Revisiting seawater Rare Earth Element patterns with an emphasis on the lithogenic sources

JIANGHUI DU[1], BRIAN HALEY[1], ALAN MIX[1]

[1]CEOAS, Oregon State University, Corvallis, OR, 97330, US

The Rare Earth Element (REE) patterns of modern seawater are often interpreted from the perspective of internal cycling within the water-column, as a consequence of the competing forces of complex formation with dissolved ligands and adsorption onto marine particles. These processes may lead to heavy REE enrichment that is characteristic of modern seawater, because particles preferentially remove light REEs (LREEs) while dissolved ligands preferentially retain heavy REEs (HREEs). However, such an interpretation ignores the influence of the sources of marine REEs, which are often assumed to have flat shale-normalized patterns. This assumption is at odds with the observations of seawater neodymium isotopic composition (ε_{Nd}), which require input of mantle derived lithogenic sources that do not have flat shale-normalized REE patterns.

The heterogeneity of seawater ε_{Nd} in the modern ocean points to heterogenous lithogenic sources of REEs, which should also manifest in seawater REE patterns. To test this hypothesis we analyzed published paired ε_{Nd}-REE data from the global ocean. We performed speciation-adsorption modeling of seawater REEs considering both dissolved ligands and typical scavenging phases (including particulate organic matters, iron and manganese oxides). The calculations were performed for each individual seawater sample using *in situ* seawater chemistry data derived from gridded global products. We find that the progressive enrichment of seawater HREEs from the deep Atlantic to the deep Pacific is highly correlated to the trend of increasingly radiogenic ε_{Nd}. We show that this progressive HREE enrichment cannot be fully explained by aqueous speciation-adsorption, rather, it requires addition of HREE enriched sources to the deep ocean. This is consistent with the prediction based on seawater ε_{Nd} suggesting increasing input of volcanic sources of REEs from the Atlantic to the Pacific, as volcanic materials are both HREE enriched and have more radiogenic ε_{Nd} compared to continental crustal materials. Exisitng evidence suggests that such lithogenic input of REEs is mostly likely related to low temperature weathering of marine sediments on seafloor.