SEABED SEEPAGE IN THE MEDITERRANEAN SEA : WHAT DID WE LEARN FROM MULTIBEAM SWATH DATA AT DIFFERENT SCALES?

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Abstract

High-resolution swath data acquired using ship-borne and near-bottom multibeam systems have considerably increased our knowledge and understanding of active sea floor processes in the Mediterranean Sea. Swath mapping of large areas with ship-borne systems has revealed the regional distribution of seabed seepage structures in particular across the Eastern Mediterranean Sea deep-sea basins. Near-bottom multbeam data have revealed remarkable details of seabed features resulting from the expulsion of mud, fluid and gas. The latter data almost bridge the gap between ship-borne data and visual observations, and have been especially useful for planning in situ observations, measurements and sampling.

Keywords: Eastern Mediterranean, Swath Mapping, Mud Volcanoes

Multibeam seabed surveys conducted during the last decade in the Mediterranean Sea [1] have modified our understanding of the active geological and related biological processes that impact the seafloor of this oceanic space over time. One of the most spectacular results concerns the numerous seepage structures mapped and studied on the sea floor of the Eastern Mediterranean Sea, within two different tectonic settings: (a) tectono-sedimentary accretionary wedges (the Calabrian Arc and the Mediterranean and Florence rises) resulting from subduction of Africa beneath Europe [2] and (b) passive margin segments (particularly off northern Egypt) that have been the locus of huge sedimentary accumulations since Mesozoic times [3]. In this presentation, we briefly discuss and illustrate different types of data obtained using swath multibeam systems operated at different frequencies, and the potential level of interpretation they are providing to better image, study and understand the various fluid expulsion features and processes within the Eastern Mediterranean Sea. Multibeam systems provide two types of swath data: morpho-bathymetric data, and acoustic reflectivity (also often called backscatter or acoustic imagery). Swath data may be acquired using either ship-borne systems, typically located on research vessel's hull, or at much higher resolution using systems operating at near-bottom depths (10 to 50 m above the seabed), carried by Autonomous Underwater Vehicles (AUV) [4] or Remotely Operated Vehicles (ROV) [5] (Figure 1). - Swath bathymetric and acoustic imagery from ship-borne systems have allowed regional mapping of extensive fields of fluid escape structures, only some of which were previously known from either standard bathymetric mapping or discontinuous sonar studies. Compilation of data from numerous multibeam surveys [1] have provided regional maps at various scales (DTMs with pixel sizes ranging from 30-500 m depending on the area and the system used), which reveal the regional distribution of relatively large-scale features (a few hundred metres up to several km in diameter, and a few tens metres in elevation) such as mud volcanoes, mud flows, gas chimneys and caldera-like features [2,3]. These results have afforded insights into the relationship between seepage structures and the regional tectonic framework. For example, a clear link between back-thrusting and the distribution of mud volcanoes on the Mediterranean Ridge implies a fundamental role of tectonic lineaments as conduits for mud and fluid expulsion [2]. Similarly the non-random distribution of gas chimneys along the Egyptian continental margin may be explained by specific regional characteristics such as the presence or absence of underlying seals (Messinian salt deposits), the occurrence or lack of buried organic-rich deposits, and the re-activation of former fault zones [3]. In addition to regional mapping, ship-borne swath data have provided the necessary morphologic and acoustic backgrounds to better locate "in situ" studies of active fluid seepage using manned submersibles (e.g. the Nautile from Ifremer) [5] and/or ROVs (the Victor from Ifremer or the Quest from Marum) [4] - High-resolution swath data from near-bottom multibeam systems were first recorded over seabed seepage features in the Mediterranean Sea only 4 years ago (at least on the academic side). On the Egyptian continental margin, the first use of a multibeam system mounted on an Autonomous Underwater Vehicle (AUV) allowed the construction of morpho-bathymetric and backscatter maps with 1 m pixel resolution from mud volcanoes in water depths of 1200 m [4]. Elsewhere on the Egyptian margin, maps with pixel sizes of 30 cm have recently been obtained using a ROV over two active mud volcanoes in water depths of 3000 m. These data provide new insights into the functioning of fluid escape structures and facilitate in situ samplings and measurements at high accuracy. The acquisition of seafloor bathymetric and acoustic imagery of such high-resolution almost fills the gap in spatial scale between conventional ship-borne multibeam data and in situ direct or video observations made from submersibles or remotely operated vehicles.

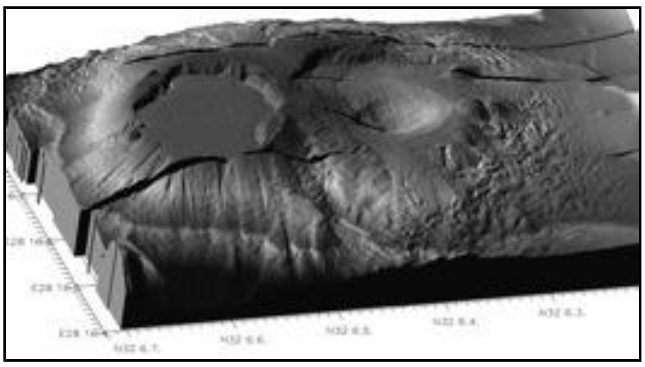

Fig. 1. 3D high-resolution bathymetry view of "Chephren" twin mud volcanoes (1m grid) by 3000 m water depth (Northern Egyptian Margin) acquired with a multibeam mounted on the Victor ROV and operated at 400 kHz.

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