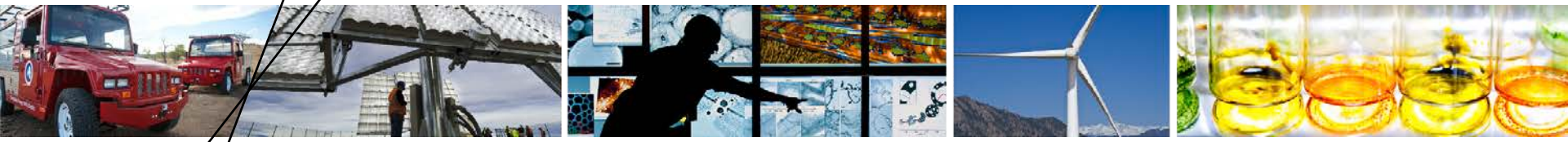
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Hydrothermal Exploration Data Gap Analysis Update



GTP Peer Review Lunch Presentation

Westminster, CO

Kate Young

Dan Getman

Ariel Esposito

May 10, 2012

PROJECT OVERVIEW

Objective

- Identify gaps in available data for geothermal exploration and prioritize collection of this data for future GTP funding opportunities.

Challenges Addressed

- The Blue Ribbon Panel Draft Document[1] stated the panel members recommended that GTP focus on locating the undiscovered resources in the near term using rapid reconnaissance surveys, surface exploration, stress measurements, fracture mapping, temperature gradient drilling.
- First understand what and where data exist, then identify and prioritize data gaps for the highest impact.

GTP Goals

Accelerate near-term hydrothermal growth by:

- Lowering risks and costs of development and exploration
- Lowering levelized cost of electricity (LCOE) to 6 cents/kWh by 2020
- Accelerating development of 30 GWe of undiscovered hydrothermal resources

Industry/GTP Impact

- A regional scale analysis of geological, geophysical, and geochemical data needs in key regions is required to improve the potential for technology to identify new geothermal capacity, accelerating development of the 30 GWe of undiscovered hydrothermal resource.

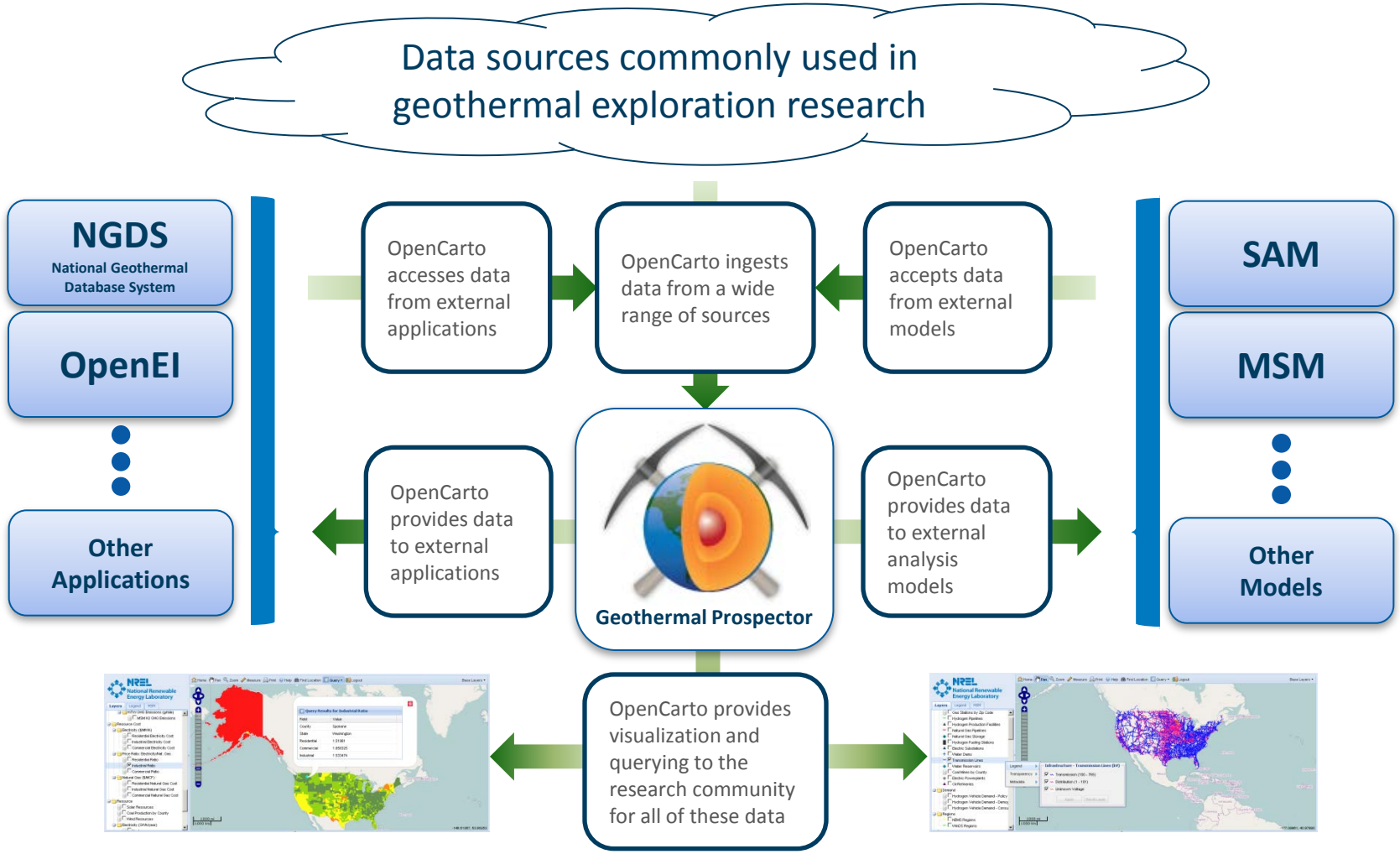
Integration

- The data gap analysis results (Task 2.1) will be used with the exploration case studies (Task 2.3) to help identify potential areas for exploration data collection in future GTP funding opportunities.

DATA GAP ANALYSIS – INFORMATION SHARING

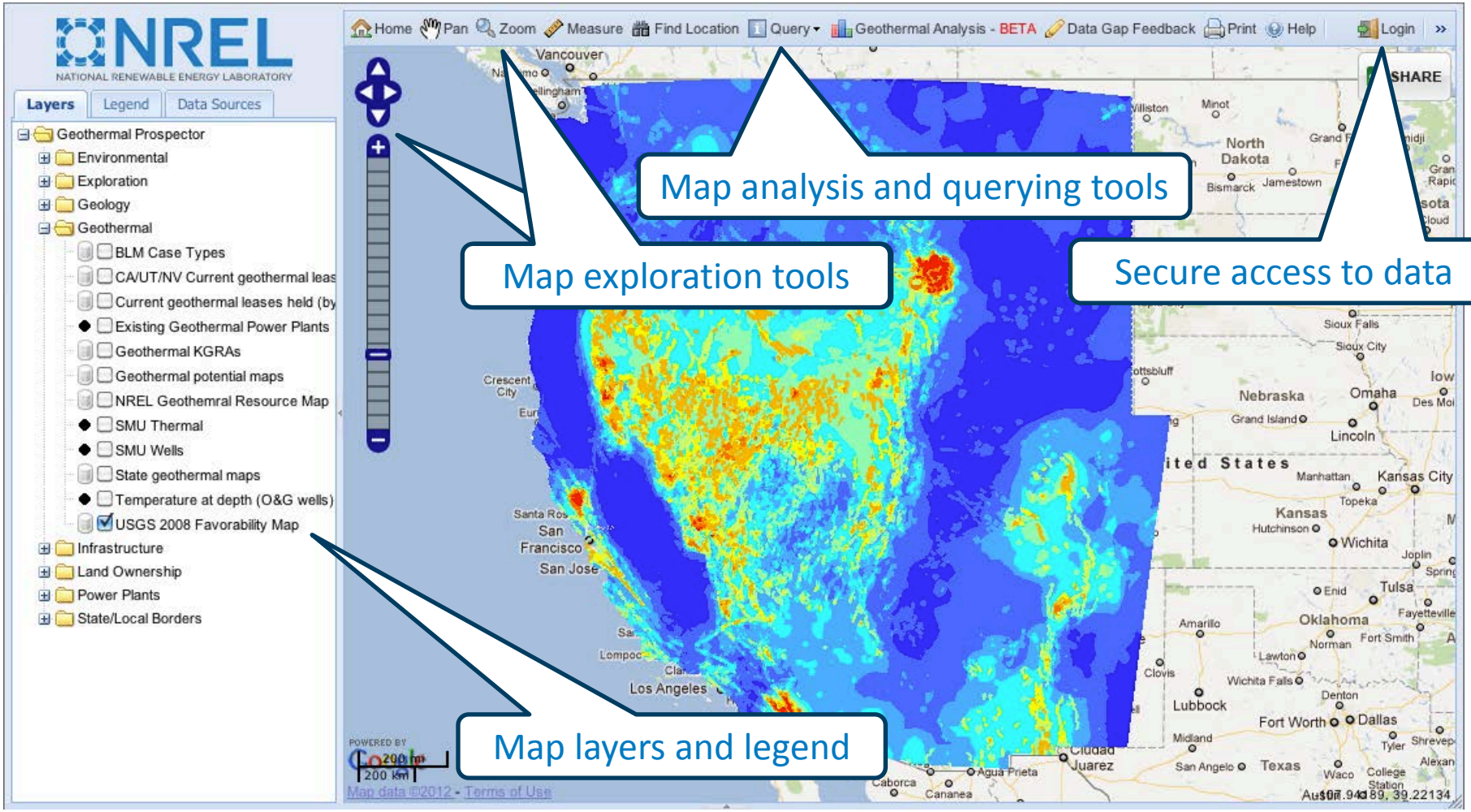
Geothermal Prospector:

- All data coverage maps, demand maps, input shapefiles, and data gap analysis will be available via Geothermal Prospector (and the NGDS)



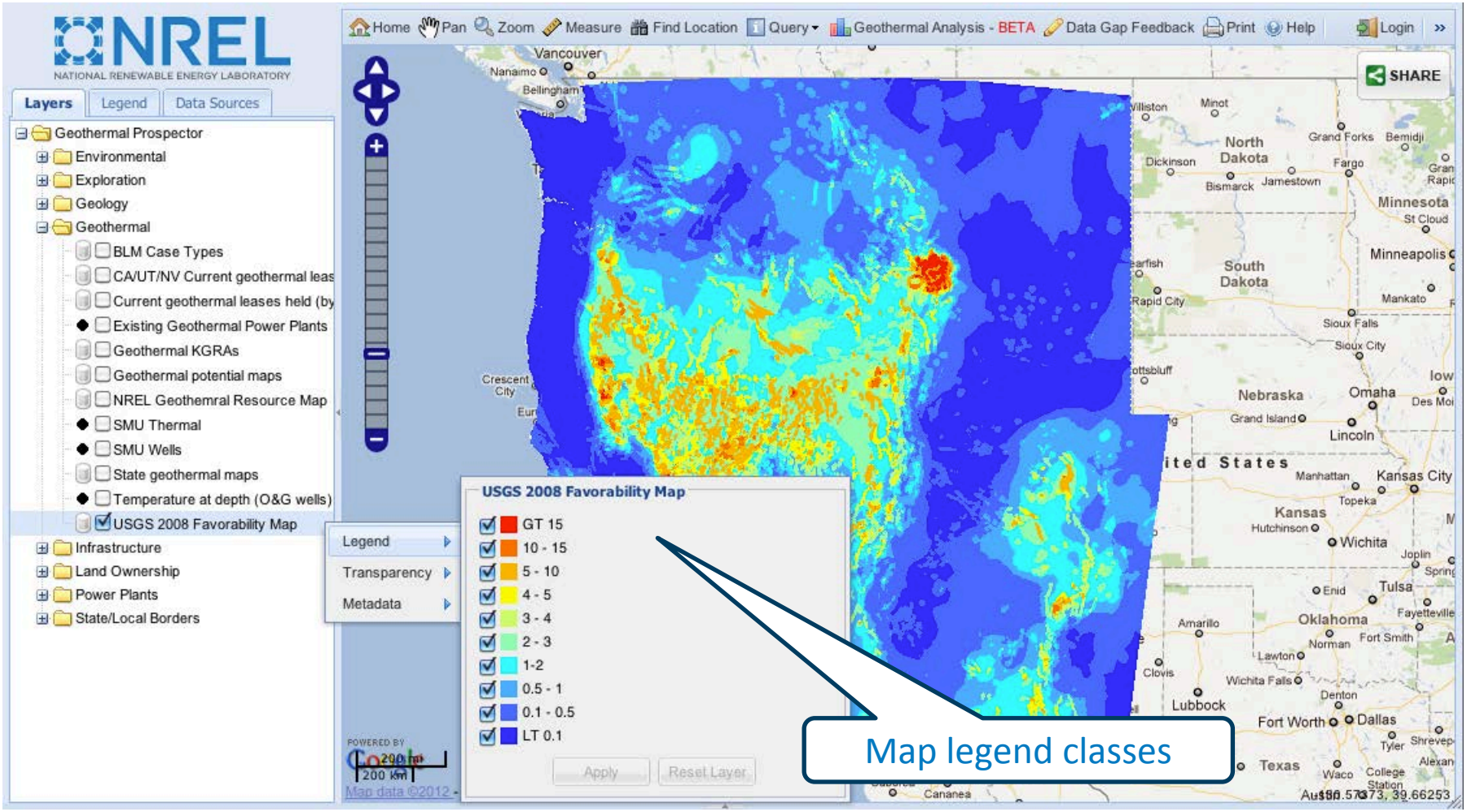
DATA GAP ANALYSIS – INFORMATION SHARING

Geothermal Prospector:



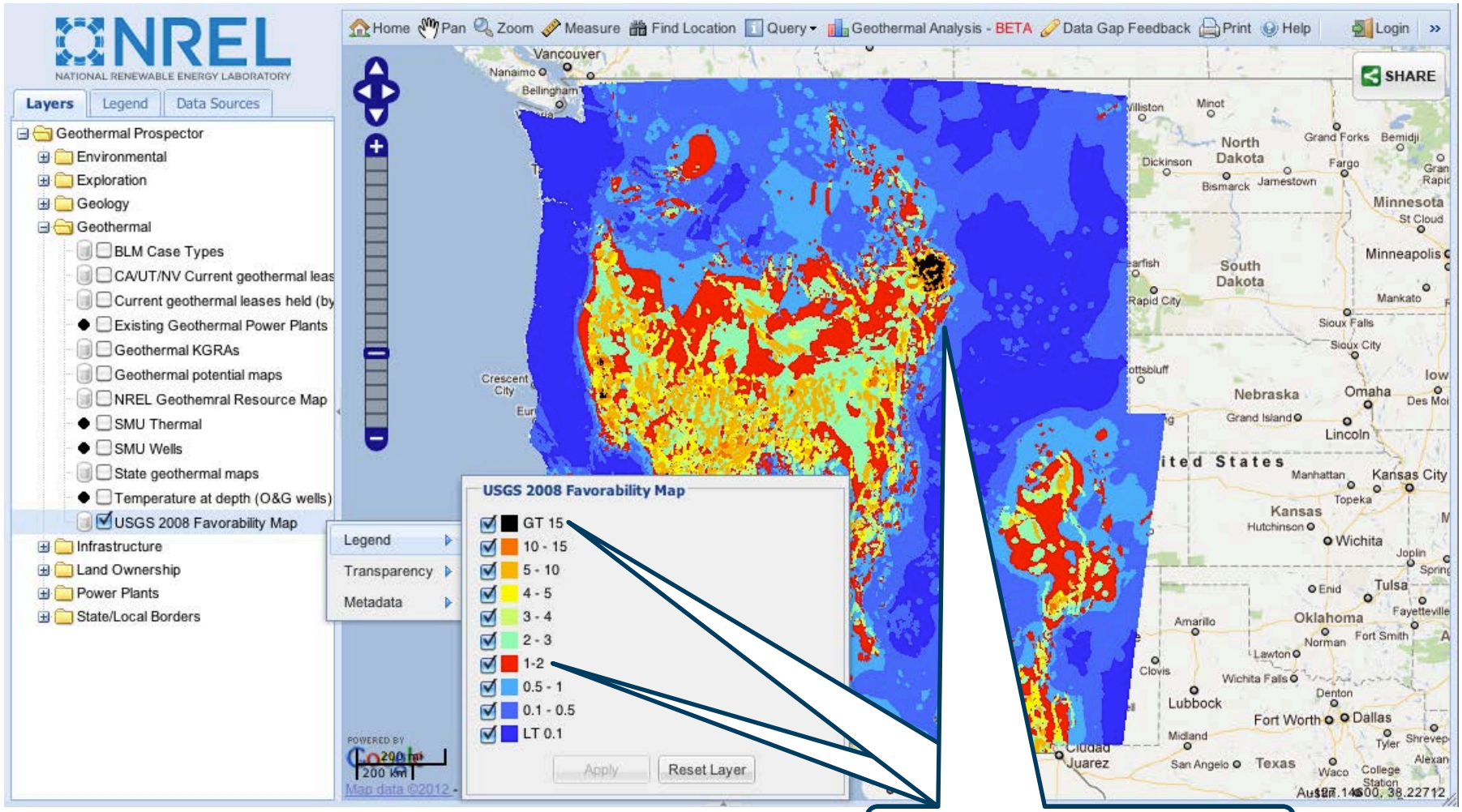
DATA GAP ANALYSIS – INFORMATION SHARING

Geothermal Prospector:



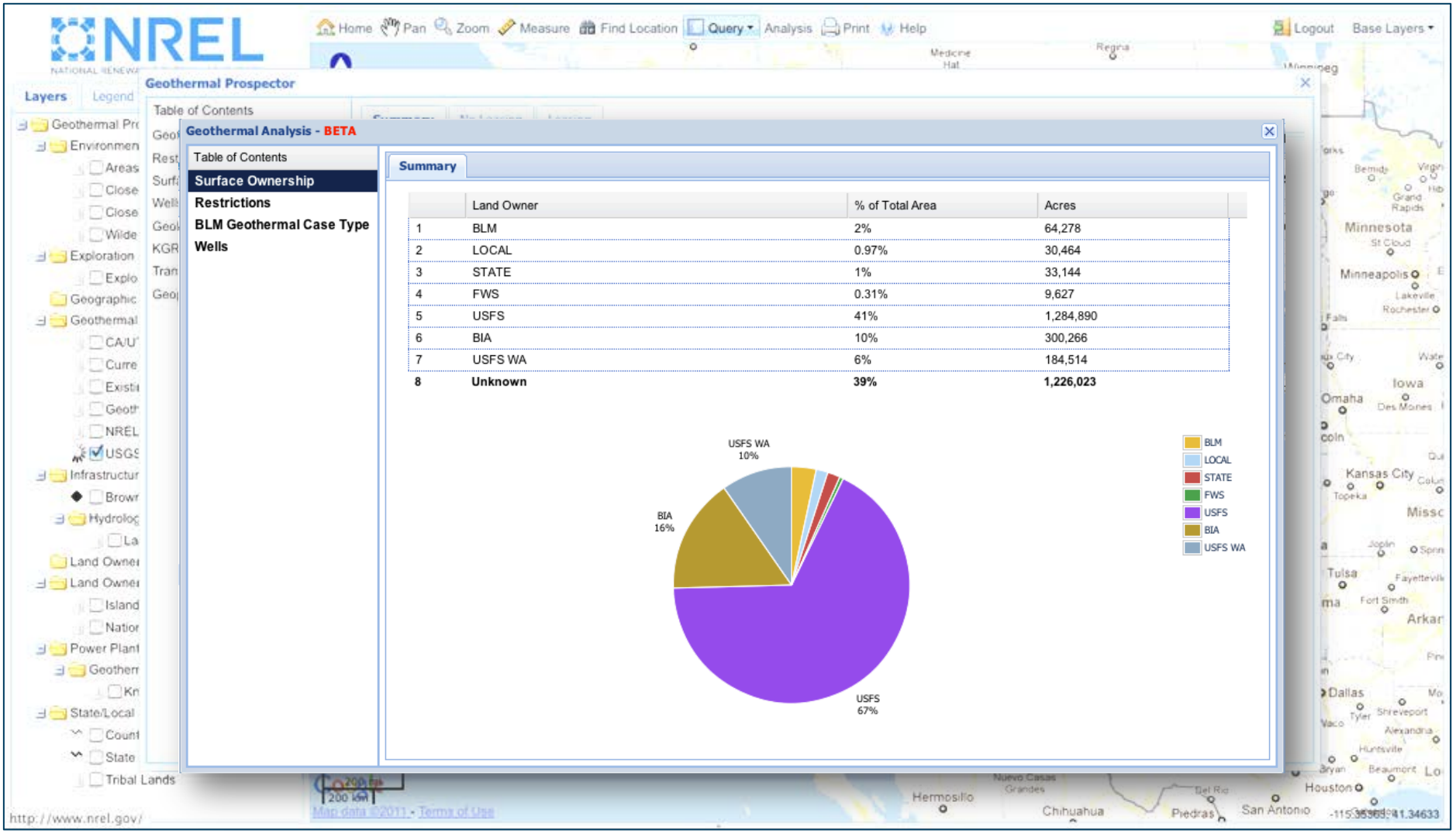
DATA GAP ANALYSIS – INFORMATION SHARING

Geothermal Prospector:



DATA GAP ANALYSIS – INFORMATION SHARING

Geothermal Prospector:



DATA GAP ANALYSIS – INFORMATION SHARING

Geothermal Prospector:

- The analysis available in Geothermal Prospector is also available as API-based services that provide the same data and analytical results without needing the application.

- Industry is actively using NREL data services to develop their own applications


```
- inputs: {
      lat: "40.015",
      lon: "-105.27",
      system_size: "4.0",
      type: "res"
  },
- outputs: {
      cost: 32676.591578681568,
    - incentives: {
        - all: [
            - {
                  PV Com. Max. Rebate $: 15000,
                  PV Com. Rebate $/kW: 1500,
                  PV Com. Rebate Max. Size (kW): 25,
                  PV NP/Govt Max. Rebate $: 15000,
                  PV NP/Govt Rebate $/kW: 1500,
                  code: "CO176F",
                  gid: 63,
                  memo: "4/22/10 added based on website and info provided by Jennifer Hampton
                  BL...",
                  notes: "The per-watt rebate rate specified below may be less if local incentives
                  are available.",
                  program_name: "Colorado - Commercial Renewable Energy Rebate Program",
                  sector: "S",
                  state: "Colorado",
                  state_abbr: "CO",
                  type: "State Rebate Program",
                  web_active: "1"
              },
            - {
                  PV Res. Rebate $/kW: 1500,
                  code: "CO175F",
                  gid: 64,
                  memo: "4/20/10 added new program based on website BL...",
                  notes: "Incentive amounts may be less if local incentives are available. Xcel and
                  Black Hills customers not eligible for this incentive.",
                  program_name: "Colorado - Residential Renewable Energy Rebate Program",
                  sector: "S",
                  state: "Colorado",
                  state_abbr: "CO",
                  type: "State Rebate Program",
                  web_active: "1"
              },
            - {
                  PV Com. Max. Rebate $: 200000,
                  PV Com. PBI $/kWh: 0.07,
                  PV Com. Rebate $/kW: 2000,
                  PV Com. Rebate Max. Size (kW): 500,
                  PV Com. Rebate Min. Size (kW): 0.5,
                  PV NP/Govt Max. Rebate $: 200000,
                  PV NP/Govt PBI $/kWh: 0.07,
                  PV NP/Govt Rebate $/kW: 2000,
                  PV PBI/FIT Duration (Years): 20,
                  PV PBI/FIT Min. Size (kW): 10.01,
                  PV Res. Max. Rebate $: 27000,
                  PV Res. Rebate $/kW: 2700,
                  PV Res. Rebate Max. Size (kW): 10,
                  PV Res. Rebate Min. Size (kW): 0.5,
```

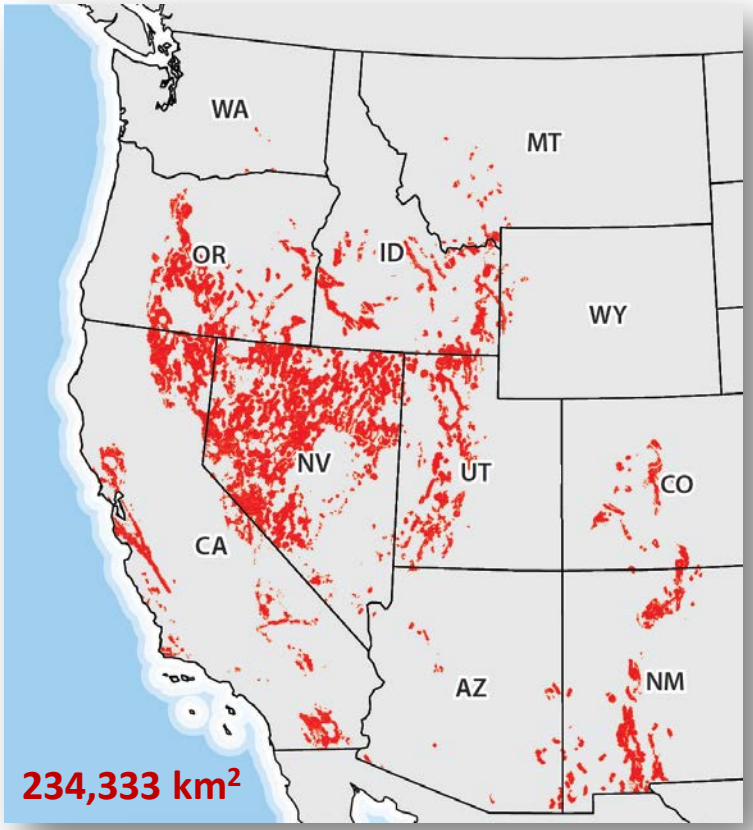
TECHNICAL APPROACH – DEMAND ANALYSIS

Where are data needed?

- GTP Goal is to identify some of the 30 GWe of undiscovered hydrothermal potential (USGS 2008) .

Approach:

- Start with USGS 2008 favorability map for undiscovered hydrothermal
  (Base Map is USGS LRPowerDensityLayer with estimates in MW/km^2)
- Remove the following areas:
  - Lower half of favorability classes (~89% of area)
    (keep only the top 5 classes)
  - Federal exclusions
    (e.g. National Parks, Wilderness Areas)
  - BLM/FS areas closed to geothermal development
    (For all western states)
  - Operating geothermal plants
    (with 10-km radius)
  - Urban areas
  - Slopes >30%



Preliminary Demand Analysis Map

Audience Feedback

1. Other areas to exclude?

TECHNICAL APPROACH – SUPPLY ANALYSIS

Where do we (as an industry) have data?

- NGDS effort is working to collect industry data - in year 2 of a 4-year project, so all data are not yet available
- To put out solicitations for data collection in FY13, GTP needs data gaps identified by the end of FY12. Efforts are being made to inventory available data.

Audience Feedback

2. Are these the right datasets to include for identifying new prospects?

Approach:

- Identify critical data needed (see table below)
- Target regional reconnaissance data that can help identify the undiscovered resources
- Develop data coverage maps (one per data type), collecting coverage information about existing datasets from industry and NGDS nodes

Blue Ribbon Panel Recommendation	GPS Geodetic Survey	Micro-Earthquake Analysis	Hyper-spectral Imaging	LiDAR	Field Mapping	Outcrop Analysis	Fluid Sampling	Soil Sampling	Gravito-meter	Magneto-meter	Wells
Rapid Reconnaissance Surveys			X	X						X	
Surface Exploration					X	X	X	X	X	X	
Stress Measurements	X	X				X					
Fracture Mapping				X	X	X					
Temperature Gradient Drilling											X

TECHNICAL APPROACH – SUPPLY ANALYSIS

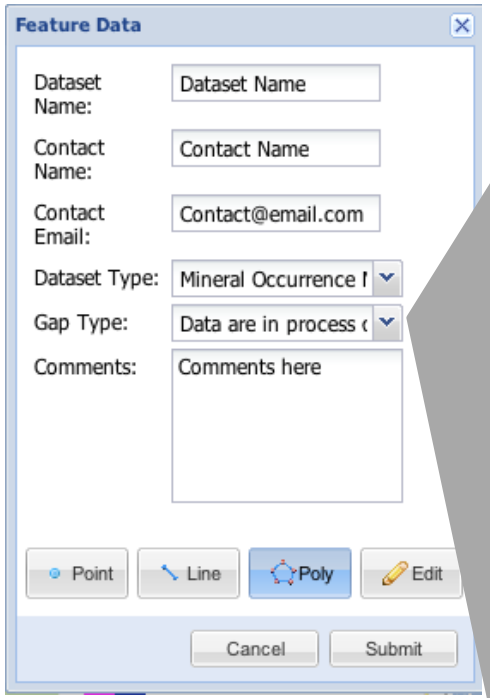
Feedback Tool:

http://maps.nrel.gov/gt_prospector

- Since all datasets may not yet be digitally and/or publically available, additional data type and coverage areas will be collected via a publically available, online tool.

Audience Feedback

3. Additional feature data to collect?
4. Additional data status to include?



Ease of Acquiring	Data Status	Description
Least Involved	I	Data available on NGDS, with complete metadata for analysis
	II	Data available on NGDS, but with incomplete/missing metadata for use in the analysis.
	III	Data are available digitally, are planned to be added to NGDS, but have not yet been added. (This includes moratorium data)
	IV	Data are available digitally, but currently, there are no plans to add it to the NGDS (but could be added).
	V	Data are available digitally, but currently, there are no plans to add it to the NGDS (data proprietary – will not be added to NGDS).
Most Involved	VI	Data are available, but not yet in a digital format.
	VII	Data are in process of being collected
	VIII	Data have not yet been collected

TECHNICAL APPROACH – SUPPLY ANALYSIS

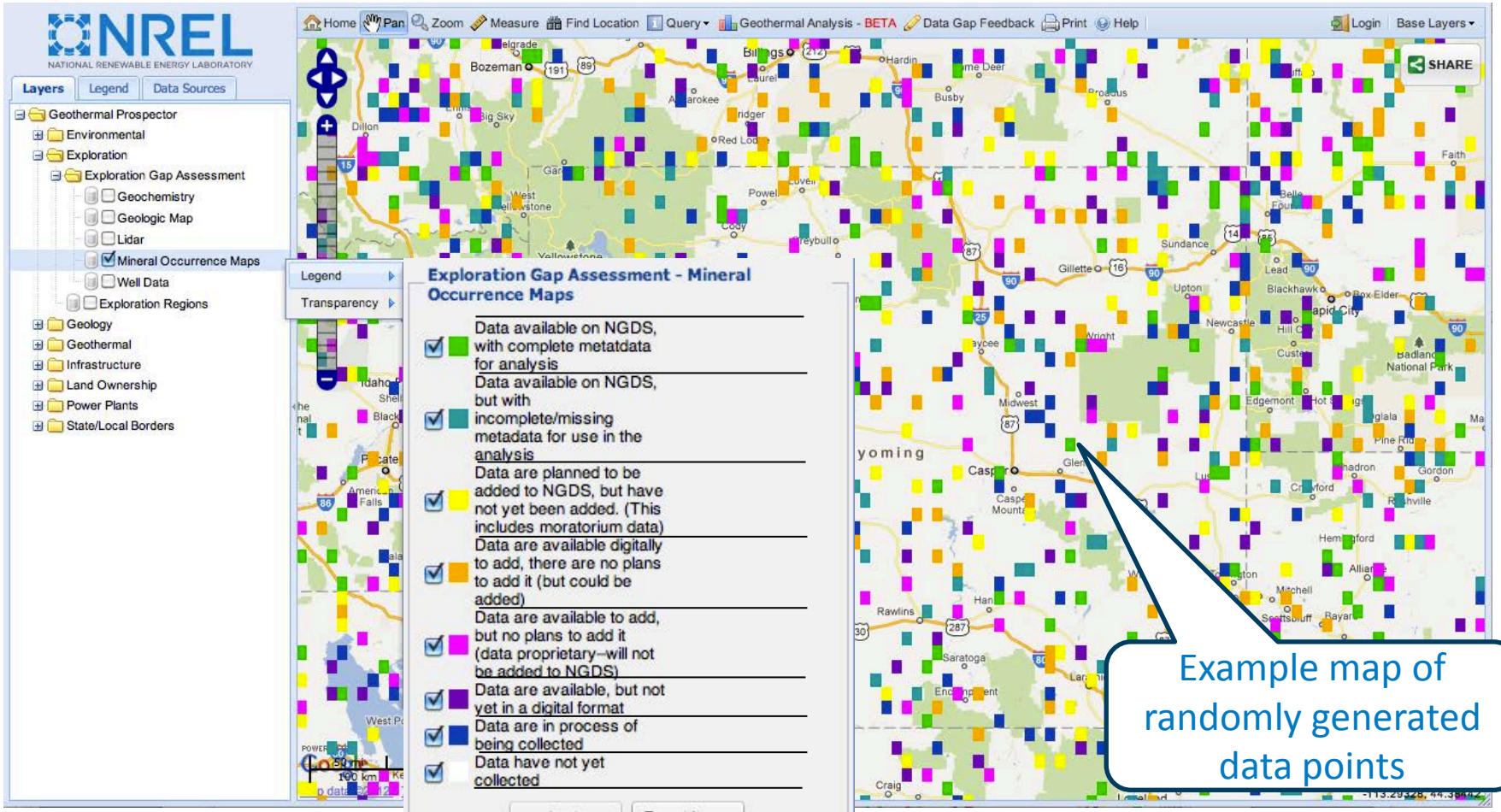
Feedback Tool:

http://maps.nrel.gov/gt_prospector

- Create 10-km-size pixel maps showing data coverage for each data type
- Pixels will be colored clear, unless specifically known to have data

Audience Feedback

5. Appropriate pixel size?

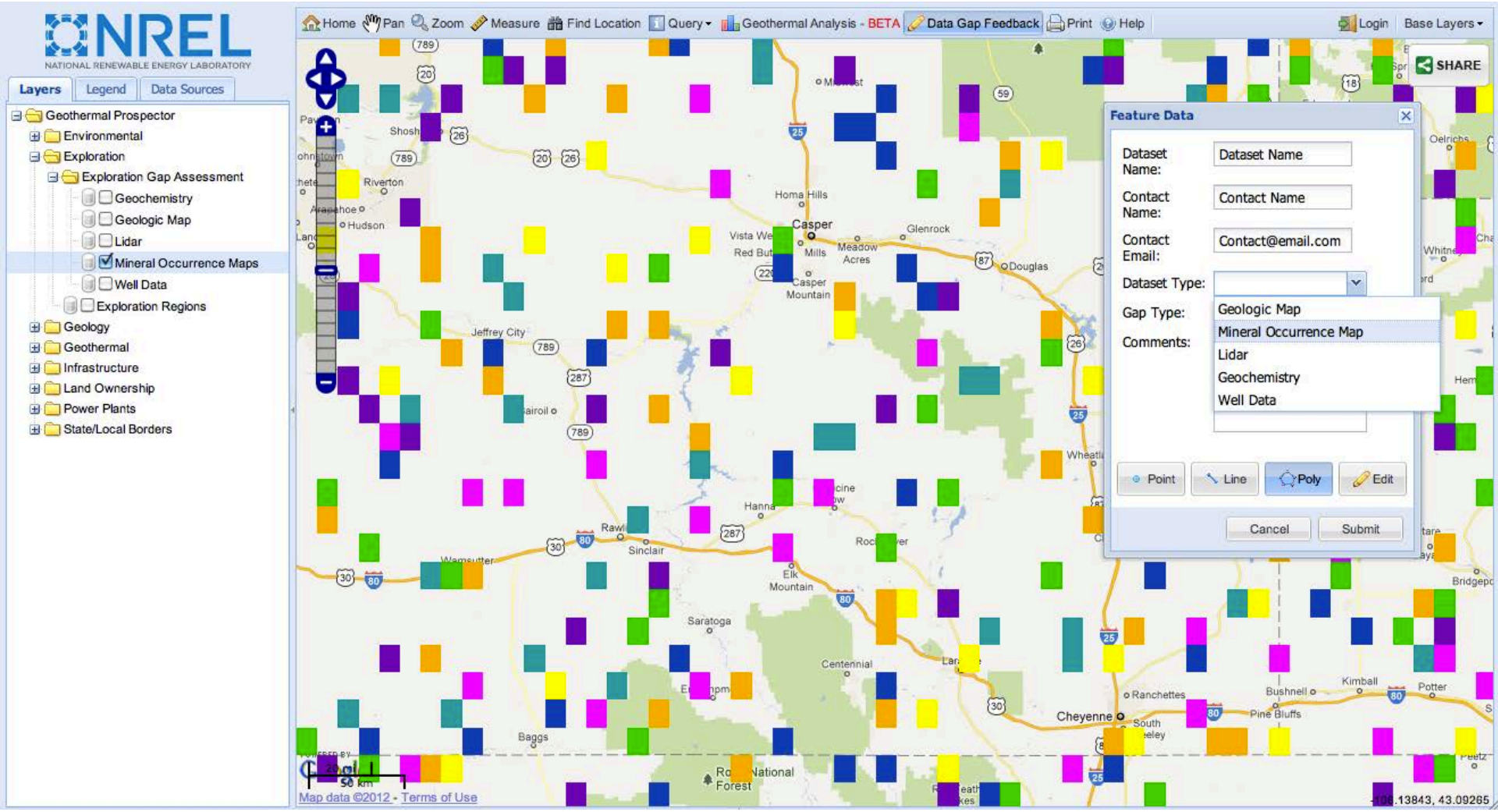


TECHNICAL APPROACH – SUPPLY ANALYSIS

Feedback Tool:

http://maps.nrel.gov/gt_prospector

- Public input

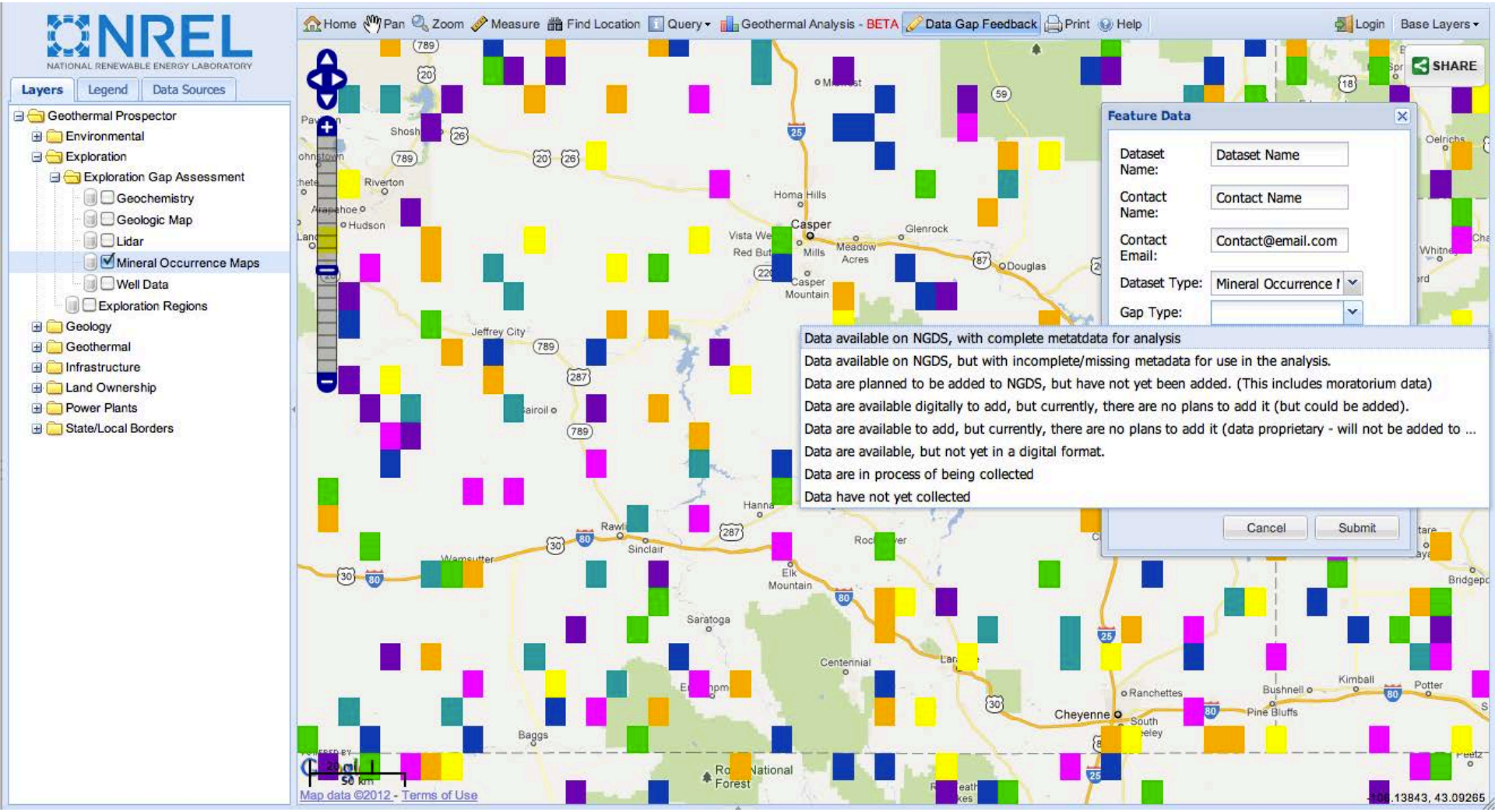


TECHNICAL APPROACH – SUPPLY ANALYSIS

Feedback Tool:

http://maps.nrel.gov/gt_prospector

- Input feature data

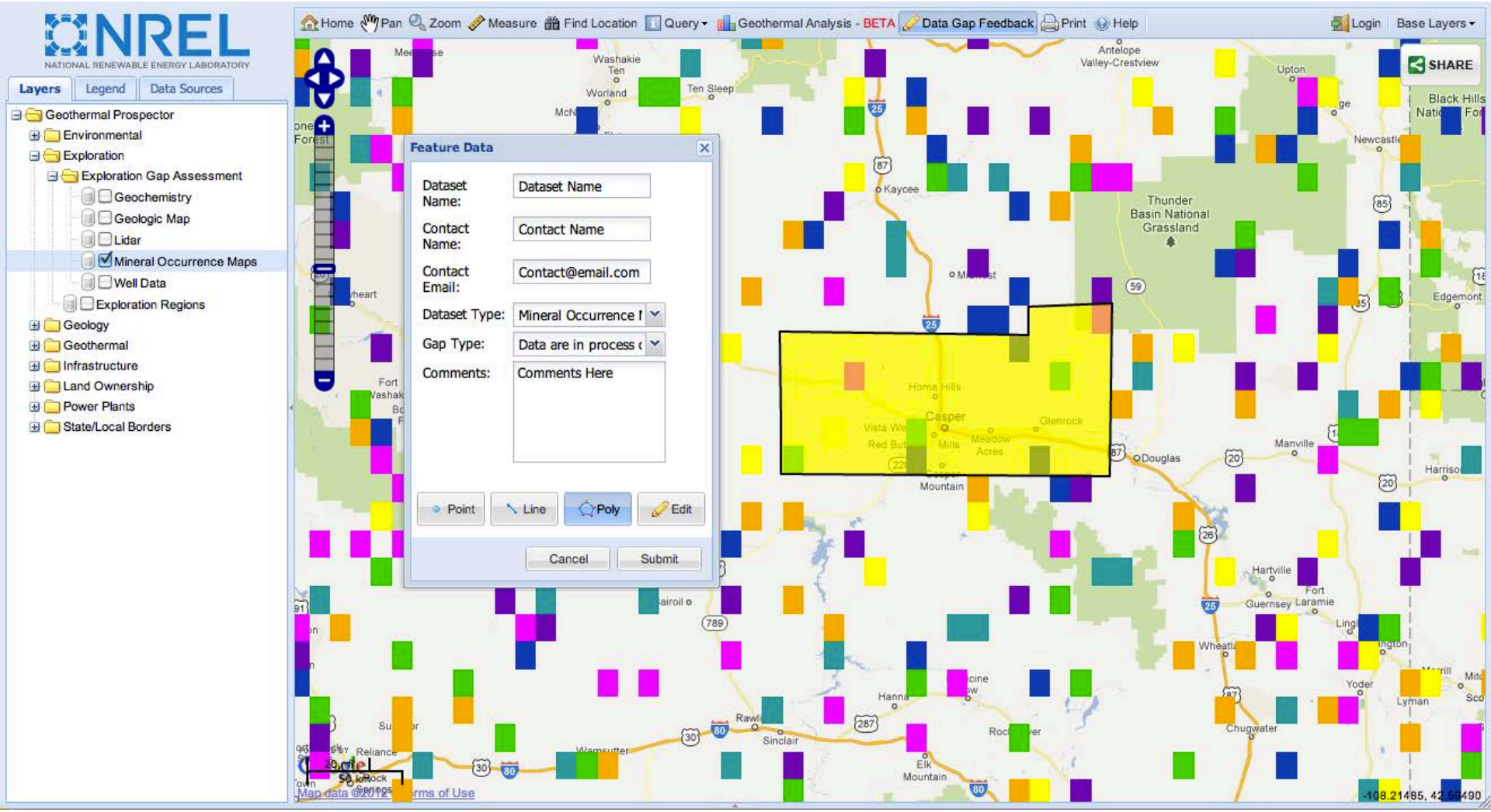


TECHNICAL APPROACH – SUPPLY ANALYSIS

Feedback Tool:

http://maps.nrel.gov/gt_prospector

- Draw data coverage area



TECHNICAL APPROACH – SUPPLY ANALYSIS

Feedback Tool:

- All data will be collected in a database and be publicly available as data layers within the geothermal prospector and as services listed in the NGDS.
- Hope to get industry input
- Will also solicit input via e-mails and phone calls to potential data holders

Partial List of Data Holders to contact:

- NGDS nodes
- USGS (including volcano observatories, seismic hazard monitoring)
- State geological surveys/agencies
- Remote sensing vendors
- Mining companies
- Oil/Gas companies

Audience Feedback

6. Suggestions for data holders to contact?

http://maps.nrel.gov/gt_prospector

TECHNICAL APPROACH – GAP ANALYSIS

Where should GTP target data collection efforts to identify undiscovered hydrothermal potential?

- In FY13, GTP wants to collect regional reconnaissance data to identify undiscovered hydrothermal potential in an effort to lower the exploration risk of going after undiscovered resources
- Regional look at the Western U.S. to identify areas that don't have data

Approach:

- Overlay data coverage maps on data demand map to identify highest priorities for data collection
- Select top sites for data collection
- Conduct high-resolution analysis at these locations

Audience Feedback

8. Are some types of datasets more important to target for identification of undiscovered resource in FY13 collection than others?

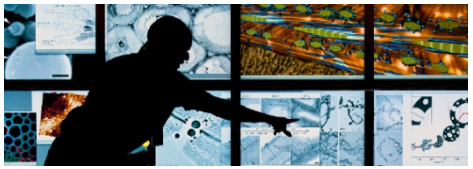
Potential Datasets

- Mineral Occurrence Maps
- Geological Maps
- Structural Maps
- Fault Maps
- Surface Fault Data
- Surface Deformation Maps
- Lineament Maps
- Geochemistry Data
- Geophysical Data
- Well Data (BHT, Depth)

This project is being funded by the Geothermal Technologies Program through Annual Operating Plan funds.

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

THANK YOU!

Special thanks to those providing input to this project:
Hidda Thorsteinsson, Arlene Anderson, Joe Iovenitti, David Cuyler, Billy Roberts, Kermit Witherbee, Walt Snyder, Steve Richard

Questions? Comments? Suggestions? We'd love to hear from you!

Kate Young
katherine.young@nrel.gov
(720) 272-8800

Dan Getman
dan.getman@nrel.gov
(303) 275-4677

Ariel Esposito
ariel.esposito@nrel.gov
(303) 275-4694