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Basin-scale west-east gradient of radiogenic neodymium isotopes reveals coupled interbasin exchange and boundary processes in the South Indian Ocean

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Trace element and isotope (TEI) distributions in the South Indian Ocean reflect the combined influence of interbasin water mass exchange as part of the global overturning circulation and continental boundary processes but this vast important region still remains understudied. Radiogenic neodymium isotopes (εNd) act as a quasi-conservative tracer of water mass provenance while remaining sensitive to lithogenic inputs, which allows to distinguish the influence of large-scale circulation from ocean margin processes.

We present full-depth εNd data from the GEOTRACES GI07 transect (November–December 2024) along ~23°S from South Africa to Western Australia. The section reveals pronounced and vertically coherent major west–east εNd gradient, making this area ideal for the application of εNd.

Surface water εNd signatures range from highly unradiogenic values (−10.6 to −15.5) along the Mozambique shelf to ~−8 east of Madagascar and to the most radiogenic compositions (−4 to −5) near Australia, which reflects African margin influence in the west and Indonesian Throughflow influence in the east. In the thermocline, Subantarctic Mode Water (350–500 m) exhibits highly unradiogenic εNd signatures (−13.6 to −10.2) with lowest values above the Madagascar Ridge increasing eastward toward Australia. Antarctic Intermediate Water shoals eastward from ~1200 m to ~700 m and exhibits εNd values between −7.2 and −8.7, with a slight eastward shift toward more radiogenic compositions. A Red Sea-derived intermediate water mass is confined to the Mozambique Channel and displays similar εNd values, whereas Indonesian Intermediate Water at the eastern boundary is characterized by more radiogenic signatures (−5 to −6). Below 2000 m, deep waters become progressively more radiogenic eastward (from ~−11 to ~−7). Unradiogenic signatures in the western basin reflect stronger North Atlantic Deep Water influence combined with boundary exchange along the African and Madagascar margins, while increasingly radiogenic values towards Australia may reflect an increasing Pacific contribution to Indian Deep Water.

In addition to the water column data, authigenic and detrital εNd signals in surface sediments will be compared with overlying waters to assess the reliability of Nd isotopes as proxy for past ocean circulation versus continental weathering provenance in the South Indian Ocean.