MAJOR BIOGEOCHEMICAL CHANGES IN A 7000-YEAR-OLD STRATIFIED LAKE AS REVEALED BY ELEMENTAL, ISOTOPIC AND MOLECULAR SIGNATURES

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Lake Pavin (92 m depth), in the Massif Central, is one of the few meromictic lakes in Europe and likely the only one in France. The volcano it rests upon was formed at 6900 cal BP, which makes it the most recent volcanic structure in mainland France. In this study, the elemental, molecular and isotopic characterization of the organic matter preserved in a 14-m long sediment core collected from the deepest part of the lake allowed reconstruction of the lake's history and biogeochemical functioning since its formation a few years/decades after the volcanic eruption.

Following the rapid development of the lacustrine aquatic ecosystem from 6900 BP onward and *ca*. 10 centuries of intense microbial and phytoplanktonic productivity, euxinic conditions developed in the water column and reached the photic zone, as revealed by lipid biomarkers characteristic of anoxygenic phototrophic bacteria. The rise of sulfides in the water column associated with a high-discharge event from the catchment (evidenced by XRF data), probably due to an increase in rainfall, was likely responsible for the collapse of the whole lake ecosystem observed around 3900 years cal BP, at which time almost no productivity was observed. This extinction event was followed by a second period of intense aquatic (both microbial and phytoplanktonic) productivity, which developed despite remaining euxinic conditions (and partial photic zone anoxia) and lasted *ca*. 2000 years. The Lake Pavin water column thus remained euxinic over more than 3000 years, during which time N_2-fixating micro-organisms (likely cyanobacteria) seemed to have developed intensively, as previously observed during some oceanic anoxic events (Kuypers et al., 2004). This long-standing euxinic period ended with further major environmental perturbations, which again interrupted the biogeochemical functioning of the lake. Indeed, two recent events (*ca*. AD 600 and AD 1300) induced the destabilization and sliding of surrounding littoral sediments to the bottom of the lake, evidenced by the presence of *ca*. 4 meters of discontinuous slump deposits within the sedimentary record (Chassiot et al., 2016). The first event may correspond to a partial opening of the crater wall, potentially induced by seismic triggering and a decreased water level. Surprisingly, the biogeochemical functioning of the lake drastically changed following this sedimentological event. It apparently marked the end of photic zone euxinia, likely initiated the (still evident) meromictic and ferruginous characteristics of the lake, and allowed the reappearance of phytoplankton species adapted to well-oxygenated surface waters.

Our results thus highlight Lake Pavin's unusual biogeochemical history, which constitutes a powerful model for studying the impact of long-standing euxinia on the structure of aquatic

communities, and which documents a rare case of an aquatic ecosystem shifting from sulfidic to ferruginous conditions.

References

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