U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Public Service of Colorado Ponnequin Wind Farm

Verification of Geothermal Tracer Methods in Highly Constrained Field Experiments

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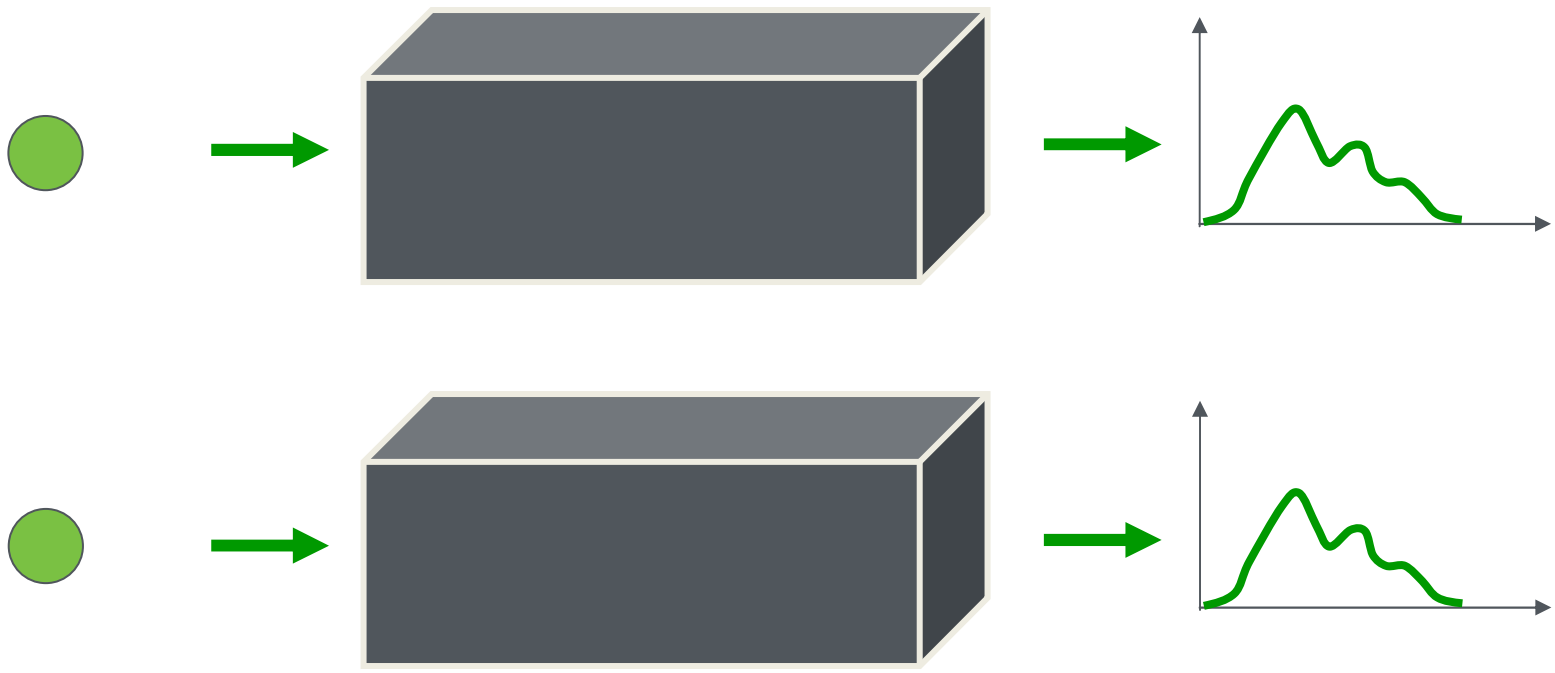
Overview

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- Timeline
  - January 29, 2010 to 12/21/2012
- Budget
  - DOE $380,156
  - Match $156,420
  - Total $536,575
- Barriers
  - Low permeability – evaluation of hydrofracturing
  - Low heat efficiency – evaluation of heat transfer
- Partners
  - George Tsoflias, University of Kansas (Ground Penetrating Radar)
  - Subaward: $150,266 DOE + $30,506 Match

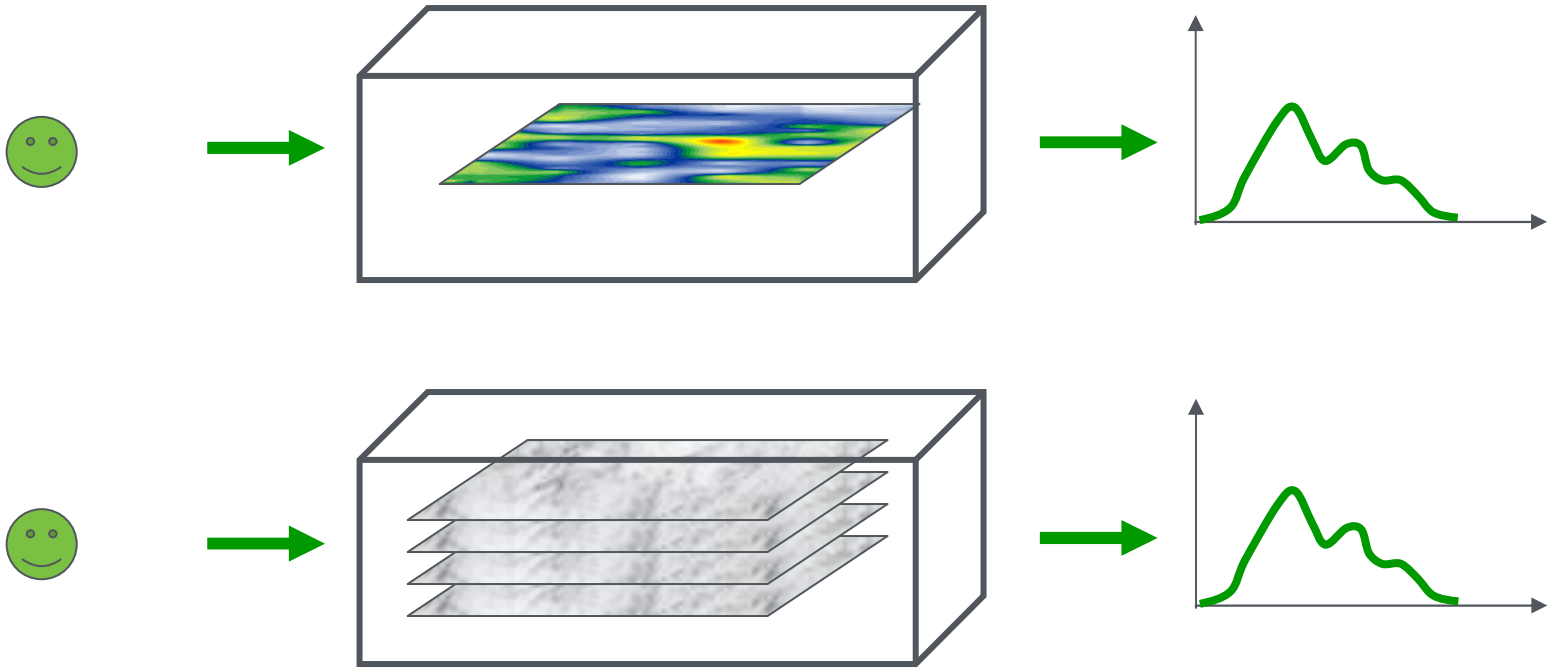
Relevance/Impact of Research

Conservative tracers can determine only residence time…



Relevance/Impact of Research

… smart tracers are designed to look inside the black box and determine the cause of residence time.



But do smart tracers work?

Relevance/Impact of Research

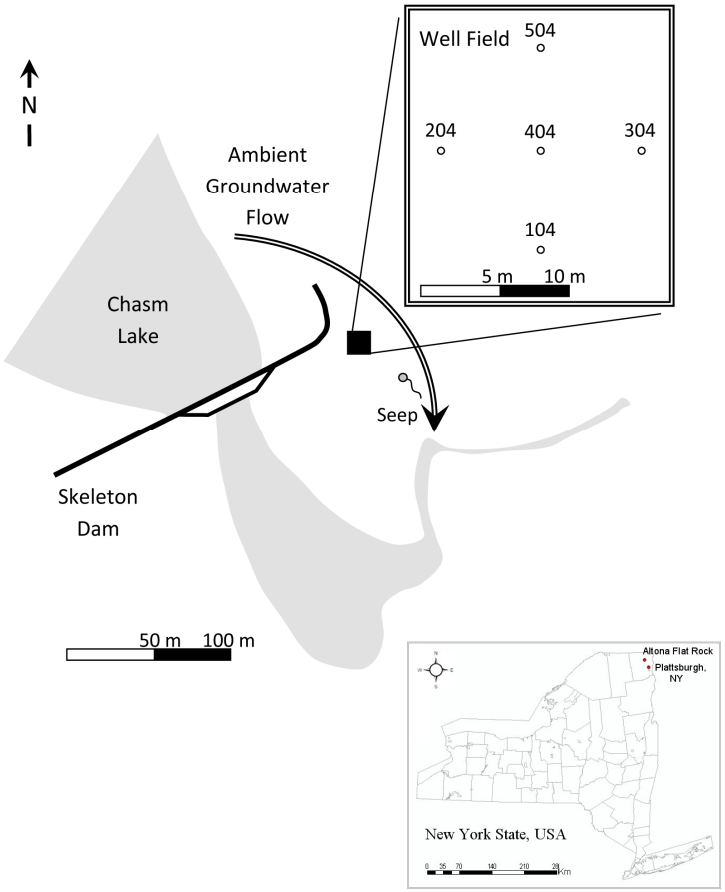
Hypothesis: Smart tracers can measure potential heat exchange between fracture and rock mass

Hypothesis Test: A tracer test proving ground

- System must be simple and fully characterized
- Flow path must be mapped
- Thermal exchange between fracture and rock mass must be measureable

Scientific/Technical Approach

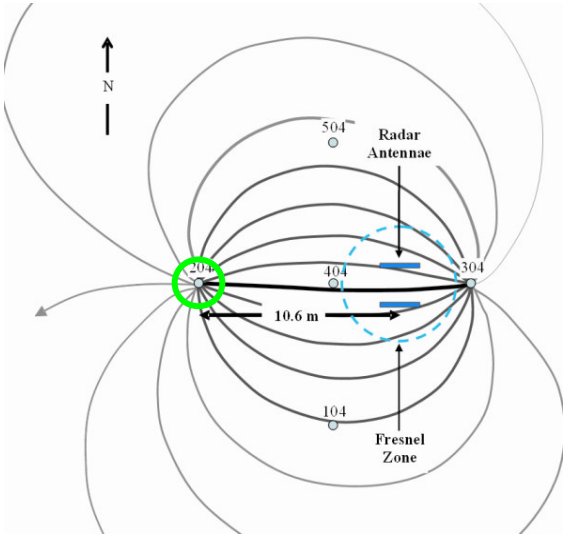
- System must be simple and fully characterized
  - ✓ Sandstone hydraulically isolated in single subhorizontal fracture
  - ✓ Multiple hydraulic, tracer, geophysical tests already completed
  - ✓ Easy site access and logistic support

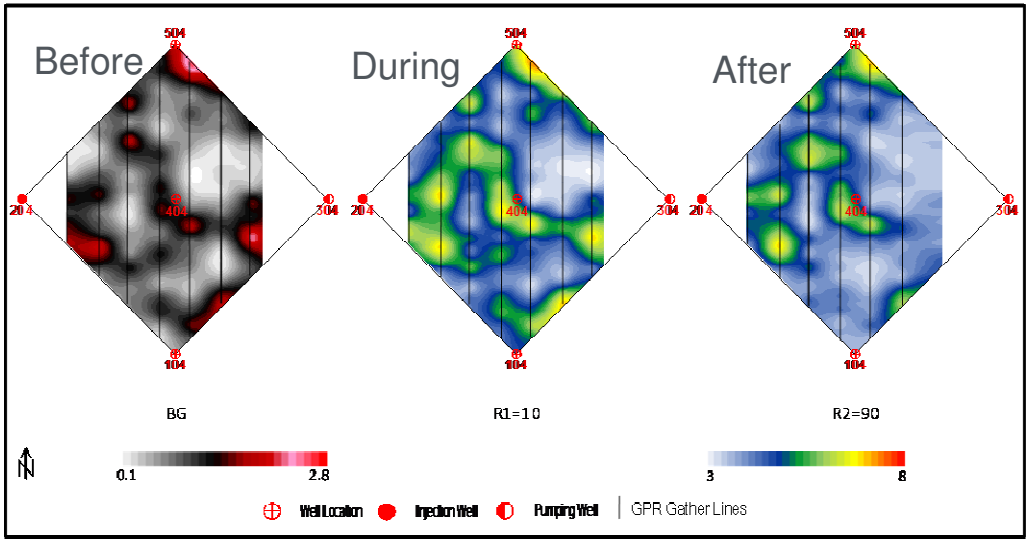


Scientific/Technical Approach

- Flow Path Must Be Mapped
  - ✓ Surface reflection ground penetrating radar to map tracer flow and aperture

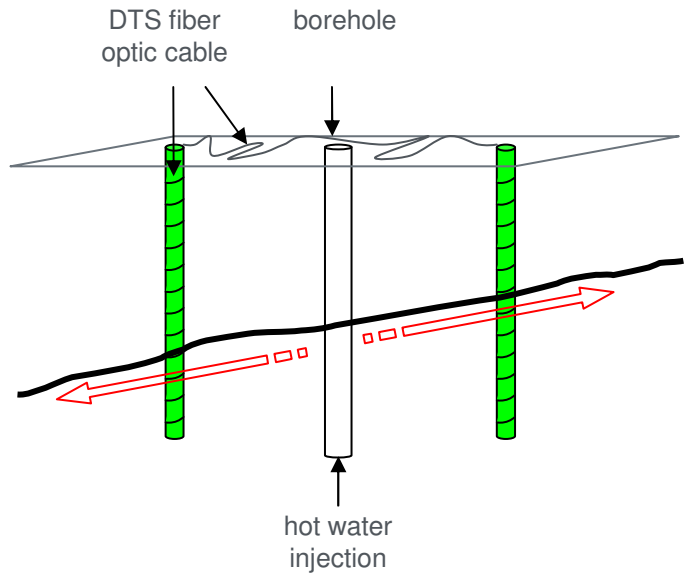
  Example below: saline tracer imaged in fracture

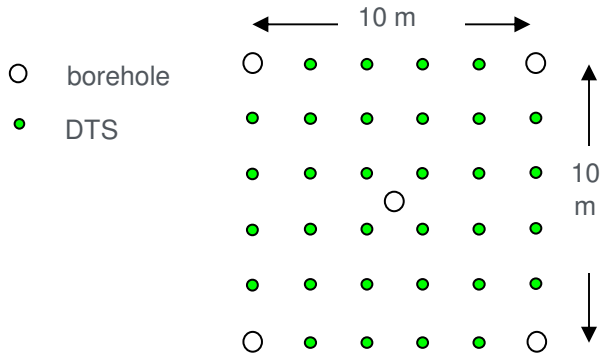




Scientific/Technical Approach

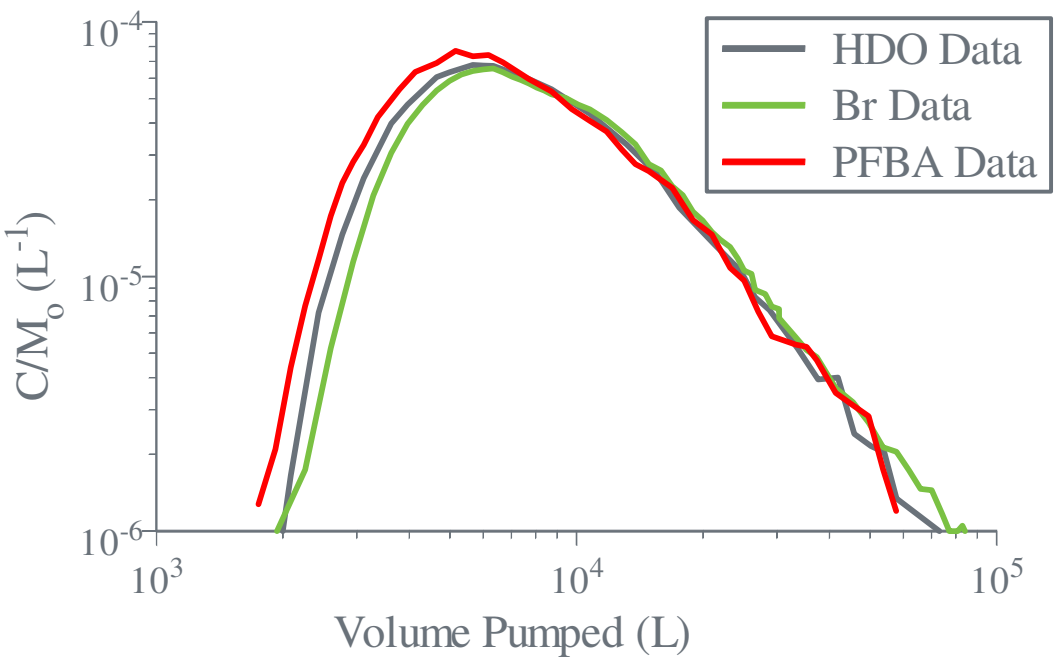
- Thermal exchange must be measureable
  - ✓ fiber optic distributed temperature sensing (DTS) to measure heat exchanged from hot water circulated through fracture
  - ✓ Produces over 4000 temperature readings every 15 minutes

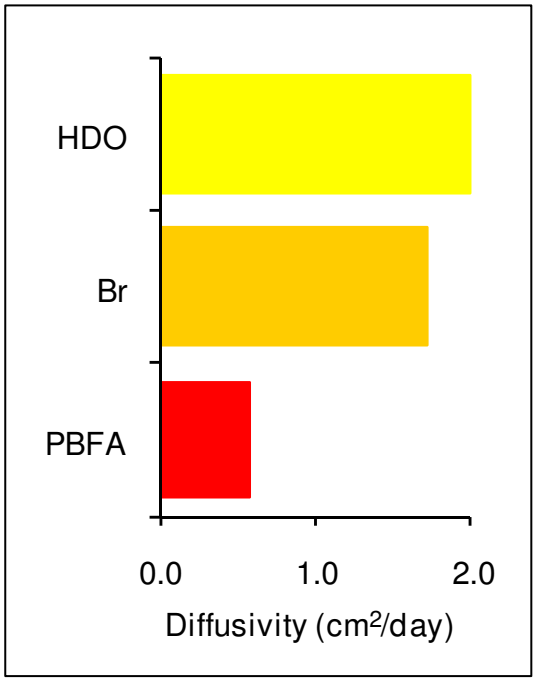




Scientific/Technical Approach

- Tracers to be tested in this project:
  - Diffusive tracers: HDO, Br-, PFBA, CML Microspheres





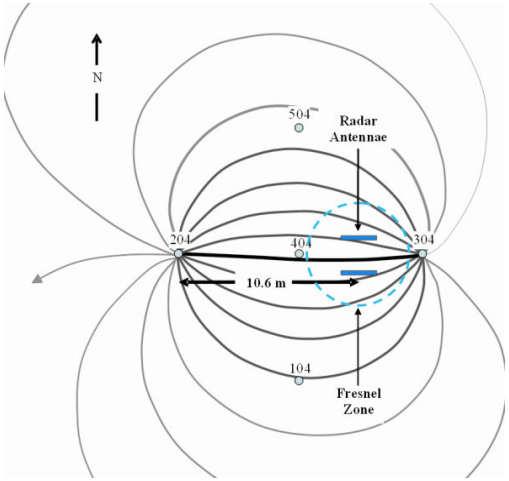
Diffusive tracers used at Mirror Lake New Hampshire fractured granite (Becker and Shapiro, WRR, 2000)

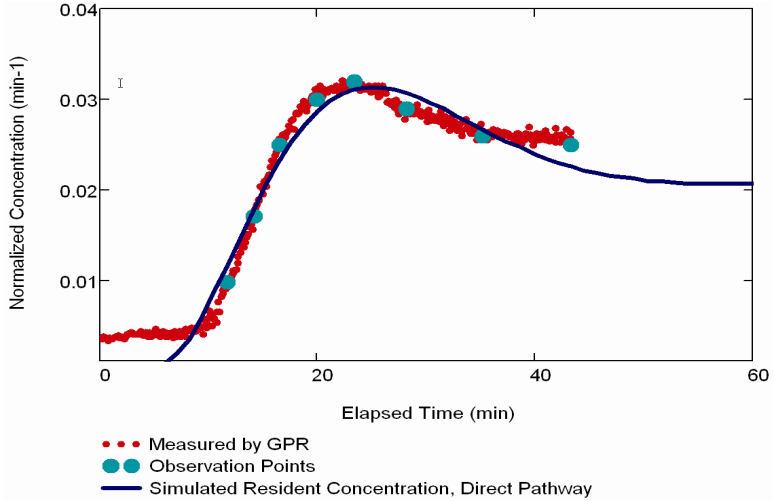
Accomplishments, Expected Outcomes and Progress

Project fully funded in April 2010

Previous work at the site has proven:

- GPR capable of mapping tracer, possibly apertures
- Tracers breakthrough is predictable
- DTS has accuracy to measure heat exchange





GPR measured tracer breakthrough at project field site (Becker and Tsoflias, WRR, in press)

Project Management/Coordination

- Locations
  - Laboratory: at CSULB
  - Field: Summers of 2010 and 2012
- Personnel:
  - CSULB: PI, 2 MS Students
  - KU: co-PI, 1 MS Student
- Task Breakdown:
  - CSULB: hydraulic, tracers, transport modeling
  - KU: GPR, data inversion, aperture estimation

Future Directions

- After characterization during this project, site will be made available for testing of smart tracers developed by EERE collaborators
- PI is in communication with University of Utah, Los Alamos Laboratories regarding their tracer programs.
- Other collaborators are welcome and are invited to contact us.

Summary Slide

- Smart tracers are needed to overcome barriers to EGS
- Smart tracers and their models need to be proven before full scale demonstration
- This project will test smart diffusive tracers for measuring heat exchange
- Future collaboration will test other field-ready smart tracers.