Thermal Conductivity and Equation of State of Porous Rocks at High Temperatures and High Pressures

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Effective thermal conductivity (ETC) of water-saturated sandstone have been measured over a temperature range from (281 to 518) K and at pressures up to 250 MPa with a steady-state parallel-plate apparatus. The estimated uncertainty of the measured ETC is 2 % (expanded uncertainties at the 95 % confidence level with a coverage factor of k=2). The porosity of the sandstone sample was 13 %. A rapid increase of ETC was found for water-saturated sandstone at low pressures between (0.1 and 100) MPa along various isotherms. At high pressures (P>100 MPa) a weak linear dependence of the ETC with pressure was observed. The temperature and pressure coefficients of water-saturated sandstone were calculated by using the measured ETC. We interpreted measured ETC data for water-saturated sandstone using various theoretical models in order to check their accuracy, predictive capability, and applicability. We demonstrated that the combined effect of porosity, temperature, pressure and fluid saturation can be predicted accurately using a Zimmerman's model. The effect of saturating fluids, structure (size, shape, and distribution of the pores), porosity, and mineralogical composition on temperature and pressure dependences of the ETC of water-saturated sandstone was discussed. Höfmeister's model was used to estimate the effect of pressure on the ETC and to develop the equation of state of the water-saturated sandstone.