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Morphometric, acoustic and lithofacies characterization of mud volcanoes in the Eastern Mediterranean: Toward a new approach and classification to constrain the regional distribution and activity of mud volcanoes?

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On continental margins, several types of seabed features recording fluid circulation within the sediment column have already been recognized, including mud volcanoes, pockmarks, carbonates pavements and/or mounds and brine lakes. They can be associated to (a) thermogenic or biogenic fluids migrating along tectonic conduits, (b) dissociation of gas hydrates, or (c) dewatering of turbidite channels and mass-transport deposits. Although fluid-escape structures have been analyzed for the last two decades using diverse and complementary data, many questions are still debated about their morphologies/architectures, origin and formation, their temporal dynamic and the impact of the geodynamical context on their location/formation.
In the Eastern Mediterranean, fluid seepages and in particular mud volcanoes, were identified in three geodynamical contexts including active margins (Calabrian accretionary prism and Mediterranean ridge) and highly-sedimented passive margin (Nil deep-sea fan). In this study, we follow a new approach allowing to (1) better quantify a broad set of morphological parameters that characterize the seabed fluid-escape structures, (2) propose an advance classification of these structures, the final goal being to test whether one or several morphological types of fluid-escape structures can be characteristic of one tectonic and sedimentological setting in the Eastern Mediterranean basin.
To achieve this classification based on geophysical and geological analysis (morphometry, reflectivity, seismic r and lithofacies features), we used a broad homogenous dataset at the scale of the Eastern Mediterranean, including multibeam bathymetry, acoustic backscatter, 2D/3D seismic reflection, and sediment cores description and analysis. More than 500 mud volcano-like structures were identified based on one criterion or on the association of several criteria, while 40 of them were clearly proved to be mud volcanoes by coring. These structures exhibit different morphologies and architectures representing end members: conical, with or without a caldera (empty or filled-up with a brine lake), to flat, circular to elongate. Identification of local mud flows on the flanks and/or the base of some mud volcanoes attest of different types of extrusive activity. Cored mud flows revealed the variety of mud breccia characteristics: a new methodology of analysis of the morphologies of mud-breccia clasts, their sizes and distribution is undertaken using X-rays images.
This new approach revealed as a first observation that some types of mud volcanoes are more or less homogeneously scattered at the scale of Eastern Mediterranean while other types are more specifically located in a single area. In every studied area, mud volcanoes exhibit or not mud flows at the seafloor or shortly beneath, suggesting that their activity can change over short time periods and distances. Lithofacies evolving from two end-members, mousse-like to breccia, also revealed drastic changes of the type of activity in and between the studied areas.