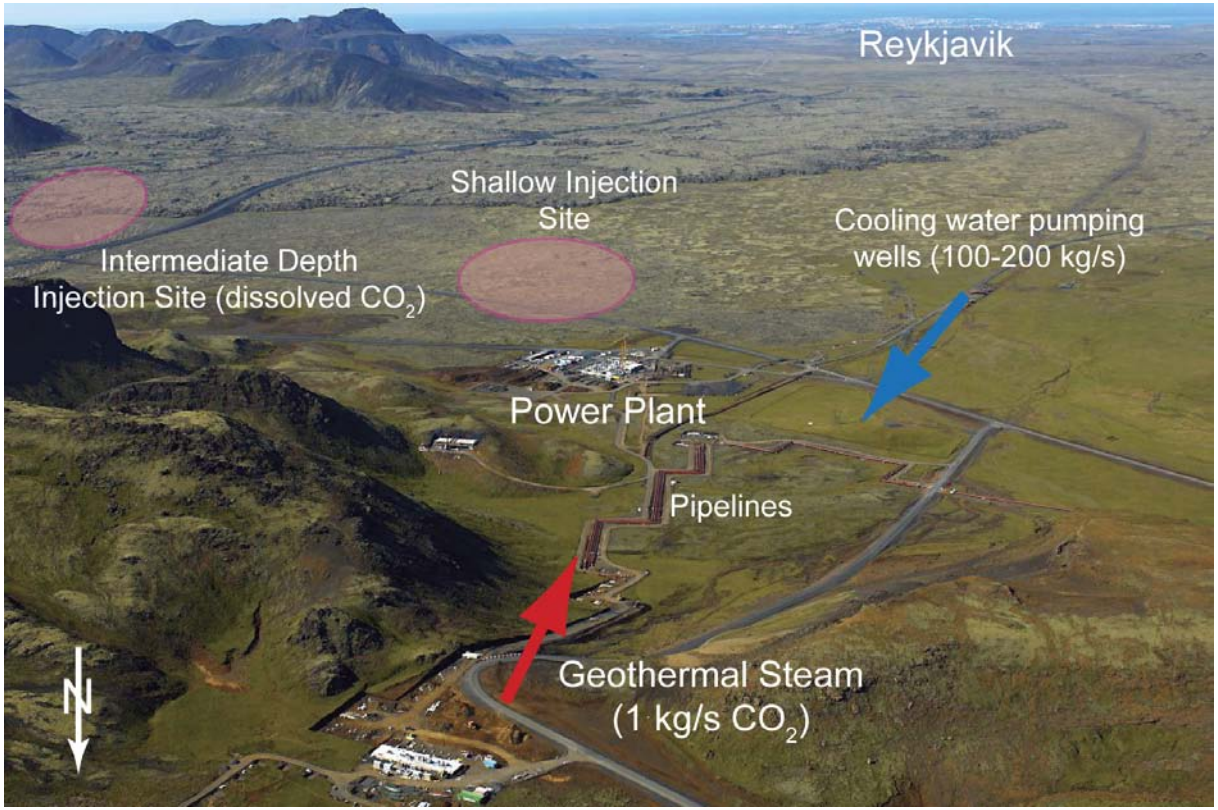


Advanced 3D Geophysical Imaging Technologies for Geothermal Resource Characterization

May 19, 2010

Principal Investigator: Greg Newman
Presenter Name:Michael Fehler
Organization: MIT

Track Name

Overview

- Timeline
  - 5/15/2010 – 5/14/2013; 0% complete
- Budget
  - Total project funding: $3,031,554
  - DOE share: $3,031,554
  - Funding received in FY09: $0.
  - Funding for FY10: $750,226
  - Iceland partners receiving own funding
- Barriers
  - Barrier A: Site selection and resource assessment
  - Barrier B: Site characterization
  - Barrier I: Images of fractures after stimulation
- Partners
  - Iceland GeoSurvey (ÍSOR); Lawrence Berkeley Laboratory; Massachusetts Institute of Technology; Reykjavík University

Project objectives

- Develop improved geophysical imaging method for characterizing subsurface structure, identify fluid locations, and characterize fractures
- Obtain the maximum amount of information from seismic, electromagnetic and gravity data by developing new joint inversion methodology
- Apply the new method to three sites
  - Improve methods by application to real data from differing environments
  - Demonstrate applicability of methods

Scientific/Technical Approach

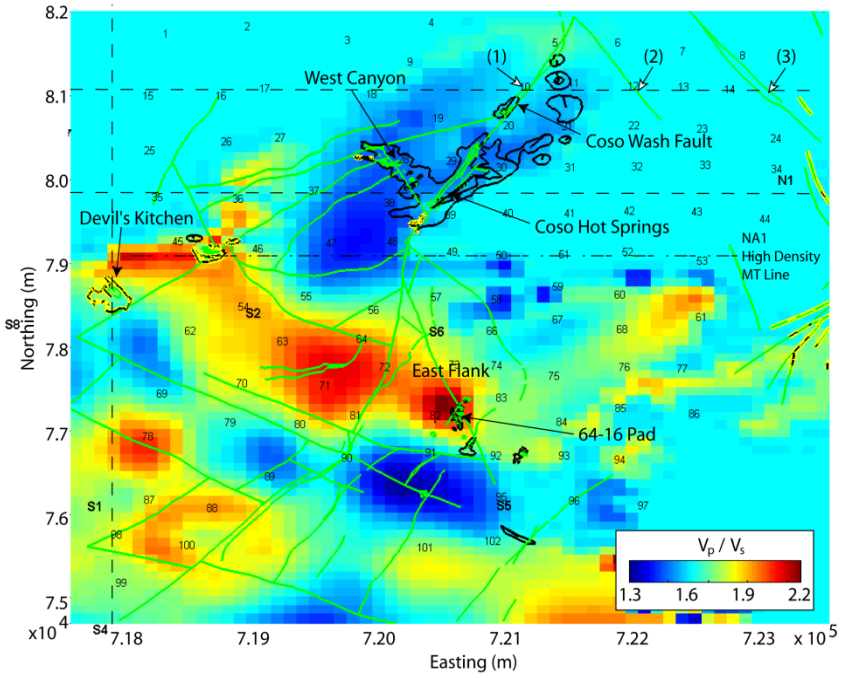
- Four-steps for combined analysis
  - Individual analysis of geophysical datasets for 3 sites
    - Integrated interpretation
  - Iterative analysis using output of one method as input to another
    - Gravity -> CSEM/TEM/MT -> Seismic
  - Fully coupled acoustic inversion
    - Find appropriate approach for scaling resolution of methods
  - Fully coupled elastic inversion
- Analysis methods used at beginning
  - Double-difference tomography (DDT) using microearthquake sources
  - Gravity analyzed separately or using coupled gravity – DDT
  - EM inversions for resistivity

Three datasets to be analyzed

- Krafla volcano, Iceland
  - First Iceland Deep Drilling Project (IDDP) well
  - Collection of two new CSEM datasets
- Reykjanes-Hengill area, Iceland
  - Several producing geothermal fields
  - Collection of new seismic data
- Coso Hot Springs, USA
  - Producing geothermal field
  - Analyze existing data

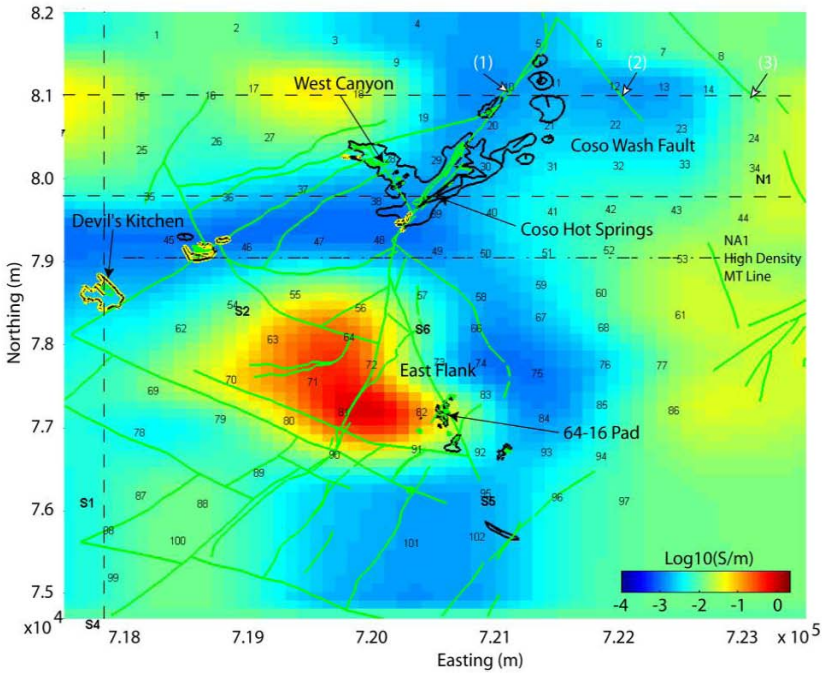
Analysis of Data from CosoHot Springs

Seismic MEQ Tomography



From Wu and Lees (2000)

MT Tomography



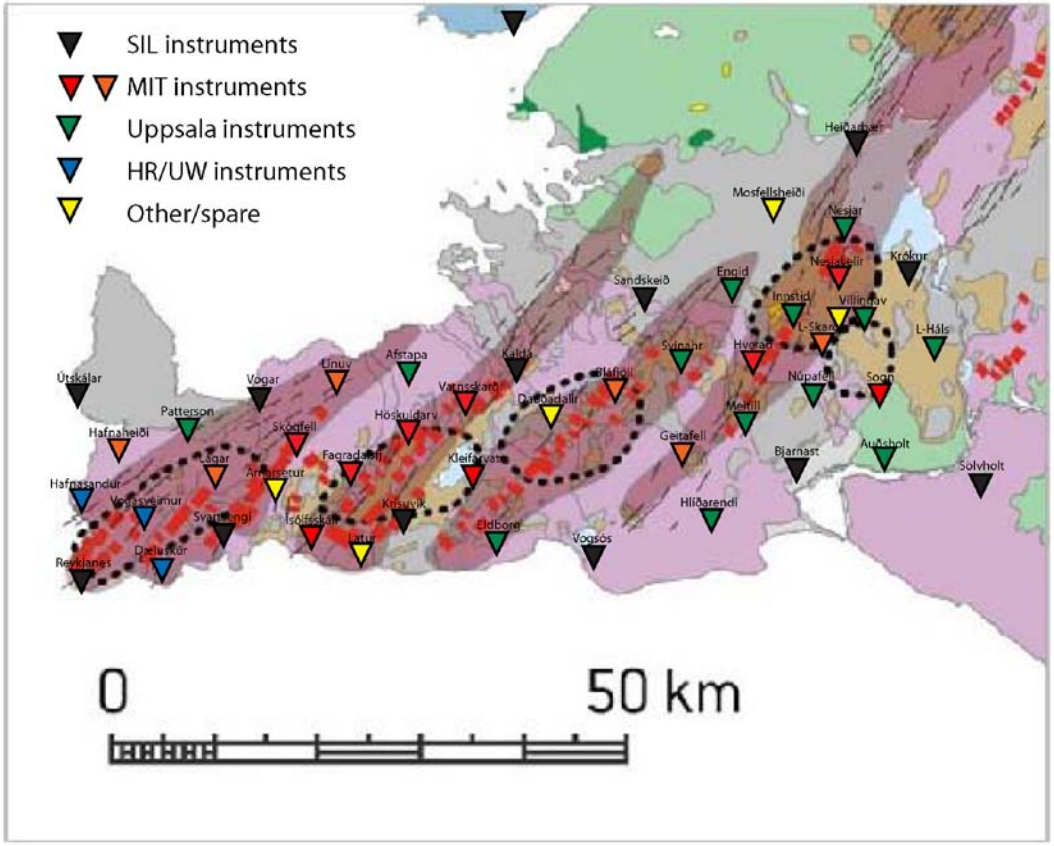
From Newman et al. (2008)

Accomplishments, Expected Outcomes and Progress

- Project kick-off meeting held May 11-12
  - Project participants from LBL, Reykjavík University, and MIT
  - Planned first phase of analysis
  - Planned seismic field work
- Existing datasets being gathered
- Seismometers being tested and prepared for shipping to Iceland for field deployment
  - Plan to deploy in summer 2010

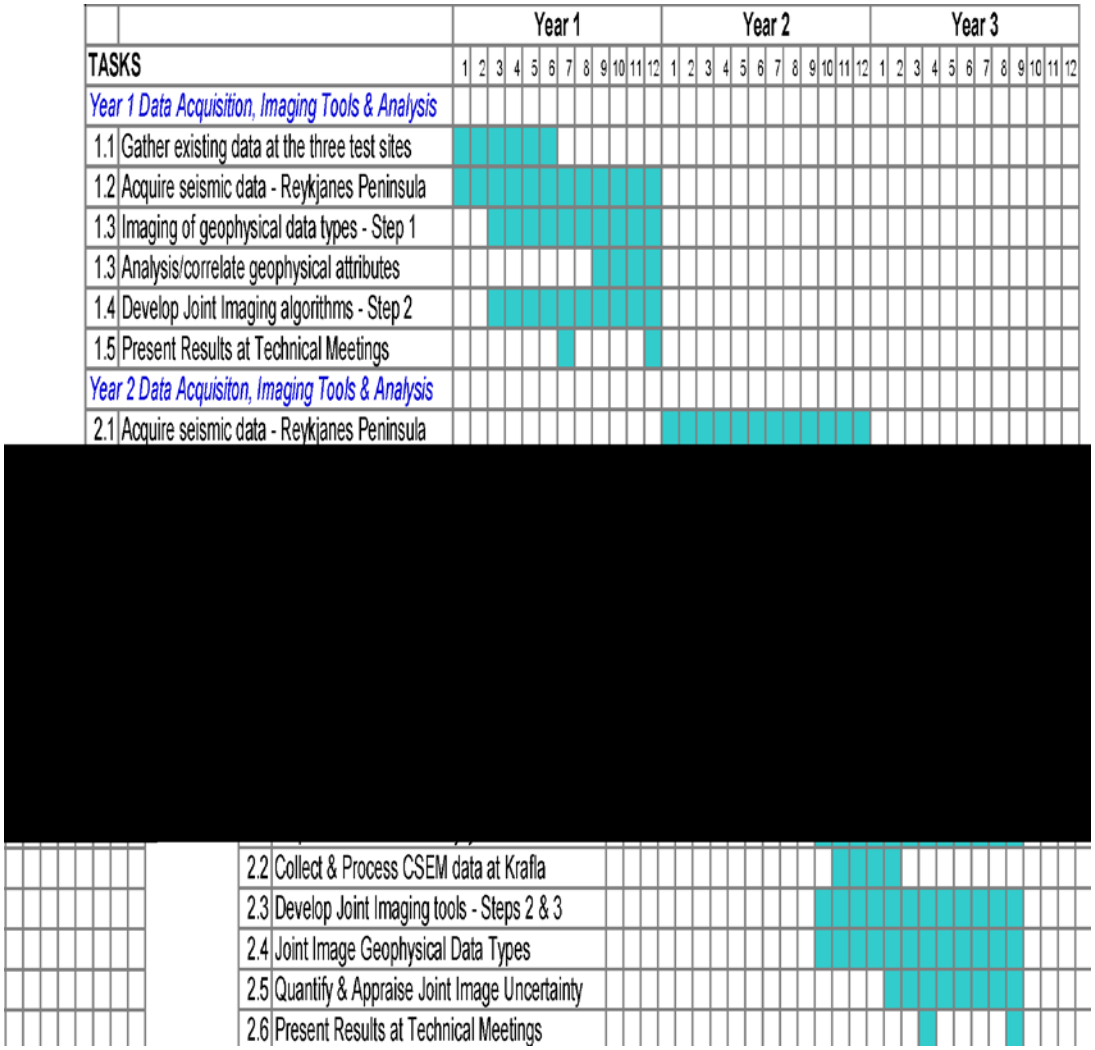
Draft Seismic Deployment Plan

(some instruments have been operating for about one year)



Project Management/Coordination

- Project Management Plans
  - Plan regular face-to-face meetings among project participants
  - Next meeting proposed for Iceland in August
- Iceland collaborators obtaining funds for participation
  - RU obtained funding for student and some field work



Future Directions

- Initial data analysis plans agreed upon at May 11-12 project meeting
- Field deployment issues and plans finalized at May 11-12 meeting
- Datasets being gathered and shared
- Major technical challenge
  - Finding appropriate method for combining all types of datasets
  - Does Microearthquake data have sufficient resolution to compliment EM data?
  - Plan 4-step approach for progressing to full joint inversion

Summary

- Correctly-formulated joint inversion has the capability to combine differing datasets to maximize the information obtained about geothermal targets
  - Useful for geothermal exploration, site characterization, and reservoir assessment
- Newly-started project
- Funded as comprehensive Icelandic/USA cooperative project under the International Partnership for Geothermal Technology (IPGT) agreement
- Involves participation of two organizations from Iceland
  - funding from GEORG Program (GEOthermal Research Group) & partner cost-sharing