Dissolved rare earth element ratios trace hydrothermal scavenging and water mass transport

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Dissolved rare earth elements (REE) in the ocean are useful tracers for the provenance of trace elements, lateral water mass transport, and particle-seawater exchange processes. The ratios of specific REEs are of particular advantage as they depict small relative REE differences and variations that can be associated with specific processes. Here we show anomalously low Dy/Er ratios and high heavy over light REE ratios in the deep Southeast Pacific that suggest extreme scavenging. The low Dy/Er ratios correlate with high hydrothermal δ^3He [1], indicating scavenging of REEs by hydrothermal particles in the extensive hydrothermal plume of the East Pacific. Similarly low Dy/Er ratios are found at the depth of Antarctic Intermediate Water (AAIW) in the South Pacific and as far north as 10ºN in the Northwest Pacific. AAIW is located above the main hydrothermal plume of the East Pacific Rise, indicating that the low Dy/Er ratios within AAIW must be a preformed signal. We suggest that the hydrothermal δ^3He and Dy/Er signals are upwelled with deep waters in the Southern Ocean and while He degasses, the low Dy/Er signature is preserved and incorporated into AAIW. Additional scavenging of REEs and hence further reduction of Dy/Er may occur in the AAIW formation region where diatom production and hence particle scavenging is high. Water mass analysis along the meridional West Pacific transect supports the conservative behavior of Dy/Er in AAIW and suggests additional scavenging at ~1500-2000 m water depth in the Tonga-Fiji area, where shallow hydrothermal sources exist [2].

[1] Bianchi *et al*. (2010) *EPSL* **297**, 379-386. [2] Lupton *et al*. (2004) *Geochem., Geophys., Geosys*. **5**, Q01003, doi: 10.1029/2003GC000607.