EVIDENCE OF ACTIVE MUD VOLCANOES ON THE CALABRIAN ACCRETIONARY PRISM, IONIAN SEA

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Abstract

Multidisciplinary studies of mud volcanoes at two sites on the Calabrian Arc provide evidence of post-glacial eruptions, and of ongoing seabed seepage that supports 'hotspot' ecosystems. Mud breccias within gravity cores record at least one extrusive episode since the last glacial maximum c. 20 ka. Seabed investigations using ROVs document ongoing seepage of gas, at one of the sites associated with chemosynthetic ecosystems and with localized outflows of warm mud. Gas hydrates are theoretically stable on the Calabrian Arc and their post-glacial destabilization represents a possible driver of seabed extrusive and seepage activity.

Keywords: Eastern Mediterranean, Ionian Sea, Deep Sea Sediments, Mud Volcanoes

Mud volcanoes were discovered offshore southern Italy during the 2005 HERMES-HYDRAMED campaign of the Italian research vessel OGS Explora, which acquired the first regional multibeam coverage of the Calabrian accretionary prism [1]. Many possible seepage sites were recognised [see 2], of which two were proven to be mud volcanoes through the acquisition of multichannel seismic data and gravity cores containing mud breccias. Seabed investigations of these two sites were subsequently undertaken using remotely operated vehicles (ROVs) during campaigns of the r/v Meteor (M70/1, 2006) and the r/v Pourquoi pas? (MEDECO, 2007). In this presentation we summarise evidence for recent eruptions and ongoing seabed seepage.

The two investigated sites lie in water depths of 1600-2300 m on the inner and central Calabrian Arc. Within the inner Spartivento forearc basin, the Madonna dello Ionio comprises three MVs, twin cones each up to 140 m high and 1.5 km wide, and a caldera up to 3 km across. On the central thrust-fold belt, the Pythagoras MV is a single mud pie up to 9 km wide, rising up to 350 m above a seabed moat. Seismic data grids across both features show the seabed mud volcanoes to be the tops of extrusive edifices that extend over 1 km into the subsurface and interfinger with the flanking sedimentary succession above a regional unconformity of mid-Pliocene age, c. 3.5-3.0 Ma [3].

Recent extrusive activity is indicated by sediment cores from the Madonna dello Ionio and Pythagoras MVs that show oxidized mud breccias to lie near seabed, beneath a veneer of hemipelagic sediments. At the Madonna dello Ionio MVs, mud breccias have erupted since the last glacial maximum (c. 20 ka), based on radiometric dating and stratigraphic markers within the hemipelagic sediments. In the caldera at the head of the Madonna, mud breccias are overlain by sediments dated to c. 15.5 ka, and appear correlative to a mud breccia lens in a nearby core 1 km from the edge of the caldera. A younger extrusive episode may be recorded by mud breccias at the base of one of the twin cones of the Madonna which are overlain by marine sediments dated to c. 2 ka.

Seabed investigations using ROVs (video observations, geothermal probes, sediment and water samples) provide evidence of ongoing seepage. At both sites, bottom waters contain methane concentrations 100-200 times normal background levels. At the Madonna dello Ionio, all three MVs have elevated geothermal gradients, 2-20 times higher than adjacent areas, and fresh outflows of warm mud were observed on two of the MVs. The tops of all three MVs are otherwise characterized by a metre-scale relief comprising mud breccia flows mantled by hemipelagic sediments, the latter exhibiting intense bioturbation in the form of conical burrows; a 30 cm blade core contained chemolithotrophic tubeworms (polychaetes) and other fauna consistent with reduced conditions. At the Pythagoras MV, an area of chaotic seabed, with irregular relief developed in exposed mud breccias, suggests a recent and violent local extrusive episode.

Glacial-interglacial changes in sea level and bottom water temperatures suggest a possible climatic influence on mud volcanism. Gas hydrates are theoretically stable on the Calabrian Arc and their post-glacial destabilisation in response to warming bottom waters could provide a driving mechanism for recent eruptions and ongoing seepage.

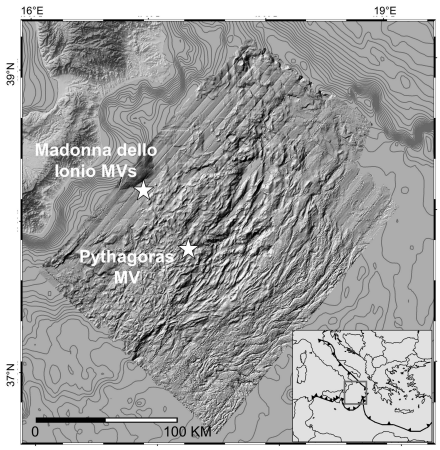

Fig. 1. Location of investigated sites of mud volcanism on the Calabrian Arc

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