Role of organic phosphorus in sediment in a shallow eutrophic lake

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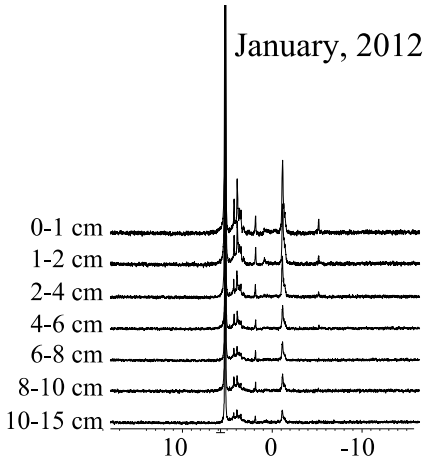
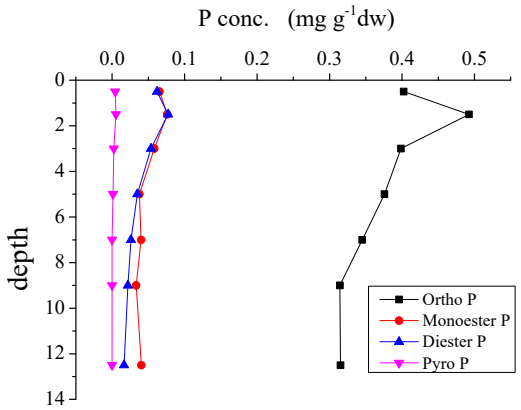
Introduction

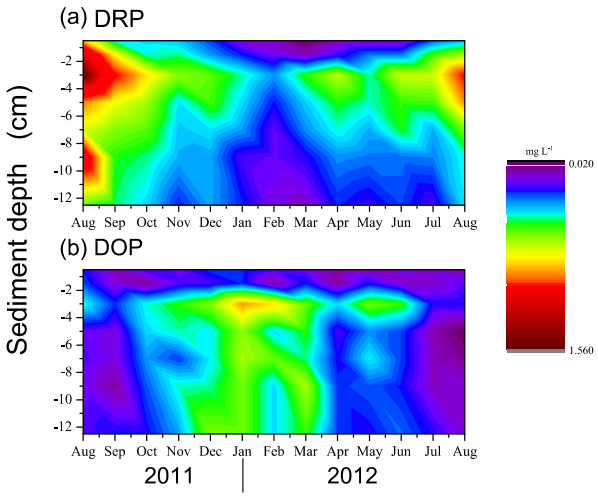
Phosphorus (P) is one of the most important nutrients for all living organisms in aquatic environments. Recently, not only inorganic P, but also organic P is considered as a source of P release from sediment to the overlying water. The current study clarified how solid phase and pore water P concentrations change in sediment in Lake Kasumigaura.

Hypothesis

We tested the hypotheses that (1) labile organic P compounds make up a part of the solid phase P in sediment; (2) changes in the organic P concentration in the solid phase affect the P concentrations in pore water; and (3) mineralization of dissolved organic phosphorus (DOP) in pore water is the major pathway for the change in the concentration of dissolved reactive P (DRP) in pore water from winter to spring.







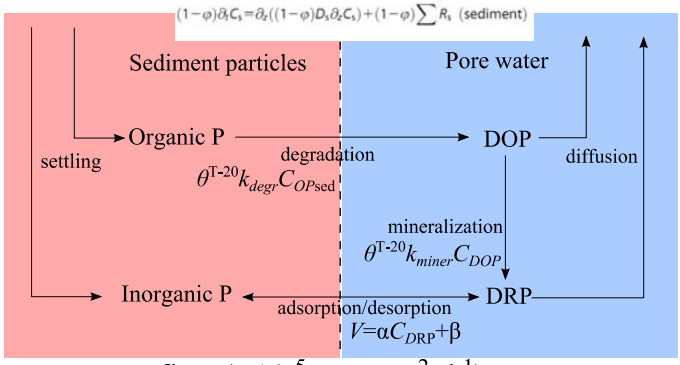
Results and discussion

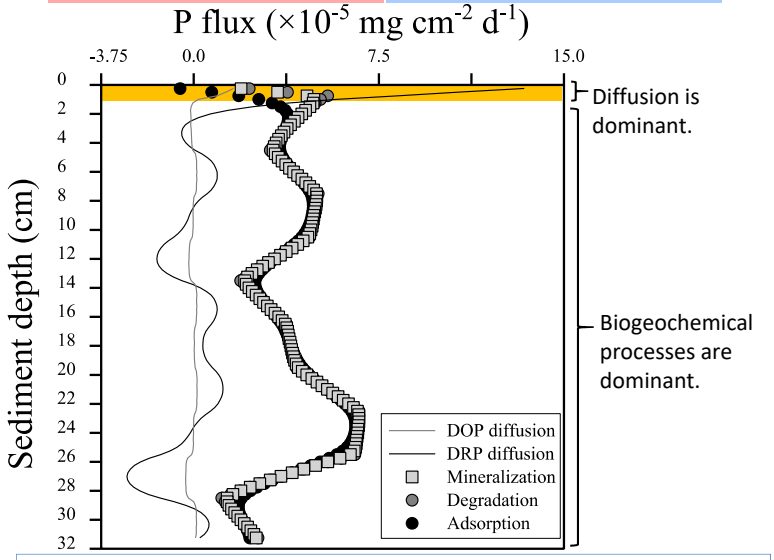
By ^{31}P nuclear magnetic resonance (NMR) spectroscopy analysis, labile organic P compound classes in the solid phase are attenuated with the sediment depth. This result indicates that labile organic P is degraded and released to the pore water. In pore water, we found a seasonal changes in the concentrations of P species; organic P in pore water (DOP) was high in winter whereas inorganic P (DRP) in pore water was high summer.

We developed a numerical simulation model to figure out the processes that dominate the processes: physical (diffusion) or biogeochemical (adsorption/desorption or degradation) between solid and solution phases. The results of the current study suggest that physical processes are dominant in the top layer (0-1cm). On the other hand, biogeochemical processes are dominant in the sediment depth of more than 1 cm.

$$\varphi\partial_t C_p = \partial_z(\varphi D_p \partial_z C_p) + \varphi\sum R_p \quad \text{(pore water)}$$

$$(1-\varphi)\partial_t C_s = \partial_z((1-\varphi)D_s\partial_z C_s) + (1-\varphi)\sum R_s \quad \text{(sediment)}$$





Methods

Lake Kasumigaura is a shallow, eutrophic lake, located on the suburb of Tokyo. The water is used for drinking water. We collected sediment at the center of the lake and sliced along with the sediment depth.

We used ^{31}P NMR to analyze the P species. We also used numerical simulation model to analyze the processes dominant in sediment.

References:

Shinohara et al. (2017) Changes in the composition of phosphorus (P) compound groups in sediment and P in sediment pore water in a shallow eutrophic lake: a ^{31}P NMR study. Limnology, 18, 141-151.

Shinohara et al. (2017) Role of organic phosphorus in sediment in a shallow eutrophic lake. Water Resources Research, 53, 7175-7189