Evaluation of transport properties of in-situ processed oil shale

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In situ extraction of usable liquid or gaseous hydrocarbon products from the kerogen in oil shale requires aggressive thermal exposure. Operationally, there are geomechanical issues associated with the in-situ processing. These include expansion associated with heating, potential heaving of surrounding and overlying material, modification of permeability and porosity with changes in the kerogen and mechanical deformation associated with changes in the pore-filling material and phase. With the exception of several key legacy publications and ongoing proprietary measurements, the thermo-mechanical response of representative oil shale is speculative. A suite of measurements on oil shale samples is planned to delineate key mechanisms (and their evolution with time and temperature) of the transport and mechanical properties of oil shale during in-situ thermal processing. A unique high pressure-high temperature triaxial vessel is being fabricated to measure representative oil shale response under realistic in-situ pressure and stress conditions when high temperature processes are applied. The apparatus will accommodate samples up to 4 inches in diameter and 8 inches long. The geologic environment is simulated by applying the axial stress (hydraulic piston, 200 ton capacity), and radial pressure (pneumatic pressure to 1500 psi). Heating to 1000°F is accomplished by electrical clamshell heaters. Increasing temperature will also transform kerogen into liquid and gaseous products, which are captured and quantified outside of the pressure vessel. Force, stress and deformation are recorded. Steady state permeability measurements will be carried out to assess the evolution or degradation of transport and mechanical properties. The experiments are anticipated to show ambient nominally elastic behavior when subjected to representative in-situ stress conditions, with increased permeability, decreased load bearing capacity and accelerated deformation with temperature and kerogen alteration. It is anticipated that post-peak deformation could be compactive or dilatant to large volumetric strains. The paper summarizes key legacy data, outlines consequences of changing transport and mechanical properties and describes the design details of this extreme triaxial testing apparatus.