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Discovery of ferromanganese hydrocarbon-related nodules associated with the Meknes mud volcano (Western Moroccan margin)

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A suite of ferromanganese nodules were sampled during the MVSEIS-2008 cruise aboard of the R/V Hespérides in the flanks of Meknes mud volcano (Moroccan margin, NE Central Atlantic). The nodules were collected at water depths between 750-850 m within a seabed area characterized by high acoustic backscatter values. Debris of cold water corals and hydrocarbon-derived authigenic carbonate crusts were sampled at same time. The nodules show tabular morphology, up to 20 cm in maximum diameter and 2 kg of weight, brown-reddish external color and they are internally composed by a concentric to complex arrangement of laminae. The results of X-ray diffraction analysis show that these ferromanganese nodules are essentially composed of goethite and lepidocrocite, being Mn-oxides, silicates (quartz and clay minerals) and carbonates (calcite, dolomite and siderite) accessory to occasional minerals. All the samples display micritic to micro-sparitic mosaic under the petrographic microscope which forms massive, laminated or dendritic-mottled textures. The nodules show a high abundance of Fe, minor Mn and low contents of trace metals and REEs. Mature hydrocarbons, as n-alkanes derived from marine bacterial activity, and phenanthrene have been detected in all the ferromanganese nodules analyzed.

These nodules display analogous characteristics (textural, mineralogical and geochemical) to the nodules studied by González et al (2009) in the carbonate mud-mounds in the Gulf of Cadiz, offshore Iberian margin. In this way, the same preliminary genetic model proposed for these nodules might be applicable to those find in the Meknes mud volcano. Therefore, the anaerobic oxidation of hydrocarbon-rich fluids within the mud-breccia sediments in the flanks of Meknes mud volcano would induce the formation of early diagenetic Fe-(Mn) carbonate nodules. Thus, the nodules were later exhumed by the erosive action of sea bottom currents generating the replacement of ferromanganese carbonates by Fe-Mn oxy-hydroxides. Thus, the hydrocarbon-rich fluid venting from deep seated reservoirs and erosive action of bottom currents must have been essential actors, as mineralization controls, for ferromanganese nodules generation and evolution.

These findings imply that this type of nodules must be considered as new product as derived from the anaerobic/aerobic oxidation of hydrocarbons in areas of active seepages.

Reference:
González, F.J., Somoza, L., Lunar, R., Martínez-Frías, J., Martín Rubí, J.A., Torres, T., Ortiz, J.E., Díaz del Río, V., Pinheiro, L.M., Magalhães, V.H., 2009. Hydrocarbon-derived ferromanganese nodules in carbonate-mud mounds from the Gulf of Cadiz: mud-breccia sediments and clasts as nucleation sites. Marine Geology 261, 64-81.