Sand Bodies of the Santa Catarina Inner Continental Shelf, Brazil

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ABSTRACT

Sand bodies present in the inner continental shelf of Santa Catarina State (Brazil) were studied as a source material for beach nourishment through a socio-economic project developed in the area.

Two portions located at the North and South of the Florianópolis city formed by quartzose sand (fine to coarse), moderately to well sorted, showing a secondary population of carbonate gravel and sand formed by shell debris, beachrock fragments and shell ash, were mapped.

Bottom samples, geological cores and high resolution seismic profiles obtained through several missions were employed in this study.

The mapped area shows a large amount of sandy sediments available for beach nourishment, with a variable thickness (1 to 3 m) along the occurrence area.

Keywords: inner shelf, sand, deposits.
INTRODUCTION

Following the study of mapping and characterization of marine sand bodies present along the southern Brazilian Inner Continental Shelf, the “Sand Stock Project (SASP)” developed a geological research in the Santa Catarina State with the purpose of outlining marine sand deposits of the Late Quaternary, extending from São Francisco island (North limit) to Mampituba river (South limit) (Fig. 1).

Studies regarding the sedimentary facies origin, distribution, age and energy level of the depositional environment in the area were mainly presented by MARTINS et al. (1967), GRÉ (1983), and CORRÊA et al. (1996).

The work developed in the region indicates the occurrence of sand deposits directly linked with the paleogeographic evolution of the area during the late Quaternary.

Economic employment of the marine sand bodies through important socio-economic projects specially linked with beach nourishment in some coastal areas in Santa Catarina were developed by HOEFEL et al. (1997), DIEHL et al. (1999), ABREU (2001), ABREU et al. (2001, 2004), MENEZES & KLEIN (2004) and REID et al. (2004).


Samples from Santa Catarina inner shelf used in this work were obtained through the use of Van-Veen, Dietz-La Fond, Shipeck, Orange Peel, Mud Snapper and Phleger samplers, during several missions developed under a co-operative project between the Diretoria de Hidrografia e Navegação – DHN (Brazilian Navy) and the Centro de Estudos de Geologia Costeira e Oceânica – CECO, Federal University of Rio Grande do Sul – UFRGS. Seismic data used to determine thickness of the sand bodies were obtained in “Vema” and “El Austral” missions.

The research area of this study is located between the latitudes of 26°30’00” S to 29°00’00” S and the longitude of 47°00’00” W to 50°00’00” W. CARUSO (1999) defined the coastal zone limits as represented landward by the “Catarinense” shield and oceanward by the Florianopolis platform. The coastline alternates rocky headlands with Quaternary sedimentary deposits forming terraces and plains with deposits of barrier beaches, dunes, beach ridges, lagoons and salt marshes.

Quartzose sand (mean 2 – 3 Ø, well to poorly sorted) with several proportions of bioclastic carbonate is the main textural component of the inner continental shelf north and south of Florianopolis, where the proportions of mud (sandy mud and muddy sand) increases. GRÉ (1983) indicates two prominent sandy areas, from São Francisco to Itajaí (north) and Laguna to Mampituba river (south).

The thickness of the sand deposits in both areas is quite irregular (1 to 3 m) usually defined by the morphology pre-Holocene original surface and the features developed by transgressive sand blanket during the Holocene transgression. A total of 55 surface samples and 8 cores of the inner continental shelf were used in the study.

The sedimentary material was analyzed through its mechanical and mineralogical composition, according methodology of MARTINS et al. (1978, 1980, 1984) and specially related with the missions LH13/76, LH71/77, LH89/91, GEOMAR and COMEMIR. Information obtained by GRÉ (1983) were also used.

SEDIMENTOLOGY

A large part of this sand was deposited in shallow waters (nearshore) during the last lower stand of the sea level. Holocene reworking has removed most of the fine grained sediments, and only sand was left.

Some fine-grained fluvi or lagunal sediments can escape the estuarine areas during floods and storms, but this influx is no sufficient to offset the winnowing action by currents and waves. Because of the lack of the current terrigenous sedimentation, the primary source of modern shelf sediments is calcareous skeletal material.

According to MARTINS et al. (1967) the sedimentary cover of the current continental shelves are formed by nearshore sediments in equilibrium with the environment, relict sediments not in equilibrium and between the two basic types, the components designated as
palimpsest formed by reworked relict material, that are deposited near the coastline where they are dispersed by longshore and other currents. One example of this process is the Albardão shoals on the inner continental shelf of Rio Grande do Sul. The banks are a result of a modern hydrodynamic action over relict carbonate sands and gravels of ancient shorelines, resulting in a palimpsest feature and sediments.

The relict sediments are present in the center and outer shelf, usually differentiated from modern sands by their coarse character, iron staining and dissolution pitting from subaerial weathering and by their association with freshwater peat, oyster shells and animal remains. According to KENNETT (1982), modern shelf muds occur only off rivers, in depressions and in coastal areas, and are probably dynamic accumulations. According to the author, in many areas modern shelf sands are dominantly of biogenic origin.

In terms of sedimentation processes, the shelf facies can be differentiated in: a) a shelf relict sand blanket, comprising pre-Holocene deposits in disequilibrium with present day processes, which is a discontinuous veneer overlapping Tertiary and older bedrocks; b) a nearshore modern sand prism that is a modern sedimentary facies consisting of beach sands comprising shoreline beaches, barriers, shoreface and sand zone, and c) a modern shelf mud further seaward, consisting of fine-grained sediment which has passed the nearshore zone and has been deposited on various parts of the shelf.

Growing awareness of the importance of the present day processes led to the differentiation between true relict sediment which should denote unworked material from...
a palimpsest sediment that is a reworked sediment with aspects of both its present and former environments.

The applications of these concepts along the southern Brazilian continental shelf were made by MARTINS et al. (1967). These authors also established the transgressive/regressive model for the studied area, which incorporates the physical processes operating with the shelf zone, the rate of sea level fluctuation, the nature and rate of the sedimentary supply (URIEN & MARTINS, 1989).

The inner continental shelf of Santa Catarina shows a predominance of the sand texture. The mean size is usually homogeneous and the changes are due to the presence of shell debris and beachrock fragments.

The facies distribution of the entire continental shelf is related with its evolutionary history related to the end of the Late Pleistocene glaciation, when the sea level started to be raised from its lowest position initiating to the marine transgression which marked the beginning of the Holocene time. The transgression started from a sea level position near the actual shelf border (average depths of -140 m) about 15,000 years B.C. This event seems to be quite uniform throughout the continental shelf, from Southern Brazil and Uruguay to Southern Argentina (URIEN & MARTINS, 1989).

GEOLOGICAL RECORD

The analysis of the Late Pleistocene events at the light of the geological record could be summarized as it follows:

a) Regressive offlap developed as a lowstand system track. The sea level reached its lowest position and the continental shelf was converted into an extensive coastal plain on which fluvial systems were over imposed. They have reached the shelf border building a series of deltaic complexes, most of them connected with submarine canyons and fans, and filled shifting depocentres as a sedimentary prism on the continental rise.

b) Transgressive onlap, represented as a highstand system track. At the end of ice age, sea level raised and started to flood the coastal and estuaries as a wave base transgressive surface. Shoreline retreated was quite fast, but intermittent. Aligned scarps (URIEN & EWING, 1974), barrier islands relicts (BUCHMAN & TOMAZELLI, 2003) and filled valleys (FURTADO et al., 1996) are an evidence of temporary stops. Beachrock and coquinas indicate also these temporary stillstands leaving shoreline relict mantled by palimpsest sands.

The transgressive/regressive concept on the analysis of onlap/offlap of sediments, combineted with morphology and sedimentology facies, allows to construct geological models. As it was discussed by URIEN & MARTINS (1989) those models describing each event in chronologic slides maps allow the understanding of stratigraphic sequences evolution and their regional correlation.

CONCLUSIONS

Beach nourishment represents a useful method developed for the artificial supply of sand, with the purpose of restoring the loss caused by erosion along coastlines. The beach replenishment is actually (see Martins, this volume) a fairly standard practice whereby sand found near the shoreline, is mapped, analyzed and pumped onshore along the beach. The understanding of this fact makes the inner shelf deposits not only of academic interest. Beach nourishment is a still debatable topic whether it is the right complete answer or only a short term solution to the problems related to erosion. Meanwhile, it is even more economic to develop projects of beach replenishment at some intervals than constructing a series of groins backed by marine seawalls.

The voluminous quantities of sand and gravel deposited in the high energy level glacial, fluvial and coastal environments migrating across the shelf during the Holocene transgression represent a viable resource of sand for beach restoration and industrial uses.

Research agencies like the U.S.Coastal Engineering Research Center (DUANE, 1968 and 1969) and Marine Mineral Service – MMS (AMATO, 1994) consider as “outer continental shelf” sediments of an undefined zone between the shallow marine environment of the shoreline inner shelf and continents slope. Shallow-marine sediments are typically a complex mixture of particles, originating from many sources that were deposited in different environments at
different times and through different processes. To compound the complexities they are continually being modified by addition removal, or supply by reorganization of the sediment.

Then, the factors that control the nature of the outer continental shelf sediments may be grouped according to: a) source and transport factors, b) nature of the original depositional environment and c) modern shelf processes. Usually climate, relief and rock type of the source region are important parameters on these factors.

The studies developed along southern Brazil, outer continental shelf (OCS) reveals, according the type of sedimentary cover, a good source of clean sand for beach nourishment. The amount of sand along the two areas of the inner continental shelf was calculated in 5.2 billions of cubic meters (Laguna to Mampituba) and 7.2 billions of cubic meters (São Francisco to Itajaí).

REFERENCES


