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Organic Geochemistry of Sediments, Interstitial Fluids and Light Volatile Hydrocarbon Gases from Giza and North Alex Mud Volcanoes, Western Nile Deep-Sea Fan

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The West Nile Delta Project is a multi-disciplinary research project lead at IFM-GEOMAR (Kiel, Germany) and funded by RWE-DEA (Hamburg, Germany). It aims at investigating the sources and transport mechanisms of fluids and hydrocarbon gases seeping at two mud volcanoes (MVs) of the western Nile Deep-Sea Fan: North Alex and Giza MVs, and at the long-term monitoring of the seepage activity at these sites [1,2]. A comparative study of the organic geochemistry of sediments, gases and fluids was carried out in order to constrain (i) the sources of fluids, mud and gases erupted at these cold seeps, and (ii) the microbial hydrocarbon-oxidation processes associated with the extrusion of mud and gases. The molecular and stable isotope composition of light volatile hydrocarbon gases stripped from pore fluids reveal a clear thermogenic origin at the less active Giza MV and at the active centre of N. Alex MV. However, they probably originate from different sources, as shown by the distinct [U+F064]13C-CH4 values of $\sim$ -45%■ and -37%■VPDB at North Alex and Giza MVs, respectively, while [U+F064]2H-CH4 values are similar ($\sim$ -228%■VSMOW). Away from the centre at North Alex MV the gases have variable compositions and are mainly produced by Archaea microbes. The microbial production of CH4 is probably sustained by the high content of the mud breccia sediments in labile organic matter. Indeed Total Organic Carbon content values are high ($\sim$ 1 and 2%weight) in MV sediments from both sites as well as at the reference site away from Giza MV, suggesting a main shallow (Plio-Pleistocene) sedimentary source. Consistently, the sedimentary lipids contain high amounts of compounds typically issued from terrestrial plants such as [U+F062]-amyrin and nC26:0 to nC30:0 fatty acids & alkenols. The hypothesis that labile terrestrial organic matter sustains intense microbial activity in the mud volcano sediments is supported by the extreme enrichment of pore fluids in a suite of Volatile Fatty Acids, in particular in acetic acid with values as high as 1 to 2mM at and near the centre of N. Alex MV. Additionally, the lipids extracted from MV sediments contain long-chain n-alkanes and biomarker compounds typically related to the presence of petroleum or bitumen as well as compounds associated with microbial communities living from the Anaerobic Oxidation of Methane. A large variety of these compounds have however been observed at the MVs, and their concentrations are quite variable as well. Here we present the results of multivariate statistical analyses applied to an extensive data set. Complementarily, Compound-Specific-Isotope-Analysis techniques have been used to study the origin of pore water Volatile Fatty Acids and of selected lipid biomarkers at Giza and North Alex MVs. Last, the information provided by geophysical imaging and heat flux measurements performed in the context of the West Nile Delta Project [1] has been taken into account to interpret the complex biogeochemical processes taking place at the MVs.

[1] Feseker et al. (2008) RV Poseidon cruise report ISSN 1614-6298, IFM-GEOMAR, Kiel (Germany).
[2] Bialas & Br¨ckmann (2008) RV Pelagia 64PE298 WND Project cruise report, IFM-GEOMAR, Kiel (Germany), 52p.