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Technique and equipment for determination of rock sample permeability

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Rock permeability is one of the most important parameters controlling fluid dynamics in geological media. The main difficulty is that permeability of rocks even of the same type may vary in many decimal orders. So, extrapolation of appropriate data on another rock type or other PT parameters is not proper. The technique and equipment for precise measurements of rock sample permeability and its anisotropy in a wide range of values (10^{-22} – 10^{-15}m^2) at ambient and high PT-parameters were developed.

1. An improvement of the pulse decay method for permeability measurements is presented. The technique is based on fitting of experimental data to analytical and numerical solutions of the filtration equations derived with regard to the variation of flowing gas properties with temperature and pressure. In contrast with conventional method only the inlet section of the sample is connected with a closed reservoir filled with gas. The outlet section of the sample remains to be open to the atmosphere. As a result sample permeability to water and the Klinkenberg factor both may be obtained in a single experiment. The permeability measurements on the samples of different rock types with various reservoir properties were carried out. The results were compared with the steady state methods data and demonstrated the accuracy and efficiency of the method.

3. The modification of similar pulse decay technique for water used as flowing fluid is developed.

2. A method for determination of two independent components of permeability tensor on the same sample in a single test is developed. The method is based on a sequence of measurements. In the different measurements, fluid from a closed upstream reser-

voir flows into the cylindrical sample through different parts of its inflow face after a step-wise jump of the fluid pressure in the reservoir. An original code for computer simulation of fluid flow through a non-isotropic sample is developed. This code is used as the base for the measurement data processing. Radial and axial components of the sample permeability are determined from the best fit of measured and calculated time-dependent pressures in the upstream reservoir.

3. The experimental setups for permeability determinations using mentioned above techniques were developed and built. Both gas and water can be used as flowing fluid. The experiments may be performed at temperatures up to 300^{o}C, fluid pressure up to 50 MPa and confining pressure up to 50 MPa. An especially designed setup for permeability measurements simulating seismic events by cyclic variations of axial or confining pressure with different amplitude and frequencies at temperature up to 250^{o}C is also presented.