

Geochemistry and environmental impact on groundwater in Eastern Serbia

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Contamination of water bodies is a large problem in many mining areas in the world. Mining activities have been carried out for about 120 years in Eastern Serbia. Nowadays, there are four active copper mines in two mining areas, the Bor mining area and the Majdanpek mining area, in Eastern Serbia. The long history of mining in Eastern Serbia causes serious environmental problems, which are most pronounced on water pollution downstream of the mining sites. Many studies focused on river water pollution. However, there is no comprehensive research about groundwater in Eastern Serbia. Therefore, this research aims to clarify the geochemistry of groundwater and to know whether mining activities give an effect on groundwater quality or not.

Sample collection was carried on in August and September 2019. The total number of groundwater samples was 172, including 144 samples collected from wells, 23 cold spring samples, 3 hot spring samples and 2 samples from boreholes. All water samples were filtrated through a 0.2 μm cellulose acetate hydrophilic filters. After filtration, two kinds of samples were prepared. They are non-acidified samples used for the determination of major elements and acidified samples (with ultrapure HNO_3) used for the determination of trace elements. In the field, coordinates of sampling points, pH and Eh values, water temperature and the concentration of HCO_3^- were also determined.

To understand the geochemical signature and environmental impact of groundwater in the study area, geochemical maps were created. Threshold values for discrimination of anomalous populations from background populations were also estimated for Ca^{2+} , SO_4^{2-} , Cu and As.

Groundwater in the study area is characterized by pH values from 6.4 to 8.8 and a high concentration of HCO_3^- (30 to 930 mg/L). In general, groundwater from the study area has good quality. However, anomalous concentrations of Ca^{2+} , SO_4^{2-} , Cu and As are recognized in groundwater around ore deposits of the Bor mine and along polluted rivers downstream of the Bor mine. Distributions of anomalous concentrations of major elements (Ca^{2+} and SO_4^{2-}) in groundwater are similar to the distributions of anomalous concentrations of these components in river water. Therefore, there is a possibility that groundwater along highly polluted river water in the Bor mining area is affected by acid mine drainage bearing-river water. Based on mass balance calculation between components in polluted river water and groundwater, polluted river water having high concentrations of Ca^{2+} and SO_4^{2-} in riverbed sediments flows into groundwater in the area where the water surface level of polluted river water is higher than the level of the groundwater table. On the other hand, the mixing was not observed based on the mass balance calculation based on the concentrations of Cu and As in river water and groundwater because of the precipitation of these elements as a result of the change of pH value from acidic to neutral. An appropriate component for groundwater monitoring in mining areas located in Eastern Serbia is SO_4^{2-} , which can be present as aqueous species without precipitation in groundwater from acidic to neutral pH.

Keywords: Bor, Groundwater pollution, Mining activities, Threshold value

