

Recovery Act: Direct Confirmation of
Commercial Geothermal Resources in
Colorado using Remote Sensing and On-
Site Exploration, Testing and Analysis

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Flint Geothermal LLC

Track #1

- **Flint Geothermal LLC – Grant Award DE-EE0002828**
- – **Timeline**
 - **Project start date: January 29, 2010**
 - **Scheduled Project**
 - **end date: September 30, 2013**
 - **(extension to be requested)**
 - **Percent complete: less than 50%**
- – **Budget**
 - **Total Project Funding –**
- **DOE share: \$4,778,234**
- **Flint Share: \$3,007,300**
- **Total spent: 18%**

- **Project Objectives**

- A) Execute a Three (3) Phased Program to locate and confirm commercial geothermal resources in Colorado

- Prioritize Ten (10) Megawatt Targets

- B) Locate Geothermal Signatures Remotely with Ground Confirmation

- via Satellite Imagery
 - Cost Effective Lead Tool
 - confirm technique superior to ground measurements alone

Program innovative aspects

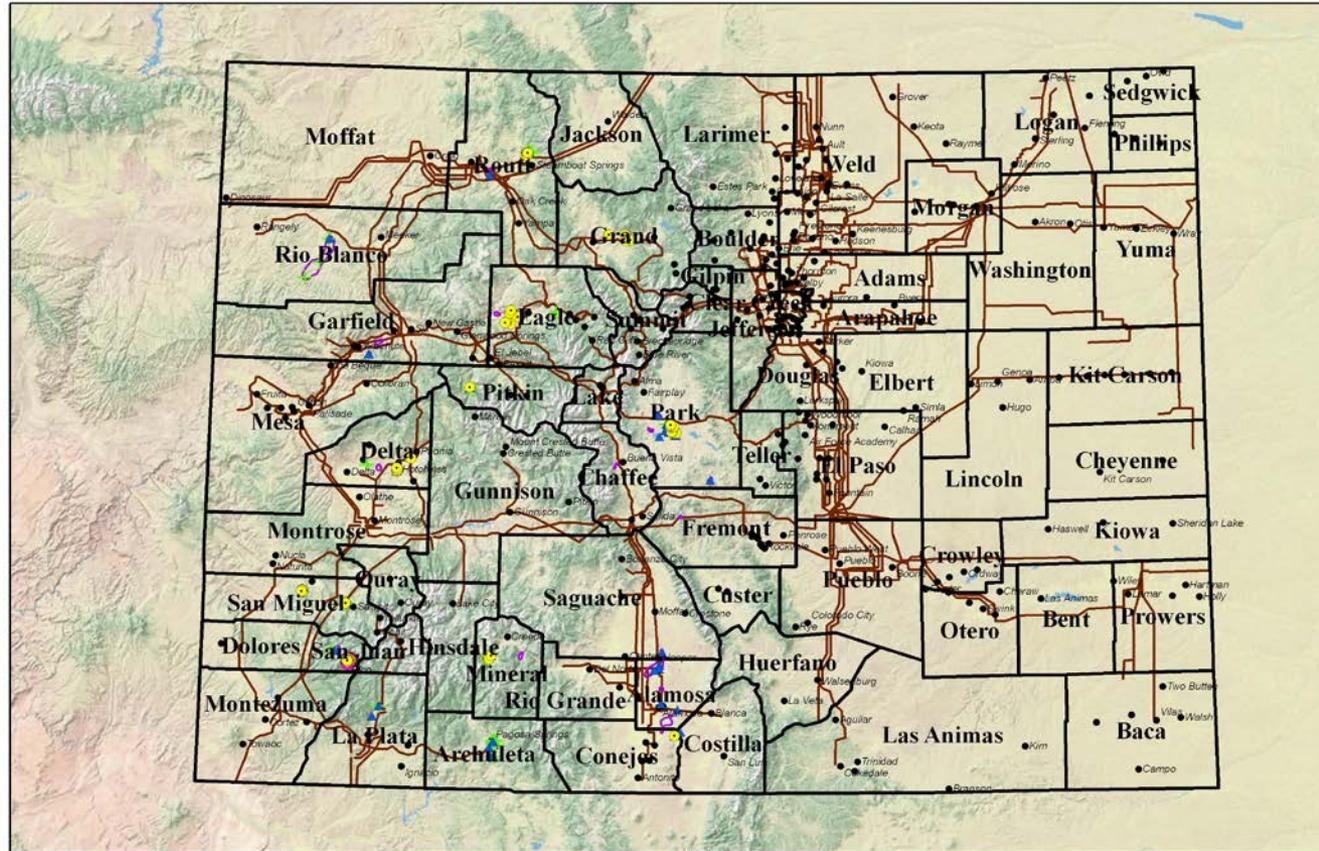
Exploration for Geothermal Resources in Three Phases:

- Phase I - Remotely Sensed Thermal Imagery Analysis
- Phase II - Ground Confirmation of Thermal Signatures
 - Including Thermal Gradient Wells
- Phase III – Confirmation of Resources
 - Deep Slim Hole Drilling & Testing

Implications of Success

- Revolutionize geothermal exploration worldwide

Phase I Sites Recommended and Phase II Field Sites Visited



Fieldwork Data

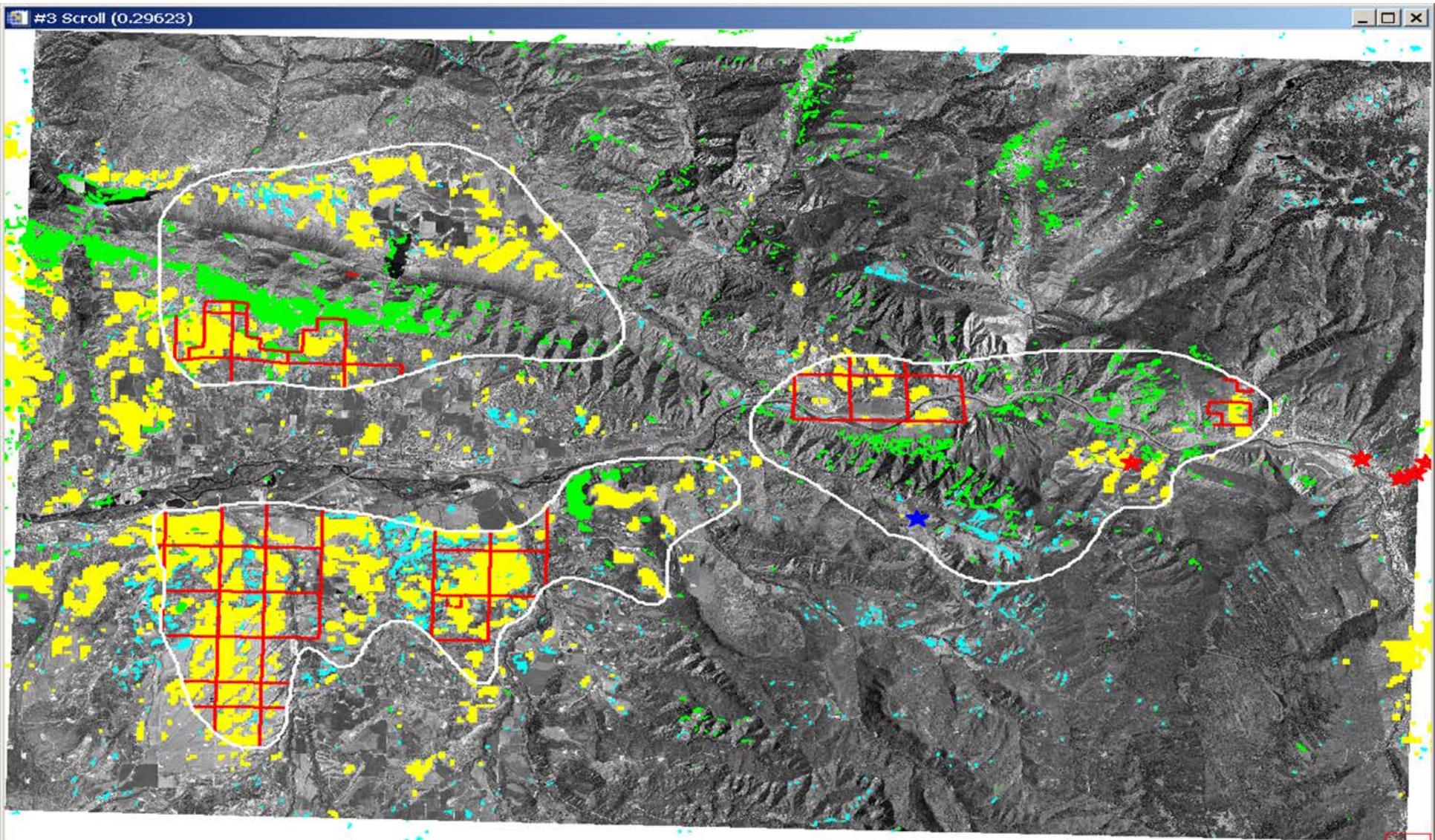
- Surface Survey
- Surface Inspection & Documentation
- 2m Survey
- Structural Data
- Hot Wells

Field Sites Visited during Summer 2011 & 2012

ASTER and Landsat Signatures

Initial Phase I Interpretation

Garfield County – Solar & Topo Issues



Field Data Acquisition Techniques Applied

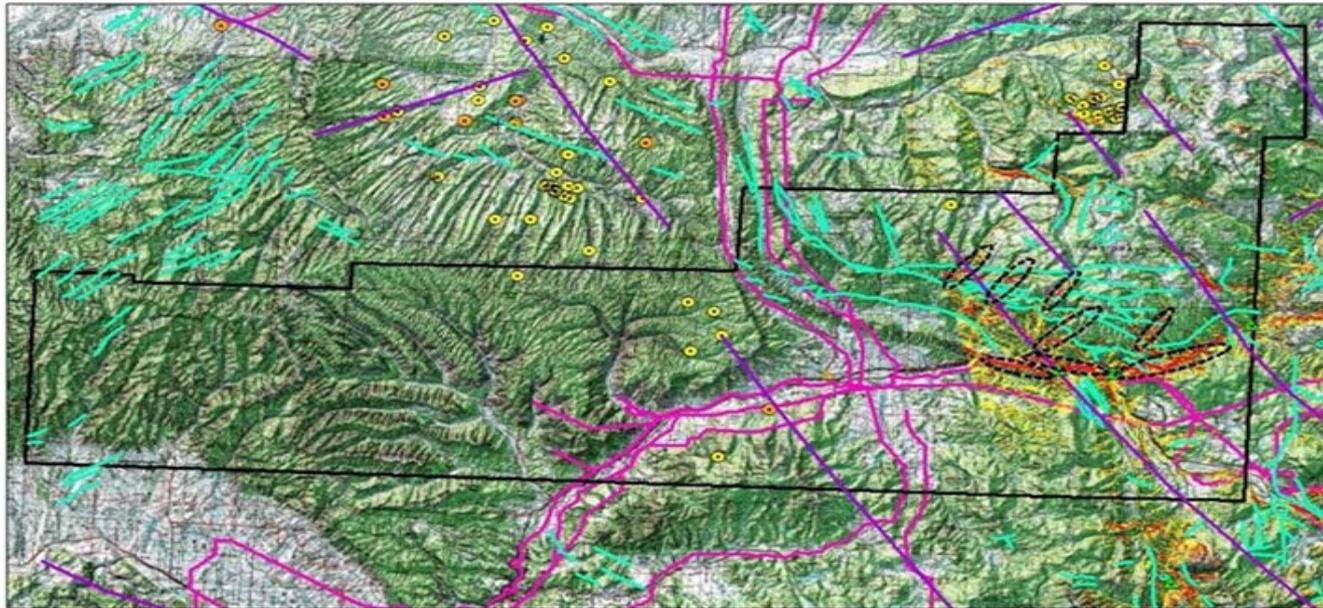
- Conduct literary search of geologic, geothermal, hydrologic, structural, alteration, heat flow, and mineral exploration data
- Detailed geologic, alteration, and structural mapping
- Water sampling of nearby springs and wells
- Shallow (2M) temperature surveys
- Closely-spaced gravity surveys (~250 m grid)

Results of Initial Phase II Confirmation

- Minimal – due to Pixel Resolution, Solar Reflectance and Topography
- Fall '11 - Return to Phase I CIRES Model - Refinement

Phase I Revised – Enhanced Thematic Mapper Signatures

Surface Temperature Anomalies derived from Night Time ASTER Data Corrected for Solar and Topographic Effects (dotted ellipses are anomalous areas), Garfield County

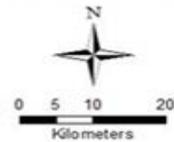


Modeled Surface Temperature (Thermal Anomalies)

- Very Warm Modeled Surface Temperature
- Warm Modeled Surface Temperature

- Favorable Geochemistry
- 2m Survey
- Structural Data

- Young Faults
- Regional Faults
- Transmission Grid



Prospect Evaluation - Using Conventional Techniques

Target	County	Geochem		Distance to Transmission	Issues
		Est Reservoir Temps (0C)	Target Area (sq-mi)		
Strawberry H.S	Routt	150	2-3	2-3	Legal from Neighbors
Rico H.S	Delores	142	2-3	Upgrade	Taxes
Pagosa Springs	Archaleta	100	2-3	local	Legal from Resorts
Alamosa	Alamosa/ Conejos	200	Broad	1-2	Depth & NIMBY
Lemon H.S	San Miguel	150	Narrow Gorge	Distant	Access & Environmental
Florence - Canon City	Fremont	130	4-6	1 mile	Agreement in Hand to Conduct Exploration

Project has completed:

Phase I – Results summarized in a CIRES Report dated 12/26/12

Phase II – SOPO Tasks 4.1 & 4.2: Data Base and Field Survey Complete

Task 4.3 – MT Surveys – Thick Shale Conductance – Defer

Project has Planned (Begin 2nd qtr):

Phase II Task 5.0 – Thermal Gradient Wells

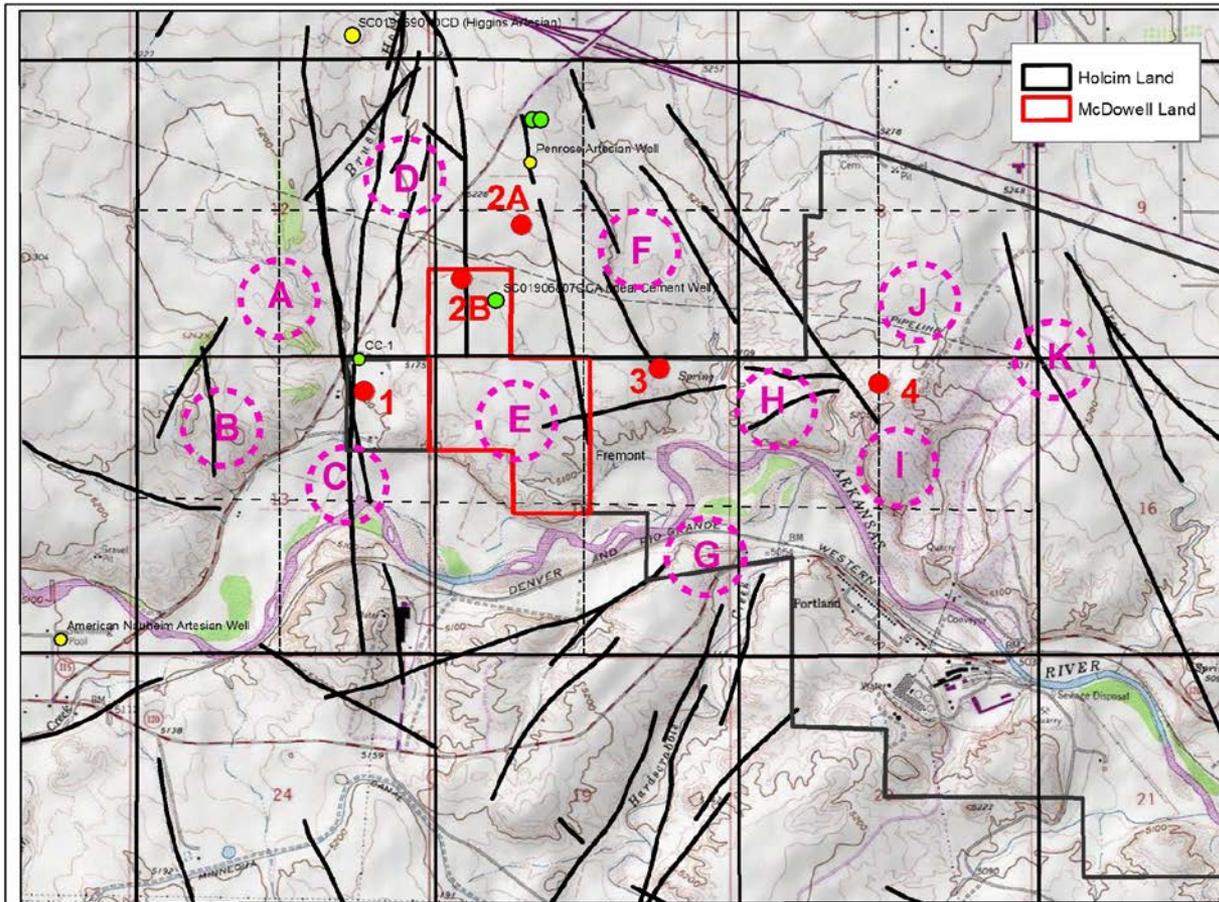
NEPA Surveys being formulated

Access Agreements subject to NEPA

SOPH Phase II - Task 5.0

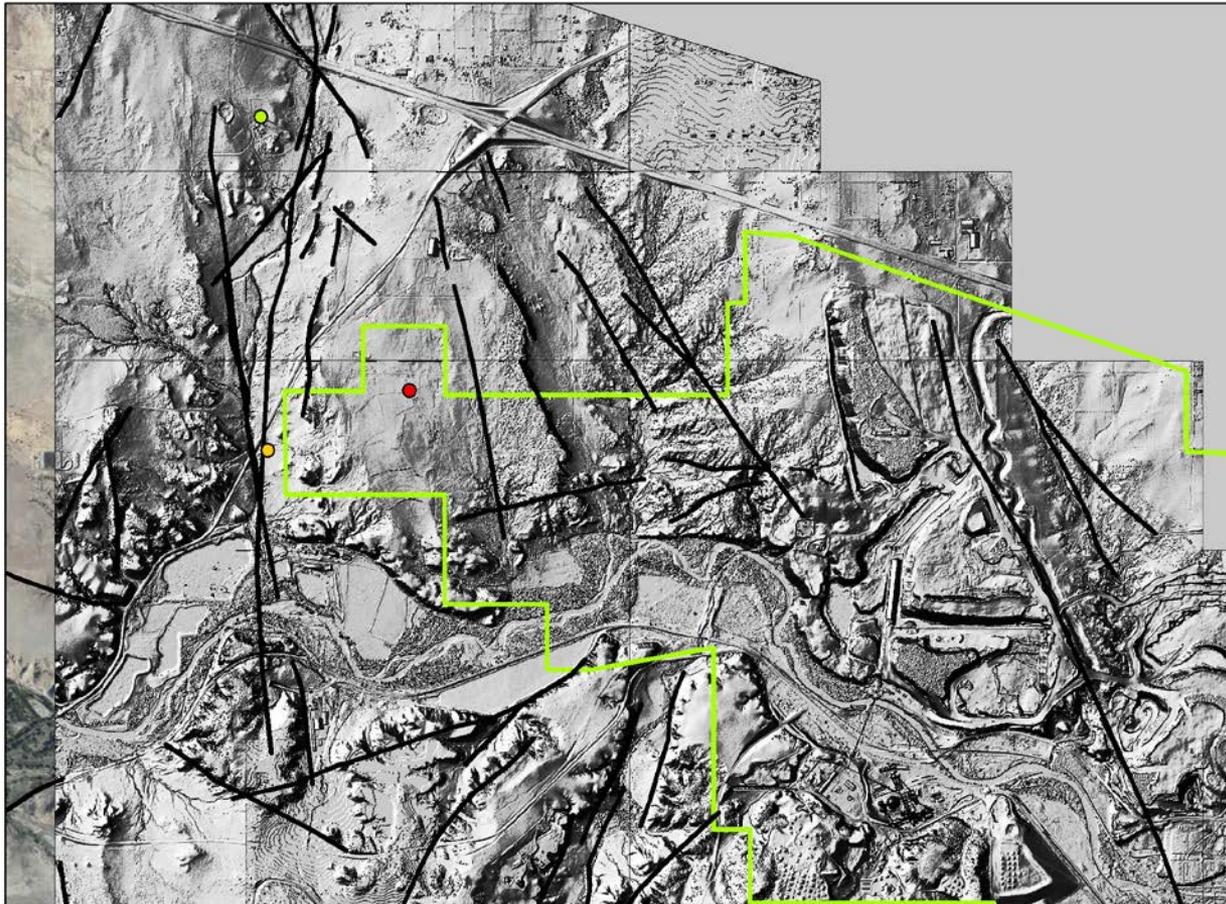
Spotting Thermal Gradient Wells

Fremont County, Colorado



Florence – Canon City

LIDAR Hillside Showing Lineaments: Structures



Describe the most important technical accomplishments and progress and their significance.

Results

- **Established that Remote Sensing may be useful to identify large targets**
 - Otherwise of limited value to locate small targets
 - Each pixel in an ASTER scene is 90m x 90m on the ground
- **Established that in spite of Colorado's rich mining history and people's general support of energy efficiency and renewables, the NIMBY challenge is generally pervasive.**
 - Access to geothermal resources challenging.
 - The need for collective political will to advance renewals is needed with \$ support
 - Restricted Access to Prospect Areas has delayed the Project by 12 months

Future Direction

- **Remain on Track to evaluate Florence Canon City. Conduct a Phase II Stage Gate Process in the 4th quarter 2013.**

- Technical points of the Project have only been highlighted above due to the broad scope of the Project and the limitations of time for this presentation – Detailed technical Reports have been prepared and are supportive of the Summary statements made.
- Remote Sensing of Geothermal Resources from Satellite Platforms (Landsat & Terra) may be effective in the future if augmented by some other tools (i.e. FLIR & iTres) operating at a lower altitudes.

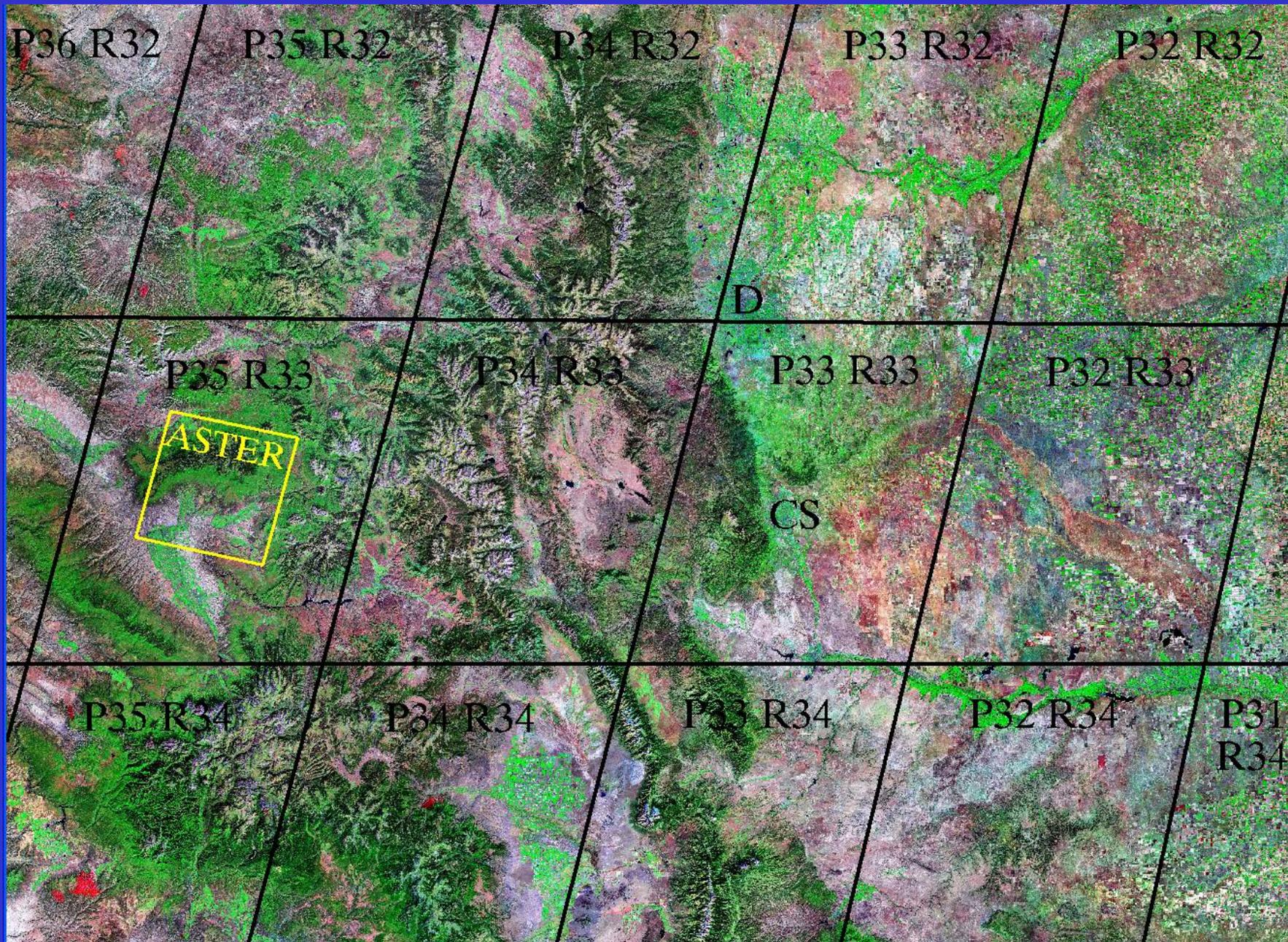
Timeline:

Planned Start Date	Planned End Date	Actual Start Date	Actual /Est. End Date
1/29/2010	6/30/2012	4/30/2010	9/30/2013

Budget:

Federal Share	Cost Share	Planned Expenses to Date	Actual Expenses to Date	Est. Value of Work Completed to Date	Funding needed to Complete Work
\$4,778,234	\$3,007,300	\$7,785,534	\$984,343	\$1,367,571	\$6,801,190

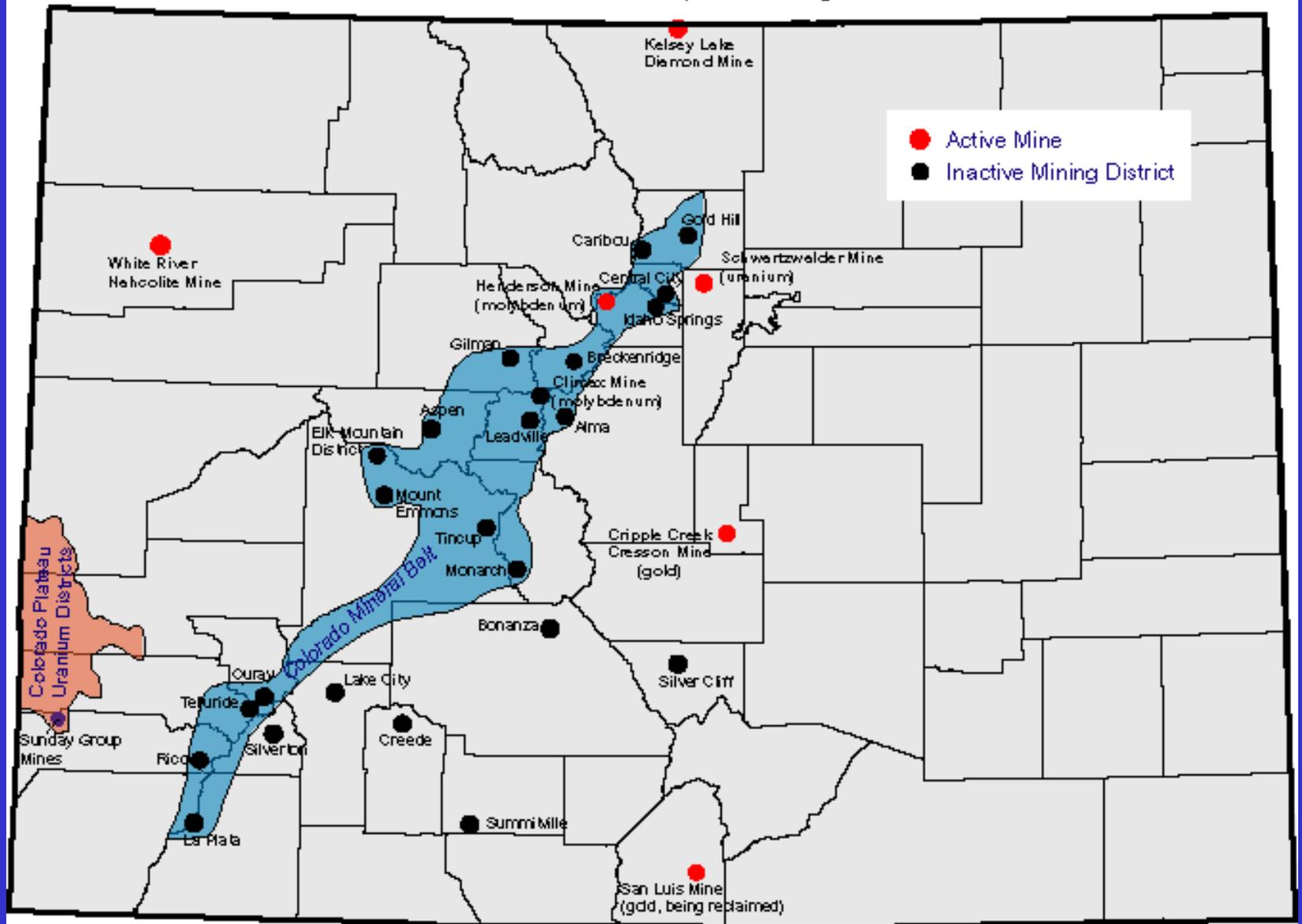
State of Colorado - Landsat Scene Coverage



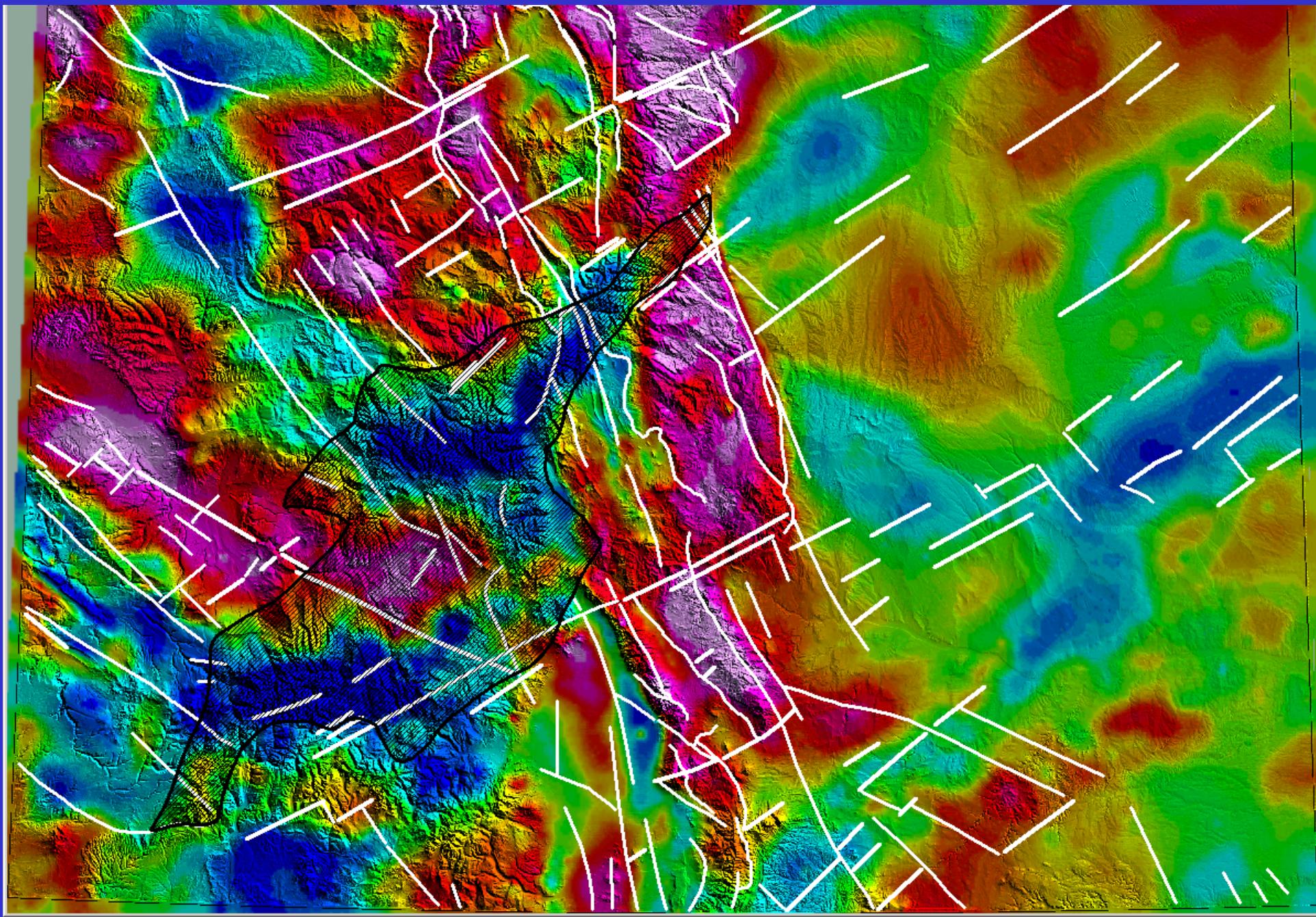
Major Mining Districts of Colorado

(Does not include coal or construction material mines)

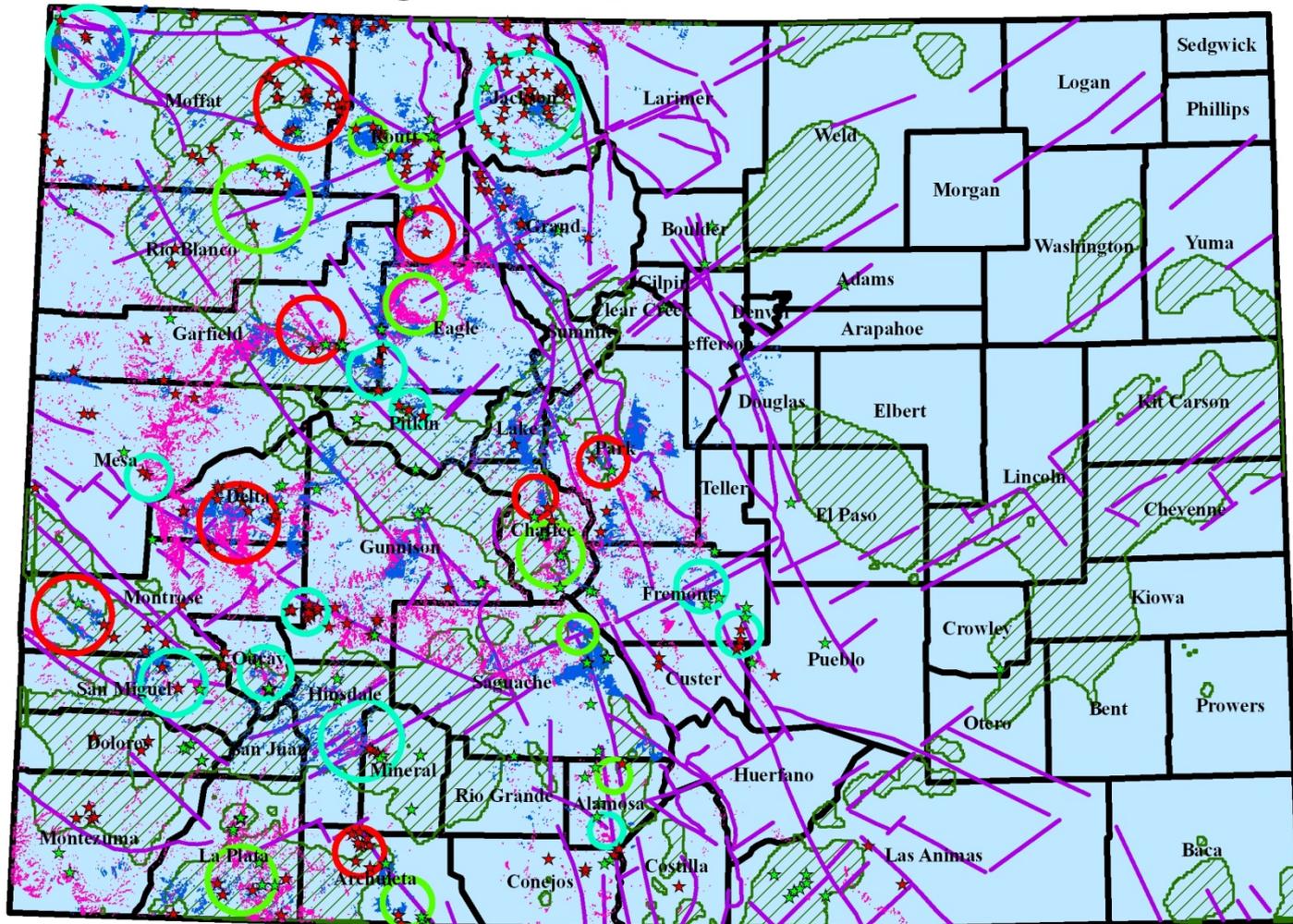
Click on location for a description of mining district



Isostatic Gravity Fused with Topography & Deep-Seated Structure



Multiple Lines Evidence Used To Identify Target Areas, Western Colorado



Initial Ranking of Target Areas

- | | | |
|---|---------------------------------------|---------------------------------------|
| ★ Known geothermal data point or hotspring area | Red circle Target area (10-11 Points) | Pink shaded Landsat thermal exposures |
| ★ Landsat thermal water feature | Green circle Target area (9 points) | Blue shaded ASTER thermal exposures |
| Purple line Deep-seated basement fault zone | Cyan circle Target areas (8 points) | Hatched box Weakened basement fairway |