ELSEVIER

Marine Geology 182 (2002) 351–372

MARINE GEOLOGY
INTERNATIONAL JOURNAL OF MARINE GEOLOGY, GEOCHEMISTRY AND GEOPHYSICS

www.elsevier.com/locate/margeo

Glacial–interglacial cycles in Sr and Nd isotopic composition of Arctic marine sediments triggered by the Svalbard/Barents Sea ice sheet

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Received 24 July 2000; accepted 3 September 2001

Abstract

Sr and Nd isotopic compositions of Arctic marine sediments characterize changes of sediment source regions and trace shelf–ocean particle pathways during glacial–interglacial transitions in the eastern Arctic Ocean. In the 140-ka sedimentary record of a marine core from Yermak Plateau, north of Svalbard, $^{87}Sr/^{86}Sr$ ratios and ε_{Nd} values vary between 0.717 and 0.740 and −9.3 and −14.9, respectively. Sr and Nd isotopic composition both change characteristically during glacial–interglacial cycles and are correlated with the extension of the Svalbard/Barents Sea ice sheet (SBIS). The downcore variation in Sr and Nd isotopic composition indicates climatically induced changes in sediment provenance from two isotopically distinct end-members: (1) Eurasian shelf sediments as a distal source; and (2) Svalbard bedrock as a proximal source that coincide with a change in transport mechanism from sea ice to glacial ice. During glacier advance from Svalbard and intensified glacial bedrock erosion, ε_{Nd} values decrease gradually to a minimum value of −14.9 due to increased input of crystalline Svalbard bedrock material. During glacial maxima, the SBIS covered the entire Barents Sea shelf and supplied increasing amounts of Eurasian shelf material to the Arctic Ocean as ice rafted detritus (IRD). ε_{Nd} values in glacial sediments reach maximum values that are comparable to the average value of modern Eurasian shelf and sea ice sediments ($\varepsilon_{Nd} = -10.3$). This confirms ice rafting as a major sediment transport mechanism for Eurasian shelf sediments into the Arctic Ocean and trace a sediment origin from the Kara Sea/Laptev Sea shelf area. After the decay of the shelf-based SBIS, the glacial shelf sediment spikes during glacial terminations I ($\varepsilon_{Nd} = -10.6$) and II ($\varepsilon_{Nd} = -10.1$) ε_{Nd} values rapidly decrease to values of −12.5 typical for interglacial averages. The downcore Sr isotopic composition is anticorrelated to the Nd isotopic composition, but may be also influenced by grain-size effects. In contrast, the Nd isotopic composition in clay- to silt-size fractions of one bulk sediment sample is similar to within 0.3–0.8 ε_{Nd} units and seems to be a grain-size independent provenance tracer.

Keywords: strontium; neodymium; isotopes; Arctic Ocean; provenance; Svalbard/Barents Sea ice sheet

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0025-3227/02/$ – see front matter
PII: S0025-3227(01)00248-1