

GEOLOGIC AGE OF BIOSILICEOUS SEDIMENTS IN PERU AND CHILE BASED UPON PLANKTONIC FORAMINIFERA

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ABSTRACT

Biosiliceous sediments are extensively developed in the coastal areas of Perú and northern Chile. Planktonic foraminiferal biostratigraphy indicates that biosiliceous facies became predominant in early middle Miocene time in Perú and in Pliocene-Pleistocene time in northern Chile, suggesting an out-of-phase increase of coastal upwelling in these areas.

Key words: Biosiliceous deposits, Planktonic Foraminifera, Upwelling, Neogene, Perú, Chile.

RESUMEN

EDAD DE LOS SEDIMENTOS BIOSILICEOS EN PERU Y CHILE SOBRE LA BASE DE FORAMINIFEROS PLANCTONICOS. Los depósitos biosilíceos presentan un amplio desarrollo en las áreas costeras de Perú y del norte de Chile. Los estudios bioestratigráficos basados en foraminíferos planctónicos indican que dichas facies biosilíceas se hacen dominantes en el Mioceno medio en Perú, y durante el Plioceno-Pleistoceno en el norte de Chile, sugiriendo que el incremento de las surgencias costeras no fue sincrónico en ambas áreas.

Palabras claves: Depósitos biosilíceos, Foraminíferos planctónicos, Surgencia, Neógeno, Perú, Chile.

INTRODUCTION

The Peruvian coast on the Pacific side of South America is a well known region of modern upwelling (Thiede, 1983). Biosiliceous sediments, developed extensively in the coastal areas in Perú and northern Chile, are considered to have been caused by the increase of coastal upwelling in these areas.

Field examinations of the Neogene sequences

including these deposits have been carried out by the staff of the University of Shizuoka and collaborators in South America since 1985 (Tsuchi, 1988, 1990). Based upon planktonic foraminiferal analyses, an attempt is made to define the geologic ages of these biosiliceous deposits and to reconstruct the development of the correlative coastal upwelling.

PLANKTONIC FORAMINIFERAL BIOSTRATIGRAPHY OF NEOGENE SEQUENCES IN PERU AND CHILE

Marine Neogene sequences are scattered on the coastal areas of Perú (Bellido, 1969) and Chile (Farraris and Di Biase, 1978). The planktonic foraminiferal biostratigraphy was studied in the following seven sections: Cerro Las Salinas and Camaná in Perú, Caleta Herradura de Mejillones, Cuenca del Tiburón, Mejillones, Quebrada Blanca

and Punta Perro in Chile (Fig. 1). Correlations and geologic age-assignments of these sections were made by utilizing age diagnostic taxa and have been compared with the biochronologic results of ODP112-Site 682 off Perú (Suess and von Huene *et al.*, 1988, Ibaraki, 1990a). Planktonic foraminiferal zonation is according to Blow (1969).

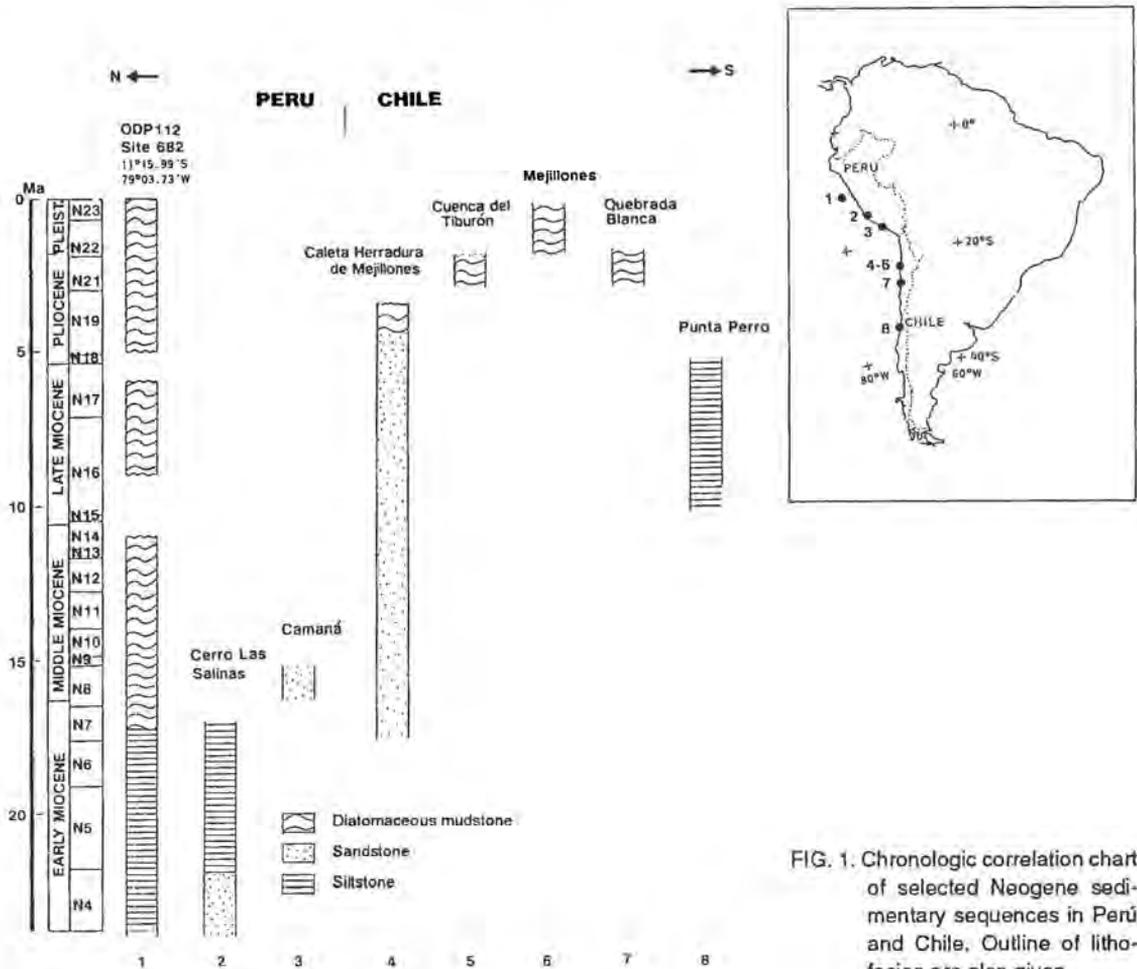


FIG. 1. Chronologic correlation chart of selected Neogene sedimentary sequences in Perú and Chile. Outline of lithofacies are also given.

CERRO LAS SALINAS IN CENTRAL PERU

The Cerro Las Salinas section is located in central Perú, south of Paracas, 260 km south of Lima. Marine sequences on the east side of a salt lake basin have a thickness of 260 m or more and consist mainly of sandstone in the lower part and siltstone in the upper part, with a few intercalations of limestone and diatomaceous layers (Fig. 2).

Planktonic foraminifera were obtained from four horizons in the middle part of the section: Loc. Pe-88-7-8, 88-7-2, 86-17-0 and 86-17-3, in ascending order. Those obtained from Pe-88-7-8 are known from earliest Miocene, such as *Globorotalia kugleri* Bolli

and *Globorotalia pseudokugleri* Blow. The horizon can be assigned to N4 of the earliest Miocene age (Blow, 1969). Locality Pe-88-7-2 is a horizon about 60 m above Pe-88-7-8. It contains *Globigerinoides immaturus* LeRoy and *Globoquadrina dehiscens* (Chapman, Parr and Collins) which are also assignable to the early Miocene. In the horizon Pe-86-17-0, early Miocene indices as *Globigerina praebulloides pseudociperoensis* Blow, *Globorotalia peripherodonda* Blow and Banner, and *Globorotalia praescitula* Blow were found. Planktonic foraminifera obtained from Loc. Pe-86-17-3 are also considered to be early Miocene. Therefore, the section is assignable to the early Miocene.

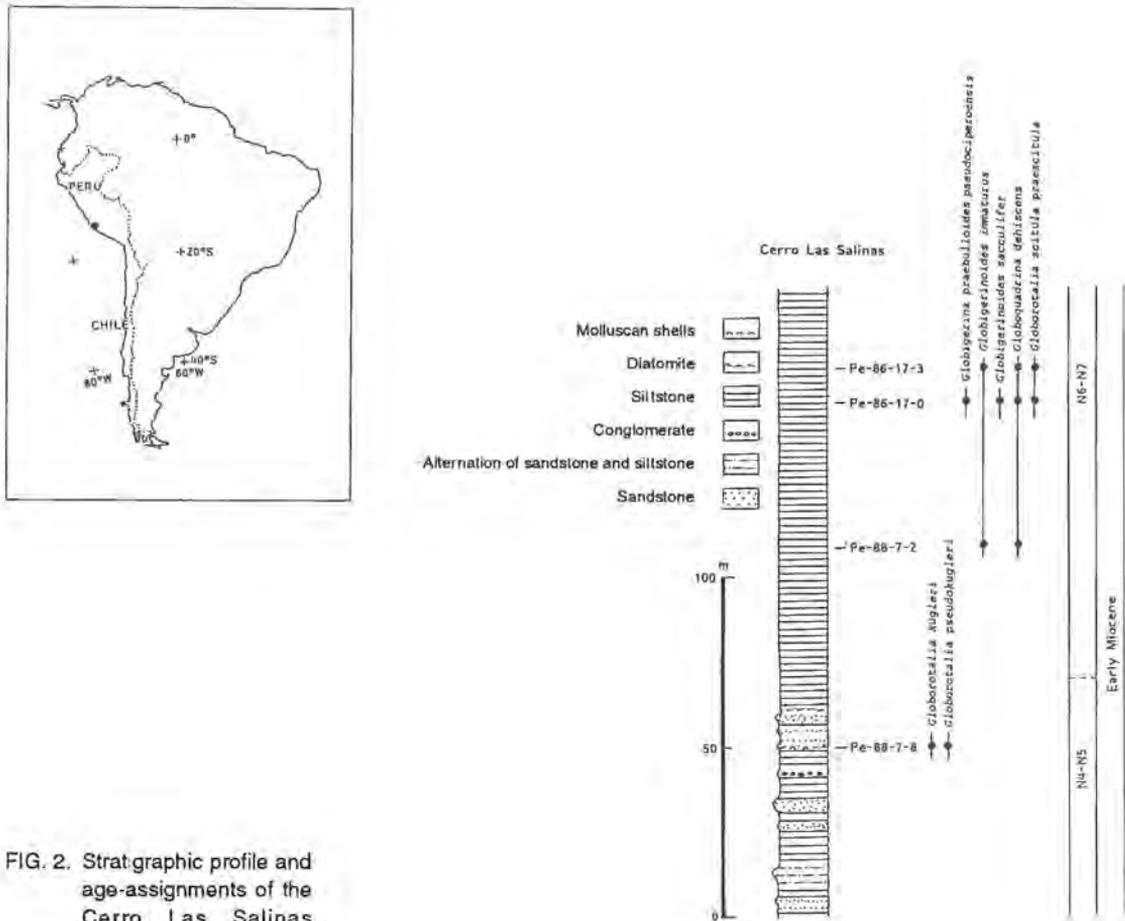


FIG. 2. Stratigraphic profile and age-assignments of the Cerro Las Salinas section.

CAMANÁ IN SOUTHERN PERU

Camaná is located 750 km south of Lima in the southern Perú. Marine Neogene sequences attain a thickness of 400-500 m and consist of calcareous sandstone in the lower part and siltstone in the upper part, developed in a basin along the coast (Fig. 3). Previous work by Pecho and Morales (1969) has shown that miogypsinid larger foraminifera occur in the lower part of the sequence. The geologic age of the Camaná Formation is believed to be Oligocene to early Miocene (Pecho and Morales, 1969), or terminal early Miocene to initial middle Miocene (Martínez-Pardo, 1990).

Planktonic foraminifera were obtained from the middle part of the sequence (Localities Pe-88-1 and

Pe-88-3, respectively; see Fig. 3). The facies of Loc. Pe-88-1 consists of coarse calcareous sandstone with shell fragments, while Pe-88-3 consists of siltstone. The presence of *Globigerinoides sicanus* De Stefani in the former horizon, and *Globigerinoides sicanus* De Stefani and *Praeorbulina glomerosa* (Blow) in the latter horizon makes it possible to assign both of them to N8 and N8b of earliest middle Miocene age, respectively. These examined horizons, considered to be adjoined, are those containing the larger foraminifera. Diatomaceous sediments are extensive on the coast of Perú, in Piura, Pisco, Ica, Río Grande and other areas. These biosiliceous sediments are possibly middle Miocene or younger in age, based on diatoms (Tsuchi, 1990).

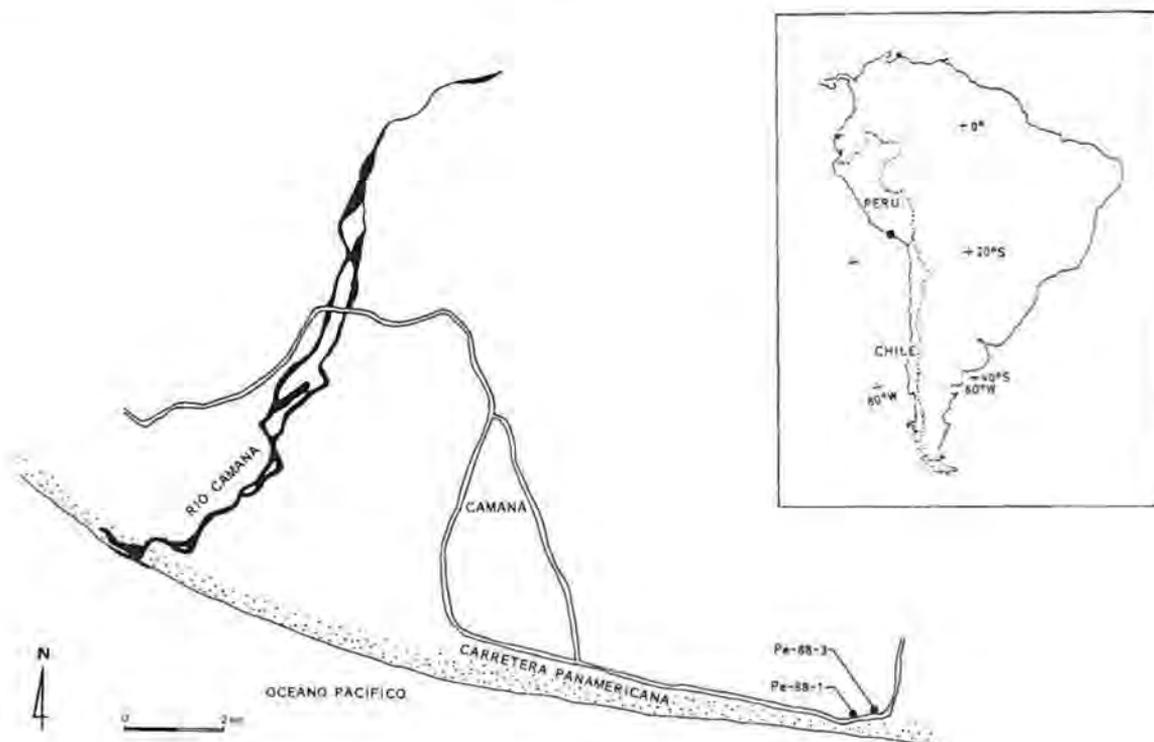


FIG. 3. Sample locality map of the Camaná Formation at Camaná.

CALETA HERRADURA DE MEJILLONES IN NORTHERN CHILE

Caleta Herradura de Mejillones is located 50 km north of Antofagasta, northern Chile. A marine Neogene sequence is well and continuously exposed on the coastal cliff. The Neogene sequence consists mainly of a sandy facies that attains a total thickness of 280 m with intercalations of alternating sandstone, siltstone, and diatomaceous layers in the top part. Fifty four species of planktonic foraminifera were obtained from many horizons of the sequence. Based upon the planktonic foraminiferal biostratigraphy (Ibaraki, 1990b), most of the sequence, except the top part, includes horizons from N7 through N16-N17 of early Miocene to late Miocene age. White-colored diatomaceous layers, 3 m thick, in the uppermost part of the section are assigned to the Pliocene on the basis of calcareous nannoplankton (Tsuchi, 1990), although these two parts of the section are said to be terminal early Miocene to basal late Miocene according to Chilean microplanktonic studies

(Martínez-Pardo, 1990; Martínez-Pardo and Martínez-Guzmán, 1991). The sequence is unconformably overlain by diatomaceous sediments of probable Pliocene-Pleistocene age.

CUENCA DEL TIBURON IN NORTHERN CHILE

Cuenca del Tiburón is located in the central part of the Mejillones Peninsula, north of Antofagasta, northern Chile. The Neogene strata are nearly horizontal and attain 25 m in thickness. They consist mostly of diatomaceous siltstone with sandstone in the upper part. Planktonic foraminifera obtained from some horizons of the section, containing *Globorotalia crassaformis* (Galloway and Wissler), *Globigerinoides obliquus obliquus* Bolli, *Neogloboquadrina asanoi* (Maiya, Saito and Sato), and dextral coiling *Pulleniatina*, are assignable to N21 of late Pliocene age (Ibaraki, 1986).

MEJILLONES IN NORTHERN CHILE

The Mejillones section is a sea cliff located on the coast, facing Bahía Mejillones, 60 km north of Antofagasta. The sequence consists mostly of diatomaceous siltstone with sandstone intercalations; total thickness is 18 m. Molluscan shells commonly occur in the sandstone of the uppermost part that unconformably overlie the sequence. Planktonic foraminifera obtained from the diatomaceous siltstone are all Recent species, including *Hastigerinopsis riedili* Rögl and Boll. The sequence is assignable to N22 of Pleistocene or later age.

QUEBRADA BLANCA IN NORTHERN CHILE

Quebrada Blanca is located to the east of Caldera, northern Chile. The sequence of nearly horizontal strata is composed mainly of diatomaceous siltstone and some intercalations of shell-bearing sandstone, 16 m in total thickness. Planktonic foraminifera obtained from the diatomaceous siltstone consist of *Globigerina bulloides* d'Orbigny, *Globigerinoides obliquus obliquus* Bolli, *Globorotalia menardii* (Parker, Jones and Brady), *Globorotalia scitula* (Brady), *Neogloboquadrina asanoi* (Maiya, Saito and Sato) and *Neogloboquadrina dutertrei* d'Orbigny, and are assignable to N21 of Pliocene age.

PUNTA PERRO IN CENTRAL CHILE

The Punta Perro section is a sea cliff near the mouth of Rapel river, 5 km north of Navidad, located 130 km south of Santiago. The Neogene marine sequence is well exposed in the cliff above the tidal flat, and is 36 m in total thickness. It consists mainly of sandstone with conglomerate in the basal part and some intercalations of siltstone in the upper part.

Diatomaceous facies are scarcely developed in the section.

Planktonic foraminifera obtained from two horizons of the basal and upper parts of the section include *Globigerina nepenthes* Todd, *Globigerina apertura* Cushman, *Globigerinoides elongatus* (d'Orbigny), *Globoquadrina dehiscens* (Chapman, Parr and Collins), *Globorotalia juanai* (Bermúdez and Bolli) and *Neogloboquadrina acostaensis* (Blow), and are assignable to N16-N17 of late Miocene age (Ibaraki, in press), although the sequence has been assigned to terminal early Miocene (Dremel in Herm, 1969) or terminal early Miocene to basal late Miocene (Martinez-Pardo, 1990).

ODP112-SITE 682

Site 682 is located at 11°15.99'S and 79°03.73'W of Huacho in waters 3788.5 m deep on the landward lower slope of the Perú Trench. Planktonic foraminifera occur sporadically in 16 horizons of the total 81 samples examined (Ibaraki, 1990a). The top part of the Hole is included in Zone N22-N23 of late Pliocene-Pleistocene age. Sample 682-35X-3, 65-67 cm, from the lower part of the core, contains *Catapsydrax stainforthi* Bolli, Löblich and Tappan, and *Globorotalia birnageae* Blow, indicating Zone N4 through N7 and N6 through N8, respectively. These species allow this horizon to be assigned to Zone N6-N7 of early Miocene age. Below this horizon, sediments of late Eocene-Oligocene and middle Eocene ages were examined.

Diatoms are abundant in Core 112-682A-1H through 112-682A-34X. The beginning of diatom-rich facies recorded in core of sample 682A-34X, is assigned to *Denticula nicobarica* Zone or NN4 (Suess and von Huene *et al.*, 1988). The horizon just below the diatomaceous facies, in core 682A-35X, is assigned to Zone N6-N7 of early Miocene age.

SUMMARY AND GEOLOGIC AGE OF THE BIOSILICEOUS SEDIMENTS

In the cores of ODP-112 off Perú, biosiliceous facies become predominant above the N6-N7 zonal interval of early Miocene age. Diatomaceous facies are scarcely found in the Cerro Las Salinas section of Oligocene to early Miocene age and are missing from

the Camaná section of early Miocene to earliest middle Miocene age. Extensive biosiliceous sediments on the coast of Perú are dated as being middle Miocene and later by diatom age dating. Biosiliceous sediments in Perú, therefore, became

predominant in middle Miocene time. However, diatomaceous facies of northern Chile were dominant in rocks of Pliocene and Pleistocene ages. It seems

that the coastal upwelling area off Perú in Miocene time may have expanded to the south in Pliocene time.

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