Light-induced redox cycling of iron in circumneutral lakes

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ABSTRACT: The light-induced redox cycling of Fe"/Fe"' was studied both in laboratory experiments and in the field in two circumneutral Swiss lakes: Greifensee, a eutrophic, natural water body, and Melchsee, an oligotrophic, artificial mountain lake. To determine Fe" at the nanomolar level, an automated flow-injection analysis system was used. Irradiation by simulated sunlight leads to pH dependent (pH 6.9-9.1) steady-state Fe" concentrations which are similar in samples from both lakes. However, the kinetics of Fe"' reduction and of apparent Fe II oxidation are considerably faster in Melchsee. On the basis of experimental results and on modeling that uses literature values of known chemical transformation processes, we suggest that superoxide may be a key parameter for light-induced iron redox cycling in these lakes. Field measurements of [Fe"] in Greifensee and Melchsee show a pronounced day/night cycle, with Fe" concentrations of ~0.1-0.2 nM at night and up to 0.9 nM near the surface during the day (pH 8.0-8.5). Depth profiles of [Fe"] have two maxima: one at the surface and the second one at a depth of 5-10 m. Empirical rates and measured physical parameters were included in a model to simulate [Fe"] as a function of time and depth. The model results indicate that Fe" at the surface of both lakes is produced by light-induced processes, whereas the deeper Fe" maxima at depths with maximal chlorophyll a concentrations are probably due to a combination of biologically and photochemically induced processes.

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