Transport of trace metals (Mn, Fe, Ni, Zn and Cd) in the western Arctic Ocean (Chukchi Sea and Canada Basin) in summer 2012

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Trace metals such as Fe, Mn, Ni, Zn and Cd are involved in numerous processes in the metabolisms for phytoplankton growth. In the Arctic Ocean, the continental shelf area comprises roughly one-third of its total area and accounts for approximately one-fifth of that of the world's ocean. Previous studies have revealed that the maximum of Fe concentration existed in the halocline waters with nutrients and dissolved organic matters, suggesting that the formation of cold and dense water in the halocline layer and the input from the continental shelf play the significant roles for Fe transport in the western Arctic Ocean (e.g., Hioki et al., 2014). On the other hand, there are only few data about the distributions of Zn, Cd, Ni and Mn in this region. In this study, distributions of dissolved and total dissolvable trace metals (Mn, Fe, Ni, Zn and Cd) were investigated in the western Arctic (Chukchi Sea and Canada Basin) in 2012 September to elucidate the mechanism of the transport of these metals in this region. We found concentration maxima not only of Fe, but also of the other trace metals in the halocline and/or near bottom waters with respect to both dissolved and total dissolvable fractions in the western Arctic Ocean. The distribution patterns were generally similar between dissolved and total dissolvable fractions for all trace metals. However, especially high concentration was observed in the near bottom water in the Chukchi Sea shelf with respect to total dissolvable Fe and Mn. On the other hand, Ni, Zn and Cd mainly existed as dissolved form. In this study area, the shelf sediments, melting sea-ice and river discharge are expected as the sources of trace metals as well as remineralization of organic matters. Among these potential sources, the remineralization is the common source for all metals measured in this study. Considering the maximum concentrations for Fe and Mn were found in the near bottom water in the Chukchi Sea shelf region, extra input such as sediments could be important. The relationship between the distance from sea-shelf and concentrations of dissolved trace metals showed that dissolved Fe and Mn in the halocline waters tended to decrease with distance logarithmically (especially in the lower halocline water), suggesting that distributions of dissolved Fe and Mn were mainly controlled by diffusion and mixing. Distributions of dissolved Cd and Zn were correlated well with phosphate concentration, suggesting that Zn and Cd were also transported to offshore via halocline water like as nutrients and dissolved organic matter. Since dissolved Ni concentration tended to be high in the surface mixed layer in this study area, the correlation with phosphate was poor. These results suggested the importance of the halocline water for the transport of Mn, Ni, Zn and Cd as well as Fe in the western Arctic during summer.

Reference

Hioki, N., K. Kuma, Y. Morita, R. Sasayama, A. Ooki, Y. Kondo, H. Obata, J. Nishioka, Y. Yamashita, S. Nishino, T. Kikuchi, M. Aoyama, Laterally spreading iron, humic-like dissolved organic matter and nutrients in cold, dense subsurface water of the Arctic Ocean, Scientific Reports, 4:6775 DOI:10.1038/srep06775, 2014.