Application of helium isotopes in shallow groundwater for geothermal exploration in the Upper Rhine Graben

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A noble gas study of shallow groundwater, focusing on $^{3}He/^{4}He$ ratios, was executed in three areas in the Upper Rhine Graben (Germany), covering both the eastern and western main faults of the rift system. Helium isotopes were applied to identify possible imprints of mantle derived fluids within the mostly young water of meteroric origin in the shallow aquifers [1]. In combination with other tracers – hydrogeochemistry including REEs, Sr and Li isotopes, REEs, ^{14}C, SF_6 and ^{3}H – the dataset is used to locate and characterise hydraulically active parts of the fault system with the goal to develop a toolset for cost-effective geothermal energy exploration.

Samples from the shallow aquifer at Groß-Gerau (western main fault) show an impact of mantle derived fluids revealed by $^{3}He/^{4}He$ isotope analyses, correlating with Sr isotope data [2] as well as an increase in salinity. The amount of ^{3}He suggests a mixing component of mantle derived fluid of approximatly 5% within the aquifer, restricted to spacially separate locations along the fault line.

In contrast, the investigation of two other sites at Heidelberg and Freiburg, both located close to the eastern main fault, could not identify any influence of mantle derived fluids in the uppermost aquifers, indicating an absence of hydraulically active sections of the fault within the sampling areas.

Our data supports the applicability of the selected set of tracers in geothermal exploration and fault characterisation, in order to narrow down the size of the field area for further geophysical exploration methods.

[1] Kennedy and van Soest (2007) *Science* **318**, 1433-1436 [2] Schmidt et al. (2014) *SDGG* **85**, 559-560