Chemical tools for tracing subsurface water movements

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The aim of this work is to present how hydrochemical and isotopic data have been used to build a hydrogeological model for SE-Hungary representing the central part of the Pannonian Basin, a large Neogene sedimentary depression. Its Paleozoic-Mesozoic basement is overlain by marine to brackish Lower-Middle Miocene (0-3000m), lacustrine (Pannonian) and deltaic (Pontian) Upper Miocene (1000-3500m), lacustrine or fluvial Pliocene (hundreds of meters), and fluvial Pleistocene (tens to hundreds of meters). Due to the tectonics-related, uneven subsidence of the basement, the total thickness of sediments varies considerably; it is usually a few kilometers. Generally, three flow systems are described in the Pannonian Basin: a local one near the surface, a regional one mostly in the deep zone (down to the Pannonian/Pontian boundary), and an intermediate one (between local and regional) in the Pleistocene. The studied depth interval ranges from the near-surface to 2500m (from the Pleistocene to the Pannonian/Pontian boundary).

Exchange of mono- and bivalent cations between water and clay minerals, ratios of dissolved ions, maturity of organic matter, ^{14}C data, water stable isotopes and the $^{87}Sr/^{86}Sr$ ratio have been used to investigate the water flow systems, their recharge and discharge areas, and to reveal water movement or its lack. In the Pleistocene sediments, the relationship between mono- and bivalent cations and their continuous change indicate an ion exchange. The direction of flow path corresponds to the direction of increase or decrease in concentrations. Recharge and discharge areas are distinguished on the basis of the relationship between Ca and Sr. An upward seepage from the Pliocene through the Pleistocene layers is shown by the distribution of Na and Cl together with a parameter indicating the degree of maturation of organic matter. In the Pleistocene layers, ^{14}C data verify the flow models. Flow systems in the deeper (Pliocene and Pontian) layers are separated by Na and Cl concentrations, water stable isotopes and $^{87}Sr/^{86}Sr$ ratios.