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Laboratory experiment to determine phosphate release rates from sediments of a formerly oligotrophic lake (Silbersee, Cuxhaven)

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The Silbersee is a small, formerly oligotrophic lake in northwestern Germany which still contains rare character species for oligotrophic lakes (Isoëtes lacustris, Littorella uniflora) threatened by eutrophication. It was suspected that the lake sediments and the redox conditions in the hypolimnon play an important role with regard to eutrophication, potentially releasing phosphorus (P) into the water column. This was the motivation to conduct experiments to estimate the release rate of phosphorus into the lake. It had been noted that the P concentrations in the bottom water were higher during summer in the stagnation phase, when conditions turned sulfidic. Eight sediment cores were taken with a Mondsee-corer (manufactured by UWITEC) at different sites of the lake. The thickness of the sediment within the cores ranged from 15cm to 35 cm and were overlying by approximately 40cm of lake water water. The headspace was approximately 10cm. The cores were stored in a fridge first under oxic, then under anoxic conditions as observed in the lake bottom water in the different seasons. Redox conditions were maintained by bubbling with oxygen and nitrogen gas during the respective time periods. During the experiment, the temperature was held constant to match the water temperature measured at the bottom of the lake ($\sim 7 \pm 1°C$). Concentrations of total phosphorus (TP) and dissolved phosphorus (DP), iron (Fe) and dissolved oxygen (DO) as well as pH were measured under oxic and anoxic conditions in the water column. The results showed that TP, DP and Fe concentrations were higher under anoxic conditions than under oxic conditions. The observed increase of phosporous in the water column during the anoxic phase was presumably a result of (i) reductive Fe-oxides dissolution and the corresponding loss of sorption sites and (ii) desorption of phosphorous via surface complexation reactions due to pH changes during the experiment.