Assessing SF₆ as a dating tool for young groundwater

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Due to the inertness and the well defined atmospheric input function, SF₆ was used in a number of studies as tool for dating surface and subsurface waters, which are separated from the atmosphere on a time scale of 0-40 a. However, especially for groundwater, the existence of natural sources, mainly in conjunction with fluorite containing minerals in the aquifer rocks or with volcanic areas became evident within the last decade, precluding the applicability of SF₆ as single dating tool. We report results from two case studies in which we applied SF₆ and ³He-³H dating of groundwater sampled at sites with different geological situations.

In the first study, the low mountain range of the northern Odenwald (South-West Germany) and the adjacent Rhine Valley plain in the west and hilly terrain in the north were sampled for young groundwater. The apparent SF₆-ages are distributed rather heterogeneously, covering the whole dating range for the majority of the samples. However, a clustering of exceptionally high concentrations was found in wells with groundwater originating from or influenced by the crystalline part of the investigated area. This finding indicates an association of natural sources with crystalline rocks, as discussed in a few earlier studies and explained by a radiochemical production mechanism for SF₆.

Data on radiogenic He and ²²²Rn from the same wells appear to support this hypothesis, as they tend to be correlated with SF₆.

The second study was conducted in the groundwater flow system of the North China Plain near the city of Shijiazhuang, consisting of fluvial and alluvial river deposits. The aim was the extraction of information about the recharge and the residence times of young groundwater covering the last decades and the comparison of ³H-³He- and SF₆-dating methods. However, the SF₆-results are partly dominated by a systematic non-atmospheric component, revealing that the dating with SF₆ is unreliable in this region. A correlation of non-atmospheric SF₆ and ³H-³He ages indicates a continuous accumulation of natural SF₆ in the groundwater of the sedimentary aquifers of the North China Plain.