

# Large sediment waves on the Gulf of Valencia continental margin (NW Mediterranean): internal structure and evolution

**Marta Ribó<sup>1</sup>, Pere Puig<sup>1</sup>, David Van Rooij<sup>2</sup>, Araceli Muñoz<sup>3</sup> and Roger Urgeles<sup>1</sup>**

- 1 Institut de Ciències del Mar (ICM-CSIC), Pg. Marítim de la Barceloneta, 37-49, E-08003, Barcelona (Spain). [mribo@icm.csic.es](mailto:mribo@icm.csic.es)
- 2 Renard Centre of Marine Geology (RCMG), Dpt. Geology & Soil Science, Ghent University, Krijglaan 281 s-8, B-9000 Ghent, Belgium.
- 3 TRAGSATEC- Secretaria General de Pesca, Madrid, Spain

**Abstract:** Several fields of sediment waves have been recently observed over the Gulf of Valencia (NW Mediterranean) continental margin. Based on their morphology and internal structure, two different sets of sediment waves can be distinguished. Large sediment waves with 500 to 1000m wavelengths and 2 to 50m wave height are developed on the foreset region of the prograding margin clinoform, being found from 250 to 850m water depth. Additionally, over the outer shelf region, a second group of sediment waves also develops; displaying wavelengths in between 400 m and 800m and heights of 2 to 4m. Eustatic cycles control the development of the sediment waves on the outer continental shelf, which show several erosional truncations and growing stages. However, the sediment waves over the continental slope region seem to continuously evolve through time, at least since the Early/Lower Pliocene, without being affected by sea level changes.

**Key words:** NW Mediterranean, sediment waves, prograding margin, eustatic changes.

## INTRODUCTION

Sediment waves have been described all over the world in many different marine sedimentary environments. Few cases of sediment waves being developed on continental slope regions have been reported and described. Some of them were first misinterpreted as a result of gravitational slope failure. This is for example the case of the “Humbolt slide” (Lee et al., 2002) or the sediment undulations on the Landes Plateau (Faugères et al., 2002).

In the NW Mediterranean Sea, sediment undulations have been observed over the Gulf of Valencia continental slope and were also initially related to creep-like deformation (Díaz del Río et al., 1986). However, recently acquired swath bathymetry and seismic profiling data allowed determining that these sediment undulations are sediment waves. Contemporary hydrodynamic data of the study area have determined the presence of strong near-inertial internal wave activity (van Haren et al., 2013), which presumably is the most likely mechanism for the sediment wave development. This study offers new information for the morphological, stratigraphic and architectural characterization of these sediment waves, providing a record of internal wave activity throughout the Pliocene and Pleistocene.

## DATA

Detailed swath bathymetry data from the Valencia Trough (Fig. 1A) was used to analyze the geomorphology of the Gulf of Valencia continental margin, while the internal structure of the sedimentary prograding wedge was interpreted from a variety of seismic reflection profiles, providing different penetrations and resolutions. 3.5kHz parametric sub-

bottom profiles (TOPAS), single-channel (Sparker), and multi-channel (Airgun) seismic reflection profiles were used to analyze the continental slope sedimentary record (Fig. 1B).

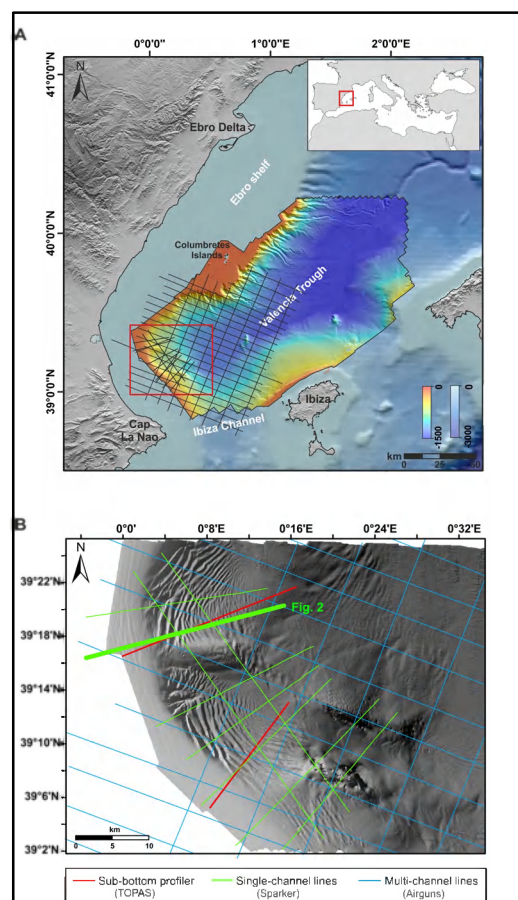


FIGURE 1. A) Bathymetric map from the Valencia Trough showing the study area (red square) and the grid of seismic profiles (solid lines). B) Shaded relief morphology of the study area indicating the different sources of the seismic reflection profiles used in this study.

## RESULTS AND DISCUSSION

Several fields of sediment waves occur over the Gulf of Valencia continental margin. The best developed sediment waves occur on the continental slope, from 250m depth to the continental rise, at 850m depth (Fig. 1B). Morphological parameters determined from the multibeam data show that the sediment wavelengths range between 500 and 1000m, with the largest ones observed on the uppermost part of the slope. Maximum wave heights of up to 50m are observed on the upper-slope, decreasing downslope to just 2m high in the continental rise. Analysis of their internal structure shows continuous internal reflectors, with waves merging down-section and sediment wave packages decreasing in thickness downslope (Fig. 2A). Sediment waves on the lower part of the slope are aggradational, and become up-slope migrating sediment waves on the upper part of the slope.

The outer continental shelf displays sediment waves that are smaller in length and height, ranging between 400 and 800 m and from 2 to 4m, respectively. These sediment waves show a clear up-slope migrating pattern. Several sediment depositional units can be distinguished in seismic reflection data. Some of these units show successive development of sediment waves, which are truncated by erosive surfaces, apparently linked to eustatic sea level oscillations (dark blue lines in Figure 2B). Such erosive surfaces can be followed downslope into conformable strata of the sediment waves on the slope.

Over the continental slope, apparent constant bedform growth is observed in the different units between two successive erosional unconformities (Fig. 2A), suggesting that sea level variations have not affected the sediment waves development. These conspicuous features are observed on the foreset region of the prograding margin clinoform, and have been preserved in the sedimentary record since the Early/Lower Pliocene. Assuming that internal wave activity is the main mechanism for sediment transport

and deposition over the Gulf of Valencia slope, and hence for the formation of these sediment waves, this oceanographic process might have been present in this sector of the margin almost since Zanclean reflooding of the Mediterranean Basin, following the Messinian desiccation event ~5.6Myrs ago (García-Castellanos et al., 2009).

## ACKNOWLEDGEMENTS

This research was supported by the projects COSTEM (CMT2009-07806) and FORMED (CGL2012-33989). M. Ribó is supported by a FPI grant (BES-2010-029949) from the Spanish Ministry of Economy and Competitiveness.

## REFERENCES

- Díaz del Río, V., Rey, J., Vegas, R., 1986. The Gulf of Valencia continental shelf: Extensional tectonics in Neogene and Quaternary sediments. *Marine Geology* 73, 169–179.
- Faugères, J.-C., Gonthier, E., Mulder, T., Kenyon, N., Cirac, P., Griboulard, R., Berné, S., Lesuavé, R., 2002. Multi-process generated sediment waves on the Landes Plateau (Bay of Biscay, North Atlantic). *Marine Geology* 182, 279–302.
- García-Castellanos, D., Estrada, F., Jiménez-Munt, I., Gorini, C., Fernández, M., Vergés, J., De Vicente, R., 2009. Catastrophic flood of the Mediterranean after the Messinian salinity crisis. *Nature* 462, 778–782.
- Lee, H.J., Syvitski, J.P.M., Parker, G., Orange, D., Locat, J., Hutton, E.W.H., Imran, J., 2002. Distinguishing sediment waves from slope failure deposits: field examples, including the “Humboldt slide”, and modelling results. *Marine Geology* 192, 79–104.
- Van Haren, H., Ribó, M., Puig, P., 2013. (Sub-)inertial wave boundary turbulence in the Gulf of Valencia. *Journal of Geophysical Research: Oceans* 118, 2067–2073.

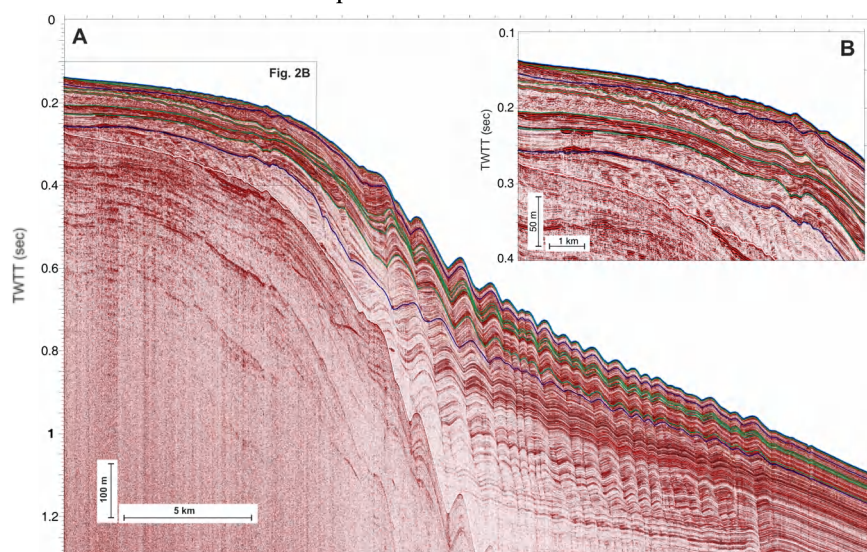


FIGURE 2. A) Single-channel line (Sparker) showing the two sets of sediment waves found on the Valencia continental margin. B) Detail of the various developing stages of the outer shelf sediment waves, truncated by erosional surfaces (dark blue lines). Dark green lines delimit the different sediment depositional units.