Syntectonic fluid flow in claystones: Constraints from stable isotopes of faults and calcite veins (Mont Terri, Switzerland)

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Investigations of fault rocks are crucial to estimate the sealing properties of rock formations, used as barriers for the storage of hydrocarbons, carbon dioxide gas or radioactive waste. Fault zones, even in tight claystones, might be associated with fluid flow. For this reason, the microfabrics of tectonic veins and fault rocks, exposed in the Mont Terri rock laboratory (NW Switzerland), were investigated using SEM and optical microscopy [1]. To reveal the provenance of calcite, precipitated in these structures, the $\delta^{18}O$ and $\delta^{13}C$ isotope ratios were measured from both syntectonic calcite as well as biogene and diagenetic carbonates of the host rocks.

The $\delta^{18}O$ values vary between 19.28 and 25.59 ‰ (VSMOW), whereas the $\delta^{13}C$ isotope ratios range between -2.28 and -0.44‰ (VPDB). An overprint by fluid flow is documented by a decrease in $\delta^{18}O$ (ca. 4‰) and $\delta^{13}C$ (ca. 1‰) from the intact rocks towards the syntectonic veins. Measurements of diffusively distributed calcite of the clay rich fault rocks confirm this trend in isotope fractionation.

The $\delta^{18}O$ signature depends on the origin and temperature of the precipitating fluids. The prevailing temperature during fault activity has been constrained at ca. 55 °C [2, 3]. Taking this temperature into account, we should expect a $\delta^{18}O$ of < -4 ‰ (VSMOW) of the vein-forming fluids, which is well below the marine porewater signature. A mixture of connate porewaters with palaeofluids, including a meteoric signature during deformation, is probable.

This imprint is not only visible in the calcite veins, but also in the diffuse scattered calcite inside the clay rich faults, documenting the degree of rock-fluid interaction in these domains, which is consistent with the microfabrics.

[1] Kneuker et al. (2017) *Eng. Geol.* **231**, 139-156. [2] Mazurek et al. (2006) *Basin Research* **18**, 27-50. [3] Nussbaum et al. (2011) *Swiss J. Geosci.* **104**, 187-210.