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Grain size separation and sediment mixing in Arctic Ocean sediments: evidence from the strontium isotope systematic

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Abstract

The $^{87}Rb/^{86}Sr$ and $^{87}Sr/^{86}Sr$ ratios of Laptev Sea sediments, of Arctic Ocean sediments and of suspended particulate matter (SPM) from Siberian rivers (Lena and Khatanga) form 'pseudo-isochrons' due to grain-size separation processes which are referred to as 'Lena Mixing Envelope' (LME) and as 'Flood Basalt Envelope' (FBE). At the land–ocean transition the reduction of the particle velocity causes a deposition of coarser grained material and the contact with saline water enhances a precipitation of finer-grained material. The coarse-grained material is enriched in Sr showing less radiogenic $^{87}Sr/^{86}Sr$ ratios whereas fine grained material is depleted in Sr relative to Rb showing more radiogenic $^{87}Sr/^{86}Sr$ ratios. The experimentally determined spread of the $^{87}Rb/^{86}Sr$ and $^{87}Sr/^{86}Sr$ ratios as a function of grain size in one sediment sample is on the same order as the natural spread of the $^{87}Sr/^{86}Sr$ ratios observed in all samples from the Arctic Ocean. Chemical Index of Alteration (CIA) for the Lena river SPM tend to confirm previous observations that chemical alteration is negligible in the Arctic environment. Thus, these 'pseudo-isochrons' reflect an average age and the average isotope composition in the river drainage area. Calculated apparent ages from the FBE reflect the age of the Siberian flood basalt of about 220 Ma and the initial ratio of 0.707(1) reflects their mantle origin. The age calculated from the LME of about 125 Ma reflects accidentally the Jurassic and Cretaceous age of the sediments drained by the Lena river and the initial ratio of 0.714(1) reflects the crustal origin of their source rocks. Comparison of geographical locations reveals that all samples from the eastern Laptev Sea (east of 120°E) fall along the LME whereas all samples from the western Laptev Sea (west of 120°E) fall between LME and FBE. Mixing calculations based on $^{143}Nd/^{144}Nd$ measurements, not influenced by grain size, show that about 75% of the western Laptev Sea sediments originate from the Lena drainage area whereas about 25% of the sediments are delivered from the Siberian flood basalt province. Sediments from the central Arctic Ocean are isotopically related to the Lena drainage area and the Siberian flood basalt province. However, sediments from the Arctic

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