Mechanisms of nutrients enclosure inside benthic microbial mats in Antarctic oligotrophic lakes by combination approach of observation data and theoretical study

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The most of water bodies of freshwater lakes in continental Antarctica are considered to be nutrients limited (Hawes et al. 1993). Our previous study on 17 fresh water lakes in Syowa region, Antarctica showed that although the nutrient concentrations of lake water are oligotrophic, the interstitial water of benthic microbial mats surface were 3-220 times higher in DIN (dissolved inorganic nitrogen) concentrations and 2-102 times higher in phosphate than that of the lake water (Tanabe et al. submitted). The nutrient concentrations of the interstitial water in Antarctic lakes are either equaling or surpassing that of temperate eutrophic lakes. Also, there are no correlations between the lake water and the interstitial water in Antarctica, which the nutrient concentrations of the interstitial water have a wide range of variations although lake waters are almost same concentrations among the lakes. Then, it is considered that there are any mechanisms the nutrients hardly discharged from lakebeds to water column in Antarctica such like nutrients enclosure. To reveal the mechanisms, we used vertical profiles of the silicate and phosphate concentration inside benthic mat cores collected from Antarctic freshwater lakes, and examined the following 2 factors considered as controlling nutrients enclosure by model study. The first factor is viscosity coating on the mats surface and inside mats, the second is uptake by phototorophs in mats surface layer.

We established two diffusion models to represent dynamics of silicate and phosphate in lake water and benthic mat on the vertical axis. The diffusion model combined with effect of mat viscosity and biological consumption was used to predict the distribution of nutrient concentration and was compared with observation data. In the silicate model, we can exclude biological consumption because there are remarkably few organisms using silicate in Antarctic lakes such as diatom. Then, we firstly estimated the effect of mat viscosity on the molecular diffusion using silicate model. The silicate model showed a wide range of variations of viscosity, and inherent values of the viscosity depending on each lake were obtained. Next we estimated the biological consumption using phosphate model with estimated mat viscosity by silicate model, then this indicated that the phototrophs surely take in phosphate in the mat surface layer. Our study by combination of theoretical and observational approach suggests that a mechanism of nutrients enclosure inside benthic mats in Antarctic oligotrophic lakes is caused by viscosity of the mats and uptake by phototrophs.