Earthquake impact on iron isotope signatures recorded in mineral spring water

JAN A. SCHUESSLER[1], HORST KÄMPF[1], ULRICH KOCH[2], MASHAL ALAWI[1]

[1]GFZ German Research Centre for Geosciences, Telegrafenberg, 14473 Potsdam, Germany (jan.schuessler@gfz-potsdam.de)
[2]August-Bebel-Str. 97, 08525 Plauen, Germany

We investigated the iron isotope signatures of dissolved Fe in the water of the Wettinquelle mineral spring (Bad Brambach, Germany) by time-series sampling covering seismically active periods related to tectonic activity near the Eger Rift system in central Europe. Our objective was to test whether Fe isotopes trace earthquake-induced abiotic and biotic changes in the fluid/rock interaction of the deep, fissured, granitic aquifer.

We found that the dissolved Fe isotope signatures in spring water are distinct from the granitic source signature ($\delta^{56}Fe$ = +0.09 ‰). Particularly, we discovered that water $\delta^{56}Fe$ values are remarkably stable (-0.01 ± 0.11 ‰, 2SD, n = 4) before and during a strong seismic swarm period in 2000 (local magnitudes $M_L > 3$), while O_2 and H_2 concentrations in water decrease and dissolved Fe content increases. Later, recurring events of lower $\delta^{56}Fe$ values down to -0.3 ‰ are observed in the period from 2001 to 2003 with intermittent seismic events ($1 < M_L < 3.2$).

The observations indicate a time lag between tectonic forcing and Fe isotope response. The role of abiotic fluid/rock interaction and Fe-utilizing bacteria identified in the mineral spring water on Fe isotope fractionation is discussed.

We explain recurring changes towards isotopically lighter values by a combination of Fe dissolution from deep granite and admixture of isotopically light Fe generated by a complex combination of abiotic and biotic processes operating in the aquifer when disturbed by swarm earthquake events. We propose a conceptual model scenario of earthquake-triggered changes in biogeochemical processes.