Geophysical Research Abstracts
Vol. 16, EGU2014-10934, 2014
EGU General Assembly 2014

Hydrothermal circulation in fault slots with topography

Sofya Titarenko and Andrew McCaig
Leeds, School of Earth and Environment, Leeds, United Kingdom (s.titarenko@leeds.ac.uk)

There are numerous cases where the circulation of hydrothermal fluid is likely to be confined within a permeable fault slot. Examples are (1) the Lost City Hydrothermal Field (LCHF) at 30 N in the Atlantic, which is likely to be controlled by large E-W faults related to the Atlantis transform fault and mass wasting on the southern wall of the Atlantis Massif, and (2) large normal faults bounding the Hess Deep rift in the East Pacific, which contain intense hydrothermal metamorphic assemblages in lower crustal gabbros formed at 200-350 ˚C. This type of circulation could occur anywhere where steep faults cut the oceanic crust, including large near-axis normal faults, transform faults and faults at subduction bend zones, and could be the major way in which the upper mantle and lower crust are hydrated. It is therefore important to constrain the controls on temperature conditions of alteration and hence mineral assemblages.

Previous 2-D modelling of the LCHF shows that seafloor topography and permeability structure combine together to localise the field near the highest point of the Atlantis Massif. Our new models are 3-D, based on a 10km cube with seafloor topography of $\sim$ 2km affecting both the fault slot and impermeable wall rocks. We have used Comsol multiphysics in this modelling, with a constant basal heatflow corresponding to the near conductive thermal gradient measured in IODP Hole 1309D, 5km north of the LCHF, and a constant temperature seafloor boundary condition. The wall rocks of the slot have a permeability of 10^{-17} m^2 while permeability in the slot is varied between 10^{-14} and 10^{-15} m^2. Initial conditions are a conductive thermal structure corresponding to the basal heatflow at steady state.

Generic models not based on any particular known topography quickly stabilise a hydrothermal system in the fault slot with a single upflow zone close to the model edge with highest topography. In models with a depth of circulation in the fault slot of about 6 km, after an initial period of higher temperature venting which removes heat from the initial condition, venting temperature is approximately 200 ˚C with a permeability of 3x10^{-15} m^2. This falls to about 170 ˚C with a permeability of 5x10^{-15} m^2. Temperatures can be reduced by restricting the depth of hydrothermal circulation.

These temperatures correspond to prehnite-chlorite assemblages seen in fault rocks at Hess Deep, but are higher than those observed at the LCHF. Work is continuing to vary permeability, fault slot geometry and topography to better match the conditions in the Atlantis Massif, and to model the effects of dyke intrusion into the fault zone as observed at Hess Deep.