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A laboratory apparatus for measuring the frequency-dependent streaming potential coupling coefficient of porous rock samples

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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 $C(\omega)$ is the ratio of the generated electric potential to the pressure difference that causes the fluid flow. The streaming potential coupling coefficient is described in the DC regime by the well known Helmholtz-Smoluchowski equation, and supported by a relatively small body of experimental data. There is no published experimental data on the streaming potential coupling coefficient on rocks in the AC regime, and only one using capillary tubes and filters. However, the frequency-dependent measurement is important for the further development of the seismo-electric method which uses seismic waves to move fluid through the pores, and then measures the electrical potential so developed. We have designed, constructed and tested a new experimental cell that is capable of measuring the DC and AC streaming potential as well as the complex electrical properties of saturated rocks. The new cell is made from stainless steel, perspex and other engineering polymers. Cylindrical samples of two different diameters (25.4 mm and 38.1 mm) can be placed in a deformable sleeve of polyolefin and subjected to a radial confining pressure of compressed nitrogen up to 4.5 MPa. Actively degassed aqueous fluids can be flowed (DC regime) by an Agilent 1200 series binary pump (0.001

to 5 cm^3/min), or pulsed (AC regime) using a precision modal shaker. 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 in the DC regime or specialized dynamic pressure transducers with a frequency range of 0.08 Hz to 170 kHz in the AC regime. The streaming potentials are measured with Harvard Apparatus LF-1 and LF-2 Ag/AgCl non-polarising micro-electrodes. The electrical properties are measured using two platinum blacked platinum gauze electrodes each end of the sample and a Solartron 1260A impedance analyzer. An axial pressure is applied (1 to 6.5 MPa) to counteract the radial pressure and provide additional axial load with a hydraulic ram. It is our intention to complete the testing of the cell and to use it to measure the electrokinetic properties of porous rocks in both the AC and the DC regime in order to provide sufficient data to improve the theories and models of DC and AC streaming potentials, a first step in which direction is described in the presentation of Paul Glover submitted to the same session.