Geophysical Research Abstracts
Vol. 13, EGU2011-12819, 2011
EGU General Assembly 2011

Burial, exhumation and fluid flow in a Buntsandstein aquifer, central Germany

Norbert Kasch (1), Jens Köster (2), Robert van Geldern (3), Markus Wehrer (4), and Jonas Kley (5)

(1) Jena University, Institute for Geosciences, Jena, Germany (norbert.kasch@uni-jena.de), (2) jens.koester@uni-jena.de, (3) GeoZentrum Nordbayern, Friedrich-Alexander-Universität Erlangen, Germany (robert.van.geldern@geol.uni-erlangen.de), (4) markus.wehrer@uni-jena.de, (5) jonas.kley@uni-jena.de

We present a case study of fracture-controlled fluid flow and fluid-rock interaction in Triassic Buntsandstein redbeds from central Germany. Evidence for these processes is localized bleaching of the red sandstones, occurring as fringes of a few mm to a few cm width along joints. The fringes are most frequent on small joints and fine cracks and can be traced along individual joints for a few dm to m. We analysed the geometry of the bleached zones on a scale of a few cm by creating a 3D model from serial sections of a small sandstone volume. The model shows that the bleached cracks form an interconnected network and allows estimates of reactive surface per volume. Bleaching is essentially due to the removal of hematite coatings. No major new, iron-bearing phase was formed, except for Fe-rich cores in calcite cements.

The timing and depth of bleaching as well as the composition of the bleaching fluid are constrained by different data sets. Regional subsidence and exhumation analysis based on stratigraphic thicknesses, thermal maturity of organic matter and low-temperature thermochronology indicates that the Buntsandstein strata now at the surface had been buried to several km depth, probably in Jurassic or Early Cretaceous time. A first phase of more or less stratiform, patchy bleaching may have occurred at this stage. Joint-controlled bleaching clearly cross-cuts the bleached patches and must be younger.

The joint systems we studied always comprise several joint sets, but bleaching is essentially restricted to one north-trending set. This set is parallel to Miocene basalt dikes in the area. In underground salt mines, CO2 is found trapped within rock salt along north-trending zones, sometimes causing violent gas eruptions into mining galleries. Taken together, these observations suggest that bleaching along north-trending joints in the Buntsandstein is causally related to the migration of CO2-rich fluids associated with the basalt volcanism and was facilitated by a N-trending major horizontal stress. If this is correct, erosional remnants of volcanoes and lava flows indicating also constrain the depth of bleaching to about 500 m beneath the Miocene paleosurface. Today, CO2 percolates to the surface in CO2-enriched waters. We analyzed 12 samples of such waters from springs and boreholes. Their δ18O values correspond to meteoric waters. The δ13C (DIC) values of four water samples show signatures typical of volcanogenic CO2. Five samples contain mixed signals of volcanogenic and carbonatic CO2 or biogenic CO2 from soil. Volcanogenic and carbonatic CO2 are restricted to waters interpreted to rise along NW-SE striking faults which penetrate the basement and cross-cut Late Permian Zechstein carbonates underlying the Buntsandstein. Hydrocarbons released from Zechstein strata and admixed to rising fluids may have been instrumental in reducing hematite and bleaching. The switch of preferential fluid channeling from N-trending fractures in Tertiary time to NW-trending fractures today is compatible with a coeval rotation of the largest horizontal stress from N to NW, corroborating the control of fluid pathways by the contemporary regional stress field. Similar changes in the fluid flow regime may therefore have occurred over large areas of Germany.