Measuring the DC electrokinetic coupling coefficient of porous rock samples in the laboratory : a new apparatus.

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Electro-kinetic properties of rocks allow the generation of an electric potential by the flow of an aqueous fluid through a porous media. The electrical potential is called the streaming potential, and the streaming potential coupling coefficient C_s is the ratio of the generated electric potential to the pressure difference that causes the fluid flow. The streaming potential coupling coefficient for rocks is described in the steady-state regime by the well known Helmholtz-Smoluchowski equation, and is supported by a relatively small body of experimental data. However, the electrokinetic coupling coefficient measurement is important for the further development of different area of expertise such as reservoir prospection and monitoring, volcano and earthquake monitoring and the underground sequestration of CO_2.

We have designed, constructed and tested a new experimental cell that is capable of measuring the DC streaming potential of consolidated and unconsolidated porous media. The new cell is made from stainless steel, perspex and other engineering polymers. Cylindrical samples of 25.4 mm can be placed in a deformable rubber sleeve and subjected to a radial confining pressure of compressed nitrogen up to 4.5 MPa. Actively degassed aqueous fluids can be flowed by an Agilent 1200 series binary pump (2 to 10 mL/min). A maximum input fluid pressure of 2.5 MPa can be applied, with a maximum exit pressure of 1 MPa to ensure sample saturation is stable and to reduce gas bubbles. The pressures each side of the sample are measured by high stability pressure transducers (Omega PX302-300GV), previously calibrated by a high precision differential pressure transducer Endress and Hauser Deltabar S PMD75. The streaming potentials are measured with Harvard Apparatus LF-1 and LF-2 Ag/AgCl non-polarising miniature electrodes. An axial pressure is applied (1 to 6.5 MPa) to counteract the radial pressure and provide additional axial load with a hydraulic piston. It is our intention to complete the testing of the cell and to use it to measure the electrokinetic properties of porous rocks in the DC regime in order to provide sufficient data to improve the theories and models of DC streaming potentials.