Cycling of calcite in hard water lakes of different trophic states

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ABSTRACT: Based on oxygen (O_2), pH, calcium (Ca^{2+}), and carbonate (CO_3^{2-}) sediment pore-water concentration profiles, we compare the benthic dissolution of autochthonous calcite in oligotrophic Lake Lucerne and eutrophic Lake Sempach. Despite their difference in trophic state, the two lakes have similar benthic O_2 regimes because L. Sempach is artificially oxygenated. This peculiarity enabled the study of the direct effect of trophic state on benthic calcite dissolution. Although areal benthic O_2 fluxes did not differ, O_2 penetrated deeper into the sediment of the oligotrophic L. Lucerne, where most organic matter (OM, 96%) was degraded aerobically, whereas in L. Sempach, aerobic and anaerobic decomposition contributed about equal amounts to the biogenic carbon dioxide production. Release rates of bicarbonate from L. Sempach sediments exceeded those of L. Lucerne nearly twofold. The HCO_3^- : Ca^{2+} ratio of benthic fluxes was 3.7 in L. Lucerne compared to 10.3 in L. Sempach, suggesting that in L. Sempach most of the released HCO_3^- did not originate from calcite dissolution. Furthermore, benthic calcite dissolution in L. Lucerne exceeded that in L. Sempach by two-fold, despite lower pH values in the pore water of L. Sempach. Differences in benthic microbial decomposition of OM and redissolution of calcite crystals are explained by the longer residence time of OM and calcite in the oxic sediment layer of the oligotrophic lake and the larger weight-specific surface area of its smaller autochthonous calcite crystals. We suggest that trophic state and O_2 supply to the sediment are key parameters controlling the cycling of calcite and organic carbon in lakes.

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