Hydrogeologic windows: regional signature detection for blind and traditional geothermal play fairways

Project Officer: Michael Weathers

Total Project Funding: $405k

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Play fairway Analysis

LA-UR-15-21186

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**Goal:** *Develop a multi-scale, science-driven approach to identify blind geothermal systems*

Objectives

(1) Develop a preliminary risk-based Play Fairway Framework (PFF) to support DOE and industry in (a) identifying potential geothermal resources and (b) reducing geothermal project risks

(2) Build the basic and transformative science supporting identification of blind geothermal systems

(3) Demonstrate end-use tool that allows stakeholders to minimize risk and identify data needs when locating a new well site
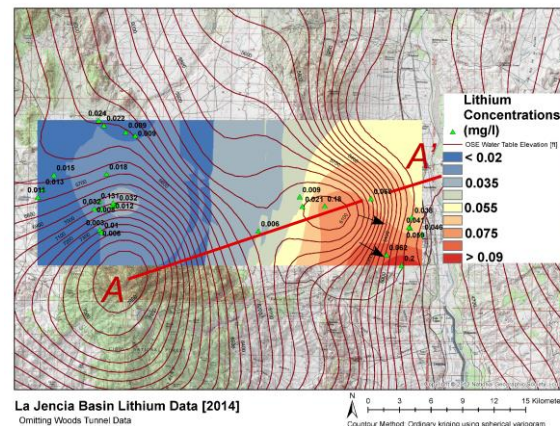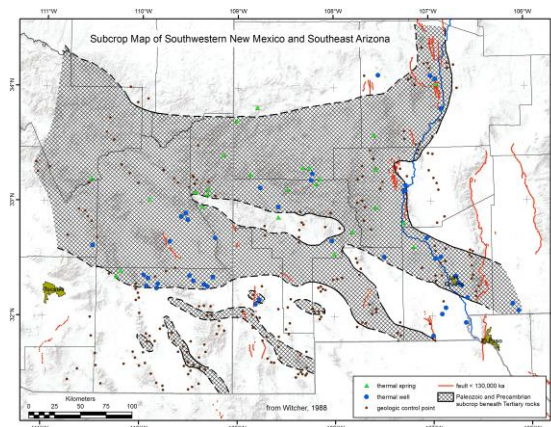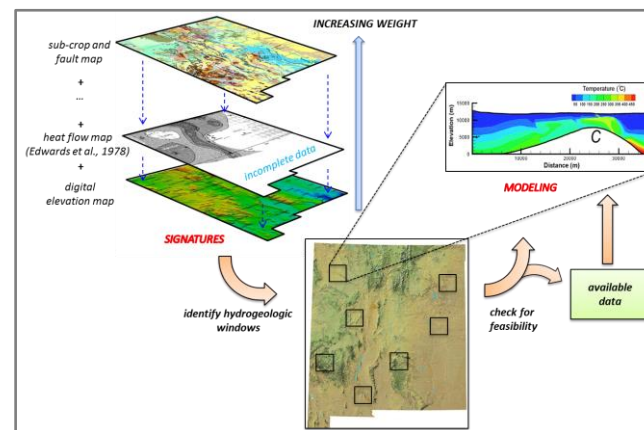
Innovative approach

Hydrogeologic windows
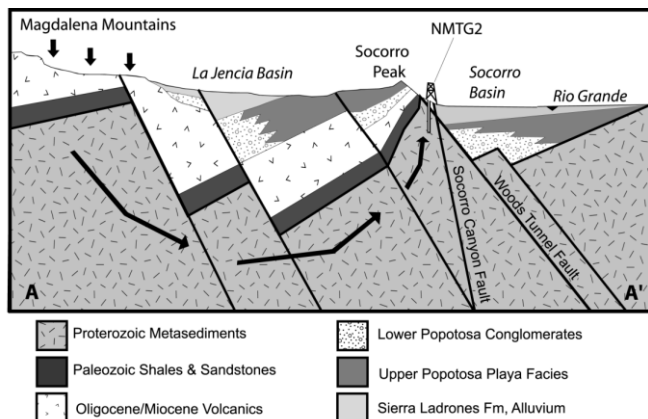
Upwinding geochemical analysis

Sub-crop mapping approach

Multi-scale risk-based framework

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Critical tasks

- Data organization, sharing
- Sub-crop mapping
- Geomorphic analysis
- Geothermal modeling
- Framework development

Execution

- Sub-contract delays
- Timeline compression
- All task scheduled to be completed on time

Milestone Summary Table — Recipient Name: Los Alamos National Laboratory (PI: Richard Middleton). Project Title: Hydrogeologic windows: regional signature detection for blind and traditional geothermal play fairways

Task	Task title	Milestone type	Milestone number	Month/quarter	Start-end month	Milestone description (Go/no-go decision criteria)	Milestone verification process (what, how, who, where)
0	Organizing existing data/modification of databases.	Milestone	M0	3/1	1-3	Incorporation of additional data from NMBG into NGDS	NGDS system managers verify compatibility
1	Sub-crop mapping	Milestone	M1	3/1	1-3	Statewide sub-crop maps constructed	Sub-crop maps shared usable by Task 8 partners.
2	Geomorphic analysis	Milestone	M2	5/2	3-5	Upflow zonal isolations estimated	Isolations shared with Task 8 partners.
3	Use of Geochemical Tracers and Upwinding Techniques to Locate Blind Geothermal Systems.	Milestone	M3	6/2	1-6	Pathline analysis of Li/B tracer flows."	Model completed and applied.
4	Crustal heat flow modeling	Milestone	M4	3/1	1-3	Estimate of bulk heat generation in New Mexico	Bulk heat calculated and shared with Task 8 partners.
5	Fault analysis	Milestone	M5	6/2	5-6	Identification of fault tip intersection	Summary of characteristics of fault tip intersections provided to Task 8 partners.
6	Remote sensing	Milestone	M6	9/3	5-6	Identify vegetation near surface expressions.	Determination of general characteristics of vegetation near surface expressions.
7	Geothermal modeling	Milestone	M7	9/3	3-9	Estimated temperatures of prospective hydrogeologic windows	Temperature profiles provided to Task 8 partners.
8	Framework development	Milestone	M8	12/4	1-12	Identification and estimation of resource potential in hydrogeologic windows	Mapping of probabilistic coefficients provided to NGDS
9	Go/no-go decision	Go/No-Go	M9	12/4	12		
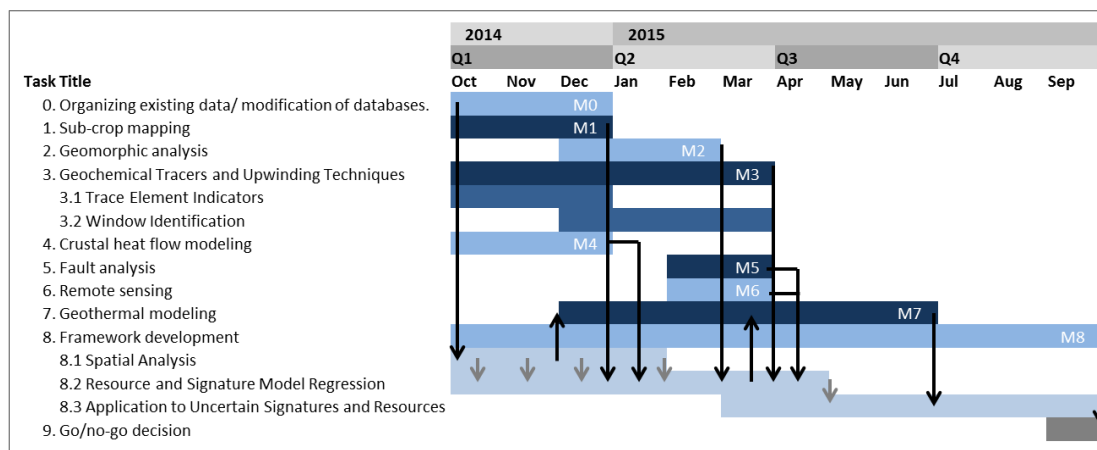
Play Fairway Framework

- Formal fairway approach to identifying and quantifying geothermal sites
- Data assimilation, management, and exploration
- Integrate data and modeling
- Understand and quantify risks, identify needs for new data

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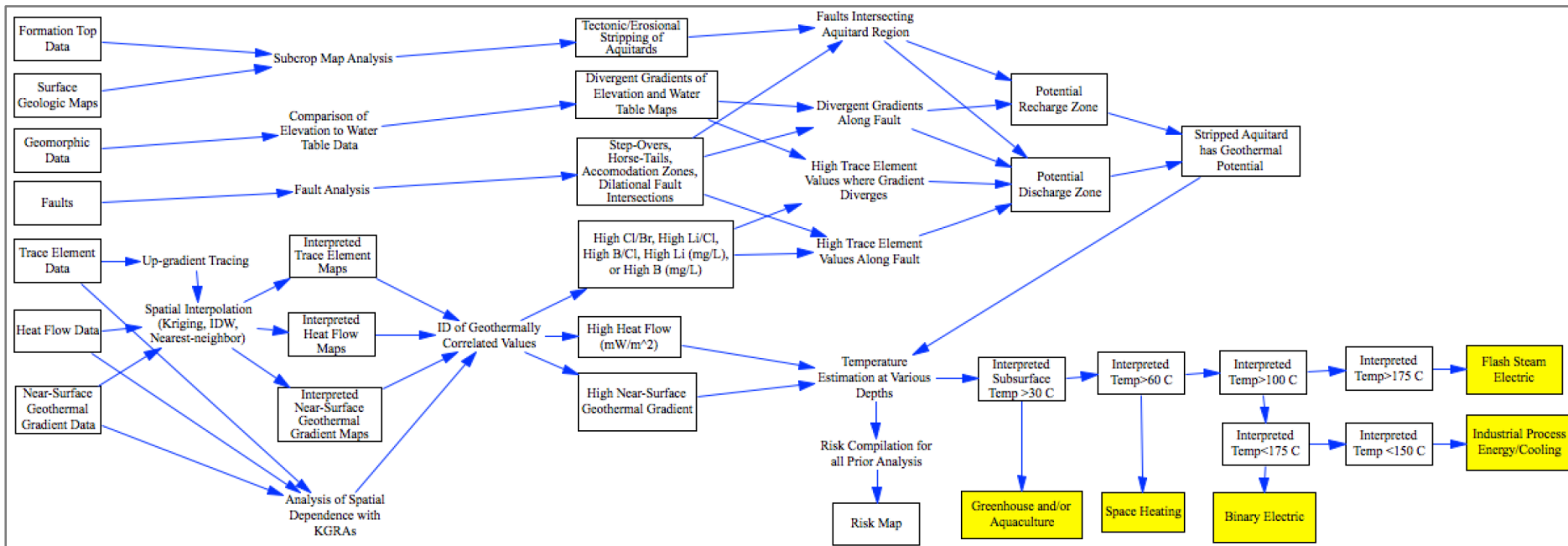
Data management & integration

- Data organized into ARC GIS layers
- Temperature-depth profiles
- Bottom-hole temperatures
- Heat flow
- Subsurface formation tops
- Basement surface
- Aqueous geochemistry
- Water table
- Fault location
- Earthquake location

Execution

- Task largely completed

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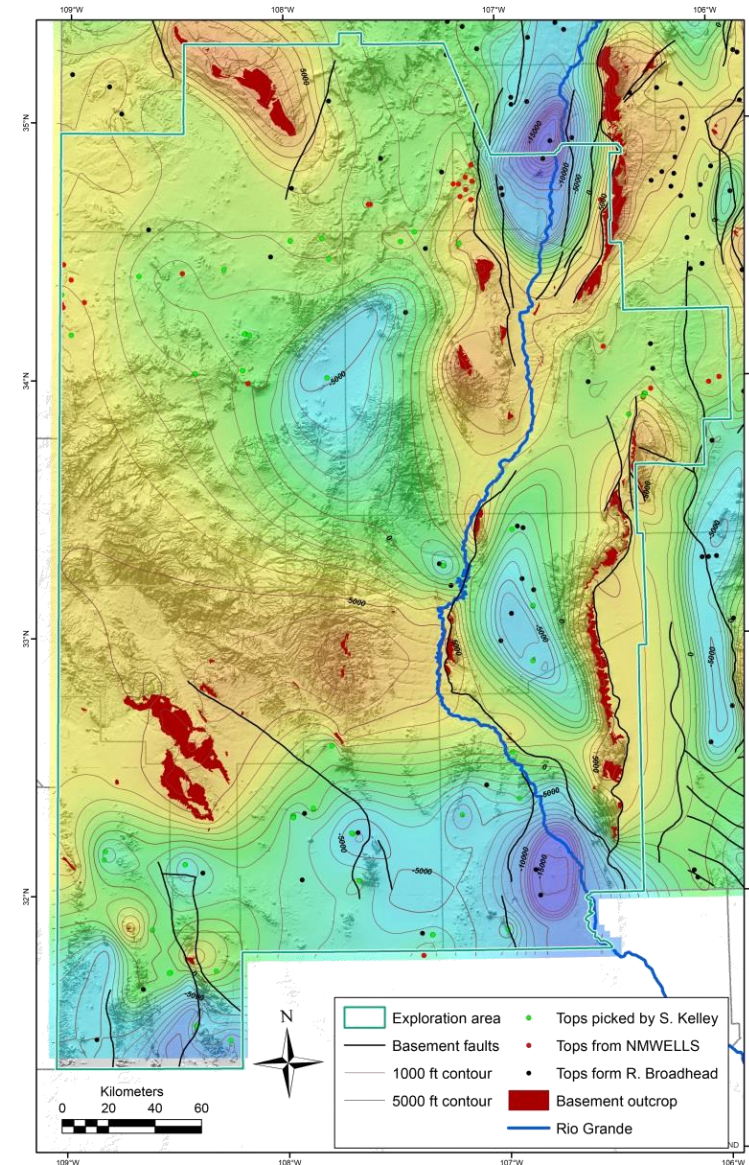
Sub-crop mapping

- Formation top data from oil wells and key outcrops from geologic maps are analyzed

- The rock units below the middle to late Cenozoic units are identified and plotted

- Sub-crop map is produced from this data

- Here we compare the sub-crop data with modern basement structure

Execution

- Task on schedule
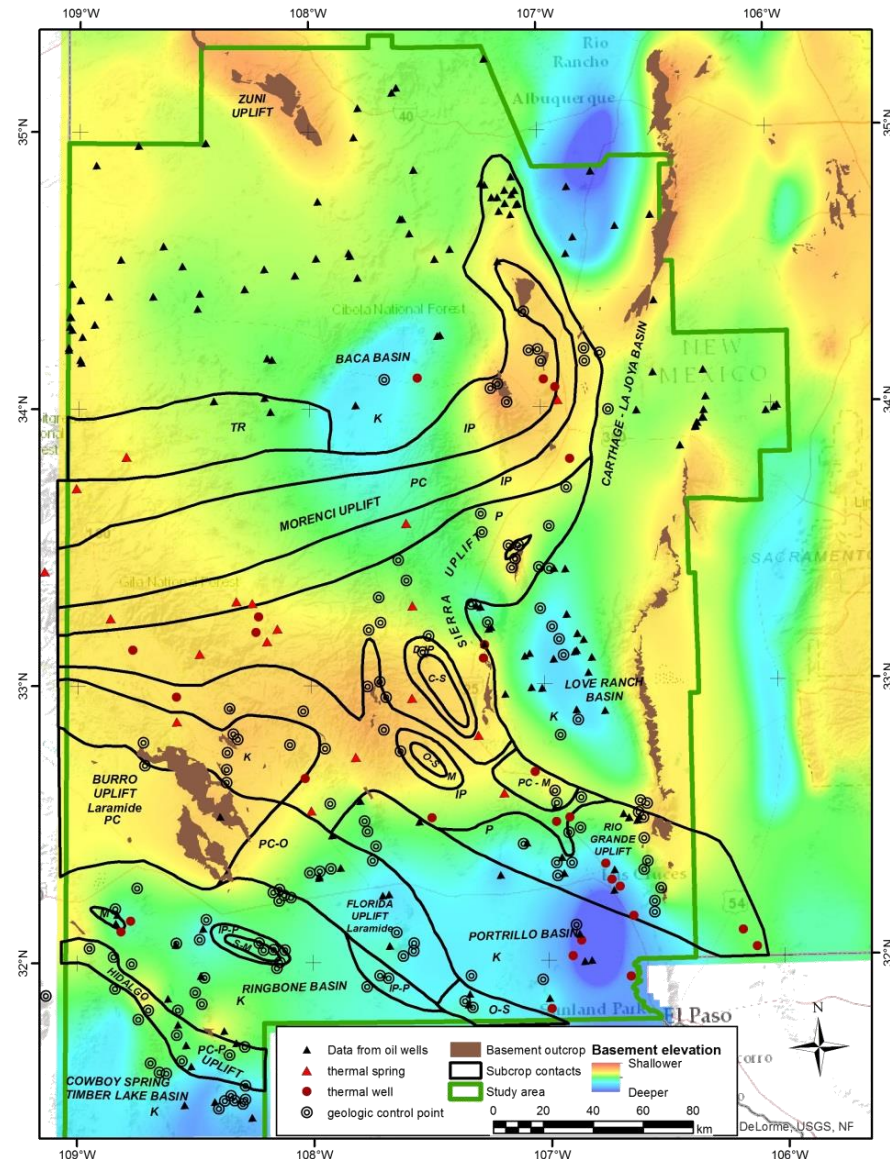
Geomorphic analysis

- Intersection of the water table and land surface

- Gray areas indicate: (1) areas of no data (often mountainous recharge areas); (2) areas where the water table is above the land surface (discharge zone)

- Current work: evaluating the significance of grey areas in terms of surface expression of geothermal activity and blind geothermal systems
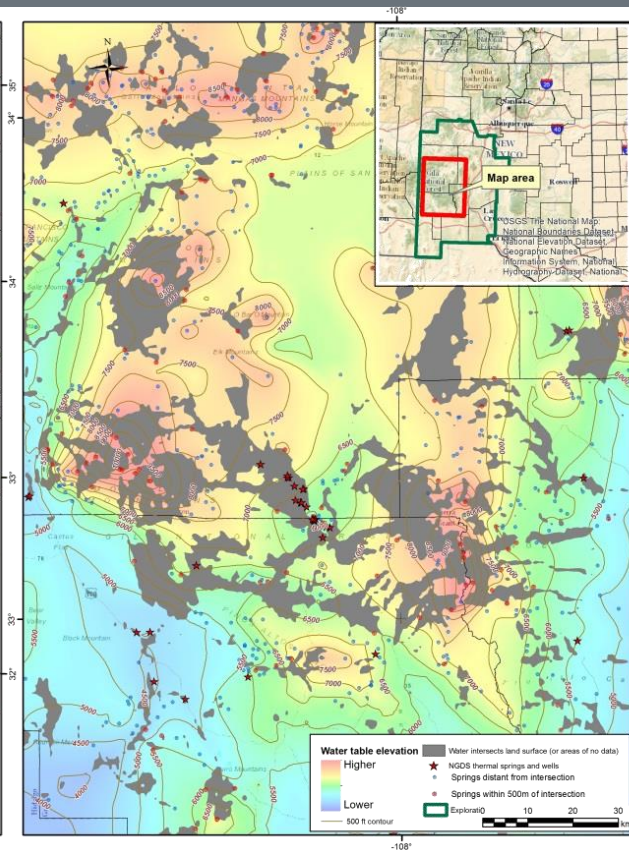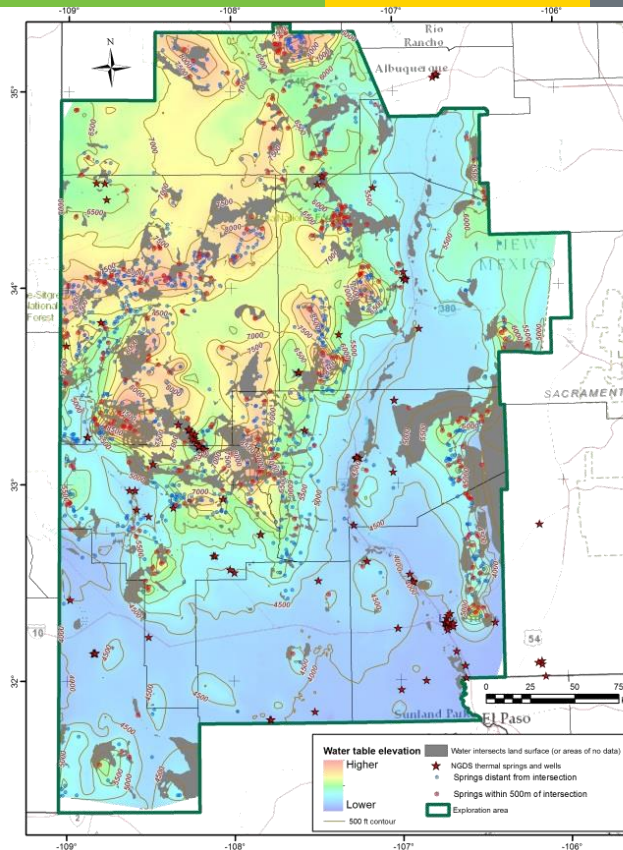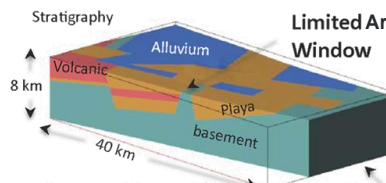
Geothermal modeling

- 2D & 3D hydrothermal modeling framework to assess the role of hydrologic windows
- Socorro-La Jencia Basin (& T or C; not shown), upwelling is confined to regions where bedrock crops out at land surface
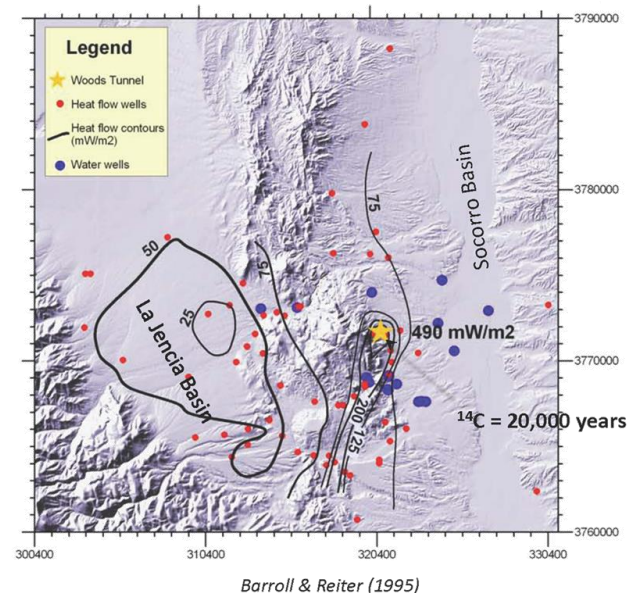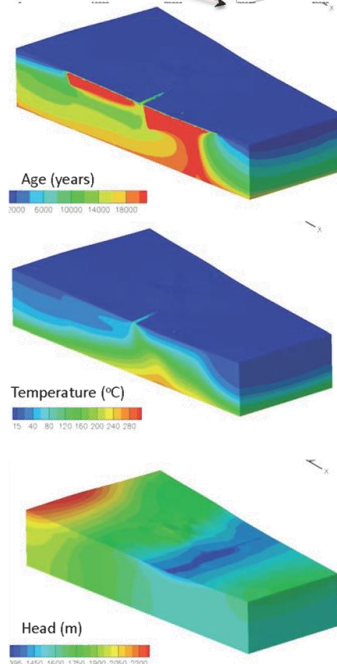- Hydrothermal model under construction for Rincon, NM

Execution

- Task on schedule

Barroll & Reiter (1995)

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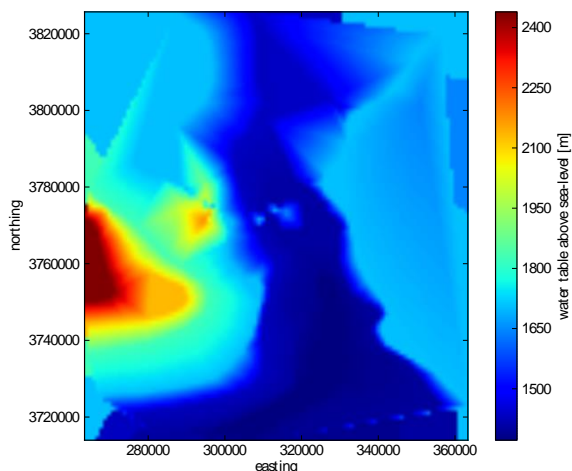
Geothermal modeling

- Modeling framework built to support geochemical tracer analysis
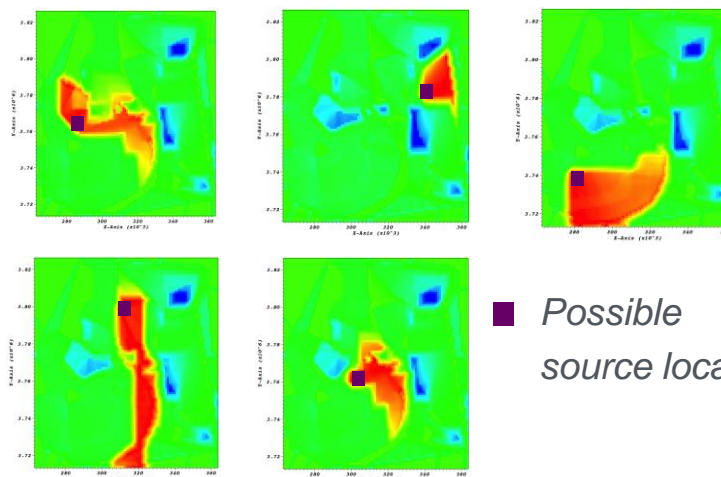- Preliminary results are promising

Execution

- Task on schedule

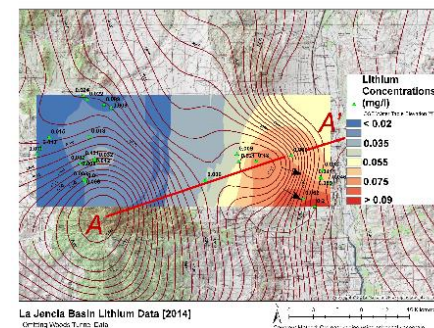Lajencia basin water table data

Multiple realizations using PFLOTRAN to invert for source location

■ *Possible source location*

Simulated Li concentration profiles

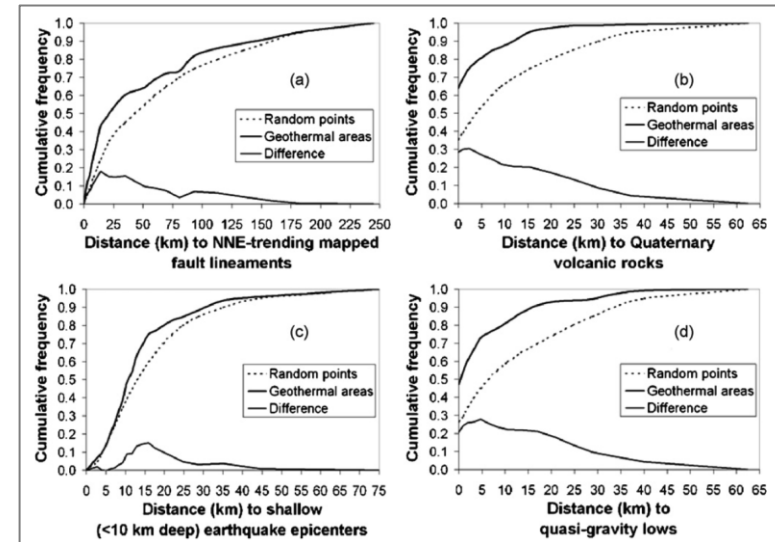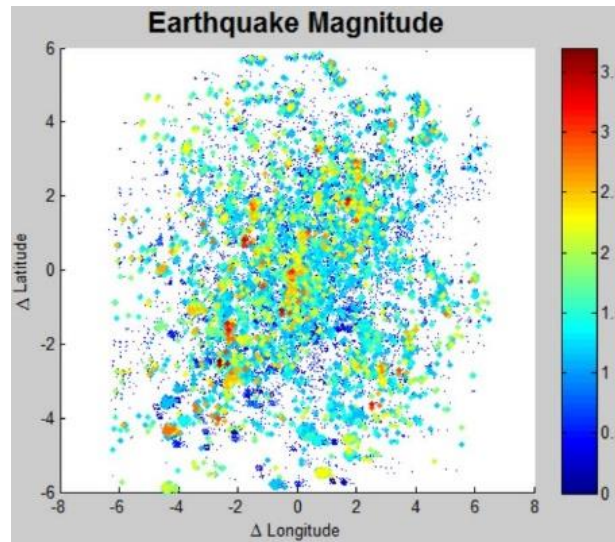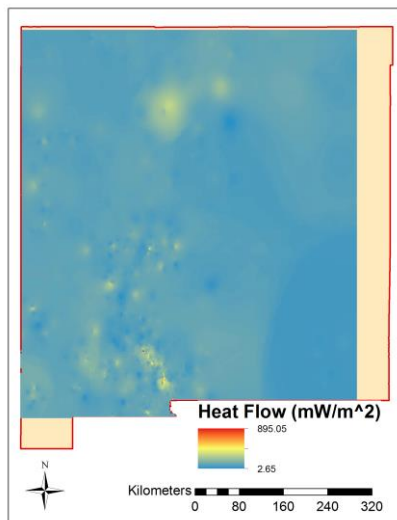Calibration targets measured Li and Bo concentrations
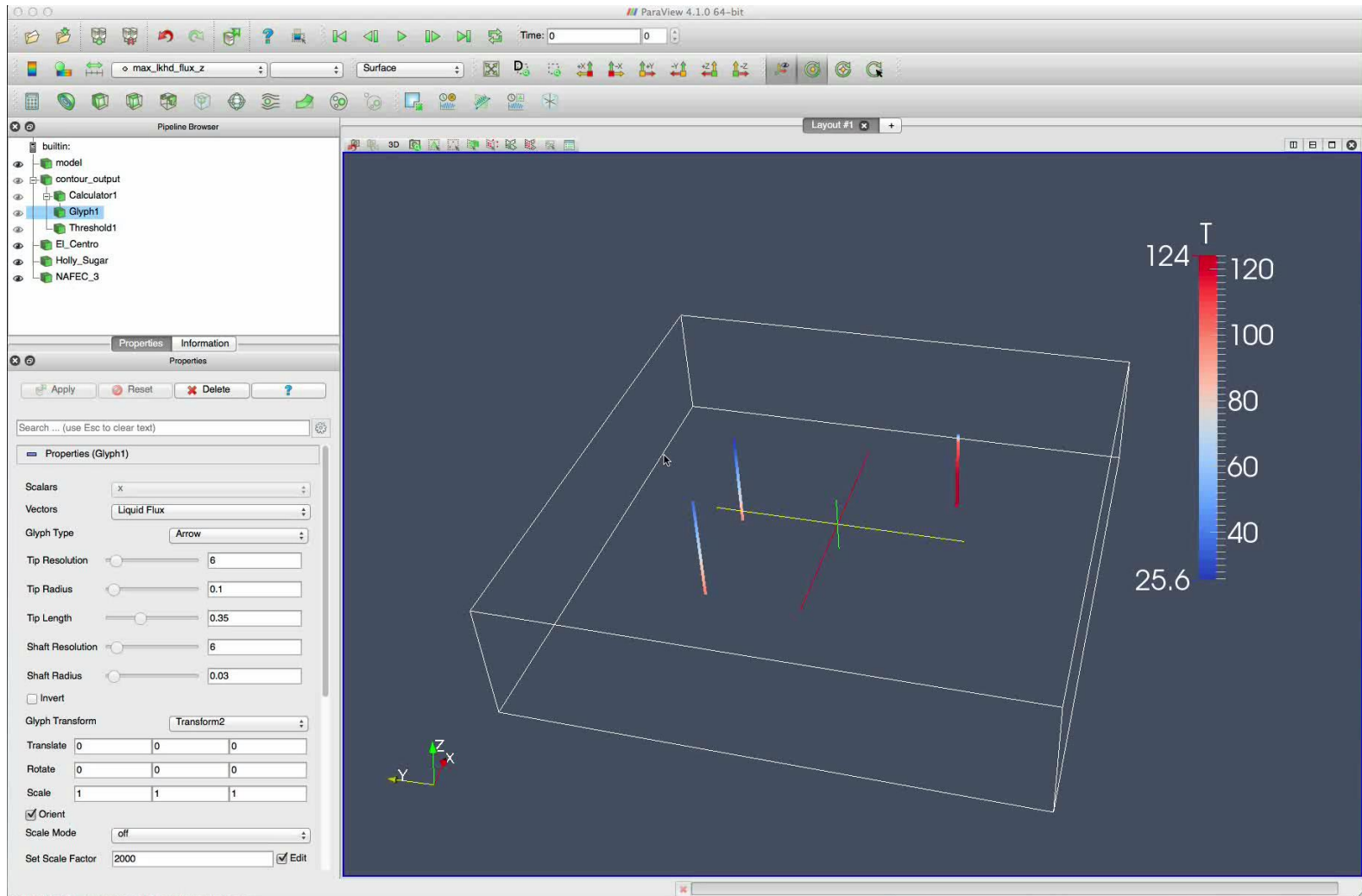
Framework development

- Initial framework built to integrate data and analysis methods
- Preliminary spatial analysis performed
- Identified spatial signature regression techniques

Execution

- Task on schedule

Risk-based tool for geothermal exploration

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Tasks

- Compressed timeline of milestones and deliverables
- Continue refinement of data analyses and modeling
- Integrate new data and analyses into the Play Fairway Framework
- Engage potential industry partners

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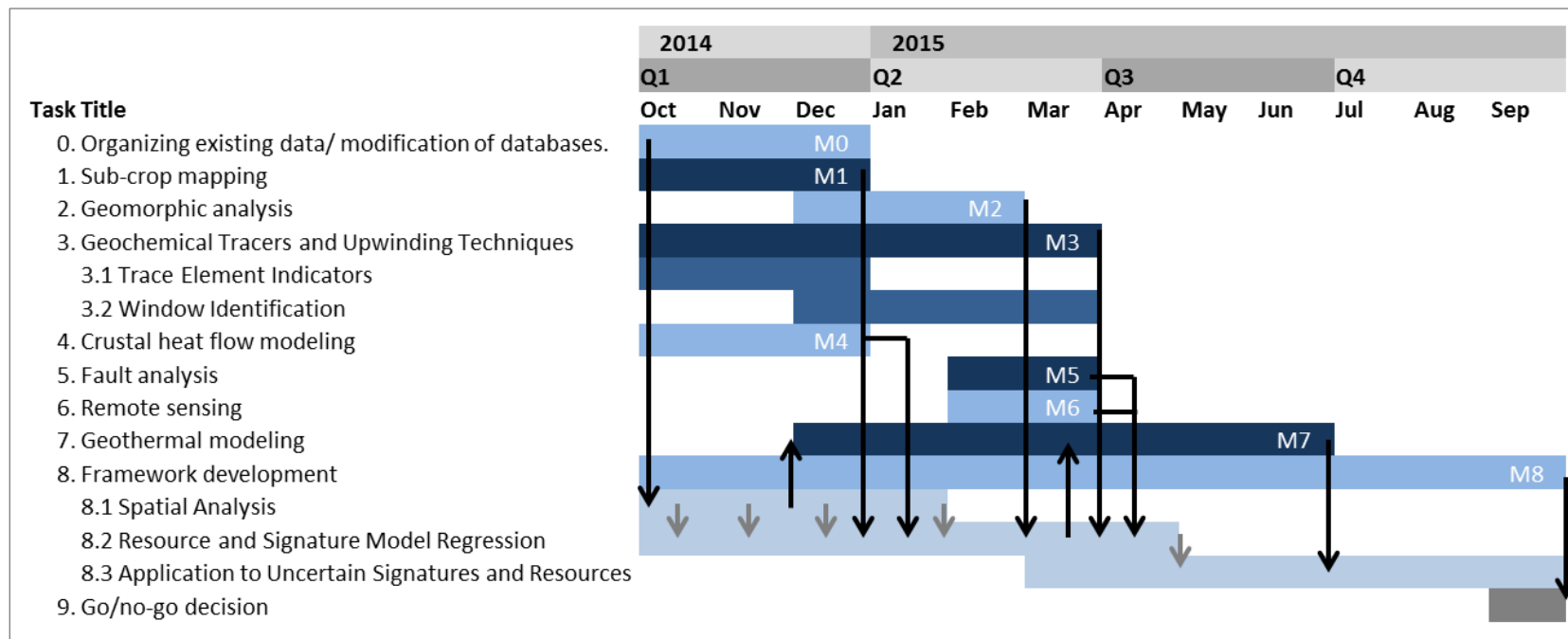
Tasks

- Identify primary targets for detailed study in second half of project
    - Rincon Valley (Ormat partner)
    - San Diego Mountain – Radium Springs (NMSU partner)
    - Eastern Colorado Plateau – western Albuquerque Basin near Belen
    - Willow Draw Fault – Alamos Creek – Engle Basin
    - Hydrogeologic windows in Grant, Luna and Hidalgo counties

- Begin assessment of exploration risk evaluation parameters
- Assess ownership of minerals and/or geothermal lease
- Evaluate permit requirements in these five areas

Geochemical tracers

- Promising method for identifying locations of geothermal upwelling

GIS-based investigation

- Straightforwardly study the interplay of complex data sets
- Unanticipated correlations become readily visible
- Eliminates areas where exploration success is unlikely
- Reduces exploration, project, and drilling risks

Databases and data exploration

- Data management/organization largely complete → dissemination
- Framework is beginning to enable comprehensive investigation of data, substantial insight is anticipated