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Morphostructure of the S. Vicente Canyon, Marquês de Pombal Fault and Pereira de Sousa Fault (SW Iberia margin)

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ABSTRACT

The S. Vicent Canyon (SVC), Marquês de Pombal Fault (MPF) and Pereira de Sousa Fault (PSF) are located along the SW Iberian margin. The SVC appears to be controlled by the S. Vicent Fault (SVF), a steep NE-SW striking fault that outcrops along the southeast flank of the canyon.

To better understand the SVC, MPF and PSF structures and the Meso-Cenozoic morphostructural evolution of this sector it is important to identify the main tectonic phases from the Mesozoic up to Plio-Quaternary. To attain this objective, the main regional structures were mapped using 2D seismic lines and multibeam swath bathymetry data, allowing the mapping of the northern prolongation of PSF and the identification of faults that do not reach the sea floor.

KEYWORDS: Portugal, SW Iberian Margin, morphostructure, Alentejo Basin.

1. Introduction

The S. Vicent Canyon (SVC), Marquês de Pombal Fault (MPF) and Pereira de Sousa Fault (PSF) are located along the SW Iberian margin, northwards of the Africa-Eurasian plate boundary comprised of the Gloria Fault and Strait of Gibraltar, which is described as a diffuse boundary by Sartori et al. (1994). This tectonic setting is particularly important to understand which structures are still accommodating the present day tectonic deformation.

The NNE-SSW trending MPF and the N-S trending PSF acted both as extensional faults during the Triassic-Early Cretaceous tectonic rifting phases in West Iberia. During the Late Cretaceous-Palaeogene and the Neogene, this margin underwent two tectonic inversion events related to the Alpine orogeny (e.g. Terrinha, 1998). During that time the MPF was inverted as a thrust-fault, whereas the PSF continued to act as a normal fault until the Recent (Terrinha et al., 2003; Zitellini et al., 2004).

The SVC appears to be controlled by the S. Vicent Fault (SVF), a steep NE-SW striking fault that outcrops along the southeast flank of the canyon (Valadares et al., 2009), and possibly is the submarine prolongation of the 600 km long Odemira-Ávila Fault.

The objective of this work is to better understand the tectonic control of the SVC, the structure of the MPF and PSF regarding their geometry and the kinematic control during the Plio-Quaternary . Furthermore the study also aims to investigate why the PSF remained a normal fault during the Meso-Cenozoic. The interpretation of multibeam bathymetry SWIM data (Zitellini et al., 2009) together with good quality multichannel

2D seismic data allowed to: i) characterise the fault distributions in depth ; ii) better define the northern termination of the PSF; iii) recognize new structures that could help explain the reason why this fault remained a normal fault after the basin inversion during the Meso-Cenozoic.

2. Data and methods

The work integrated two different datasets, the SWIM multibeam bathymetry (Zitellini et al., 2009) and the information obtained through the interpretation of 2D seismic data. The SWIM bathymetry resulted from the compilation of 19 surveys, acquired between 2000 and 2006 funded by the ESF EuroMargins SWIM project. The 2D seismic data was acquired between 2000 and 2002 with a record length of 12 seconds.. The acquisition was carried out in perpendicular directions, NW-SE and SW-NE defining a grid of 10 km by 5 km.

The SWIM bathymetry and the seismic dataset have different resolutions and spatial coverage, being both complementary to each other. The merge of the bathymetric data obtained from seismic (tracking the sea floor on seismic), with the existing SWIM bathymetry, allows to extend the bathymetry to the east. Additionally, the 2D seismic data provides a view of the subsurface over areas covered by this data.

First the sea floor horizon was mapped (“seismic bathymetry”) on seismc and the main fault segments correlated on each of the 2D seismic lines. Thereafter fault polygons were derived for the sea floor horizon. Since the seismic data is in two-way time the sea floor horizon had to be converted to depth before being integrated with the SWIM bathymetry. Following a data quality check the sets were merged in a GIS system into a common grid representing a single bathymetric map

The final map was obtained by complementing the fault polygon interpretation in areas with no seismic coverage through analysis of the SWIM bathymetry itself.

3. Results

The joint interpretation of both sets, 2D seismic data and bathymetric data, allowed the identification of the main structures that deformed the Plio-Quaternary sediments and the seafloor. The main morphostructures are the MPF, PSF, SVC, a set of thrust-faults recognized in the Príncipe de Avis Plateau and a set of N-S normal faults in the proximal margin of the Alentejo Basin and the Sagres Plateau.

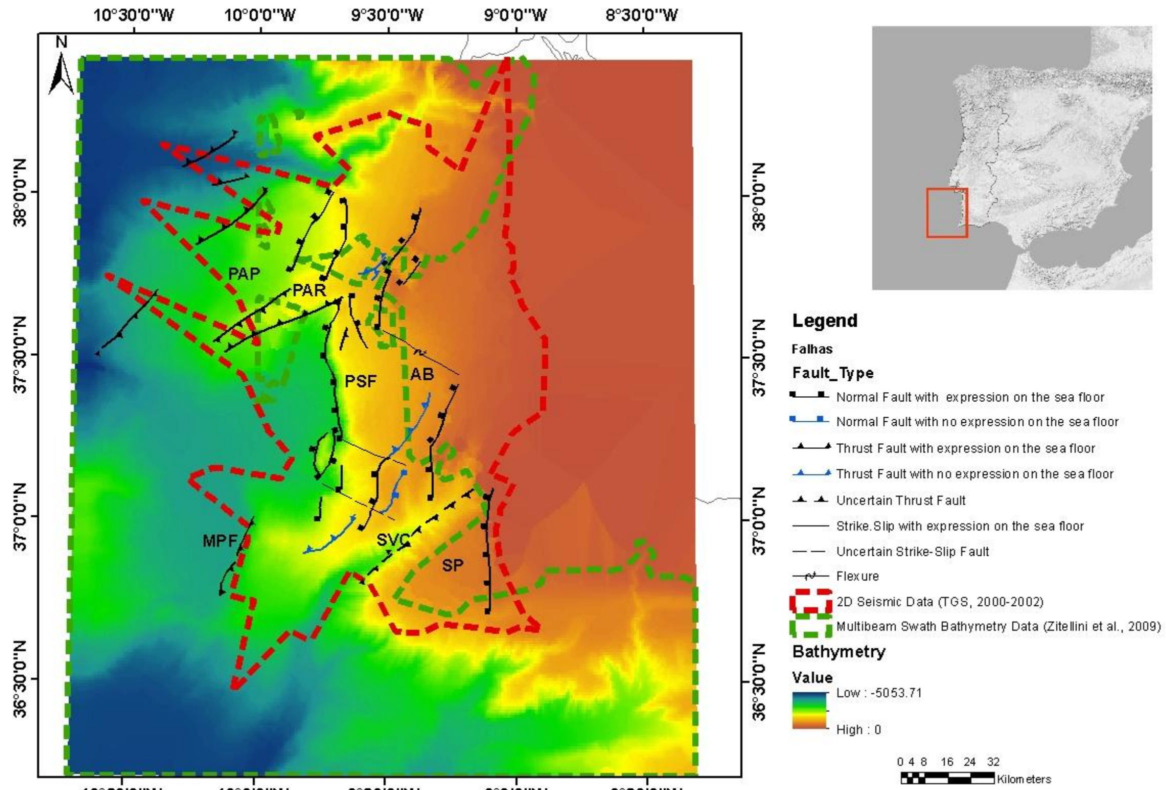

FIG.1 – Structural map of the SW Iberia Margin: **PAP** – Principe de Avis Plateau; **PAR** – Príncipe de Avis Ridge; PSF – Pereira de Sousa Fault; **MPF** – Marques de Pombal Fault; **SVC** – S. Vicent Canyon; **AB** – Alentejo Basin; **SP** - Sagres Plateau.

Clearly identifiable thrust faults with sea floor expression appear to be restricted to the west of the PSF alignment, normal faults are located in the Sagres Plateau which forms the proximal margin of the Alentejo Basin (sensu Alves et al., 2009) and in the NE end of Príncipe de Avis Plateau.

The MPF is a NNE-SSW thrust-fault dipping SE that offsets the seafloor producing a scarp about 1 km high. This fault acted as an extensional fault during the Mesozoic rifting phase related to the opening of the North Atlantic Ocean. During the Alpine compression phases at Palaeogene and Neogene, the MPF was inverted as a thrust-fault, showing evidences of Plio-Quaternary activity.

The PSF and Príncipe de Avis Plateau are relevant to better understand where the deformation is being accommodated since the Paleogene (FIG.1).

The PSF is an N-S trending steep normal-fault about 50 km long, cutting from the basement until the seafloor and forming an 1800 m high scarp. This fault is related to the Mesozoic rifting, creating accommodation space to Meso-Cenozoic sediments that reaches about 2600 m thickness in the footwall, against 3000 m in the hanging wall and there are evidences that it remained active until Plio-Quaternary.

The Príncipe de Avis Plateau is cut by a set of NNE-SSW to ENE-WSW thrust faults showing opposite vergence; these thrust faults have associated a group of minor blind faults, with the dominant vergence being NW. (FIG.1).

One of the main morphostructures identified in the Príncipe de Avis Plateau is the ENE-WSW Príncipe de Avis Ridge, a pop-up structure bounded by two opposite-dipping ENE-WSW thrust-faults. The southern thrust-fault intersects the northern culmination of the PSF. Considering the ENE-WSW trend shown by these faults, they could be ancient transfer-faults associated with the Mesozoic rifting.

The SVC seems to be controlled by a NE-SW fault which is probably a thrust.

There is a further group of thrust faults in the proximal margin of the Alentejo Basin which do not show any morphological expression, since their movements occurred until the beginning of Paleogene.

The set of N-S normal faults in Sagres Plateau and proximal margin of the Alentejo Basin were active until the beginning of the Paleogene.

4. Discussion and conclusion

Comparing the structural model propose in this work and the one presented by Terrinha et al. (2003) for this area, several remarks can be made: i) it is confirmed that the PSF is a normal-fault, probably still active, that consist of a Mesozoic extensional fault related to the rifting of the West Iberia Margin and was not reactivated as a thrust-fault during the Cenozoic; ii) there is no evidence in the seismic data of the WNW-ESE sinistral strike-slip faults that offset the PSF, as suggested by Terrinha et al. (2003). The possible existence of these faults could be suggested by the bathymetric data and the lack of continuity between the N-S normal faults in the southern end of this fault; iii) the thrust-faults that bound the pop-up structure, named Príncipe de Avis Ridge in this work, could be correlated with the TTR-10 and F1 faults mapped by Terrinha et al. (2003).

The N-S orientation and the deep and steep fault plane geometry that characterized the PSF probably prevent its reactivation as reverse-fault during the Cenozoic Alpine phases. The TTR-10 fault intercepts the PSF fault and is probably the reason why this fault ends abruptly. Conversely, the nearby MPF, also a Mesozoic normal rift fault, was reactivated as a reverse fault during the Cenozoic.

In the Príncipe de Avis Plateau area the Neogene compressive deformation seems to be accommodated by a succession of NNE-SSW to ENE-WSW blind thrust-faults.

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