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The Rhume springs revisited: A multi-tracer approach to one of the largest European carbonate-gypsum karst systems

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Modern karst ground water systems are at the cutting edge between atmosphere, hydrosphere, and geosphere and are impacted by the biosphere and anthroposphere. The hydrogeochemical processes in karst terrains are sensitive to both climate change and anthropogenic activity, thereby affecting the quality of these ground waters. Therefore, understanding the transport processes and hydrogeochemical interactions between surface and ground waters is of fundamental importance for the prediction of future quality developments of large drinking water resources.

The system of the Rhume spring, at the SW border of the Harz Mountains (Germany), one of the largest the largest European karst springs, has been investigated for hydrogeochemical and isotope variations to study the impact of river waters on the Rhume spring system. Rivers from the Harz Mountains are infiltrating Quaternary strata and emerging, after a passage through Permian (Zechstein) carbonate and sulfate rocks at the Rhume springs. By using a hydrogeochemical tracer approach it was found earlier, that an old mineralized ground water that had been modified by subterrestrial water-rock interactions is mixed with less mineralized younger karst waters before emerging in the different Rhume spring pits [1-4]. In the present communication, we present new results from a revisit of the Rhume springs and the rivers and streams in the direct and tributary recharge areas focussing on trace metal concentrations and multi-stable isotope signatures under different hydrological conditions. It was the aim of the investigation to re-analyze the proposed mixing model and provide additional evidence for a relative age estimate (H-3 dating) of the different waters emerging in the Rhume spring area. One focus was set on a high water-impact period.

By the application of a multi-tracer approach (e.g., Sr, Ba, Fe, Mn, Mo, PO4, Si), and different isotope systems (S-32/S-34 in sulfate; O-16, O-17, O-18, H-1, H-2, and H-3 in water, C-12/C-13 in DIC), and water temperature, a net mass balance approach for sub-terrestrial processes is applied. Chemically conservative elements and stable isotopes are used as mixing tracers to derive relative mixing proportions between surface and mineralized waters, emerging in the Rhume springs. Deviations from ideality for non-conservative elements are discussed. O-17 contents are followed in the system for the first time.

The eastern-most part of the springs (the so-called 'Johannis springs') are directly connected with the other springs, and carried the highest proportion of a mineralized ground water component of higher age. In contrast, the northern and north-eastern spring pits are more influenced by younger, less mineralized waters.

References:

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