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Imaging shallow migration pathways in a mud-volcano province using an autonomous underwater vehicle towing source and an array of hydrophones (Malta Plateau, Mediterranean Sea)

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In the submarine environment, the identification and characterization of macro-seeps requires support of geophysical remote-sensing techniques. In our work, data acquired by an Autonomous Underwater Vehicle (AUV) towing a source (1600 Hz – 3500 Hz) and an horizontal array of hydrophones have been analysed to image discrete, isolated or even a small cluster of scatterers within the sediment, to determine shallow migration paths of hydrocarbons in a mud-volcano system in the Malta Plateau (MP). The AUV source and receiver were towed close to (about 18 m above) the seafloor, permitting a horizontal resolution of roughly 3-5 m and 5-10 m resolution in the vertical, with an acoustic penetration of about 100 m. An algorithm based on a semblance function was applied to the acoustic data to highlight scatterers rather than interface reflections. The resulting scatterer map, obtained along the AUV track, provides a pseudo-3D coverage of the study area. This map was combined with high-resolution bathymetric and backscattering seafloor maps generated by previous explorations. This integrated dataset provides new evidence for the role of fault zones as a preferential path for gas/fluid migration and reveals the intermittent activity of seeping gas. The data show, in particular, that gas bubble slugs, i.e. discontinuous gas columns, rise through Plio-quaternary sediments along a complex system of conduits terminating at the surface into quiescent mud volcanoes.