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Contrasting behavior of nickel and copper on the Chukchi shelf is driven by iron redox cycling

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The waters overlying the Chukchi shelf are characterized by a sharp pycnocline and strong vertical gradients in several trace metals. The most notable feature is the enrichment of dissolved iron (Fe) between the pycnocline and sediment-water interface. Fe(II) accumulates in this zone even in the presence of oxidation presumably because oxidation rates are slow at low temperature and benthic fluxes are high. Here we consider the relationship between Fe(II) and another noteworthy feature - the contrasting distributions of nickel and copper in the Chukchi shelf. We measured dissolved copper (Cu) and nickel (Ni) concentrations from an archive of samples from 31 stations on the Chukchi Shelf during the 2013 Oshoro-Maru (C255) research cruise to examine these unique local processes of Cu and Ni cycling. Seawater samples were prepared by automatic preconcentration using a NOBIAS metal chelating column and analyzed on an Agilent 8900 triple quadrupole inductively coupled plasma mass spectrometer. While Cu concentrations are relatively uniform with depth, Ni is strongly enriched below the pycnocline at the stations that also display high Fe(II). It is likely that reduction of Fe and Mn oxides at the seafloor that supply Fe(II) to the overlying water also mobilizes Ni associated with these solid phases. Our results extend previous studies, providing a larger dataset and complimentary Fe(II) concentrations. Copper is probably strongly complexed by organic matter and thus may be largely decoupled from this cycle. Our results demonstrate that reducing conditions and local processes at the Chukchi Shelf lead to divergent behavior of Cu and Ni concentrations from typical global ocean depth profiles. These observations suggest that the Chukchi shelf can be considered a ferruginous regime - which is remarkable given the high oxygen concentrations throughout the water column. This may arise from a unique combination of circumstances including a shallow shelf, high supply of metals and organic matter from Arctic rivers and exceedingly low temperatures below the pycnocline. Fe(II) is not dominant in other low temperature regions like the Amundsen Sea, but the features may be widespread in other shelf regions in the Arctic that have yet to be explored.