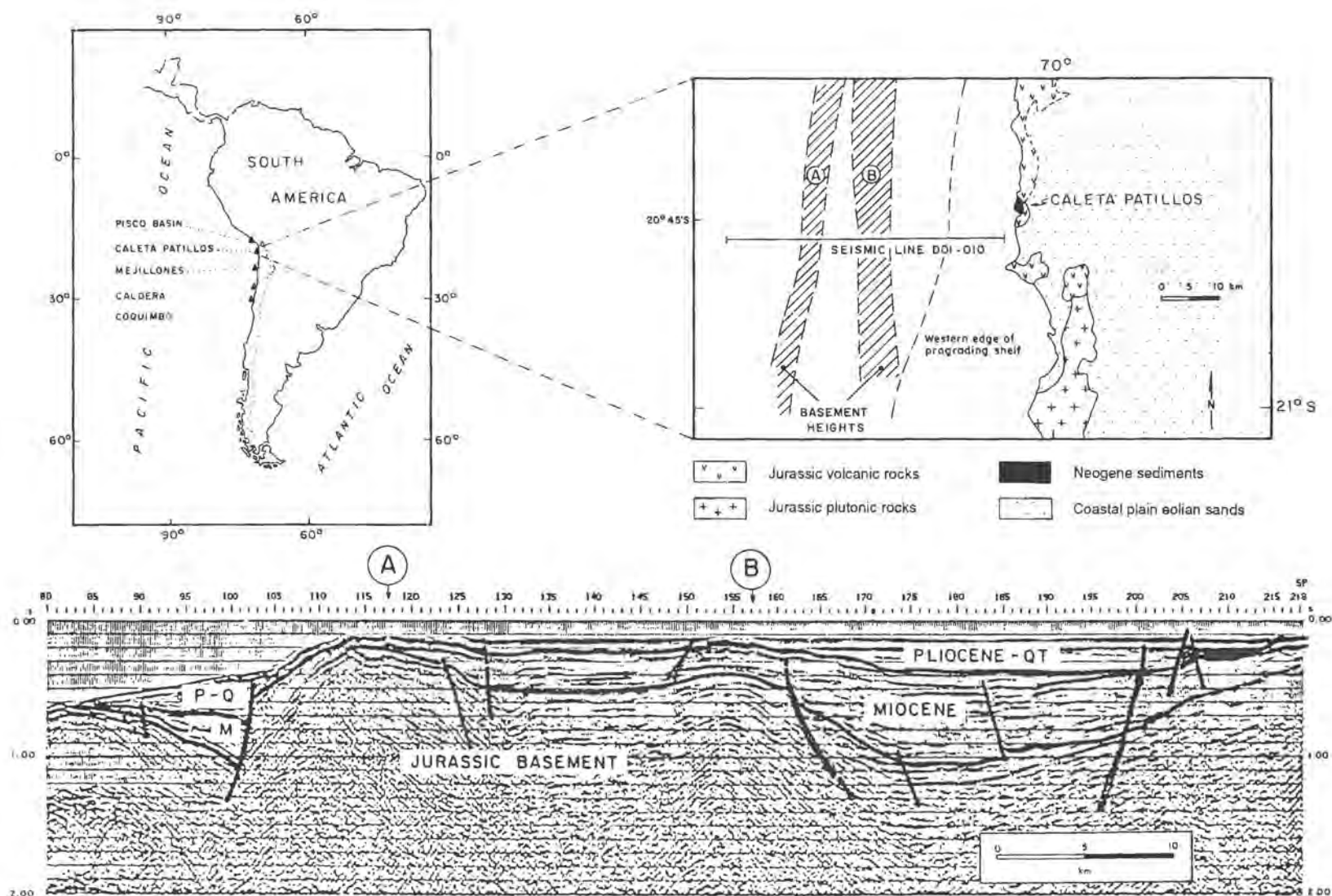


Fig. 1. Location map of Caleta Patillos area and multichannel seismic line D01-010.

INTRODUCTION

Up to the present, Neogene marine biogenic siliceous sediments have been reported to occur in northern Chile in three major sedimentary basins: in the Mejillones (23°15'S), Caldera (27°05'S) and Coquimbo (30°00'S) basins. Siliceous fossil assemblages in these sediments consist of diatoms, silicoflagellates, sponge spicules, radiolarians and dinoflagellates. They form discrete beds up to 3 m thick intercalated within bioclastic calcareous and terrigenous sediments and locally, beds bearing the diagenetic mineral assemblage phosphate, dolomite and glauconite, and evaporites such as gypsum. Coquinas and bioclastic sandstones include a variety of species of planktonic and benthic foraminifera and nannoplankton. Foraminifera and diatoms indicate an age ranging from middle Miocene to Pliocene for these sediments (Martínez, 1980; Martínez and Caro, 1980; Tsuchi *et al.*, 1988; Krebs *et al.*, 1989). Cenozoic sediments lie directly and unconformably on Cambrian to Jurassic basement rocks (Baeza and Venegas, 1988). Although biostratigraphic work is available to some extent, the complex sedimentary facies distribution in these areas and their depositional and tectonic environments have not been fully studied.

This paper reports the discovery of an isolated

exposure of a similar marine sedimentary sequence at Caleta Patillos, located on the coast at latitude 20°43'S, 80 km south of Iquique and 250 km north of the Península de Mejillones (Fig. 1). One sample collected from this sequence contains a diverse and moderately well preserved assemblage of diatoms which are closely related to those described in the Caleta Herradura Formation at Herradura Bay on the western slope of Península de Mejillones (Tsuchi *et al.*, 1988). Caleta Patillos is of considerable interest because it is the first documented occurrence of Neogene diatomaceous marine sediments between Mejillones and the southernmost part of the Pisco Basin in Perú, a distance of about 800 km.

Analyses of a seismic line of this area revealed an important sedimentary basin located in the shelf, extending virtually from the continental margin to the coastline for approximately 50 km (Fig. 1). The basin contains 1,200 m of Neogene to Recent sediments lying on Jurassic basement rocks and in water depths between 0-100 m. Data on lithology and bio- and chronostratigraphy obtained from studies carried out on the sequence exposed onland at Caleta Patillos give us an insight into the sediments that may be infilling the basin.

GEOLOGIC SETTING

The Neogene sequence observed at Caleta Herradura and other places of the Península de Mejillones area, wedges gradually out to the north over a distance of 50 km. Most cliffs along the coast and outcrops on the Coastal Plain from Mejillones to Caleta Patillos are composed of Jurassic volcanic and plutonic rocks of the La Negra magmatic arc. These rocks form the main lithologies of the Cordillera de la Costa in most parts of northern Chile (Mapa Geológico de Chile, 1982). They are almost entirely covered by Recent eolian sands and silts, bioclastic sands and coquina beaches.

Neogene sediments at Caleta Patillos belong to an unnamed formation and rest unconformably on the Jurassic volcanic rocks. Sediments have a maximum thickness of 10 m measured in a low coastal cliff, and are observed to pinch out to the

north and east as they overlap the basement rocks. They represent the nearshore uppermost part of an approximately 1,200 m thick sequence that is infilling the offshore and slope basins, as shown by the multichannel seismic line D01-010.

Sediments were deposited in the Andean forearc basin domain which has characterized the continental margin of Chile and Perú since Mesozoic times (Moberly *et al.*, 1982). In contrast to southern Perú where the shelf is sufficiently wide to hold several basins (Dunbar *et al.*, 1990), the Chilean shelf in the northern part of the country is very narrow, only 20-50 km wide. Up to date, the only Cenozoic basins on the shelf with possibilities of having significant sequences are the offshore extensions of those where the Mejillones, Caldera and Coquimbo sediments were deposited. According to Kulm *et al.*

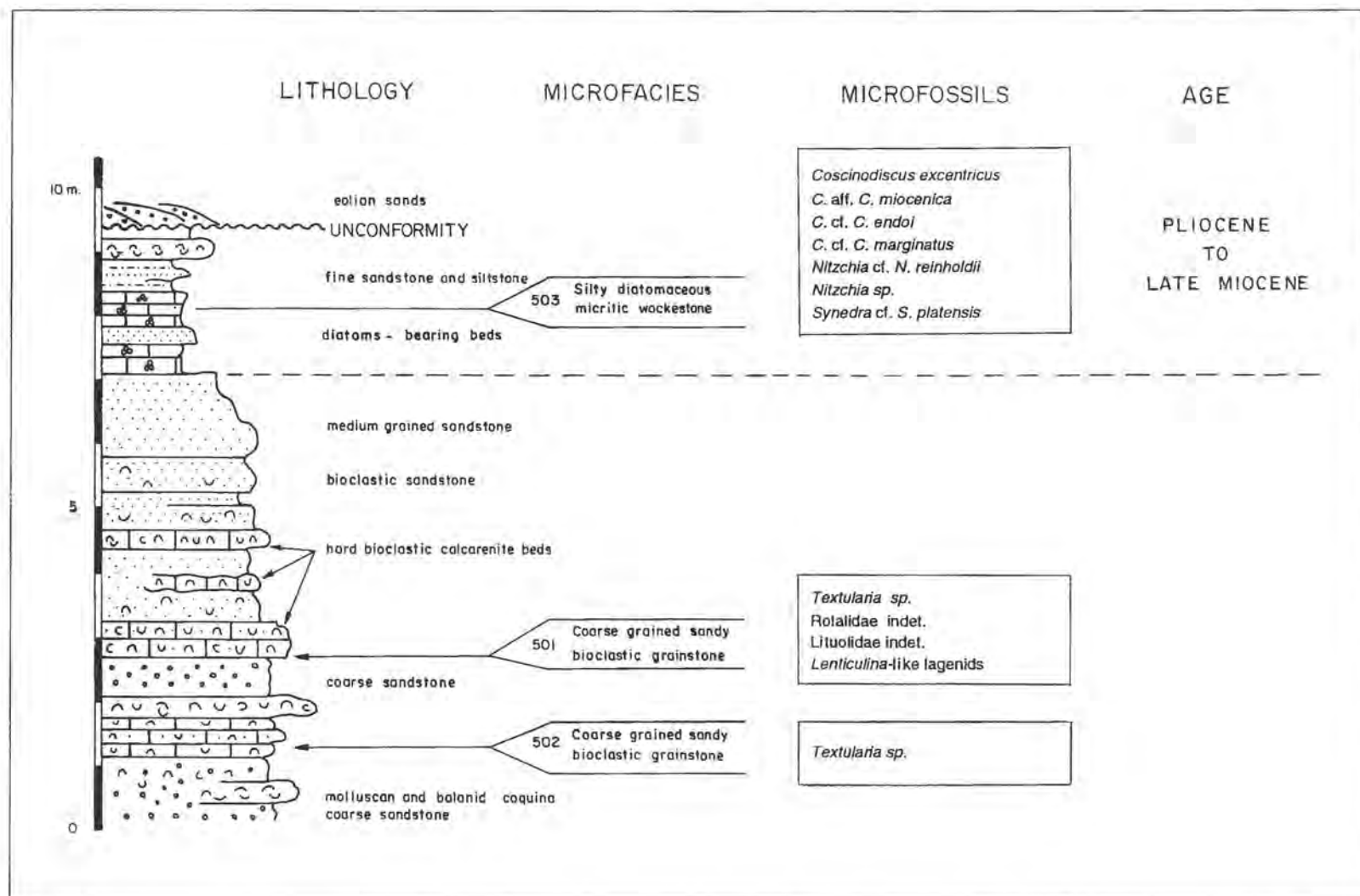


Fig. 2. Stratigraphic section of Neogene sediments at Caleta Patillos.

(1977), the reason being that in northern Chile the subducting oceanic plate is broken into high relief extensional blocks and the forearc region is characterized by steep trench walls, absence of slope benches or basins, and truncated coastal

structures. Only a few isolated and starved sedimentary basins developed preferentially within faulted basement in the middle of the slope, 30 to 90 km offshore in water depths of 900 to 1,200 m (Coulbourn, 1981; Mordojovich, 1981).

LITHOLOGY, AGE AND BIOSTRATIGRAPHY

The 10 m sequence exposed at Caleta Patillos is horizontal and composed of well bedded strata with a general upward fining character; at the base it consists of pale yellow coarse grained siliciclastic sandstones interbedded with light gray molluscan and balanid coquinas. In the middle part of the section there are several hard bioclastic calcarenite beds and siliciclastic sandstones. Finally, at the top there are fine grained sandstones, siltstones and yellow terrigenous diatomaceous beds (Fig. 2).

Three samples for petrographic and micropaleontological work were selected from the most biogenic calcareous and diatomaceous facies. Samples 501 and 502 are from a coarse grained sandy bioclastic grainstone composed of molluscan, balanid and echinoderm fragments and foraminifera tests; the terrigenoclastic component makes up 20% of the total grains and consists of quartz and volcanic lithic fragments probably derived from the Jurassic basement rocks. A few small, structureless colophane peloids are also present. Despite the coarse grain size of these sedimentary rocks, the foraminifera are moderately well preserved, allowing the recognition of *Textularia* sp., Rotalidae indet., Lituolidae indet. and probably *Lenticulina*-like lagenids (M.C. López¹).

Sample 503 is a silty diatomaceous micritic

wackestone. Diatoms are poorly to moderately preserved, generally broken and partially replaced by carbonate. Monoaxon sponge spicules were the only other organic remains found. Diatoms determined were:

- Coscinodiscus excentricus* Ehrenberg
- C. aff. C. miocenica* Schrader
- C. cf. C. endoi* Kanaya
- C. cf. C. marginatus* Ehrenberg
- Nitzschia cf. N. reinholdii* Kanaya and Koizumi
- Nitzschia* sp.
- Synedra cf. S. platensis* Frenguelli
- Actinopteryx* sp.
- Denticulopsis* sp.
- Campylodiscus* sp.

According to M.C. López¹, although the foraminifera assemblage has a reduced chronologic value, the existing microflora suggests a late Miocene to Pliocene age for these sediments on the basis of ranges of selected stratigraphically useful marine planktonic diatoms given by Barron (1985). It correlates well with the diatomaceous horizons described by Tsuchi *et al.* (1988) and Krebs *et al.* (1989) at Caleta Herradura de Mejillones.

PALEOENVIRONMENTAL SIGNIFICANCE

The microflora assemblage that characterizes the upper part of the sequence is mainly composed of planktonic and neritic warm water forms with a minor non-marine component. Diatoms show strong evidence of having been abraded, transported and deposited in an environment where calcareous sediments prevailed.

Diatomaceous sediments were probably

transported to and trapped in a depression on the open shelf during a maximum marine transgression in the Neogene. Their presence suggests that a diatom ooze was being deposited nearby in a high productivity environment with moderate to intermittently strong upwelling and warm water influence. The presence of rare freshwater diatoms may be due to river inflow.

¹ 1989. Estado micropaleontológico de las muestras HPS-501, HPS-502 y HPS-503. Empresa Nacional del Petróleo (Inédito), 2 p. Santiago.

CONCLUSIONS

The small section of the Neogene sedimentary sequence exposed at Caleta Patillos contains the typical facies and microfossiliferous assemblages observed in other occurrences of similar age in northern Chile, that is: coarse terrigenoclastic sediments interbedded with molluscan and balanid bioclastic sands and coquinas in the lower part of the sequence and biogenic siliceous sediments in its upper part. However, it neither contains the diversity of siliceous flora nor the diagenetic mineral association present in the other locations. This may be due to the fact that sediments observed at Caleta Patillos represent the nearshore uppermost part of a major sequence which is at present mainly offshore. More

siliceous biogenic sediments may be present within this offshore sequence.

Diatoms in Caleta Patillos sequence suggest a late Miocene to Pliocene age for these sediments. This correlates well with the Caleta Herradura diatomite exposed on the Península de Mejillones (Tsuchi *et al.*, 1988; Krebs *et al.*, 1989).

This discovery shows that Neogene marine basins and associated biogenic siliceous sediments in northern Chile have more continuous extension than was thought in the past, and opens up possibilities of finding other exposures or offshore sequences between Península de Mejillones and the Pisco Basin.

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