Experimenting induced seismicity phenomena using Geophysical Imaging triaxial cell at RFDF

A preliminary report by M.H.B. Nasseri and S. Lui

Research objective: Research investigation on understanding of the triggered or induced seismicity have recently been the focus of many investigators in relation to hydraulic fracturing practice associated with the unconventional oil and gas production industry in North America. Such projects usually involve recording and processing of seismic events using axillary bore holes equipped with seismological recording devices near to the field of interest. Induced seismicity is in association with fluid-injection processes and elevation of pore pressure affecting pre-existing stable/critically stressed fault systems causing instability by increasing shear stress leading to fault plane slippage thus creating a man-made earthquake. We are reporting a preliminary result on simulating the aforementioned phenomena on a saw cut Westerly granite specimen with bore hole drilled to access the fault plane. The saw-cut fault plane makes an angel of 30 degrees with respect to the axial stress and the long axis of the cylindrical specimen as shown below.

Figure 1. Shows the saw cut Westerly granite with a central Fluid-injection hole to access the fault plane

Experimental approach and preliminary result: We measured the axial and diametral strains during hydrostatic loading up to an initial stress of 25 MPa. While keeping the confining pressure=25 MPa, the axial stress was raised to a critical stress of about 48 MPa where initial signs of fault movement were recorded followed by axial load reduction. Next, using a constant flow rate of 0.5 ml/min distilled water was injected through a packer system down the hole over the fault plane while monitoring the water pressure close to the fault plane. As soon as water pressure was found to build up to 10 MPa the first fault slippage took place recording a diametral increase of %1 as the two halves sample slipped over each other and an axial strain of %1.25 was recorded. Few AE events were registered due to this initial slippage (figure 2 left image). Under constant flow of water injection mode the next seismic slippage happened when water pressure registered a value of 13 MPa causing a large axial strain of %4 and a diametral strain of %15. This slippage caused much larger magnitude AE events (Figure 2, right image). The fault plane surface roughness was measured before and after the test too.

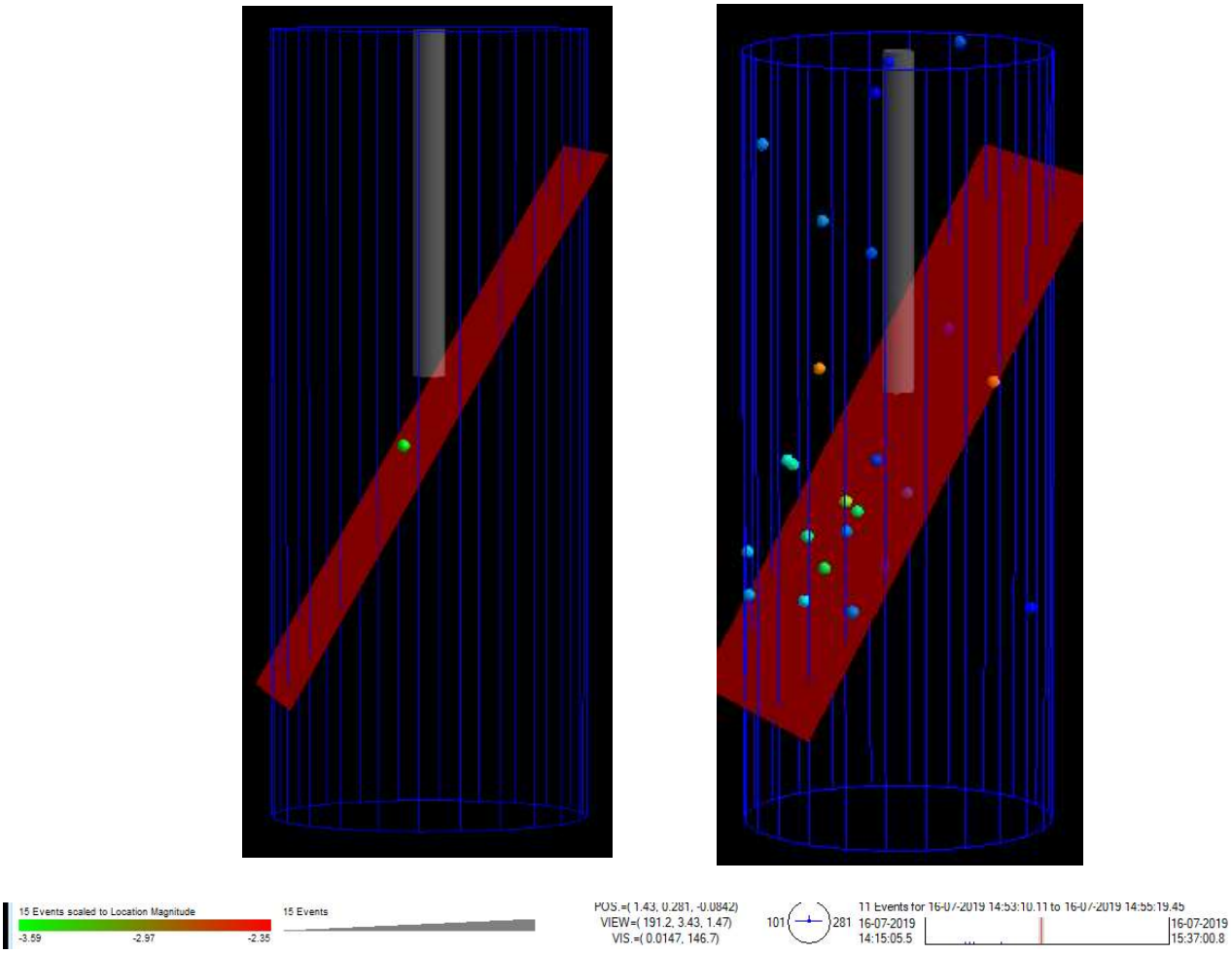

Figure 2. Image on the left shows the fault plan in red and the bore hole to access the fault plane in gray with the initial AE event located during first slip. The image on the right shows all the AE event recorded/located during much larger second slippage. Coloured scale shows the event magnitude.