Silicon Cycling and Shelf Input in the Central Arctic Ocean: Insights from Stable Silicon Isotopes

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The Arctic Ocean, is surrounded by extensive shallow shelves and receives water from the Atlantic and Pacific oceans and freshwater from Siberian and Canadian rivers. Below 200 m water depth, the major inflow is from the Atlantic, while brine formation on the shelves leads to formation of dense waters. In addition to input from and mixing of these sources, Si cycling can be influenced by primary production and particle fluxes. However, given the unique conditions of the Arctic Ocean, the relative importance of these factors for the biogeochemical Si cycle in the Arctic is poorly understood.

Here, we present the first study on the dissolved and biogenic Si isotope ($\delta^{30}Si$) composition from >200 m water depth in the Nansen, Amundsen, and Makarov Basins. The samples were taken in summer 2015 at 10 stations in the Central Arctic during GEOTRACES cruise GN04 (PS94, TransArc II). In general, the sampling coincided with the season of low sea ice concentration, high primary production and high river input.

Water profiles show an increase in dissolved Si (DSi) concentrations with depth whereas biogenic Si (bSi) profiles show higher concentrations at shallower depths decreasing toward greater depths. Both the $\delta^{30}Si_{DSi}$ and $\delta^{30}Si_{bSi}$ show higher values around 500 m and decrease toward greater depths. Such pattern indicates an incursion of isotopically heavier water from the shelves, predominant dense Arctic Atlantic Water that was identified and quantified using Optimum Multi Parameter Analysis. In contrast to expectation, $\delta^{30}Si_{bSi}$ decreases with depths >500 m, possibly due to the contribution of vertically fast sinking diatom aggregates or bigger diatom cells that are not uniformly remineralized. However, due to the low concentrations of bSi, the remineralization and release of low $\delta^{30}Si_{bSi}$ signatures does not influence the deep water column $\delta^{30}Si_{DSi}$.

We concluded that the factors influencing the cycling of Si in the central Arctic below 200 m water depth are mainly shelf water input, conservative mixing and particle fluxes, in contrast to other ocean basins, where primary production plays a major/important role.