Late Quaternary Nd-Hf isotope evolution of the Weddell Sea and the abyssal Southern Ocean

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The Southern Ocean deep circulation has played a critical role in regulating the atmospheric CO_2 concentration over glacial-interglacial time scales. While Nd and Hf isotopes have been demonstrated to be effective tracers of water mass circulation and continental weathering inputs to the deep ocean, relatively little is known about glacial-interglacial Hf isotopic evolution in Southern Ocean or the Nd isotope evolution of waters fully bathed in Antarctic bottom water. We present Nd-Hf isotope time series from the Weddell Sea margin (PS1388-3, water depth 2526 m) and abyssal Southern Ocean (PS2082-1, water depth 4610 m, abyssal Agulhas Basin) over the last 250 kyr in order to better understand the deep circulation and weathering inputs.

Nd isotope signatures of sediment leachates of PS2082-1 are consistent with previously published records from the neighboring Cape Basin revealing less radiogenic signatures in interglacials and more radiogenic signatures in glacials. However, ε_{Nd} values of the last glacial maximum (LGM) in the Agulhas Basin are systematically more radiogenic by about ~0.7 ε_{Nd} units than the Cape Bain records, which may imply a higher Pacific contribution. In contrast, Hf isotope signatures of the same leachates show an opposite evolution trend compared with Nd isotopes (i.e., less radiogenic in glacials), implying the Hf isotopes may be controlled by high southern latitude weathering regime changes. All PS2082 leachate data of Nd-Hf isotopes are within the seawater data range constrained by surface scrapings of Fe-Mn nodules and modern seawater from the Southern Ocean, supporting a seawater origin for the leachate Nd and Hf isotope signatures.

Surprisingly, Nd isotope compositions of PS1388-3 leachates have nearly invariant signatures (ε_{Nd}: ~ -12.0) over glacial-interglacial times and are much less radiogenic than the abyssal Southern Ocean, while the Hf isotopes show radiogenic peaks (ε_{Hf} > +8.0) after deglaciations. The results indicate that these signatures have been controlled by Antarctic weathering inputs, while dissolution of fresh surfaces of minerals with high Lu/Hf after deglaciations may explain the radiogenic Hf peaks.

Pb isotope evidence from the Oka carbonatite complex for a distinct mantle reservoir

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Pb isotope data from young (<200 Ma-old) carbonatite complexes plot well within the fields defined by present-day mid-ocean ridge basalts (MORBs) and oceanic island basalts (OIBs). Thus, one interpretation is that carbonaties are derived from similar mantle components (i.e., HIMU, EMI, EMII, DMM) sampled by modern oceanic basalts. Here, we report new in-situ Pb isotopic data for calcite, nepheline, and melilite from various rocks types associated with the Oka carbonatite complex (Québec, Canada). Linear trends observed in Pb *vs*. Pb isotope diagrams (e.g., Fig. 1) reflect open-system behavior involving mixing of at least two distinct mantle reservoirs. However, the unradiogenic $^{207}Pb/^{204}Pb$ and $^{208}Pb/^{204}Pb$ ratios for given $^{206}Pb/^{204}Pb$ values (e.g., Fig. 1) for Oka and associated alkaline rocks from the Monteregian Igneous Province (MIP) are distinct, and point to the involvement of an unidentified (depleted) mantle reservoir. This unradiogenic $^{207}Pb/^{204}Pb$ isotopic composition may be attributed to U/Pb fractionation early in Earth's history. Moreover, in-situ Sr and Nd isotope compositions for apatite from Oka overlap those for basalts derived from "FOZO", which suggests derivation from a deep mantle source.

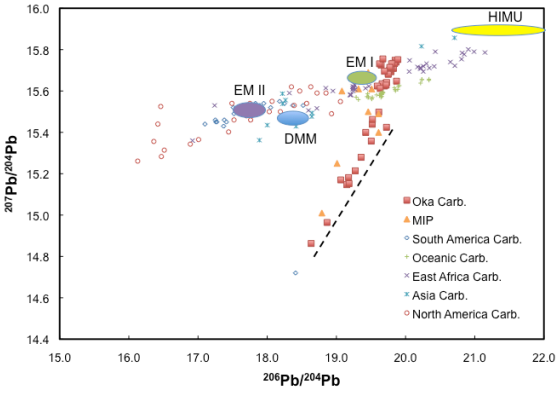

Figure 1 Pb isotope ratios for Oka and MIP intrusions.

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