

Sediments from the karstic lake Visovac (Krka River, Croatia)

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Sediments from the karstic lake Visovac (Krka River, Croatia) were investigated to evaluate metal input and temporal and spatial environmental changes. Sediment was sampled at three locations (VT, VL, VS) (Fig. 1) using a hand driven acrylic corer by scuba diver where undisturbed sediment and continuous sedimentation were expected. In total 14 sediment cores (15 cm) were analysed for sediment content of major (Ca, K, Fe, Mg, Ti, Al) and minor (Pb, Cu, Zn, Rb, Sr, Zr, Ba) elements, activities of natural radionuclides (⁴⁰K and ²³²Th), stable isotope compositions of organic carbon and nitrogen ($\delta^{13}\text{C}_{\text{org}}$ and $\delta^{15}\text{N}$), as well as stable isotope composition of sedimentary carbonate ($\delta^{13}\text{C}_{\text{carb}}$ and $\delta^{18}\text{O}_{\text{carb}}$).

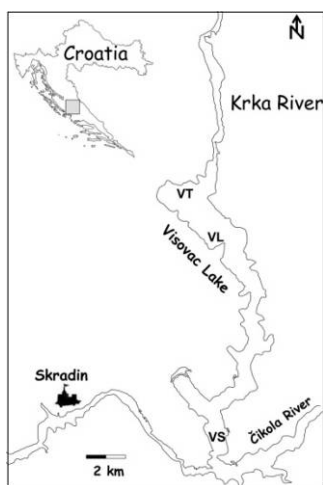


Fig. 1.: Visovac Lake with sampling locations.

Correlation coefficient method was used to assess the interrelations between the investigated elements that could indicate the existence of the same source or behavior for two or more elements. Correlation was made between the normalized element concentrations. The Al was used as conservative parameter. Only correlations with $p < 0.05$ or better, that simultaneously have $c.c. > 0.7$ are taken into account. Strong positive correlations were found between the contents of Al, Fe, K, Zr, Rb and Ti. The Al, Fe, K and Ti are typical terrigenous elements, so dependencies between these elements can be explained by their common natural source, most probably originating from erosion of bauxite deposits and terra rossa, which are present in this area (Miko *et al.*, 1999). Very strong dependencies were also found between the sediment content of Ca and Sr ($c.c. = 0.99$), Ca and Ba ($c.c. = 0.96$), Ba and Sr ($c.c. = 0.96$). Strong positive correlations between these elements indicate their common association with carbonates. The Zn and Mg show no significant correlation with the

rest of analysed elements. Such behavior of Zn is probably consequence of its anthropogenic origin. Regarding sediment quality guidelines (SQG) for freshwater ecosystems (MacDonald *et al.*, 2000) Zn is only analysed element whose concentrations (10-15 cm, upper part of the Lake) were above TEC value. The Pb and Cu were below the detection limit.

Observation of spatial and temporal variation of typical terrigenous elements (Al, K, Fe, Ti) showed that much higher values can be found in the upper part than in the lower part of the Lake. This indicates that majority of terrigenous material was deposited in the upper part of the Lake Visovac. Observed decrease of values with depth indicates decrease of terrigenous material input over time. These temporal and spatial changes were conferred by activities of natural radionuclides.

Variations in carbonate C and O stable isotope composition are a result of a combination of changes in abundance of particulate and dissolved C sources, through biogeochemical processes and erosion (Herczeg *et al.*, 2001). The obtained $\delta^{13}\text{C}_{\text{carb}}$ and $\delta^{18}\text{O}_{\text{carb}}$ values at all investigated sites are typical for authigenic lacustrine environments (Cukrov *et al.*, 2013). This indicates that the primary source of carbonate in the sediment is the in-situ precipitation from the river water constantly supersaturated with respect to calcite (Lojen *et al.*, 2004). Obtained $\delta^{15}\text{N}$ values are found in narrow range (between 5.4‰ and 7.9‰) and increasing with depth. $\delta^{15}\text{N}$ values in general resemble the values observed in lakes with predominant autochthonous primary production (Vreća & Muri, 2006). Obtained $\delta^{13}\text{C}_{\text{org}}$ values are found in wide range (between -34.77‰ and -29.39‰) and increasing with depth. Large differences between surface layer and 10-15 cm layer indicate a gradual change in SOM sources and diagenetic processes – decomposition of SOM that modified its carbon stable isotope composition (Cukrov *et al.*, 2013).

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