GeoRePORT: Geothermal Resource Portfolio Optimization & Reporting Technique

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Clean Energy Solutions Center Webinar
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## Sanyal Classification

<table>
<thead>
<tr>
<th>Class of Resource</th>
<th>Reservoir Temperature</th>
<th>Mobile Fluid Phase in Reservoir</th>
<th>Production Mechanism</th>
<th>Fluid State at Wellhead</th>
<th>Well productivity and Controlling Factors other than temperature</th>
<th>Applicable Power Conversion Technology</th>
<th>Unusual Development or Operational Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely Low Temperature*</td>
<td>&lt; 100°C</td>
<td>Liquid water</td>
<td>Artesian self-flowing wells; pumped wells</td>
<td>Liquid water</td>
<td>Well productivity dependent on reservoir flow capacity and static water level</td>
<td>Direct Use; Binary (in areas of very low air temperatures)*</td>
<td></td>
</tr>
<tr>
<td>Very Low Temperature</td>
<td>100°C to 150°C</td>
<td>Liquid water</td>
<td>Pumped wells</td>
<td>Liquid water (for pumped wells); steam-water mixture (for self-flowing wells)</td>
<td>Typical well capacity 2 to 4 MWe; dependent on reservoir flow capacity and gas content in water; well productivity often limited by pump capacity</td>
<td>Binary</td>
<td></td>
</tr>
<tr>
<td>Low Temperature</td>
<td>150°C to 190°C</td>
<td>Liquid water</td>
<td>Pumped wells; self-flowing wells (only at the higher-temperature end of the range)</td>
<td>Liquid water (for pumped wells); steam-water mixture (for self-flowing wells)</td>
<td>Typical well capacity 3 to 5 MWe; dependent on reservoir pressures, reservoir flow capacity and gas content in water; productivity of pumped wells typically limited by pump capacity and pump parasitic power need; productivity of self-flowing wells strongly dependent on reservoir flow capacity</td>
<td>Binary; Two-stage Flash; Hybrid</td>
<td>Calcite scaling in production wells and stibnite scaling in binary plant are occasional problems</td>
</tr>
<tr>
<td>Moderate Temperature</td>
<td>190° to 230°C</td>
<td>Liquid water</td>
<td>Self-flowing wells</td>
<td>Steam–water mixture (enthalpy equal to that of saturated liquid at reservoir temperature)</td>
<td>Well productivity highly variable (3 to 12 MWe); strongly dependent on reservoir flow capacity</td>
<td>Single-stage Flash; Two-stage Flash; Hybrid</td>
<td>Calcite scaling in production wells occasional problem; alumino-silicate scale in injection system a rare problem</td>
</tr>
<tr>
<td>High Temperature</td>
<td>230°C to 300°C</td>
<td>Liquid water; Liquid-dominated two-phase</td>
<td>Self-flowing wells</td>
<td>Steam–water mixture (enthalpy equal to or higher than that of saturated liquid at reservoir temperature); saturated steam</td>
<td>Well productivity highly variable (up to 25 MWe); dependent on reservoir flow capacity and steam saturation</td>
<td>Single-stage Flash; Hybrid</td>
<td>Silica scaling in injection system; occasionally corrosion; occasionally high NCG content</td>
</tr>
</tbody>
</table>

Australia - Opportunities for Enhanced Geothermal Systems (EGS)

predicted temperature of Australian Basement rocks at 1 km intervals between 3-10 km depth
Challenge: How does GTO measure the impact of its funding?

Need for metrics for goal-setting and measuring impact

Example:

- When government funding became available in 2008, the U.S. National Geothermal Resource Assessment\(^1\) had just been released—30 GW (mean) Undiscovered, 9 GW (mean) Identified
- One current program goal: “Accelerate development of 30 GWe of undiscovered hydrothermal resources” – but how is this measured?

1. What portion of the 30 GW does each funded project represent before funding?
2. What portion of the 30 GW was expected to be moved by the funding?
3. What portion of the 30 GW was moved by funding – what was the funding impact?
4. How could we ensure consistency in reporting across projects?

Would have needed to collect these data as part of the applications
Would have needed to collect this information in a required final close-out report
Would need a standard method for reporting consistency (e.g., the way GETEM cost model was used)

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Purpose of Research

**Additional Industry Challenges**

- Apart from temperature and depth, how do we, as an industry, grade geothermal resources?
- What data are needed to measure baseline values and advancement?
- Which industry barrier, if overcome, has the potential to have the largest impact on geothermal deployment?
- How do you set goals to be impactful, and what is the potential impact realized by overcoming the prescribed program goals?
- How do we communicate these goals, impacts, and advancements to non-technical audiences (e.g., Congress, policymakers, the public)?

*However beautiful the strategy, you should occasionally look at the results.*

-Winston Churchill
Why GeoRePORT?

A Barrier to Development

Experts in their fields produce large amounts of complex data. Volumes of scientific data can be incomprehensible and overwhelming for decision makers.

- acoustic reflectivity
- wellbore control
- wildfire hazard
- cold water breakthrough
- environmentally sensitive areas
- topography
- lithologic cores
- policies
- temperature
- atomic absorption spectrometry
- degree of isolation
- fluid inclusions
- FMI logs
- state lease queue
- non- condensable gas content
- permeability
- conductivity
- flow tests
- depth
- tribal resources
- geothermometry
- titration
- tribal resources
- calcite
- land ownership
- active seismic reflection
- site road access
- bottom hole diameter
- gravity survey
- pH analysis
- drilling experience
- conceptual model
- gravity survey
- field mapping
- regulation
- conductivity
- field mapping

Decision Maker
The Solution

Data is translated by experts to a common language, which both experts and non-experts can use to communicate effectively.
Purpose of Research

Objective

The goals of this project were to:

• Develop a clear, objective, comprehensive, understandable methodology for reporting geothermal resource grade and project progress.

• Provide examples for using the methodology for goal setting, measuring baselines, and reporting the impact of funded projects.

This methodology will help to:

• Quantitatively **identify** the greatest barriers to geothermal development

• **Develop** measurable program goals that will have the greatest impact to geothermal deployment

• Objectively **evaluate** proposals based (in part) on a project’s ability to contribute to program goals

• **Monitor** project progress

• **Report** on portfolio performance.

A goal without a plan is just a wish.

-Antione de Saint-Exupéry
How it Works

Two parts to the GeoRePORT System: Resource Grade and Project Readiness Level

How good is our resource?
The resource grade is an assessment of resource quality which allows for an apples-to-apples comparison.

How far along is our project?
The project readiness level is an assessment of the progress of the major components of a project.
Resource Grade

- To evaluate each attribute (e.g., temperature, volume) systematically, we developed three indices—character, activity, and execution.
- Indices are independently evaluated for each attribute using qualitative grades of A-E (A being the “best”).

**Character Grade**
- Used to describe the attribute itself
- Should not change throughout the project (unless originally incorrectly assigned)

**Activity Index**
- Qualitative ranking of activities used to assign the character index; appropriate for each attribute
- Progressive throughout the project as additional activities are conducted

**Execution Index**
- Compares the diligence with which the technique was executed for the activity
- May progress, if activities are repeated.

Example:
- **Geological**
  - Four attributes: Temperature, Volume, Permeability, Fluid Chemistry

- **Technical**
  - Power Conversion, Reservoir Management, Drilling, Logistics

- **Socio-economic**
  - Land Access, Permitting, Transmission, Market
### Resource Grade: Example Attribute Indices - Temperature

#### How it Works

<table>
<thead>
<tr>
<th>Character Index</th>
<th>Activity Index</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong> &gt;300°C</td>
<td>Measured temperatures: Downhole temperature probe readings (well(s) drilled into reservoir)</td>
</tr>
<tr>
<td><strong>B</strong> 230 - &lt;300°C</td>
<td>Extrapolated temperatures: (TGH/well(s) not drilled into reservoir)</td>
</tr>
<tr>
<td><strong>C</strong> 150-&lt;230°C</td>
<td>Geothermometry (reservoir brines or gases)</td>
</tr>
<tr>
<td><strong>D</strong> 90-&lt;150°C</td>
<td>Geothermometry (immature or mixed fluids, inconsistent results between geothermometers)</td>
</tr>
<tr>
<td><strong>E</strong> &lt;90°C</td>
<td>Regional heat flow data</td>
</tr>
</tbody>
</table>

#### Execution Index

<table>
<thead>
<tr>
<th>Character Index</th>
<th>Activity Index</th>
<th>Execution Index</th>
</tr>
</thead>
</table>
| **A** >300°C    | Measured temperatures: Downhole temperature probe readings (well(s) drilled into reservoir) | • Probe allowed to equilibrate  
• Cuttings and/or geophysics confirms measurement within the reservoir (i.e. downhole alteration mineralogy consistent with reading) |
| **B** 230 - <300°C | Extrapolated temperatures: (TGH/well(s) not drilled into reservoir) | • Probe allowed to equilibrate  
• Cuttings and/or geophysics have *not* confirmed measurement within the reservoir (i.e. downhole alteration mineralogy not consistent with readings) |
| **C** 150-<230°C | Geothermometry (reservoir brines or gases) | • Probe *not* allowed to equilibrate  
• Cuttings and/or geophysics have *not* confirmed measurement within the reservoir |
| **D** 90-<150°C | Geothermometry (immature or mixed fluids, inconsistent results between geothermometers) | • Results taken from previous third-party studies of the area (either literature or contractors) with little or limited information on survey methods, replication, or error. |
| **E** <90°C     | Regional heat flow data | • Assumed from studies of analogous geothermal settings, or extrapolated from studies of nearby areas. |

**Character Index:**
- **A:** High-temperature two-phase liquid-dominated OR high enthalpy vapor-dominated
- **B:** Two-phase liquid-dominated systems: high T, high enthalpy - moderate T, moderate enthalpy
- **C:** Moderate to low temperature, moderate to low enthalpy liquid-only systems
- **D:** Low temperature systems
- **E:** Very low temperature systems

**Activity Index:**
- **Activity A:** Measured temperatures
- **Activity B:** Extrapolated temperatures
- **Activity C:** Geothermometry
- **Activity D:** Geothermometry
- **Activity E:** Regional heat flow data

**Execution Index (Ex: Subsurface Temperature Probe Readings):**
- **Execution A:** Probe allowed to equilibrate  
Cuttings and/or geophysics confirms measurement within the reservoir (i.e. downhole alteration mineralogy consistent with reading)
- **Execution B:** Probe allowed to equilibrate  
Cuttings and/or geophysics have *not* confirmed measurement within the reservoir (i.e. downhole alteration mineralogy not consistent with readings)
- **Execution C:** Probe *not* allowed to equilibrate  
Cuttings and/or geophysics have *not* confirmed measurement within the reservoir
- **Execution D:** Results taken from previous third-party studies of the area (either literature or contractors) with little or limited information on survey methods, replication, or error.
- **Execution E:** Assumed from studies of analogous geothermal settings, or extrapolated from studies of nearby areas.
How it Works

Temperature

Resource Grade
Polar Area Chart

The bigger the pie piece, the better the attribute grade
How it Works

Resource Grade
Polar Area Chart
The bigger the pie piece, the better the attribute grade

Dark Wedges
indicate grade

Light Wedges
indicate certainty
OVERVIEW OF METHODOLOGY

Resource Grade Summary Chart
Displaying all 12 Character Grades in one graphic
How it Works

2 Grades from many experts are assembled
Grading from many different experts on a huge variety of data can be collected and assembled, and individual reports can be added, removed or updated as needed.

3 GeoRePORT is compiled
Collected reports can be combined into a complete GeoRePORT, which helps everyone to speak the same language and allows non-experts to understand the suitability of the data.
Ways to Use It

II. The Project Level

At the project level, GeoRePORT allows for different projects to be directly compared in terms of resource quality and project readiness. It can also be used to monitor project progress.

- Location Specific
- Highly Detailed
- Track Progress
- Compare Projects
EXAMPLE: Visualizing Grade for Multiple Geothermal Areas

Geological Grade:
Temperature, Volume, Permeability, & Fluid Chemistry

Temperature = A
Temperature = B
Temperature = C
Temperature = D
Temperature = E

Volume = A
Volume = B
Volume = C
Volume = D
Volume = E

Permeability

Fluid Chemistry

A
B
C
D
E

50 MW
50 MW
50 MW

NATIONAL RENEWABLE ENERGY LABORATORY
Ways to Use It

I. The National Level

At the national level, GeoRePORT allows for the creation of baseline maps using publicly available data which can be used by DOE to identify the greatest barriers to geothermal development and to aid in setting quantifiable, measurable program goals.

- Identify Major Barriers
- Identify Resource Availability
- Set Baseline Goals
- Measure Impacts
How it Works

**Resource Grade**
- **Polar Area Chart**
- The bigger the pie piece, the better the attribute grade

**Dark Wedges**
- Indicate grade

**Light Wedges**
- Indicate certainty

**Temperature**

**Volume**

**Permeability**

**Fluid Chemistry**

- ** execution**
- **character**
- **activity**
- **character**
OVERVIEW OF METHODOLOGY

Resource Grade Summary Chart

Displaying all 12 Character Grades in one graphic
GeoRePORT: Socio-Economic Grades

**Land Access**
- Cultural and Tribal Resources: 3
- Environmentally Sensitive Areas: 3
- Biological Resources: 3
- Land Ownership: 2
- Federal and State Lease Queue: 1
- Military Installation: 1

**Permitting**
- Environmental Review Process: 3
- Regulatory Framework: 2
  - State Regulatory Framework: 2
  - Federal Regulatory Framework: 1
- Ancillary Permits: 1

**Transmission**
- Distance to the nearest transmission line: 1
- Interconnection costs: 1
- Transmission (wheeling) costs: 1

**Market**
- Policies: 2
- Incentives: 2
- Market Demand: 1
- Wholesale Price of Electricity: 1
**Attribute:** Permitting  
**Sub-Attribute:** State Regulatory Framework

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>State/County has a permit coordinating office, geothermal regulations and experience successfully permitting projects</td>
</tr>
<tr>
<td>B</td>
<td>State/County has geothermal regulations and experience successfully permitting projects</td>
</tr>
<tr>
<td>C</td>
<td>State/County has geothermal regulations, but has not successfully permitted a project or is in the process of changing the regulations</td>
</tr>
<tr>
<td>D</td>
<td>State/County has a definition of geothermal resources, but does not have permitting regulations</td>
</tr>
<tr>
<td>E</td>
<td>State/County does not have any geothermal power regulations</td>
</tr>
</tbody>
</table>
Example Sub-Attribute Map

**Attribute:** Permitting

**Sub-Attribute:** Federal Regulatory Framework

- **A** BLM-administered mineral estate in an area with experience permitting geothermal exploration and development projects and BLM has an MOU with the state.
- **B** BLM-administered mineral estate in an area with experience permitting geothermal exploration and development projects and BLM does not have an MOU with the state.
- **C** BLM-administered mineral estate in an area without experience permitting geothermal exploration and development projects and BLM has an MOU with the state.
- **D** BLM-administered mineral estate in an area without experience permitting geothermal exploration and development projects and BLM does not have an MOU with the state.
- **E** No geothermal staff or funding
**Attribute:** Land Access  
**Sub-attribute:** Environmentally Sensitive Areas

- **A** Not located in an environmentally sensitive area. 2-3 month staff review.
- **B** Manageable environmental sensitivities (recreational, geologic, wildlife or scenic value) 3-6 month staff review.
- **C** Environmentally sensitive area complications (Waters of the United States) 6 - 12 month staff resolution.
- **D** Difficult environmentally sensitive area complications (Wild and Scenic Rivers, National Wildlife Refuge, National Preserves) Not likely to resolve, 1-2 years or longer if resolution possible.
- **E** Extreme environmentally sensitive area complications (National Park, National Monument, wilderness areas or wilderness study areas, U.S. Forest Service (USFS) inventoried roadless areas*, state and private conservation land) Not likely to be resolved, 2+ years.
This map represents the summary of all of the Land Access sub-attributes. The colors in the summary map reflect a range of scores from 12 (all six sub-attributes graded as A) to 60 (all six sub-attributes graded as E). *Unallowed* areas (grade E) are shown in black; *significant-barriers* areas (grade D) are shown in red.
## Example Program Planning

### USGS Identified Potential

<table>
<thead>
<tr>
<th>Potential Type</th>
<th>MW Affected</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sites &lt;=150°C</td>
<td>1,634</td>
<td>18%</td>
</tr>
<tr>
<td>Developed (as of 2010)</td>
<td>2,612</td>
<td>28%</td>
</tr>
<tr>
<td>Unallowed</td>
<td>129</td>
<td>1%</td>
</tr>
<tr>
<td>Developer-Identified “Significant Barriers”</td>
<td>796</td>
<td>9%</td>
</tr>
</tbody>
</table>

### USGS Undiscovered Potential

<table>
<thead>
<tr>
<th>Potential Type</th>
<th>MW Affected</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknown MW (AK, HI)</td>
<td>4,223</td>
<td>14%</td>
</tr>
<tr>
<td>Developed (as of 2010)</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Unallowed MW</td>
<td>5,350</td>
<td>18%</td>
</tr>
<tr>
<td>Developer-Identified “Significant Barriers”</td>
<td>7,387</td>
<td>25%</td>
</tr>
</tbody>
</table>

### Remaining Clear MW

- **USGS Identified Potential:** 4,027 MW (44%)
- **USGS Undiscovered Potential:** 13,073 MW (44%)

Unallowed areas were due to biological or environmentally sensitive areas.

USGS map doesn’t cover Alaska or Hawaii, so we couldn’t overlay barriers maps – remaining 4.2 GW were not analyzed for impact of barriers.

#### Developer-Defined Significant Barrier(s)

<table>
<thead>
<tr>
<th>Significant Barrier(s)</th>
<th>Identified MW Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmentally Sensitive Area (ESA)</td>
<td>401</td>
</tr>
<tr>
<td>Lease, Cultural</td>
<td>266</td>
</tr>
<tr>
<td>Transmission, ESA</td>
<td>62</td>
</tr>
<tr>
<td>Lease</td>
<td>50</td>
</tr>
<tr>
<td>Biological</td>
<td>18</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>796</strong></td>
</tr>
</tbody>
</table>

#### Undiscovered Significant Barrier(s)

<table>
<thead>
<tr>
<th>Significant Barrier(s)</th>
<th>Undiscovered MW Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lease</td>
<td>2,668</td>
</tr>
<tr>
<td>Transmission</td>
<td>2,629</td>
</tr>
<tr>
<td>Biological</td>
<td>790</td>
</tr>
<tr>
<td>Lease, Transmission</td>
<td>606</td>
</tr>
<tr>
<td>Biological, Transmission</td>
<td>381</td>
</tr>
<tr>
<td>Environmentally Sensitive Areas (ESA)</td>
<td>168</td>
</tr>
<tr>
<td>Other Combinations</td>
<td>145</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7,387</strong></td>
</tr>
</tbody>
</table>
GeoRePORT Tools: GeoProspector

Geothermal Prospector (Globally RE Explorer)
Screen capture from the GeoRePORT web tool on GeoProspector ([https://maps.nrel.gov/geothermal-prospector](https://maps.nrel.gov/geothermal-prospector)) that provides a detailed look at the grades reported for a selected point location, based on country SEAT maps developed for the United States. *(Text on actual web page continues beyond what can be shown in this screen capture.)*
# GeoRePORT Tools: Input Spreadsheet

## Sub-Attribute Details

| ATTRIBUTES: | Fluid Chemistry |

<table>
<thead>
<tr>
<th>Select</th>
<th>Grade</th>
<th>Description</th>
<th>Wt Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 pH</td>
<td>C</td>
<td>Challenging.</td>
<td>3</td>
</tr>
<tr>
<td>Character:</td>
<td>-</td>
<td>Information unknown/not tested at this time.</td>
<td>-</td>
</tr>
<tr>
<td>Activity:</td>
<td>-</td>
<td>Information unknown/not tested at this time.</td>
<td>-</td>
</tr>
<tr>
<td>Execution:</td>
<td>Third Party Results</td>
<td>Results taken from previous Third Party studies of the area (either literature of contractors) with little or limited information on survey methods, replication, or error.</td>
<td>-</td>
</tr>
<tr>
<td>2 Corrosive Gas Content</td>
<td>-</td>
<td>Information unknown/not tested at this time.</td>
<td>-</td>
</tr>
<tr>
<td>Character:</td>
<td>-</td>
<td>Information unknown/not tested at this time.</td>
<td>-</td>
</tr>
<tr>
<td>Activity:</td>
<td>-</td>
<td>Information unknown/not tested at this time.</td>
<td>-</td>
</tr>
<tr>
<td>Execution:</td>
<td>-</td>
<td>Information unknown/not tested at this time.</td>
<td>-</td>
</tr>
<tr>
<td>3 Non-condensable Gas Content</td>
<td>E</td>
<td>Inefficient.</td>
<td>1</td>
</tr>
<tr>
<td>Character:</td>
<td>&gt;5 wT%</td>
<td>Information unknown/not tested at this time.</td>
<td>-</td>
</tr>
<tr>
<td>Activity:</td>
<td>-</td>
<td>Information unknown/not tested at this time.</td>
<td>-</td>
</tr>
<tr>
<td>Execution:</td>
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<td>Results taken from previous Third Party studies of the area (either literature of contractors) with little or limited information on survey methods, replication, or error.</td>
<td>-</td>
</tr>
<tr>
<td>4 Bicarbonate Content</td>
<td>-</td>
<td>Information unknown/not tested at this time.</td>
<td>-</td>
</tr>
<tr>
<td>Character:</td>
<td>-</td>
<td>Information unknown/not tested at this time.</td>
<td>-</td>
</tr>
<tr>
<td>Activity:</td>
<td>-</td>
<td>Information unknown/not tested at this time.</td>
<td>-</td>
</tr>
</tbody>
</table>
# Geological Overview

## Category Summary

<table>
<thead>
<tr>
<th>Volume</th>
<th>Character Grade</th>
<th>Activity Index</th>
<th>Execution Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Attribute</td>
<td>Grade</td>
<td>Weighted Ranking</td>
<td>Index</td>
</tr>
<tr>
<td>1. Volume</td>
<td>A</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td>Area</td>
<td>-</td>
<td>-</td>
<td>D</td>
</tr>
<tr>
<td>Thickness</td>
<td>-</td>
<td>-</td>
<td>C</td>
</tr>
<tr>
<td><strong>TOTALS:</strong></td>
<td>A</td>
<td>10</td>
<td>d</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Character Grade</th>
<th>Activity Index</th>
<th>Execution Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Attribute</td>
<td>Grade</td>
<td>Weighted Ranking</td>
<td>Index</td>
</tr>
<tr>
<td>1. Temperature</td>
<td>A</td>
<td>5</td>
<td>A</td>
</tr>
<tr>
<td><strong>TOTALS:</strong></td>
<td>A</td>
<td>5</td>
<td>a</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fluid Chemistry</th>
<th>Character Grade</th>
<th>Activity Index</th>
<th>Execution Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Attribute</td>
<td>Grade</td>
<td>Weighted Ranking</td>
<td>Index</td>
</tr>
<tr>
<td>1. pH</td>
<td>C</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>2. Corrosive Gas Content</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3. Non-Condensable Gas Content</td>
<td>E</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>4. Bicarbonate Content</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5. Total Dissolved Solid Content</td>
<td>C</td>
<td>3</td>
<td>B</td>
</tr>
<tr>
<td>6. Silica Content</td>
<td>B</td>
<td>4</td>
<td>C</td>
</tr>
<tr>
<td><strong>TOTALS:</strong></td>
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</tbody>
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<table>
<thead>
<tr>
<th>Permeability</th>
<th>Character Grade</th>
<th>Activity Index</th>
<th>Execution Index</th>
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<tbody>
<tr>
<td>Sub-Attribute</td>
<td>Grade</td>
<td>Weighted Ranking</td>
<td>Index</td>
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<tr>
<td>1. Fault/Fracture Orientation</td>
<td>B</td>
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<td>B</td>
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<td>2. Fault/Fracture Aperture</td>
<td>C</td>
<td>3</td>
<td>D</td>
</tr>
<tr>
<td>3. Mineralization</td>
<td>C</td>
<td>3</td>
<td>B</td>
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<tr>
<td>4. Fracture Spacing</td>
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<td>5. Fracture Roughness</td>
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*Note: Scientist determined the designated sub-attribute has the most impact on the reservoir’s attribute.*
# GeoRePORT Tools: Input Spreadsheet

<table>
<thead>
<tr>
<th>Reservoir Site:</th>
<th>Coso Geothermal Area - California, USA</th>
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<tr>
<td>Completed By:</td>
<td>Melinda St. Onge</td>
</tr>
<tr>
<td>Date Completed:</td>
<td>4/6/17</td>
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</table>

**Opening Remarks**

This report has been conducted by a third-party non-geoscientist. Based on public records and available technical reports the following should be noted: (1) This is a case study test of the GeoRePORT and how well it represents the provided data. (2) Many conducted research activities were difficult to appropriately categorize and therefore may have been given higher or lower representative grades. (3) Missing information does not mean tests have not been conducted. (4) This report is in no way a complete cross-examination of the resource, the information in this report will change provided project experts input.

**Reservoir Description**

The Coso Geothermal Field is located in Inyo County, California, within the Naval Air Weapons Station at China Lake and in the northern region of the Mojave Desert. The entirety of the site is approximately 510 acres. The Coso Geothermal Field has been producing geothermal electricity power continuously since 1987. The field contains several divisions and power plants. Navy 1, Navy 2, and BLM are site locations with existing operational power plants. The Northern frontier is still in exploratory phases.

**Attribute Overview**

![Socio-Economic Diagram](image)

**Technical**

- Fluid Chemistry
- Temperature
- Volume
- Power Conversion
- Drilling
- Logistics
- Permitting
- Remanement

**Attribute Summary**

- Cover Page
- Project Readiness
- GeoSummary
- Temperature
- Volume
- Fluid Chemistry
- Permeability
Thank You!

For more information about GeoRePORT, visit the website at:
http://en.openei.org/wiki/GeoRePORT

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303-384-7402