Geophysical Research Abstracts, Vol. 8, 05801, 2006
SRef-ID: 1607-7962/gra/EGU06-A-05801

Fluid and gas migration in the North German Basin

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Detailed studies of fluid inclusions (microthermometry, laser-Raman spectroscopy, crush-leach and laser ablation ICP-MS analyses) as well as sulfur isotope analyses have been performed in order to decipher the fluid evolution and fluid/gas migration history in the eastern part of the North German Basin (NGB). The results reveal compelling evidence for multiple events of fluid migration in the NGB (Lüders et al. 2005). The fluid systems developed from H_2O-NaCl±KCl type during the early stage of basin subsidence to H_2O-NaCl-$CaCl_2$ type during further burial.

Aqueous fluid inclusions in quartz, from fissures hosted by Carboniferous sedimentary rocks, are commonly associated with co-genetically trapped CH_4-CO_2 inclusions. P-T conditions estimated via isochore construction yield pressure conditions between 620 and 1650 bars and temperatures between 170 and 300˚C during fluid entrapment. The migration of CH_4-rich gases within the Carboniferous can be related to the main stage of basin subsidence and stages of basin uplift.

A different situation is recorded in fluid inclusions in fissure minerals hosted by Permian strata: aqueous fluid inclusions in calcite, quartz, fluorite and anhydrite are always H_2O-NaCl-$CaCl_2$-rich and show homogenization temperatures between 120 and 180˚C. Co-genetically trapped gas inclusions are generally less frequent. When present, they often show variable N_2-CH_4 compositions but no CO_2 content. P-T reconstructions indicate low-pressure conditions during fluid entrapment, always below 500 bars and correspond, depending on the sample depth, to a hydrostatic pressure regime during gas entrapment. The entrapment of N_2-CH_4 inclusions, therefore, seems to be related to phases of tectonic uplift during the Upper Cretaceous.

Intensive interaction of brines with Carboniferous or even older shales, which are assumed to represent potential sources for nitrogen in reservoirs of the NGB (Mingram et al. 2005), is evidenced by fluid inclusion data (enrichment in Li, Ba, Pb, Zn, Mg) and sulfur isotopic compositions of abundant anhydrite from fissures. The mostly light δ^{34}S values of the fissure anhydrites suggest that sulfate is either derived through oxidation and re-deposition of biogenic sulfur or mixing of SO_4^{2-} rich formation waters with variable amounts of dissolved biogenic sulfide.

References

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