Geophysical Research Abstracts,
Vol. 11, EGU2009-8565, 2009
EGU General Assembly 2009

Hydrothermal vein formation by extension-driven dewatering of the middle crust: An example from SW Germany

P.D. Bons, S. Staude, and G. Markl

Eberhard Karls University Tübingen, Earth Sciences, Tübingen, Germany (paul.bons@uni-tuebingen.de)

Hydrothermal deposits in extensional settings, particularly in basins, are common worldwide. Usually, deep-crustal brines are invoked as their main ore-forming fluid. F̈luid circulationïs often named to be the mechanism of fluid ascent and mixing, but the driving force for such a circulation is often unclear. Here we present a new model to explain the upward release of significant amounts of fluid from the middle and upper crust in extensional settings. The isostatic balance during extensional thinning of the crust causes exhumation of mid- and deep-crustal rocks while the upper part of the crust may be subsiding, forming basins. The difference in compressibility between fluid in pores and solid rock has a significant effect on fluid pressure evolution. The overburden or matrix pressure decreases during exhumation while the pore fluid pressure is steady due to the relative incompressibility of rocks. Pores with initially lithostatic pore fluid pressure will exceed the actual decreasing lithostatic pressure and release their fluid by hydrofracturing. A decompression of 100 MPa results in the release of approximately 5% of the available pore fluid. Pores with a hydrostatic fluid pressure drain part of their content through connected pores to regain a hydrostatic fluid pressure.

The amount of released fluid can be calculated if the crustal thickness and the amount of exhumation are known. Other controlling factors are the depth-dependent porosity and the depth- and density-dependent thermal expansion. One km of basin subsidence in a “best case” scenario (1% porosity, lithostatic pore fluid pressure) would result in the release of about 2.2 m3 fluid per surface m2 of crust. In a ”worst case” scenario (0.5% porosity, hydrostatic pore fluid pressure) about 0.4 m3 fluid per m2 of crust would be released. These two values bracket the expected actual release of excess fluid per m2 of the extending crust.

This model is applied to the Black Forest ore district, SW Germany, where five different mineralization groups can be distinguished by geochemistry and age. They all formed during periods of extensional tectonics. The fluid volume required to precipitate the known deposits of the various groups are quantified and compared to the fluid volume generated by our model. It appears that the fluid volumes required for the Black Forest hydrothermal ore deposits can adequately be explained by our model.