

Assessing the Conservative Behavior of Radiogenic Nd Isotopes in the South Pacific Ocean

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The radiogenic neodymium isotope composition (ϵNd) has been used widely as a tracer for reconstructing past water mass mixing, relying on the assumption of its quasi-conservative behavior. However, emerging evidence — particularly from the Pacific Ocean, which hosts fast-spreading mid ocean ridges, numerous volcanic hotspots, and sluggish deep-water circulation — suggests that benthic fluxes, particle interactions, and hydrothermal or volcanic inputs may introduce non-conservative Nd signals. This highlights the need to critically assess the conservative behavior of ϵNd in the Pacific Ocean.

In this study, we present ϵNd and Nd concentration distributions from a cross-Pacific GEOTRACES zonal transect (GP21; Feb.-Apr. 2022) in the South Pacific (26-32°S). Our data confirm that ϵNd effectively fingerprints all major water masses, with less radiogenic signatures in those originating from the Southern Ocean and more radiogenic signatures in those from the North and Equatorial Pacific. Using fractional water mass distributions obtained from an Optimum Multi-Parameter Analysis, we find overall conservative behavior in the gyre and only identify small deviations of ϵNd from conservative mixing at the eastern and western boundaries. We test the sensitivity of these results to the choice of the Pacific Deep Water (PDW) endmember values and find that difference choices, as used in previous studies, can significantly affect interpretations of the non-conservative behavior of Nd in the South Pacific. The results emphasize the necessity of selecting a PDW endmember south of the equator to accurately assess Nd conservative behavior in the South Pacific.

To further assess the modification of ϵNd and Nd concentrations along the flow paths of major water masses in the South Pacific, we compare our results with data from other cross-Pacific transects: US GEOTRACES GP16 (10-15°S), German GEOTRACES GPpr09 (23.5-40°S), SO213 (36-45°S), and ANT-XXVI/2 (40-70°S). We find that Nd concentrations remain largely stable along neutral density surfaces in intermediate and deep waters from the southern South Pacific to ~26°S but decrease markedly at 10-15°S. Furthermore, ϵNd signatures in the cores of Southern Ocean-sourced water masses retain their unradiogenic signal up to 26°S before becoming more radiogenic at 10-15°S, mostly due to significant dilution through mixing at low latitudes.