Active tectonic and sedimentary processes along the São Vicente Canyon (SW Iberian Margin): High-Resolution Imaging

A. Vizcaino (1), E. Gràcia (1), R. Pallàs (2), P. Terrinha (3), S. Diez (4), J. Dañobeitia (1) and D, Masson (4)

(1) Unitat de Tecnologia Marina (CMIMA) - CSIC, Barcelona, Spain,
+34 93 2309500, alexis@utm.csic.es.
(2) Facultat de Geologia, Universitat de Barcelona, Barcelona, Spain,
(3) Faculdade de Lisboa, Dept. de Geologia, Lisboa, Portugal,
(4) Challenger Div. Seafloor Processes, Southampton Oceanography Centre, United Kingdom

1. Introduction

The SW Iberian Margin hosts the present-day boundary between the Eurasian and African Plates. Plate convergence of 4 mm/yr is accommodated over a large and diffuse deformation zone, characterized by significant and widespread seismic activity. The region is also the source of the largest earthquakes and tsunamis in Western Europe, such as the 1755 Lisbon event. One of the most prominent structures in this margin is the São Vicente Canyon (SVC), a deeply carved long conduit linking the Portuguese shelf and Horseshoe Abyssal Plain at 5000 m depth. The seafloor morphology and shallow structure of the SVC was the object of study as part of the HITS cruise on board the Spanish RV Hespérides (September, 2001).

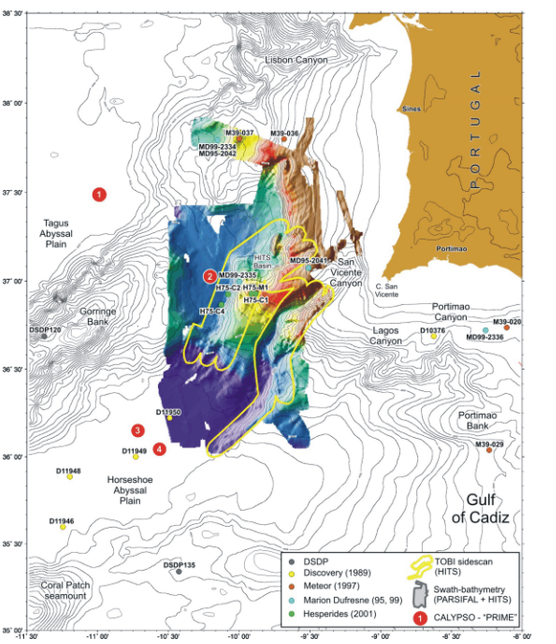

Fig. 1. Bathymetric map of the SW Portuguese Margin (contour 200 m). High-resolution swath-bathymetry survey is depicted in colour (Gràcia et al., 2003a). TOBI sidescan sonar data and piston cores longer than 1m acquired in the area are also located. Large filled circles correspond to the acquired CALYPSO giant piston corer sites

2. Results and Discussion

We present here our main results based on the analyses and integration of the newly acquired data: swath-bathymetry, TOBI sidescan sonar backscatter and high-resolution seismics.

The SVC is deeply incised in a large amplitude syncline bounded by active structures (the São Vicente Faults and Horseshoe Faults), as suggested by swarms of shallow to intermediate earthquakes and seafloor faulting ruptures. The SVC is over 100 km long, 20 km wide and with more than 1000 m of vertical relief on its highest part. The canyon has asymmetric and rectilinear flanks following three main segments, from North to South: the canyon head with a N030 trend, the central part with a N045 direction, and the canyon mouth trending N-S. The Horseshoe Fault, which delineates the east flank of the SVC at the Horseshoe Abyssal Plain, follows a main N43 direction. The TOBI image from the SVC shows a large variety of acoustic facies illustrating different tectono-sedimentary processes. The canyon floor is highly reflective and heterogeneous, where areas of coarse-grained bedload with chaotic seismic facies co-exist with localized outcrops of bared stratified rock-strata. The canyon flanks are mainly dominated by homogenous low reflectivity characteristic of hemipelagic sedimentation. However, high reflective areas and strong acoustic shadows are common towards the middle part and base of the canyon flanks, corresponding to incised gullies, landslide headscarps and mass wasting deposits..

3. Conclusions

Tectonic activity, submarine erosion and ephemeral sediment transport draining to the Horseshoe Abyssal Plain (HAP) defines the present-day morphostructure of the SVC. During the Holocene, the most likely mechanism of landslide triggering in the SW Iberian Margin is seismic activity. Thus, the mass wasting processes (turbidites and debris flows) filling the HAP may give us valuable information of the earthquake event history of the margin, which we are also studying as part of the ESF

EuroMargins SWIM project.
The authors are grateful for funding from MCYT Acción Especial HITS (REN2000-2150-E), European Commission EASSS-III programme (HPRI-CT99-0047), European Large Scale Facility (HPRI-CT2001-00120) and Spanish National Project IMPULS (REN2003-05996MAR).

4. References

[1] W.E. Smith, “Instrumentation”, Marcel Dekker, New York, 1998.
[2] L.W. Hi, Evolutions in Electronics Engineering, Proc. IMTC Meeting, Phoenix, 2005.
[1] D.F., Argus, Gordon, R.G., De Mets, C. & S,Stein, Closure of the Africa-Eurasia-North America Plate Motion Circuit and Tectonics of the Gloria Fault. Journal of Geophysical Research, 94, B5: 5585-5602. 1989.
[2] M.A. Baptista,., P.M.A., Miranda, J.M., Miranda, and L., Mendes Victor, Constrains on the source of the 1755 Lisbon Tsunami inferred from numerical modelling of historical data: J. Geodynamics, 25: 159-174. 1998.
[3] E., Buforn, C. Sanz de Galdeano and A. Udias Seismotectonics of the Ibero-Maghrebian region. Tectonophysics, 248: 247-261. (1995)
[4] N.L. Grimison, and W.P., Chen, The Azores-Gibraltar Plate Boundary: Focal Mechanisms, Dephts of Earthquakes and their Tectonic Implications. Journal of Geophysical Research, 91, B2, 2029-2047. 1986.
[5] E., Gràcia, J.J., Dañobeitia, and HITS cruise party,High-Resolution Imaging of Tsunamigenic Structures in the SW Iberian Margin (Eurasia-Africa Convergence): Implications for Seismic Hazard Assessment. EOS Trans AGU, 82(47), Fall meeting Suppl., San Francisco (USA), S51B-0610. 2001.
[6] E., Gràcia, J.J., Dañobeitia, J., Vergés, and R., Bartolomé, Crustal architecture and tectonic evolution of the Gulf of Cadiz (SW Iberian Margin) at the convergence of the Eurasian and African plates. Tectonics, 22 (4), 1033-1057 2003a.
[7] E., Gràcia, J.J., Dañobeitia, J., Vergés, and PARSIFAL Team, Mapping active faults offshore Portugal (36ºN-38ºN): Implications for seismic hazard assessment in the SW Iberian Margin. Geology, 31(1): 83-86. 2003b.
[8] R., Sartori, L. Torelli, N. Zitellini, D. Peis, and E. Lodolo, Eastern segment of the Azores-Gibraltar line (central-eastern Atlantic): An oceanic plate boundary with diffuse compressional deformation, Geology, 22:, 555-558. 1994.
[9] L., Torelli, R., Sartori, and N., Zitellini, The giant chaotic body in the Atlantic ocean off Gibraltar: new results from a deep seismic reflection survey. Marine and Petroleum Geology, 14: 125-138. 1997,
[10] N., Zitellini, L., Mendes Victor, D., Córdoba J.J.,, Dañobeitia, R., Nicolich G.,, Pellis, A., Ribeiro, R., Sartori, L., Torelli, and BIGSETS Team, Source of the 1755 Lisbon Earthquake and Tsunami Investigated. EOS Trans. AGU, 82: 285-290-291. 2001.

Georeferenced Photo-Mosaicing of the Seafloor

R. Garcia, X. Cufí, R. Prados, A. Elibol, J. Ferrer, M. Villanueva, T. Nicosevici

Computer Vision and Robotics Group, University of Girona,
Campus Montilivi, Edif. P-4, Girona, Spain, E-17003. Tel. +34 972 418881.
E-mail: rafa@eia.udg.es.

1. Introduction

Optical imaging provides to scientists high level of detail of the ocean floor. Unfortunately, underwater imaging has to face the problems related to the special transmission properties of the light in the aquatic medium, namely absorption and scattering [1]. These transmission properties of the medium cause blurring of image features and limited visual range [2, 3], restricting the practical coverage of a single image to only a few square meters.

Seafloor imagery is routinely acquired in near-bottom geophysical surveys with AUVs, ROVs or submersibles. Due to the large number of images and the lack of adequate tools to properly visualize these data, they are often under-utilized. If images are systematically acquired and properly aligned, a composite image that combines the set of frames taken from the camera can be built. This composite image is known in the literature as photo-mosaic, and can be used as a visual map for undersea exploration and research [4]. Seafloor photo-mosaicing is an important tool to study the structure and characteristics of the seafloor, providing a “panoramic” view of the interest area. They also provide the basis to carry out temporal studies of the floor, by comparing photo-mosaics taken at different times.

FOTOGEO is a research project funded by the Spanish Ministry of Science and Technology with the aim of developing new algorithms and techniques to build seafloor photo-mosaics. Specifically, the test bed of the project will be processing a large set of seafloor images collected over the Lucky Strike site during the LUSTRE’96 cruise [5]. This is one of the hydrothermal vent sites in the MOMAR area that is the focus of integrated studies to characterize active processes and their interactions at the axis of slow-spreading ridges. An ARGO II survey was carried out over the vent field (map), with N-S and E-W tracks spaced at ~50 m, with closer spacing over particular vent fields. A total of 20.000 black and white, electronic still images where recorded. At the same time, navigation data of the vehicle Argo II was acquired by means of an acoustic transponder network (LBL).