High-resolution seismic profiling applied to echo-character mapping on the continental platform,Sergipe-Brazil

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Abstract

During the period from 11 to 16 of July/2012, high resolution geophysical surveys were carried out on the continental platform of the state of Sergipe with aid of an EdgeTech sub-bottom profiler operating at frequency ranges of 1 to 6 kHz, 0.5 to 7 kHz and 2 to 15 kHz. Given that the high frequency seismic echo-characters distribution has close relation with the environment sedimentary characteristics distribution geophysical survey were carried out in order to acoustically map the seabed. All of the data used on this work belongs to the Laboratory of costal and marine research, GeoRioeMar, responsible for the geology and morphology studies of the Sergipe-Alagoas platform, Brazil.

Introduction

In recent years, a number of studies have proven that the high-resolution seismic data are a valuable tool in the study of the deposition and erosion processes acting on the seafloor. High resolution geophysical surveys were carried out on the continental margin of Sergipe, aiming to acoustically map the seabed in reason of search for information about the echo-characters interaction. The term echo-characters correspond to the set of reflected echo physical characteristics which resulted from the interaction between the seabed and the pulse energy used by the high-resolution acoustic source. The regional distribution of the different types of echo-characters provides important information regarding to the dominant sedimentary process in a given area. Once that the echo return is produced depending on the seabed acoustic response due to the acoustic impedance contrast in reason of the grain size, texture, compaction and morphology, the work consists in the acquisition of seismic data using an EdgeTech 3200 Sub-bottom Profiler System which operates at frequency range of 500 Hz to 12 kHz and input power of 2000 Watts. Some parameters were analyzed during the echo-characters classification, such as: the reflectors number, the seafloor acoustic impedance and the seismic signal penetration depth. As known that the high-frequency seismic echo-characters distribution have close relation with the environment sedimentary characteristics distribution, correlations were verified, grouping the seismic echo-characters according to the seafloor characteristics.

Study Area

Location

The Brazilian continental margin is classified as the Atlantic type (passive margin) and comprises a total area of 5.003.397 Km^2, equivalent to 59% of the Brazilian emerged territory (Coutinho, 1976). The seismic profiles were collected by an EdgeTech Sub-bottom Profiler sub-XS-3200, SB-512i and are located in the Sergipe-Alagoas sedimentary basin, at an area which encompasses the Sergipe sub-basin and the Jacuípe sub-basin. The region includes the inner and middle platform surfaces between the Sergipe River and the Piauí River mouth. It was bounded by a polygon with 1036 Km^2 in area, with 74 km length NE-SW and 14 km width NW-SE.

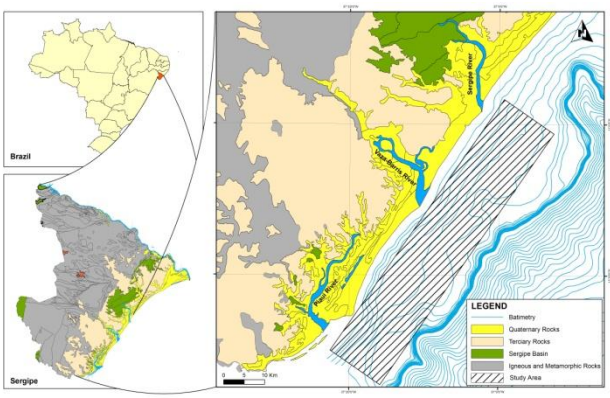

Figure 1: Location map of the study area.

Surface Sediments Distribution on the SEAL Continental Shelf

According to Coutinho (1976), the gravels dominate the middle and outer shelf at the north of the São Francisco River, being underrepresented in south. The sands cover the entire inner shelf, except for the area in front of the São Francisco. The current terrigenous sedimentation is represented by the mud which the percentage is higher in the rivers influenced zones. Stating that the platform north of the São Francisco River consists of coarse sediment, with some isolated patches of fine material, while in the south of the river there is a mixed sequence of sand and mud.

Methodology

The data used for the echo-characters characterization were provided by the Laboratory GeoRioeMar at the Federal University of Sergipe in partnership with PETROBRAS, at the context of the MARSEAL program. The applied method was the high-resolution shallow seismic using the XS-3200 EdgeTech Sub-bottom Profiler System, SB-512i model. This sonar has a topside processor which is real time connected to the sonar via a communication cable and it is comprised of acoustic signal emitters (transducers) and hydrophones. The spatial seismic profiling distribution was performed using a Trimble R6 geodesic GPS which was directly coupled to the software. However, georeferenced profiles were not used in this study. Different acquisition parameters were tested along with the seismic data acquisition.

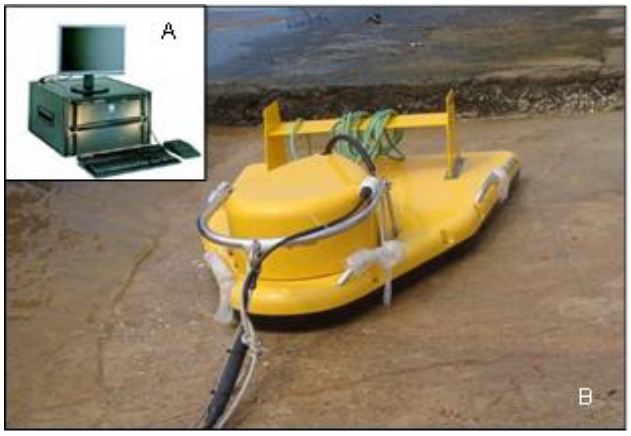

Figure 2 – A: Topside Processor B: Sub-bottom Profiling System.

During the survey, the sonar, also known as "*fish*" was located to the vessel port side at a distance of approximately 0.5 meters. The relative distance between the sonar and the water surface varied in the range of 1 to 3 meters.

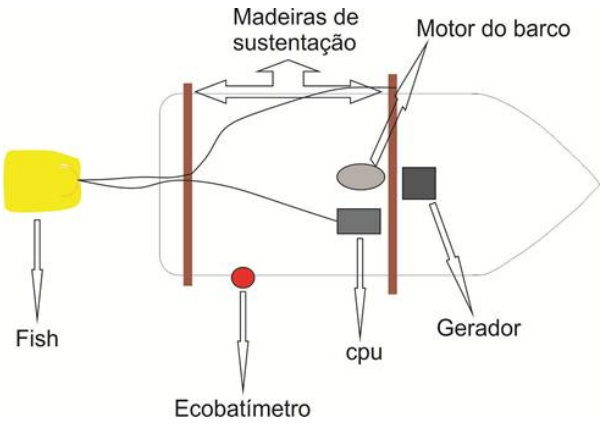

Figure 3 – Geometry of the equipment.

Figure 4 – Acquisition of the seismic profiles using the DISCOVER Software.

The data was pre-processed in situ by the DISCOVER acquisition Software. The post-processing was subsequently performed using the Sonarwiz5 Software to identify the seafloor bottom (bottom track) and remove the waterfall noise. The next step was the wave filter application and the gain improvement using the AGC tool (Automatic Gain Control). The data interpretation for echo-characters distribution was performed by seismic images analyzes. The Software ArcGIS 10 (ESRI) was used to create the location map of the study area.

Results

Three echo-characters named A (Figures 5 and 6), B (Figures 7 and 8) and C (Figures 9 and 10) were described during the seismic lines interpretation located in the polygon which covers the region of the inner and middle platform surfaces between the Sergipe River and the Piauí River mouth. During the echo-characters classification were analyzed: the reflectors number, the seafloor acoustic impedance and the seismic signal penetration depth. Due to the lack of sample data in this work, the correlation between the echo-characters and the seafloor sedimentation was based on the comparison of the echo-characters distribution and the surface sediments distribution on the SEAL continental shelf.

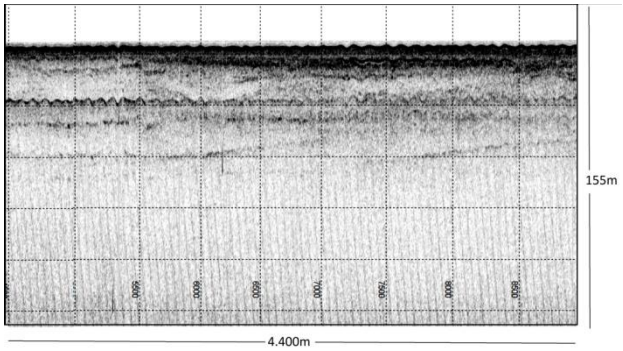

Figure 5: Echo-character (A) Muddy/Sandy Muddy area.

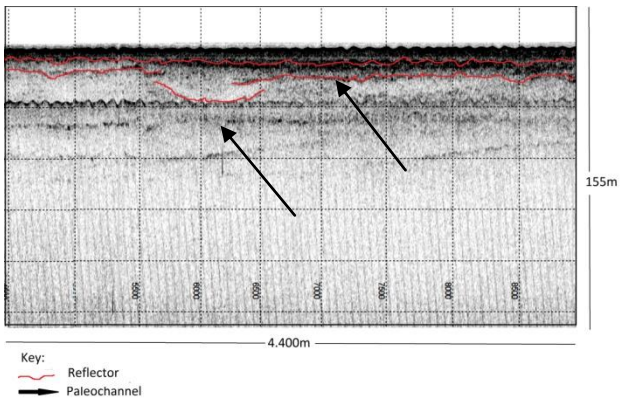

Figure 6: Paleochannel feature identified in Echo A.

The first echo-character (A) is observed in an area of 4.400 m width and 155 m depth. The data acquisition was held in a sandy muddy seafloor with frequency ranges from 0.5 to 7 kHz. It is characterized by the presence of two strong reflectors with signal penetration varying from 5 to 35 m. There is a loss on the reflectors continuity located in the first 50 m depth between the 1000 m and 2 000 m swath, which created some paleochannel features. External noises are confirmed by the presence of multipath and plane-parallel vertical features along the profile bottom.

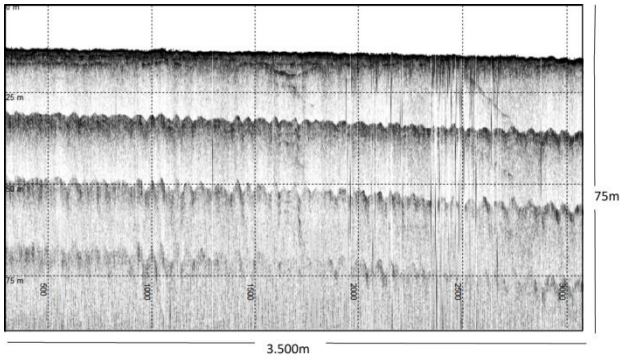

Figure 7: Echo-character (B). Sandy area.

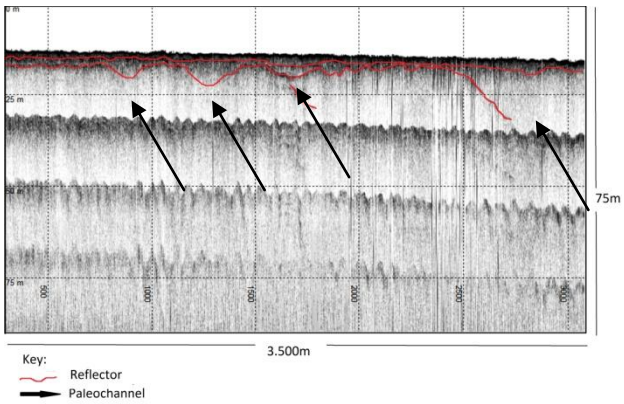

Figure 8: Paleochannels identified in Echo B.

The second echo-character (B) identified in the seismic recording is observed in an area of 3.500 m width and 75 m depth. It is characterized by the presence of two strong reflectors, where the first one shows a continuous behavior and the second one is discontinuous and reaches the depth ranges of 7 to 17.5 m. The profile was acquired on a sandy bottom using the frequency ranges from 1 to 6 kHz. Three paleochannels with approximately 150 to 250 m in length have been identified, followed by a deeper reflector interpreted as a larger dimensions paleochannel.

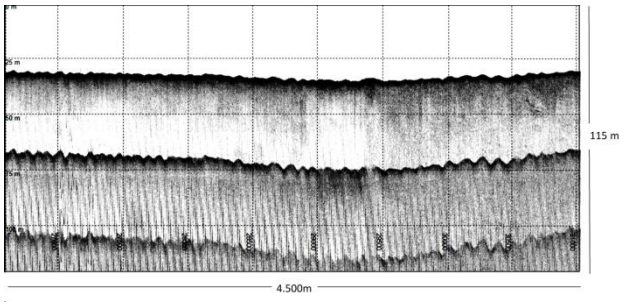

Figure 9: Echo-character (C). Area of medium to coarse granulometry.

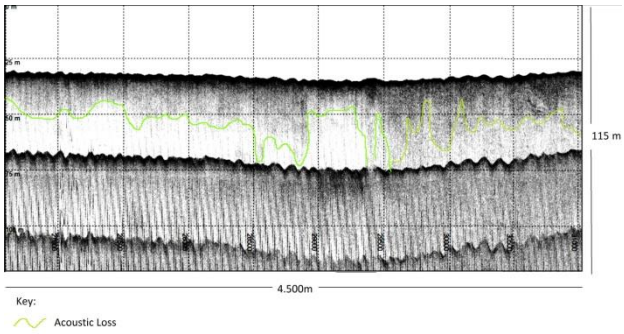

Figure 10: Acoustic transparency caused by the presence of coarse sediments.

The echo-character type (C) is analyzed at a seismic profile of 4.500 m width and 115 m depth with the frequency ranges varying from 2 to 15 kHz. The acoustic transparency shows the predominance of medium to coarse sediments on the seabed.

Conclusion

The high resolution seismic provided the recognition and characterization of three types of echo-characters in areas of different compositions sediment on the continental margin of the state of Sergipe. This enabled the identification of paleochannels and confirmed the surface sediments distribution suggested by Coutinho (1976) from the results of the visual analysis of acoustic impedance and the seismic signal penetration. The study allowed recognizing that the echo-characters reflect not only the geology of the seabed as well as the sedimentary process that were active during the material deposition.

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