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Advances and benefits of fractal models to predict streaming potentials in partially saturated porous media

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Understanding streaming potential generation in porous media is of high interest for hydrological and reservoir studies as it allows to relate water fluxes to measurable electrical potential distributions in subsurface geological settings. The evolution of streaming potential stems from electrokinetic coupling between water and electrical fluxes due to the presence of an electrical double layer at the interface between the mineral and the pore water. Two different approaches can be used to model and interpret the generation of the streaming potential in porous media: the classical coupling coefficient approach based on the Helmholtz-Smoluchowski equation, and the effective excess charge density. Recent studies based on both approaches use a mathematical up-scaling procedure that employs the so-called fractal theory. In these studies, the porous medium is represented by a bundle of tortuous capillaries characterized by a fractal capillary-size distribution law. The electrokinetic coupling between the fluid flow and electric current is obtained by averaging the processes that take place in a single capillary. In most cases, closed-form expressions for the electrokinetic parameters are obtained in terms of macroscopic hydraulic variables like permeability, saturation and porosity. In this presentation we propose a review of the existing fractal distribution models that predict the streaming potential in porous media and discuss their benefits compared against other published models.