Transient changes in Southern Ocean Nd isotope composition in response to Antarctic glaciation

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Two high-resolution neodymium (Nd) isotope records, generated from fossil fish teeth recovered from lower Oligocene to upper Eocene sediments from Ocean Drilling Program (ODP) Sites 689 (Maud Rise, 64°18'S, 3°6' E, 2080 m) and 1090 (Agulhas Ridge, 42°54'S, 8°54'E, 3702m), show significant excursions to nonradiogenic compositions. Comparison of the Nd isotope records with high-resolution benthic foraminiferal $\delta^{18}O$ records from these sites reveals that the least radiogenic ε_{Nd} values coincide with the interval of increasing $\delta^{18}O$ values prior to the Oi-1 glaciation, in agreement with coupled Nd isotope and $\delta^{18}O$ records from ODP Site 738 on Kerguelen Plateau. The magnitude of the Nd isotope shift is 1.5 ε_{Nd} at both sites in this study. The nadir of the excursion is -9.2 ε_{Nd} at Site 689 and -7.5 at Site 1090. Following the excursion, both sites recover to within 0.5 ε_{Nd} of pre-excursion values. Site 689 shows two short-term shifts to low ε_{Nd} values prior to the main excursion.

The source of nonradiogenic Nd to the Southern Ocean during this interval is most likely glacial weathering of ancient crust on East Antarctica during ice sheet growth. This mechanism is preferred over a pulse of deep water sourced from the North Atlantic because the magnitude of the excursions observed in this study are 50% compared to that at ODP Site 738, which is furthest from this source of deep waters. The distribution of Nd isotopes in the Southern Ocean during the buildup of the Antarctic ice sheet strongly indicates that a large proportion of glacially weathered material was funneled through the Lambert Graben towards Prydz Bay, producing a large Nd isotope response in waters bathing the southern Kerguelen Plateau. Nearly synchronous shifts to lower ε_{Nd} values at Maud Rise and Agulhas Ridge suggest that the Nd isotopic signal of glacial weathering was rapidly transmitted through the Southern Ocean by circulating water masses, and diluted by mixing with other water masses. Short-term variations in ε_{Nd} values at Maud Rise possibly reflect local changes in weathering and/or changes in water mass mixing between the Weddell Sea and Southern Ocean.

XRD data of Saharan and Sahelian dusts and soils – A compilation

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The Sahara and its margins are the largest source for mineral dust on earth, supplying c. 50 % of the total global mineral dust burden to the atmosphere. The presence of different Saharan dust particles in the atmosphere has large impacts on the radiative forcing by direct (scattering, absorption) and indirect (e.g. cloud condensation nuclei) effects and is, for example, also important for the nutrient budget in the pedological and oceanic systems, respectively. A better understanding of the distribution of the mineralogical composition in potential dust source areas of North Africa will also help to improve (paleo)climatological models.

Our compilation of X-ray diffraction data shows that especially the amounts of calcite, palygorskite, illite, and kaolinite in dusts can be used as `compositional fingerprints´ for Saharan and Sahelian dust. Combining the observed mineralogical trends in North African dusts and soils with the most active source areas (detected for example by TOMS AI), it can be shown that specific source regions are characterized by a typical mineral assemblage (Table 1).

Source area	I/K ratio	calcite	palygorskite
Atlas region	high (> 2.0)	high	abundant
Libya/Egypt	low (c. 0.5-1.0)	medium – high	rarely
S Algeria	low (c. 0.5)	variable	rarely
Sahel region (Chad/Niger/Mali)	very low (< 0.5)	very low	absent

Table 1: Major source regions in North Africa and their mineralogical characteristics (I/K = illite/kaolinite)

In the future, we will also integrate the available elemental and isotope compositional data and the results of individual-particle analysis of Saharan and Sahelian dusts and soils in our dataset. This will further help to improve the discrimination between the different major source areas in North Africa.