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Investigating Volcanic Input and Water Mass Mixing in the Southwest Pacific Ocean using Radiogenic Neodymium Isotopes and Rare Earth Elements

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The Pacific Ocean is known for its active volcanic activity. However, the impact of volcanic activity, in particular large volcanic eruption events, on the geochemical cycling of trace elements in the area is not well understood. The South Pacific GEOTRACES cruise GP21 (February to Aprial, 2022) was conducted right after the major Hunga Tonga-Hunga Ha'apai eruption (20.5°S, 175°W) in January 2022. During the cruise, floating pumice was found while crossing the Tonga-Kermadec Arc. Here, we present results of radiogenic neodymium isotope (ε_{Nd}) and rare earth elements (REEs) along a latitudinal transect at 26°S from the western edge of the Pacific Plate (150°W) to the South Fiji Basin (170°E), which exhibit volcanic input of trace elements and water mass mixing.

The pumice exhibits distinctive isotopic signature and PAAS normalized REE pattern compared to the surrounding surface seawater, including a radiogenic signature (ε_{Nd} = +9.3), weak Ce anomaly, strong Eu anomaly, and a high ratio of heavy to light REE (HREE/LREE). The surface water ε_{Nd} peaked at +0.9 west of the Kermadec Ridge, about one unit more radiogenic than the eastern side. Weaker Ce anomalies, stronger Eu anomalies, and elevated HREE/LREE values also prevailed to the west of the Kermadec Ridge. Collectively, these findings strongly suggest the dissolution of fresh volcanogenic material in the surface water.

Various water masses in intermediate and deep waters exhibit unique REE and ε_{Nd} signatures, including the Antarctic Intermediate Water (ε_{Nd} ~ -7) at approximately 800m, Upper Circumpolar Deep Water (ε_{Nd} ~ -4) at ~2500m, and Lower Circumpolar Deep Water below 4000m (ε_{Nd} ~ -8), which is found only on the eastern side of the Kermadec Arc. The ε_{Nd} signatures in surface and bottom waters display systematic offsets compared to nearby locations sampled in 2005, implying potential impact of partial dissolution of volcanic material on the entire water column's ε_{Nd} signatures, which we quantify through excess ε_{Nd} and excess Nd calculations using endmember water mass properties. Overall, our findings shed light on the impact of volcanic activity on the geochemical cycling of trace elements and biological response to the relief of micronutrient stress in the Pacific Ocean.