GEOPHYSICAL SIGNATURE FOR SEEPAGE ACTIVITY AT THE MENES CALDERA: AN EXCEPTIONAL SITE OF BRINE, GAS AND MUD EXPULSIONS IN THE DEEP WATERS OFF NORTH-WESTERN EGYPT

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Abstract

The Nile Deep Sea Fan hosts numerous active fluid escape structures associated with large gas emitting mud volcanoes, authigenic carbonates, pockmarks and briny mud volcanoes. During the Medeco2 expedition (HERMES Program), some of these seeps were investigated with the research vessel Pourquoi pas?. Subbottom profilers and water column imageries were acquired with a CHIRP and an EA600 echosounder. Near bottom geophysical investigations were conducted with the use of the Victor ROV that was equipped with 1) a Reson 7125 multibeam system for high-resolution bathymetry and backscatter seafloor imagery and 2) an OTUS camera for black and white imaging. We present here the geophysical characterization of the large mud volcano Menes caldera complex located in the Western Nile Province.

Keywords: Deep Sea Processes, Eastern Mediterranean, Geophysics, Mud Volcanoes

The Menes Caldera discovered on the foot of the northwestern Egyptian continental slope [1, 2] was surveyed in 2007 in great details with in particular the use of the Victor ROV for near bottom geophysical surveys and in situ samplings and measurements. The dataset previously acquired [1, 2] was completed by geophysical imageries of the sediments, the seabed and the water column.

Extending by 3000 m water depths with a diameter of ~8 km, the Menes Caldera contains several active mud volcanoes. Chephren and Cheops mud volcanoes located in the south and roughly in the centre of the caldera, respectively, are the most spectacular.

The Chephren structure is composed of two craters of 250 to 300 m in diameter each. The northern crater is filled up with muddy brine sediments. Within this brine lake, salinity reaches high values (120 to 145 psu). Gas analysis in the water column revealed high methane concentrations, 0.4 to 5.6 mmol/l. The temperatures within the lake indicate uniform values with depth, reaching ~60°C. In contrast, the southern crater is relatively cold with thermal gradients similar to background values. This crater 10 to 20 metres deep corresponds to a former brine lake that is at present inactive in terms of brine seepage. Running outflows emitted from the northern brine lake are visible all around the mud volcano with the most recent activity located at the northern side. The seepage activity there corresponds to highly unstable seafloor environment. The fauna is mostly restricted within the close periphery of the brine lake. The small and narrow subcircular plateaus that composed the upper part of the crater attracts many crabs and polychaete tubeworms. Within the brine lake, the less unstable areas appear to be characterized by dense accumulation of white filaments that correspond to sulfur associated with arcobater, sulphide oxidizing bacteria (Boetius et al.).

Cheops mud volcano, similarly to Chephren, exhibits high salinity values and methane concentrations (respectively 210 to 240 psu and 2.4 to 3.7 mmol/l). Cheops mud volcano, with an average diameter of ~250m, is composed of a brine lake surrounded by an almost continuous depression ring, covered in some places with recent outflows. This latter probably corresponds to a former edge of the lake. As previously suspected by [2], the inner domain of this mud volcano correlates with an almost flat top where numerous muddy brine pools, decimetre to metre in scale and covered by whitish filaments, were observed at the surface of the lake. An average temperature of ~43°C was recorded from the surface of the lake down to 440m through a very unconsolidated material. The uniformity of the temperature profile with depth clearly supports the occurrence of first order active convection within a mud/brine/fluid conduit.

The newly acquired geophysical dataset and high-resolution seabed photographic images brought more details, in particular, in the seabed morphology and spatial distribution of the seepage activity. The seepage activity is not restricted to the major mud volcanoes. The entire caldera is disturbed by fluids associated in depth with numerous faults and fractures and at the seabed with brine-related features. Acoustic anomalies were detected in the water column using the 38 kHz echosounder of the R/V Pourquoi pas?. An echo contiguous to the seafloor was recorded up to 600 m above the seafloor at the south-western border of the Menes. This acoustic anomaly is interpreted as a gas flare associated with a listric fault in relation with salt tectonics.

References

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