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Electrokinetic coupling in fractured rock

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Flow and transport through fractured rock are often modeled based on double-porosity or "MINC" double-porosity representation. In such reservoir descriptions, global mass exchange between adjacent macroscopic computational grid blocks takes place mainly through the "fracture zone". Inter-block flow through the "matrix region" is relatively unimportant and is usually neglected in most MINC treatments. But this approximation is inappropriate when calculating the global "drag current" caused by electric charges moving with the flowing fluid due to electrokinetic coupling. Since the magnitude of the drag current density is proportional not to the permeability but to the porosity of the medium, the contribution of the drag current through the matrix region to the total global current between adjacent macroscopic grid blocks is not negligible. Although the magnitude of zeta potential measured for intact samples is substantially smaller than that for crushed granular samples especially with low salinity solutions (Ishido and Matsushima, 2007), the contribution of the drag current through the matrix region is still significant owing to large ratio of total pore volumes in the matrix region to the fracture zone. In case of SP, we can measure the transients of "microscopic potential" both in the fracture and matrix regions with small-size electrodes installed outside the electrically-insulated casing of a wellbore. In addition, measurement of "average potential" over "REV" scale is also possible by using electrodes of sufficiently large size. Numerical simulation results show that behavior peculiar to fractured media is much more enhanced in the microscopic matrix-region SP and average SP transients than is the case for pressure or microscopic fracture-zone SP transients. Combining continuous pressure and SP measurements is thought to provide a means

for better characterizing fractured reservoirs.