

Bay Area Geophysical Society Seminar Series



4D Electrical Resistivity Imaging of Stress-Induced Changes in Secondary Porosity During High Pressure Injections into a Deep Crystalline Rock Formation

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December 30th, 2021 4 PM PST -- Zoom Talk

Abstract:

Fluid flow through fractured rock systems is governed in large part by the distribution, interconnectivity, and size of fracture apertures. In-situ stress is one of the primary factors controlling fracture aperture, and one that is altered significantly during high-pressure fluid injections or extractions. Interactions between stress, pore pressure, aperture, and fluid flow can result in complex and evolving poroelastic behavior with significant implications regarding the predictability and risk involved with developing and managing deep subsurface reservoirs (geothermal, fossil energy, and geologic carbon sequestration).

In saturated rocks, bulk electrical conductivity is sensitive to both primary and secondary porosity (i.e. matrix porosity and fractures), and therefore to fracture aperture size and distribution. We demonstrate the use of time-lapse 3D electrical resistivity tomography for remotely monitoring stress induced changes in aperture distribution during high pressure injections into a dense fractured rock system at a scale of tens of meters. Results reveal a complex and continuously evolving stress field involving aperture dilations in the natural fracture system and aperture contractions in adjacent zones of shadow stress. Results provide information about the spatiotemporal changes in the system behavior and point to the potential of electrical imaging for autonomously and remotely monitoring evolving stress conditions by proxy through changes in bulk electrical conductivity.

Presenter's Bio:



Dr. Tim Johnson is a computational geophysicist at the Pacific Northwest National Laboratory. He is internationally recognized for his technical contributions to subsurface geophysical imaging and process monitoring. His primary research is focused on characterizing and monitoring subsurface properties and processes using autonomous geophysical measurements, with an emphasis on electrical methods. Dr. Johnson is the original developer of the award winning E4D software, parallel electrical resistivity tomography and spectral induced polarization inversion code designed specifically for 4D subsurface imaging (<https://e4d.pnnl.gov>).

Zoom meeting information:

Zoom ID: 920 8661 4412

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