Geophysical Research Abstracts
Vol. 19, EGU2017-18903, 2017
EGU General Assembly 2017

The Tethys Rifting of the Valencia Trough Basin

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The western Mediterranean submarine realm is composed of several basin inferred to be formed by a common geodynamic process: upper plate extension during slab rollback of a retreating subduction zone. Although the time evolution of the geometry of the trenches is debated, all models assume that basins opened sequentially from NW (Gulf of Lions) towards the SE (Ligurian-Provençal and later Tyrrhenian basins) and SW (Valencia Trough and later Algerian-South Balearic and Alboran Basin) as trenches migrated. Basin opening history is key to reconstruct kinematics of slab retreat preferred in each model. However, the deep structure of basins is inadequately known due to the paucity of modern wide-angle and multichannel reflection seismic studies across entire systems, and absence of deep drilling in the deep-water regions of the basins, as a result, much of the opening evolution is inferred from indirect evidence.

In the Valencia Trough Basin (VTB), drilling and vintage seismic data provide good knowledge of the shallow geology of the basin. However, crustal-scale information across the entire VTB has been limited to two studies (Figure 1): One in the late 80's (Valsis experiment) with three Expanded Spread Profiles that yielded local 1D velocity/depth models used to constrain 2D gravity modeling, and a few multichannel seismic profiles along the Iberian shelf and across segments of the basin. A second study in the early 90's (ESCI experiment) collected a low-resolution deep-penetration multichannel seismic reflection profile across the basin and a coincident wide-angle seismic line with numerous land stations in Iberia but a handful of widely-spaced Ocean Bottom Seismometers. In the absence of modern detailed crustal structure, the origin and evolution of the VTB is still debated.

Industry multichannel seismic reflection profiles cover the SW segment of the VTB. This is a region where the basin sea floor is comparatively shallower and has numerous industry wells reaching deep into the sediment sequence, which provides an unprecedented view of the tectonic structure and distribution of synrift deposits across the entire basin, from the Iberian to the North Balearic margin (Figure 2). Here we first show that the seismic records provide full crustal-scale information. Later we discuss the tectonic and sedimentary structure that supports that crustal stretching and basin formation of the VTB occurred fundamentally during the Mesozoic times by strike-slip tectonics and not during Tertiary times by back-arc extension. We show that the current sea floor morphological configuration giving rise to the so-called Valencia Trough does not represent the changes in crystalline basement thickness related to rifting, but fundamentally a product of sediment dynamics, particularly by the development during post-Messinian times of the Ebro-river delta. Our results are significant to understand Tethyan rifting and need to be considered for plate kinematic reconstructions of the western Mediterranean.