Geophysical Research Abstracts
Vol. 14, EGU2012-13450, 2012
EGU General Assembly 2012

Influence of elevated temperature and pore fluid chemistry on electrokinetic signals generated during the deformation of sandstone

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Electrokinetic signals have been used at a crustal scale to infer fluid movement associated with rock deformation and in sub-surface reservoirs. While aspects of the electrokinetic phenomenon are well understood, the thermo-chemo-mechanical effects due to rock deformation under crustal conditions have been little explored. Here we present results from laboratory experiments where the combined influences of temperature, pore fluids and deformation strain rate on the generation of electrical potential signals are investigated. Sandstone samples were deformed in triaxial deformation with up to temperatures of 1250C using a range pore fluids with different chemistries, including deionised water and simulated reservoir formation waters (SFW's). We find that the most likely mechanism to generate electrical signals is the electrokinetic effect. The magnitude of the signals is influenced by temperature and pore fluid chemistry; however, the dependence on temperature requires sufficient time for thermal equilibrium to be reached to manifest itself. With the addition of ionic pore fluids, the magnitude of the electrical signals decreases with increasing temperature. Extrapolation shows that at temperatures above 2000C, no electrical potential signals would be observed. Projecting to a crustal scale, these results suggest that an earthquake at a depth of greater than 4 km with characteristic crustal fluids would not produce electrical signals distinguishable from background electrical noise.