Tracing the origin of Arctic sea ice and freshwater by neodymium isotopes and rare earth elements

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Neodymium (Nd) isotopes (expressed as ε_{Nd}) and rare earth elements (REEs) in seawater have been successfully used to trace water mass mixing in the Arctic region [1, 2, 3]. However, the potential to trace the origin of drifting Arctic sea ice with ε_{Nd} and REEs has not yet been directly explored. Freshwater originating from various Siberian rivers is mixed and diluted prior to its advection to the central Arctic Ocean and the Fram Strait, thereby inhibiting an assessment of the individual contribution of the different rivers [1, 2]. In contrast, sea ice may preserve the marine or riverine ε_{Nd} and REE signatures from Siberian shelf waters while transported across the Arctic Ocean. This mechanism is demonstrated here for the first time by comparing ε_{Nd} and REE signatures determined from unfiltered but essentially sediment-free sea ice with corresponding signatures expected for surface seawater in the formation region of the ice. Sea-ice cores were recovered in the Eurasian Basin of the central Arctic Ocean in 2012. Based on satellite-derived ice drift and concentration data, some of the sea-ice floes sampled formed east of Vilkitsky Strait and are characterized by ε_{Nd} values near -8 in agreement with the incorporation of radiogenic freshwater (ε_{Nd} -6) from the Yenisei and Ob rivers [4]. A second sea-ice source was located north of the Laptev Sea as reflected by ε_{Nd} values near -11, which is consistent with mixed contributions of radiogenic waters from the Kara Sea and northward flowing highly unradiogenic freshwater ($\varepsilon_{Nd} <$ -15) of the Lena River [4]. These first data suggest that Nd isotopes can trace both the origin of drifting sea ice and of freshwater. The REE concentrations in the ice are depleted compared to those in Siberian shelf waters, indicating salt-associated REE rejection during sea-ice formation.

[1] Laukert *et al.* (2017) *Geochim. Cosmochim. Acta* **202**, 285-309. [2] Porcelli *et al.* (2009) *Geochim. Cosmochim. Acta* **73**, 2645-2659. [3] Andersson *et al.* (2008) *Geochim. Cosmochim. Acta* **72**, 2854-2867. [4] Laukert *et al.* (2016) *Goldschmidt Abstracts* **2016**, 1688.