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Glaciomarine Sediments from Southern Argentina Continental Shelf. Preliminary Note

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Abstract – The Argentinian continental shelf shows along its extension a dominantly terrigenous sandy textural cover. The mean size is extremely homogeneous and the changes on this pattern are due to the ingression of bioclastic fragments (mainly mollusk shells) and terrigenous gravel, as in the Patagonia sector. The southernmost part, on contrary, has more a prominent presence of coarse material - rudaceous components - indicating a different source for this sediment. Geological and morphological aspects obtained through studies done on the continent and offshore indicates Pleistocene glacial and periglacial extensions up to areas near the present coastline and also on the continental shelf. Therefore, the sediment distribution and the associated bottom features shows, besides the remarkable glacial and periglacial origin of this material, the strong influence of an high energy sedimentation level, indicating a shallow costal environment. Otherwise, the absence of fine components (silt and clay) in some sectors linked with elongate bottom forms denotes a high energy sedimentation environment. These elements reveal a connected action of transgressive/regressive sea level effects, combined with glacial and periglacial events that gives to this sector an unusual sedimentary characteristic in relation with the remainder of the Argentina continental shelf.

Resumo – A plataforma continental da Argentina apresenta, em praticamente toda a sua extensão, uma marcante predominância da textura arenosa terrígena. O tamanho médio das distribuições granulométricas presentes é bastante homogêneo e as mudanças ocorrentes são devidas particularmente ao ingresso de fragmentos de conchas de moluscos ou cascalho terrígeno, especialmente no setor patagônico. A zona mais austral, pelo contrário, possui elementos de maior diâmetro - grânulos e seixos (cascalhos) - indicando um aporte de material diferente do restante da região. Aspectos morfológicos e geológicos revelados através de estudos realizados no continente e em mar aberto, indicam extensões glaciais e periglaciais pleistocênicas, desenvolvendo-se até setores próximos à atual linha de costa, bem como na plataforma. A atual distribuição dos sedimentos de fundo, bem como as feições associadas, indicam uma inquestionável vinculação com uma origem glacial e periglacial associada a um retrabalhamento por processos costeiros. A ausência de quantidades apreciáveis de material fino (silte e argila) em alguns setores, e a presença de morfologias alongadas no fundo marinho, sugerem a atuação de ambientes de alta energia, diagnosticando atividade costeira. Perfis batimétricos de precisão e de sísmica de alta resolução, confirmam a ocorrência dessas formas de fundo. Os elementos acima discutidos mostram uma ação combinada de efeitos transgressivos/regressivos do nível do mar, associada com eventos glaciais e periglaciais, e que imprimem a este setor características sedimentares distintas com relação ao restante da plataforma continental da Argentina.

INTRODUCTION

The late Quaternary knowledge of the Argentina continental shelf has been the objective of large number of studies specially developed during the last two decades.

Some researches were devoted to the analysis of surface sedimentary cover, based on a large number of bottom and core samples, giving as a consistent result, sedimentological maps like those published by Urien (1970), Servicio de Hidrografia Naval (1974), Urien & Martins (1974 a, 1979), Martins & Urien (1979) and Urien *et al.* (1992). A synthesis of the eastern South America Quaternary costal and marine geology was made by Martins & Villwock (1987).

Several portions of the continental shelf, such as the sedimentary model of the Buenos Aires province (Urien *et al.*, 1979), the Rio de La Plata history during the Late Quaternary (Urien & Ottmann, 1971), the sedimentation adjacent to the Rio de La Plata (Ayup-Zouain, 1988), the Wisconsin sea level, (Fray & Ewing, 1963), the aligned shoals in the Punta Medanos area (Parker & Violante, 1978; Parker *et al.*, 1982), the Bahia Blanca sector (Gelós *et al.*, 1987; Gelós & Chaar, 1988), the Megellan strait and Beagle channel Holocenec levels (Porter *et al.*, 1984; Rabassa *et al.*, 1986),

the paleogeographic evolution of the Buenos Aires area (Urien & Ewing, 1974; Urien & Martins, 1979; Martins & Urien, 1979; Urien & Martins 1987, 1989) and the morphology and glacialic sediments of Tierra del Fuego (Isla & Schnack, 1989; Isla & Bujaleski, 1990; Isla *et al.*, 1991), were studied with some details.

The present preliminary note, has the purpose to discuss the main results obtained through the study of bottom and core samples, camera stations, seismic and bathymetric profiles gathered on the austral portion of the Argentina continental shelf, in a situation where the influence of the glacial and periglacial processes and materials impress to the sedimentary system an unique characteristic, not found along other sectors of the continental shelf. The geological samples were analysed through the classic methodology summarized by Martins *et al.* (1978).

A high resolution EG & G dual side scan sonar, an EDDO 3.5/7.0 KHz sub bottom profiler and an Alpine 311 underwater camera were used to obtain additional information regarding the shelf bottom. For comparison, bottom photographs and data from Eltanin cruises, were obtained from the United States Antarctic Research - USARP (Jacobs *et al.*, 1970, 1972; Goodell, 1964).

The studied area is located approximately between the latitudes 50° to 55° S and longitudes 62° to 69° W, in the Tierra del Fuego region (Fig. 1).

(USA) and the Servicio de Hidrografia Naval (Argentina), and this study represents part of a cooperative research project established between the Centro de Oceanografia of Instituto

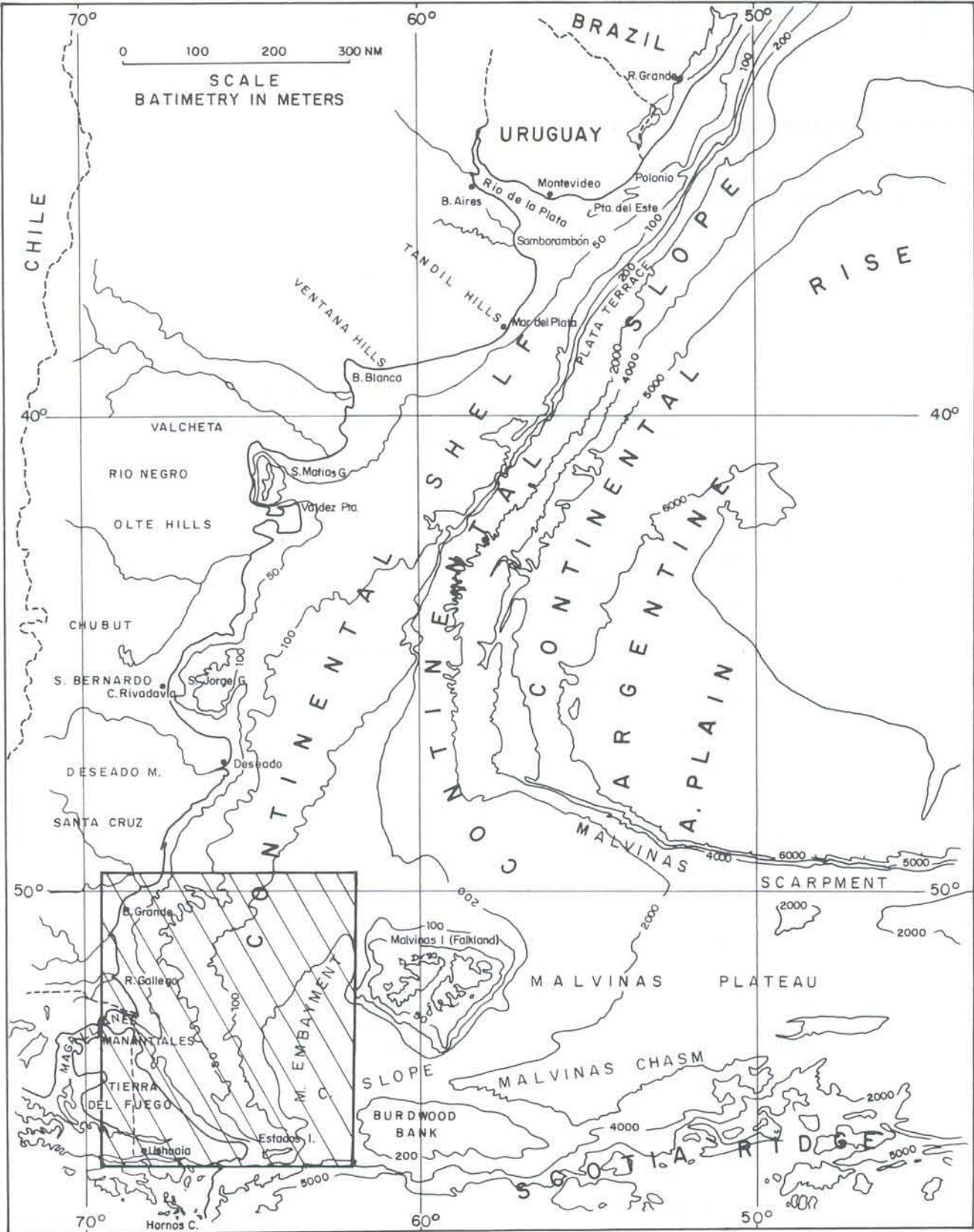


Figure 1 – Location of the studied area.

The analysed material was obtained throught missions accomplished by Lamont Doherty Geological Observatory

Tecnológico de Buenos Aires - COBA/ITBA (Argentina) and the Centro de Estudos de Geologia Costeira e Oceânica, of the Universidade Federal do Rio Grande do Sul - CECO/

UFRGS (Brazil).

This type of marine geology study, was developed in accordance with Programme of Ocean Sciences in relation to Non Living Resources - OSNLR (South West Atlantic Group) under the sponsorship of the Intergovernmental Oceanographic Commission - IOC (UNESCO) and the United Nations Office for Ocean Affairs and the Law of the Sea - OALOS (UN).

BOTTOM MORPHOLOGY AND SEDIMENTS

Studying the sediment distribution of the sedimentary cover of the South America continental shelf between Cabo Santa Marta (Brazil) and Tierra del Fuego (Argentina), Urien & Martins (1974) divided the area on five distinct zones according to age, source and textural properties of the sediments.

The Tierra del Fuego continental shelf is characterized by an irregular and abrupt topography with the occurrence of several shoals mainly linked with a previous morphology acquired during lowered sea-level (relict features), or developed through Holocene processes during the sea-level rise or as it occurs on its inner portion across the present hydraulic conditions (modern features).

Isla *et al.* (1991) noted that in the northeastern of Tierra del Fuego, the Holocene mean sea-level fluctuation reworked much pre-wisconsin glacial drift into sand/gravel beaches and spits and sand/mud tidal flats. The presence of an extremely severe energy conditions gives to the sedimentary covering a gravelly sand texture, prevailing over the fine sediments. Sediments from glaciers ice and grounded sheets that enter and are more or less reworked on the sea floor, were identified and described as glaciomarine by Phillippi (1912). They are usually crudely sorted detrital sediments including gravels and sands, silt and clay, and biogenic material. Glaciological and oceanographic process and the sea bed characteristics will control the pattern of the glaciomarine sedimentation, and a lithofacies classification for this type of deposits based upon a suite of properties such as grain size, fabric, internal structure and bed contact relationships can be used (Drewry, 1987).

A general distribution of the sedimentary textures occurring at the studied area is showed in the map of the Figure 2. The dominance of coarse components come out by sands and gravels that occupies a well developed belt, bordered by fine sediments on the inner shelf and along the outer shelf and slope is remarkable. All this coarse material did not represent a modern contribution, but was mainly deposited during periods when the continental shelf was exposed during the Pleistocene, specially at the Wisconsin sea level, when a succession of deposits linked with glacial and periglacial events were responsible by the transportation and deposition of these materials.

Over the then exposed continental shelf, terrestrial glacial deposits such as till and outwash were easily weathered eroded and reworked. Submerged moraines in the Tierra del Fuego continental shelf were identified at a depth of 50 meters (TOTAL AUSTRAL GEOMATTER, 1980). The reworking processes was chiefly conducted during the Holocene transgression and its associated still-stands that generates high energy coastlines and a winnowing of the fine fractions.

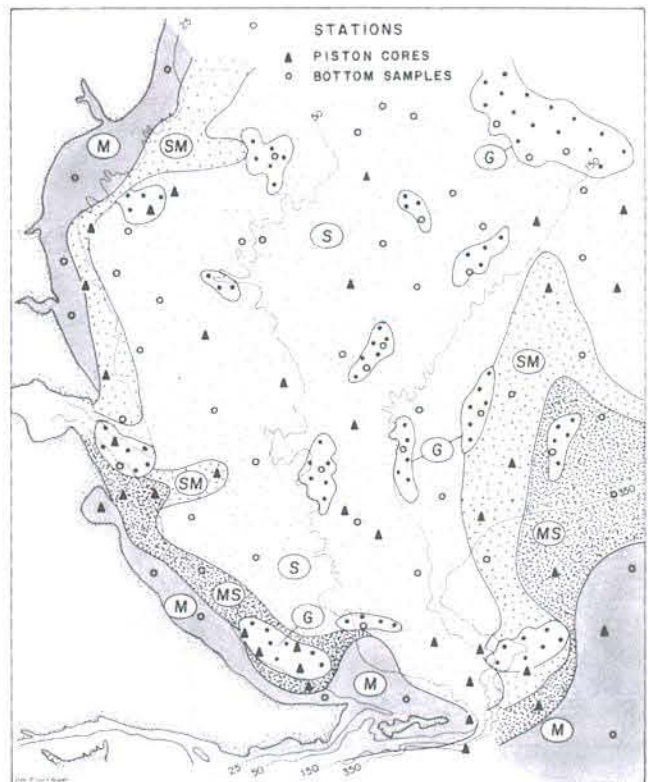


Figure 2 - Piston cores, bottom samples stations and main textures distribution. M=mud; S=sand; G=gravel; MS=muddy sand; SM=sandy mud. The texture limits were controlled through dredging samples.

Recently, Isla & Schnack (1989), using high resolution seismic methods and side-scan sonar profiles, identified between 30 and 80 meters, a set of bottom features and outcropping stratigraphic units, mainly connected with the ice retreat and sea level rise. The authors mapped two aligned moraines, associated with glaciogenic deposits, that originates submerged beaches, sand waves and strips oriented according the tidal currents activity along the Megellan strait.

In fact, a large part of the Tierra del Fuego continental shelf is covered by relict sediments on unbalance situation with the hydraulic conditions prevailing today. However, the sea-level rise during the Holocene and its temporary still-stands, generates a series of coastlines (as the two ones that were identified and dated in the present research), with a high energy level sedimentation and responsible by the reworking of these materials and promoting a sedimentary palimpsest type of covering.

The map showed in the Figure 3 presents the main bottom features obtained through camera stations, as well as a dynamic interpretation in terms of type of sediments. The study identified old deltas, drowned at present, mainly connected with ancient fluvial activity. These features, were submitted to a high expressive tide/wave energy that reworked sediments from tills and outwash plains.

The present sediment contribution are small and restricted to fine sediments that carpet the inner shelf.

The wide sandy cover is attired predominantly by ripple marks and formed by reworked relict neritic sediments.

A sandy mud strip covers the outer shelf and represents an old neritic zone on a stage of lower sea-level (probably during the Wisconsin) and is relict, but was deposited on conditions similar to those found along the inner shelf of the present coastline. This outer zone changes to muds, that dominates on the continental slope.

Regarding the coastal area, Isla & Bujaleski (1990) indicates that the Quaternary and modern beach deposits are quite different at the north and south regions of Tierra del

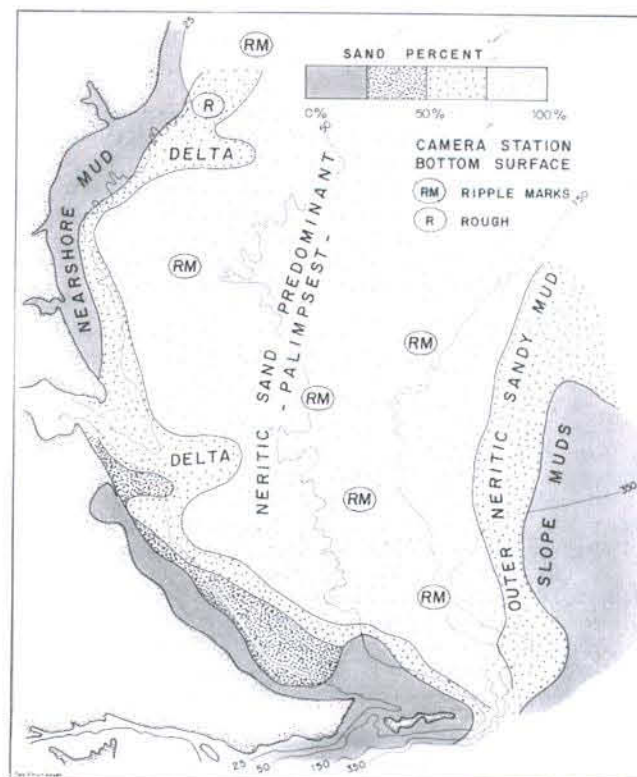


Figure 3 – Bottom surface features identified through camera station and dynamic aspects of the sedimentary cover.

Fuego. At the north, gravel spits and extended beaches induced by longshore currents are present, while at the Beagle channel the beach material is mainly formed by shells and terrigenous angular clasts. Different wave energy and tidal range (up to 10 meters at the Atlantic coast and less than 1 meter in the channel), plays also a significant role on the sedimentation processes and consequently on the sedimentary coastal forms and sediments along the two distinct areas.

FACIES DISTRIBUTION

The lithofacies distribution of the southern Argentina continental shelf is synthetized in the map of the Figure 4, that indicates the following types:

a) inner shelf (nearshore muds) composed by fine sediments of modern contribution or reworked from old deposits;

b) middle/outer shelf (sands) dominantly formed by terrigenous sands and gravels with its source linked with glacial and periglacial activity (direct ice action or fluvio-glacial) that dominates along the area during lower stages of sea-level retreat (Pleistocene) and reworked on several grades during the Holocene transgression;

c) outer shelf/shelf border (sandy muds) also relict and represented by fine sediments similar to those found on the inner shelf forming an old sedimentary environment that was

governed by the same parameters that are acting along the present coastline, but on a low stillstand (Wisconsin);

d) slope (muds – slope muds and deep clinoform muds) formed by a thick mud deposit with clinoform or prograding characteristics that modelling the slope during regressive periods, specially developed from Late Tertiary through Early Quaternary.

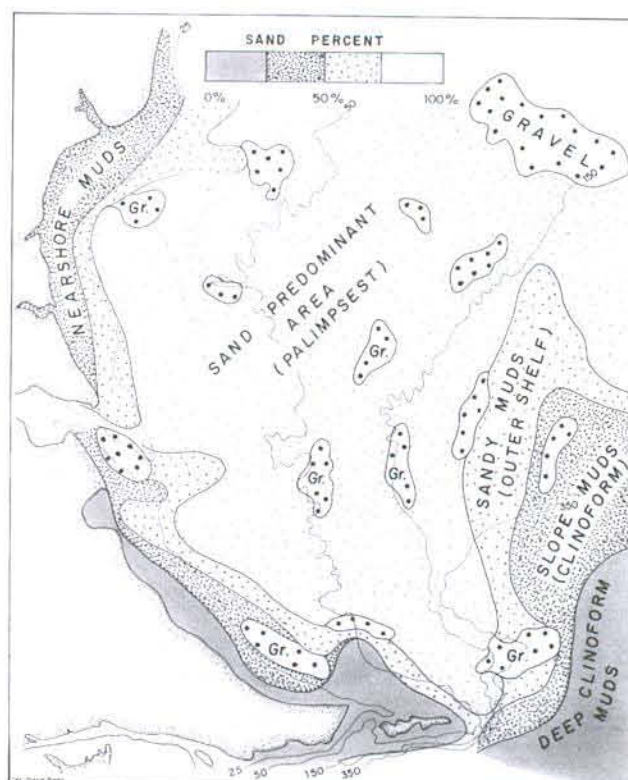


Figure 4 – Sedimentary facies distribution of the area, based on sedimentary distribution, camera stations, side scan sonar and detailed bathymetric data.

PALEOGEOGRAPHIC REMARKS

During the Holocene transgression, and associated with sea-level still-stands, a set of deltaic fronts were developed over conglomeratic planes of glacial origin built during Upper Tertiary and Pleistocene lower sea-level, as showed at the Figure 5.

The widespread of these features, is mainly related to a strong combined action of waves and tidal currents. Besides that, two relict coastlines were identified through the mechanical and mineralogical aspects of the sediments high resolution seismic profiles, associated biogenic components, and C_{14} dated; one at -157 meters (18.000 years BP) and other at -119 meters (12.000 years BP).

This partial paleogeographic reconstruction of the studied area is not conclusive and needs a number of new information coming from data and samples of which processing is running through the present research project. Nevertheless the work developed at the glacial and periglacial activity and related deposits were the leading supplier of sedimentary material to the continental shelf during its exposition times at Upper Tertiary and Pleistocene lower sea-level.

The Holocene transgression and still-stands creates a

series of temporary coastlines, that reworked these materials under a strong action of waves and tidal currents, that were responsible for the dispersion of the glacial sediments.

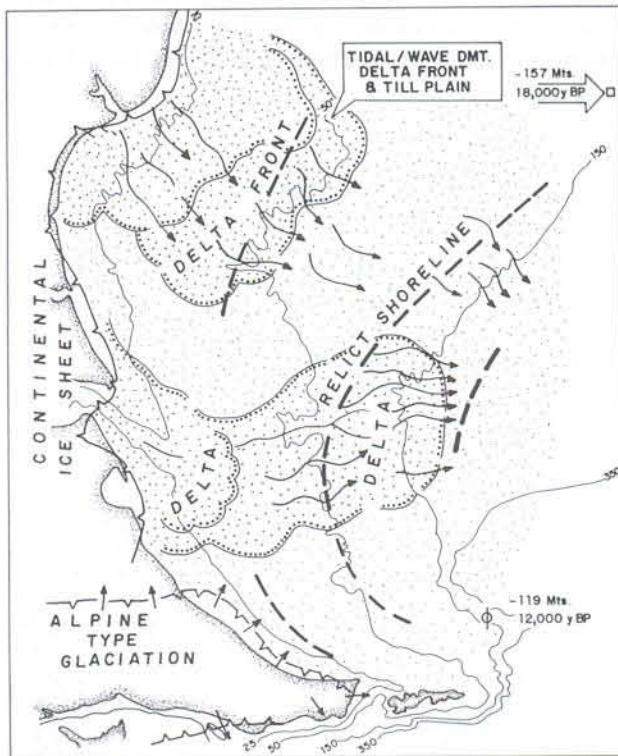


Figure 5 – Partial paleogeographic reconstruction of the continental shelf showing the strong glacial and periglacial influence on the sedimentary processes and modeling.
C₁₄ datings were made on two Holocene stillstands.

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