Characterization of the continental shelf of Faial and Pico islands (Azores) using chirp echo character

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1. INTRODUCTION

High-frequency (3.5-12 kHz) subbottom profiling has served as an invaluable tool for the study of ocean-bottom processes (Damuth, 1975, 1977, 1980; Chough et al, 2002; Lee et al, 2002). Damuth (1975, 1977, 1980) realized that the types and regional distribution of the reflected echoes recorded were an important basis for the interpretation of depositional and erosional processes and developed a classification for the various types of echoes. According to Damuth (1975, 1980) the reflected echoes are mainly controlled by surface topography, subsurface geometry and sedimentary texture of the sequence.

2. DATA AND METHODS

During July 2001 and July 2002 the Marine Geology Department of IGM conducted two surveys to map the sand distribution around the Faial and Pico islands. A total of 643 Km lines of high-resolution (1,5-10 KHz) seismic profiles were collected using a Chirp sonar system (Datasonics CAP-6000W) between 0 and 100m water depth. Bathymetric data were acquired concurrently using a probe KODEN CVS-821. The survey lines were made parallel and normal (ca. 0.4-0.8 Km intervals) to the shore (fig. 1). Another line was made around both islands crosscutting the previous network at 30 m water depth.

The area covered was about 200 Km^2 (80 km^2 in Faial and 120 Km^2 in Pico). Navigation was controlled using a

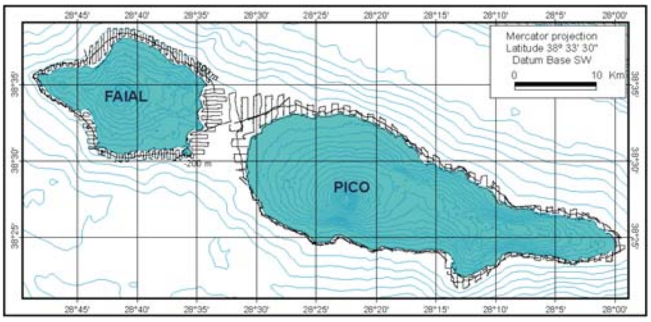

Figure 1: Location and track lines of Chirp seismic profiles.

Global Positioning System (GPS PLOTER SIMRAD SE32) with a positional accuracy of ± 30 m.

3. RESULTS

Acquisition of closely spaced Chirp subbottom profiles in the continental shelf of the Faial and Pico islands provided a valuable dataset for the detailed analysis of echo characters and its regional distribution. Damuth (1980) made a classification based on the acoustic character of the sea floor, including clarity and continuity of bottom echoes and seafloor morphology. Taking into account the regional differences, four dominant echo types were identified, adapted from the schemes of Damuth (1980):

- Type I - Distinct, continuous, sharp bottom echo with no apparent sub-bottom reflectors. The surface echo shows nearly flat or gently sloping topography. In some cases the surface echo shows irregularities that appear to be wavy bedforms, which became more pronounced in the deeper areas (fig. 2).
- Type II – Distinct to indistinct, continuous, prolonged echo with no apparent sub-bottom reflectors. The surface topography is similar to type II (fig.2).

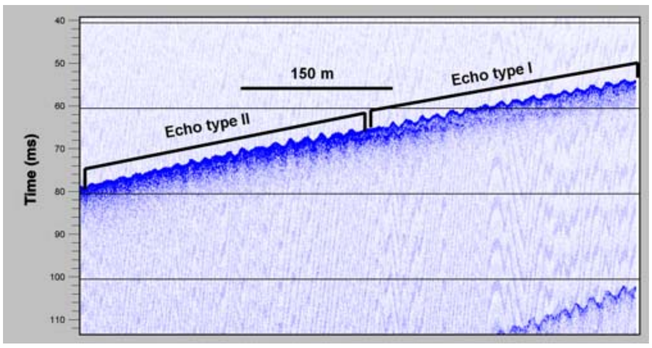

Figure 2: Echo types I and II.

- Type III – Indistinct, continuous, prolonged, fuzzy echo with no apparent sub-bottom reflectors.
- Type IV - Indistinct, continuous to discontinuous, very prolonged echo with no apparent sub-bottom reflectors. The surface echo is extremely irregular, showing changes of four meters (fig.3).

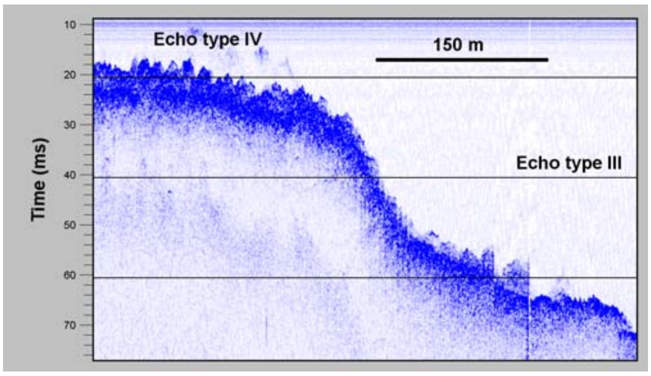

Figure 3: Echo types III and IV

4. DISCUSSION

The nearshore areas of Faial and Pico Islands are mainly occupied by echo type IV (fig. 3). These areas are often truncated by transverse gullies and downslope by scarps where gives place to echo type III (fig. 3). According to several authors (Bryan and Markl, 1966; Damuth, 1975, 1978: Embley, 1975, 1976; in Damuth, 1980), the prolonged echoes with no sub-bottom reflections result from the scattering of acoustic energy by small erosional/ depositional bedforms on or just beneath the sea floor. If the bedforms are of sharp vertical relief (<1meter to a few meters) and are closely spaced (<100m in wavelength) they will scatter the acoustic energy to the point that no sub-bottom echoes are visible and only a very prolonged or fuzzy bottom echo is returned. That appears to be the case of echo type IV. The authors believe that this kind of echo corresponds to rock outcrops. Type III echoes probably correspond to displaced rocky material falling along the scarps.

Further away from the coastline, between the 30 and 100 meters water depth, echo types I and II dominate (fig. 2). In the areas where the coastline is concave they often appear nearshore. The very sharp bottom echo with no internal reflectors reflects dominance of coarse-grained sediments such as sands or gravels on the surface. Damuth and Hayes (1977) state that they are very good reflectors of sound energy and consequently little or no sound penetrates to buried sediment interfaces. The authors believe that echo type I and II reveal the existence of coarse-grained sediments, being echo type II coarser than type I. Two processes can generate the existence of the wavy bedforms. Damuth (1980) suggests that turbidity currents and other related downslope processes could produce these kinds of bedforms. Chough et al. (2002) state that this type of bedforms can also be formed under the influence of tidal currents. In this case it appears that this forms are more related with tidal currents, because these are often observed in low slope areas where normally turbidity currents and related downslope processes do not occur. Furthermore, this bedforms are more developed in the channel Fail-Pico, which is well know for the influence of this kind of currents.

5. CONCLUSIONS

A detailed analysis of high-resolution (Chirp) subbottom profiles revealed the distribution of the echo characters of the continental shelf of the Faial and Pico islands. The interpretation of these data has provided the mapping of the sea floor and the sedimentary processes involved. Divers from the Department of Oceanography and Fisheries (DOP) of the University of Azores are conducting scuba dive filming and sampling in order to test the interpretation made in this paper.

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