VERY LARGE SUBAQUEOUS DUNES ALONG AN OUTER CONTINENTAL SHELF (SOUTHERN EBRO CONTINENTAL SHELF; WESTERN MEDITERRANEAN SEA)

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Abstract
High resolution Multi Beam data and sediment samples were collected across the outer shelf region of the Columbretes Islands (Southern Ebro continental shelf, Western Mediterranean Sea). Very large subaqueous dunes were observed across relict sand bodies and their distribution and morphological characteristics have been analyzed to evaluate possible potential formation mechanisms. It is discussed that these bedforms could be produced by the action of the Liguro-Provencal-Catalan (LPC) geostrophic current, flowing southward and reaching very intense near-bottom curents when interacting with the local geomorphology of the study area.
Keywords: Continental Shelf, Geomorphology, Swath Mapping, Western Mediterranean

Large and very large subaqueous dunes [1] have been observed in a number of outer shelf regions around the world, usually developing on fossil sand bodies and ridges [2,3]. Dunes observed on outer shelves usually display large dimensions with maximum longitudes reaching up to 500 m and heights up to 20 m [3,4]. Forcing mechanisms able to induce their formation have been described as strong bottom currents related to tidal variations and water masses flowing under geostrophic conditions, usually controlled and enhanced by local geomorphologic configurations [2,3,5]. In this study, such bed features have been recognized around the Columbretes Islands, mapped and measured, with the aim to reconstruct which are the forcing processes that could generate them in relation to the local settings of the area.

Swath-bathymetry around the Columbretes Islands was collected using the Simrad EM-300 30 kHz (R/V Vizconde de Eza) and the Elac Seabeam 1050D 180 kHz (R/V Garcia del Cid) Multi Beam echo-sounders for a 50-400 m water depth range. Additionally, sediment samples were recovered by means of a Van-Veen grab and a HAPS corer, to carry out grain size analysis of surface sediments. Bathymetric data revealed the presence of three main relict sand bodies along the outer shelf, for a 80-116 m depth range, above which asymmetrical, slightly asymmetrical and symmetrical large and very large 2D and 3D subaqueous dunes were observed (Fig.1). Dunes range from 150 to 760 m in wavelength and from tens of cm to 6 m in height.

These bedforms are composed of sandy sediments, presumably coming from the degraded relict sand bodies on which they developed, mixed to fine fractions, coming from the recent draping holocenic sediments. The orientation of the dunes is SSW and progressively turns to W directions moving towards the southernmost sector of the area, following the trend of the shelf-edge. Observed dunes display a strong asymmetric profile for those occurring along the shelf-edge (Symmetry Index (SI): 2.6) and lose progressively their asymmetry towards the inner portion of the shelf (SI: 0.5), being 0.6 the minimum SI value to classify the dunes as asymmetric [6]. The subaqueous dunes observed along the studied region are amongst the largest ever recognized on an outer shelf setting. Morphologic characters and the orientation towards SW and W directions suggest the LPC current as the primary forcing factor in their formation.

Contemporary hydrodynamic measurement at the Ebro continental shelf-edge show that near-bottom wave action is negligible in this area, whereas maximum shear stresses induced by currents are able to resuspend fine sand particles and prevent the relict transgressive deposits from being covered by mud [7]. However, recorded values are below the critical shear stresses for transport the relict coarse sands found in the study area and form large bedforms. The comparison of successive bathymetric images and the aspect of the wavelenght-height regression curve suggest that the described very large dunes are inactive features over long periods, as observed in similar environments along several continental margins. Thus, the morphological configuration of the Columbretes outer shelf must have played a crucial role in enhancing the southward flowing bottom currents during energetic hydrodynamic events, giving them the potential to generate bedforms.

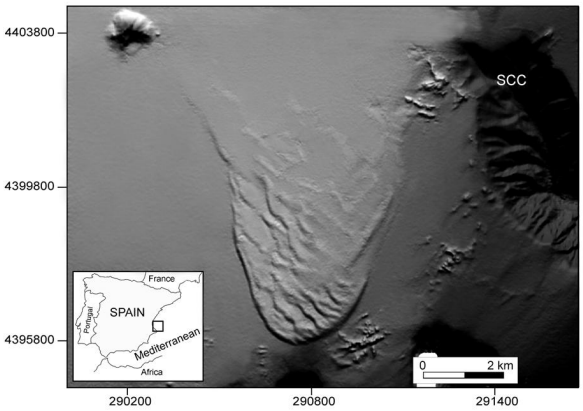

Fig. 1. Shaded relief image of large subaqueous dunes developed on relict sand bodies along the Columbretes outer shelf. SCC: Southern Columbretes Canyon.

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