MINERALOGY AND GEOCHEMISTRY OF THE DIAGENETIC CARBONATE CRUSTS FROM THE MUD VOLCANOES OF THE NILE DEEP-SEA FAN

S. Gontharet [1], C. Pierre [1] *, M.M. Blanc-Valleron [2], J.M. Rouchy [2], Y. Fouquet [3], G. Bayon [3] and the NAUTINIL scientific party

[1] UPMC, LODYC, 4 Place Jussieu, 75252 Paris Cedex 05, France
[2] MNHN, Laboratoire de Géologie, 43 rue Buffon, 75005 Paris, France
[3] IFREMER, Centre de Brest, Géosciences Marines, Plouzané, 29280, France

Abstract

Carbonate crusts and concretions associated with mud volcanoes from the Nile deep-sea fan were recovered during the NAUTINIL cruise. These authigenic carbonates consist mainly of aragonite and Mg-calcite and of minor dolomite. The wide range of the oxygen and carbon isotopic compositions of these carbonates indicate variable sources of deep fluids providing methane which is oxidized by microbial processes either through bacterial sulfate-reduction within the sediment or via bacterial aerobic oxidation at the sea floor.

Keywords: Nile deep sea fan, mud volcano, diagenetic carbonate, oxygen and carbon isotopes

During the NAUTINIL cruise (September -October 2003), 22 submersible dives have been realized in the Nile deep-sea fan area. The main objective of this cruise was to investigate by a multidisciplinary approach, selected mud volcanoes which are very abundant and of various morphologies in the whole area (1). The deepest site (3019 m) located in the western part of the deep-sea fan, corresponds to a large caldera (about 8 km of diameter) where brines are seeping along the flanks of the structure and are sometimes collected in pools and lakes. The other sites in the central and eastern parts of the deep-sea fan correspond respectively to pock-marks located at 2120 m and to a mud volcano located at 1130 m where active ventings of fluids were identified by the presence of living benthic organisms (mainly vestimentiferan worms; rarely bivalves). At these three sites, hard carbonate crusts cover irregularly the sea floor and are sometimes present as dispersed fragments within the topmost sediments. The sediments from the venting areas are organic-rich and have a strong H_2S smell which is indicative of active sulfato-reduction. The petrographic observations and XRD analyses of the carbonate crusts indicate that aragonite, calcite, Mg-calcite are the dominant authigenic carbonate phases with a minor contribution of dolomite. The oxygen and carbon isotopic compositions of the bulk carbonate exibit very large variations ($-2.67 < \delta^{18}O$ ‰ PDB < 3.87 ; $-37.97 < \delta^{13}C$ ‰ PDB < 2.96). The distribution of the isotopic values is explained by the mixing of the authigenic carbonate with the sedimentary matrix which corresponds itself to a mixture of pelagic sediment and mud breccia issued from the mud volcano activity. The rather large range of $\delta^{18}O$ values might reflect variable sources of fluids, a ^{18}O-rich deep source and a ^{18}O-poor continental source. Typically, the very low $\delta^{13}C$ values of the diagenetic carbonates indicate that methane was the major source carbon which was oxidized as CO_2 either through bacterial sulfate-reduction within the sediment or via bacterial aerobic oxidation at the sea floor. Similar isotopic values were previously measured in the diagenetic carbonate crusts from the mud volcanoes of the Mediterranean Ridge area (2) as well as in other areas of cold seeps outside the Mediterranean sea (for instance Gulf of Mexico, Cascadia margin, Barbados prism).

References

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