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Influence of Mining Related Activity on Heavy Metals in Water and Sediment from the Kalimanci Lake (NE Macedonia)

T. Dolenec (1,2), T. Serafimovski (3), **M. Dolenec** (1), M. Dobnikar (1), G. Tasev (3), B. Pivko (1)

(1) Faculty of Natural Sciences and Engineering, University of Ljubljana, Aškerčeva 12, 1000 Ljubljana, Slovenia (matej.dolenec@s5.net), (2) Department of Environmental Sciences, Jožef Stefan Institute, Jamova 39, 1000 Ljubljana, Slovenia, (3) Faculty of Mining and Geology, Goce Delčev 89, 2000 Štip, Macedonia

Due to the lack of regulations and an environmental programme the Pb-Zn ore district at Sasa in northeastern Macedonia is now a residential area suffering from the considerable consequences of poorly regulated mining and tailing activities. In this study, sediment and water samples from Kamenica River and the artificial Kalimanci Lake, constructed for the purposes of irrigating the paddy field of the Kočani Field, as well as the tailing materials were analyzed with the ICP-MS and ICP-AES methods for their major, minor and trace element compositions to assess the possible effects of the base-metal mining activities on the Bregalnica riverine and Kalimanci Lake ecosystems.

Highly elevated concentrations of Pb (20.350 mg/kg), Zn (19.850 mg/kg), Cu (641 mg/kg), As (90 mg/kg) and Cd (233 mg/kg) in the Sasa tailing materials are a potential source of riverine, lake water and sediment contamination with these heavy metals. The large contaminant increases in the sediment and water below the tailing dam. Although the heavy metal concentrations in the stream sediments and water decreases with increasing distance from the tailings, high levels of Pb (6.734 mg/kg), Zn (7.707 mg/kg), Cu (298 mg/kg), As (100 mg/kg) and Cd (69 mg/kg) were also measured in the Kalimanci Lake sediments. The Kamenica River, below the tailing dam, has fairly high concentrations of Pb (5.120 μg/L), Zn (1340 μg/L), Cu (26 μg/L), As (2.4 μg/L) and Cd (9,2 μg/L). Further downstream, where the river discharged into

the lake, non-contaminated waters of the Bregalnica River, which is the main feeding source of the lake water, dilute the heavy metal water concentrations of the Kamenica River. Although the Bregalnica River below the lake exhibit elevated sediment metal concentrations its heavy metal content mostly decreased to background values: Pb (2.4 μg/L), Zn (67 μg/L), Cu (3 μg/L), As (0.53 μg/L) and Cd (0.39 μg/L). The extent of metal removal in the Kalimanci Lake can be controlled by precipitation-dissolution and co-precipitation reactions as well as by adsorption on other mineral phases, mostly Fe and Mn oxides and hydroxides. This is indicated by a strong correlation ($r > 0.89$) between the analysed heavy metals and the Fe and Mn content in the lake sediments. To clarify the heavy metal impact on the water and lake sediment and to assess the ecological effects due to their possible transfer from sediment and water into the food web further studies, including heavy metal analyses of biota are warranted.