PROCESSING AND INTERPRETATION OF MULTICHANNEL SEISMIC REFLECTION DATA (SWIM-06 CRUISE): FROM THE HORSESHOE TO SEINE ABYSSAL PLAINS (GULF OF CADIZ)

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1. Introduction

During June 2006 we carried out the ESF-EuroMargins SWIM marine geophysical cruise on board the Spanish RV Hespérides (PI. E. Gràcia) with the main objective to characterize the geometry, deep structure and timing of deformation of the active faults located at the westernmost Gulf of Cadiz (SW Iberian Margin). This region is where the epicentres of recent large magnitude earthquakes are located, such as the 28 February 1969 (Mw 8.0) and the 12 February 2007 (Mw 6.0) [1], as a consequence of the convergence (about 4-5 mm/yr) [2] between the European and the African Plates. We acquired sixteen high-resolution multi-channel seismic (MCS) profiles together with Simrad EM120 swath-bathymetry and TOPAS sub-bottom profiler, totalizing more than 2700 km of data. Here we will focus on the Coral Patch Ridge (CPR) and the adjacent Horseshoe and Seine Abyssal Plain corresponding to the profiles SW8 to SW16 (Fig.1).

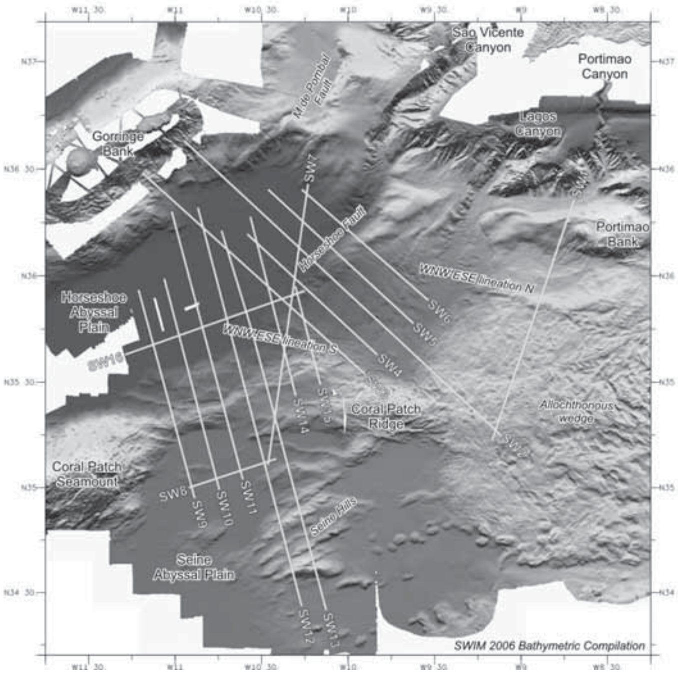

Fig 1: Bathymetric map of the SW Iberian Margin (Diez et al. 2005) [3] with the location of the MCS profiles acquired during the SWIM-06 cruise.

2. Processing of the data

Seismic acquisition was performed using a 10 m long 8-airgun array totalling 1050 c.i. and a streamer with 2.4 km of active section, totalizing 96 channels with 25 m separation. Standard MCS processing was accomplished using PROMAX software, and included: data resampling at 4 ms, channel and shot editing, top mute in shot gather domain, true amplitude recovery, anti-alias, FK fan filter, band-pass filter, predictive deconvolution, geometry CMP gather, NMO, stack, and Stolt FK migration (1500 m/s). The record length was 11s TWTT with a shot distance every 37.5 m. In average, the profiles range between 9000 and 12000 CMPs, with 12.5 m CMP distance and 30 fold traces per CMP.

3. Results and discussion

The eight MCS lines presented here were acquired in order to obtain the best image of the structure and tectonic evolution of the Horseshoe Abyssal Plain (HAP), the Seine Abyssal Plain (SAP) and Coral Patch Ridge (CPR). This set of lines help us to understand the distribution of the deformation in the study area, the involvement of basement in the regional tectonics, and the seismic activity occurring on the region.

The basement and sedimentary cover are clearly imaged on the MCS profiles (Fig. 2). We have differentiated six seismo-stratigraphic units: I) a Triassic to lower Jurassic unit, composed of evaporites and carbonates; II) an upper Jurassic to Aptian unit, made up of marls and limestones; III) an upper Cretaceous to lower Eocene terrigenous unit; IV) an upper Oligocene to Miocene unit, only recognized at the HAP; V) the Allocthonous Unit of Gulf of Cadiz of Tortonian age, and VI) the uppermost unit of Plio-Quaternary age, composed of hemipelagites, countourites and turbidite layers [4].

The structure of the basement follows a horst and graben geometry corresponding to the Mesozoic tectonic pattern, reactivated during the Neogene [2, 5]. The CPR is composed of a series of positive relieves corresponding to the eastern prolongation of the Coral Patch Seamount which abruptly ends against towards a NW-SE trending fault. The CPR consists of a series of narrowly spaced ENE-WSW trending folds and thrusts mainly with NW vergence, although conjugated faults are also observed, corresponding to the Seine Abyssal Hills. We have also identified a 300 km long WNW-ESE trending lineament corresponding to an active dextral strike-slip fault that cut across most of the HAP, the Horseshoe Fault and the western part of the Gulf of Cadiz accretionary wedge (Fig. 2).

Present-day active faulting is observed at the HAP and SAP, mainly subvertical faults cutting the whole sedimentary sequences up to the surface [6, 7]. They are also associated with earthquake swarms.

4. Conclusions

The MCS profiles reveal recent tectonic activity. We can identify seafloor ruptures of active faults, potential sources of large seismic events in the Gulf of Cadiz. The uppermost units of Plio-Quaternary age show evidence of recent activity. The most likely mechanism of landslide triggering in the SW Iberian Margin is seismic activity; therefore, the filling of the HAP will give us valuable information about the past-earthquake event history of the region. Forthcoming pre-stack migration of selected MCS profiles in the frame of the EU-NEAREST project will allow us to obtain the corrected geometry for detailed neotectonic interpretation and calculation of fault seismic parameters.

5. Ackowledgements

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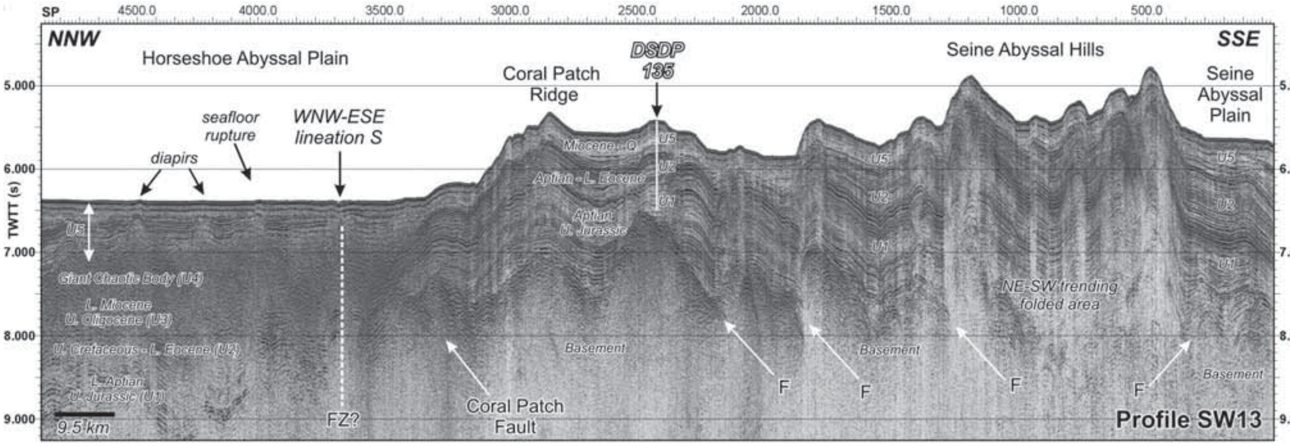

Fig 2: Interpretation of MCS profile SWIM-13 crossing the deformation area of the CPR.

NON-DESTRUCTIVE SCANNERS TO STUDY MARINE SEDIMENT

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1. Introduction

Marine geology constitutes a specific scientific field submitted to continuous advances. These advances are directly related to constant developments of new technology and instrumentation. New approaches of marine geological studies and technologies imply a potential increase in the number of analytical measures on the sediment. Thus, because the acquired amount of sample is very low, the main handicap of marine geologists is to apply the major number of analytical measurements on the same sediment sample. To avoid the fatal consequences generated by the irreparable lost of sediment by a single analysis, new non-destructive techniques have been developed and implemented in the last decade. Nowadays, interdisciplinar studies may be carried out based in a single sample to obtain a high resolution dataset keeping the stratigraphical order.

2. Methods and Instrumentation

Continuous non-destructive analyses can be applied during four different stages since the onboard sediment recovery, keeping the stratigraphical characteristics of the sediment. The four main stages are: (1) drilling, (2) whole-section core, (3) half-section core and (4) U-Channel.

During the first stage, drilling of the sediment deposits, a number of sensors are incorporated into the tube and are able to measure different physical properties (e.g. resistivity, porosity, density). Once the core is on board, the liners with sediment are usually divided in 1.5m sections for easy working.

The second stage starts with the cores onboard and liners with sediment divided into easy to work with 1.5m sections. Sediment sections are recorded and can be imaged using an Infra-Red camera, which is usually used in studies about temperature conditions of sediment. Furthermore, analyzing the whole section core using a Multi-Sensor Core Logger (MSCL) (Fig. 1), we can obtain in a single logging several physical properties of the sediment which include magnetic susceptibility, density, P-wave velocity, P-wave amplitude, impedance, fractional porosity, and electrical resistivity.

In the third stage, after core section splitting, new data can be acquired from the half section cores. Images on visible (Fig. 1), Infra-Red and X-Ray wavelengths of the sediment surface give information about the stratigraphic features and temperature of the record. Afterwards, the visible image can be processed obtaining RGB diagrams for spectral analyses. RGB diagrams together with the color parameters (lightness, a* and b*) obtained with the spectral photometer, allow us to characterize different sedimentary facies. In this stage, geochemical analyses can be applied on the sediment surface as the XRF scan. Using this method we obtain the chemical composition in relative values (cps) of each measurement in few seconds. The XRF scan can be run at resolution ranging from decimeters down to one millimeter.