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Relaxation of streaming potential: numerical modeling

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Revil et al. (2005) showed that when an argillaceous sample is submitted to a sharp pressure, there is a finite interval of time before which the streaming potential arrives at a steady state value. We model numerically transient streaming potential response to sharp application of the pressure drop to samples of various hydraulic diffusivities and various hydraulic lengths. The numerical modeling is carried out using the finite-difference GWFGEM code. The model corresponds to typical experimental setup included the core sample enclosed between two reservoirs with different pressure. The modeled area is broken up into 468 rectangular cells of different size. The sample area is broken up into 126 cells to ensure calculation of pressure and of electrical potential in details. The numerical experiments show: (1) The relaxation time constant depends on the hydraulic diffusivity and on the square of the length of sample (according to the theory proposed in Revil et al. (2005)); (2) During the relaxation stage as well as at the steady state conditions the streaming potential value is linearly related to the pressure drop between the cells modeling the edges of the sample. (3) The SP transient response to applied pressure do not exhibit the exponential relationship as suggested in Revil et al.(2005). It is better approximated using the time-domain analogue of the Cole - Cole equation (Pelton et al., 1979) with exponent c=0.71. This work is supported by Russian Foundation for Basic Research (RFBR) grant # 05-05-64610 a.

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