Rare earth element cycling in the West Pacific – method and application

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Rare earth elements (REE) are used as diagnostic tools for oceanic cycling of trace elements. So far, the low concentrations (picomolar) of dissolved REE, time-consuming methods, and the required high precision, are the main difficulties that prevented their extensive use. Here, we present the first application of the automated seaFAST system (Elemental Scientific Inc.) in offline mode (i.e., not connected to an ICP-MS) for a robust and rapid preconcentration of REE from small volumes of seawater, and provide an accurate and precise multi-element isotope dilution ICP-MS method for routine REE analyses. We applied this method to provide high-resolution seawater REE profiles in the West Pacific between South Korea and Fiji together with dissolved neodymium (Nd) isotope ratios ($^{143}Nd/^{144}Nd$, expressed as ε_{Nd}). Near South Korea, unradiogenic Nd isotopes (ε_{Nd}=-7.3), elevated REE concentrations (Nd=15.3 pmol/kg) and low salinity gradually change to Pacific open ocean values (e.g., ε_{Nd}=-3.3, Nd=5.55 pmol/kg) at the surface, indicating trace element input via river discharge and gradual dilution away from the source. In the tropical West Pacific (10°N-15°S), radiogenic ε_{Nd} (+0.7) and shale-normalized positive Eu anomalies in surface and subsurface waters trace the influence of volcanic islands and the eastward transport into the zonal current system of the tropical Pacific. In the tropical to southern subtropical Pacific, surface to intermediate waters show strong light over heavy REE depletion and varying middle REE enrichment indicating different vertical partitioning of trace elements between dissolved and particulate fractions. These results suggest that boundary exchange, as well as lateral transport and the balance between supply and scavenging control the trace element distribution in this area.