

Geochemical and isotopic characteristics of groundwater from Velenje Basin, Slovenia

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The Velenje Basin in Slovenia is one of the largest actively mined coal basins in central Europe, producing around 4 million tons of lignite per year. Large amounts of groundwater are extracted from aquifers to facilitate underground mining of coal, and coal seam gas outbursts are a serious mine safety concern. This study analyses the geochemical and isotopic composition of groundwater to provide a general understanding of hydrogeological and geochemical processes in groundwater.

Thirty-eight groundwater samples were taken from dewatering objects in the mine and at the surface in years 2014–2015. Groundwater in the Triassic aquifer is dominated by hydrogen carbonate, calcium, magnesium and isotopic composition of dissolved inorganic carbon in the range from -19.3 to -2.8‰ indicating degradation of soil organic matter and dissolution of carbonate minerals. In contrast, groundwater in the Pliocene aquifers is enriched in magnesium, sodium, calcium, potassium, and silicon, and has high alkalinity, with isotopic composition of dissolved inorganic carbon in the range of -14.4 to $+4.6\text{‰}$. Based on isotopic composition of dissolved inorganic carbon values in all aquifers (Pliocene and Triassic), influencing processes are the dissolution of carbonate minerals and dissolution of organic matter, and additionally methanogenesis in the Pliocene aquifers. Based on the Principal Component Analysis (PCA) we can conclude that following different types of groundwater in Velenje Basin could be distinguished based on geochemical and isotopic data: Triassic aquifers with higher pH and lower conductivity and chloride, Pliocene, Pliocene 1 and Pliocene 2 aquifers with lower pH and higher conductivity and chloride contents, and Pliocene 3 and Pliocene 2, 3 aquifers with the highest pH and lowest conductivity and chloride contents.

Major dissolved gas component in groundwater are carbon dioxide, nitrogen and methane. Concentrations of dissolved gases dewatering Triassic strata are low, indicating no bacterial activity in comparison to groundwater dewatering Pliocene aquifer. Isotopic composition of oxygen and isotopic composition of hydrogen indicates that the water is recharged from local precipitation. Isotopic composition of carbon in methane from groundwater dewatering Pliocene aquifer exhibits values in the range of -77.7 to -65.4‰ and isotopic composition of deuterium in methane from -231.8 to -162‰ indicating bacterial origin.