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Laboratory measurements of basalt electrical conductivity on saturated samples at upper crust conditions: a new electrical HT, HP cell.

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Electrical resistivity soundings have been used for 50 years to explore geothermal resources in Iceland. They have generally revealed two zones of high electrical conductivity, one at shallow depths (Flovenz et al., 1985) and another at 10-30 km depth (Beblo and Björnsson, 1978, Árnason et al., 2010). Laboratory measurements of electrical conductivity of rocks at simulated crustal conditions of temperature, pressure, saturation and pore pressures are quite important to interpret the resistivity structure in terms of composition and in-situ physical conditions. The existing laboratory measurements are limited to temperatures below 250 °C which is a pity since many geothermal reservoirs have much higher temperatures. Here we present a new cell capable of measuring electrical conductivity of large saturated samples at confining pressure up to 200 MPa, pore pressure up to 50 MPa, and temperature up to 500 °C. The measurement cell has been developed in a commercial, internally heated, gas pressure apparatus (Paterson press). It is based on the concept of "guard ring" electrode (Glover and Wine, 1995), which is adapted to samples that are jacketed by a very conductive, metallic material. Numerical modeling of the current flow in the electrical cell allowed defining the optimal cell geometry. Calibration tests have been performed on Fontainebleau sandstones saturated with electrolytes of different conductivities, up to 350 °C. The resulting electrical formation factor and temperature dependence of electrical conductivity are in very good agreement with previous studies. The first measurements of conductivity at temperature higher than 400 °C were performed on basalts. Three basalt samples from Iceland were collected respectively from smectite, actinolite and amphibolite alteration zones. They were selected for their very low porosity (<3 %), their high degree of alteration, and their representativeness of Icelandic hydrothermal alteration. These first results suggest that the surface conductivity linked to alteration is probably the dominant conduction at high temperature (> 300 °C). This new cell will improve the exploration and exploitation of deep fluid reservoirs, as in unconventional, high temperature geothermal fields. In particular, the investigations address possible effects of fluid-rock interactions on electrical resistivity of a reservoir host rock.

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