

Neodymium isotope investigation of 2.6 Ga Hamersley Group carbonate, Western Australia

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REE in Precambrian Seawater

Nd isotopes in banded iron formations (BIF) are commonly used to determine the sources of rare earth elements (REE) in Precambrian seawater. Previous work has suggested that most of the Fe and Nd of iron formations is derived from hydrothermal sources, and that the REE co-precipitate with iron when 'fertilized' deep waters encounter shallow oxygenated waters. This model predicts that near-shore carbonates should preserve a signature characteristic of continental sources. To test this scenario, we measured Nd isotope ratios in carbonate of the Hamersley Group, Western Australia.

Nd Isotope Results and Discussion

Dolomite samples from the 2.6 Ga Wittenoom Formation, interpreted to be off-platform, deep water carbonate (Simonson et al., 1993), yield initial ϵ_{Nd} values in the range of -1.9 to -0.4, consistent with values previously measured from Hamersley BIF. These data suggest that the carbonates scavenged REE from the same (hydrothermal?) source as the iron formations. We note, however, that the Wittenoom Sm-Nd data form an 'isochron' (9 points) with a calculated age of about 2.1 Ga, consistent with partial resetting during a previously-recognized 2.1 Ga metamorphic event.

Three samples from the associated (but slightly older; Simonson et al., 2002) shallow-water carbonate of the Carawine Formation have a somewhat lower range of values, reaching as low as -3.3, indicating a greater contribution from continental sources. The Carawine samples show no evidence of metamorphic resetting at 2.1 Ga. Taken together, the Carawine and Wittenoom data suggest (but do not require) stratification of seawater with respect to REE, with more continent-like signatures at shallow depths, and hydrothermally-derived REE at deeper levels. The REE+Y patterns of both the Carawine and Wittenoom carbonate are remarkably similar to those of modern seawater, with the exception of the redox-sensitive elements Eu and Ce.

References

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REE migration in groundwaters close to the natural fission reactor of Bangombé (Gabon)

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The natural fission reactor of Bangombé is located at roughly 12m depth and has undergone supergene weathering and chemical exchange with groundwater. The reactor is an ideal natural analogue for geological radioactive waste repositories. This study mainly considers REE mobility at the interface between groundwater and aquifer sediment. Water samples and aquifer sediments have been taken from the reactor zone and from various drill holes that are situated along the direction of the groundwater flow. It has been shown that phosphate dissolution in the weathering profile was an important mechanism allowing the mobilization of phosphorous and REE. The availability of phosphorous allowed the formation of secondary minerals like phosphatian coffinites and Fe-uranyl phosphate hydroxide hydrates. The aquifer sediment and the water taken directly in the reactor show anomalous $^{143}\text{Nd}/^{146}\text{Nd}$, $^{145}\text{Nd}/^{146}\text{Nd}$ and $^{149}\text{Sm}/^{147}\text{Sm}$ isotope ratios of 0.7235, 0.4933 and 0.843, respectively, pointing to mixing between a fissiogenic and a normal REE component in both the solid phases of the aquifer and the groundwater near the reactor zone. 2.3% of the dissolved Nd is of fissiogenic origin. Suspended loads from within the reactor show similar isotopic anomalies with a fissiogenic contribution of 2.8 to 3.2%. Both dissolved and suspended load samples from the more distant wells have normal isotope ratios. Thus, the prevailing physico-chemical conditions within the groundwater system did not allow the migration of the fissiogenic REE over large distances (<3m). Although there is a large scale REE availability in the reactor zone, the REE concentrations of the water being in contact with the sediments of this zone are very low. Most important lanthanide and actinide sinks are uraninites, coffinites and Fe-uranyl phosphate hydroxide hydrates.