# *REE* geochemistry in nodule formation processes in surface sediments of Guatemala Deep, Pacific Ocean.

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## Introduction

The problem of nodule formation can be connected to a considerable extent with postdeposional phase transformations in sediments. This information may be obtained from *REE*. Previous studies have shown that *REE* scavenged by hydrogenous Fe oxyhydroxides have positive Ce anomaly and more abundance in *LREE*. On the contrary hydrothermal Fe oxyhydroxides uptake *REE* from seawater with negative Ce anomaly and depletion in *LREE*. On the base of this difference in *REE* patterns the fate of Fe oxyhydroxides in the sediments with hydrothermal input during diagenesis can be considered. This study describes *REE* behaviour in sediments, nodules and micronodules (MN) of Guatemala Deep.

## Methods.

Sediments and nodules of station 3874 (630.2'N, 9246.95'W, depth 3610 m) were recovered during R/V 'Dm.Mendeleev' expedition in 1988. Micronodules of three fractions (0.1-0.25, 0.25-0.5 and >0.5 mm) from sediments (0-2 cm) presented by clayey siliceous oozes were hand-picked. *REE* content were determined by ICP-MS method (Dubinin, 1993). Accuracy was monitored by standard reference samples BCR-1, SDO-7, SDO-9 and precision was better than 5%. Fe, Mn, Al, Co, Ni, Cu were analyzed in this samples by AAS and P was determined by spectrophotometrically. In order to study Fe and Mn oxyhydroxide composition in sediments, nodule and micronodules they were treated by 1M hydroxilamin + 25% acetic acid (Chester, Hughes, 1967).

## Results and discussion.

Surface sediment of st.3874 is enriched in Mn (4.13%) while other elements have normal concentrations for sediments from this area. The enrichment of Mn can be resulted from both the processes of suboxic diagenesis and the input of hydrothermal Mn to the sediments. Fe-Mn deposits are also enriched in Mn, Mn/Fe in nodule 16, in MN 16-21.

*REE* compositions of sediment, nodule, MN and their leachates were shown on Ce/Ce* *vs.* *LREE/HREE* plot (Fig. 1), where $Ce/Ce^* = 2Ce'/(La' + Nd')$ and $LREE/HREE = (La' + Pr' + Nd')/(Er' + Tm' + Yb' + Lu')$. Ln' is a lanthanide content normalized to shale (NASC). From MN to sediment negative Ce anomaly increases with the depletion in *LREE*. For labile fraction these differences in *REE* composition are more significant and their increasing demonstrates that the cause of these differences are in the labile fraction composition.

The *REE* contents in sediment (sum of *REE* 140 ppm) are higher than in nodule (126 ppm) and MN (98–110 ppm). In the Fe-Mn deposits 84–90% of bulk *REE* content were found in their leachates. Only 68% of total *REE* were leached from the sediment. The amount of leached *REE* is correlated with that of Fe and Al, although their amounts are lower: 66–76% Fe and 32–56% Al for Fe-Mn deposits and 29% Fe and 14% Al for sediment. In the MN 93–95% P is in the leachate, but in the nodule only 51% P can be leached. Total P content varies from 0.13 to 0.16% for MN and nodule. From our data P in sediments to a considerable extent is connected with Fe oxyhydroxides.

From (Dymond *et al.*, 1984 and Murphy, Dymond, 1984) one can see that *REE* in nodules from Guatemala Deep close correlate with Fe. Therefore, the *REE* composition in labile fraction of sediment, nodule and MN may depend on Fe oxyhydroxide origin. Gradual changing of *REE* composition from sediment to fine fraction of MN can be resulted from the common source and different mobility of hydrothermal and hydrogenous Fe oxyhydroxides during diagenesis. *REE* composition of MN is influenced by greater participation of hydrogenous material. During MN and nodule accretion *REE* composition tends to that in labile fractions of sediments. *REE* pattern of hydrogenous crusts dredged on

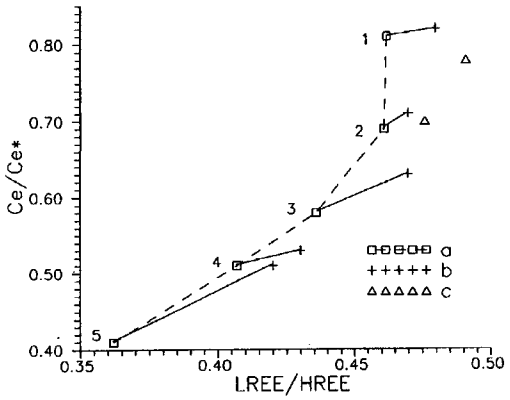


FIG. 1. Ce/Ce* versus *LREE/HREE* plot of labile fraction (a) and total (b) of micronodules (1: 0.1–0.25 mm, 2: 0.25–0.5 mm, on two hydrogenous crusts from MANOP Site H (Murphy, Dymond, 1984) are shown (c).

basalts (Murphy, Dymond, 1984), which are shown in fig. 1, is similar to that of two MN fine fractions. MN are more enriched in Mn, Cu and Ni. Therefore, MN appear to be accreted from labile fraction of sediment but not directly from seawater.

## References

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