Tracing changes in winter biogeochemical processes in Arctic rivers with amorphous silica precipitation

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The ice-covered period of large Arctic rivers is shortening. To what extent will this affect biogeochemical processing of key nutrients during winter months? Here we reveal, with silicon isotopes ($\delta^{30}Si$), a key winter pathway for nutrients under river ice. During colder winter phases in the Lena River catchment, conditions are met for frazil ice accumulation creating microzones. These are conducive for lengthened reaction time for biogeochemical processes under ice. The heavier $\delta^{30}Si$ values (3.5 ± 0.5 ‰) in river water reflect that 39 ± 11% of the Lena River discharge went through these microzones. This can be explained by the supersaturation and precipitation of amorphous silica preferentially incorporating the lighter silicon isotopes, leaving the water isotopically heavier. Amorphous silica precipitation concomitant to an increase in ammonium concentration and changes in dissolved organic carbon aromaticity in Lena River water support microbially mediated processing of key nutrients (carbon, nitrogen) in these microzones. In a warming scenario considering shorter ice-covered periods, decreasing winter microbial processes in large Arctic rivers will decrease nitrogen supply to the Arctic Ocean, a key limiting nutrient.

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