MODELING OF ELASTIC AND ELECTRICAL PROPERTIES OF DRY AND SATURATED POROUS ROCK

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A fractal model for physical properties of porous rock was used to describe porous rock microstructure using a borehole logging data such as shear and plane wave velocities as well as conductivity. The model allows interpretation of either elastic or electrical macroscopic rock properties in the frame of the same geometrical model. Moreover, the fractal approach to modeling of grain-to-grain contact regions allows description physical properties in a very wide range from the contact cementation to the fluid flow. The original model, developed independently by Spangenberg for elastic properties and by Bahr for electrical ones, was modified so as to describe partial saturated porous rock case. Monte-Carlo modeling of physical properties of rock mixture with different grain-to-pore relations and grains orientations allowed comparison of the modified theory results with the results of O'Connell & Budansky theory for seismic velocities in dry and saturated cracked solids. The modified model was involved to two boreholes logging data analysis. The first is a 746 m deep borehole penetrating the Nojima fault at Hirabayashi in Awaji Island, Central Japan. The second is the Ohtaki borehole (Nagano, Central Japan). In both cases complex microstructure of surrounding rocks is evidently demonstrated either by logging data or by direct core analysis. The model is succeeded to describe a fault gouge and a fault zone, found at the case of Nojima fault at 623.1-625.3 m and 426-746 m respectively. Measured value of fluid conductivity and other physical parameters were used for the modeling. The modeling results were compared with core analysis data. The described model is realized in a form of software adapted for end user needs; it provided by GUI and allow to present experimental data in comparison with modeled results in a number of standard graphs. The modified model is demonstrated to be a useful tool for recognizing porous rock microstructure using such macroscopic rock properties as seismic velocities together with conductivity.