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Modern Amundsen Sea Circumpolar Deep Water Nd isotope composition and its evolution since the Antarctic Cold Reversal

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The Amundsen Sea in the Pacific sector of the Southern Ocean is one of the most remote and least explored ocean basins on Earth. To date, for example, there are only a few water column Nd concentration and isotopic data predominantly from seawater samples of water masses bathing the shelf that were collected during cruises JR141 and JR179 with RRS James Clark Ross in 2006 and 2008, respectively. In spring 2010 additional water column samples were taken in this area during RV Polarstern cruise ANT-XXVI/3, in order to cross-calibrate deep-sea coral derived fossil Nd isotope compositions collected during this and an earlier RV Polarstern cruise in 2006. The aim of our study is to evaluate the Nd concentration and isotopic budget of this sector of the Southern Ocean today, and to reconstruct the Circumpolar Deep Water (CDW) Nd isotopic variability in intermediate water depth back into the last glacial period. Fossil corals were dredged from water depths ranging from 2500 m to 1400 m.

Over most of the water column in the vicinity of the Marie Byrd Seamounts ($\sim$123˚W, $\sim$69˚S), the Nd isotope composition (expressed in ε_{Nd}) displays typical CDW compositions ranging from $\varepsilon_{Nd}$of -9.0 in 500 m water depth to values of -7.9 in 3000 m (n=6). These compositions are in excellent agreement with late Holocene fossil coral-derived ε_{Nd} that scatter around values of $\sim$-8.4. However, seawater ε_{Nd} values 160 m above the seafloor are almost three ε_{Nd}, and those 1.5 m above the seabed almost five ε_{Nd} more radiogenic than the ε_{Nd} compositions seen throughout the upper 3 km of the water column. Given that the hydrographic data (potential temperature and density, salinity) in these water depths are still characteristic for CDW, the radiogenic ε_{Nd} values above the sediment-bottom water interface suggest that solute fluxes and exchange processes, referred to as "boundary exchange" by Lacan and Jeandel (2005), are also evident from the abyssal Southern Ocean.

Past CDW ε_{Nd}, as recorded in our radiocarbon-dated calcitic scleraxonian octocorals, show only minor variability throughout the Holocene and the latest stage of the last deglaciation, though mimicking trends seen in Holocene deep-sea corals as distant as the intermediate North Atlantic (Colin et al., 2010). Conversely, several Amundsen Sea corals dating back to approximately the Antarctic Cold Reversal (ca. 14.5-12.5 ka BP) and the middle Marine Isotope Stage 3, respectively, show considerable variability towards more radiogenic ε_{Nd}, in agreement with Fe-Mn oxyhydroxide-derived bottom water Nd isotope reconstructions from the Cape Basin in the Atlantic sector of the Southern Ocean (Piotrowski et al., 2005). Overall our data suggest a strong connection of North Atlantic Deep Water (NADW) contributions to the Antarctic Circumpolar Current on the one hand and Amundsen Sea CDW ε_{Nd} on the other for a given time. This finding is in agreement with suggestions brought forward by Piepgras and Wasserburg (1982) for a strong influence of Atlantic-derived Nd in setting an ACC ε_{Nd}.

References

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