Electrical conductivity vs. seismic velocity correlations for two-phase system in equilibrium

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Possibilities to clarify the stress-state in a region on the basis of joint analysis of seismic and electromagnetic data have been recently shown. For reliable quantitative analysis of the experimental data, determination of electrical conductivity vs. seismic velocity correlations is important for plausible pore geometries in the Earth's interior. Electrical conductivity of two-phase system with equilibrium, interfacial energy-controlled phase geometry is calculated for the dihedral angles of 20-80 degrees that are typical for aqueous fluid - rock and partial molten systems of lower crust and upper mantle. Equilibrium geometries of interfacial surfaces are numerically simulated under a constraint of constant mean curvature for the cases of tetrakaidekahedral and rhombic dodecahedral grains. The simulated conductivities are in agreement with conductivities measured for open-cell metal foam. Electrical conductivity vs. seismic velocity correlations are acquired by combining of the simulated electrical conductivities with the seismic velocity calculated for the same equilibrium geometries. It is shown that melt, characterized with dihedral angles of 20-40 degrees, forms continuous channel system even for small melt fraction, while aqueous fluids with dihedral angles of 40-80 degrees may collect in grain corners forming isolated pores. Channel pinch-off results in reduction of conductivity by orders of magnitude and can explain seeming discrepancy of low velocity region, attributed to high fluid fraction, and low conductivity of the same region, which sometimes is faced at collocated electromagnetic and seismic experiments.