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Fluid seepage on continental margins: recent results from the Nile deep sea fan and the Gulf of Cadiz continental slope

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This work addresses fluid seepage structures and processes in two distinct geographical and geological settings, the Nile deep sea fan and the Gulf of Cadiz continental slope, investigated within the framework of the multidisciplinary MEDIFLUX and MVSEIS Euromargins Collaborative Research Projects.

The Nile deep sea fan (NDSF) is a thick sedimentary wedge constructed chiefly since late Miocene by terrigenous sediments delivered by the Nile river. The total sedimentary thickness probably reaches 9-10 km, including up to 2 km of Messinian evaporites. Deep faulting creates pathways for fluid migration from deeply buried sediments. As part of the Euromargins MEDIFLUX Project, two recent cruises, the NAUTINIL expedition of R/V L'Atalante (2003) with submersible Nautile and the MIMES expedition of R/V Pelagia (2004) with deep-towed sonar Edgetech, have collected an ample set of near-bottom and sea floor observations that document a high activity of fluid seepage throughout the NDSF. Menes Caldeira, at a depth of 3000 m in the western region of the NDSF, is one of the most interesting sites, with a brine accumulation over 250 m deep, at a temperature throughout of 57 deg C, in a crater pool on the summit of Chefren mud cone. Fluid seepage is observed under a variety of forms in the NDSF, being associated with geological structures ranging from large gas chimneys and mud pies (several kilometers across) to smaller mud cones and pockmarks (tens to hundreds of meters across). Biogenic and thermogenic hydrocarbon gases are emitted

at seeps, generating chemical plumes in the water column and active biochemical processes at the water-sediment interface. The NDSF adds new observational evidences for a large activity of fluid seepage in the eastern Mediterranean basin, other areas of previous or current studies including the Mediterranean Ridge south of Crete and the Anaximander Mountains south of Turkey.

The Gulf of Cadiz is located in an area of intense tectonic deformation and seismicity close to the Açores-Gibraltar plate boundary. Seafloor-mapping results point to a dense distribution of mud volcanoes (30 confirmed by coring), diapiric ridges, pockmarks and broad areas with carbonate pavements. Methane gas hydrate with a thermogenic origin of the gas has been sampled in near seafloor sediments at three mud volcanoes (Ginsburg, Captain Arutyunov and Bonjardin), which suggests active degassing through the seafloor. Several cruises in this area since 1999 have considerably documented fluid seepage activity. As part of the Euromargins MVSEIS Project, recent cruises (CADIPOR, 2002; GAP, 2003; DELILA, 2004; TTR-14, 2004), complemented by the Portuguese MATESPRO Expedition (2004), have placed new constraints on the geological control of fluid seepage. Authigenic carbonates are mainly found along seafloor ridges close to the Main Channel of the Mediterranean Outflow. Geomicrobiological and isotopic studies have revealed the importance of bacteria-mediated anaerobic methane oxidation and sulfate reduction in the formation of carbonates.