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Modelling the complex electrical properties of porous media as a function of frequency

P.W.J. Glover (1), N. Déry (1) and T.J. Ransford (2)

(1) Département de Géologie et de Génie Géologique, Université Laval, Québec, Canada, (2) Département de Mathématiques et de Statistique, Université Laval, Québec, Canada (paglover@ggl.ulaval.ca / Fax : +1 418 656 7339)

Electro-kinetic and electro-kinetic-acoustic techniques are beginning to be used in the oil industry. Several authors have published methods for deriving fluid permeability from electrical measurements, and there is a movement towards the development of electro-kinetic-acoustic down-hole tools and other potential reservoir applications. The successful outcome of these developments depends ultimately upon the development of a frequency-dependent theory for electrical conduction in porous media that may, in time, be extended to include fluid flow and acoustic perturbation. This contribution combines the electrical theory Revil and Glover (*Phys RevB*, **55(3),** 1757-1773, 1997) with a physical attribute-based development of an AC theory for the electrical permittivity of porous media. The resulting model takes into account surface mediated conduction and surface generated dispersion. The model has been used to predict the complex permittivities of artificial porous media as a function of frequency from 0.1 Hz to 1 MHz. The results from the model have been compared against the results of AC impedance spectroscopy measurements for the same frequency range on quartz beads of varying size, size mixtures, sample lengths, fluid saturations and fluid pH. In each case a reasonable match is found between the modelled and experimental data. Although successful, this type of modelling is not a sufficient fundamental theoretical basis for the AC properties of porous media. However, such models may be used to examine which physical attributes of a porous system dominate for any given set of porosity, pH, salinity, grain size and fluid conductivity data. This information will be invaluable in the development of a fundamental AC conduction theory in porous media.