

CHEMICAL SIGNATURES AT THE CRETACEOUS-TERTIARY BOUNDARY WITHIN A SINGLE MANGANESE NODULE.; A.V.Murali, D.P.Blanchard, SN2 Johnson Space Center, Houston, TX 77058, B.L.K.Somayajulu, Physical Research Laboratory, Ahmedabad, 380009, India, and J.C.Laul, Battelle, Pacific Northwest Laboratories, Richland, WA 99352

Manganese nodules on the ocean floor grow by the slow and authigenic precipitation of the hydroxides of iron and manganese which continuously scavenge a host of trace elements from the marine environment. The compositions of the nodules are highly influenced by the nearby sediments but are also influenced by several other accretionary processes(1,2). The nodule, Zetes-3D, collected at 3000m depth from Pacific Ocean (40° 16'N; 170° 20'E), is one of the few manganese nodules that has been carefully dated by different radiometric methods(3,4). These data confirm its slow and uniform accumulation rate over the last 15 my (the outermost 1.3 centimeters). A linear extrapolation of the growth rate determined by ¹⁰Be measurements through the 4000 cm³ bulk of the nodule indicates that it existed on the ocean floor for the last 100 my and, in all probability, witnessed the global Cretaceous-Tertiary.

This nodule was carefully sampled at different intervals from surface to 10cm depth. Seven samples were collected for chemical characterization to study the temporal variation of the marine environment during the life span of the nodule. The apparent ages (depth/growth rate) of our samples #1 through #7 correspond to 0-1.5; 2.7-3.1; 15.4-19.2; 46.2-53.8; 53.8-61.5; 61.5-69; 69.2-76.9 my respectively. In view of the 10% uncertainty reported for the ¹⁰Be method (3), samples 4, 5 and 6 were collected at close intervals, i.e., covering approximately 20% on either side of probable C-T boundary region.

Fresh chips and pieces from each region were analyzed in triplicate by INAA techniques. Duplicate samples of BCR, DTS, SARM-7 and Parsa meteorite(5) were also irradiated with elemental standards as controls for checking the precision and accuracy. The estimated errors (1 sigma) for various elements are better than 1-2% for Fe, Co, Sc, La and Sm, 3-5% for Ni, Ce and Eu, 5-8% for Mn, Mo, and Yb, 10-14% for Tb and Lu, and 20-25% for Nd. The values obtained on different aliquots from each region were well within the observed analytical uncertainty for each element.

Our results so far indicate the samples 4, 5 and 6, taken from the region corresponding to the C-T boundary region, are chemically similar to each other but are distinctly different from the layers deposited before and after them.

1. They are depleted in Fe by 30%, in Sc and the REE by 40-50% but enriched in Mn, Co, Ni and Mo by 20-40% (figure 2).

2. The positive Ce anomaly that is observed throughout the nodule nearly doubles (9x vs 5x) through this region (figures 1 and 2).

3. The Mn/Fe ratio is distinctly higher (2.7) in this region than in the rest of the nodule (1.8). The sum of Mn and Fe, however, remains constant (Fe + Mn = 30) (figure 2).

We believe these observations strongly indicate that, for at least a short time during the Cretaceous-Tertiary transition, the oceans became more oxidizing. This episode of oxidizing conditions in the oceans may be related to the "sudden and short" temperature rise during the same period suggested by (6). We base this conclusion primarily on the observed increase in the Ce concentrations without a corresponding increase in the concentrations of the other REE (the exaggerated Ce anomalies). Ce is more efficiently scavenged as ceric oxide thus an increase in oxidation potential will favor a positive Ce anomaly in the sediments which will in turn be reflected in the nodules.

The observed depletion of the REE may be related to the reduced river discharge into the oceans (7) and/or to the dilution of ocean water by polar melting (8) that may have accompanied the C-T transition. The increased concentrations of Mn, Co, Ni and Mo may be due to the increased load of sulfide bearing biogenic detritus deposited during the same period (9) or may be associated with the addition of material to the oceans from an Earth-impacting projectile (6,10). Our present data cannot distinguish among these possibilities. The Ce data can best be explained by appealing to an oxidizing episode that decouples its behavior from the other REE.

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FIGURE 2

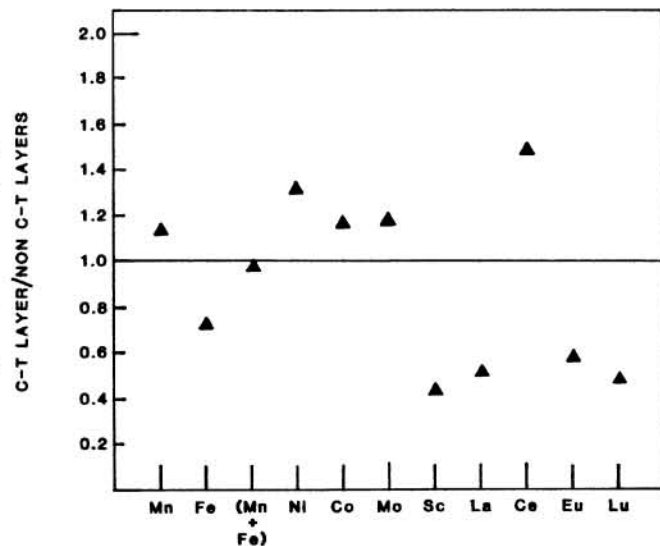


FIGURE 1

