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# A multiproxy study of Holocene water-depth and environmental changes in Lake St Ana, Eastern Carpathian Mountains, Romania

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This study presents the results of a multi-disciplinary investigation carried out on the sediment of a crater lake (Lake Saint Ana, 950 m a.s.l.) from the Eastern Carpathian Mountains. The lake is set in a base-poor volcanic environment with oligotrophic and slightly acidic water. Loss-on-ignition, major and trace element, pollen, plant macrofossil and siliceous algae analyses were used to reconstruct Holocene environmental and water-depth changes.

Diatom-based transfer functions were applied to estimate the lake's trophic status and pH, while reconstruction of the water-depth changes was based on the plant macrofossil and diatom records. The lowest Holocene water-depths were found between 9,000 and 7,400 calibrated BP years, when the crater was occupied by Sphagnum-bog and bog-pools. The major trend from 7,400 years BP was a gradual increase, but the basin was still dominated by poor-fen and poor fen-pools. Significant increases in water-depth, and meso/oligotrophic lake conditions were found from 5,350(1), 3,300(2) and 2,700 years BP. Of these, the first two coincided with major terrestrial vegetation changes, namely the establishment of Carpinus betulus on the crater slope (1), and the replacement of the lakeshore Picea abies forest by Fagus sylvatica (2). The chemical record clearly indicated significant soil changes along with the canopy changes (from coniferous to deciduous), that in turn led to increased in-lake productivity and pH. A further increase in water-depth around 2,700 years BP resulted in stable thermal stratification and hypolimnetic anoxia that via P-release further increased in-lake productivity and eventually led to phytoplankton blooms with large populations of Scenedesmus cf. S. brasiliensis. High productivity was depressed by anthropogenic lakeshore forest clearances commencing from ca. 1,000 years BP that led to the re-establishment of Picea abies on the lakeshore and consequent acidification of the lake-water. On the whole, these data allow the following main inference to be made: Lake Saint Ana is a vulnerable ecosystem; hydrological, biological and chemical processes in the lake are heavily influenced by the lakeshore forest and the soil underlying it. In-lake productivity is higher under deciduous canopy and litter, and considerably repressed by coniferous canopy and litter. The lake today subsists in a managed environment, that is however far from its natural state. This would be a dense Fagus sylvatica forest supplying more nutrients and keeping up a more productive in-lake flora and fauna. An overview of the regional Holocene lake-level records suggests that the general lake-level trends of this study agree with other records in the region, except for the lat 2,700 years, for which conflicting trends were found. The pollen based palaeo-precipitation record in NW Romania signals lower precipitation, while our, and some other records, signal significant increase in available moisture. Further studies are needed to resolve this problem.