

Fe, Mn, Cd, and Pb Quantitatively Analysed in Sea Ice

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Sea ice plays a significant role in polar oceans. During sea ice formation both dissolved and particulate sea water constituents (trace metals, macro-nutrients, sediments, etc) accumulate through scavenging or suspension freezing (Reimnitz et al., 1992,1993; Nürnberg et al., 1994). This can allow for sea ice to hold trace metal concentrations higher than the underlying water (Grotti et al. 2005; Tovar-Sanchez et al. 2010). Floating (pack) sea ice can then transport incorporated materials into new areas as it melts, seeding the water community below (van der Merwe et al., 2011). Although many studies have looked at sea ice and trace metals, the mechanism and geochemical cycling role for trace metal accumulation is still largely unknown (Kanna et al., 2014). In this study we examined the following metal fractions for Fe, Mn, Cd and Pb: Dissolved (D, $<0.2 \mu\text{m}$), and Labile Particulate (LP, Total Dissolvable - Dissolved) from Chukchi Sea pack ice and the surrounding seawater (shelf and coast). Samples were pre-concentrated utilizing the solid-phase extraction NOBIAS Chelate PA1 resin (Hitachi High-Technologies) following a modification of Sohrin et al. (2008) and Kondo et al. (2016) methods. Finally, samples were analyzed on a Graphite Furnace Atomic Absorption Spectrometer (GFAAS). Applying the modified solid-phase extraction method on sea ice measurements allowed us to accurately detect low levels of trace metals. Utilizing this method allowed us to gain insightful information on the geochemical cycling of trace metals within sea ice.

LPPe, LPMn and LPPb composed 98-99% of Fe, Mn and Pb in Chukchi sea ice where LPCd was 84%. Although Cd and Pb were detectable, the concentrations for the dissolved and labile particulate fractions were very low ($0.05 \pm 0.04 \text{ nM}$ – $6.3 \pm 5.9 \text{ nM}$). Overall in sea ice and seawater, the labile particulate fraction had higher concentrations than the dissolved. Sea ice has been shown to have a temporal decoupling of trace metals (i.e. Fe), with the dissolved metals being released with the brine and particulate metals release with advanced melting (van der Merwe et al., 2011). Since our samples were collected during summer, advanced melting could have led to the dominance of the labile particulate fraction. Chukchi seawater (shelf and coast) samples also showed the same trends where Fe and Mn had higher concentrations than Cd and Pb. LPPe and LPPb composed 99-100% of Fe and Pb in Chukchi seawater. One interesting point was that Pb was detectable in sea ice for both the dissolved and labile particulate fractions but only detectable as LPPb in seawater. Mn and Cd composition in Chukchi seawater was dominated by the dissolved fraction (75% and 43% respectively). DFe is removed from seawater by oxyhydroxide formation and particle scavenging, which can give it have lower concentrations than DMn (Landing and Bruland, 1987).

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