Evidence from REE patterns for microbial contribution to the formation of natural Fe oxides and BIF

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Microbes have played a role in mineral formation throuhough earth's history. Many biomineralization studies have been carried out from a chemical, mineralogical, and microbiological point of view, but the fact remains that it is difficult to quantify the contribution of microbial activity to the formation of ancient geological samples. There is therefore a need to obtain more evidence of the involvement of microorganisms, especially in geological samples like BIF, using different geochemical tools. In this study, the use of rare-earth element (REE) distribution patterns is proposed as probes of bacterial presence in natural minerals.

At first, sorption of REE onto *Bacillus subtilis*, *Escherichia coli*, *Alcaligenes faecalis*, *Shewanella putrefaciens*, and *Pseudomonas fluorescens* was studied in the laboratory. The distribution coefficients of REE between the bacterial cell surface and water showed a pattern with a prominent enrichment of heavy REE and a maximum around Sm [1]. These characteristics are well explained by surface complexation of REE with various binding sites on the bacterial surfaces. The results were confirmed by XAFS studies on the local structure of REE sorbed onto bacteria.

In natural water, similar REE patterns were also observed in modern natural microbial biofilms containing *Gallionella ferruginea* and *Leptothrix* sp. found in the Budo pond in Hiroshima. In addition, the HREE enrichment was also observed in Fe oxyhydroxide precipitates found in association with neutrophilic Fe-oxidizing bacteria when compared with Fe oxyhydroxides formed inorganically by precipitation. These results strongly suggest that microbial activity appears to modify the REE patterns of natural Fe oxide minerals and that the REE patterns can be used as probes of bacterial activity in pure bacterial suspensions, natural biofilms, and natural Fe oxides formed as a result of microbial activity. Some REE patterns of BIF in the Hamersley Basin in northwestern Australia also show similar REE features, suggesting the potential role of bacteria in the formation of some BIF.

References

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