

Kinetic fractionation of stable hydrogen and oxygen isotopes upon sea-ice formation

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Under equilibrium conditions, heavier isotopes are typically enriched in the denser phase. Likewise, oxygen-18 is enriched in sea ice with respect to the parent seawater solution. Nevertheless, the isotopic fractionation is subject to kinetic effects related to the rate at which sea ice forms.

In 2010 and 2011, we collected surface seawater and the co-existing, newly formed sea-ice (pancake ice and frazil ice) in Lancaster Sound near Resolute Bay in the Canadian Arctic Archipelago. The isotopic composition ($\delta^2\text{H}$ and $\delta^{18}\text{O}$) and practical salinity (S_p) of the surface seawater and sea ice were analyzed and results reveal a linear relationship between the difference in the isotopic composition ($\delta^{18}\text{O}_{\text{ice}} - \delta^{18}\text{O}_{\text{sw}}$ and $\delta^2\text{H}_{\text{ice}} - \delta^2\text{H}_{\text{sw}}$) and salinity ($S_{p,\text{sw}} - S_{p,\text{ice}}$; a proxy of the rate of sea-ice formation) of the sea ice and surface seawater. The slope of the relationships is positive and confirms a strong kinetic effect on the fractionation of stable hydrogen and oxygen isotopes during early sea-ice formation.