SEDIMENTOLOGICAL AND GEOACOUSTIC FACIES MODEL FOR THE MUD BANK OF CABO FRIO UPWELLING SYSTEM ON SOUTHWEST ATLANTIC

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1. INTRODUCTION

Physical and acoustic properties of marine sediments are important variables that can be used to point out geological events recorded in marine deposit. In the continental shelf, they can reflect the history of sea-level and sediment delivery through the textural change that results from such fluctuation. The Cabo Frio shelf in Southeast Brazil is an example of an eastern continental shelf upwelling system, which has high effect on the sediment deposition. The shelf and its coastal environments were both influenced by Late Pleistocene-Holocene sea-level changes and climatic oscillations (Angulo & Lessa, 1997). The aim of this study is to analyze the physical, chemical and geoacoustic properties of the sea floor sediment along a 77 – 127 m water depth transect in order to understand the recent sedimentological evolution of the Cabo Frio shelf.

2. METODOLOGY / STUDY AREA

There were two cruises on board RV *Ocean Survey*. The first one in the end of 2009 was in order to obtain bathymetric and seismic data, and the second in the beginning of 2010 to collect four piston cores (Fig. 1). Bathymetry was recorded using an echo sounder *Multibeam Simrad EM3000 Dual Head*. The raw data were tidally corrected using the tidal harmonic constants for Arraial do Cabo. The geophysical survey included seismic profiling using the *Geopulse Geoacustics* system. The high-resolution seismic bathymetric survey covered a total area of 680 km^2 (Fig. 1). One middle line with 35,5 km were SE-NW oriented, whereas 42 cross lines spaced at intervals of 1500 m with lengths ranging from 3 to 20,85 km were NE-SW oriented.

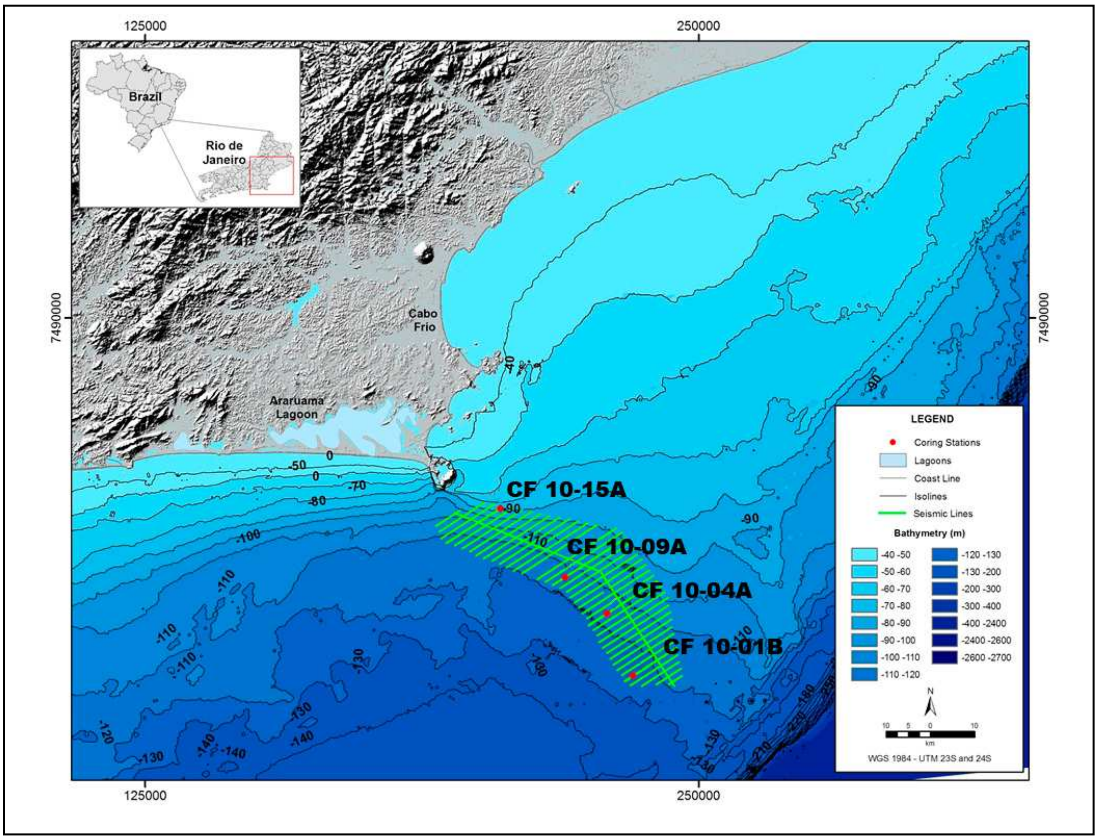

Figure 1: Location map with regional setting of Cabo Frio indicating the seismic lines and coring locations

A GEOTEK multi-sensor core-logger measured the P-wave velocity (Vp) and gamma density over successive core sections at 1-cm interval, using two mounted p-wave transducers (PWTs) and a gamma ray attenuation system, respectively. In order to establish a chronological control of sediments, the bulk organic matter from twenty samples were dated through AMS radiocarbon technique. Radiocarbon ages were calibrated using Calib 6.0 (http://calib.qub.ac.uk/calib) software considering intervals between 2σ and a regional reservoir effect of AR = 8 ± 17 years (Angulo *et al*., 2005).

Sediment cores were sampled at intervals of 5 cm for water content, total organic carbon (TOC) and grain size analyses. TOC was measured with a LECO CHN elemental analyzer, after acidification with 1N HCL. Fresh sediment samples (2 g) were oven dried at 105°C until constant weight. The loss in weight was expressed as percentage of dry matter. Grain size was analyzed after carbonate dissolution with 1N HCl and through rinsing with de-ionized water until neutral pH. Grain size composition of the fractions with diameters less than 500 µm mesh sieve was analyzed using 2 g gross weight of sediment and determined with a Cilas® 1064 laser diffraction analyzer. The samples were sieved in 0.5 phi intervals. A further analysis of sedimentary parameters was determined by Gradistat routine (Blott and Pye, 2001).

3. RESULTS / DISCUSSION

Sedimentary thickness of the upper sedimentary layer varies between less than 1 m and up to 20 m. In general, along a NW-SE line the layer is thicker on the SW side, whereas the layer is thinner on the NE side, often below 5 meters, but we can also see the largest thickness on the North (Fig. 2). The high-resolution seismic has identified two main echo-characters in the area. The first one at the central portion of the muddy bank is described by a sequence of parallels sub-bottom reflectors up to 15 ms below the seafloor and is associated to essentially muddy sediments. The second echo-character is observed at NE and SE portion of the area, and is characterized by a chaotic to transparent sequence with non obvious sub-bottom reflectors associated to sediments with a higher percentage of coarse material.

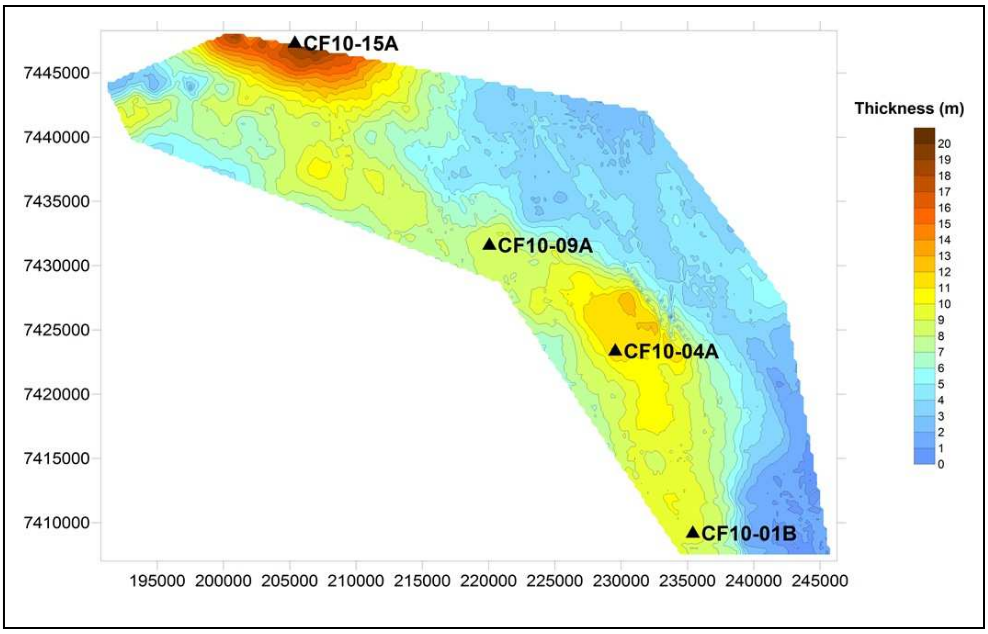

Figure 2: Map view of the sediment thickness of upper sedimentary unit and the coring locations.

Core CF10-01B represents the last 11.1 ky cal BP whereas the others cores represents the last 7.2 ky cal BP based on the ^{14}C dating.

The velocity of "P" wave (Vp) values ranged from 1409 to 1764 m.s^{-1}. In general, cores CF10-01B and CF10-15A showed the highest values (mean 1560 m.s^{-1}), while cores CF10-04A and CF10-09A showed low values (mean 1502 m.s^{-1}). Density profiling ranged among 1.3 and 2.4 g/cm³. Cores CF10-01B and CF10-15A exhibited the highest values (> 1.7 g/cm³), whereas CF10-04A and CF10-09A are showing the lowest one (< 1.9 g/cm³). Vp and density increase in cores CF10-01B and CF10-015A associated to a medium silt and very fine sand predominance (mean phi 3.2 - 6.2), reflecting a decrease in porosity and an effective increase of the effective pressure indicating a normal compaction (Gangi, 1991; Gueguen and Palciauskas, 1994)

The TOC varied from 0.16 to 3.35 % (Fig. 3). The highest TOC observed in CF10-09A (mean 2.8 %) and CF10-04A (mean 1.9 %) was related primarily to the grain size, in which the fine grains minerals accumulation are normally associated to high organic matter concentrations. High TOC was found in sediments with low density which is consistent with the preferential association of organic matter with clay-silty rich sediments (mean phi 5.1 – 9.5). Water contents in cores CF10-01B and CF10-15A ranging from 21 to 38 %, are grouped together with TOC both and have quite 30 % lower water content than cores CF10-04A and CF10-09A which exhibited values ranging from 34 to 57 %. As expected, the water content decrease in depth with increasing density, since as compaction processes due to the overburden weight take place the water is squeezed out of sediment.

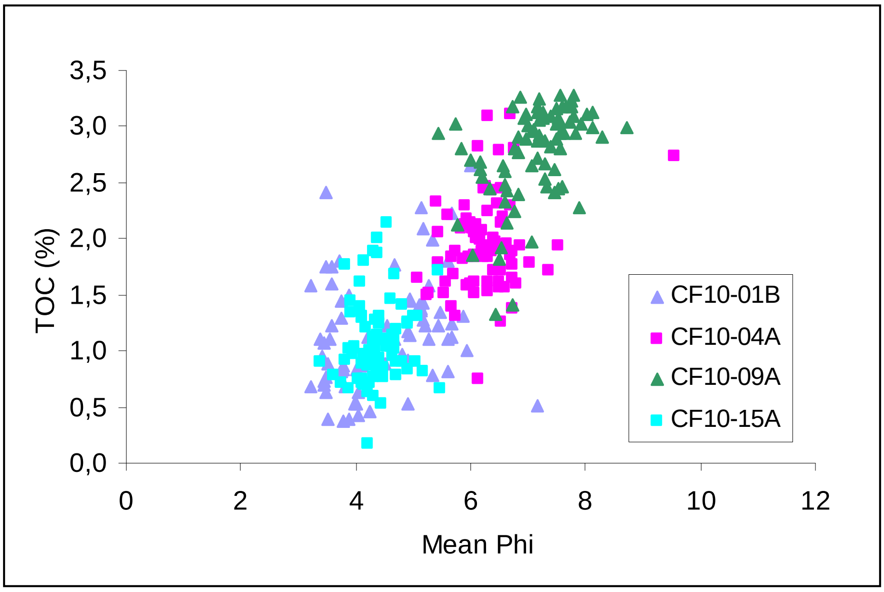

Figure 3: Correlation of sediment total organic carbon (TOC) and mean phi grain size.

4. CONCLUSION

Cores CF10-04A and CF10-09A could represent the record of a confined shallow marine setting where a drastic drop on hydrodynamics acts on a high concentration of suspended mud on water, characterizing paleo-shoreface dominated by mud. Core CB10-01B and CF10-15A have very similar sedimentological and acoustic pattern despite the fact that they are end members of this sedimentation model, where wave-driven alongshore drift system could have acted as the main agent on the depositional pattern. The sand at the base of the cores CF10-01B and CF10-15A could represent influence of convergent alongshore drift supplied by erosion of shelf during relative sea-level rise.

5. ACKNOWLEDGMENTS

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