AASG State Geological Survey

Contributions to the NGDS

Project Officer: Arlene Anderson
Total Project Funding: $21,858,224
April 22, 2013

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Co – PI:
Stephen M. Richard, Ph.D.

Arizona Geological Survey

Data Systems
Relevance/Impact of Research

Impact

1. This project facilitates and streamlines the discovery, access to, and integration of geoscience and geospatial information used to locate, evaluate, and develop geothermal resources

   - EERE GTO Goals Relevance:
     - Lower risks and costs of exploration and exploration
     - Expand reference and resource data for Research and Development activities, including data in low-temperature locations
     - Lead to Innovative Exploration Technologies through increased data availability on geothermal energy capacity while collecting new data in previously unexplored or under-explored locations

2. Prototypes data interoperability and distributed data networks from concept into production

3. Provide a framework for a new paradigm in data stewardship and delivery that supports broader open government, digital government, and Big Data initiatives

Relevance/Current Challenges

1. Data Access for Industry and Policy-makers
   - Lack of publicly available data
   - Availability of consistent, interoperable, and reliable geothermal-relevant data

2. Cost
   - High cost and risk associated with exploration hampers industry growth
   - High cost of staff time devoted to finding, retrieving, converting, and verifying information

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Relevance/Impact of Research Innovation

Project managed by AZGS 50 State Geological Surveys

- data “nodes” digitize, archive, manage, and provide content independently
- open source software and standard protocols
- distributed framework and a unified catalog search interface
Relevance/Impact of Research Impact on NGDS

- ~4.5 million data points online
- 294 Layers in 193 Web Services with nearly all data exchange types represented
- >17,000 records – documents & data sets - in the AASG State Geothermal Repository
  - Includes some NGDS Design-Test (BSU) subrecipient items
Scientific/Technical Approach

Summary

- Adapt the USGS-AASG Geoscience Information Network (USGIN) for use by the NGDS
  - Modular, distributed, web-based, interoperable
  - Open-source or common off-the-shelf software
  - Focus on adapting existing capabilities
  - Federated catalog of distributed geothermal-relevant resources using global standards
    - USGIN Metadata profile, utilize ISO standards for encoding
    - Open Geospatial Consortium (OGC) Catalog Service for the Web (CSW)
  - Develop and document protocols for data access
    - OGC Web Map Service (WMS) and Web Feature Service (WFS)
    - Develop simple feature templates for standard data types
    - User tutorials online
    - Webinars & webcasts
    - Developers tools online

- Deploy NGDS across all 50 states
- Work with State and Federal Geological Surveys & Partners to assemble and serve datasets online
- Ensure compatibility with the NGDS Architecture, Design, and Testing project which is utilizing CKAN (open-source software for data publishing) for the Node Deployment Software Stack. CKAN is also utilized by data.gov.
Scientific/Technical Approach
Data Types and Tiers

• Tier One Data: Data Online and can be Discovered
  – Format: downloadable file or a service
  – Requirement: catalogued in a meaningful way, e.g. provide a USGIN-style metadata record to catalog that is part of the NGDS System
  – Result: no interoperability, only discoverability
  – Difficulty: Easy

• Tier Two Data: Data Discoverable with Basic Interoperability
  – Format/Requirement: data tabular (i.e. Excel, Access), and available in standard (e.g. OGC web service); metadata are in a catalog
  – Result: Tier One discoverability and a basic level of interoperability since software can be written to ingest data directly
  – Difficulty: translating the data to tabular format can be time consuming, there may be restrictions from internal IT for service deployment; however, setting up an OGC service is free and fairly simple

• Tier Three Data: Analyze Across Data Sets
  – Format/Requirement: data are transformed into a standard interchange format, are accessible via OGC web service, and metadata are in a catalog for them
  – Result: data are discoverable, software can ingest data through standard OGC service calls, software can know what the data means, directly comparable across datasets; i.e. Software can now do analyses that cross dataset boundaries – Interoperability!
  – Difficulty: ETL can be time consuming and consensus on data exchange formats can be difficult
Scientific/Technical Approach
Data Types, Tier 3 Data

Active Fault/Quaternary Fault
Aqueous Chemistry –wells & springs
Borehole Lithology Intercepts
Borehole Temperature
Direct Use Feature
Drill Stem Test Observations
Fault Feature
Fluid Flux Injection and Disposal
Geologic Contact Feature
Geologic Unit Feature
Geothermal Area
Geothermal Fluid Production
Geothermal Power Plant
Heat Flow
Heat Pump Facility
Lithology Interval Log Feature

Metadata
Physical Sample
Powell Cummings
Geothermometry
Power Plant Production
Radiogenic Heat Production
Rock Chemistry
Seismic Event Hypocenter
Thermal Conductivity
Thermal/Hot Spring Feature
Volcanic Vents
Well Fluid Production
Well Header
Well Log Data Compilation
Workbook
Well Log Observation
Well Tests
1. Annual Statement of Work review by the Science Advisory Board – a panel of Geothermal Experts identified to review the applicability and utility of the proposed data collection efforts for each state.

2. Debug iterations are made between the NGDS system and each data producer until the prototype is demonstrated to work and provides the necessary content.

3. The prototype dataset is made accessible online in the system, but flagged as development data set; the final submission provides the complete dataset evolved from the prototype and made accessible online as a web accessible dataset through a node in the network.
Scientific/Technical Approach
Addressing Key Issues

• Use of Existing Formats whenever possible
  – ISO 19115 for Metadata; ISO 19139 for XML encoding
  – Open Geospatial Consortium (OGC) services

• Use of Free and Open Source Software
  – CKAN content management system (also used by Data.gov)
  – GeoPortal catalog service implementation
  – GitHub for code sharing

• Loose Coupling
  – Based on WWW architecture
  – Third party user applications (“apps”) can use data from any
    server offering a compatible service profile
  – Catalog is standardized to allow user applications to automate
    data access

Discover, Access, Explore
### Accomplishments, Results and Progress

<table>
<thead>
<tr>
<th>Original Planned Milestone/ Technical Accomplishment</th>
<th>Actual Milestone/Technical Accomplishment</th>
<th>Date Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>No-Cost Extension</td>
<td>Received NCE through 4/30/2014 to accommodate subrecipient contracting delays and expand upon the sustainability of the network</td>
<td>06/2012</td>
</tr>
<tr>
<td>Comprehensive Data Production</td>
<td>Ongoing; finalized nearly all YR 1 and YR 2 data; reached mini-goal of data for more than 1 million wells in the system</td>
<td>12/2012</td>
</tr>
<tr>
<td>Enhanced User Access</td>
<td>Released enhanced <a href="http://www.geothermaldata.org">www.geothermaldata.org</a> prior to the GRC/GEA Annual Meeting &amp; Expo; will combine our experiences with the NGDS Architecture, Design, &amp; Testing UI work</td>
<td>09/2012</td>
</tr>
<tr>
<td>New Field Data Collected</td>
<td>Ongoing; 4 of 6 states have completed their thermal gradient wells, majority of additional data collection (well logging, spring sampling) is well underway; Accomplishment: UT discovered geothermal reservoir in sedimentary basin</td>
<td>ongoing</td>
</tr>
<tr>
<td>Sustainability Plan for the Network</td>
<td>Extensive outreach and engagement of external parties; planning of AASG subrecipient end-user workshops for sustaining the network; business models under development</td>
<td>ongoing</td>
</tr>
</tbody>
</table>
Accomplishments, Results and Progress
Special Awards & Recognition

UGS discovery in the Black Rock Desert listed as #7

Geothermal’s Big 12 Events of 2012
With 128 megawatts of geothermal coming on-line in 2012, we present a geothermal year in review.
Herman K. Trabish
2012

JSON TEXT:

GRC Best Presentation Award
In recognition of quality of Content and Presentation at the Exploration 1 Session
A Geothermal Data System for Exploration and Development

2012 GRC Annual Meeting
Reno, Nevada • USA

One of 34 Best Presentation Awards from over 180 presentations at 2012 GRC

New Geothermal Data System Could Open Up Clean-Energy Reserves
Forgotten and filed away decades ago, millions of documents on geothermal research are now helping scientists make harvesting Earth's energy affordable
By William Ferguson
Accomplishments, Results and Progress

Improved Search Functionality

Regional Search for Well Headers; data results displayed within search

Additional Search Tool Functionality:
- More Details on the Dataset
- XML metadata
- Access WMS/WFS (and preview)
- Access Esri services (and preview)
- Preview data table
- Download File
- Get OGC WMS/WFS Capabilities
- Esri Service Endpoint
- Contact Distributor
Accomplishments, Results and Progress
New Data Collection

New temperature gradient wells completed in UT, ID, WA, & WI; pending wells in OR & NV

Program Officer Arlene Anderson and ID Geological Survey PI, John Welhan pose at one of three drill sites within the Blackfoot-Gem Valley of SE ID

Sedimentary basin geothermal

Black Rock Desert of central UT; temperatures of 150 to 250 degrees C at 3-4km depth
Accomplishments, Results and Progress
New Data Collection

Thermal Spring Sampling in WA & AZ: results being entered into the NGDS

Temperature logging in WA
Accomplishments, Results and Progress Outreach & Engagement

One example of the more than 30 talks and presentations by the AASG subrecipients: Don Thomas, PI for the HI data collection at the 2012 AGU Fall Meeting (above)


Exhibit Booth at the 2012 AGU Fall Meeting (above) and at the GSA Annual Meeting (right) with Jamie Robertson, WI State Geologist and Co-PI Richard
Future Directions
Sustainability

• NGDS is *sustainable, stable, and extensible* since it encourages distributed knowledge sharing through open source online data discovery and access
  – Concept can be expanded for adoption by a variety of communities, e.g. adoption by WRP

• Low barrier to entry enables broad participation
  – Tier 1 data entry requires minimal time; building a community of practice around data sharing will make quality metadata creation a step in the scientific process rather than a burden

• Promoting awareness to the end user community is critical to sustaining the network
  – End User Engagement through Workshops, Training Sessions
  – End User Awareness through Outreach, Engagement, and Marketing of the System and its capabilities

• Large number of potential collaborators and uses
Future Directions
Collaborators & Linkages
## Future Directions

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Status &amp; Expected Completion Date</th>
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<tbody>
<tr>
<td>Conduct status review to ensure target completion date</td>
<td>Planned: June 2013</td>
</tr>
<tr>
<td>Publish enhanced end-user material for broader system deployment</td>
<td>Planned: July 2013</td>
</tr>
<tr>
<td>Host at least two participant workshops on network sustainability</td>
<td>Planned: May 2013 &amp; July 2013</td>
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<tr>
<td>Have initiated at least 2 collaborative efforts on sustaining the network</td>
<td>Planned: September 2013</td>
</tr>
<tr>
<td>Complete at least ¾ of the data collection efforts from subrecipients</td>
<td>Planned: October 2013</td>
</tr>
<tr>
<td>Finalize data collection efforts from subrecipients</td>
<td>Planned: December 2013</td>
</tr>
<tr>
<td>Finalize system for delivery to sustaining institution</td>
<td>Planned: April 2014</td>
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NGDS is a prototype functional system with nationwide data online *today*

- Production mode on data accessibility and digitization of legacy data
- Improved user interface
- Improved collaboration with the NGDS Architecture, Design, and Testing
- New geothermal data collection underway
- Expanded industry and stakeholder collaboration
Application of Resources
- Leveraging additional resources, e.g. NSF and USGS funds, Energistics Energy Industry Profile
- Exceeded Cost-Share in FY13 Q1
- Subrecipient spending checks and balances, e.g. data deliverable review per invoice and Science Advisory Board annual review

Integration with Other Projects
- Contributing to the NGDS Architecture, Design, and Testing by providing data from all 50 states as well as systems architecture
- Advising the SMU and Geothermal Data Repository projects on node requirements

Coordination with Industry & Stakeholders
- Aggressive Education Outreach and Training including 34 talks, workshops, and publications; 3 exhibit hall presentations; and more than 30 talks, presentations, or publications by the subrecipients
- Received a best presentation award from the 2012 Geothermal Resources Council Annual Meeting
- Initiated numerous discussions on sustainability and utilization of the network

All States Have Submitted Data