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Nd-Sr-Pb Isotopic Variations in Deep-Sea Clays, Kerguelen Drift: A 7 Ma Record of Fluctuations in the Antarctic Ice-Sheet?

James Gleason (jdgleaso@umich.edu), **David Rea** (davidrea@umich.edu), **Leah Joseph** (ljoseph@umich.edu), **Robert Owen** (rowen@umich.edu), **Joel Blum** (jdblum@umich.edu), **Andrea Klaue** (aklaue@umich.edu) & **Bjorn Klaue** (bklaue@umich.edu)

Department of Geological Sciences, University of Michigan, Ann Arbor, MI, 48109, USA

Introduction. ODP Site 745 located on the southeast flank of Kerguelen Plateau contains variable proportions of ice-rafted debris (IRD), hemipelagic silts and clays, and biogenic sediment. The terrigenous sediment provide a record of weathering and ice-sheet fluctuations on Antarctica over the past 7 Ma. Previous work has demonstrated that the mineralogy of the clay fraction is consistent with East Antarctic sources (Ehrmann et al., 1991). Terrigenous flux calculations and grain-size analysis for 67 samples from this site have also been reported elsewhere (Joseph et al., in press). For this study, we analyzed the radiogenic isotopic composition of the remaining pure detrital component (IRD and hemipelagites) which had been previously isolated from its matrix by removing all calcium carbonate, biogenic silica and oxy-hydroxide coatings. We report the Nd-Sr-Pb isotopic compositions for selected samples which were analyzed to confirm their provenance and to assess potential isotopic variability that may be linked to proxy erosional indicators such as the sediment mass accumulation rate (MAR). Results. 10 samples analyzed to date reveal a crude co-variation in Nd-Sr-Pb isotopes with a strong correlation between Nd isotopic composition (Fig. 1) and calculated mass accumulation rates (g/cm^2/ky). Values of ε_{Nd} = -20 are characteristic of periods with high sediment flux (ca. 5 Ma and 1 Ma), while periods of lower sediment flux are shifted to much less negative values (ε_{Nd} = -9). The isotopic compositions appear to correlate with ice-rafting intervals before 4 Ma, some of which have been interpreted as times of increased instability in the Antarctic ice sheet (Breza, 1992) during periods of increased global warmth (Kennett and Hodell, 1993). A significant increase in the average magnetic susceptibility of sediments after 4 Ma (and continuing to the present) also does not correlate with any of the isotopic provenance indicators. The broad isotopic patterns are indicative of dominantly East Antarctic continental sources supplying sediment to this site, with intervals of increased erosion and delivery of sediments to the Antarctic margin correlating with more negative ε_{Nd}.

Discussion. Selective weathering of older, weathered surfaces during glacial processes could impart some variability in the isotopic signature, but the neodymium isotopic variations appear to be best explained by simple two-component end-member mixing. The simplest explanation is that a Kerguelen sedimentary source provided a fairly constant background signature, with variable input from Antarctic sources providing most of the observed isotopic variation. Simplified calculations carried out for a Kerguelen Plateau basaltic end-member (average values compiled from the literature) mixed with an Antarctic glacial sediment end-member (here taken as the most negative ε_{Nd} from our data set) suggest that the Antarctic component may vary between 90% and 30%, averaging about 65% (based on Nd vs. MAR). Additional components are possible; eolian dust, however, is not present in the samples. The isotopic data suggest that the measured physical characteristics of sediment from this site can be used to diagnose climate and erosional conditions influencing sediment supply from Antarctica since the Late Neogene/Early Pliocene.

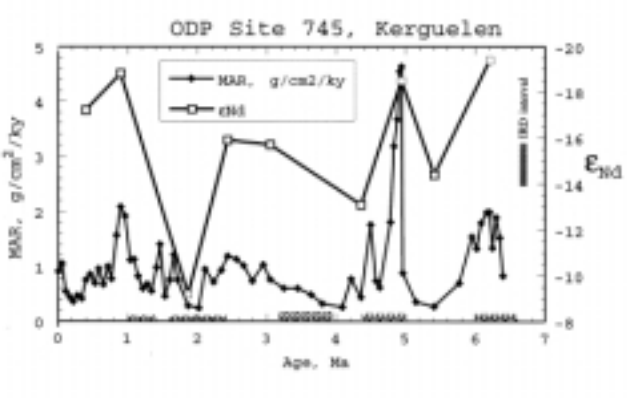

Figure 1. Mass Accumulation Rate (MAR) of terrigenous sediment from ODP Site 745 co-varies with neodymium isotopic composition, indicating a mixed provenance (see text).

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