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Biogeochemical impacts of volcanic eruptions on alkaline lake environments: A case study on Lake Van in the eastern Turkey

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Volcanic ashes ejected during explosive volcanic eruptions can release more than fifty-five soluble elements in contact with water, most of which have environmental significance such as fluoride, chloride, the nutrients like the fixed-nitrogen, phosphate, silica and a variety of key trace metals including iron. Deposition of volcanic ash onto the aqueous environments can therefore affect the water geochemistry and eventually the phytoplankton growth in the ash fallout regions. Alkaline (soda) lakes are distributed world-wide and located almost exclusively in the volcanic regions, which have been related to the long term dissolution of volcanic products. However, although alkali lakes are found in the high volcanic impact regions, the way in which the biogeochemistry of the alkaline lake waters is affected by the volcanic eruptions still remains unknown. Lake Van, located in the eastern Turkey, is the largest of the alkaline lakes on Earth and had been exposed to various volcanic ash fallouts produced by the historical eruptions of neighbouring semi-active volcanoes Nemrut, Süphan and Tendürek. Here, we present new data from geochemical analyses of Lake Van sediments, aiming to determine the potential changes in the primary productivity related to the volcanic eruptions, by using organic biomarkers such as pigments chlorin and fucoxanthin, long chain alkenons, total organic and inorganic carbon contents of sediment layers above and below the ten selected tephra fallout deposits dating back from 1 ka to 82 ka. Furthermore, we have performed microscopic observations of the microfossils (diatoms and coccoliths) in the Lake Van sediments. Our data pointed out variable changes related to different fallout deposits including significant positive (fertilizing affect) and negative (toxic affect) impacts and as well as nearly negligible changes in the biomarker concentrations in the sediments overlying the ten tephra layers compared to the underlying sediments. We suggest that different biogeochemical responses to volcanic eruptions could have arisen from the type and magnitude of the volcanic eruptions and/or the initial biogeochemical and paleoclimatical conditions of Lake Van waters during the ash fallout events occurred in the past 82 ka.