

Physical properties of rocks and aqueous fluids at conditions simulating near- and supercritical reservoirs

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The growing interest in exploiting supercritical geothermal reservoirs calls for a thorough identification and understanding of physico-chemical processes occurring in geological settings with a high heat flow. In reservoir engineering, electrical sounding methods are common geophysical exploration and monitoring tools. However, a realistic interpretation of field measurements is based on the knowledge of both, the physical properties of the rock and those of the interacting fluid at defined temperature and pressure conditions. Thus, laboratory studies at simulated in-situ conditions provide a link between the field data and the material properties in the depth. The physico-chemical properties of fluids change dramatically above the critical point, which is for pure water 374.21 °C and 221.2 bar. In supercritical fluids mass transfer and diffusion-controlled chemical reactions are enhanced and cause mineral alterations. Also, ion mobility and ion concentration are affected by the change of physical state. All this cause changes in the electrical resistivity of supercritical fluids and may have considerable effects on the porosity and hydraulic properties of the rocks they are in contact with. While there are some datasets available for physical and chemical properties of water and single component salt solutions above their critical points, there exist nearly no data for electrical properties of mixed brines, representing the composition of natural geothermal fluids. Also, the impact of fluid-rock interactions on the electrical properties of multicomponent fluids in a supercritical region is scarcely investigated.

For a better understanding of fluid-driven processes in a near- and supercritical geological environment, in the framework of the EU-funded FP7 program *IMAGE* we have measured (1) the electrical resistivity of geothermal fluids and (2) physical properties of fluid saturated rock samples at simulated in-situ conditions. The permeability and electrical resistivity of a quartz-gabbro from a fossil hydrothermal system on Iceland were determined between 25 – 350 °C at a controlled pore pressure of 22.2 MPa. The measured resistivities were correlated with resistivity data obtained in a fluid measuring cell for a synthetic brine that mimics the composition of Icelandic Krafla geothermal fluid. The observed linear decrease of the apparent formation factor is assumed to arise primarily from surface conductance. Additionally, fluid samples were taken at every temperature step for chemical analyses. The concentrations of Si and Al increase significantly by an order of magnitude with increasing temperature. However, taken as a whole, both physical and chemical data indicate only slight fluid-rock interactions up to near-critical conditions, which is due to the low permeability of the studied rock sample and the limited fluid – rock contact area in a fracture-dominated pore network.