Away from the Range Front - Intra-Basin Geothermal Exploration

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This presentation does not contain any proprietary confidential, or otherwise restricted information.
Scientific/Technical Approach

• Target open fractures at depth from detailed surface structural and mechanical data and evidence for shallow thermal upflow.

• Extend the range front fault targeting method with early detail
  – Increase the number of complementary structural/mechanical data sets
  – Quantify fracture permeability mechanics early

• Apply existing technology from outside the geothermal industry
  – Geotechnical Industry – push core drilling and fault trenching
  – Mining Industry – stress over-coring
  – Research – Lidar and stress/fracture pattern permeability models

• Milestones
  – Establish full project team
  – Target deep wells
  – Drill first deep well
  – Drill second deep well
Accomplishments, Expected Outcomes and Progress

1. No accomplishments so far

2. Expected outcomes: Technical success, uncertain drilling result
   1. Application of known techniques in a new way
   2. Uncertain extension of near surface data to depth

3. Progress
   1. NEPA/NOI process started
   2. Lidar bid and contracted
   3. Pre-existing data acquired
# Project Management - Budget

## Summary of Budget Categories: Phase 1, 2 and 3

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>Budget Period 1 Costs</th>
<th>Budget Period 2 Costs</th>
<th>Budget Period 3 Costs</th>
<th>Total Costs</th>
<th>Project Costs %</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Personnel</td>
<td>$667,200</td>
<td>$580,800</td>
<td>$1,072,200</td>
<td>$2,320,200</td>
<td>31.50%</td>
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<tr>
<td>b. Fringe Benefits</td>
<td>$166,800</td>
<td>$145,200</td>
<td>$268,050</td>
<td>$580,050</td>
<td>7.90%</td>
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<tr>
<td>c. Travel</td>
<td>$20,250</td>
<td>$22,250</td>
<td>$9,250</td>
<td>$51,750</td>
<td>0.70%</td>
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<tr>
<td>d. Equipment</td>
<td>$0</td>
<td>$65,000</td>
<td>$0</td>
<td>$65,000</td>
<td>0.90%</td>
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<tr>
<td>e. Supplies</td>
<td>$1,040</td>
<td>$124,500</td>
<td>$2,500</td>
<td>$128,040</td>
<td>1.70%</td>
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<tr>
<td>f. Contractual</td>
<td>$378,500</td>
<td>$3,650,191</td>
<td>$15,500</td>
<td>$4,044,191</td>
<td>54.90%</td>
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<td>g. Construction</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>0.00%</td>
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<tr>
<td>h. Other Direct Costs</td>
<td>$66,100</td>
<td>$100,000</td>
<td>$6,600</td>
<td>$172,700</td>
<td>2.30%</td>
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<tr>
<td>i. Indirect Charges</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>0.00%</td>
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<tr>
<td><strong>Total DOE-approved Project Costs</strong></td>
<td><strong>$1,299,890</strong></td>
<td><strong>$4,687,941</strong></td>
<td><strong>$1,374,100</strong></td>
<td><strong>$7,361,931</strong></td>
<td><strong>100.00%</strong></td>
</tr>
</tbody>
</table>
Project Management – Implementation

• Establish team
  – Project Coordinator – starts May 30
  – Graduate student selection in progress
  – GGE team engaged in Chile through May 30

• Finalize documents
  – Government (BLM, DOE, State)
  – University (UCSB, UNR)
  – Contractors (NA)

• Start technical projects
  – Lidar project poised to start
Future Directions

• 2010 Sub-projects
  – Survey designs and locations
  – Contractor bids and specifications
  – Lidar, Push core drilling, water sampling, over-coring, trenching, laser tri-lateration baseline
  – Conceptual model and targeting

• Deep Drilling Decisions
  – Areal extent of target zones
  – Expected reservoir temperature and depth
  – Expected IRR projection from cost model
  – Likelihood of drilling success

• Solar-Geothermal Hybrid to increase project size
• Deep permeability is a rare event
• Observations have revealed:
  – Success at the Range Front at fault irregularities
  – Relative fault-stress orientations can affect permeability
  – Lithology and contrasts can affect permeability
• Challenges
  – Explore away from the range front
  – Geomechanical/structural information is sparse relative to fracture complexity
  – Stress and propping may both be necessary to keep fractures open
• Escalate mechanical and structural methods to build on the results of studies in existing well-fields
  – Traditional: TGH and fault maps from the range front
  – This Project: shallow wells and geomechanics before drilling

• Push-core may optimize shallow drilling
  – Much lower cost than TGH
  – Lower environmental impact
  – Measure 30 m gradient rather than 2 m temperature
  – Fluid sampling opportunity

• Over-coring stress measurement may reveal local stress
  – Fault pattern studies suggest permeability at fault irregularities
  – A developed technique in a new application