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Significant contribution of mangrove systems to marine neodymium and hafnium isotope budgets

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Tropical mangrove systems play an important role in sequestering atmospheric CO_2 and exporting dissolved organic carbon to the oceans [1]. In addition, solid iron (Fe) and manganese (Mn) phases and organic matter can dissolve as the pH, redox conditions, and salinity rapidly change in mangrove systems [2], thus these phases may contribute significantly to the availability of trace elements in coastal areas. However, this is not well quantified for dissolved neodymium (Nd) and hafnium (Hf) isotopes and rare earth element and yttrium (REY) concentrations. Therefore, we have analyzed water samples from the mangroves and adjacent shelf area near the Amazon mouth obtained during RV Meteor cruise M147, process study GApr11 of the international GEOTRACES program. The isotopic signatures and REY patterns of groundwaters and surface sediments were also measured to further constrain the sources of the trace elements.

Our results demonstrate that mangrove-fringed river supply and porewater outwelling via groundwater discharge increase the REY, Nd and Hf export from the mangrove systems and dominate the Nd and Hf isotopic signatures of coastal seawater in the shelf area. Isotope mass balance calculations suggest that 1.5×10^7 g Nd yr^{-1} (net) and 3.0×10^5 g Hf yr^{-1} (net) are exported from an area of 2200 km^2 of Amazonian mangroves. These data were extrapolated to a global scale and the estimations indicate that the net fluxes of Nd and Hf from the global area of 1.6×10^5 km^2 of mangrove forests are 1.1×10^9 g yr^{-1} and 2.0×10^7 g yr^{-1}, respectively. The net Nd flux supplied by mangrove systems is comparable to the global dissolved riverine Nd flux and accounts for 12-20% of the global marine Nd input [3, 4], suggesting that mangrove systems need to be considered as a key trace element source to the coastal oceans.

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