DOE's EGS Program Review

Seismic (MEQ) Characterization of EGS Fracture Network Lifecycles

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Marriott Hotel
Golden, CO

Project Objective

❖ To image seismically an EGS fracture network, and its evolution with time

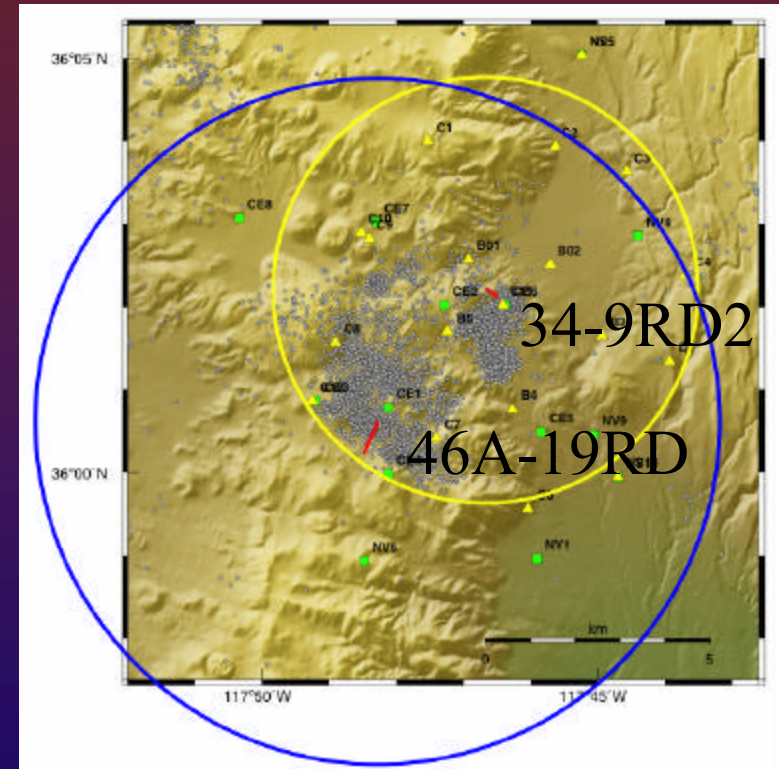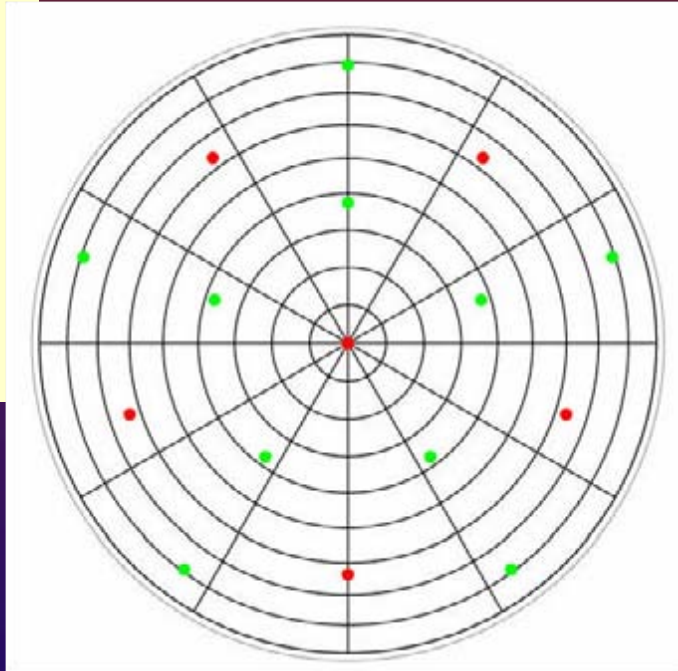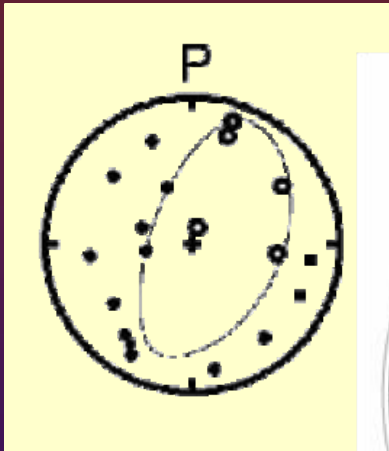July 18, 2006

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EGS Problem

❖ Project will contribute to numerous program goals:

    ❖ fracture mapping - extent & geometry

    ❖ effective fracture area, volume in contact with circulating fluids

    ❖ pathways & trajectories of circulating fluids

    ❖ mode of failure on fractures

        ❖ potential for fluid circulation

        ❖ need for fracture propping

    ❖ stress regime in hydrofractured volume

    ❖ evolution of stresses

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Background/Approach: Current work

- ❖ Operate temporary network around 46A-19RD

- ❖ Format, merge data with US Navy permanent network data

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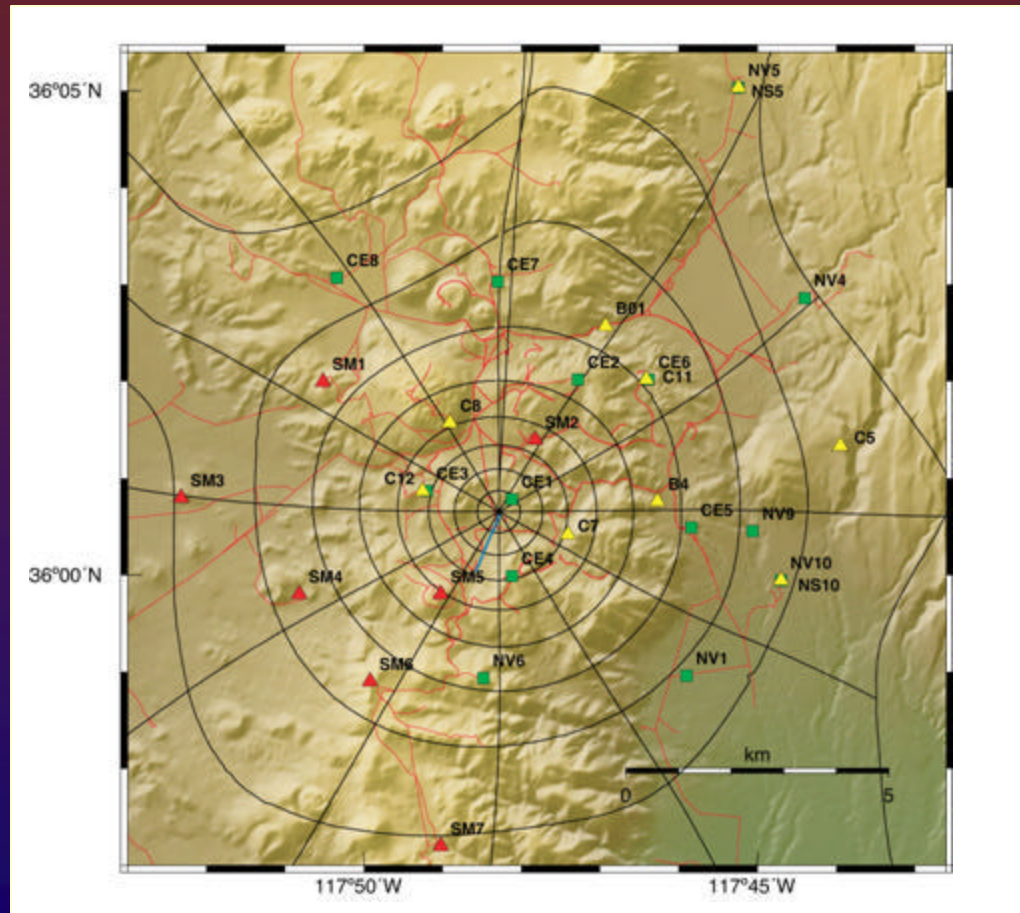# Background/Approach: Current work

Faces & **vertices** of regular icosahedron

34-9RD2

46A-19RD

Background/Approach: Current work

△ New

△ Old

■ Navy

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Background/Approach: New project

- *Seismic (MEQ) Characterization of EGS Fracture Network Lifecycles*
- Project will run 1st Oct 2006 - 30th Sept 2007
- 3 tasks:
  - Software development
  - Application of new techniques to 46A-19RD at Coso
  - Integration of results with other knowledge

Background/Approach: New project
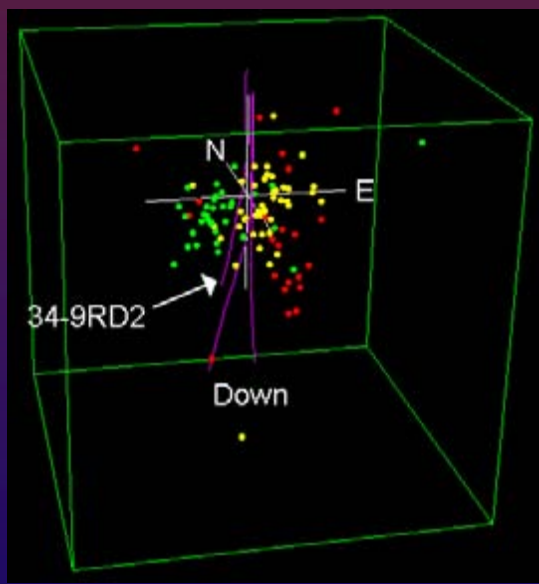
❖ Software development

  ❖ High-resolution MEQ locations: waveform cross-correlation + *hypocc*

  ❖ 4-D tomography: invert for structural changes
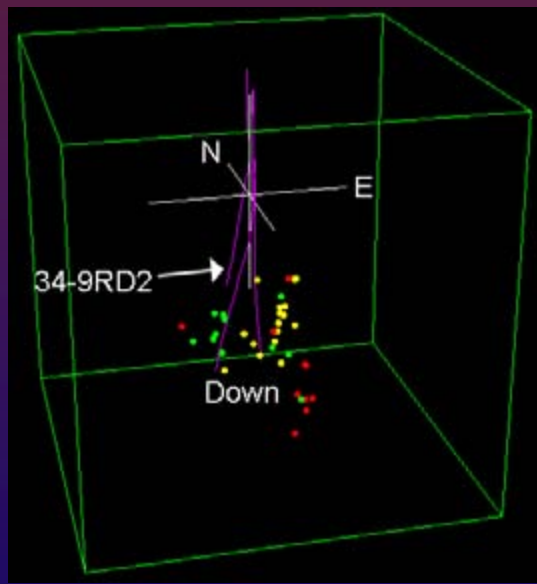
  ❖ Focal mechanisms (moment tensors): add errors
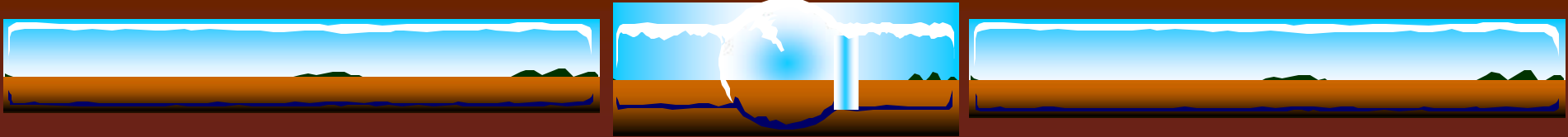
Background/Approach: New project

❖ High-resolution MEQ locations: waveform cross-correlation + *hypocc*
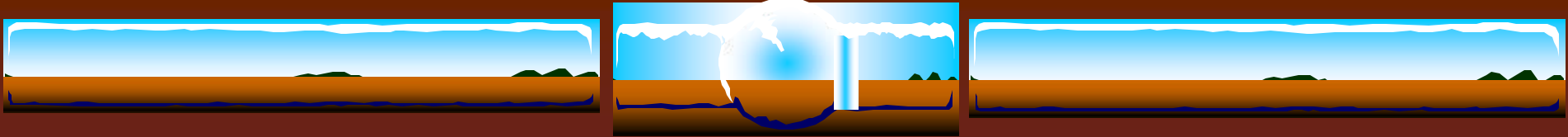
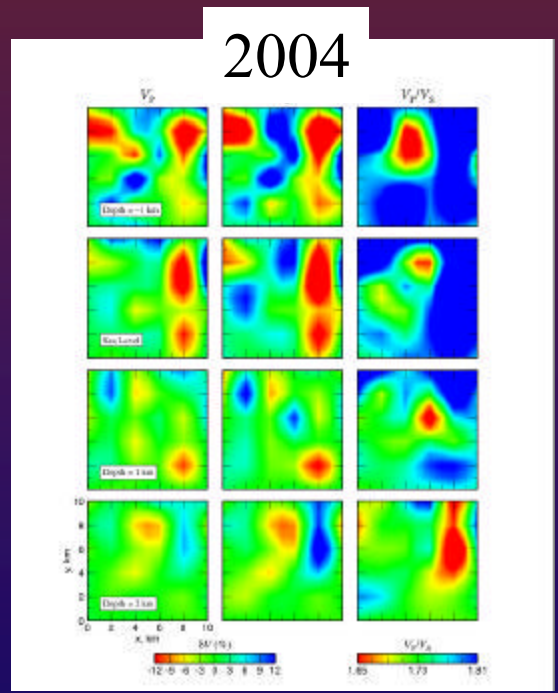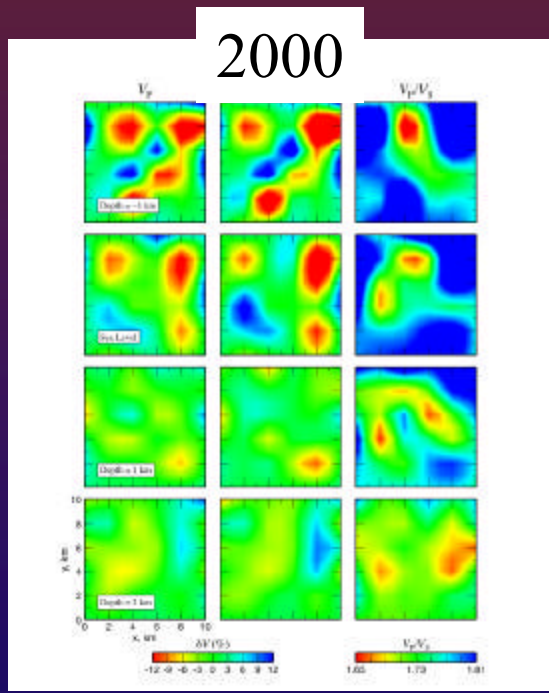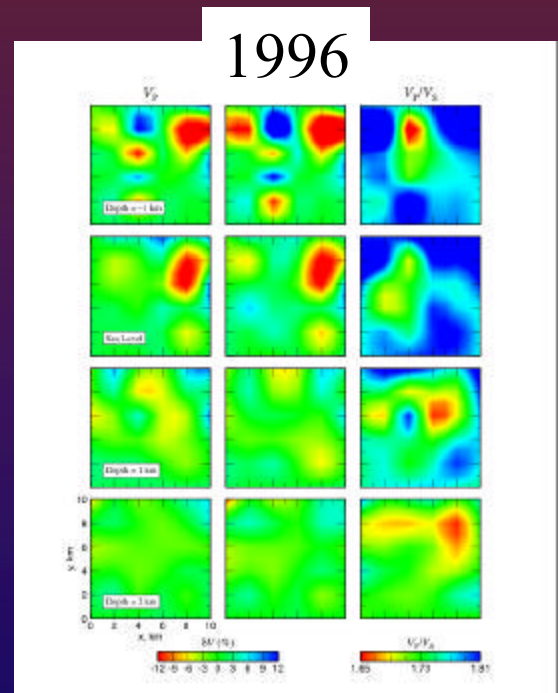Routine catalog hypocenters

Relatively relocated hypocenters

34-9RD2 injection

green: pre-injection; yellow: co-injection; red: post-injection

Background/Approach: New project
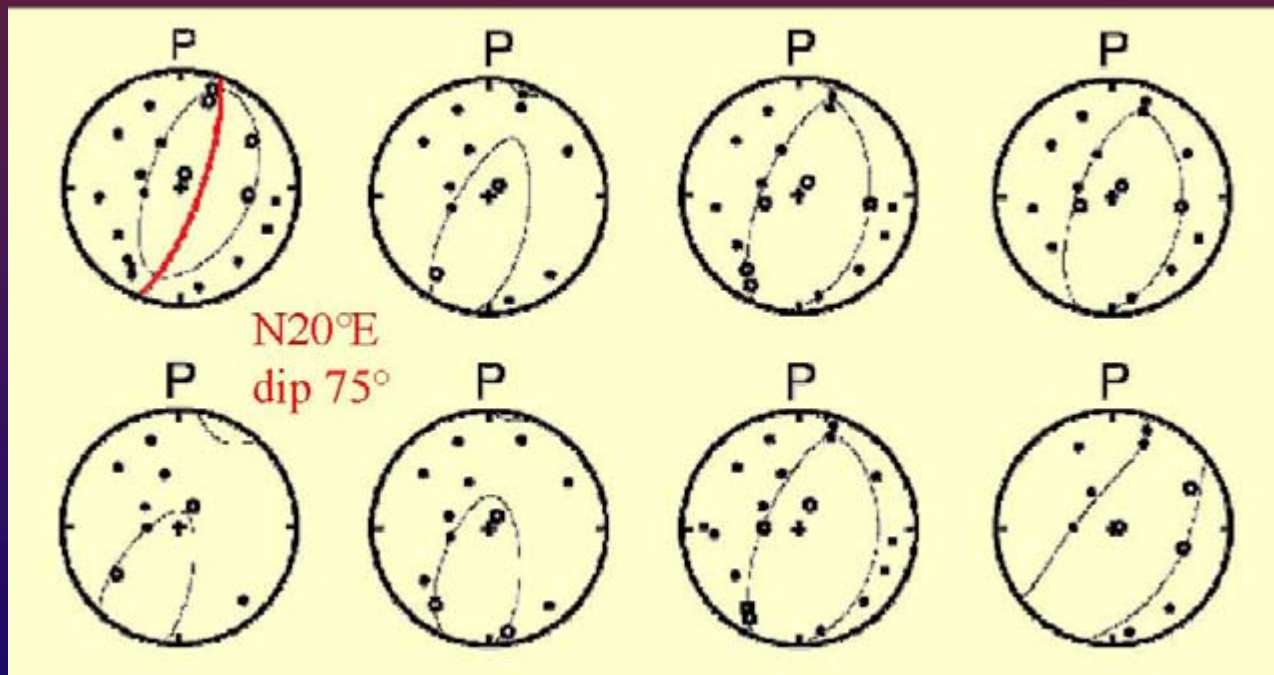
❖ 4-D tomography: invert for structural changes

1996

2000

2004

Background/Approach: New project

❖ Focal mechanisms (moment tensors): add errors

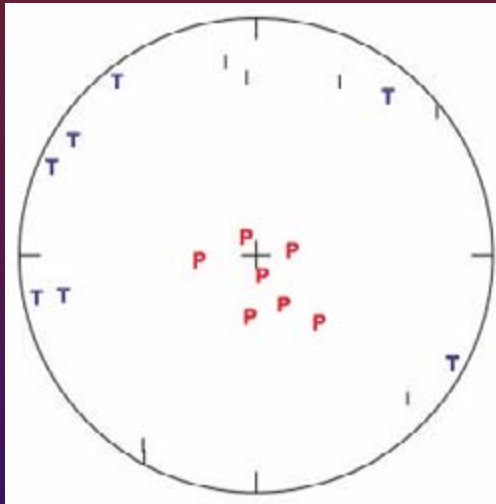❖ Red line: seismic zone revealed by relative relocations
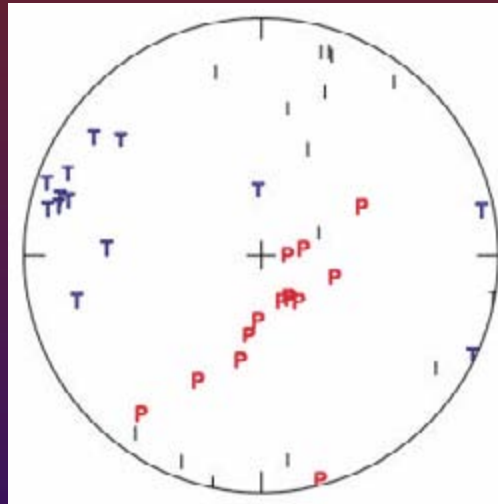
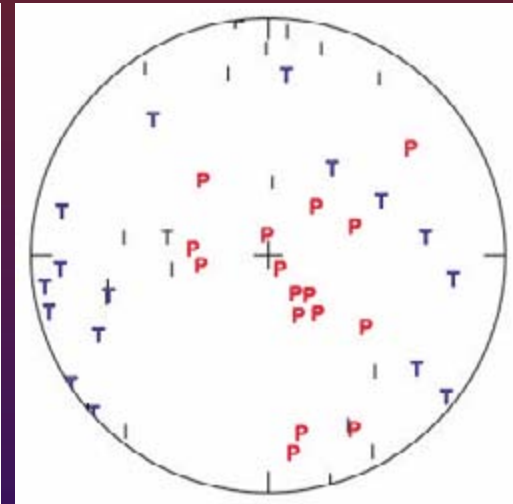❖ Crack-opening component

34-9RD2 injection

Background/Approach: Earlier results

34-9RD2 injection

Pre-swarm   Co-swarm   Post-swarm
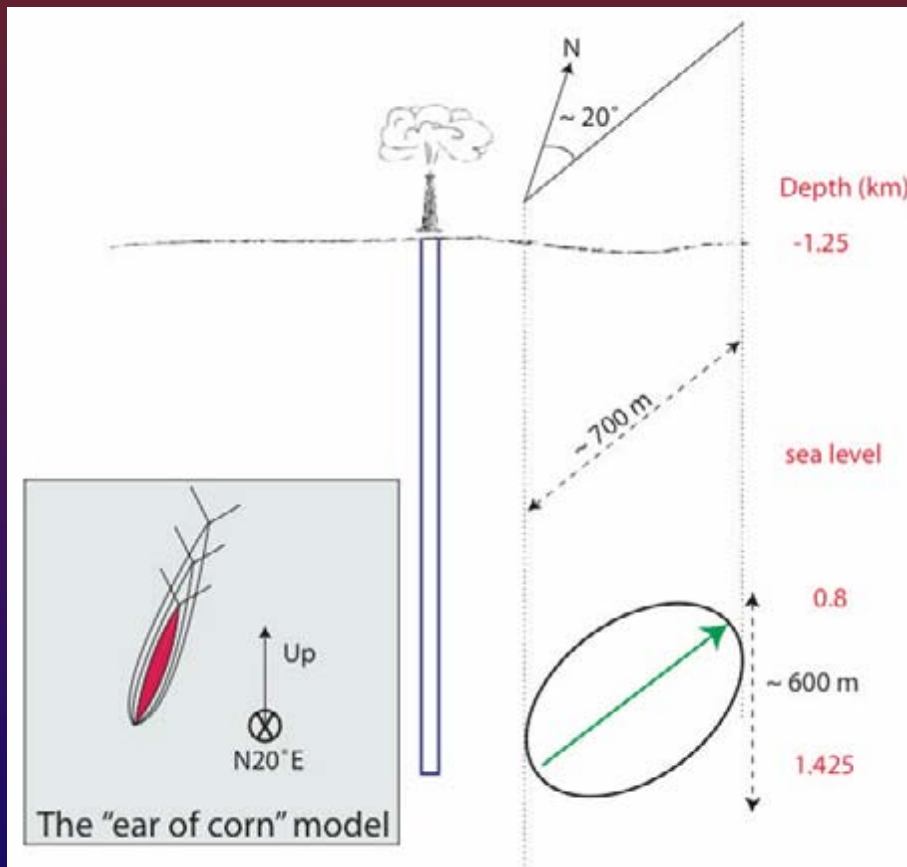
❖ Stress release during of pre-, co- and post-swarm MEQs different

❖ Indicates lifecycle of new EGS hydrofracture

Background/Approach: Earlier results

The "ear of corn" model

- ❖ Hydrofracturing of 34-9RD2
- ❖ Fracture mapped
- ❖ Fracture size/area estimated
- ❖ Trajectory determined
- ❖ Mode of failure
- ❖ Potential for circulation
- ❖ Stress regime
- ❖ Changes in stress with time

Results/Accomplishments

❖ MEQ study should be a standard geothermal exploration/monitoring tool

❖ HOWEVER, its full potential is only realised for:

  ❖ appropriately high-quality data

  ❖ appropriate processing methods

Conclusion

❖ *Seismic (MEQ) Characterization of EGS Fracture Network Lifecycles*

❖ Will the project objective be achieved by the project completion date? YES

❖ For 46A-19RD: Expect to characterize:

  ❖ fracture geometry - orientation, length & area

  ❖ mode of failure and thus permeability prospects

  ❖ stress regime & changes with time