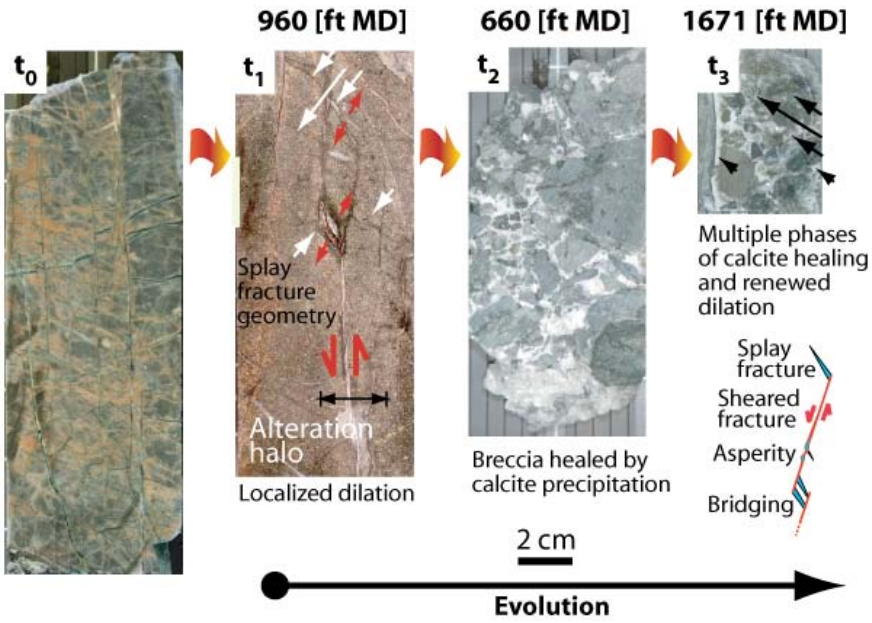

Development of a Geological and Geomechanical Framework for the Analysis of MEQ in EGS Experiments

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EGS Component R&D › Induced Seismicity

Overview

- **Timeline**
  - Project Established: April, 2010
  - Project End: May, 2013
  - Percent Completed: Just Beginning
- **Budget**
  - Total project funding: $1,607,442
  - DOE share: $1,061,245,
  - Awardee share: $546.197
  - Funding received in FY 09: $100K
- **Barriers**: Prediction of Reservoir's Response to Stimulation; Induced Seismicity
- **Partners**: Temple University , AltaRock Energy, Inc., New England Research: Princeton Engineering Group

Relevance/Impact of Research

- The objective of this project is to develop a framework for investigating processes that contribute to the occurrence of seismicity in enhanced geothermal systems with particular reference to the Newberry demonstration experiment and the potential Geysers EGS demonstration experiment.

- We will use an integrated geological and geomechanical approach to identify the causal mechanisms of MEQs, and to relate their occurrence to accompanying changes in rock mass characteristics.

Relevance/Impact of Research

- Phase 1: Geologic & Geomechanical Studies of EGS Sites
  - Develop a preliminary stress model and stimulation design using core from the Geysers, Newberry
  - Determine the rock mechanical properties
    - Elastic and poroelastic properties such as Biot's coefficient and Skempton's parameters for geomechancial characterization of reservoir and its response to injection
  - Study dilatancy of natural fractures during shearing; geological study of the mechanisms accommodating deformation at fracture walls using literature review, core observations, and numerical simulations

Relevance/Impact of Research

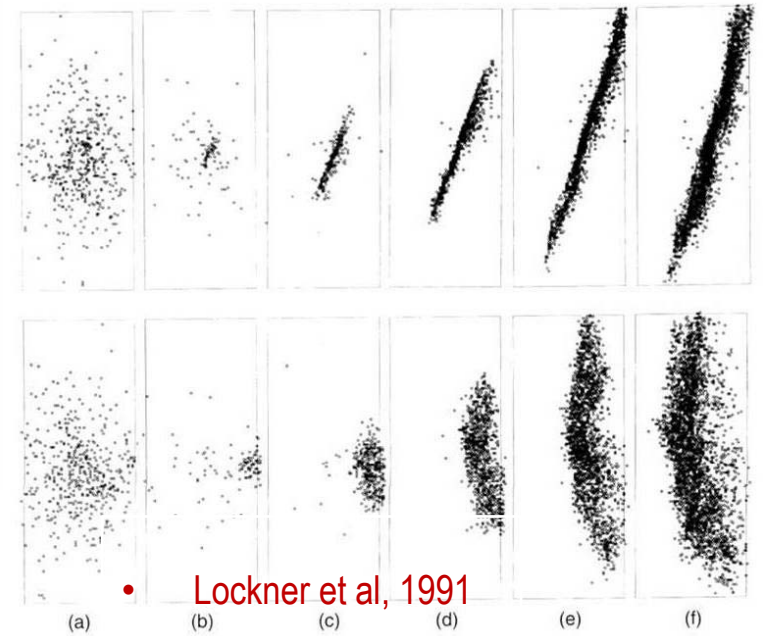
- **Futures Phases**:
  - Geological /geomechanical analysis of area; and drill core
    - Stress
    - Fracture distribution
  - Investigate MEQ/porosity/permeability in injection experiments
  - Integrated field, literature, and lab, and numerical studies to catalog a set of geological and geomechanical conditions that are responsible for generation of MEQ, and to help identify role of poromechanical processes.

Relevance/Impact of Research

- **By helping remove barriers to reservoir creation ad development, the project will help increase reserves and lower costs**
- Permeable zones have to be created by stimulation, a process that involves fracture initiation and/or activation of discontinuities
- Rock stimulation can be accompanied by multiple micro-seismic events.
- Improve understanding of the relation between the location of the MEQ and fluid flow based on geological/geomechancial criteria that can then be used as a model for study of other EGS sites.

Scientific/Technical Approach

- An integrated geological and geomechanical approach to identify causal mechanisms of MEQs, and relate MEQ occurrence to resulting permeability characteristics
  - (i) characterize petrophysical and geomechanical properties of type rock from the Geysers and the Newberry using rock deformation experiments under various pressure & temperature conditions



- Lockner et al, 1991

Scientific/Technical Approach

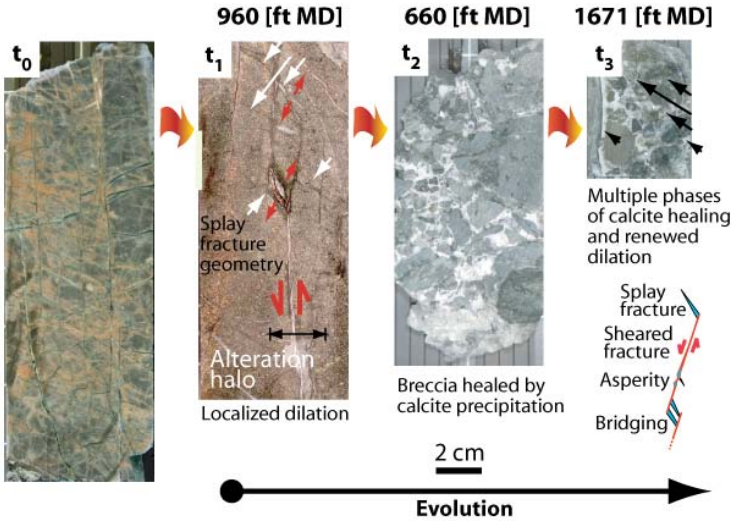
(ii) study generation of MEQ's under a triaxial stress state, characterize permeability during injection

(iii) Study natural fractures in the Newberry to establish a fracturing history

(iv) identify the mechanisms associated with generation of MEQ's in relation to maintenance of natural fracture permeability using analytical and numerical tools benchmarked by observations of naturally and experimentally deformed samples

Planned Milestones/Outcomes

- Develop a preliminary stress model and stimulation design using core from the Geysers, Newberry
- Determine the rock mechanical properties, failure envelop
- Study dilatancy of natural fractures during shearing, study the mechanisms accommodating deformation at fracture walls
  - literature review, core observations, and numerical simulations



- **Temple University** : **Dr. Nicholas Davatzes** structural geologist: fault zones, their physical properties, and the stresses in earth that drive their movement.

- **AltaRock Energy, Inc**.

- **New England Research**, Princeton Engineering Group

Project Management/Coordination

- Work will commence this June
- Full staffing of project upon full funding; Post-Doc/grad students
- Will attract funds from petroleum industry-Crisman Institute once project is fully funded
- Will meet with partners this summer (possibly in June) to coordinate research efforts, future testing and input data needs
- This project is integrated with other projects through workshops; participating demonstration projects
- All non-proprietary data from the project will be provided to the National Geothermal Data System

Future Directions

- Conduct hydraulic fracture/ injection experiments in the lab under stress to study the nature of fracturing in response to different injection rates and stress levels and temperatures.

- Characterize fractures that result from fluid injection; correlate with the recorded acoustic emissions

Summary Slide

- Develop geomechanical framework for MEQ
  - Catalog a set of geological and geomechanical conditions that are responsible for generation of MEQ, identify fracturing type, permeability structure
- Provide improved understanding of the relation between the location of MEQ's and the fluid flow
- Resulting criteria can then be used as a model for study of other EGS sites