National Geothermal Data System

JANUARY 28, 2014

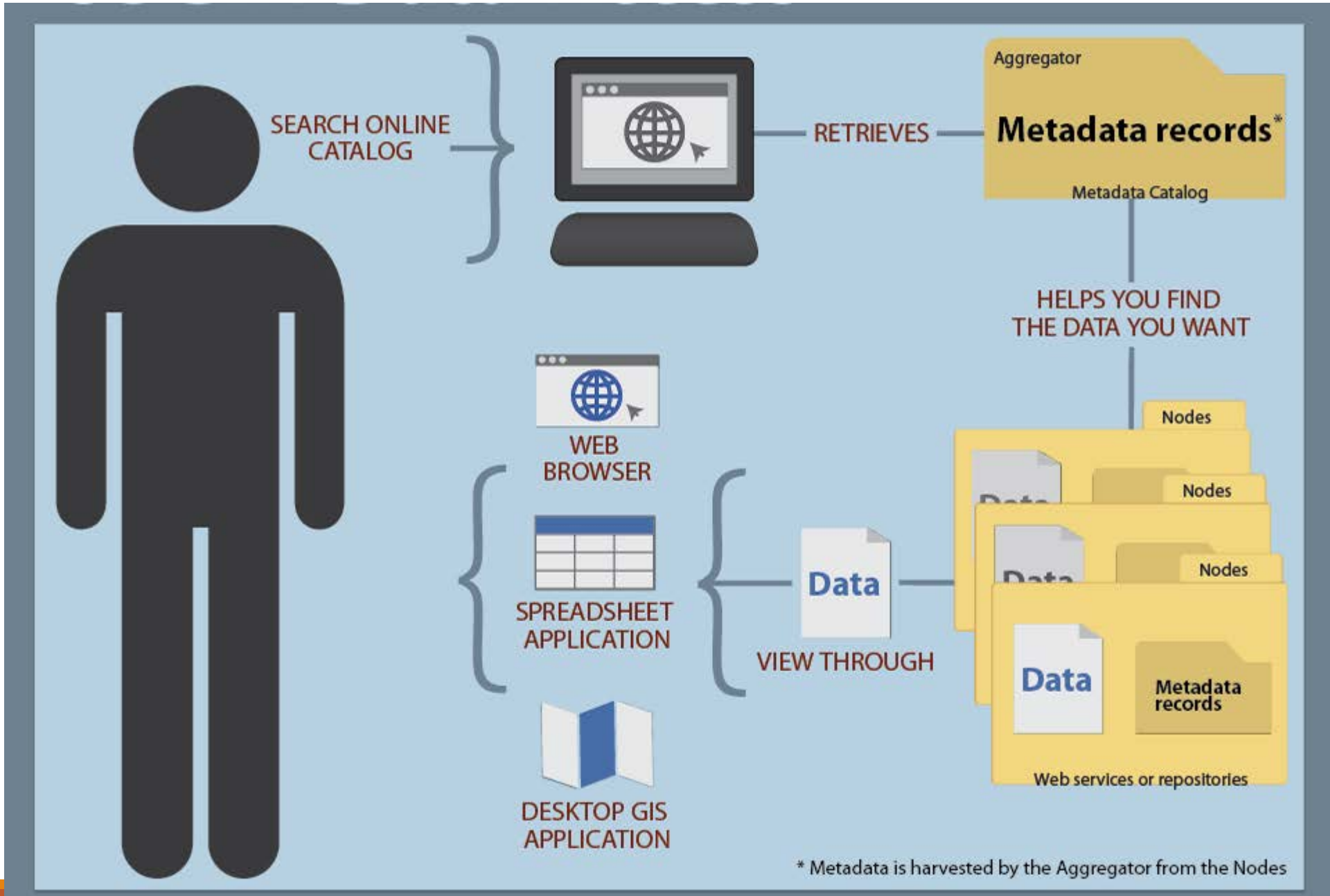
ARIZONA GEOLOGICAL SURVEY

A Data System NOT a Database

Discover and access data served from many different sources, including (more than 60 sources):

System is unified by:

- Catalog and standardized metadata
- Data access protocols and interchange formats (it's the Web for data)


SEARCH ONLINE CATALOG
RETRIEVES
Aggregator
Metadata records*
Metadata Catalog
HELPS YOU FIND THE DATA YOU WANT
WEB BROWSER
SPREADSHEET APPLICATION
DESKTOP GIS APPLICATION
Data
VIEW THROUGH
Nodes
Nodes
Nodes
Data
Metadata records
Web services or repositories
* Metadata is harvested by the Aggregator from the Nodes

About USGIN

Search

http://about.usgin.org

Open and Interoperable Data Platform

The U.S. Geoscience Information Network (USGIN) collects, connects, and opens geoscience data. Our team of experts can help your agency move beyond compliance with the 2009 Open Data Initiative to create an independent data exchange network.

Here's How

Scalable, Cost Effective, and Agile

USGIN is a federated information-sharing framework that uses free and open-source technology to help agencies go **beyond compliance** with the 2009 Open Data Initiative by creating agile, distributed data-sharing networks capable of interacting with similarly configured data-sharing networks. This approach offers a long-term solution to data storage and sharing without requiring proprietary software.

Build a Network

Who is the NGDS built for?

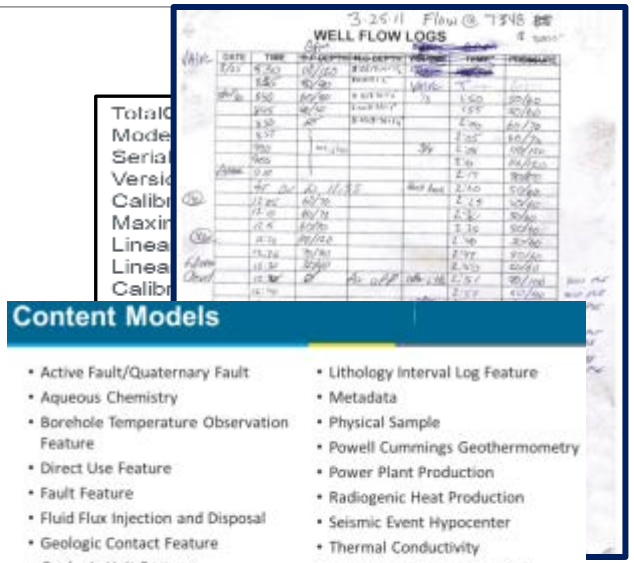
Those who want to Search, Find & Get Data…

…and those who want to Catalog Resources & Publish Data

Image Credits: Idaho Geological Survey, Washington Geological Survey, Arlene Anderson

Data Interoperability Tiers

- Tier 1: unstructured content in files
  - Text, images, graphics files
  - MS Word, Adobe Acrobat, Illustrator, TIFF….
- Tier 2: Structured data, custom formats
  - May be accessed in files or via services
  - Excel, Microsoft Access, dbf, xml…
- Tier 3: Information Exchange:
  - Structured data in standard schema and encoding
  - Deliver via web service, or in file.



The key to interoperability…

http://schemas.usgin.org/home/

Geoscience Content Models

Get faster results. Common data formats means less time munging data and more time doing science.

This is geoscientific data sharing, simplified.

Learn more »

Content Models

We all spend too much time reformatting data and not enough time doing meaningful analysis. By using common content models to share information, we can be sure that other people will understand our data as we meant it to be understood.

View model details »

WFS Validator

At USGIN, we focus on data sharing through Web-Feature Services. You can use this tool to check and see that your WFS conforms to the content model that you intend it to, and then feel good knowing that you're making other scientists happier.

Validate a WFS »

Recently...

Date	Model Name	Version
Sept. 13, 2013	Thermal Conductivity Observation	2.1
June 4, 2013	Contour Lines	1.0
June 4, 2013	Gravity Stations	0.1

What Kinds of Data? Highlights:

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

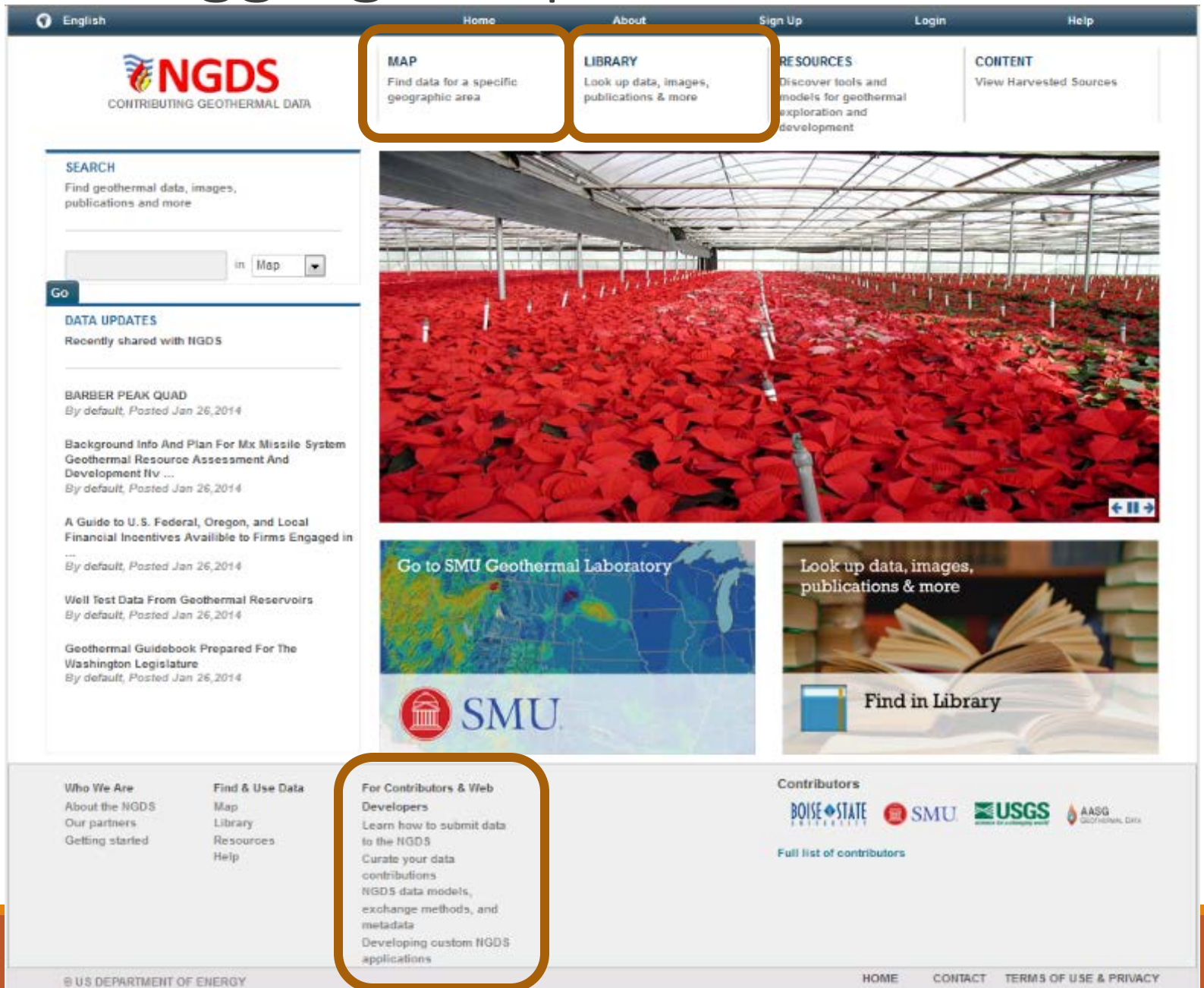
Well Tests

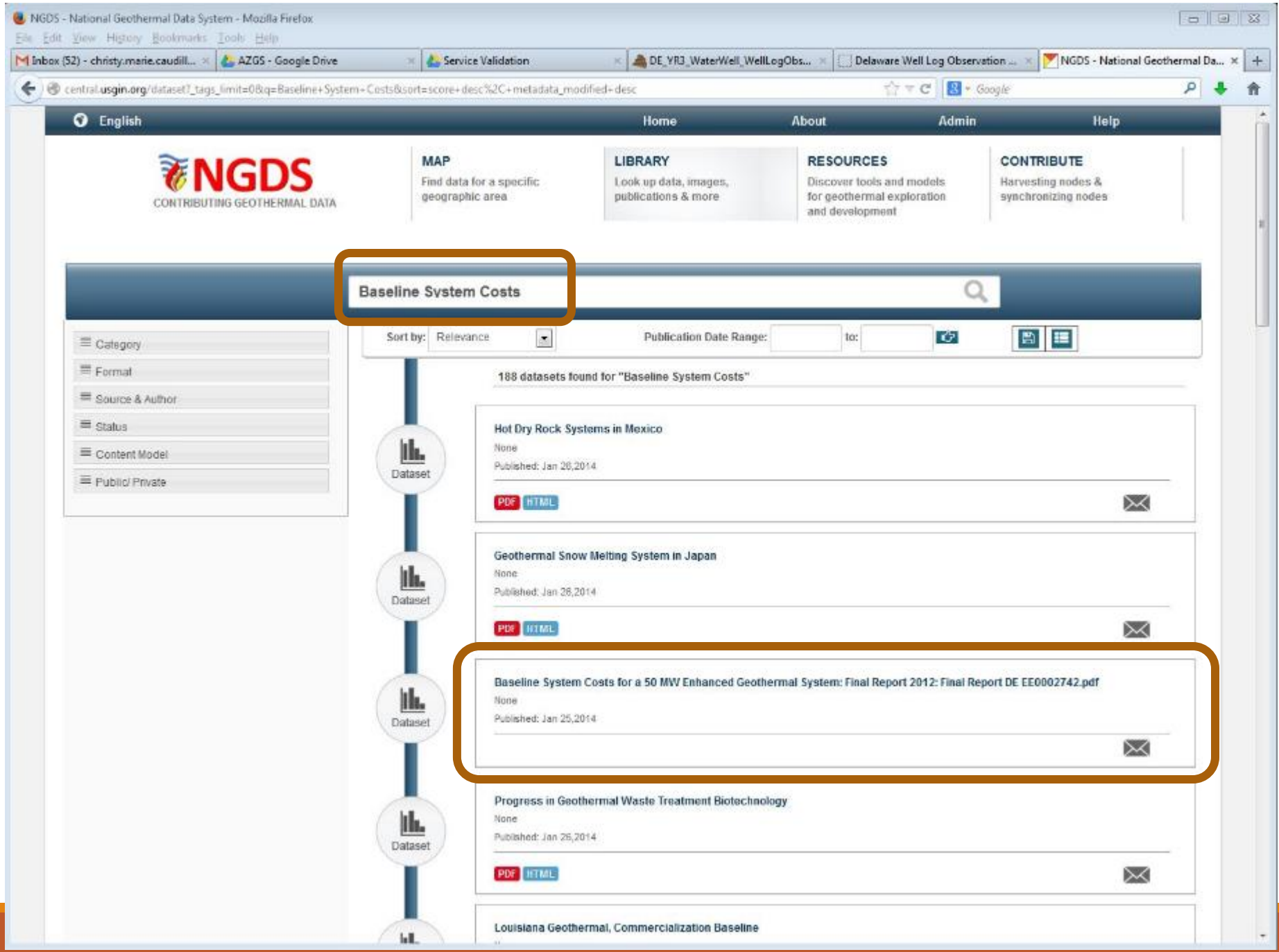
Metadata Content Model – Basic Resource Documentation

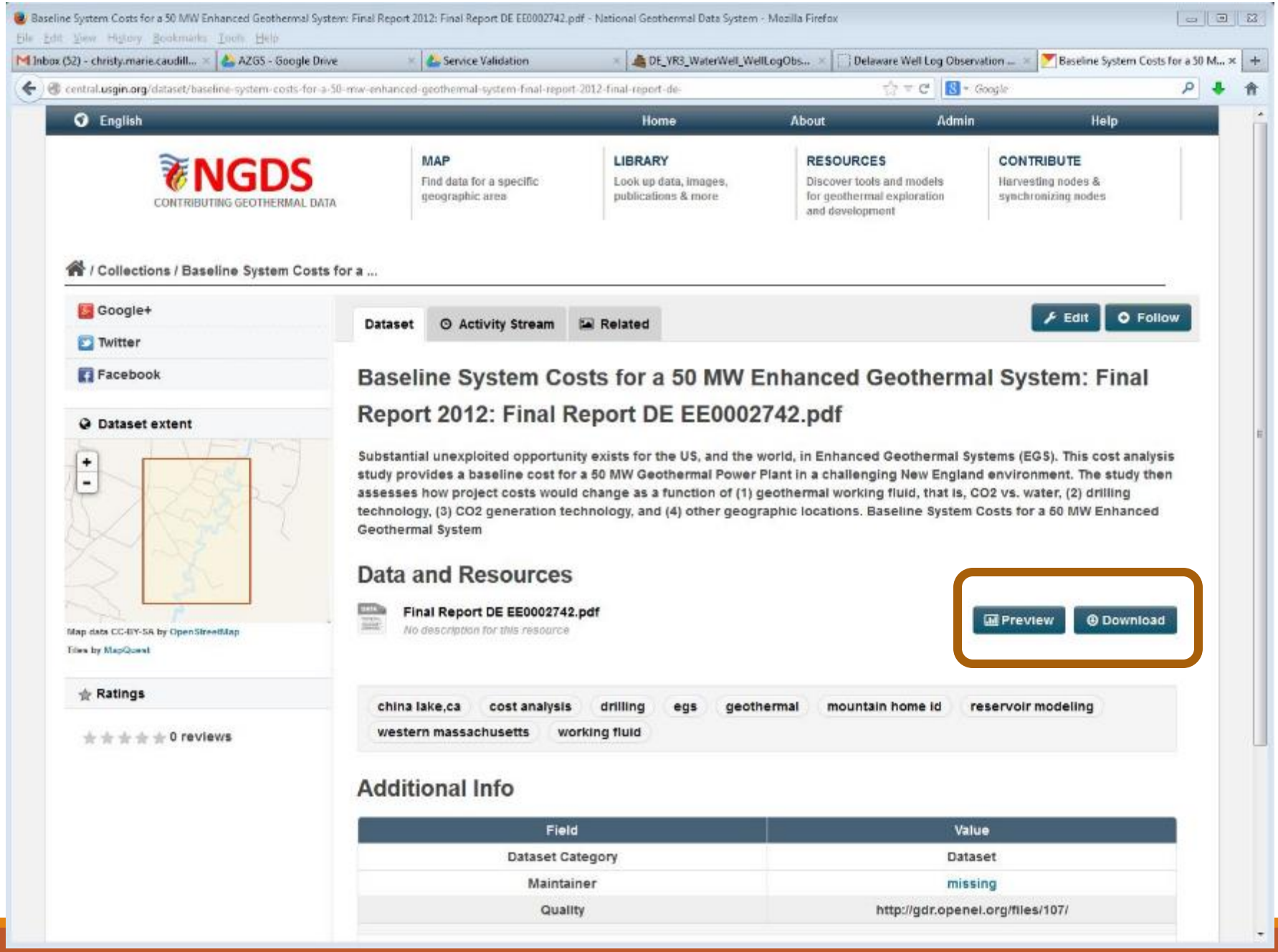
- Title
- Extent
  - Geographic
  - Vertical
  - Temporal
- Access instructions
- Description
- Keywords
- Originator(s)
- Date
- Resource ID
- Access constraints
- Language
- Quality
- Lineage
- Citation
- Distribution contact
- Metadata
  - Date
  - Contact
  - Specification
  - Identifier

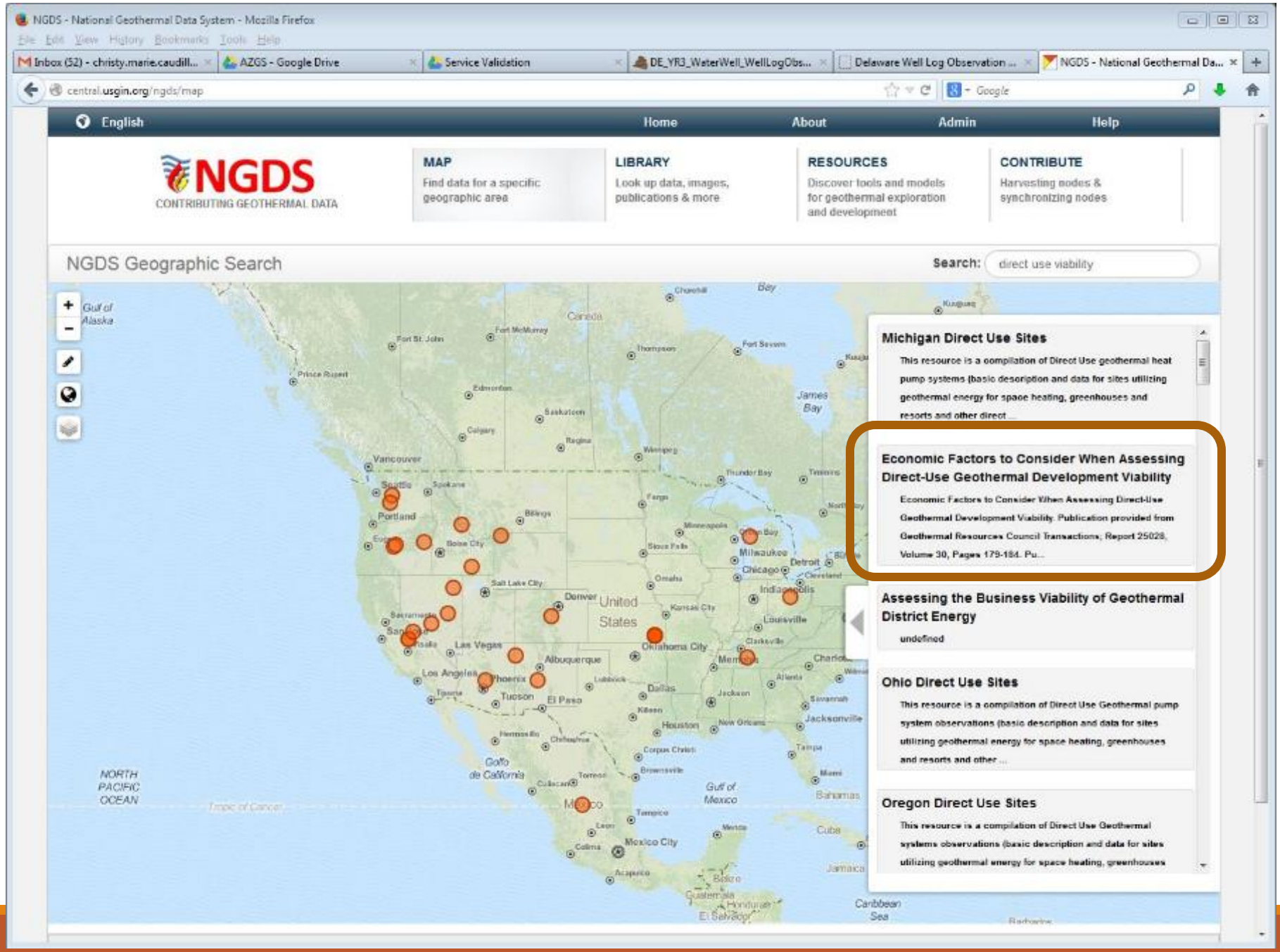
Online document: http://lab.usgin.org/profiles/doc/metadata-content-recommendations

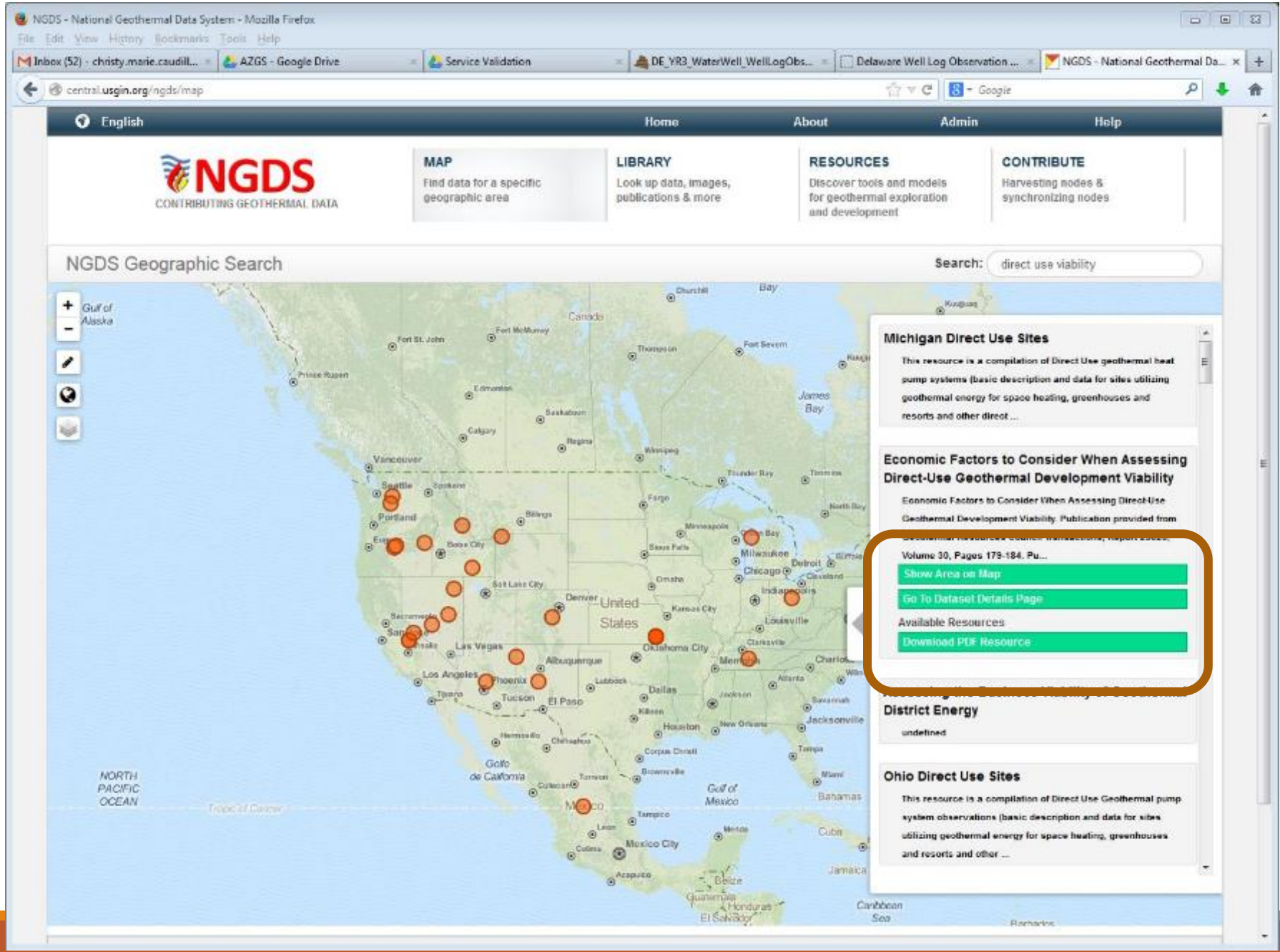
The aggregator portal: *(beta)*




NGDS - National Geothermal Data System - Mozilla Firefox
Inbox (52) - christy.marie.caudill...
AZGS - Google Drive
Service Validation
DE_YR3_WaterWell_WellLogObs...
Delaware Well Log Observation ...
NGDS - National Geothermal Da...
central.usgin.org/dataset?_tags_limit=0&q=Baseline+System+Costs&sort=score+desc%2C+metadata_modified+desc
English
Home
About
Admin
Help
NGDS
CONTRIBUTING GEOTHERMAL DATA
MAP
Find data for a specific geographic area
LIBRARY
Look up data, images, publications & more
RESOURCES
Discover tools and models for geothermal exploration and development
CONTRIBUTE
Harvesting nodes & synchronizing nodes
Baseline System Costs
Category
Format
Source & Author
Status
Content Model
Public/ Private
Sort by: Relevance
Publication Date Range:
to:
188 datasets found for "Baseline System Costs"
Dataset
Hot Dry Rock Systems in Mexico
None
Published: Jan 26,2014
PDF
HTML
Dataset
Geothermal Snow Melting System in Japan
None
Published: Jan 26,2014
PDF
HTML
Dataset
Baseline System Costs for a 50 MW Enhanced Geothermal System: Final Report 2012: Final Report DE EE0002742.pdf
None
Published: Jan 25,2014
Dataset
Progress in Geothermal Waste Treatment Biotechnology
None
Published: Jan 26,2014
PDF
HTML
Louisiana Geothermal, Commercialization Baseline


Baseline System Costs for a 50 MW Enhanced Geothermal System: Final Report 2012: Final Report DE EE0002742.pdf - National Geothermal Data System - Mozilla Firefox
central.usgin.org/dataset/baseline-system-costs-for-a-50-mw-enhanced-geothermal-system-final-report-2012-final-report-de-
English
Home
About
Admin
Help
NGDS
CONTRIBUTING GEOTHERMAL DATA
MAP
Find data for a specific geographic area
LIBRARY
Look up data, images, publications & more
RESOURCES
Discover tools and models for geothermal exploration and development
CONTRIBUTE
Harvesting nodes & synchronizing nodes
/ Collections / Baseline System Costs for a ...
Google+
Twitter
Facebook
Dataset extent
Map data CC-BY-SA by OpenStreetMap
Tiles by MapQuest
Ratings
0 reviews
Dataset
Activity Stream
Related
Edit
Follow
Baseline System Costs for a 50 MW Enhanced Geothermal System: Final Report 2012: Final Report DE EE0002742.pdf
Substantial unexploited opportunity exists for the US, and the world, in Enhanced Geothermal Systems (EGS). This cost analysis study provides a baseline cost for a 50 MW Geothermal Power Plant in a challenging New England environment. The study then assesses how project costs would change as a function of (1) geothermal working fluid, that is, CO2 vs. water, (2) drilling technology, (3) CO2 generation technology, and (4) other geographic locations. Baseline System Costs for a 50 MW Enhanced Geothermal System
Data and Resources
Final Report DE EE0002742.pdf
No description for this resource
Preview
Download
china lake,ca
cost analysis
drilling
egs
geothermal
mountain home id
reservoir modeling
western massachusetts
working fluid
Additional Info
Field
Value
Dataset Category
Dataset
Maintainer
missing
Quality
http://gdr.openei.org/files/107/


NGDS - National Geothermal Data System - Mozilla Firefox
central.usgin.org/ngds/map
English
Home
About
Admin
Help
NGDS
CONTRIBUTING GEOTHERMAL DATA
MAP
Find data for a specific geographic area
LIBRARY
Look up data, images, publications & more
RESOURCES
Discover tools and models for geothermal exploration and development
CONTRIBUTE
Harvesting nodes & synchronizing nodes
NGDS Geographic Search
Search:
direct use viability
Michigan Direct Use Sites
This resource is a compilation of Direct Use geothermal heat pump systems (basic description and data for sites utilizing geothermal energy for space heating, greenhouses and resorts and other direct ...
Economic Factors to Consider When Assessing Direct-Use Geothermal Development Viability
Economic Factors to Consider When Assessing Direct-Use Geothermal Development Viability. Publication provided from Geothermal Resources Council Transactions; Report 25028, Volume 30, Pages 179-184. Pu...
Assessing the Business Viability of Geothermal District Energy
undefined
Ohio Direct Use Sites
This resource is a compilation of Direct Use Geothermal pump system observations (basic description and data for sites utilizing geothermal energy for space heating, greenhouses and resorts and other ...
Oregon Direct Use Sites
This resource is a compilation of Direct Use Geothermal systems observations (basic description and data for sites utilizing geothermal energy for space heating, greenhouses
United States
Canada
Mexico
NORTH PACIFIC OCEAN
Gulf of Mexico
Golfo de California


NGDS - National Geothermal Data System - Mozilla Firefox
central.usgin.org/ngds/map
English
Home
About
Admin
Help
NGDS
CONTRIBUTING GEOTHERMAL DATA
MAP
Find data for a specific geographic area
LIBRARY
Look up data, images, publications & more
RESOURCES
Discover tools and models for geothermal exploration and development
CONTRIBUTE
Harvesting nodes & synchronizing nodes
NGDS Geographic Search
Search:
direct use viability
Michigan Direct Use Sites
This resource is a compilation of Direct Use geothermal heat pump systems (basic description and data for sites utilizing geothermal energy for space heating, greenhouses and resorts and other direct ...
Economic Factors to Consider When Assessing Direct-Use Geothermal Development Viability
Economic Factors to Consider When Assessing Direct-Use Geothermal Development Viability. Publication provided from
Volume 30, Pages 179-184. Pu...
Show Area on Map
Go To Dataset Details Page
Available Resources
Download PDF Resource
District Energy
undefined
Ohio Direct Use Sites
This resource is a compilation of Direct Use Geothermal pump system observations (basic description and data for sites utilizing geothermal energy for space heating, greenhouses and resorts and other ...
United States
Canada
Mexico
Gulf of Alaska
NORTH PACIFIC OCEAN
Gulf of Mexico
Caribbean Sea

Economic Factors to Consider When Assessing Direct-Use Geothermal Development Viability

R. Gordon Bloomquist

Washington State University Extension Energy Program
Olympia, Washington USA

Keywords

Economics, direct use, geothermal, development, revenue generation

ABSTRACT

Economic factors that must be considered when assessing the economic viability of a direct-use geothermal project include: provision of fuel (the geothermal resource), design and construction, operation and maintenance and the generation of revenue. Many projects can have access to several sources of revenue including: electrical generation (co-generation), co-production of minerals and sale of thermal energy. Determining the economic viability of any direct-use geothermal project must be an interactive process with a new evaluation completed at each stage of the project as more and more information becomes available.

Introduction

The factors that must be considered when assessing the economic viability of a geothermal project vary from project to project, from conversion technology to conversion technology, and especially from electrical generation to direct use. There are, however, a number of factors common to all projects, although actual cost and impact on project economics will be, to a large extent, dependent upon resource characteristics and national or even local political and economic circumstances. This paper will concentrate primarily on direct-use economic factors; however, increasingly more and more projects are combined heat and power and thus economic factors related to electrical production must also be given at least some consideration, and economic viability may require a number of revenue streams from, for example, power sales or offset, sales of thermal energy or products produced, or even sales of by-products such as minerals.

The economic factors that are common to all projects include: provision of fuel, i.e., the geo-thermal resource; design and construction of the conversion facility and related surface equipment, in the case of district heating the distribution system and customer connections; financing; and of course the generation of revenue. The cost of obtaining the required fuel supply, together with the capital cost of the conversion facility, will determine the amount that must be financed. Revenue generated through the sale of electricity, by-products, thermal energy, or product produced, e.g., vegetables, plants, or flowers from a greenhouse, minus the cost of operations and maintenance (O&M) of the fuel supply and conversion facility, must be sufficient to meet or exceed the requirements of the financing package and expected rate of return on investment.

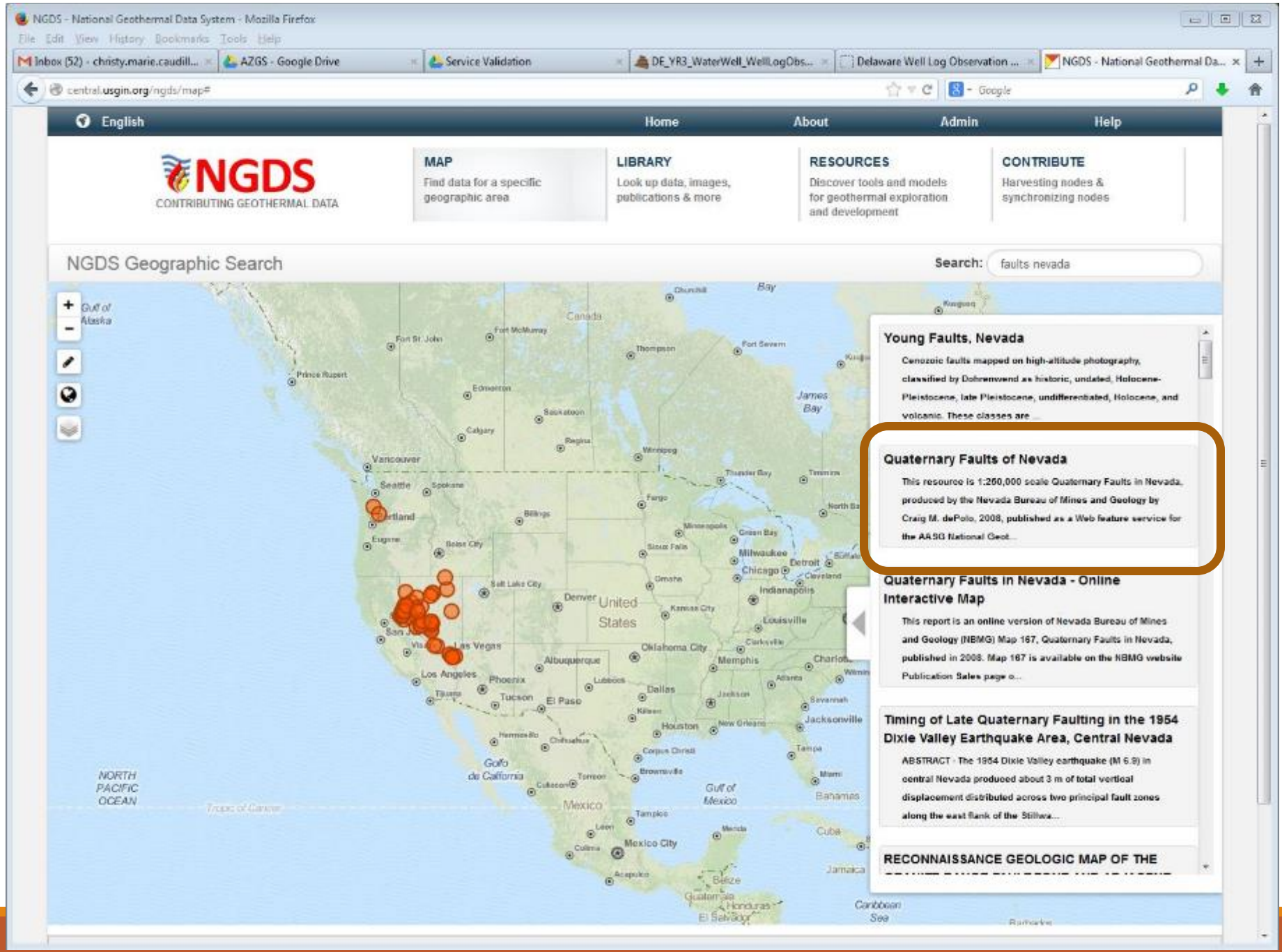
Economic Considerations

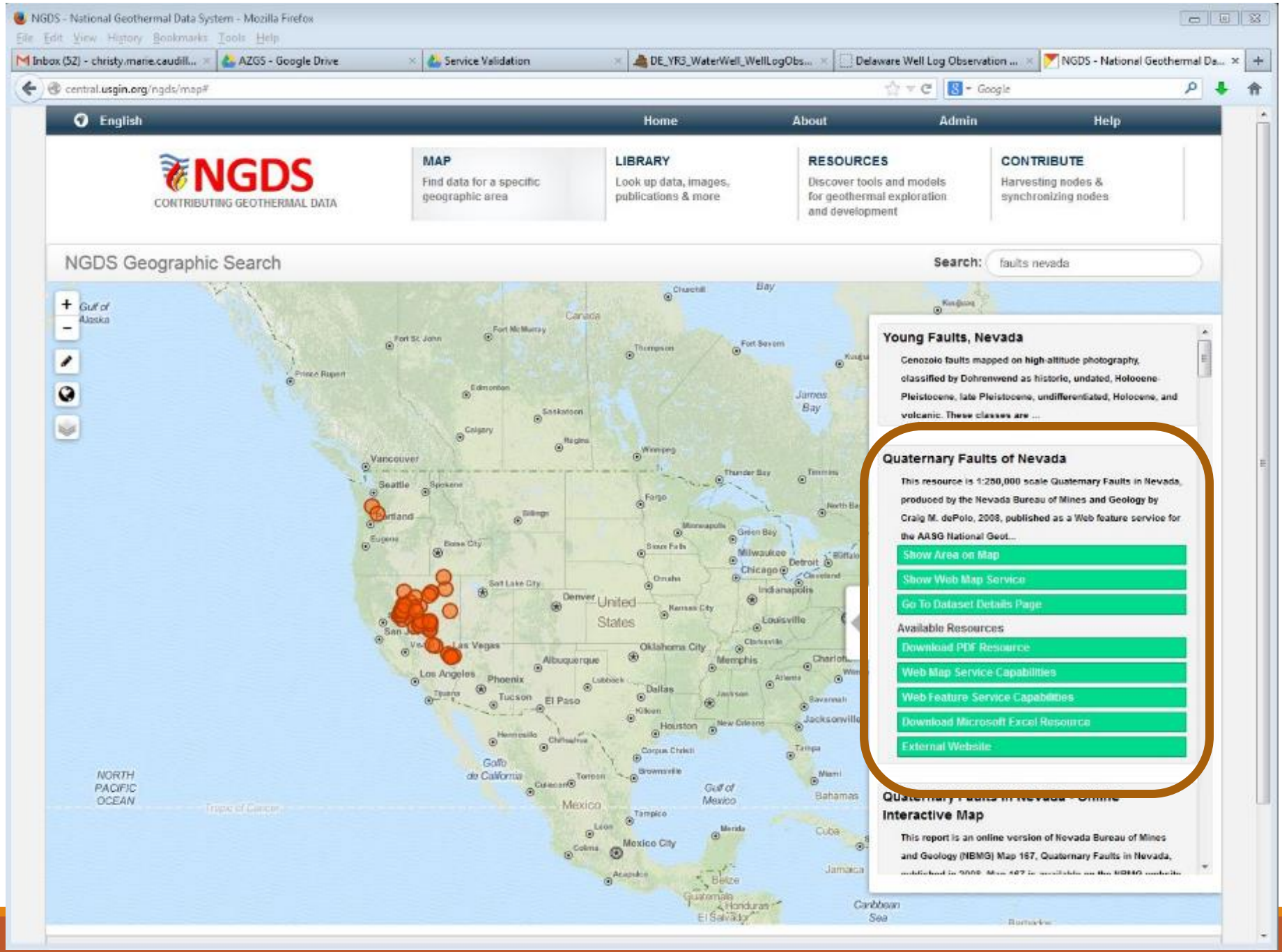
Provision of Fuel

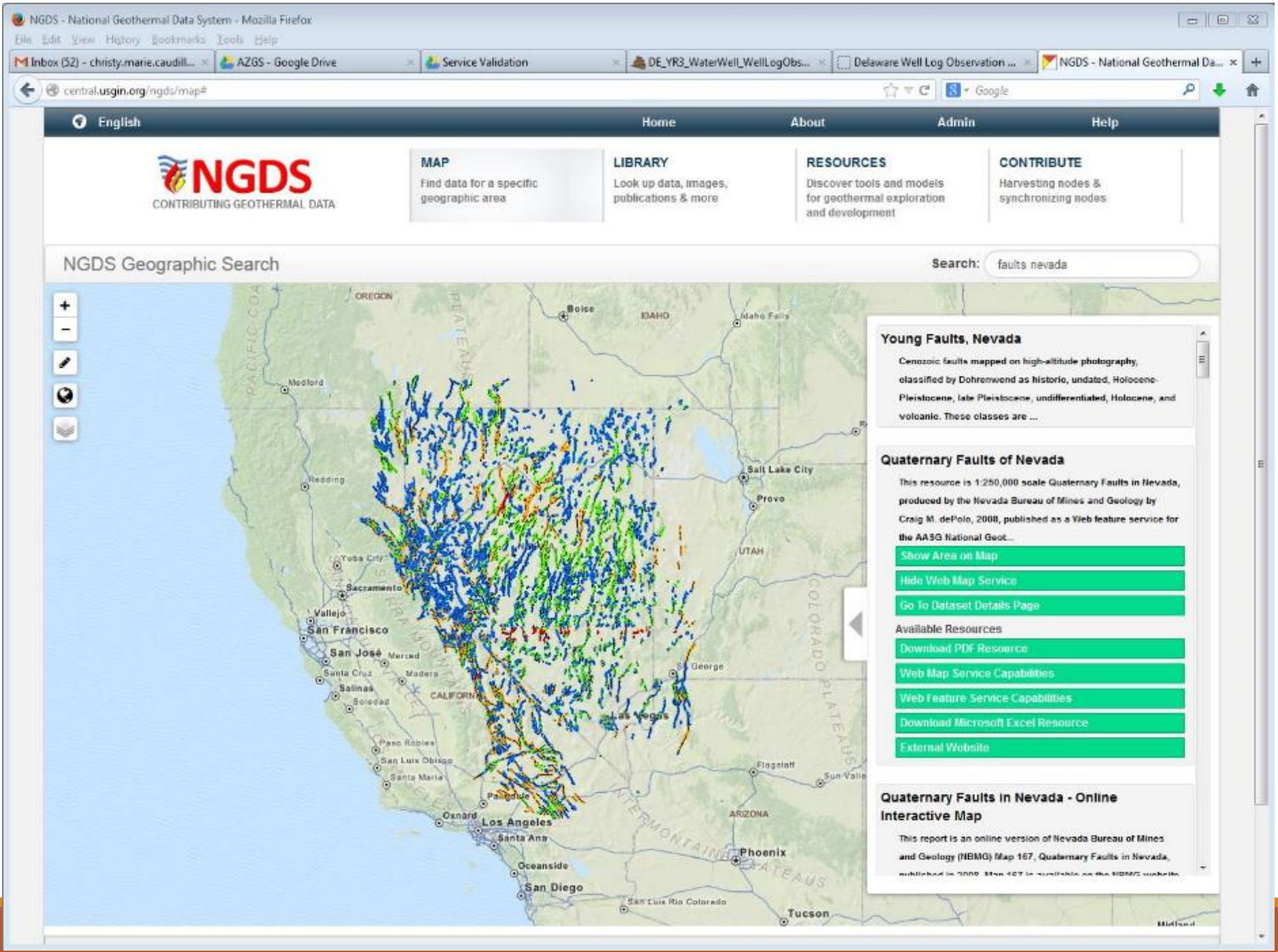
For most projects that require a sustained and economically attractive fuel supply, the project sponsor must only contact a supplier and negotiate a long-term supply of natural gas, oil, pro-pane, biomass, or coal.

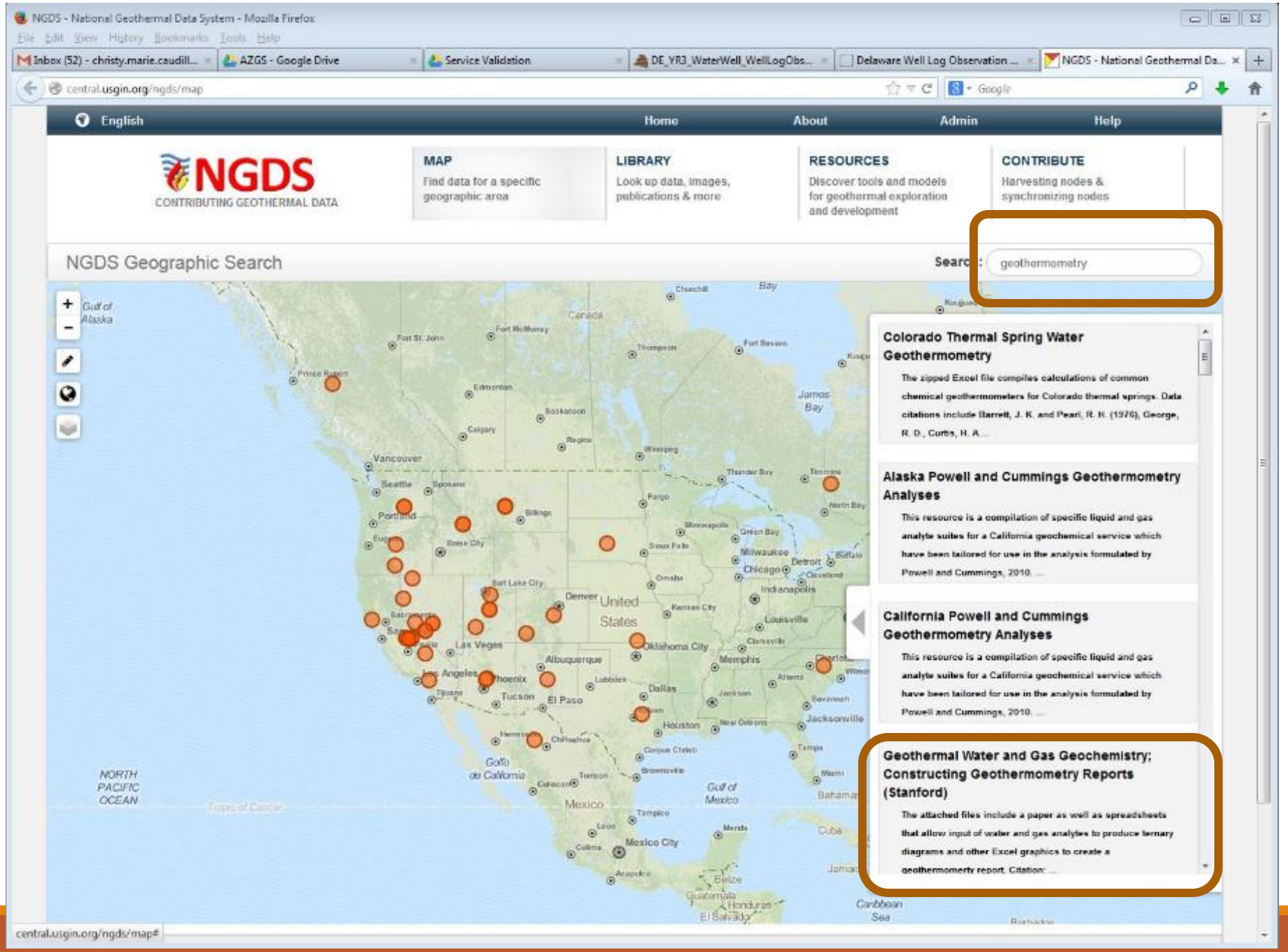
In the case of geothermal resources, however, the fuel cannot be purchased on the open market, legislated into existence, bought from a local utility, or transported over long distances from a remote field.

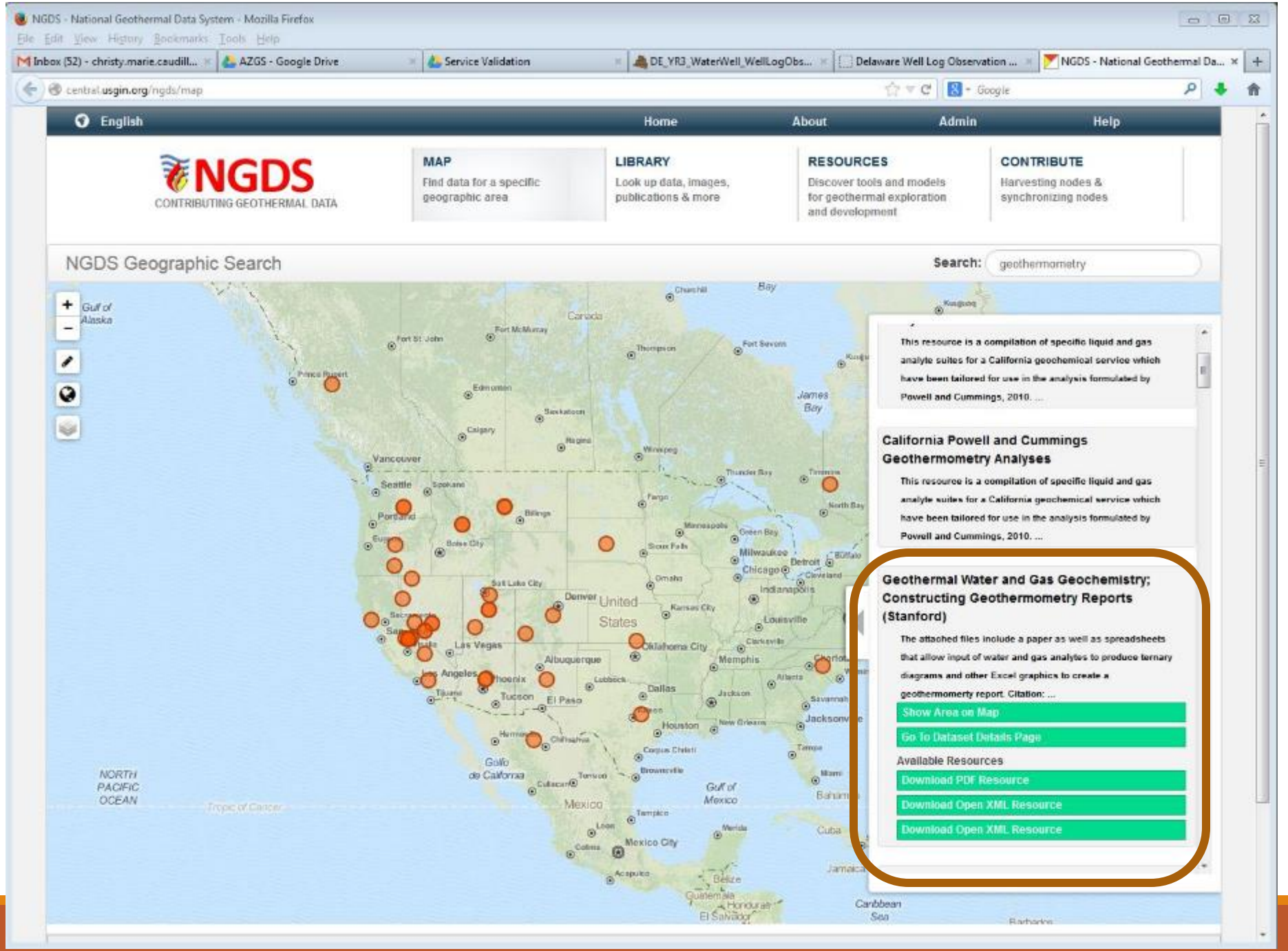
Whether the steam or hot water is to be provided by the project sponsor, i.e., the geothermal field and conversion facility are under one ownership, or whether the steam or hot water is to be provided by a resource company, the geothermal fuel is only available after extensive exploration, confirmation drilling, and detailed reservoir testing and engineering. Once located, it must be used near the site and must be able to meet the fuel requirements of the project for the lifetime of the project. Even before exploration can begin, however, the project sponsor may incur significant cost, and a number of extremely important legal, institutional, regulatory, and environmental factors must be fully evaluated and their potential economic impacts considered.


NGDS - National Geothermal Data System - Mozilla Firefox
central.usgin.org/ngds/map#
English
Home
About
Admin
Help
NGDS
CONTRIBUTING GEOTHERMAL DATA
MAP
Find data for a specific geographic area
LIBRARY
Look up data, images, publications & more
RESOURCES
Discover tools and models for geothermal exploration and development
CONTRIBUTE
Harvesting nodes & synchronizing nodes
NGDS Geographic Search
Search:
faults nevada
Young Faults, Nevada
Cenozoic faults mapped on high-altitude photography, classified by Dohrenwend as historic, undated, Holocene-Pleistocene, late Pleistocene, undifferentiated, Holocene, and volcanic. These classes are ...
Quaternary Faults of Nevada
This resource is 1:250,000 scale Quaternary Faults in Nevada, produced by the Nevada Bureau of Mines and Geology by Craig M. dePolo, 2008, published as a Web feature service for the AASG National Geot...
Quaternary Faults in Nevada - Online Interactive Map
This report is an online version of Nevada Bureau of Mines and Geology (NBMG) Map 167, Quaternary Faults in Nevada, published in 2008. Map 167 is available on the NBMG website Publication Sales page o...
Timing of Late Quaternary Faulting in the 1954 Dixie Valley Earthquake Area, Central Nevada
ABSTRACT - The 1954 Dixie Valley earthquake (M 6.9) in central Nevada produced about 3 m of total vertical displacement distributed across two principal fault zones along the east flank of the Stillwa...
RECONNAISSANCE GEOLOGIC MAP OF THE
United States
Mexico
Canada
NORTH PACIFIC OCEAN
Gulf of Mexico
Golfo de California


NGDS - National Geothermal Data System - Mozilla Firefox
File Edit View History Bookmarks Tools Help
Inbox (52) - christy.marie.caudill...
AZGS - Google Drive
Service Validation
DE_YR3_WaterWell_WellLogObs...
Delaware Well Log Observation ...
NGDS - National Geothermal Da...
central.usgin.org/ngds/map#
English
Home
About
Admin
Help
NGDS
CONTRIBUTING GEOTHERMAL DATA
MAP
Find data for a specific geographic area
LIBRARY
Look up data, images, publications & more
RESOURCES
Discover tools and models for geothermal exploration and development
CONTRIBUTE
Harvesting nodes & synchronizing nodes
NGDS Geographic Search
Search:
faults nevada
Young Faults, Nevada
Cenozoic faults mapped on high-altitude photography, classified by Dohrenwend as historic, undated, Holocene-Pleistocene, late Pleistocene, undifferentiated, Holocene, and volcanic. These classes are ...
Quaternary Faults of Nevada
This resource is 1:250,000 scale Quaternary Faults in Nevada, produced by the Nevada Bureau of Mines and Geology by Craig M. dePolo, 2008, published as a Web feature service for the AASG National Geot...
Show Area on Map
Show Web Map Service
Go To Dataset Details Page
Available Resources
Download PDF Resource
Web Map Service Capabilities
Web Feature Service Capabilities
Download Microsoft Excel Resource
External Website
Interactive Map
This report is an online version of Nevada Bureau of Mines and Geology (NBMG) Map 167, Quaternary Faults in Nevada,
Gulf of Alaska
Canada
Vancouver
Seattle
Portland
San Francisco
Las Vegas
Los Angeles
Phoenix
Tucson
El Paso
Albuquerque
Denver
Salt Lake City
United States
Chicago
Detroit
Milwaukee
Indianapolis
Louisville
Memphis
Oklahoma City
Dallas
Houston
Kansas City
Omaha
Minneapolis
Jacksonville
Miami
Bahamas
Cuba
Jamaica
Mexico City
Gulf of Mexico
Golfo de California
NORTH PACIFIC OCEAN
Caribbean Sea
Guatemala
Honduras
El Salvador
Belize


NGDS - National Geothermal Data System - Mozilla Firefox
File Edit View History Bookmarks Tools Help
Inbox (52) - christy.marie.caudill...
AZGS - Google Drive
Service Validation
DE_YR3_WaterWell_WellLogObs...
Delaware Well Log Observation ...
NGDS - National Geothermal Da...
central.usgin.org/ngds/map#
English
Home
About
Admin
Help
NGDS
CONTRIBUTING GEOTHERMAL DATA
MAP
Find data for a specific geographic area
LIBRARY
Look up data, images, publications & more
RESOURCES
Discover tools and models for geothermal exploration and development
CONTRIBUTE
Harvesting nodes & synchronizing nodes
NGDS Geographic Search
Search:
faults nevada
Young Faults, Nevada
Cenozoic faults mapped on high-altitude photography, classified by Dohrenwend as historic, undated, Holocene-Pleistocene, late Pleistocene, undifferentiated, Holocene, and volcanic. These classes are ...
Quaternary Faults of Nevada
This resource is 1:250,000 scale Quaternary Faults in Nevada, produced by the Nevada Bureau of Mines and Geology by Craig M. dePolo, 2008, published as a Web feature service for the AASG National Geot...
Show Area on Map
Hide Web Map Service
Go To Dataset Details Page
Available Resources
Download PDF Resource
Web Map Service Capabilities
Web Feature Service Capabilities
Download Microsoft Excel Resource
External Website
Quaternary Faults in Nevada - Online Interactive Map
This report is an online version of Nevada Bureau of Mines and Geology (NBMG) Map 167, Quaternary Faults in Nevada,
OREGON
Boise
IDAHO
Idaho Falls
Medford
Redding
Salt Lake City
Provo
UTAH
Yuba City
Sacramento
Vallejo
San Francisco
San José
Merced
Santa Cruz
Modesto
Salinas
Soledad
CALIFORNIA
St George
Las Vegas
Paso Robles
San Luis Obispo
Santa Maria
Flagstaff
Oxnard
Los Angeles
Santa Ana
ARIZONA
Phoenix
Oceanside
San Diego
San Luis Rio Colorado
Tucson


NGDS - National Geothermal Data System - Mozilla Firefox
central.usgin.org/ngds/map
English
Home
About
Admin
Help
NGDS
CONTRIBUTING GEOTHERMAL DATA
MAP
Find data for a specific geographic area
LIBRARY
Look up data, images, publications & more
RESOURCES
Discover tools and models for geothermal exploration and development
CONTRIBUTE
Harvesting nodes & synchronizing nodes
NGDS Geographic Search
Search :
geothermometry
Colorado Thermal Spring Water Geothermometry
The zipped Excel file compiles calculations of common chemical geothermometers for Colorado thermal springs. Data citations include Barrett, J. K. and Pearl, R. H. (1976), George, R. D., Curtis, H. A. ...
Alaska Powell and Cummings Geothermometry Analyses
This resource is a compilation of specific liquid and gas analyte suites for a California geochemical service which have been tailored for use in the analysis formulated by Powell and Cummings, 2010. ...
California Powell and Cummings Geothermometry Analyses
This resource is a compilation of specific liquid and gas analyte suites for a California geochemical service which have been tailored for use in the analysis formulated by Powell and Cummings, 2010. ...
Geothermal Water and Gas Geochemistry; Constructing Geothermometry Reports (Stanford)
The attached files include a paper as well as spreadsheets that allow input of water and gas analytes to produce ternary diagrams and other Excel graphics to create a geothermometry report. Citation: ...
Gulf of Alaska
Canada
United States
Mexico
NORTH PACIFIC OCEAN
Gulf of Mexico
Caribbean Sea
Vancouver
Seattle
Portland
Las Vegas
Los Angeles
Phoenix
Tucson
El Paso
Albuquerque
Denver
Salt Lake City
Chicago
Detroit
Milwaukee
Indianapolis
Oklahoma City
Dallas
Houston
Memphis
Jacksonville
Mexico City
central.usgin.org/ngds/map#


NGDS - National Geothermal Data System - Mozilla Firefox
English
Home
About
Admin
Help
NGDS
CONTRIBUTING GEOTHERMAL DATA
MAP
Find data for a specific geographic area
LIBRARY
Look up data, images, publications & more
RESOURCES
Discover tools and models for geothermal exploration and development
CONTRIBUTE
Harvesting nodes & synchronizing nodes
NGDS Geographic Search
Search: geothermometry
This resource is a compilation of specific liquid and gas analyte suites for a California geochemical service which have been tailored for use in the analysis formulated by Powell and Cummings, 2010. ...
California Powell and Cummings Geothermometry Analyses
This resource is a compilation of specific liquid and gas analyte suites for a California geochemical service which have been tailored for use in the analysis formulated by Powell and Cummings, 2010. ...
Geothermal Water and Gas Geochemistry; Constructing Geothermometry Reports (Stanford)
The attached files include a paper as well as spreadsheets that allow input of water and gas analytes to produce ternary diagrams and other Excel graphics to create a geothermometry report. Citation: ...
Show Area on Map
Go To Dataset Details Page
Available Resources
Download PDF Resource
Download Open XML Resource
Download Open XML Resource

Geothermal Water and Gas Geochemistry; Constructing Geothermometry Reports (Stanford) - National Geothermal Data System - Mozilla Firefox

File Edit View History Bookmarks Tools Help

Inbox (52) - christy.marie.c... | AZGS - Google Drive | Service Validation | DE_YR3_WaterWell_WellLo... | Delaware Well Log Observ... | NGDS - National Geother... | Geothermal Water and Ga...

central.usgin.org/dataset/geothermal-water-and-gas-geochemistry-constructing-geothermometry-reports-stanford

English | Home | About | Admin | Help

NGDS
CONTRIBUTING GEOTHERMAL DATA

MAP
Find data for a specific geographic area

LIBRARY
Look up data, images, publications & more

RESOURCES
Discover tools and models for geothermal exploration and development

CONTRIBUTE
Harvesting nodes & synchronizing nodes

/ Collections / Geothermal Water and Gas ...

Google+
Twitter
Facebook

Dataset extent

Map data CC-BY-SA by OpenStreetMap
Tiles by MapQuest

Ratings

0 reviews

Dataset | Activity Stream | Related

Edit | Follow

Geothermal Water and Gas Geochemistry; Constructing Geothermometry Reports (Stanford)

The attached files include a paper as well as spreadsheets that allow input of water and gas analytes to produce ternary diagrams and other Excel graphics to create a geothermomerty report. Citation: Powell, Tom and Cumming, William 2010. Spreadsheets for Geothermal Water and Gas Geochemistry. Thirty-Fifth Workshop on Geothermal Reservoir Engineering Stanford University, Stanford, California, February 1-3, 2010. SGP-TR-188 (https://pangea.stanford.edu/ERE/pdf/IGAstandard/SGW/2010/powell.pdf). Specific analyte suites in AASG Geothermal Project Powell and Cummings Geothermometry content model and services have been tailored for use in this analysis. See a specific dataset for the desired inputs. To create a service, see http://www.stategeothermaldata.org/data_delivery/content_models/powell_cummings_geothermometry. For further information on Stanford University's Geothermal Program, see https://pangea.stanford.edu/researchgroups/geothermal/.

Data and Resources

Paper: Spreadsheets for Geothermal Water and Gas ...
No description for this resource
Preview | Download

Liquid Analysis Excel Spreadsheets, Powell and ...
No description for this resource
Preview | Download

Gas Analysis Excel Spreadsheets, Powell and ...
No description for this resource
Preview | Download

BSU | Downloadable Files | Stanford University... | analytes | aqueous chemistry | chemical analysis | data | dissolved silica | document | geothermal | geothermal fluid | geothermal system | geothermometry

PROCEEDINGS, Thirty-Fifth Workshop on Geothermal Reservoir Engineering
Stanford University, Stanford, California, February 1-3, 2010
SGP-TR-188

SPREADSHEETS FOR GEOTHERMAL WATER AND GAS GEOCHEMISTRY

Tom Powell[1] and William Cumming[2]

[1]Mighty River Power
P.O. Box 445
Hamilton, New Zealand
email: tom.powell@mightyriver.co.nz

[2]Cumming Geoscience
4728 Shade Tree Lane
Santa Rosa CA 95405-7841
email: wcumming@wcumming.com

ABSTRACT

Two Excel spreadsheets released with this paper support many of the common graphical analyses of water and gas chemistry used to interpret hot spring, fumarole and well samples in geothermal exploration and development. Cross-plots and ternary diagrams are generated from measured concentrations of chemical species using formulas based on equilibrium reactions and empirical relationships. Typical applications include geothermometry, fluid and gas space and time trend characterization, and data quality assessment. The spreadsheets provide charting capability compatible with all versions of Excel from 1997 to 2007.

Liquid_Analysis_v1_Powell-2010-StanfordGW.xls takes tabulated water chemistry data input in ppm weight and stable isotope data in per mil and tabulates geothermometers and quality assurance parameters. Explanations for the calculations are referenced. Charts include the ubiquitous Giggenbach Na-K-Mg geothermometer ternary, three temperature "geoindicator" cross-plots, δ^{18}O-δD, Cl-enthalpy, and four commonly used trace element ternary plots. Brief outlines of applications reference publications that provide more detailed case histories.

Gas_Analysis_v1_Powell-2010-StanfordGW.xls takes gas analyses from steam samples in a variety of commonly reported units, makes an air correction (if needed) and plots four common ternaries, three3 "Y-T" gas geothermometer grids and two gas ratio

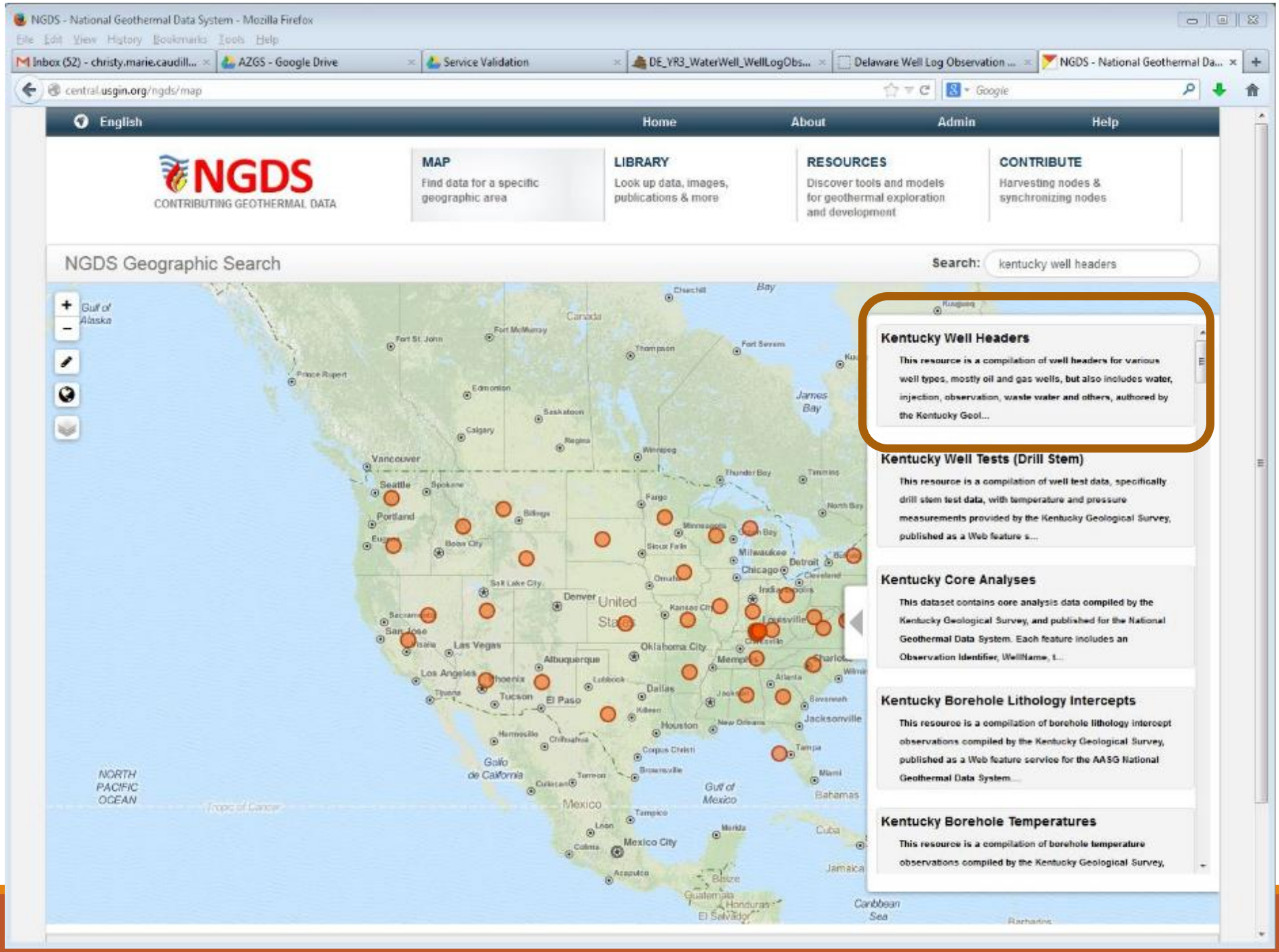
These spreadsheets are offered as freeware, without warranty of fitness for any purpose under the GNU General Public License 3, subject to users' reference to this paper in initial publications of work based on these spreadsheets.

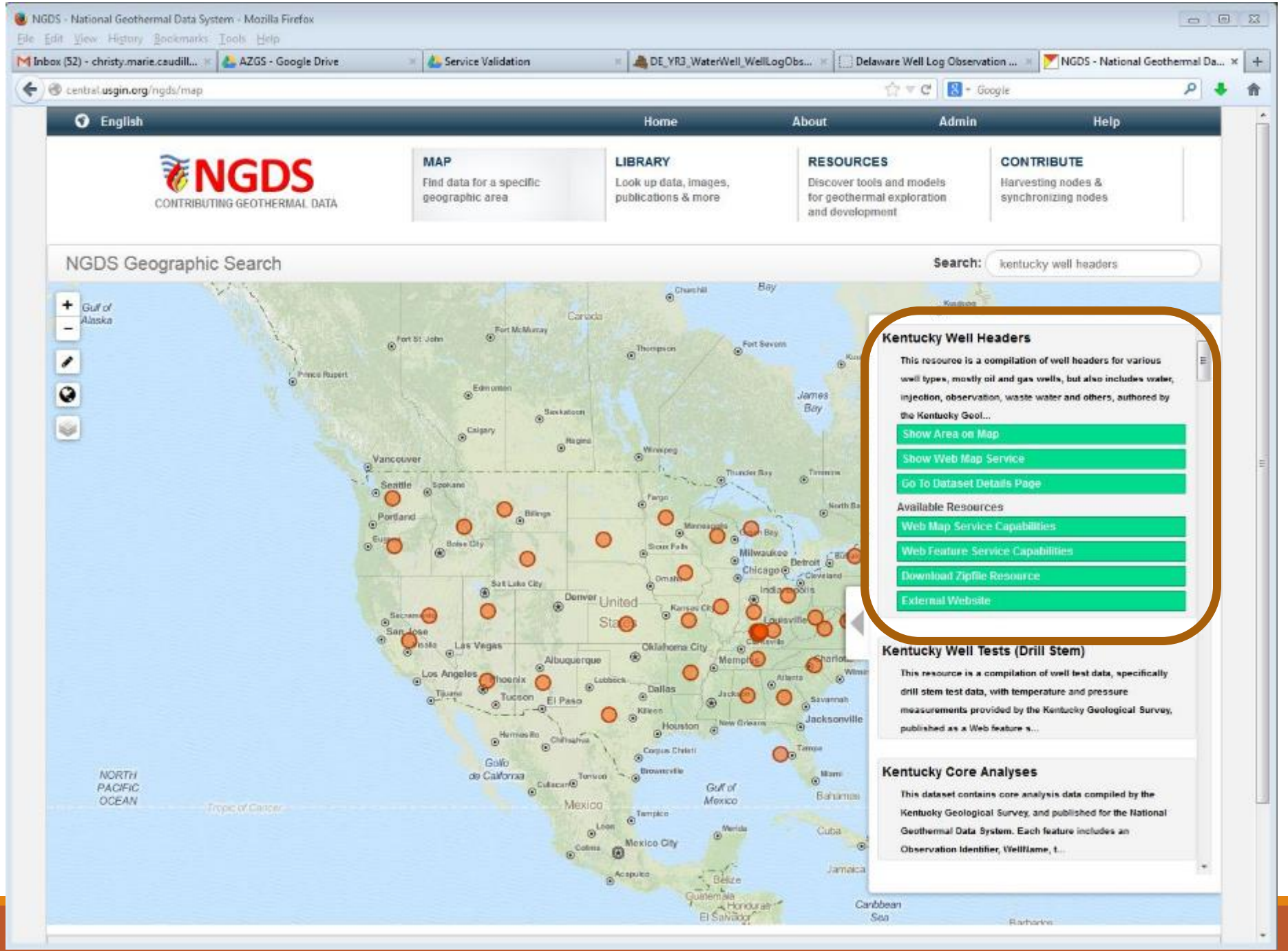
INTRODUCTION

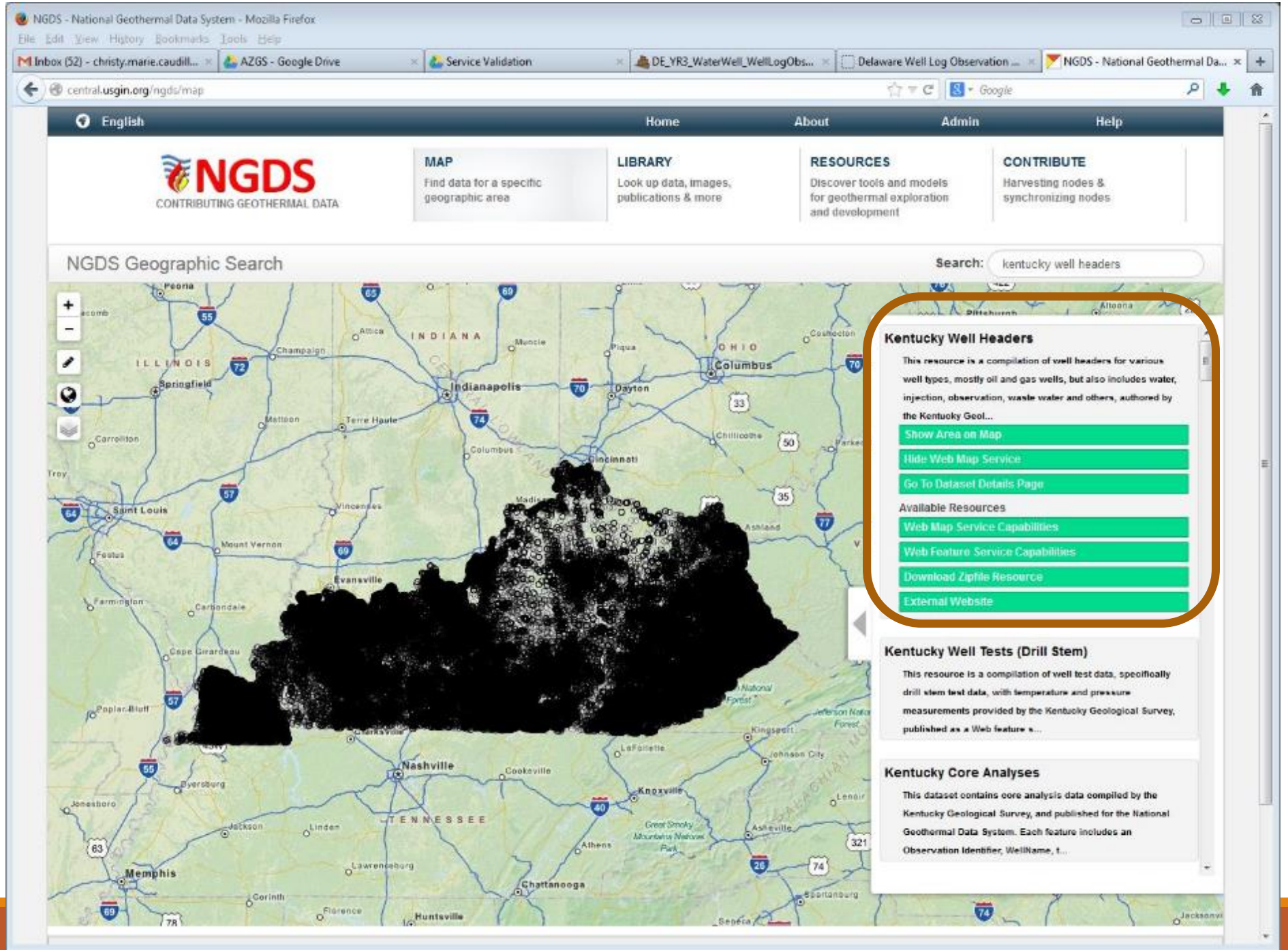
The genesis of this paper was the interest expressed by many people, particularly the second author, in a review paper that would describe the Excel spreadsheets that the first author developed as an aid to geothermal geochemistry interpretation. The Stanford Workshop on Geothermal Reservoir Engineering seemed an appropriate forum because the spreadsheets themselves could be included with this explanatory paper in the freely available online version of the Workshop Proceedings.

As a cursory outline of geochemistry interpretation tools, this paper uses references to clarify their application. A few texts have been written on the subject of geothermal geochemistry, although only Arnórsson (2000) is still in print. Despite being out-of-print, Nicholson (1993) is still a reasonably current general reference on geothermal geochemistry that can sometimes be found used. Ellis and Mahon (1977) is less current but often cited. Henley et al. (1984) is a useful teaching resource and reference for geothermal geochemistry problems and is available in digital form from the Society of Economic Geologists online bookstore.

Klein (2007) provides a summary and bibliography

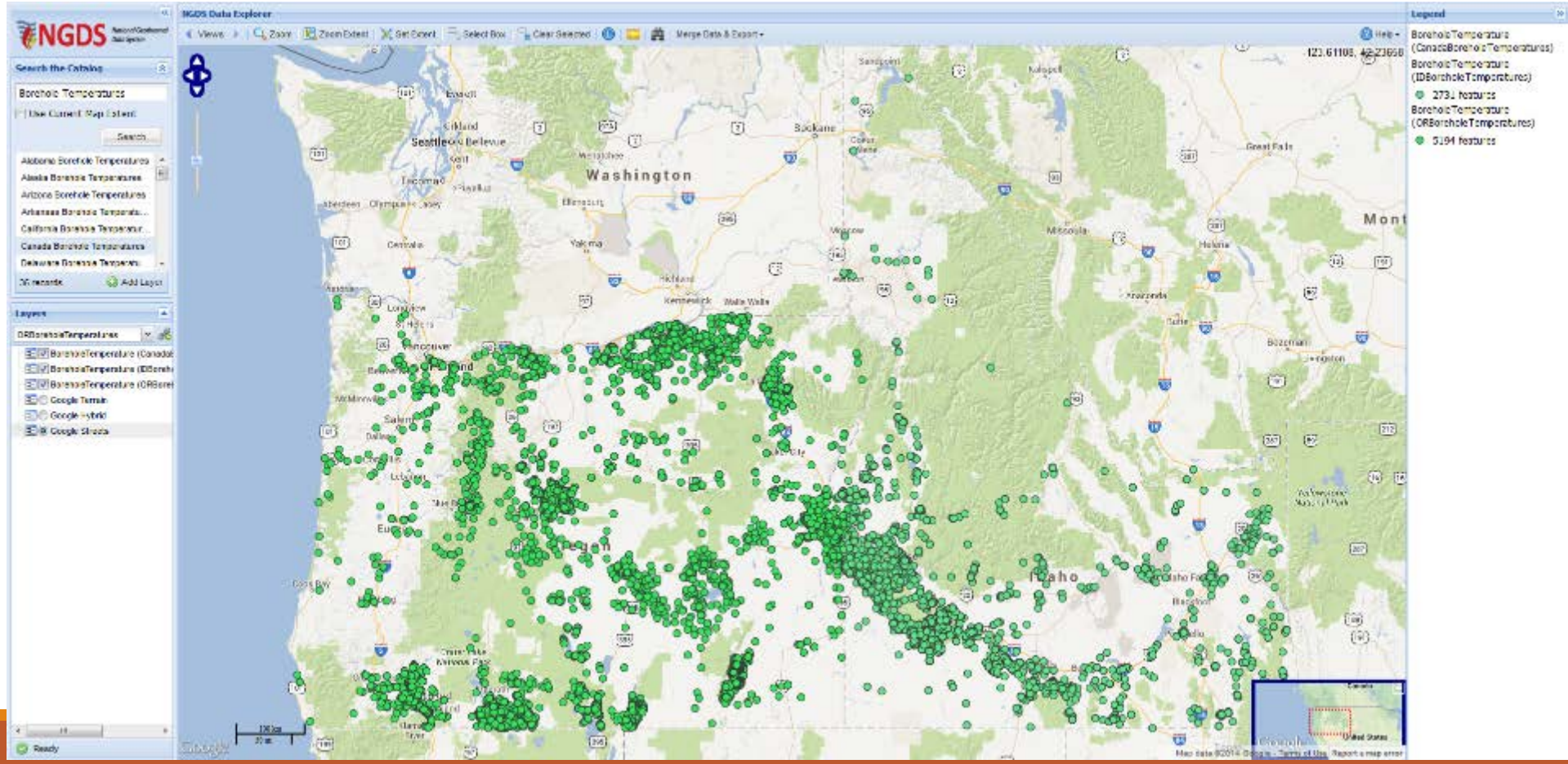

NGDS - National Geothermal Data System - Mozilla Firefox
central.usgin.org/ngds/map
English
Home
About
Admin
Help
NGDS
CONTRIBUTING GEOTHERMAL DATA
MAP
Find data for a specific geographic area
LIBRARY
Look up data, images, publications & more
RESOURCES
Discover tools and models for geothermal exploration and development
CONTRIBUTE
Harvesting nodes & synchronizing nodes
NGDS Geographic Search
Search:
kentucky well headers
Kentucky Well Headers
This resource is a compilation of well headers for various well types, mostly oil and gas wells, but also includes water, injection, observation, waste water and others, authored by the Kentucky Geol...
Kentucky Well Tests (Drill Stem)
This resource is a compilation of well test data, specifically drill stem test data, with temperature and pressure measurements provided by the Kentucky Geological Survey, published as a Web feature s...
Kentucky Core Analyses
This dataset contains core analysis data compiled by the Kentucky Geological Survey, and published for the National Geothermal Data System. Each feature includes an Observation Identifier, WellName, t...
Kentucky Borehole Lithology Intercepts
This resource is a compilation of borehole lithology intercept observations compiled by the Kentucky Geological Survey, published as a Web feature service for the AASG National Geothermal Data System...
Kentucky Borehole Temperatures
This resource is a compilation of borehole temperature observations compiled by the Kentucky Geological Survey,

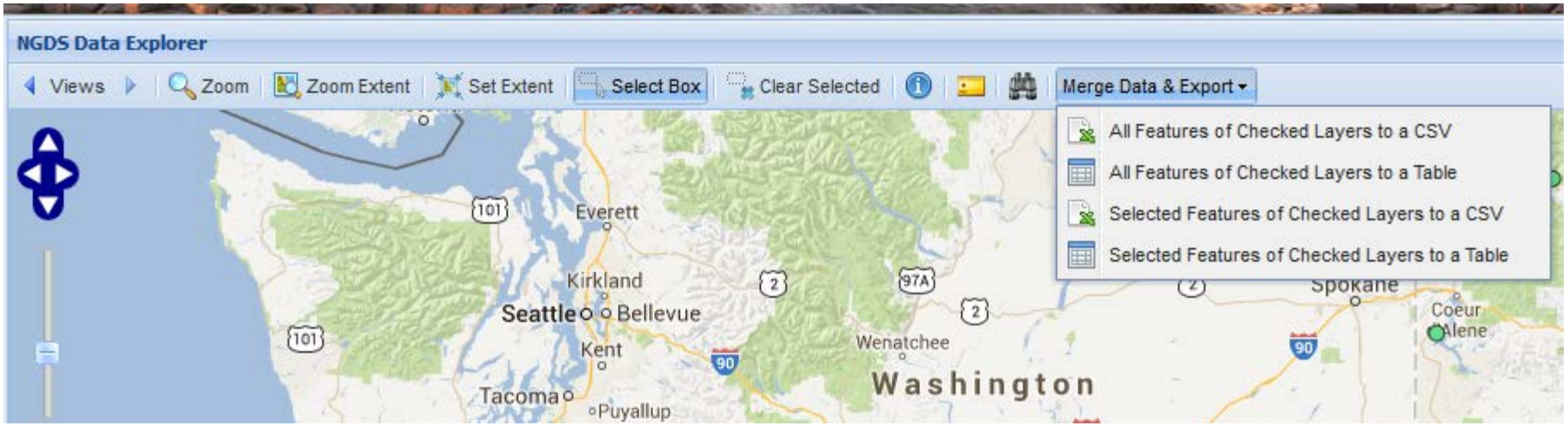

NGDS - National Geothermal Data System - Mozilla Firefox
File Edit View History Bookmarks Tools Help
Inbox (52) - christy.marie.caudill...
AZGS - Google Drive
Service Validation
DE_YR3_WaterWell_WellLogObs...
Delaware Well Log Observation ...
NGDS - National Geothermal Da...
central.usgin.org/ngds/map
English
Home
About
Admin
Help
NGDS
CONTRIBUTING GEOTHERMAL DATA
MAP
Find data for a specific geographic area
LIBRARY
Look up data, images, publications & more
RESOURCES
Discover tools and models for geothermal exploration and development
CONTRIBUTE
Harvesting nodes & synchronizing nodes
NGDS Geographic Search
Search:
kentucky well headers
Kentucky Well Headers
This resource is a compilation of well headers for various well types, mostly oil and gas wells, but also includes water, injection, observation, waste water and others, authored by the Kentucky Geol...
Show Area on Map
Show Web Map Service
Go To Dataset Details Page
Available Resources
Web Map Service Capabilities
Web Feature Service Capabilities
Download Zipfile Resource
External Website
Kentucky Well Tests (Drill Stem)
This resource is a compilation of well test data, specifically drill stem test data, with temperature and pressure measurements provided by the Kentucky Geological Survey, published as a Web feature s...
Kentucky Core Analyses
This dataset contains core analysis data compiled by the Kentucky Geological Survey, and published for the National Geothermal Data System. Each feature includes an Observation Identifier, WellName, t...
Gulf of Alaska
Canada
Vancouver
Seattle
Portland
San Francisco
Los Angeles
Las Vegas
Phoenix
Tucson
El Paso
Albuquerque
Denver
Salt Lake City
Oklahoma City
Dallas
Houston
Chicago
Milwaukee
Detroit
Memphis
Jacksonville
Mexico City
Gulf of Mexico
NORTH PACIFIC OCEAN
Tropic of Cancer
Caribbean Sea


NGDS - National Geothermal Data System - Mozilla Firefox
central.usgin.org/ngds/map
English
Home
About
Admin
Help
NGDS
CONTRIBUTING GEOTHERMAL DATA
MAP
Find data for a specific geographic area
LIBRARY
Look up data, images, publications & more
RESOURCES
Discover tools and models for geothermal exploration and development
CONTRIBUTE
Harvesting nodes & synchronizing nodes
NGDS Geographic Search
Search:
kentucky well headers
Kentucky Well Headers
This resource is a compilation of well headers for various well types, mostly oil and gas wells, but also includes water, injection, observation, waste water and others, authored by the Kentucky Geol...
Show Area on Map
Hide Web Map Service
Go To Dataset Details Page
Available Resources
Web Map Service Capabilities
Web Feature Service Capabilities
Download Zipfile Resource
External Website
Kentucky Well Tests (Drill Stem)
This resource is a compilation of well test data, specifically drill stem test data, with temperature and pressure measurements provided by the Kentucky Geological Survey, published as a Web feature s...
Kentucky Core Analyses
This dataset contains core analysis data compiled by the Kentucky Geological Survey, and published for the National Geothermal Data System. Each feature includes an Observation Identifier, WellName, t...
Indianapolis
Columbus
Cincinnati
Nashville
Memphis
Knoxville
Chattanooga
Evansville
Saint Louis
Springfield
Champaign
Terre Haute
Dayton
Cookeville
Huntsville
INDIANA
OHIO
ILLINOIS
TENNESSEE

Create your own portal!

Example: NGDS Data Explorer at http://data.geothermaldatasystem.org/

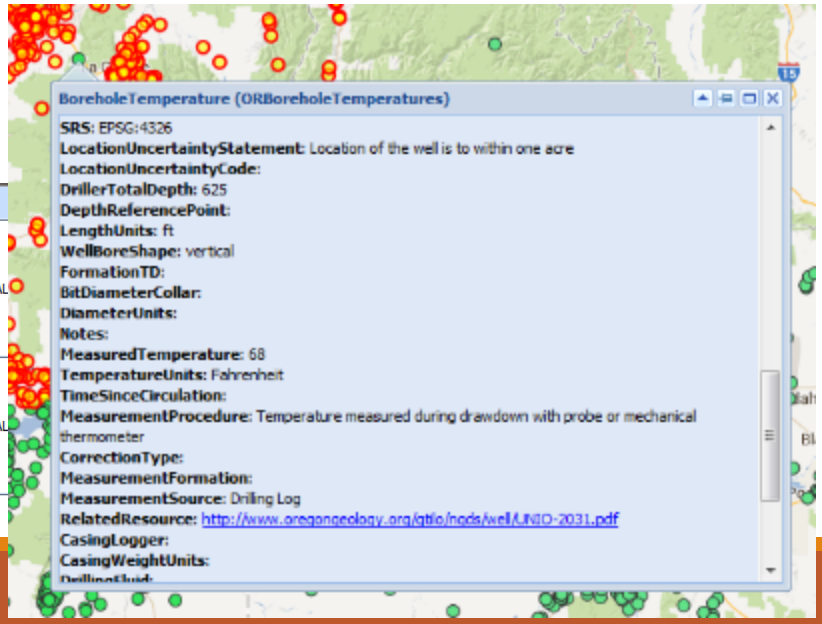




Data Explorer functions:

- Data Selection Across Data Sets (e.g. Washington and Idaho borehole temperatures)
- Export as CSV or HTML table
- Measuring Distance between points
- Point-by-point Data

Layer Name	OBJECTID	ObservationURI	WellName	APINo	HeaderURI	
BoreholeTemperature (ORBoreholeTemperatures)	2	http://resources.usgin.org/uri-gin/ogs/bhtemp/1_GP-049/	1		http://resources.usgin.org/uri-gin/ogs/well_pdf/1_GP-049/	VAL
BoreholeTemperature (ORBoreholeTemperatures)	13	http://resources.usgin.org/uri-gin/ogs/bhtemp/2_GP-049/	2		http://resources.usgin.org/uri-gin/ogs/well_pdf/2_GP-049/	VAL



Portal Demonstrations

Software of Your Choice

Node-In-A-Box Demo

What does the NGDS node-in-a-box do?

Create metadata records to register resources

Provide repository to upload files that need hosting

Expose metadata for harvesting by aggregators

For datasets conforming to an information exchange content model

- Validate schema
- Deploy data as WMS and WFS services

Spatial search map interface

Text search interface for non-geographic resources

Simple data browse and visualization

Why deploy a node

Straight-forward way to put datasets and documents in a repository and generate metadata that can be harvested to DOE (or other) aggregator

Technology to meet open data requirements

Standards-based solution, widely deployed

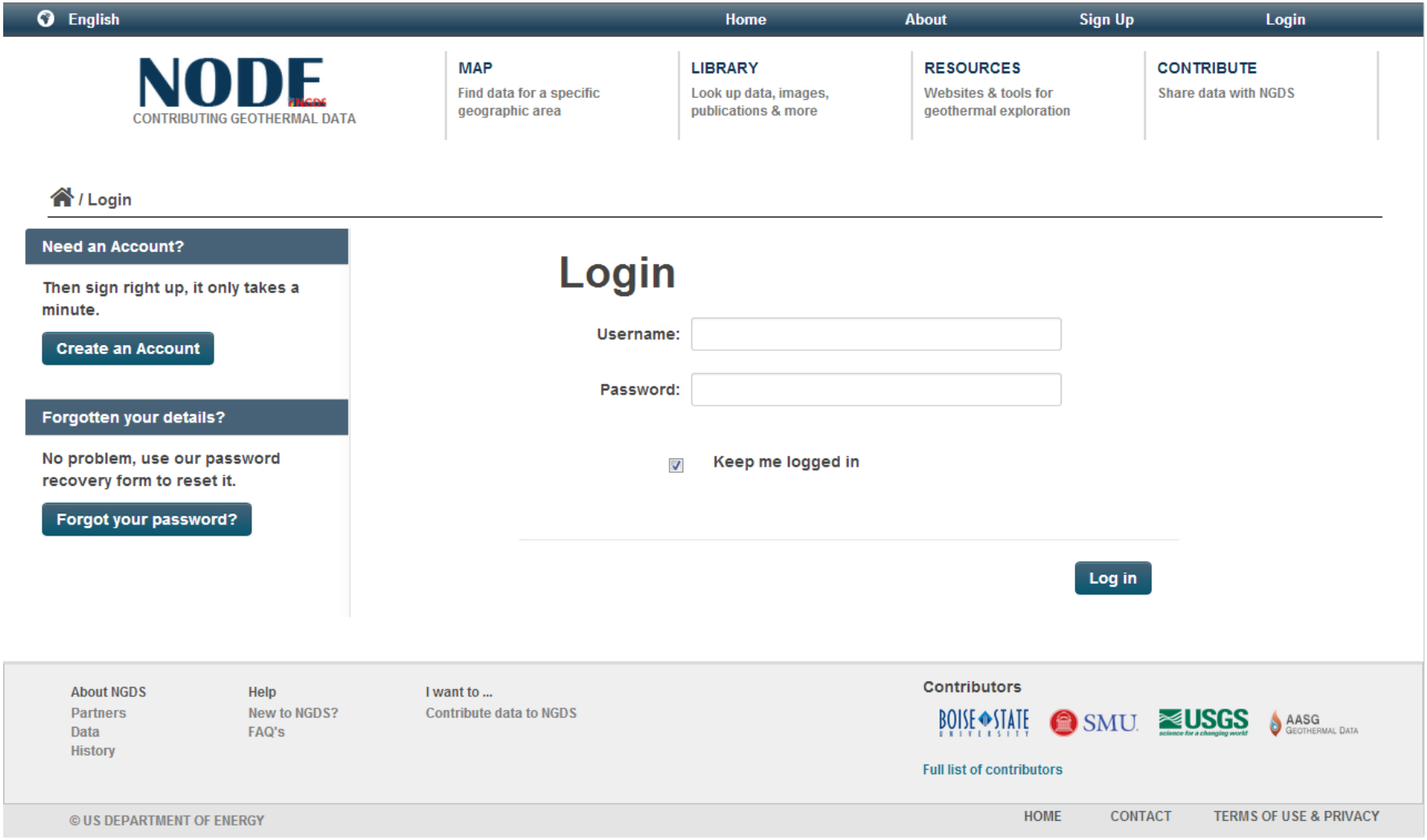
Community of users and developers facilitate maintenance and sustainability

Integration of your data with a growing worldwide network of other data providers

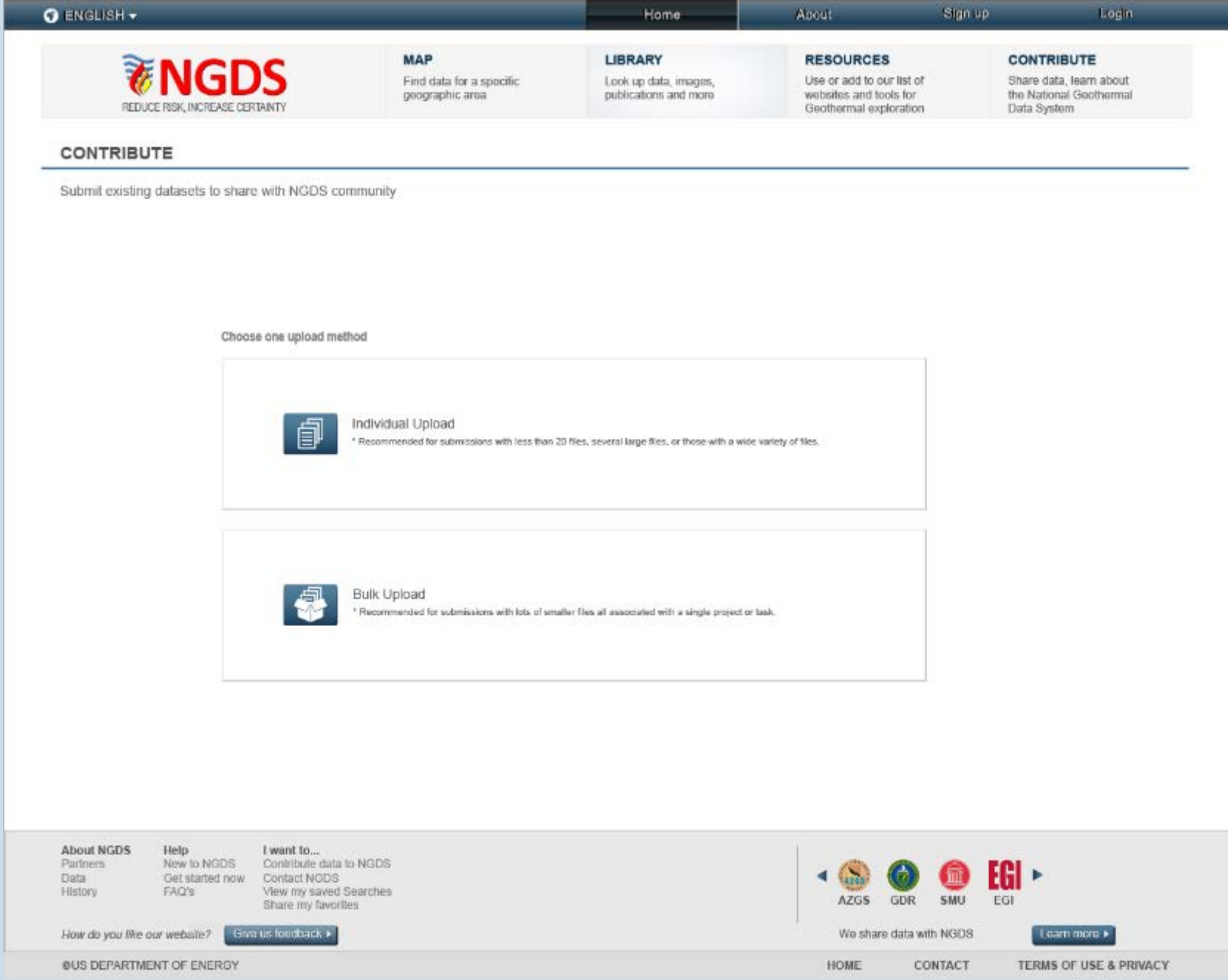
NIAB Contributing Forces

How do you deploy a Node?

1. Identify the host system (Linux or Windows w/ Linux VM)
2. Get the installer (download); run through the install process
3. Register resources with the system catalog


English
Home
About
Sign Up
Login
NODE
NGDS
CONTRIBUTING GEOTHERMAL DATA
MAP
Find data for a specific geographic area
LIBRARY
Look up data, images, publications & more
RESOURCES
Websites & tools for geothermal exploration
CONTRIBUTE
Share data with NGDS
/ Login
Need an Account?
Then sign right up, it only takes a minute.
Create an Account
Forgotten your details?
No problem, use our password recovery form to reset it.
Forgot your password?
Login
Username:
Password:
Keep me logged in
Log in
About NGDS
Partners
Data
History
Help
New to NGDS?
FAQ's
I want to ...
Contribute data to NGDS
Contributors
BOISE STATE UNIVERSITY
SMU
USGS
science for a changing world
AASG
GEOTHERMAL DATA
Full list of contributors
© US DEPARTMENT OF ENERGY
HOME
CONTACT
TERMS OF USE & PRIVACY

Contribute landing page



Contribute Section pages 1/4

ENGLISH

Home | About | Sign up | Login

NGDS
REDUCE RISK, INCREASE CERTAINTY

MAP
Find data for a specific geographic area

LIBRARY
Look up data, images, publications and more

RESOURCES
Use or add to our list of websites and tools for Geothermal exploration

CONTRIBUTE
Share data, learn about the National Geothermal Data System

CONTRIBUTE

Submit existing datasets to share with NGDS community

1. Create Dataset | 2. Add Resource | 3. Review

Title

URL

Description

Keywords

Category

Map Data Location

Locaiton Keyword

Author

Role

+ Add Author

License

Contribute Section pages 2/4

Keywords

Category

Map Data Location

Locaiton Keyword

Author

Role

+ Add Author

License

Publication Data

Quality

Lineage

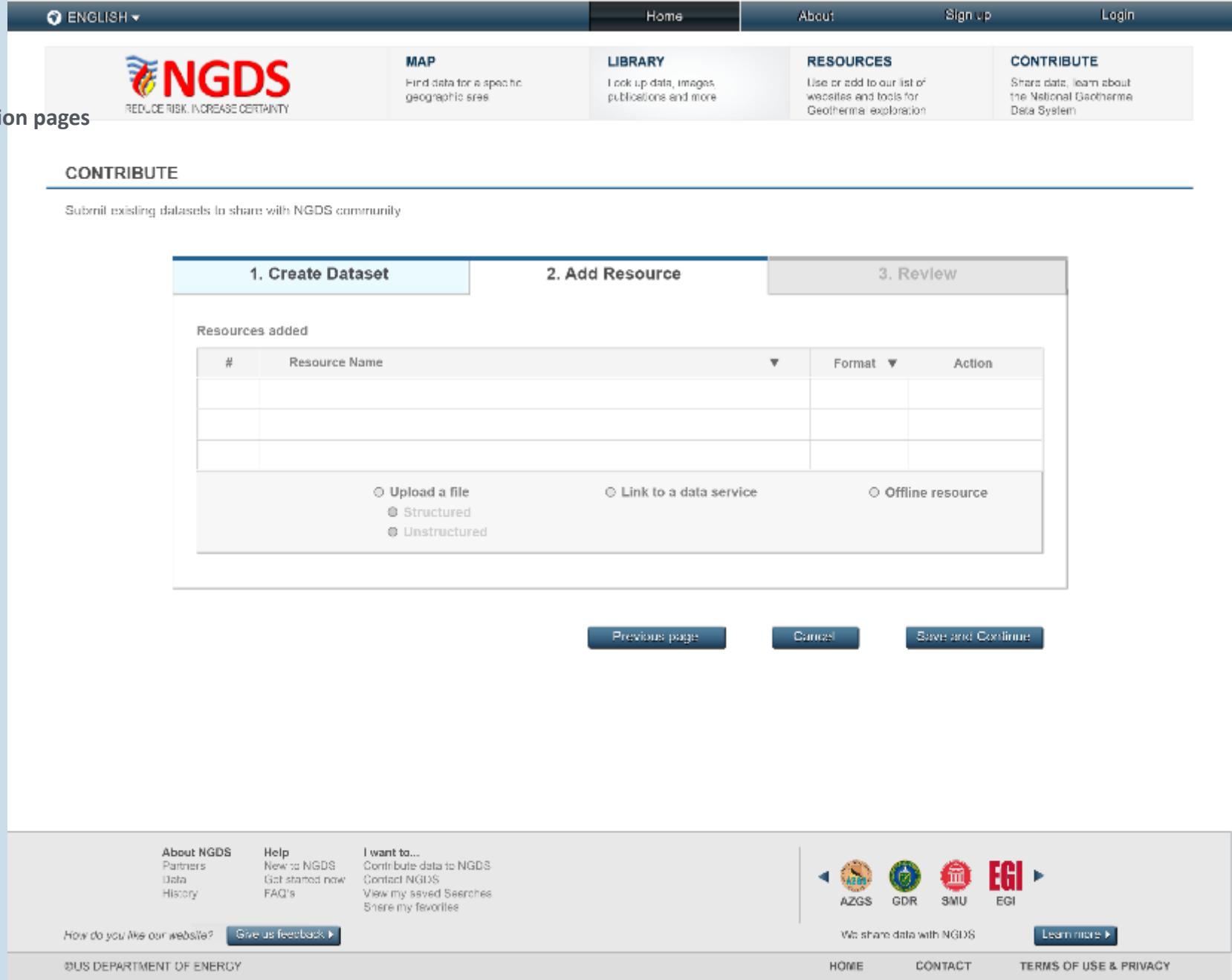
Status

Language

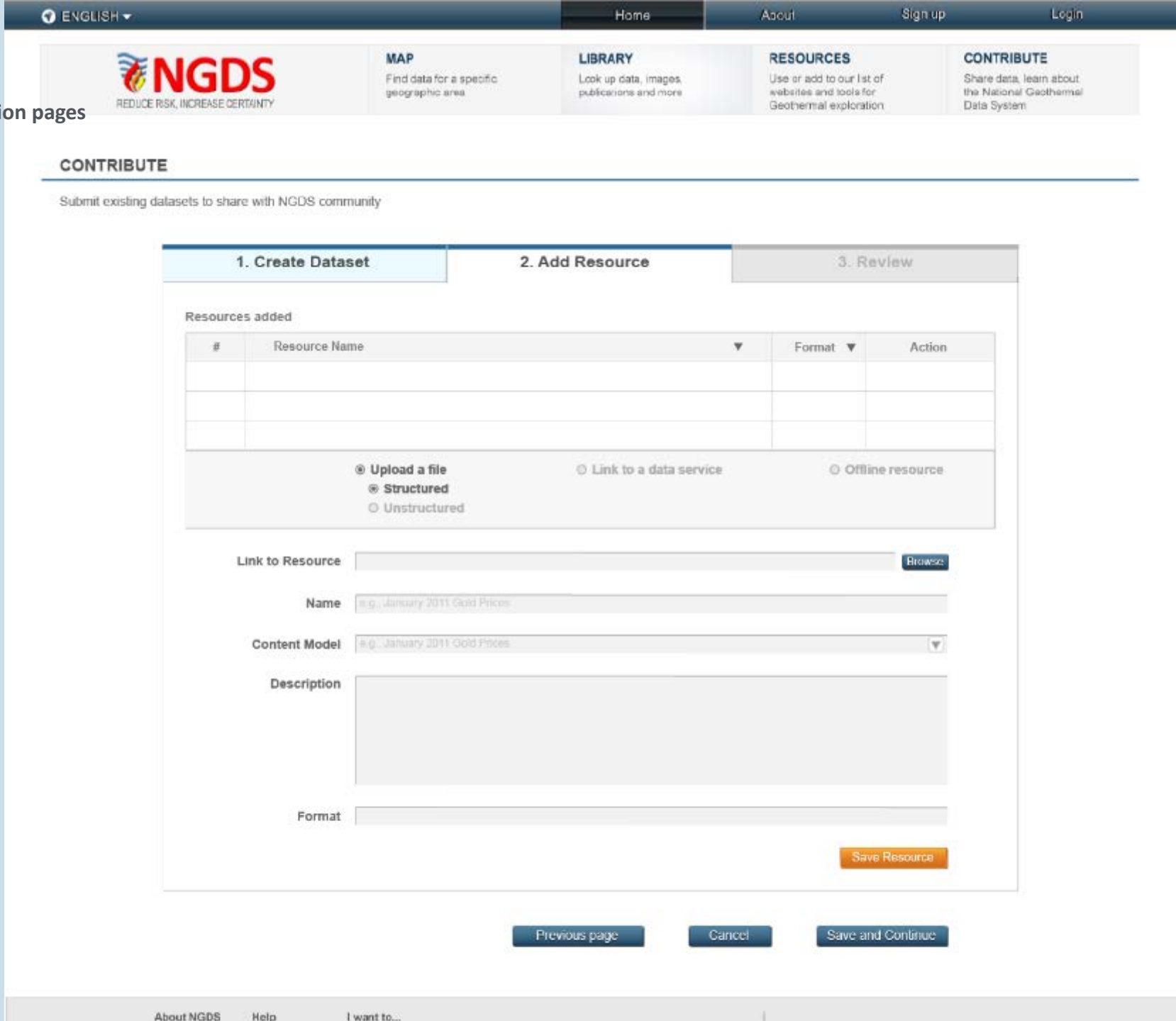
Cancel

Save and Continue

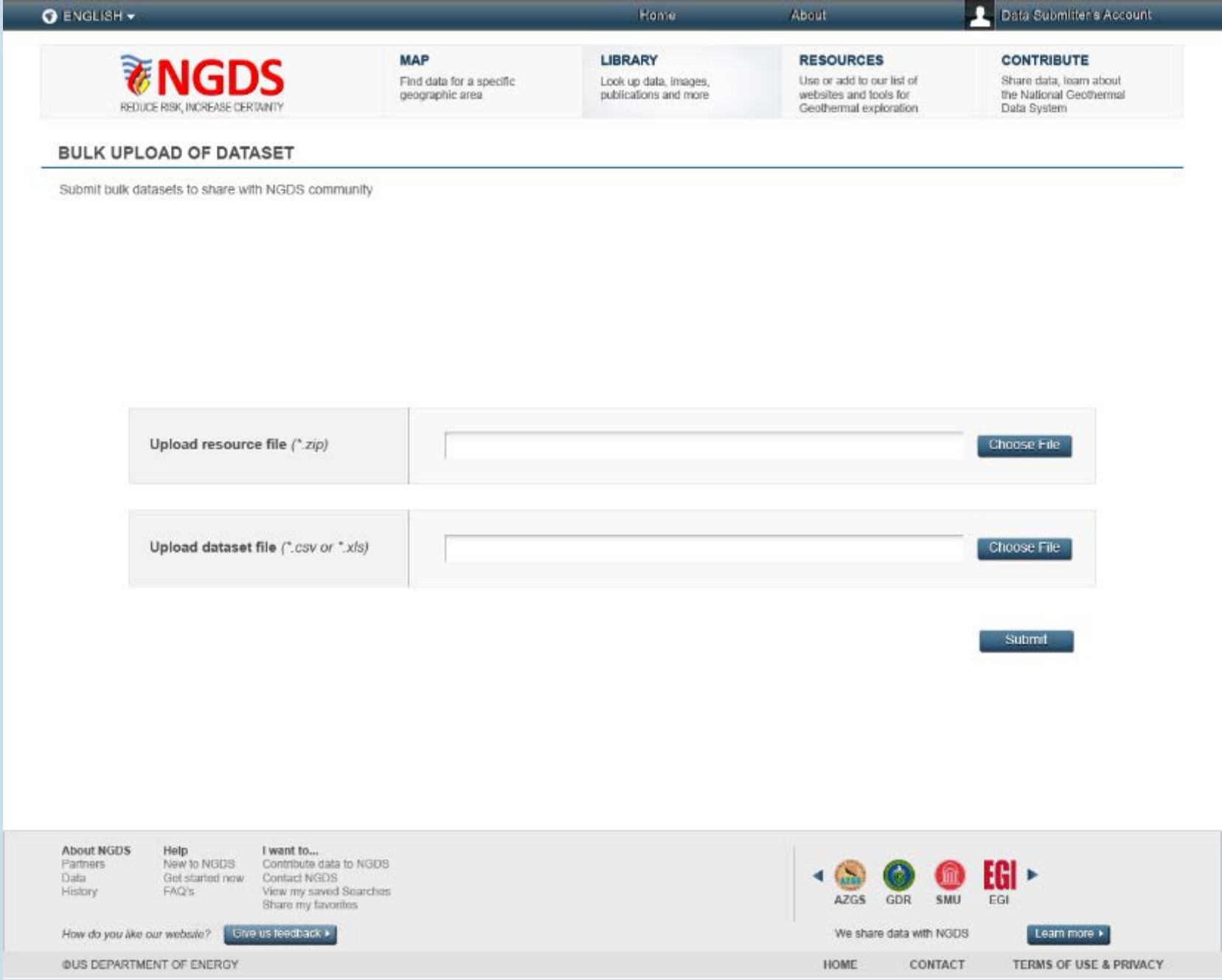
Contribute Section pages 3/4



Contribute Section pages 4/4



Bulk Upload 1/2



Bulk Upload 2/2

BULK UPLOADED RESOURCES

Status of uploaded resource files.

#	Data File	Resources File	Status	Comments	Uploaded Date	
1	Dataset_Files.xls	Unstructred Data resouce 21.zip	FAILURE	Data Error: No Standing data matching the input - ...	2013-04-15 17:55:30.024591	Details
2	Dataset_Files.xls	Structred Data resouce 24.zip	COMPLETED		2013-04-15 18:22:32.211774	Details
3	Dataset_Files.xls	Unstructred Data resouce 21.zip	INVALID	Mandatory field 'name' can't be empty.	2013-04-19 15:52:33.653928	Details
4	Dataset_Files.xls	Structred Data resouce 24.zip	COMPLETED		2013-04-19 15:55:49.384903	Details
5	Dataset_Files.xls	Unstructred Data resouce 21.zip	COMPLETED	Uploaded resource small_with_lat_long.csv is not ...	2013-04-19 18:10:00.492839	Details
6	Dataset_Files.xls	Structred Data resouce 24.zip	FAILURE		2013-04-19 18:15:32.521617	Details
7	Dataset_Files.xls	Unstructred Data resouce 21.zip	COMPLETED	Mandatory field 'name' can't be empty.	2013-04-19 18:17:12.439383	Details
8	Dataset_Files.xls	Structred Data resouce 24.zip	INVALID	Mandatory field 'name' can't be empty.	2013-05-15 20:16:40.439794	Details
9	Dataset_Files.xls	Unstructred Data resouce 21.zip	FAILURE		2013-04-19 18:15:32.521617	Details
10	Dataset_Files.xls	Structred Data resouce 24.zip	INVALID	Uploaded resource small_with_lat_long.csv is not ...	2013-04-19 18:17:12.439383	Details
11	Dataset_Files.xls	Unstructred Data resouce 21.zip	COMPLETED		2013-05-15 20:16:40.439794	Details
12	Dataset_Files.xls	Structred Data resouce 24.zip	FAILURE	Mandatory field 'name' can't be empty.	2013-05-15 20:16:40.439794	Details

Node Demonstration

In Closing

NGDS implements USGIN information exchange approach to data publication

NIAB provides a standards-based software stack for open data

Good documentation (metadata) for datasets is essential to making data discoverable and useful; it's not easy to get

Open data servers are infrastructure and require ongoing maintenance

NGDS is available to you TODAY and will only continue to improve, to test contact us at http://geothermaldata.org/contact

Scheduled full release April 2014!

AZGS NGDS Data & Development Team

Lee Allison, Principal Investigator, AASG State Geological Survey Contributions

Steve Richard, Geoinformatics Section Chief

Christy Caudill, Deputy Section Chief, Geoinformatics

Diane Love, Data Manager

Adrian Sonnenschein, Lead CKAN Developer

Leah Musil, Metadata Guru

Jessica Alisdairi, Programmer/Developer

Esty Pape, Information Technology Specialist

Kim Patten, Project Manager

Thank You!