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Hydrogeochemical changes in thermal waters of the Western Pannonian Basin

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Abstract

Due to the continuous thermal water abstractions of the last 50 years, in some sub-regions of the western part of the Pannonian Basin groundwater heads significantly decreased. New aquifer layers started to contribute to thermal wells, which in some cases leads to changes in the hydrogeochemical composition. Mixtures of different chemical types of thermal water are the results of these changes. To characterize the changing process, study of the hydrogeochemical composition of thermal waters was performed, and end-members of the mixing processes were identified. Finally, hydrogeochemical models were developed applying PHREEQC to simulate the processes and follow the ongoing changes.

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Keywords: thermal water, overexploitation, hydrogeochemical modelling

1. Introduction

The study area is situated in the Alpokalja region of Hungary, where several famous spas are found, such as Sárvár and Bük in Hungary, or Lutzmannsburg on the Austrian side of the national border. The balneological utilization started at the beginning of the 1960s and nowadays more than 20 active wells can be found in the region.

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Besides the current thermal utilization, hydrocarbon investigation was carried out in the area. Although the explored gas most often contains CO_2 [6], the intensive research, including deep drillings and different-type geophysical measurements, resulted in important new geological and geothermal knowledge [5]. Furthermore, some of the hydrocarbon exploration wells have been transformed into geothermal wells.

The amount of the extracted thermal water has gradually increased for the last 50 years. The continuous withdrawals caused a decrease of groundwater heads in the vicinity of the concentrated utilization sites (Sárvár, Bük, Kapuvár, Szombathely, etc.). These local effects are not followed by a regional decrease of the groundwater head, but, in some locations, led to changes in the chemical composition of the thermal water. Also, new thermal water aquifers started to contribute to the withdrawals. The newly activated aquifers enable mixing of different chemical types of thermal water. To characterise the change, time series of the selected chemical components were created. In addition, studying the hydrogeochemical composition of thermal waters, potential end-members of the changing process were searched. Classical hydrogeochemical graphical methods were combined with cluster analysis in the course of the investigation. Hydrogeochemical models were developed applying PHREEQC software in order to identify the potential mixing end-members, simulate the processes, and follow the ongoing changes.

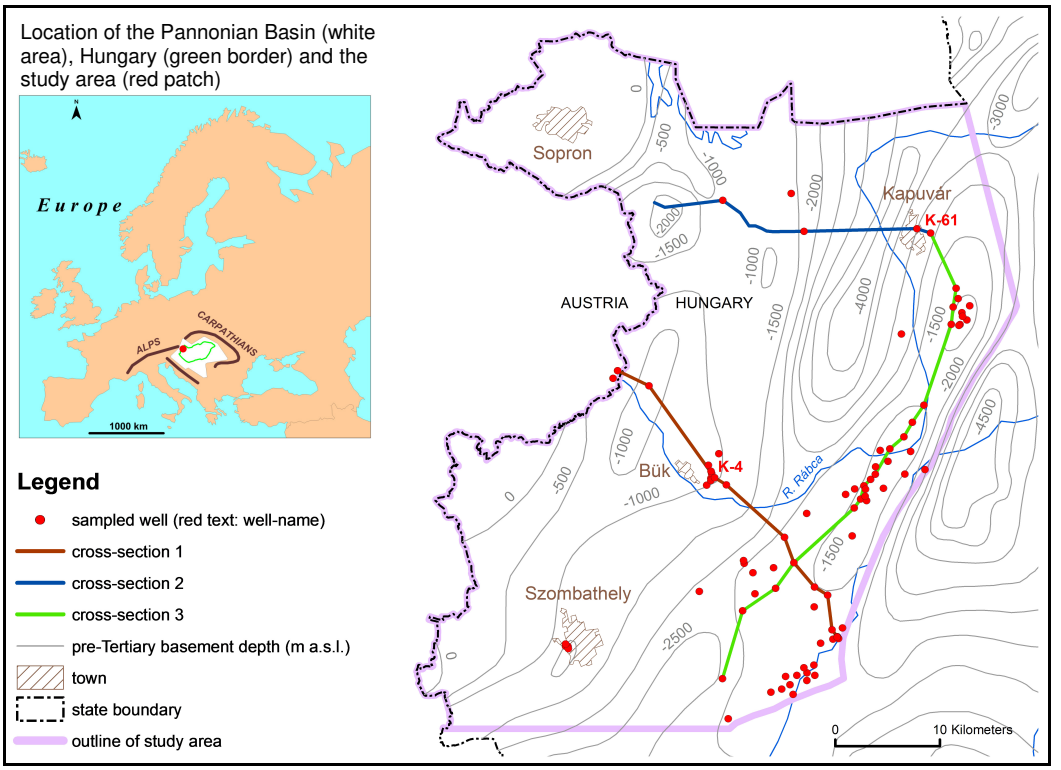

Fig. 1. Location of the study area

2. Geothermal reservoirs

Located in the western margin of the Pannonian Basin, the pre-Cenozoic basement is built up by different metamorphic formations of Penninic and Austroalpine nappe system units [4]. Due to the Alpine orogeny, these geological units show complicated structures of nappes and thrust sheets, separated by strike slip structures and normal fault systems [7, 8]. The surface of the pre-Cenozoic basement is variable. NE-SW oriented basement highs alter with deep trenches (Fig. 1) dividing the Neogene basin into several sub-basins. Although the Paleozoic and Mesozoic metamorphic crystalline basement has a low porosity, the upper weathered zone can be considered as a