State Geological Survey Contributions to the National Geothermal Data System: Accomplishments for Federal Fiscal Year 2013 October 1, 2012 to September 30, 2013

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Arizona Geological Survey

National Geothermal Data System profiled in May 2013 Scientific American

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M. Lee Allison, State Geologist and Director

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Accomplishments for Federal Fiscal Year 2013
October 1, 2012 through September 30, 2013

AASG
GEOTHERMAL DATA

Arizona Geological Survey

State Geological Survey Contributions to the National Geothermal Data System

Accomplishments for Federal Fiscal Year 2013
October 1, 2012 to September 30, 2013

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Under U.S. Department of Energy award DE-EE0002850

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ANNUAL RESEARCH PERFORMANCE PROGRESS REPORT

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DUNS Number: 806758298
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Project Partners:

Alaska Division of Geological & Geophysical Surveys
Geological Survey of Alabama
Arkansas Geological Survey
Arizona Geological Survey
Colorado Geological Survey
Florida Geological Survey
University of Hawaii
Iowa Department of Natural Resources – Geological & Water Resources Survey
Idaho Geological Survey
The Board of Trustees of the University of Illinois, Illinois Geological Survey
Trustees of Indiana University, Indiana Geological Survey
University of Kansas Center for Research, Inc., Kansas Geological Survey
University of Kentucky Research Foundation, Kentucky Geological Survey
Board of Supervisors of Louisiana State University and A&M College, Louisiana Geological Survey
Massachusetts Geological Survey
Maine Geological Survey
Missouri Geological Survey, Department of Natural Resources, Division of Geology and Land Survey
Mississippi Department of Environmental Quality
Montana Bureau of Mines & Geology
North Carolina Geological Survey
University of North Dakota

New Hampshire Geological Survey
New Jersey Geological Survey
New Mexico Institute of Mining & Technology
Board of Regents, NSHE, obo University of Nevada, Reno, Nevada Bureau of Mines and Geology
New York State Geological Survey
Ohio Department of Natural Resources, Division of Geological Survey
The Board of Regents of the University of Oklahoma, Oklahoma Geological Survey
Oregon Department of Geology and Mineral Industries
Pennsylvania Geological Survey
Rhode Island Geological Survey
South Carolina Geological Survey
Sinte Gleska University, South Dakota
Tennessee Division of Geology
Texas Bureau of Economic Geology
Utah Geological Survey
Virginia Division of Geology and Mineral Resources
Vermont Office of Department of Environmental Conservation
Washington State Department of Natural Resources
Wisconsin Geological and Natural History Survey
West Virginia Geological and Economic Survey
Wyoming State Geological Survey

In-Kind Partners:

Connecticut Geological Survey (through Massachusetts Geological Survey)
Delaware, Georgia, and Maryland Geological Surveys (through the Virginia Division of Geology and Mineral Resources)
Nebraska Geological Survey (through the University of North Dakota)
North Dakota Geological Survey (through the University of North Dakota)
South Dakota Geological Survey

Cost Share Partners:

Alabama Geological Survey
Illinois Geological Survey
Minnesota Geological Survey
Oklahoma Geological Survey

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EXECUTIVE SUMMARY

For the third year in a row, the project received "good" or "outstanding" review comments during the annual sponsor peer review (scores for all elements were between 7 and 10 with the majority of scores as 8's and 9's). Progress this year has focused on data collection and deployment, we have successfully more than doubled the available data points from FY12, approximately 2 million, to more than 5 million at the end of FY13. The project reached a milestone of providing access to information for more than 1 million wells in December of 2012.

This year, significant strides in public relations and engagement occurred, including featured articles in *Scientific American, EARTH*, a Geothermal Resources Council Best Presentation Award, and one of the Top 12 Geothermal Events of 2012. *EARTH* described the NGDS as "one of the most successful programs to date," for data sharing and Big Data in the geosciences. In addition, the release of the Federal Open Data Policy provides a promising shift in data management and stewardship at the federal level promoting accessibility and discovery of data, for which the National Geothermal Data System is an exemplar. In the next year we will continue to pursue avenues of sustainability incorporating the new Federal Open Data Policy including a National Academy of Sciences/Association of American State Geologists supported Open Data Roundtable and Open Data Compliance eHandbook.

Figure 1: The National Geothermal Data System is featured in *Scientific American*, May 2013.

All 50 states are represented in the project and subcontractors been actively participating in data digitization, collection, and distribution having delivered more than 5 million data points. New data collection tasks have occurred in Arizona, Colorado, Idaho, Indiana, Massachusetts, Maine, New Jersey, New Mexico, Nevada, Oklahoma, Oregon, Pennsylvania, Utah, Vermont, Washington, and West Virginia. Initial results are already showing positive contributions to the geothermal industry, including the discovery of a new geothermal resource in Utah's Black Rock Desert (ranked #7 of the top 12 Geothermal Discoveries of 2012).[1]

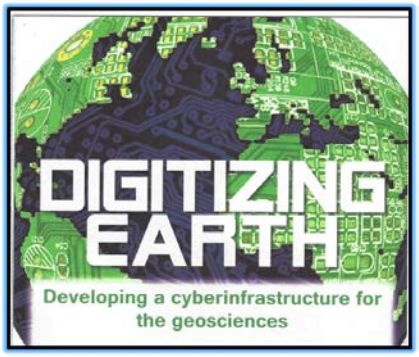
With the new project team at the NGDS Architecture, Design, Testing, and Maintenance project and progress towards a functioning user interface, aggregator catalog, and easily deployable software stack for data distribution (Node-in-a-Box, NIAB), the National Geothermal Data System is on track to meeting its goal of providing improved access for exploration and development.

[1] http://seekingalpha.com/article/1071191-geothermals-big-12-events-of-2012

Milestones:

- Completed Year 1 and Year 2 deliverables for most subrecipients.
- Finalized Year 3 statements of work with State Geological Survey subrecipients including a mid-year review for some recipients.
- Achieved access to more than 5 million data points provided using Web services via NGDS
- Hosted meetings of the project Principal Investigator's and Scientific Advisory Boards; PIs met at the Association of American State Geologists Annual Meeting in Deadwood, SD and the Science Advisory Board meeting mid-year review was held virtually in January of 2013.
- Hosted the three regional workshops focused on sustainability; training the subrecipients on data review and deployment, including the newly developed Node-in-a-Box software stack.
- Continued resolving metadata content and quality issues at respository.stategeothermaldata.org site.
- Continued improvements to the NGDS Data Explorer (data.geothermaldatasystem.org).
- Released a series of new tools to expedite and validate data deployed for the NGDS.
- Released a new online content model repository (http://schemas.usgin.org/home/).
- Improved (or created) public source code repositories at GitHub.
- Released new and revised tutorials to assist in technology transfer (usgin.org and accessible through stategeothermaldata.org and geothermaldata.org)
- National Environmental Policy Act clearance completed on all projects; four of the five drill projects have completed
- Participated in coordinated sessions and papers for the Stanford Geothermal Workshop and Geothermal Resources Council Annual Meeting.
- Coordinated the first cohesive NGDS booth at the Geothermal Energy Association Expo.
- Community engagement activities, including booths and talks at American Geophysical Union Fall Meeting, Geological Society of America Annual Meeting, International Geological Congress, European Geological Union Annual Meeting, and many more at the state and national levels.
- Interviews cited in multiple national media sources including *Scientific American* (both online and print editions), the American Geosciences Institute *EARTH* magazine, and Arizona Public Media.
- Developed, updated, or approved content models in conjunction with the DOE-chaired Geothermal Data System Design and Population Working Group (GDSDPWG). There are 32 active content models, and development documents are now in GitHub (https://github.com/usgin-models)
- Continued developing external partnerships including partnerships with the International Renewable Energy Association, U.S. Energy Association, ESRI, and OneGeology.
- The AZGS talk on NGDS at the GRC 2012 annual meeting received a Best Presentation award.

"One of the most successful programs to date is the National Geothermal Data System…"
EARTH magazine, Sept. 2013



TECHNICAL ACCOMPLISHMENTS

DATA DELIVERY

The following represents a summary of the data sets submitted by participants to AZGS for QA/QC over the year and includes data from both the Association of American State Geologists (AASG) participating entities and the NGDS Architecture, Design, Testing, and Maintenance project subcontractors (led by Boise State University).

Table 1: Data sets submitted for QA/QC

Month	Number of Data Sets	Number of States Represented
October 2012	36	19
November 2012	28	13
December 2012	40	23
January 2013	33	16
February 2013	26	6 (plus 3 Design/Testing Subs)
March 2013	20	10 (plus 1 Design/Testing Sub)
April 2013	23	10 (plus 2 Design/Testing Subs)
May 2013	47	15
June 2013	41	13 (plus 2 Design/Testing Subs)
July 2013	24	13 (plus 1 Design/Testing Sub)
August 2013	52	15 (plus 1 Design/Testing Sub)
September 2013	35	13 (plus 1 Design/Testing Sub)
TOTAL	**405**	

The following represents a summary of the data sets approved by AZGS as meeting project standards, placed online as a Web service, and added to the online project catalog over the year. If a dataset is incomplete the set is returned to the subrecipient with requests for additional information or clarification. Also note that some datasets submitted, when deployed, are added to an existing service. For example, if a state submits 500 well logs the first year and 500 well logs the second year, it is counted as two datasets but deployed as one contiguous service.

Table 2: Data sets approved for service deployment

Month	Number of Data Sets	Number of States Represented
October 2012	23	14
November 2012	48	20
December 2012	77	24
January 2013	59	21 (plus 2 Design/Testing Subs)
February 2013	54	15 (plus 1 Design/Testing Sub)
March 2013	38	20 (plus 1 Design/Testing Sub)
April 2013	43	19
May 2013	57	26 (plus 1 Design/Testing Sub)
June 2013	67	26 (plus 2 Design/Testing Subs)
July 2013	99	35
August 2013	84	32
September 2013	42	22 (plus 1 Design/Testing Sub)
TOTAL	**691**	

DATA INTEROPERABILITY & CONTENT MODELS

Last year we identified and began classifying data along three tiers of data. These include:

1. Tier 1 -- Serving arbitrary data files (often digitized documents) via Web-services annotated with metadata in the NGDS catalog;
2. Tier 2 -- Serving structured data in files or via (geospatial) web services annotated with metadata in the NGDS catalog;
3. Tier 3 -- Serving structured tabular data via geospatial web services according to NGDS-adopted community content models annotated with metadata in the NGDS catalog.

Tier 1 data allows discovery and access since a simple metadata record is produced. Thus you ensure discoverability but have no interoperability. Tier 2 data allows discoverability through a USGIN-style metadata format and basic interoperability since the data are provided in a tabular format and most software can be written to ingest these data directly. Tier 3 allows data discovery, software ingestion of data through a standard OGC service where the software knows and understands what the data mean, and you can directly compare that data to other datasets in the same format; hence true interoperability and analysis of integrated data sets.

Classifying and describing the data in this format has assisted us in communicating the importance of achieving Tier 3 data, or interoperability through the data schemas. We have incorporated the data tiers

and following table in our tech transfer and outreach.

Table 1 provides additional detail on the data tier, type of data, and input/output requirements of each tier.

Table 3: Additional detail on the three tiers of data interoperability

Data Tier	Type of Data	Input Requirements	Output Requirements
Tier 1	Scanned Documents	Upload the file to a web accessible location; Create metadata for record	Accessible via HTTP GET; Metadata provides URL to get file.
Tier 2	Structured (tabular) data not conforming to an NGDS content model. Examples include Excel/csv tables, Microsoft Access databases	Upload files to a web accessible location; Create metadata for record. Metadata should include descriptive information about the column headers and data types that the documents contain.	Accessible via HTTP GET; Metadata provides URL to get file, and documents the data structure. Optional – data may be exposed as a WFS/WMS.
Tier 3	Structured data conforming to an NGDS content model	Upload files to a web accessible location; WFS and WMS services are deployed to serve data; Create metadata pointing at all endpoints (because the content model defines entity/attribute information the creation of metadata is less cumbersome).	Accessible via HTTP GET; Data exposed as WFS/WMS services; Metadata provides URLs for file access and service endpoints.

Tier 3 data are distributed using a pre-defined content model. These content models are now available in a USGIN repository at http://schemas.usgin.org/home/. This page also includes a WFS validation tool for ensuring the content model is complete. USGIN is currently implementing these interchange formats as GML Simple Features to be served by an Open Geospatial Consortium (OGC) WFS. If data to be served are not accounted for by an existing content model, network participants are invited to propose new models. A document with guidelines for construction of a content model workbook is available online at http://repository.usgin.org/uri_gin/usgin/dlio/340. Currently in progress for FY14 is a mechanism for "crowd-sourcing" content models in the future, most likely through the project's GitHub page.

The following is a list of available content models:

- Active Fault/Quaternary Fault
- Aqueous Chemistry
- Borehole Lithology Intercepts
- Borehole Lithology Interval Feature
- Borehole Temperature Observation
- Contour Lines
- Direct Use Feature
- Fault Feature/Shear Displacement Structure
- Fluid Flux Injection and Disposal
- Geologic Contact Feature
- Geologic Reservoir
- Geologic Units
- Geothermal Area
- Geothermal Metadata Compilation
- Geothermal Power Plant Facility
- Gravity Stations
- Heat Flow
- Heat Pump Facility
- Hydraulic Properties
- Physical Sample
- Powell Cummings Geothermometry
- Power Plant Production
- Radiogenic Heat Production
- Rock Chemistry
- Seismic Event Hypocenter
- Thermal Conductivity Observation
- Thermal/Hot Spring Feature

- Volcanic Vents
- Well Fluid Production
- Well Header Observation
- Well Log Observation
- Well Tests

METADATA

Metadata for the NGDS should be provided using USGIN metadata content recommendations (http://lab.usgin.org/profiles/doc/metadata-content-recommendations). These requirements specify the content of the metadata, but not the delivery format. ISO19139 XML is the preferred encoding based on its expanding adoption in the national and international community. USGIN guidelines for implementing the content recommendations in ISO19139 XML are available as part of the AASG State Geothermal Data Repository (http://repository.stategeothermaldata.org/repository/resource/98ddf901b9782a25982e01af3b0ec3ea/), as well as a detailed USGIN profile for interoperable metadata using ISO19139 (http://repository.stategeothermaldata.org/repository/resource/98ddf901b9782a25982e01af3b0bda50/). Both individual metadata records for simple (single-distribution) and those requiring file uploads can be created using the new AASG State Geothermal Data Repository (http://repository.stategeothermaldata.org/repository/). AASG participants can provide metadata in multiple formats: by building a CSW with USGIN style metadata available for harvest, by completing the metadata compilation spreadsheet (http://schemas.usgin.org/models/#Metadata), or by entering a repository submission at the AASG repository.

To bulk load metadata records in the metadata content model we have developed a software application to read the metadata from an Excel table and serialize as XML that can be imported to the AASG catalog. The tool is available at https://github.com/usgin/csvtometadata and was developed by Ryan Clark at the AZGS.

REPOSITORIES

We are currently maintaining four repositories: two data repositories and two source code repositories, including:

1. USGIN (respository.usgin.org)
2. State Geothermal Data (repository.stategeothermaldata.org)
3. USGIN GitHub (github.com/usgin)
4. NGDS GitHub (github.com/ngds)

AASG REPOSITORY

The AASG Repository (http://repository.stategeothermaldata.org/repository/) was created last year to manage project metadata that had originally been placed in the USGIN repository. This enabled the existing records produced during the initial phase of project work to be updated and improved, and provides a collection-level repository for the AASG records. The repository is used for maintenance of metadata that describe resources contributed to the AASG State Geothermal Data Project. The repository also provides an archive for files that are not hosted by the agency contributing the resource. The application was implemented using open-source software Django, Node.js, and CouchDB by AZGS Developer, Ryan Clark. The code is available at https://github.com/usgin/metadata-repository. Over the last project year, improvements to the repository and the metadata within the repository have been ongoing by AZGS Information Technology Technician, Leah Musil.

The repository allows users to “Browse the Collections,” “Manage Resources,” or “Register for an

Account." When browsing the repository for data there are three ways in which to do so, by data theme and state, resource accessibility, or by source organization. The datasets by data theme and state are probably the most applicable for the domain scientists and engineers (public), the datasets by resource accessibility is probably most applicable to information technology specialists interested in the implementation of the NGDS, the datasets by source organization includes the organization that created the metadata. The source organization is probably only useful for those interested in a particular agency's contributions since a number of entities are collection data for a different state, for example, the Arizona Geological Survey is collecting the data for California.

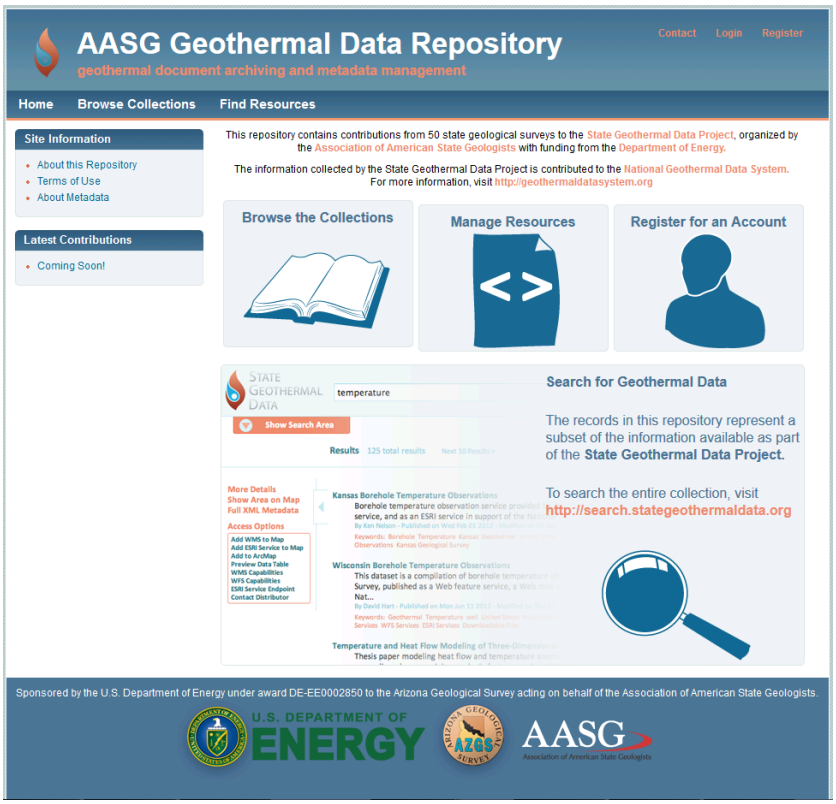


Figure 2: Screen shot of the AASG Geothermal Data Respository available at www.repository.stategeothermaldata.org

SOURCE CODE REPOSITORY

To implement the NGDS/USGIN open-source policy, a GitHub repository was created to help facilitate the sharing and development of code developed for USGIN systems. This repository is available at https://github.com/usgin. Examples of available code in the repository include:

- Content Model Manager
- WFS Search Client
- URI Redirect
- Metadata Repository
- Metadata Server
- USGIN Geoportal Addon
- AASG Tracking Site
- ArcMap Client
- XML Validation Tool
- CSW Search Client
- Excel to NGDS Service Tool
- NGDS Data Explorer
- Issue Trackers
- Specifications
- Well Log Data Tools
- Vocabularies

In addition to the USGIN repository, there is a specific NGDS repository on GitHub for the soon-to-be-released CKAN Node-in-a-Box installation. The NGDS repository is available at https://github.com/ngds. Current applications include the current CKAN Extension, Service Notifications, Metadata Issues Tracker, and the System Design documents. As of Sept. 30, access to the CKAN extension repository was still restricted due to Siemens corporate policies, but the repository was made public in October.

APPLICATIONS

The concept behind NGDS is to encourage third-party development or adaption of software applications, emulating the World Wide Web. These applications can cover data deployment to data visualization. This section details the applications developed by the AZGS for data deployment, discovery, and visualization.

SEARCH APPLICATIONS

In order to show this functionality, the AZGS team has created three applications for searching data:

1. Prototype Search Portal, http://search.geothermaldata.org/
2. ArcMap CSW Client, https://github.com/usgin/arcmap-cswclient
3. NGDS Data Explorer, http://data.geothermaldatasystem.org/

Each of the search/visualization applications was created in previous project years, however they were updated during the course of this project year.

The Prototype search portal was the least updated, only correcting minor errors and improving usability through language updates/changes. The functionality includes the ability to preview the dataset on a map, download directly into ArcMap, review the full metadata record, view full XML metadata, preview a sample of the attribute table, and a variety of access options including Get Capabilities for WMS/WFS. The access options vary depending on the type of data and permissions associated with the data.

The ArcMap client is for ArcMap v.10.1 and is easily installed via an executable file located at the USGIN GitHub. The application permits a Catalog Service for the Web (CSW) compliant catalog to be searched within ArcMap (the user does not have to leave their software application), and allows the user to add some types of services directly to their working map. The ArcMap client currently searches four catalogs: USGIN Catalog, OneGeology Portal, GeoData Government Catalog, and AASG Geothermal Data Catalog. See Figure 1 for an example of the ArcMap Client in use.

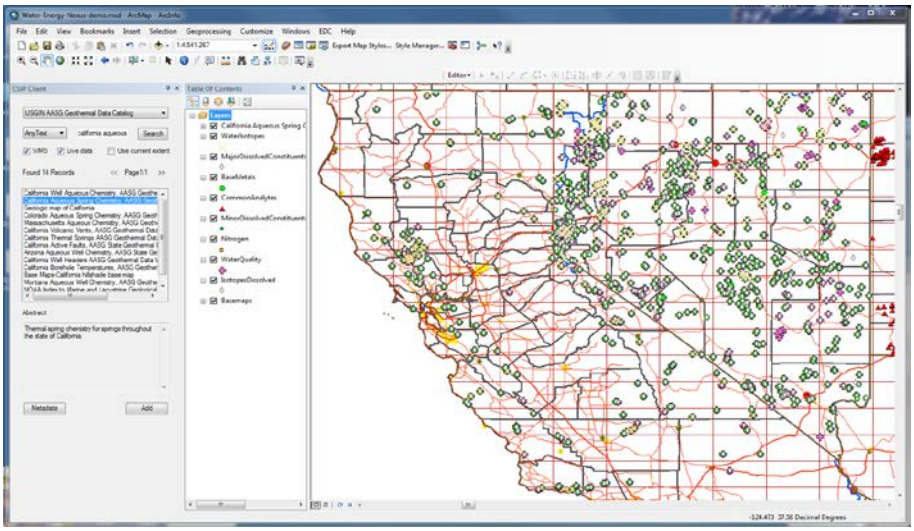


Figure 3: Esri ArcMap Catalog Search Client displayed to the left side of the image. The data mashup to the right side of the image displays datasets discovered through the catalog search

The NGDS Data Explorer extraction tool built using OpenLayers was updated by adding functionality this project year. The application allows the user to search, preview, and extract data from WFS in a tabular form, either html or csv. Because the data in the NGDS is formatted so that data are interoperable, this tool permits you to extract features from multiple providers at once. In addition, functionality such as "commonly searched layers," a distance measurement tool, and location search has been included. A tutorial was created to help users maximize the functionality of the tool and is available on the http://usgin.org/tutorials page.

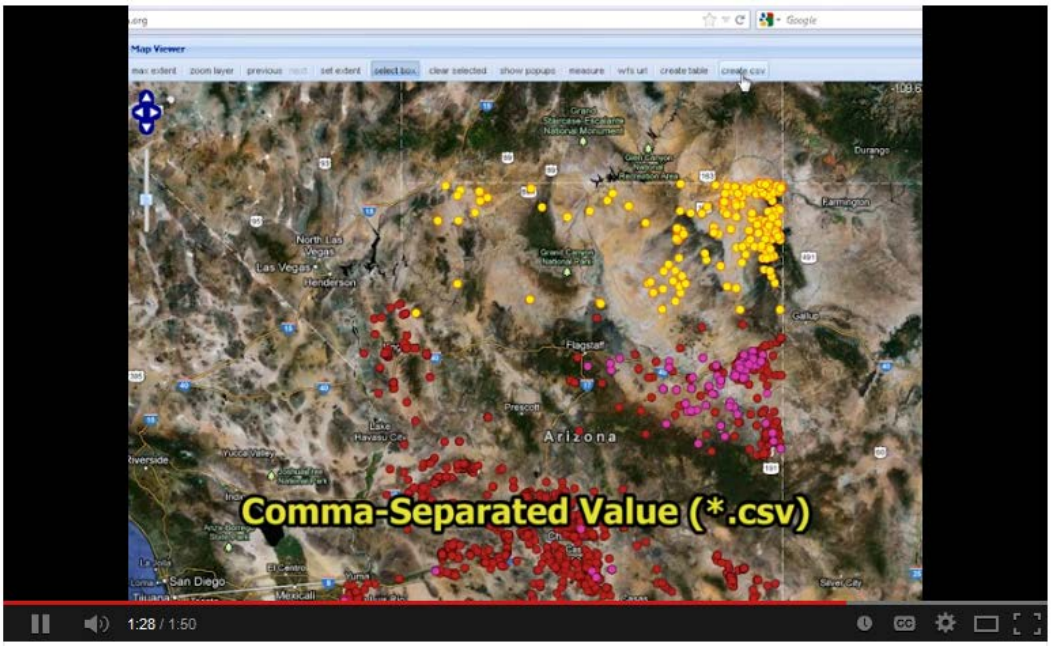


Figure 4: Screen capture of the NGDS Data Explorer video tutorial.

DATA DELIVERY APPLICATIONS & TOOLS

To assist users during the data delivery process a number of tools have been developed to simplify deployment.

1. Excel to NGDS Service, https://github.com/usgin/ExcelToNGDSServiceTool
2. XSD to GeoXML Converter, https://github.com/usgin/XSDtoGeoXMLConverter
3. URI Redirection Engine, https://github.com/usgin/uriredirect
4. Well Log Data Tools, https://github.com/usgin/WellLogDataTools
5. Service Notifications, https://github.com/usgin/service-notifications

The Excel to NGDS Service Tool validates and converts a spreadsheet in an NGDS Excel content model to a geodatabase ready to be deployed as an NGDS Service. This simplifies the process for data providers. The tool is available for ArcGIS 10.0, 10.1, and 10.2. This tool was developed by AZGS developer Jessica Good Alisdairi in May of 2013.

The XSD to GeoXML Converter converts schema (XSD) formats into mapping files for use in the GeoServer application schemas extension. The tool was developed by Jessica Good Alisdairi in June of 2013.

The URI Redirection Engine provides URI Redirection capabilities and provides the groundwork for distributed URI-resolution endpoints. The tool was developed in 2011 by Ryan Clark and continually improved upon throughout the project to fix bugs/add functionality.

The Well Log Data Tools provides a Python script for the conversion of the Borehole LAS Log Data model to a LAS 2.0 file or the conversion from a LAS 2.0 file to an entry in the Well Log Content Model, thus simplifying data entry. The tool was developed by Jessica Good Alisdairi in August of 2013.

MANAGEMENT AND OPERATIONS ACCOMPLISHMENTS

For the third year in a row, the project has received "good" or "outstanding" review comments (scores ranging from 7 to 10, with the majority as 8's and 9's) in all categories during the annual sponsor peer review.

Select comments from the review include:

- "*The volume and types of information being amassed as part of this project is of great potential value to the entire geothermal community. The focus on expressing these data in predictable, standards-based formats adds to the likely usefulness of the collection."*
- *The data approach was appropriate for the effort. The results are substantial.*
- *The loosely couple approach being used helps ensure that the various project participants can proceed according to their own constraints without significantly impacting other participants.*
- *The project has been successful because of the focus on managing it well. The state's contribution efforts were well coordinated and have produced valuable data.*
- *Adequate progress has been made on each of the sub-tasks listed in the SOPO. In several cases, it appears to have expanded beyond the originally conceived results.*

The project management tools developed for tracking deliverables and tasks are still in use. The in-house task tracking site allows technical reviewers the ability to track progress through the QA/QC process while the publicly accessible site available from the project website at stategeothermaldata.org allows project participants to track their progress as well as their data's progress through the QA/QC process. The publicly accessible site has been very successful and popular with participants and the public.

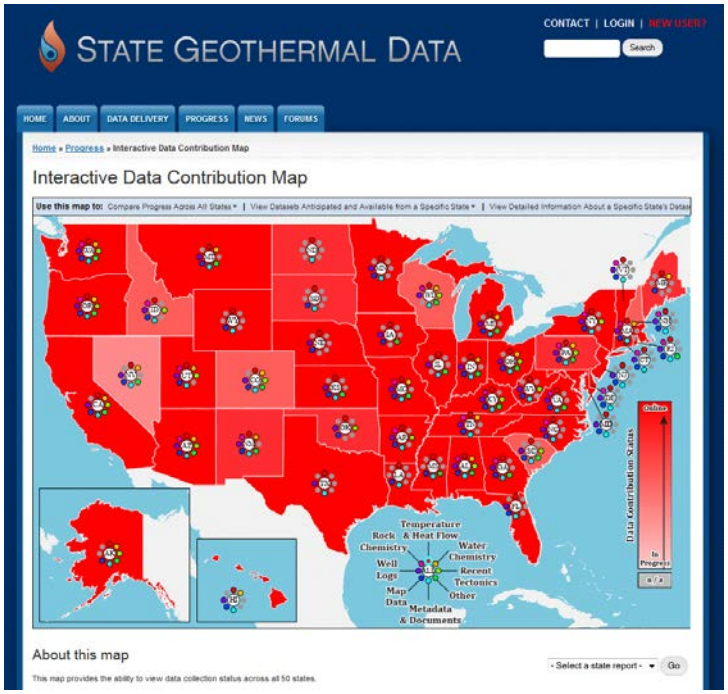


Figure 5: Interactive progress tracking map, viewing the progress of all "Temperature & Heat Flow" data.

PROJECT MEETINGS

Project members met at the Association of American State Geologist's (AASG) Annual Conference in Deadwood, SD in June of 2013. A series of events at the AASG Annual Meeting constituted the annual project meeting. These events included a plenary talk, three breakout sessions (one on digital delivery, one on the progress of the supplemental funding projects, and one on sustainability of the network), and a series of demonstrations in the common areas.

In addition, we hosted three regional workshops for technology transfer and network sustainability; additional information on the agenda with links to the presentations and topics covered is in the "Communications, Outreach, Technology Transfer" section of this report.

SCIENCE ADVISORY BOARD (SAB)

The SAB was called upon on February 7, 2013 to review the progress on subrecipients that were not far enough along in their Year 1 and 2 progress to make adequate recommendations for Year 3 during the FY12 SAB review in Austin, TX. The January event was held over the course of 3 hours and done through virtual communications using GoToMeeting. For consistency, the same reviewers were invited and included geothermal experts from DOE and Principal Investigators of other NGDS projects. This ensured de-duplication of effort and consistency between projects.

Each statement of work was reviewed using the following criteria:

1. The relevance and significance of the proposed deliverables for development of geothermal resources
2. The appropriateness and utility of the proposed delivery mechanism
3. Whether the quantity of delivered data is consistent with the funding level and reasonable estimation of the effort required to produce the proposed deliverable.

Each member of the SAB was assigned as lead for a subset of states for review; however they were all provided with the updated progress on Year 1 and Year 2 deliverables, as well as the Year 3 proposals and updated information on the amount of funds expended and requested amount for each subrecipient.

SAB members associated with a particular state were asked to recuse themselves during the review of that state (e.g. the state geologist of Washington recused himself during the review of the Washington Geological Survey proposal). By splitting the subrecipients among the core membership of the SAB, we were able to maximize the review time by allowing each member to focus on a smaller number of states. This methodology was based on a similar well-established and successful process used by the USGS and AASG in reviews of proposals for the STATEMAP component of the National Cooperative Geologic Mapping Program.

In addition, SAB members provided recommendations on quality assurance plans, duplication of efforts, and other factors as they saw fit. The SAB is guided by the "Science Advisory Board Plan" dated July 6, 2010 and included in the FY2010 annual report.

Membership:

Chair- Rick Allis, Utah Geological Survey
John Costain, Virginia Tech University
Dave Norman, Washington Geological Survey
Arlene Anderson, Department of Energy
Lisa Shevenell, Nevada Bureau of Mines and Geology
Chacko John, Louisiana Geological Survey

Invited Guests:
Dave Blackwell, Southern Methodist University
John Ziagos, Lawrence Livermore National Lab
Colin Williams, U.S. Geological Survey

Conclusions of the event were that:

1. Overall the project is progressing well
2. All but one project was to progress on to Year 3

MANAGEMENT ADVISORY BOARD

The MAB was briefed at the Association of American State Geologists Annual Meeting in Deadwood, South Dakota.

COLLABORATION

- Federal Open Data Policy – in February of 2013, the White House Office of Science and Technology Policy issued a Memorandum for the Heads of Executive Departments and Agencies on "Increasing Access to the Results of Federally Funded Scientific Research." Following this Memo in May of 2013 an Executive Order, "Making Open and Machine Readable the New Default for Government Information," and an Office of Management and Budget Memo on implementing the new Open Data Policy. These policies call for open source distributions, metadata management, scalability, and interoperability. NGDS, and its underlying framework, USGIN, meet or exceed these requirements and as such, we are working to promote NGDS as an exemplar of the Open Data Policy.
- Western Regional Partnership – AZGS hosted a day-long workshop for the WRP at the Arizona State Office Complex in April of 2013. The contract for operations of the WRP Web mapping application and GIS repository was awarded to a new vendor, Booze Allen Hamilton. AZGS PI Lee Allison briefed the WRP Principals and the new contractor on the USGIN/NGDS design and its applicability. Further briefings are planned as BAH takes on their duties.
- International GeoSample Number – we have implemented a Physical Sample content model that is compliant with the IGSN registration.
- DOE Energy/Water Nexus – AZGS presented on the NGDS to promote the underlying architecture for multiple energy related data sources, indicating that a number of the data sets are currently related to relevant data, such as oil & gas wells and water wells.
- International Ground Source Heat Pump Association – due to the AZGS efforts and presentations at the Arizona Governor's Office of Energy Policy a collaboration with the International Ground Source Heat Pump association is in negotiation. The NGDS, and particularly state contributions, includes a number or relevant GSHP data, including thermal conductivity and depth-to-bedrock maps. This project, under the auspices of the AASG also wrote letters of support to the National Renewable Energy Lab and Oak Ridge National Lab providing data for a nationwide assessment of heat pump potential.
- International Renewable Energy Association – IRENA is currently working on a global renewable energy atlas and is interested in incorporating NGDS data for the US; a meeting at the Geothermal Resources Council meeting has been scheduled.

STAFFING

AZGS maintained most of the management and technical team established over the last two years of the project. The following are updates on project staffing during the year.

- Celia Coleman, Geoinformatics Content Specialist, left the survey; her work has been distributed

between Christy Caudill-Daugherty (Lead Geoinformatics Content Specialist) and three graduate interns.

- Jessica Good Alisdairi and Adrian Sonnenschein, graduate interns during FY12, were hired as full-time employees to join the geoinformatics/developers team. Jessica has a background in Computer Sciences and built one of the map-based user-interfaces for the NGDS at data.geothermaldatasystem.org. Adrian has an environmental science background and has developed his Python coding while at the Survey through the development of a Natural Hazards Viewer; he will assist with the CKAN based search interface and Node-in-a-Box development.
- Genhan Chen, Map Services Developer, left the survey, her work has been distributed to Jessica Good Alisdairi and Adrian Sonnenschein.
- AZGS contracted with Blue Canoe Marketing LLC to provide marketing expertise on overall product development.

COMMUNICATIONS, OUTREACH, TECHNOLOGY TRANSFER

We have maintained the project website at www.stategeothermaldata.org and the associated tracking service at http://stategeothermaldata.org/content/interactive_data_contribution_map and http://services.usgin.org/track/report/. These sites continue to be a successful way of tracking deliverables from a project management standpoint as well as for the public. The newsletter functionality within the site allows us to contact specific individuals for the project including financial contacts or principal investigators; newsletters/updates are sent as needed with the goal of at least once per month.

We continue to update www.geothermaldata.org, a NGDS wide front-end Web page for the public, and plan to transfer the URL to the newly designed, CKAN based central catalog aggregator as developed by the NGDS Architecture, Design, Testing, and Maintenance Project. The current site provides details for NGDS users, data publishers, and developers; this content is being mapped to the aggregator site prior to the URL transition.

The tutorials and cookbooks available to NGDS users continue to expand, as PDF documents, online tutorials, and video tutorials. The tutorials site has been made easier to navigate at http://usgin.org/tutorials.

Overall, we continue an aggressive outreach campaign at scientific and technical meetings including participation in the leading geothermal industry conference, the joint meeting of the Geothermal Resources Council/Geothermal Energy Association. Additional outreach was conducted at the Geological Society of American Annual Meeting and American Geophysical Union Fall Meeting. In the next fiscal year we hope to continue this trend to the broader user community by engaging them directly in hands-on training events and workshops.

REGIONAL WORKSHOPS

This year we conducted three workshops across the country, focusing on the regions covered by the regional server Hubs at Illinois, Kentucky, and Nevada. The workshops are documented, with agendas and all hand-outs, at the USGIN GitHub site at: https://github.com/usgin/Workshops. The following provides a summary of each of the three workshops. The Regional Hub Workshops were coordinated by AZGS and the Nevada Bureau of Mines and Geology for the Western Regional Workshop, AZGS and the Illinois Geological Survey for the Eastern Regional Workshop, and the Virginia Division of Geology and Mineral Resources for the Southeast Workshop.

WESTERN REGIONAL WORKSHOP

The purpose of the workshop was to "demystify interoperability" and provide state geological survey users with insight into the data review/data deployment process in order to promote use of the same techniques across state geological surveys. Thus, the workshop was focused on sustaining the network by providing the individual subrecipients the tools necessary to review and deploy their own data.

The agenda included:

1. Introductions with a round table approach of how subrecipients are currently deploying data, what is working, what's not. A demonstration of the NGDS Data Explorer (http://data.geothermaldatasystem.org/) followed to demonstrate the value of interoperable data sets.
2. Sustainability discussion and the data services paradigm shift; data services are part of the survey's cost of doing business. What does it cost to run a server? Who do you need to run a server? Are there other business models? The presentation is available at https://github.com/usgin/Workshops/blob/master/WesternRegionalWorkshop/NGDSSustainability.pptx
3. Disaster Recovery using Hyper V Replication, a document on implementing this replication was produced and is available at https://github.com/usgin/Workshops/blob/master/WesternRegionalWorkshop/Hyper-V%202012%20Replication%20on%20Workgroup%20Servers.docx
4. Breakouts on virtualizing server deployment and map data. The map data breakout focused on tiers of USGIN/NGDS compliant data delivery, how institutions current efforts can be a part of the NGDS, how you can transform your existing databases into services, and a brief overview of the content models/data schemas. Slides for the breakout session are available at https://github.com/usgin/Workshops/blob/master/WesternRegionalWorkshop/BreakoutSession.pptx
5. Hands on service deployment including different methods of validating and deploying services including Excel to Post GIS, namespaces/URI redirects, deploying services using ArcGIS from ArcMap project, xml validation and testing, Geoserver deployment with app schema, and connecting to a service using a variety of softwares. A document on the Excel to NGDS services and the presentation is available at https://github.com/usgin/Workshops/tree/master/WesternRegionalWorkshop

Approximately 20 participants from UT, ID, WA, NV, NM, and ND attended the workshop help May 14, 2013 in Reno, NV.

EASTERN REGIONAL WORKSHOP

The purpose of the Eastern Regional Workshop, held at the Illinois Geological Survey on the campus of the University of Illinois Champaign-Urbana, was the same as the Western Regional Workshop. At this event, because there were more end-users, we limited the discussion on Hyper V replication and focused on data services and deployment, including a new ArcGIS validation tool (Excel to NGDS Service Tool) and the upcoming Node-in-a-Box software stack. Full documentation, including demo data, is available at https://github.com/usgin/Workshops/tree/master/EasternRegionalWorkshop.

The workshop took place July 25-26, 2013. Approximately 25 participants attended from CO, IN, IL, AR, IA, MI, AL, and KY.

SOUTHEAST WORKSHOP

The Southeast Workshop, hosted by the Virginia Division of Geology and Mineral Resources catered to a different group of project participants. Most of the states that participated in the workshop were not directly funded by the AASG State Geological Survey Contributions project. Rather, the data collection for Delaware, Georgia, Maryland, North Carolina, and Virginia were handled by the Virginia survey. Thus this was the first opportunity for representatives from these states to meet in order to discuss next steps for the data and the findings associated with the data.

The purpose of the workshop was to provide a forum for discussion between the subrecipients of the NGDS project, the status of the geothermal data contributions, data needs, and the work products that would be of value to understanding the potential for geothermal resource development in the southeastern U.S. The workshop provided a forum for participants to leave with a better understanding of the NGDS as a system as well as generate new ideas for regional initiatives and partnerships.

The agenda included presentations on data for each of the states covered in the region (NC, SC, GA, MD, DE, VA) as well as a discussion on work products like water table elevation estimates and an updated heat flow map of the region, ending with a discussion on sustainability, which included data gaps, data hosting/services, potential customers/users of the data.

Presentations from the workshop are recorded and available on the NGDS YouTube channel at http://www.youtube.com/geothermaldata.

The workshop took place August 7-8, 2013. Approximately 30 participants attended.

Figure 6: Southeast Regional Geothermal Workshop, organizer William Lassetter presenting. Photo credit: Virginia Division of Geology and Mineral Resources.

Figure 7: The NGDS booth at the American Geophysical Union Fall Meeting, San Francisco, CA. Attendance topped 22,000.

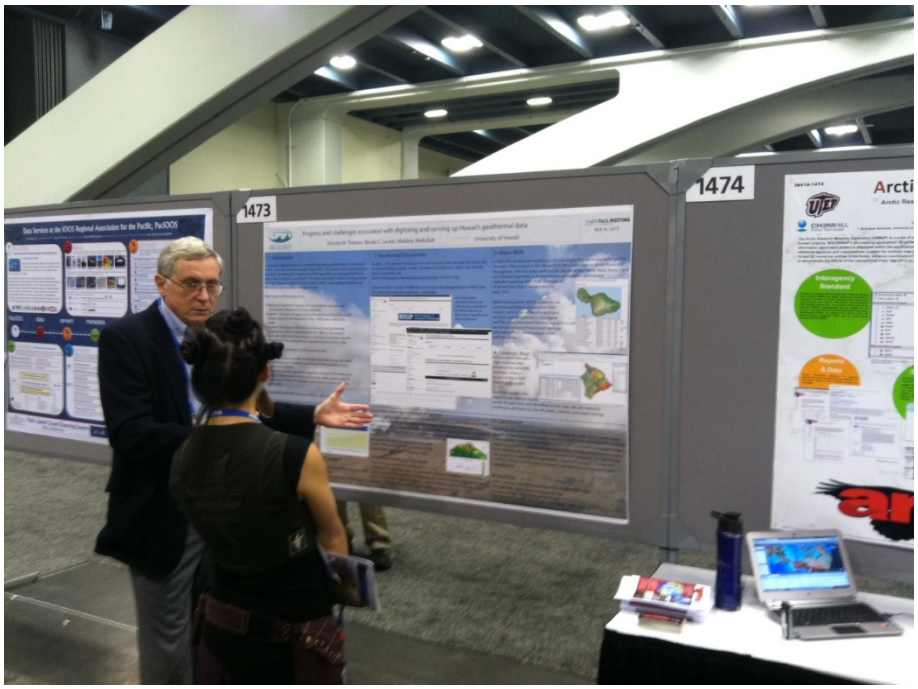


Figure 8; Don Thomas, PI for the Hawaii data collection effort explains the work and results currently taking place in Hawaii during a poster presentation at the American Geophysical Union Fall Meeting 2012 in San Francisco.

PUBLICATIONS

Allison, M. Lee, Richard, Stephen M., Clark, Ryan C., Patten, Kim, Love, Diane S., Coleman, Celia, Chen, Genhan, Matti, Jordan, Day, Janel, Pape, Esty, Musil, Leah, Caudill, Christy, 2012, "A Geothermal Data System for Exploration and Development," Geothermal Resources Council *Transactions*, Geothermal Resources Council Annual Meeting, Reno, Nevada, September 30-October 3, 2012.

Blackman, Harold, Boyd, Suzanne, Patten, Kim, and Zheng, Sam, "NGDS User Centered Design – Meeting the Needs of the Geothermal Community," Proceedings of the 38th Stanford Geothermal Workshop on Reservoir Engineering, Stanford, California, February 11, 2013.

Anderson, Arlene, Blackwell, David, Chickering Cathy, Boyd, Toni, Horne, Roland, MacKenzie, Matthew, Moore, Joe, Nickull, Duane, Richard, Stephen, Shevenell, Lisa, "National Geothermal Data System (NGDS) Geothermal Data Domain: Assessment of Geothermal Community Data Needs," Proceedings of the 38th Stanford Geothermal Workshop on Reservoir Engineering, Stanford, California, February 11, 2013.

Clark, Ryan, Kuhmuench, Christoph, Richard, Stephen, "NGDS Node Deployment Adoption of CKAN for Domestic and International Data Deployment," Proceedings of the 38th Stanford Geothermal Workshop on Reservoir Engineering, Stanford, California, February 11, 2013

Patten, Kim (editor), "National Geothermal Data System: Transforming the Discovery, Access, and Analytics of Data for Geothermal Exploration: Compendium of Papers from the 38th Workshop on Geothermal Reservoir Engineering." Arizona Geological Survey Open File Report 13-06, 2013, http://repository.azgs.az.gov/uri_gin/azgs/dlio/1502.

Allison, M. Lee, Richard, Stephen M. 2013 "State Geological Survey Contributions to the National Geothermal Data System [2012 Annual Report]," OFR 13-11, http://repository.azgs.az.gov/uri_gin/azgs/dlio/1528

PRESENTATIONS

TALKS

Allison, M Lee, Richard, Stephen M., Clark, Ryan C., Patten, Kim J., Love, Diane S., Coleman, Celia, Chen, Genhan, Matti, Jordan, Day, Janel, Pape, Esty, Musil, Leah, and Caudill, Christy, "A Geothermal Data System for Exploration and Development," October 1, 2012 [paper and oral presentation].[2]

Allison, M. Lee, and Genevieve Pearthree, "Gathering Community Input on Governance for EarthCube," EarthCube End-user Domain Workshop for EarthScope, Arizona State University, Tempe, AZ, October 29, 2012 [poster].

Allison, M. Lee, Stephen M. Richard, Ryan Clark, Kim J. Patten, Diane S. Love, Christy Caudill, Celia Coleman, Jordan Matti, Janel Day, Genhan Chen, Leah Musil, "National Geothermal Data System: State Geological Survey Contributions to Date," Geological Society of America Annual Meeting, Charlotte, NC, November 6, 2012.

[2] Received Geothermal Resources Council Annual Meeting Best Presentation Award

Kim Patten; M L. Allison; Stephen M. Richard; Ryan Clark; Diane Love; Celia Coleman; Christy Caudill; Jordan Matti; Leah Musil; Janel Day; Genhan Chen, "National Geothermal Data System: State Geological Survey Contributions to Date," American Geophysical Union Fall Meeting, San Francisco, December 3, 2012 [oral].

Van Daalen, Tirza, and M. Lee Allison (presenter), "OneGeology – a geoscience exemplar for worldwide cyberinfrastructure capacity-building and scientific innovation," American Geophysical Union Fall Meeting, San Francisco, December 4, 2012 [poster].

Allison, M. Lee, Co-convenor, American Geophysical Union Fall Meeting, Union Session, "Towards a Global Cyberinfrastructure for the Geosciences," December 5, 2012 [oral].

Stephen M. Richard; Interoperability Working Group Commission for the Management and Application of Geoscience Information, IUGS, "GeoSciML and EarthResourceML Update, 2012," American Geophysical Union Fall Meeting, San Francisco, December 5, 2012 [poster].

Nils Moosdorf; Stephen M. Richard, "A Lithology Based Map Unit Schema For Onegeology Regional Geologic Map Integration," American Geophysical Union Fall Meeting, San Francisco, December 7, 2012 [poster].

Blackman, Harold, Boyd, Suzanne, Patten, Kim, and Zheng, Sam, "NGDS User Centered Design – Meeting the Needs of the Geothermal Community," 38th Stanford Geothermal Workshop on Reservoir Engineering, Stanford, California, February 11, 2013.

Anderson, Arlene, Blackwell, David, Chickering Cathy, Boyd, Toni, Horne, Roland, MacKenzie, Matthew, Moore, Joe, Nickull, Duane, Richard, Stephen, Shevenell, Lisa, "National Geothermal Data System (NGDS) Geothermal Data Domain: Assessment of Geothermal Community Data Needs," 38th Stanford Geothermal Workshop on Reservoir Engineering, Stanford, California, February 11, 2013.

Clark, Ryan, Kuhmuench, Christoph, Richard, Stephen, "NGDS Node Deployment Adoption of CKAN for Domestic and International Data Deployment," 38th Stanford Geothermal Workshop on Reservoir Engineering, Stanford, California, February 11, 2013.

Allison, Lee, "An NGDS model for Canada," CanGEA (Canadian Geothermal Energy Association) Annual Meeting, Calgary, Canada, March 21, 2013.

Richard, Stephen, "Future of Canadian & Global Databases," panel discussion, CanGEA (Canadian Geothermal Energy Association) Annual Meeting, Calgary, Canada, March 21, 2013.

Richard, Stephen, "Mapping & Database Workshop," CanGEA (Canadian Geothermal Energy Association) Annual Meeting, Calgary, Canada, March 21, 2013.

Allison, M. Lee, "The National Geothermal Data System: A National Sustainabile, Distributed, interoperable Data Network," Research Data Access & Preservation Summit 2013, Baltimore, MD, April 4, 2013.

Richard, Stephen M., Clark, Ryan, Chen, Genhan, and Anderson, Arlene, "U.S. National Geothermal Data System: Web Feature Services and System Operations," European Geophysical Union General Assembly, Vienna, Austria, April 8, 2013 (presented by Kim Patten)

Allison, M. Lee, "NGDS Overview," seminar, Cornell Energy Institute & Atkinson Center for a Sustainable Future, Cornell University, Ithaca, NY, May 1, 2013

Allison, M. Lee, "The Digicene: the Age of Digital Geosciences," Cornell University Geological

Sciences Lecture Series, Ithaca, NY, May 1, 2013

Clark, Ryan, Genhan, Chen, Kuhmuench, Christoph, “An Open Source Stack for the National Geothermal Data System,” Free and Open Source Software for Geospatial North America (FOSS-4G), Minneapolis, MN, May 22, 2013.

Richard, Stephen M. “Terminology Development to Support Geoscience Information Interoperability: the CGI Geoscience Terminology Working Group,” IUGS Commission for Management of Geoscience Information (CGI) GeoSciML and GTWG workgroup meetings plenary session, St. Petersburg, Russia, June 1, 2013.

Clark, Ryan, “Faster, More Responsive Web GIS: Three technologies to watch,” Digital Mapping Techniques Conference, Denver, CO, June 3, 2013.

Day, Janel, “Integrating GeoSciML with OneGeology,” Digital Mapping Techniques Conference, Denver, CO, June 4, 2013.

Allison, M. Lee, “National Geothermal Data System – An AASG Success Story,” Association of American State Geologists Annual Meeting, Plenary Session, Deadwood, SD, June 10, 2013.

Allison, M. Lee, moderator, “Web Accessibility Strategies,” Association of American State Geologists Annual Meeting, Breakout Session, Deadwood, SD, June 10, 2013.

Allison, M. Lee, “NGDS Project Annual Meeting: Sustainability and Additional Funding Options,” Association of American State Geologists Annual Meeting, Breakout Session, Deadwood, SD, June 11, 2013.

Patten, Kim, “NGDS User Interface,” Association of American State Geologists Annual Meeting, Breakout Session, Deadwood, SD, June 11, 2013.

Allison, M. Lee, “Arizona Geothermal Energy Potential,” Arizona Master Energy Task Force, Natural Resources and Land Use Work Group, Phoenix, AZ, July 10, 2013.

Richard, Stephen M., “Machine actionable links: a hypermedia format for data,” Breakout session, ESIP Summer Meeting, Chapel Hill, North Carolina, July 12, 2013.

Richard, Stephen M., “National Geothermal Data System,” Breakout session, ESIP Summer Meeting, Chapel Hill, North Carolina, July 12, 2013.

BRIEFINGS

Allison, M. Lee, “Energy/Water Datasets and Models Workshop”, U.S. Department of Energy, National Renewable Energy Lab, GoToMeeting, November 28, 2012.

Allison, M. Lee, “AASG State Geological Survey Contributions to the NGDS,” U.S. Department of Energy, Geothermal Technologies Office Annual Peer Review, Denver, CO, April 22, 2013.

Patten, Kim, “Arizona’s Geothermal Energy Potential and the NGDS,” Governor’s Office of Energy Policy’s Geothermal Energy Workshop IV, Phoenix, AZ, May 2, 2013.

Allison, M. Lee, “NGDS Sustainability Briefing,” Geothermal Resources Council Board of Directors, Las Vegas, NV, September 28, 2013.

CONFERENCE EXHIBITS

Geothermal Resources Council Annual Meeting, Reno, NV, September 30- October 3, 2012. [Exhibited the new data search tool, new NGDS website, and new data collection from UT]

Geological Society of America Annual Meeting, Charlotte, NC, November 4-7, 2012.

American Geophysical Union Fall Meeting, San Francisco, CA, December 3-7, 2012.

"Geothermal Energy in Arizona: the role of the National Geothermal Data System," Science in the City, Tech in Tucson Showcase, Tucson Electric Power Headquarters, Tucson, AZ, February 16, 2013.

U.S. Department of Energy, Geothermal Technologies Office Annual Peer Review, Denver, CO, April 22-24, 2013.

American Association of Petroleum Geologists (AAPG) Annual Meeting, Pittsburgh, PA, May 19-22, 2013.

WEB PRESENTATIONS

AZGS, "Updated Data Delivery Tools for AASG NGDS," October 4, 2012.

Allison, M. Lee, "The National Geothermal Data System and the Energy-Water Nexus," Energy/Water Datasets and Models Workshop, U.S. DOE, Virtual, November 28, 2012.

Allison, M. Lee, Caudill, Christy, Patten, Kim, "The National Geothermal Data System," Arizona Mining Review, Livestream, Tucson, AZ, May 31, 2013. http://www.youtube.com/watch?v=TpAPvJ7E-Rs

Allison, M. Lee, moderator, "Web Accessibility Strategies," Association of American State Geologists Annual Meeting, Breakout Session, Deadwood, SD, June 10, 2013. LiveStream & YouTube. http://www.youtube.com/watch?v=_rggaq-hCs8&feature=share&list=UU8wP7yOz8_ebyNkSoUGmdSg

Caudill-Daugherty, Christy, "Excel to NGDS Conversion," US DOE Geothermal Technologies Office Lunch and Learn Seminar, Washington DC, August 2, GoToMeeting

WORKSHOPS

Arizona Governor's Office of Energy Policy, "Geothermal Workshop," Phoenix, AZ, May 2, 2013.

AZGS, "AASG NGDS Western Regional Hub," Reno, NV, May 14, 2013.

AZGS, "AASG NGDS Eastern Regional Hub," Champaign-Urbana, IL, July 25-26, 2013.

NGDS Southeast Regional Workshop, hosted by the Virginia Department of Mines, Minerals, and Energy, Charlottesville, VA, August 7-8, 2013.

NEWS INTERVIEWS AND OTHER GENERAL INTEREST ARTICLES

Geothermal Energy Association's Geothermal Energy Weekly, "National News: National Geothermal Data System Aggregates Nationwide Info on Wells," Week of December 6, 2012.

Patten, Kim, "Success Stories from the National Geothermal Data System," *Arizona Geology Magazine*, December 2012, http://azgeology.azgs.az.gov/article/geothermal/2012/12/success-stories-national-geothermal-data-system.

Associated Press, "Oregon's Geothermal Resources on Display in New Online Interactive Map," February 12, 2013, http://www.oregonlive.com/environment/index.ssf/2013/02/oregons_geothermal_resources_o.html.

Anderson, Arlene, "Pinpointing America's Geothermal Resources with Open Source Data," Energy.gov, January 3, 2013, http://energy.gov/articles/pinpointing-america-s-geothermal-resources-open-source-data.

University of Idaho News, "Idaho Geological Survey and U-Idaho Explore for Geothermal Energy," January 10, 2013, http://www.uidaho.edu/newsevents/item?name=idaho-geological-survey-and-u-idaho-explore-for-geothermal-energy and EERE GTO http://www1.eere.energy.gov/geothermal/news_detail.html?news_id=18923.

KTVZ News Sources, "Spotlight on Oregon's Geothermal Potential," KTVZ, February 24, 2013, http://www.ktvz.com/news/Spotlight-on-Oregon-s-geothermal-potential/-/413192/19066336/-/1lw7lnz/-/index.html.

Ferguson, William, "New Geothermal Data System Could Open Up Clean-Energy Reserves," *Scientific American,* February 25, 2013, http://www.scientificamerican.com/article.cfm?id=new-geothermal-data-system.

Geothermal Energy Association, "Geothermal Energy Weekly," March 1, 2013, http://geo-energy.org/Newsletter/2013/Geothermal%20Energy%20Weekly%20March%201%202013.pdf?utm_source=March+1+GEW&utm_campaign=March+1+GEW&utm_medium=email.

Arizona Public Media, *Arizona Illustrated*, "Tracking Geothermal Energy Sources," Tucson, AZ, May 7, 2013, https://ondemand.azpm.org/p/segments/2013/5/7/24206-tracking-geothermal-energy-sources/

North American Clean Energy, "The National Geothermal Data System," July/August 2013, http://www.nacleanenergy.com/articles/16454/the-national-geothermal-data-system

Pratt, Sarah E., "Digitizing Earth: Developing a Cyberinfrastructure for the Geosciences," EARTH Magazine, a publication of the American Geosciences Institute, September, 2013, http://www.earthmagazine.org/tags/september-2013 [cover story].

SUBRECIPIENT PRESENTATIONS AND NEWS INTERVIEWS

Tutolo, Benjamin M., and Saar, Martin O., "Geothermal Energy in Minnesota: Revised Prospects Based on Heat Flow Measurements." Midwest Ground Water Conference, October 1-3, 2012 (Minnesota Geological Survey).

Oberbeck, Steven, "Big Source of Power Looming in Desert?" *Salt Lake City Tribune*. September 28, 2012 (article on the Utah Geological Survey Supplemental Funding Project). A video based on this article and report was created by UGS and shown at the Geothermal Resources Council; it will also be shown at the Geological Society of America meeting. (Utah Geological Survey).

Allis, Rick, et al., "Stratigraphic Reservoirs in the Great Basin – the Bridge to Development of Enhanced Geothermal Systems in the U.S." Geothermal Resources Council Annual Meeting in Reno, NV. September 29-October 3, 2012 (Utah Geological Survey).

Hardwick, C. and Chapman, D. "Geothermal Resources in the Black Rock Desert, Utah: MT and Gravity surveys," Geothermal Resources Council Annual Meeting in Reno, NV. September 29-October 3, 2012 (Utah Geological Survey).

Crowell, Anna, Ochsner, Aaron, Gosnold, Will, "Correcting Bottom-Hole Temperatures in the Denver Basin, Colorado and Nebraska," Geothermal Resources Council, Transactions 2012, 11pp. Geothermal Resources Council Annual Meeting in Reno, NV. September 29-October 3, 2012 (University of North Dakota).

Majorowicz, Jacek; Gosnold, Will; Gray, Allan; Safanda, Jan; Klenner, Rob; and Unsworth, Martyn. "Implications for Post-Glacial Warming for Northern Alberta Heat Flow - Correcting for the Underestimate of the Geothermal Potential," Geothermal Resources Council Trans. Geothermal Resources Council Annual Meeting in Reno, NV. September 29-October 3, 2012 (University of North Dakota).

Gosnold, Will, McDonald, Mark, Klenner, Robert, Merriam, Daniel, "Thermostratigraphy of the Williston Basin," Geothermal Resources Council Transactions, 2012, 21 pp. 2012, 21 pp. Geothermal Resources Council Annual Meeting in Reno, NV. September 29-October 3, 2012 (University of North Dakota).

Kolomitz, Christopher, "New Geothermal Discovery made in Utah," Energize Weekly Newsletter, October 10, 2012.

Clough, Jim, "Opportunities for Energy and Geothermal Resources on the Seward Peninsula." October, 2012 (Alaska Geological Survey).

Clough, Jim, "Presentation to the Nome City Council on Energy Opportunities." November, 2012 (Alaska Geological Survey).

Rhodes, J. Michael, Koteas, Christopher, Mabee, Stephen, Thomas, Margaret, Gagnon, Teresa, "Heat Production as a Tool in Geothermal Exploration," December 3, 2012, American Geophysical Union Fall Meeting (Massachusetts Geological Survey, Connecticut Geological Survey).

Crowell, Anna M, and Gosnold, William D., "Available Thermal Energy in the Denver Basin Dakota Group: Colorado and Nebraska," December 3, 2012, American Geophysical Union Fall Meeting (University of North Dakota).

James Crowell and William D. Gosnold, "Using a Divided Bar Apparatus to Measure Thermal Conductivity of Samples of Odd Sizes and Shapes," December 3, 2012, American Geophysical Union Fall Meeting (University of North Dakota).

Gosnold, William D. and Crowell, Anna M., "Synthesis of Bottom Hole Temperatures and Heat Flow Data," December 3, 2012, American Geophysical Union Fall Meeting (University of North Dakota).

Naylor, Shawn, Gustin, Andrew R., Ellett, Kevin M., "Quantifying the Influence of Near-Surface Water-Energy Budgets on Soil Thermal Properties Using a Network of Coupled Meteorological and Vadose Zone Instrument Arrays in Indiana, USA," December 5, 2012, American Geophysical Union Fall Meeting (Indiana Geological Survey).

Thomas, Donald M., Lautze, Nicole C., and Abdullah, Mahany, "Progress and challenges associated with digitizing and serving Hawaii's geothermal data," December 6, 2012, American Geophysical Union Fall Meeting (University of Hawaii Manoa).

Trabish, Herman, "Geothermal's Big 12 Events of 2012,"Seeking Alpha, December 18, 2012, http://seekingalpha.com/article/1071191-geothermal-s-big-12-events-of-2012. (Utah Geological Survey

work featured as number 7).

World Wide Geothermal Resource, “Has Utah Discovered a New Source of Geothermal Energy?” December 2012, Volume 3, Number 12, pg. 10.

World Wide Drilling Resource, “Utah Explores New Type of Geothermal Resource,” February 2013, Volume 10, Number 2, pg. 36.

Iowa Geological Survey, "Brown bag on geology and geohydrology of ground source heat pump development in Iowa” to Iowa Geological and Water Survey staff, December, 2012.

Iowa Geological Survey, “Geology of Heat Pumps” Presentation to Cedar Valley Rock and Mineral Society, December, 2012.

Bowman, Jeff, “Washington State Contribution to the NGDS,” USGS Oregon Water Science Center, Portland, OR, January 8, 2013. (Washington Geological Survey).

Barnard, Jeff, “Interactive map shows Oregon’s geothermal resources,” Associated Press, February 13, 2013. http://www.katu.com/news/local/Interactive-map-shows-Oregons-geothermal-resources-191044801.html (Oregon Geological Survey).

Gwynn, Mark, "New Geothermal Resource Delineated Beneath Black Rock Desert, Utah,” 38th Stanford Geothermal Workshop on Reservoir Engineering, Stanford, California, February 11-13, 2013. (Utah Geological Survey).

Allis, Rick, "Characterizing the power potential of hot stratigraphic reservoirs in the Great Basin, U.S." 38th Stanford Geothermal Workshop on Reservoir Engineering, Stanford, California, February 11-13, 2013. (Utah Geological Survey).

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Welhan, John, Garwood, Dean, Feeney, Dennis, *"*The Blackfoot Volcanic Field, Southeast Idaho: A Hidden High-T Geothermal Resource Revealed Through Data Mining of the National Geothermal Data Repository*,"* Geothermal Resources Council Annual Meeting, Las Vegas, NV, September 30, 2013. (Idaho Geological Survey)

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SCHEDULE, MILESTONES, AND STATUS

The primary goal for fiscal year 2014 is to complete the data collection and deployment for legacy and new data. We also plan to improve documentation of the system as a whole, due to the advances in architecture and design as well as conduct additional outreach to industry and end-users. Finally, we plan to finalize our hub maintenance plan to ensure continued support for the data stored at the hubs.

PLANS FOR FY 2014

The following are highlights and milestones for FY 2014:

- October – Present project at the Geothermal Resources Council/Geothermal Energy Association Annual meeting as a paper, an exhibit booth, and through an end-user workshop. This was the first time there was a coordinated presence of the NGDS at the GEA Expo, in previous year's the State Contributions and NGDS booths were separate.
- November – Present the project in association with the AASG at the Geological Society of America Annual Meeting in Denver, CO, focusing on NGDS as an exemplar of the Federal Open Data Policy. Remind subrecipients of the December deadline. Establish non-profit corporation, USGIN, for maintenance and sustainability. Set up service notifications feed for data services.
- December – Exhibit and demonstrate the NGDS and give technical presentations at the American Geophysical Union Fall Meeting in San Francisco, CA, December 9-13, 2013. Process and review the majority of state's final submissions. Request no-cost extension.
- January – Promote NIAB to the State Geological Surveys; continue processing data; schedule final Hub Meeting; schedule and plan industry event; transfer www.geothermaldata.org URL to CKAN site.
- February – Participate in the Stanford Geothermal Workshop; host final Hub Meeting; continue planning industry event, ensuring all invitations are sent.
- March – Host industry event, preferably in Reno, NV (industry hub). Testing and debugging data and metadata in production system.

- April – Finish project, including all data collection processed and deployed, sustainability plan in place.

If the no-cost extension is successful, we plan to deploy at least 6 Node-in-a-Box (NIAB) installations across the State Geological Surveys and 2 additional NIAB in external partners.

COST STATUS

As of September 30, 2013 the project has expended $16,947,778.06. To date a total of $439,078.94 in cost share has been reported; exceeding our cost share commitment by $180,181.94.

We have requested a no-cost extension in order to accomplish the goal of implementing the Node-in-a-Box software stack created under the NGDS Architecture, Design, Testing, and Maintenance Project. This is further explained in the "Actual or Anticipated Problems or Delays" section.

ARRA JOBS REPORTING

As reported by the subrecipients, the jobs created or saved have steadied over the past year to an average of 49.73 over the reporting year. We expect this number to remain steady for the first quarter of 2014 and then decline as the project concludes. The following table reflects reported jobs.

Reporting Quarter with Period	Jobs Created or Saved
Q1 (Oct – Dec 2012)	48.10
Q2 (Jan – March 2013)	49.32
Q3 (April – June 2013)	49.47
Q4 (July – Sept 2013)	52.01

Positions created or saved under this award include professional and technical positions in the sciences and computer programming as well as financial and administrative. In addition a number of workforce development positions have been created to educate and train the next generation of scientists.

The following contains a representative sample of the positions reported as created or saved during FY 2013:

- Analyst
- Assistant Chief
- Associate Research Geologist
- Computer Software Engineer
- Contract Labor
- Data Specialists
- Database Administrators
- Electronic Design Coordinator
- Environmental Scientist
- Environmental Technician
- Executive Officer
- Geoinformatics Content Specialist
- Geologic Program Manager
- Geological Technicians
- Geologist I
- Geologist II
- Geologist III
- Geologist IV
- Geologist V
- Geologist in Training
- Geologists
- Geotechnician
- GIMS Database Administrator
- GIS Analyst
- GIS Specialist
- GIS Technician
- Graduate Research Assistant

- Hydrogeologist
- Information Manager/Specialist
- Intern
- Lab Technician
- Librarian
- Natural Resource Scientist
- Petroleum Geologist
- Physical Scientist/Researcher
- Post-Doctoral Associate
- Principal Senior Geophysicist
- Principal Senior Petroleum Geologist
- Program Director
- Programmer
- Professor
- Publications Editor
- Research Associate
- Research Geologist
- Research Scientist
- Scientist
- Senior Cartographer
- Senior Geoinformatics Specialist
- Senior Geologist
- Senior Scientist
- Senior Systems Administrator
- State Geologist\
- Supervising Environmental Engineer
- Supervising Environmental Specialist
- Technical Assistant
- Technology Transfer Specialist
- Web Administrator
- Web Applications Developer

ACTUAL OR ANTICIPATED PROBLEMS OR DELAYS

We have been able to resolve most subrecipient delays by extending the project deliverables to December 31, 2013. A few projects are extending further than the December date due to extraneous circumstances, for example, one survey accepted the data collection responsibilities of another state that was unable to participate in early FY13 while another survey was dissolved and absorbed by a University which caused an administrative delay. We have been able to accommodate these requests due to the fact that the majority of surveys have delivered their products on time and our task backlog has been reduced.

There was one additional delay due to the National Environmental Policy Act (NEPA) clearance for a supplemental funding drill project. However, this delay was due to the fact that a new, higher-priority, drill site became available and thus, negated much of the original clearance work. Therefore, new site assessments were required. This clearance occurred in late summer of 2013 and drilling commenced in late FY13/early FY14.

Due to the NGDS Architecture, Design, Testing, and Maintenance Project reboot at BSU last year, significant progress has been made on the Node-in-a-Box (NIAB) open source software stack, developed to ease deployment and hosting of web services. However, the NIAB is scheduled for release in January of 2014, past the date most state surveys will have completed their deliverables. The NIAB will be critical to the maintenance and sustainability of the NGDS as it provides a fairly quick and inexpensive mechanism for data deployment in NGDS compliant services. Thus, it allows for additional data stewardship and ownership. We have asked for a no-cost extension through December 31, 2014 in order to deploy the NIAB to at least 6 state geological surveys that could act as their own node in the network; thus reducing the necessity for regional server hubs for data storage and deployment. If the extension is granted, the following Schedule and Milestones are proposed:

> January, 2014 – promote the finalized documentation and software stack to the SGS for implementation; contact the targeted SGS to ensure their interest in participation
>
> Selection criteria for the targeted SGS include: geothermal potential; relevant data holdings; and at least 2 prototypes each from states with high technology competency, mid-range competency, and limited competency. Selection will occur through a review panel with the project's Science Advisory Board and Management Advisory Board in consultation with the project PI and DOE

Program Officer.

February, 2014 – confirm participation of targeted NIAB states; a minimum of 6 NIAB installations will occur, with a target of 10 NIAB installations across the country by the end of the 2014

March through June, 2014 – assist with the implementation and transfer of data holdings from hubs to individual SGS

July through October, 2014 – document and troubleshoot issues that occur with the NIAB and frequent usage, including updates to the data; conduct additional outreach to potential end-users of NIAB

October through December, 2014 – encourage at least 2 additional installations of NIAB, preferably in the private sector with demonstrated success in the SGS

STATEMENT OF PROJECT OBJECTIVES STATUS OF TASKS AND MILESTONES

The Purpose, Approach, Milestone, and Outcome are directly from the projects Statement of Project Objectives (SOPO). Status updates are as of September 30, 2012. Future goals are reflected in the Plans for FY2013 section.

PHASE 1 – DATA RETRIEVAL, COLLECTION, DEVELOPMENT, AND QUALITY ANALYSIS

Task 1. RDC and QA vision
Purpose: Specify how this project will advance and dovetail with ongoing NGDS design, testing, and management
Approach: Meet with NGDS Boise State project team to plan coordination between the data acquisition activities of this project and NGDS system development.
Milestone: Meetings and conference calls of project managers and developers from Boise State NGDS project and AASG NGDS project to plan project coordination.
Outcome: A coordinated approach and vision for NGDS development.

STATUS: AZGS participates in all scheduled NGDS project wide meetings, including the Geothermal Data System Development & Population Working Group (GDSDPWG). We continue to work with and coordinate with other projects within the NGDS portfolio, such as the Geothermal Data Repository, to ensure system-wide coordination.

Task 2. Data Retrieval, Collection, and Development
Purpose: Consistently identify, add, collect, and document data from participants to the NGDS
Approach: The Project's Science Advisory Board (SAB) will serve as a peer review panel to evaluate and make recommendations on the data types, amounts, and priorities for deliverables on an annual basis for each Project participant.
Milestone: The SAB will review and recommend approval or changes to each participant's Scope of Work for each year of the project. Each subcontractor will be expected to deliver at least one data product for each Phase One cycle in which they receive funding. Bring IT specialists aboard at beginning of Phase I to manage the servers and provide support to participants.
Outcome: Appropriate prioritization of each participant's contributions to NGDS.

STATUS: Annual milestone complete with the mid-year review of subrecipient progress. All Year 1 and Year 2 data submitted and finalized, most states are finalizing their Year 3 data in the first quarter of FY14.

> Subtask 2.1 Determining amounts and types of data that will be made available
> *Purpose:* To identify the types of data most relevant to the geothermal resources in each state, prioritize that to be added to NGDS, and establish annual deliverables and milestones for subcontractors.
> *Approach*: Each state will identify the types of data most in demand or most critical to identifying and characterizing its geothermal resources by cataloguing its data resources, and submitting a statement of work to the Science Advisory Board for review and approval at regular intervals. This Scope of Work will explicitly identify deliverables and milestone for the subsequent work period.
> *Milestone:* Submission of Scope of Work listing the amounts and types of data proposed for digitization and inclusion. At regular intervals, submission of deliverable products is a prerequisite for submission of a Scope of Work for the work period.
> *Outcome:* State-by-state determination of data priorities to support local situations, milestones and deliverables as metrics for subcontractor performance.
>
> STATUS: Annual Milestone Complete. We continually to work with data providers to ensure all relevant data is provided.

Subtask 2.2 Collection, digitization, and indexing of “legacy” data
Purpose: Digitize existing priority data to add to state-based data bases.
Approach: Each state will digitize data, beginning with their highest priorities developing metadata as they do so and populate state-based data bases. AZGS will coordinate data structures to promote compatibility between data from different states.
Milestone: Data will be added incrementally and continually. Specific product delivery schedules will be based on SAB-established priorities and the size and complexity of targeted data.
Outcome: Populating of state data bases with the most at risk or important data.

STATUS: Ongoing. All states are required to submit data on an annual basis and encouraged to do so more frequently as data are compiled and available. Our geoinformatics content specialists and graduate interns continue to work through the data backlog and tasks on task.usgin.org site (internal task tracking site).

Subtask 2.3 Documenting and adding digital data bases to the NGDS
Purpose: Add existing digital data to the NGDS with appropriate metadata
Approach: Expose existing digital data bases to the NGDS or convert obsolete digital databases to data schema and formats suitable for incorporation in to NGDS, based on priorities established by the Science Advisory Board.
Milestone: Digital databases will be converted and/or documented incrementally and continually. Specific product delivery schedules will be based on SAB-established priorities and the size and complexity of targeted data.
Outcome: Preservation and addition of digital data to the NGDS and conversion of at-risk digital data for inclusion in NGDS.

STATUS: Ongoing. The WRP contractors for the GIS repository and Web map viewer, ManTech, were temporarily furloughed in Fall, 2013 due to federal budget sequestration. Upon return, the contract renewal was awarded to Booze Allen Hamilton. The WRP part of the national contract is small and BAH was briefed on the agreement between WRP and USGIN. The WRP Principals reaffirmed their commitment to the MOU and the current work plan to integrate the WRP GIS repository as a node on USGIN/NGDS. AZGS offered additional training to BAH to get them familiar with NGDS design and operations. Metadata was successfully harvested from the USGS ScienceBase, but the metadata do not include bounding boxes or location keywords and have not been published through the NGDS catalog awaiting more complete geolocation information. We have scheduled a meeting with the IRENA (International Renewable Energy Agency) to incorporate geothermal data into their Global Atlas; we will pursue this partnership in FY14.

Subtask 2.4 Collection of new data
Purpose: Make new measurements calculations, and interpretations, and collect samples.
Approach: Each state will assess the extent, usefulness, and nature of data to determine what gaps are most critical to fill.
Milestone: Data will be collected incrementally and continually. Specific product delivery schedules will be based on SAB established priorities and the size and complexity of targeted data.
Outcome: New data will lead to derived geothermal gradients, heat flow, thermal conductivity, radioactive heat production numbers, and other geothermal relevant data as necessary in areas where such data are inadequate or lacking.
This subtask will include new data contributions from the following:

- Subtask 2.4 (A) Wisconsin: See general Subtask 2.4 description above.
- Subtask 2.4 (B) New Mexico: See general Subtask 2.4 description above.
- Subtask 2.4 (C) Washington: See general Subtask 2.4 description above.
- Subtask 2.4 (D) Indiana: See general Subtask 2.4 description above.
- Subtask 2.4 (E) West Virginia: See general Subtask 2.4 description above.
- Subtask 2.4 (F) Oklahoma: See general Subtask 2.4 description above.

- Subtask 2.4 (G) Massachusetts: See general Subtask 2.4 description above.
- Subtask 2.4 (H) Connecticut: See general Subtask 2.4 description above.
- Subtask 2.4 (I) Vermont: See general Subtask 2.4 description above.
- Subtask 2.4 (J) Colorado: See general Subtask 2.4 description above.
- Subtask 2.4 (K) Idaho: See general Subtask 2.4 description above.
- Subtask 2.4 (L) Utah: See general Subtask 2.4 description above.
- Subtask 2.4 (M) Oregon: See general Subtask 2.4 description above.
- Subtask 2.4 (N) Nevada: See general Subtask 2.4 description above.
- Subtask 2.4 (O) Maine: See general Subtask 2.4 description above.
- Subtask 2.4 (P) Arizona: See general Subtask 2.4 description above.
- Subtask 2.4 (Q) New Jersey: See general Subtask 2.4 description above.
- Subtask 2.4 (R) Pennsylvania: See general Subtask 2.4 description above.

STATUS: Ongoing. Drill projects are complete in UT, ID, WA, and OR. NV is finalizing their drilling in FY14 Q1 and Q2, all non-drill projects are completed. Unfortunately PA has had issues gaining access to the site where they were planning to conduct temperature logging.

Subtask 2.5 Creation of metadata catalogs
Purpose: Provide for easy user discovery of and access to data in the NGDS
Approach: Set standards and requirements for metadata content and procedures for entry and preservation of metadata for all information resources exposed to the NGDS. Metadata will be made available through the standard Open Geospatial Consortium Catalog Services for the Web (CSW) interface. AZGS will work with each data provider to determine the most efficient procedure to create metadata and enter it into the NGDS catalog.
Milestones: Profiles for metadata content and catalog service implementation are being developed currently, under the primary (BSU-managed) NGDS project. Implementation of the catalog system will be demonstrated during Phase I of that project. Metadata production and entry into the catalog will be an integral part of data acquisition, so milestones for this task will be synchronized with milestones for Subtask 2.2, 2.3, and 2.4.
Outcome: Accessible and searchable online metadata describing the type, nature, amount, and location of data available through NGDS will be available for NGDS users and for external applications in open source environments.

STATUS: Complete. Metadata management and a Catalog Service for the Web (CSW), were implemented using the ESRI open-source Geoportal platform, as one of the first items completed on the project. After reviewing the metadata management workflow we opted to revise the process in FY12 and are now harvesting and maintain metadata at repository.stategeothermal-data.org, and using the Geoportal solely to implement the CSW service.

Task 3. Quality and integrity analysis of the data
Purpose: To ensure the quality and integrity of the data provided to NGDS meets the system standards.
Approach: AZGS will follow the guidelines of the EPA "Guidance for Quality Assurance Plans." AZGS will also use guidelines in place and under development for the NGGDPP National Digital Catalog that are being used by all the SGSs currently, and guidelines developed for the US Geosciences Information Network. In addition, AZGS will employ standard measures of quality using statistical tools expected to be provided by the NGDS to assess variability, bias, systematic error, imprecision, accuracy, precision, reproducibility, etc.

The project will disseminate preliminary guidelines for data content, format, and quality to all participants at the start of the project and require that each participant address them in the Scopes of Work to be reviewed for the first cycle of Phase 1 by the SAB. Final policies and procedures for metadata and data submission, validation and acceptance will be developed by the technical team, in collaboration with the NGDS prime development team during Phase 1, and submitted to the Management Board for review and approval, and subsequent Scopes of Work will be required to conform to these policies.
Milestone: Regular reviews of each data provider's Scope of Work and regular reviews of

accomplishments, to ensure compliance with NGDS procedures and goals.
Outcome: Establishment, documentation, and maintenance of data quality in the NGDS.

STATUS: Ongoing. Data QA/QC is completed as data deliverables are submitted. We conduct monthly invoice reviews with the project technical team or via the tracking site; we then follow up with the subrecipients. This is conducted either by the Project Manager, technical team, or PIs. Tasks are tracked internally via a task website (task.usgin.org); data deliverables are tracked at stategeothermaldata.org.

Task 4. Establish regional technical resource centers
Purpose: To provide training, guidance, and assistance to Surveys in developing and implementing data quality and integrity guidelines, developing metadata, implementing data services, and configuring their servers to link seamlessly with the NGDS.
Approach: The project will establish multiple regional technical resource centers with a programmer/developer in each one, to serve that region. These centers will utilize existing facilities at the host agency.
Milestone: Hiring of the regional programmers will occur during the beginning of Phase I.
Outcome: Technical resources will be working with participants to meet project goals and standards.

STATUS: Complete and Ongoing. Complete in that there are four regional hubs currently operational. This is ongoing in that there is continuing maintenance at each hub and in the hub networking. A disaster recovery plan utilizing Hyper V replication has been implemented in 2 of the 4 hubs and already utilized this FY as the NV Hub experienced difficulty prior to the Geothermal Resources Council Annual Meeting. Had it not been for the recovery plan in place, the NV Hub data services would not have been online for the largest meeting of geothermal experts. A series of workshops across the country, hosted by the different hubs occurred (see the Outreach and Tech Transfer section above), a final Hub meeting is planned for February/March of 2014 to finalize disaster recovery and maintenance plans.

PHASE 2 – TRANSFER AND VALIDATION OF INFORMATION TO DATA SYSTEM

Task 5.0 Data integration into NGDS
Purpose: Enable catalogs and databases to be exposed to the network for discovery, access, and retrieval
Approach: Develop, document, implement, and deploy web services to enable open access to information resources of the NGDS
Milestone: Service specifications are being developed as part of the BSU-led NDGS Prime project and will be ready for deployment early in Phase I. Data exchange procedures are ready to be implemented now, but they will be made more user-friendly throughout the project. Service implementation and deployment will be prioritized to make data that the SGS collaborators are producing during each cycle accessible.
Outcome: The NGDS is an effective system to enable discovery and access to data provided by the state geological surveys using standard interfaces.

STATUS: Ongoing. Participation in multiple meetings and sprints with the NGDS Architecture, Design, Testing, and Maintenance project including the system vision and software requirements have occurred. We continue to add AASG subrecipient data to the catalog as it becomes available. Data delivery procedures are in place at stategeothermaldata.org and through USGIN tutorials.

Subtask 5.1 Registration of resources.
Purpose: Enable data providers to register their resources by publishing metadata in the NGDS catalog. Verify that metadata meets requirements, and that registered resource exists and can be accessed using information in metadata.
Approach: Acceptance and publication of metadata in the NGDS catalog will be the formal

mechanism for making a resource part of the NGDS. The publication process requires a validation process to determine that metadata and the described resource are conformant with system requirements. This is a technical validation, not a scientific review. Project technical staff will work with data and application providers to efficiently produce metadata meeting system requirements and publish it using the NGDS core, and to develop automated processes for data and metadata validation. Policies for this validation process developed by Project technical staff and the NGDS core team, reviewed for approval by the Technical Advisory Board, and once approved, will be made publically available.

Technical approaches for metadata publication include provider exposing conformant metadata through their own catalog service, use of web crawling software to harvest metadata from other online information provided by data provider, submission of metadata in a structured file for import to the metadata catalog, or production of metadata directly into the catalog using online forms. Once metadata are available from at least one catalog server in the system they can be harvested to archive in the NGDS Core catalog.

Milestone: Data delivered by project participants as Task 2 deliverables validated and registered to become part of the NGDS following a documented process.

Outcome: Allows participants to expose data, metadata, and catalogs to the NGDS as soon as they are available using a standard registration, validation, and publication process that provides data consumers with confidence in the quality of the products.

STATUS: Resources are being registered by entering metadata in USGIN and State Geothermal Data repository or submitting Excel Workbooks with metadata loaded into XML. The metadata.stategeothermaldata.org is now available; this replaces the USGIN metadata wizard. The new catalog and repository (repository.stategeothermaldata.org) was released in FY12, metadata edits and improvements are ongoing.

Subtask 5.2 Implementing data exchange software 'wrappers' to provide for interoperability of databases

Purpose: Provide tools and guidance to map data into interchange formats used by web services to make data available interoperability.

Approach: Project technical staff will prepare training manuals ('cookbooks') and offer workshops on how to encode information for transmission and integration into NGDS. The technical staff will consult by phone and online with data providers. For providers without the technical staff to implement the interchange mapping, the AZGS project staff will do it for them. Schema and vocabulary mapping necessary to produce the interchange formats may be done using queries in a database, through xml transformations, or using custom software. Standardization of the interchange formats will reduce the amount of development required by enabling reuse of components and workflows.

Milestone: Each data delivery package will require implementation of access through NGDS services using standard interchange formats, so the mapping of data schema and vocabulary, and document formatting required to produce interchange-format documents will be coupled with data delivery (subtasks 2.2, 2.3, 2.4). Training and assistance will be carried out continuously throughout all Phases.

Outcome: Data providers will have the ability to transform their own data and assistance and tools will be available for others to map their data into NGDS interchange formats.

STATUS: We continue to support data providers on interchange mapping which can be done using database queries, XML transformations, or custom software. We have updated data delivery tutorials and made them accessible for the NGDS. We released a few tools for processing data to improve the accuracy and quality of the data submissions. These include an Excel to NGDS FeatureClass validation tool and WFS validation tool. Both are available on the project's GitHub, forum discussion page, and project sites. In addition, the content models are now in a repository of their own at http://schemas.usgin.org/home/; this repository is then "fed" to the geothermal data websites for instantaneous uploads (i.e. each time a content model is

updated, it now only requires updating in one location).

Task 6.0 "Uploading" data to the NGDS
Purpose: To make each provider's data accessible to the NGDS through standard web service interfaces.
Approach: Providers will publish their data via services, which they may implement themselves, or work through arrangements with other providers or the NGDS core. Services will follow documented NGDS service conventions.
Milestone: Have multiple NGDS nodes delivering data live in an operational prototype network for the data delivered in the first Phase One data acquisition cycle, with at least one operational, production OCG CSW catalog service. Later, have data services implemented and in production operation for data delivered in the second Phase One cycle, and have services implemented and tested for inclusion of data delivered at the end of the third Phase One cycle.
Outcome: Data available to NGDS clients; establish pattern and technology for open data publication that will enable growth of the data cloud independent of any particular project.

STATUS: Ongoing. Initial milestone of having multiple NGDS nodes delivering data live in an operational prototype network is complete. Nodes include the hub states as well as states that are self-serving data. In FY14 we plan to incorporate the newly developed NIAB.

Task 7.0 Establishing links and/or virtual portals to the retrieved/collected/developed data
Purpose: To make data and service products available through the NGDS Geothermal Desktop and other web portals
Approach: Project technical staff will work with the NGDS Geothermal Desktop developers and external groups to create necessary web services, ontologies, and interface standardization to link the aggregated data resources of the project to NGDS web portal and enable other, independent portals to interface with the System. Work with other client application developers to implement connectors to NGDS catalog and data services. The objective is to enable widely used, off the shelf, ideally low-cost or free, software to access data provided by NGDS.
Milestone: Demonstrate access to at least one NGDS data service by client applications (desktop or web based). Demonstrate access to all implemented NGDS services by at least one client application. The NGDS Prime Geothermal Desktop is an obvious first choice of clients, but software development for this application is under control of the NGDS core project, so AZGS cannot set milestones based on development if its functionality.
Outcome: Software applications are available that will access and utilize project resources.

STATUS: At this time we are not pursuing any additional virtual portals since the CKAN UI development is well underway in the BSU project. We have been testing service URLs, online file and server locations, and other testing of online applications hosted by hubs or other states, to ensure that the distributed system is working. The portals that were developed by the AZGS team include:

- Data Explorer, http://data.geothermaldatasystem.org/
- Prototype Search Interface, http://search.geothermaldata.org
- ArcMap Catalog Search, https://github.com/usgin/arcmap-cswclient

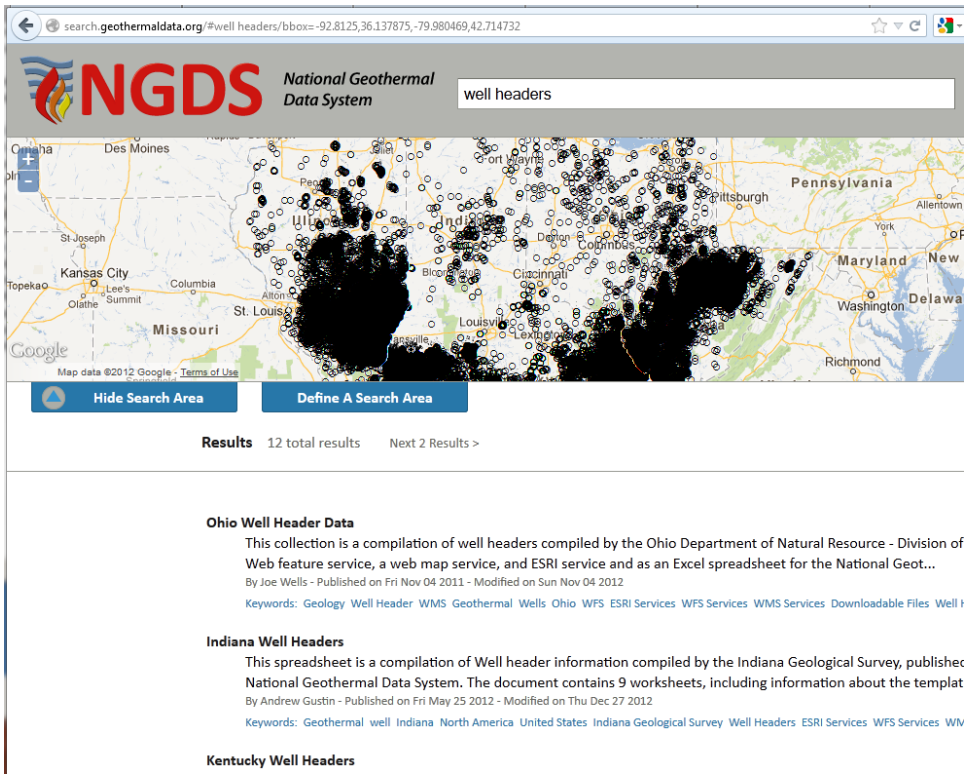

Figure 9: Prototype search interface, screen shot viewing well headers in the midwest.

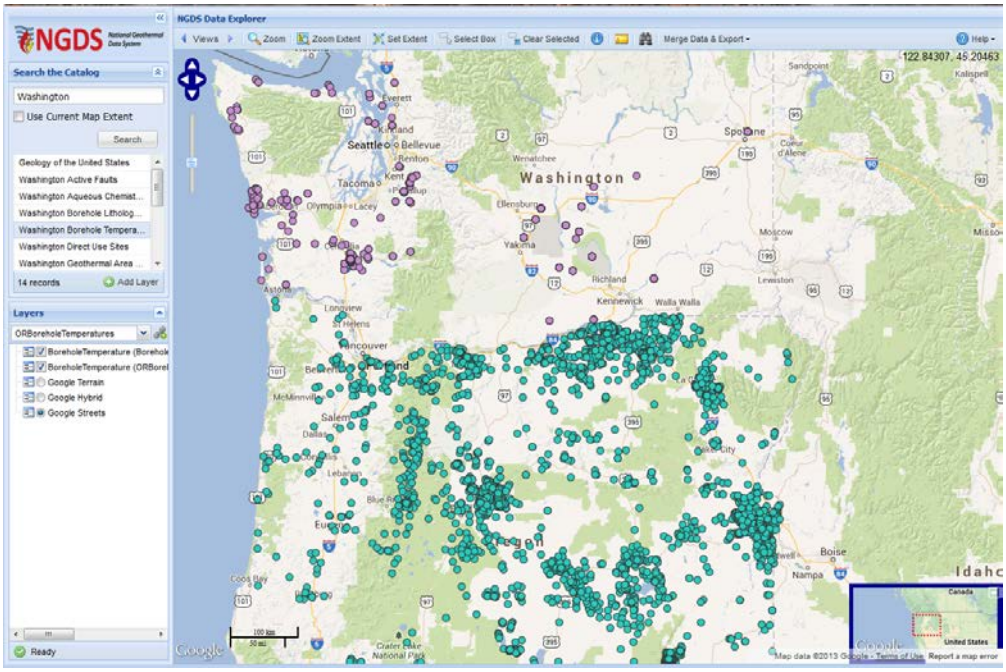

Figure 10: NGDS Data Explorer - demonstrating borehole temperatures in Washington and Oregon. Since this is built to query Web Feature Services, each of the points can be queried.

Task 8.0 System testing in conjunction with NGDS
Purpose: By the time AZGS is in late Phase I and Phase II, where AZGS are starting to register data services with catalogs and implement data exchange standards, the NGDS will still be in development and testing of key components of the system.
Approach: Work with NGDS Core development team (BSU led) to test services and data formatting. NGDS core has stated intention to implement service status monitoring, and AZGS hopes to include conformance testing of data services against technical specifications. An operational network will require ongoing monitoring, and standardized performance and reliability testing. In collaboration with NGDS core developers, define standard tests of NGDS services that can be run to determine if service instances are functioning properly.
Milestone: Development of system to monitor service availability and make current status of system services visible to users. Implement more than one functional unit test modules by end of project.
Outcome: Beta-style development, deployment, and testing of key components of NGDS increases reliability of services and quality of data and metadata.

STATUS: Ongoing. We have collected the majority of data from the NGDS Architecture, Design, Testing, and Maintenance Project's subrecipients and added them to the catalog. We have also deployed an aggregating CKAN node and Data publication node for demonstration and testing. We have successfully harvested resources from the Geothermal Data Repository at NREL, harvesting 261 entries from the GDR and harvested an initial batch of metadata from the SMU node; however, this is still ongoing as there is additional work on the SMU server.

Task 9.0 Assurance of the integrity of the original data set
Purpose: Establish criteria that can be used to filter data and categorize them according to established and user-defined quality levels.
Approach: Research will be necessary to identify automated processes that may be used to assess quality of data offered by a service. Automation can be used to assess conformance to usage of controlled vocabularies and schema cardinality requirements, the percentage of data fields that are null or have invalid data type values, and other similar metrics. More subjective judgment of data quality can be made by the data provider and provided in metadata data quality elements, but these will probably not be mandatory in the near term because the information is commonly not available. A system for user feedback on data quality will be investigated as well. Implementation of such complex advanced features is not within the scope of the current project, but AZGS will work with NGDS core developers to identify approaches that can be implemented with resources available. Available quality information will be reported with each metadata search. When data with incomplete metadata is identified the entity responsible for the metadata will be notified.
Milestone: Criteria will be reviewed with the NGDS Architecture, Design, Testing, and Maintenance project during service development. At least one integrity test will be selected for implementation with service per year
Outcome: The system will assist users to evaluate data quality and enable filtering of datasets according to their needs.

STATUS: As part of the data delivery process all data submitted by the states are reviewed in spread sheet formats before deployment as a web service and validated using the Excel to NGDS FeatureClass tool. Subrecipients were trained on this tool at the NGDS Regional Workshops.

PHASE 3 – EXECUTION OF DATA MAINTENANCE SUSTAINABILITY PLAN

Task 10.0 Formulation of the data maintenance and sustainability strategy
Purpose: Ensure availability, reliability, and update of data and services in the NGDS during and beyond the project.
Approach: Educate system data providers and users through workshops at the regional technical resource centers. Data provided by state geological surveys can be hosted by the originating survey, at

one of the regional centers, or by the NGDS core, and depending on policies developed by NGDS may be mirrored by other NGDS system servers. Regional centers will mirror and backup data for their region, and provide redundant service instances to prevent a single point of failure. Develop a business model to sustain system maintenance for data and services by engaging stakeholders who have financial resources available and an interest in continuing system operation.
Milestones: Create a network of NGDS servers with the regional centers, and determine what resources each center will mirror and backup. Implement mirroring and backup during Phase 3. Sustainability plan must be in place.
Outcome: Data and services are backed up and a system is in place for continuity beyond the duration of the project.

STATUS: Ongoing. We have successfully documented and created a disaster recovery plan utilizing Hyper V for the server hubs. Also, as part of the sustainability of the network we hosted three workshops to inform users of current data deployment practices. In addition, a draft sustainability plan was submitted to the NGDS Architecture, Design, Testing, and Maintenance Project in May of 2013. Since then, we have been working to implement components of the plan, including the formation of a non-profit organization. We were referred by the Arizona Attorney General (legal representation to AZGS) to the private sector firm of Rusing, Lopez, and Lizzardi, PLLC in Tucson, AZ for incorporation as a non-profit entity based on the NGDS sustainability plan. After consultation with RLL, we were provided with a document on the benefits of public charities versus private foundations and are moving forward with incorporation and registration with the IRS as a private foundation. In addition, we have contracted with a marketing and tech transfer company in the Tucson area to assist with product scope and marketing plan for sustainability of the system. Compliance plans with the Open Data Initiatives and collaboration with DOE's EERE for implementation of a USGIN/NGDS style system across EERE is recommended. In addition, we have met with the USGS and OSTP to organize a round table convened by the White House under the auspices of the National Research Council, likely at the National Academies on USGIN/NGDS Exemplar of the White House Open Data initiative.

> Subtask 10.1 Implementation of regional aggregation services and back-up of data
> *Purpose*: To ensure data backup, continuity of service, and the potential for a permanent repository
> *Approach:* Each regional center will host a data server that provides multiple functions: mirrored services for state servers in that region to ensure data backup, continuity of service, and the potential for a permanent repository.
> *Milestone:* Multiple regional backup and mirroring systems will be set up and configured.
> *Outcome:* Data are backed up and aggregated for enhanced functionality.
>
> STATUS: Ongoing. Hubs are in the process of virtualizing their servers; two of the four hubs are currently virtual (cloud-based). A test between the two virtual machines occurred in early 2013 and a full disaster recovery was implemented in September of 2013.

Task 11.0 Adding new technical or institutional data
Purpose: Add new data from participants and add participants
Approach: Participants will revise their Scopes of Work regularly in accord with guidance from the Scientific Advisory Board. Project management will be seeking participation by additional data and service providers throughout the project.
Milestone: Participants will quantify and identify their data to be provided at the beginning of the project and update plans regularly as new data become available.
Outcome: The system operates in a mode of continual update and expansion.

STATUS: Ongoing. We are still experiencing delays collecting WRP metadata; with sequestration the WRP GIS Subcommittee is investigating opportunities for maintenance of the data currently available in the WRP catalog. It is currently unclear where the WRP catalog will be housed. If all else fails, we will manually create metadata for some of the more relevant data available in the WRP catalog for use in the

NGDS. This will not provide active services, but will at least promote users awareness of the data.

Task 12.0 Publicizing addition of the new data
Purpose: To keep providers and users aware of new data available
Approach: Use the project Technology Transfer plan (Subtask 13.4) and provide notification and syndication features in the servers and portals so that users can receive automatic notification when new data are available, including ability to select only data from certain areas or of certain type.
Milestone: Technology Transfer and public outreach have begun during the project negotiation phase and will be ongoing throughout the project.
Outcome: Increase the use and value of the NGDS.

STATUS: Ongoing. We continue to promote the NGDS through an aggressive community engagement and outreach program as demonstrated by the many talks and presentations listed above. We also provide live demonstrations of the data at high-profile national meetings, which include the Geothermal Resources Council Annual Meeting, Geological Society of America Annual Meeting, and the American Geophysical Union Fall Meeting. In addition, we have developed a Service Notification RSS feed for services currently in the NGDS, it is available for registration at https://github.com/usgin/service-notifications.

Task 13.0 Project Management and Reporting
Purpose and Approach: Reports and other deliverables will be provided in accordance with the Federal Assistance Reporting Checklist following the instructions included therein. Comprehensive reports at the end of each project phase will serve as the basic milestones for each of the tasks and their subtasks. These reports will serve as the basis for go / no-go decisions for the project as a whole and for the various tasks. It is anticipated that the review of the reports will also lead to revisions of the tasks and subtasks as necessary.
Outcome: Quarterly and Phase I Reports.

STATUS: Ongoing. All ARRA Jobs Reporting and Quarterly Reports were submitted on schedule and approved. This report completes the Annual Report requirement as outlined in the Federal Assistance Reporting Checklist.

Subtask 13.1 Implementation of organization structure
Purpose: To achieve project goals on budget and on schedule
Approach: Establish a management team at AZGS for the project; outline duties of the Management and Scientific Advisory Boards and appoint members; coordinate with the external Technical Advisory Board; implement the project Communications Plan; develop the Technical Training Plan.
Milestone: The Management Team is already in place, with the hiring of a full-time project manager and administrative assistant. The MAB and SAB duties will be established and members appointed by the official start of the project. The Communications Plan is under development and will be completed during the beginning of Phase I. The web developer/graphic designer has been hired. The Technical Training Plan will be developed during the beginning of Phase I.
Outcome: The Management Team is in place prior to the project kick-off to ensure that project goals will be met.

STATUS: Complete. Over the last year changes in project team staffing occurred and the Technical Advisory Board was absorbed by the NGDS-wide technical committee - GDSDPWG.

Subtask 13.2 Coordination among participants, collaborators, NGDS, and stakeholders
Purpose: To ensure the project meets the needs of the NGDS, as well as project participants, collaborators, and stakeholders.
Approach: Establish advisory boards (describe in Tasks 2, 3, and 13.1); integrate NGDS key

personnel into the project management and technical processes; hold regular meetings with NGDS and participants; establish formal affiliations among participants and collaborators; develop regular working relationships among the parties.
Milestone: The formal relationships will be largely complete prior to the project kick-off. Informal working relations are established and will continue to be nurtured. Schedules and plans for formal meetings and reviews will be partly completed prior to the project kick-off and finalized during the beginning of Phase I. Meeting schedules will be set on a regular basis.
Outcome: AZGS will have a well-coordinated and effective interactions and collaboration among all parties.

STATUS: Ongoing. We have daily one-on-one communications through email and phone calls with subrecipients. We also have an eNews mailing through the stategeothermaldata.org site, which we try to provide at least monthly updates. Over the next year we will host a series of online webinars for finalizing the project and introducing the NIAB concept.

We began conversations with the US Energy Association Program Coordinator for collaboration on the USAID/USEA East Africa Geothermal program and have plans to meet and discuss further at the GRC/GEA event in October.

We were invited to participate – with costs covered – at the International Ground Source Heat Pump Association Annual Meeting and will be sending Christy Caudill-Daugherty to the event to represent AZGS/NGDS. The IGSPHA connection is directly related to our participation in the Arizona Governor's Office of Energy Policy Geothermal Workshop series that AZGS has presented at over the last two years. There is significant opportunity in the GSHP industry for participation in NGDS. This is also true within the DOE EERE Building Technologies program and we look forward to continued engagement with that program.

Subtask 13.3 Milestones
Purpose: To coordinate the project deliverables with the NGDS
Approach: Management and technical staff from the project and from NGDS are working collaboratively and will be formally integrated into the respective projects.
Milestone: NGDS standards and protocols will be developed during Phase I and implemented for project data concurrently. Networking functions will be implemented during Phase II.
Outcome: NGDS standards and protocols will be available to project data providers at the appropriate time to contribute to the NGDS

STATUS: Ongoing. We are encouraged by the progress of the NGDS Architecture, Design, Testing, and Maintenance project under the new Principal Investigator at Boise State University as well as the new technical team in place to complete the project.

Subtask 13.4 Technology Transfer
Purpose: To reach out beyond the project participants and collaborators
Approach: Make presentations at geothermal and geosciences meetings and conferences; exhibit at technical and industry conferences (in partnership with NGDS core, AASG, and others as opportunities permit); maintain and contribute to Web site(s); hold workshops and seminars (for data providers) opened to non-SGS's; prepare and distribute training materials (cookbooks and online tutorials) freely to anyone.
Milestone: Presentations and exhibits are already being made prior to the kick-off. A regular work plan will be developed in the beginning of Phase I and updated as needed.
Outcome: Effective communications to data and service providers and users about the NGDS capabilities and opportunities.

STATUS: Ongoing. Access to the tutorials is now improved with a refined interface at http://usgin.org/tutorials. We are now undergoing user-testing of the Tutorials. Currently

available online tutorials include:

- Data Delivery Cycle Tutorial (PDF)
- GeoSciML Portrayal Cookbook (PDF)
- NGDS Content Model Tutorial (Web, PDF, and Video)
- NGDS Data Explorer Tutorial (Web, PDF, and Video)
- NGDS Geothermal Data Repository Tutorial (PDF)
- NGDS Naming Conventions (Web, PDF)
- USGIN CSW Client (Web, PDF, Video)
- USGIN Metadata Tutorial (Web)
- USGIN URI Tutorial (Web, PDF)
- XML Tutorial (Web, PDF)

A series of "scenario" cards or use cases were developed for the Geothermal Resources Council/Geothermal Energy Association Annual Meeting and Expo, we plan to incorporate those into user tutorials and videos to help inform new users of the potential of NGDS. In addition, we have a new eHandbook started on achieving Open Data Compliance as well as a revised USGIN page (in progress) with simplified information to help provide an overview of the system and how an individual can join the system/add data to the system.

In addition to expanding the tutorials, we have worked to expand our online presence with GitHub and YouTube, but also on Facebook. The following are new to the project in FY13:

- NGDS GitHub, https://github.com/ngds
- NGDS Facebook, https://www.facebook.com/NationalGeothermalDataSystem
- NGDS YouTube, http://www.youtube.com/geothermaldata
- USGIN GitHub, https://github.com/usgin

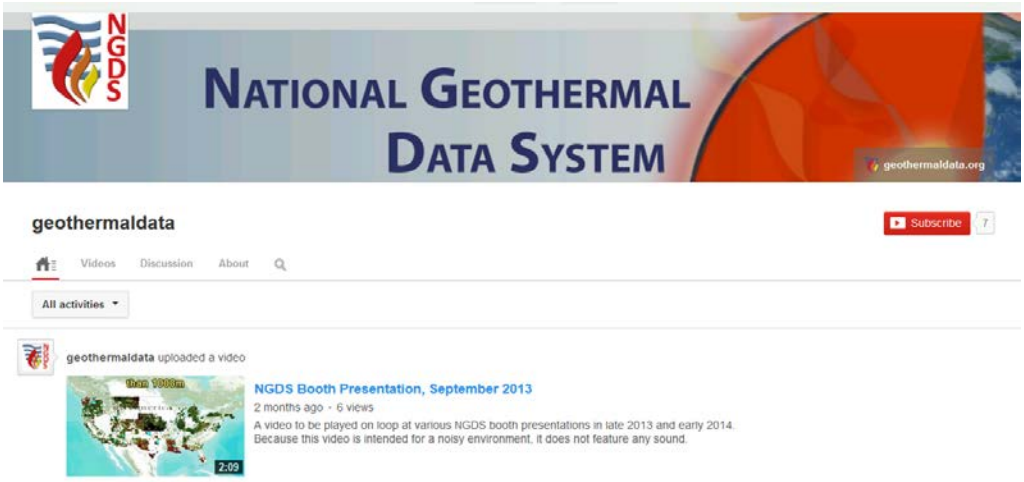

Figure 11: YouTube channel screen shot, www.youtube.com/geothermaldata