SOLAR RADIATION AS THE LIKELY CAUSE OF ACID-SOLUBLE RARE-EARTH ELEMENTS IN SEDIMENTS OF FRESH WATER HUMIC LAKES

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We studied photochemically induced precipitation of Rare Earth Elements (REEs) in water from a tributary to Plešné Lake, and a tributary to Jiřická Pond, Czech Republic. Both tributaries had high concentrations of dissolved organic matter (DOM, ~1.8 mmol C L^{-1}). Filtered (0.2 µm) samples were exposed to artificial solar radiation of 350 W m^{-2} for 48 to 96 hr, corresponding to 3 to 6 days of natural solar radiation in summer at the sampling locations. Experiments were performed with altered and unaltered pH ranging from 3.8 to 6.0. The formation of particulate REEs occurred in all exposed samples with the fastest formation observed at the original pH. The formation of particulate metals continued in irradiated samples after the end of irradiation, suggesting that photochemically-induced reactions and/or continuing precipitation continue in darkness or in deeper water due to mixing. Results were compared with paleolimnological records in Plešné Lake sediment. At pH 5.0, the photochemically-induced sediment flux was 3509 nmol m^{-2} y^{-1} for Ce, corresponding to 42% of the REEs' annual sediment flux in recent sediment layers. Combining the formation rates obtained in the laboratory irradiation experiments and known one-day incident solar radiation enabled the estimation of a possible REE sediment flux. For Plešné Lake, the photochemically-induced formation of particulate REEs explained 10–44% of the REE concentrations in the upper sediment layers. Observed photochemically-induced sequestration of REEs into sediment can explain a significant part of the REEs' history in the Holocene sediment.