Accumulation processes of trace metals into arctic sea ice: distribution of Fe, Mn and Cd associated with ice structure

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Increased loss of Arctic summer sea ice can influence the cycling of biogeochemical materials (trace metals, nutrients, etc.), affecting seawater’ s biology and chemistry. Sea ice is important for the supply of biogeochemical materials, especially trace metals, to the surface waters of the polar oceans; but its role is not clear. Understanding the accumulation and release mechanisms into Arctic sea ice will clarify the geochemical behaviour of trace metals. This study compared dissolved (D) and labile particulate (LP) Fe, Mn, and Cd to the observed sea ice structure from a single Arctic sea ice core. The structure of sea ice reflects the process of ice formation, which may aid in the determination of accumulation processes. Using photographic analysis for the percentage of pore microstructure and $\delta^{18}O$ analysis, sea ice structure was observed as: snow, granular (frazil), mixed (granular and columnar) and columnar ice. Salinity and nutrients were low, indicating brine drainage and multi-year ice. High trace metal concentrations in snow ice indicated meteoric snow as a source and accumulation during snow ice formation. High concentrations of LPFe in granular ice indicated accumulation via suspension freezing by frazil ice followed by entrainment. Dissolved Mn and Cd accumulated in snow and granular ice through chemical transformation processes. Elevated DMn and DCd in granular ice resulted from the reduction and release from accumulated Fe and Mn oxides. Elevated DMn and DCd in snow ice may have been due to the photochemical reduction of LPFe and LPMn. Low trace metal concentrations in mixed and columnar ice indicated trace metal release due to brine drainage. Our study clearly indicated that the differences observed in trace metals, within sea ice structure, showed that sea ice formation, chemical reduction and brine release were the processes behind trace metal accumulation and release in this Arctic sea ice.

Keywords: Trace Metals, Dissolved , Labile Particulate , Sea Ice Structure

