DESIGN OF A MESO-SCALE POLY-AXIAL TESTING DEVICE FOR EXAMINING THE ROLE OF ANISOTROPIC STRESS ON FLUID FLOW IN FRACTURED ROCK

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Fluid flow in the shallow crust (< 100 meters) is not typically sensitive to the low magnitude crustal stress conditions present. Fractured rocks, unlike porous sedimentary rocks, in this respect are unique since most un-cemented fractures are compliant at lower stress states and fracture apertures can be strongly influenced by the loading. As a result, fracture permeability of the rocks can be strongly dependent on depth and loading conditions (e.g. residual tectonic stresses). This has implications for depth of flow systems and connections between deeper and shallower systems. This paper presents the design of a poly-axial testing apparatus for testing the role of low magnitude ($< 2MPa$) anisotropic stress fields on the flow and transport properties of fractured rock on meso-scale samples of fractured rock. A "true-triaxial" stress state will allow a more accurate description of shallow crustal conditions and isolation of the role of these stresses on fluid flow.

Previous investigations into stress induced anisotropic conditions in fractured rocks have used traditional triaxial stress conditions to simulate crustal conditions. We constructed a frame with 6 loading pistons, two on each axis, which will be capable of stressing a cubic sample in 3 independent directions, thus creating a more realistic 3D stress state in the rock. The frame allows access to the sample on all sides. Six separate platens isolate each face of the sample permitting the measurement of fluid pressure response to off axis loading. The platens are designed to transfer the loads to the sample while allowing fluid flow monitoring and sampling. Design considerations also include geophysical characterization of the sample through both ultrasonic and NMR testing. We hope to quantify the relationships between stress fields and fluid flow through the fractured rock for low crustal stresses. Specifically we expect to be able to more completely quantify the aperture reduction on a fractured surface when a stress is not applied normal to the fractured surface at a scale larger than previously explored in the laboratory.