

Regional Geology Interactive Web Based Mapping Application

Mid-FY2016 Milestone Report

Fuel Cycle Research & Development

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SUMMARY

This is a milestone report for the FY2016 continuation of the Used Fuels and Research program development of the Regional Geology Web Mapping Application by the Idaho National Laboratory Geospatial Science and Engineering group. This tool was developed for general public use and is an interactive web based application to visualize, reference, and analyze geological features of the US pertinent to the Used Fuel Disposal program. This tool is designed to facilitate capability and understanding of regional geology of the continental US.

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ACRONYMS

AOI – Area of Interest

ArcGIS – Suite of Esri's GIS software

DMZ – Demilitarized Zone

Esri - Environmental Systems Research Institute

FLEX – Open source application framework for building and maintaining expressive web applications

FY2016 – Fiscal Year 2016

IE – Internet Explorer

INL – Idaho National Laboratory

RGWM - Regional Geology Web Map

GeoSE – Geospatial Science and Engineering Group

GIS – Geographic Information System

LANL – Los Alamos National Laboratory

MXD – ArcGIS Map Document

NE - Office of Nuclear Energy

UFD – Used Fuel Disposal

URL – Uniform Resource Locator

US – United States

USGS – United States Geological Survey

UTM – Universal Transverse Mercator

REGIONAL GEOLOGY INTERACTIVE WEB BASED MAPPING APPLICATION MILESTONE REPORT

1. INTRODUCTION

As part of the US Department of Energy's Office of Nuclear Energy (NE) Used Fuel Disposal Program (UFD), Los Alamos National Laboratory (LANL) has developed GIS (geographic information system) data for understanding the relationships between potential geologic host rocks for a high-level nuclear waste repository and potential siting guidelines that could influence the eventual siting of a repository. NE has employed Idaho National Laboratory (INL) to provide this information to the public through a web-based interactive GIS application. This application will allow users to better understand potential siting issues for certain regions of the country including the presence or lack of potential host rocks, natural hazards, potential for future drilling of natural resources, and proximity to population centers.

This document serves as the FY2016 mid-year progress report for continuation of development of the Regional Geology Web Map (RGWM) application. This document is presented at a high level; INL project requirements were to develop, maintain, and host this application, which resides on INL's external GIS server and will take advantage of current GIS application hosting software licenses (ArcGIS for Server). It can be accessed at <https://gis.inl.gov/RegionalGeology>. The application has been built using FLEX, an open source Esri ArcGIS Viewer for Flex platform for web development. Due to INL's experience developing web map applications with this platform, the project realized a significant reduction in development costs. Flex is a common web based software application language used to develop rich mapping experiences in a web browser environment. The application is a server side application that does not require users to download software. Rather, the application is provided on a web-enabled server to users via an internet browser such as Internet Explorer (IE), Google Chrome, Mozilla Firefox, or Safari. The initial interface of RGWM can be viewed in Figure 1.

1.1 Spatial Data

The Regional Geology Application includes various spatial base reference and geological layers specifically identified and provided by LANL. The data are organized in five mapservices (e.g., published ArcGIS map documents (MXD)). Below is a list of those mapservices, associated layers and some descriptions of layers:

- **Base Reference Layers**
 - US Population Density - Only areas of greater than 1000 people per mile²
 - State Boundaries and Labels
 - Major Lakes of the US
- **Alternative Disposal Media**
 - Bedded Salt Formations
 - Raster layer(s) for 25 salt formation (depth only)
 - Vector layer (polygon) showing extents of areas of interest (AOI)
 - Vector layer (line) of contours within AOI showing depth intervals
 - Shale Formations
 - Raster layer(s) for 25 salt formation (depth only)

- Vector layer (polygon) showing extents of areas of interest (AOI)
 - Vector layer (line) of contours within AOI showing depth intervals
- **Potential Siting Guideline Data Layer**
 - Quaternary Faulting
 - Vector layer (line) showing the distribution of quaternary faults (USGS)
 - Vector polygon layer showing areas of Quaternary Faulting
 - Plio-Quaternary Volcanic Rocks
 - Vector layer (polygon) showing the distribution of Pleistocene and Quaternary volcanic rocks (USGS)
 - Sedimentary Rock Thickness (2000 meter contours)
 - Sedimentary Basins of the US - Outlines of the basins in the continental US and extending in the Gulf of Mexico
 - Oil and Gas Production
 - Vector layer (polygon) 0.5 km polygons showing location of oil and gas drilling (USGS)
 - Crystalline Basement Structures from Sims et al., (2005)
 - Magnetic Derived Structures
 - Thrust Faults associated with suture zones
 - Structure Types
 - High Angle Faulting
 - Ductile Shear Zone
 - Boundary of Major Rift Zones
 - Subsurface Heat Flow
 - Raster layer from Southern Methodist University (SMU)
 - Stress Fields – locations of known tectonic interactions
 - Seismic Hazard
 - Raster layer showing peak ground acceleration
 - Granitic/Gneissic Rock – Plutonic and metamorphic granitoid rock types
- **Depth to Basement Rock**
 - Contours of Sediment Thickness and labels
 - Depth to Basement – in meters
- **Aeromagnetic and Slope Maps**
 - Smoothed Topographic Slope in Degrees
 - Aeromagnetic Map of the Continental US
- **Federal Lands**
 - Map Service showing land administration for the US – (USGS Protected Areas Database map service)
- **ArcGIS Online Base Layers**
 - Aerial Imagery
 - Streets
 - USGS Topographic
 - Shaded Relief
 - Hybrid (Streets and Imagery)
 - Terrain Hybrid Streets and Shaded Relief

- This is the default background.
-

1.2 Tools

RGWM application provides users with a robust set of tools for referencing pertinent geological features and siting potential. The specialized tools are designed to allow for greater usability, referencing of data, and specific layer targeting. Below is the list of tools provided in the application:

- **Navigation** – This standard map tool provides navigation of the map by zooming to scale, panning, front and back zoom, directional pan, and return to last or original extent.
- **Base Layer Toggling Tool** – Gives users the option to switch between base layers of imagery, streets layer, shaded relief, and topographic layer depending on user background layer preference.
- **Scale Bar and Latitude/Longitude Coordinates** – These are additional standard map tools giving the user location and scale distance information. Tool automatically updates information while user interacts with application.
- **Overview Map** – Provides users with an overview map of the location of the current extent in the main map window.
- **Layer List** – This tool provides the user with the ability to interact with the data layers by turning them on and off, adjusting layer transparency, moving layers up and down in the table of contents, and provides descriptions of the data layers.
- **Identify** – This tool allows the user to identify specific features of visible layers. Users can identify on all layers visible or select a single visible layer.
- **Geological Unit Query Tool** – A suite of tools designed to provide the user with name of and depths of subsurface formations.
 - **Query by Location** – Allows a user to find the name and depth of a location on specific features of salt and shale units as well as depth to basement rock.
- **Analyze Tools**
 - **Viewshed** – This can be used to identify a topographic view shed (the area in the field that can be seen) of a specific location selected by the user.
 - **Elevation Profile** – This tool allows the user to see the elevation profile of a line that is drawn on the map by the user.
 - **Draw and Measure Tool** – This tool allows for a user to draw graphics on the map and get specific units of measure (area, distance) of those graphics.
 - **Add Excel Data** – If a user chooses to do so, they can add Excel data with coordinate attributes to the map and the RGWM will project them on the map.
- **Navigate Tools** – This suite of tools is designed to help user with some basic navigation of the RGWM.
 - **Locate Tool** – Allows the user to input Latitude and Longitude coordinates (decimal degrees, degrees – minutes – seconds, and Universal Transverse Mercator (UTM)). Also allows the user to specify an address of a location in the US (Street number, name, city, state). The tool will give the user ranked options depending on the specificity the address input.

- **Map Extents** – Map Extents allows the user to select default map extents across the US as well as add custom extents. These extents allow for quick zoom navigation to places that are of interest to the user.
- **Print Tool** - Allows a user to save or print the current visible map within RGWM.
- **Help and Feedback Tool** – Allows the user to provide the developers with feedback (bug reporting, comments, suggestions) and allow the user to utilize the help documentation for navigating and utilizing RGWM.

1.3 Export Control

For the software to meet functionality and policy standards, an overview was performed with the Scientific & Technical Information Management Systems (STIMS) team and review by INL's Export Compliance to gain approval for release to public use of the RGWM application. Review of the application found to have no security or functionality issues to address.

1.4 External Hosting of Application

To provide this application to the public, the INL has implemented a web-enabled server for GIS data and application which provided the host location of the RGWM. In FY2015, a number of issues were identified with the server's capabilities that were addressed before the RGWM could be deployed. For better workflow upgrades and installations of the Esri's ArcGIS suite of software were performed. Previous versions of ArcGIS for Server were problematic with security configurations before the updates were performed. ArcGIS for Desktop was also installed to improve the efficiency of publishing mapservices used in the RGWM.

1.5 Software Development Testing and Migration

Using INL's GeoSE development workstations, RGWM was tested for functionality of layers and tools. The application was then compiled and migrated to an application beta testing server within the INL internal network. The testing environment allowed for members of the GeoSE group to test functionality in a server environment similar to the host server. Once functionality was considered satisfactory, the application and data were migrated to the INL external ArcGIS for Server on the INL's Demilitarized Zone Network (DMZ) for use by the public. The RGWM is currently functional and publically accessible. It can be accessed by the following Uniform Resource Locator (URL):

<https://gis.inl.gov/regionalgeology>.

1.6 Maintenance

Maintenance of the RGWM is anticipated to continue through FY2016 and performed by the developers. The RGWM is deployed with a Help and Feedback tool that allows users to give feedback and report software bugs. This tool sends the development group an email with the users' comments and contact information. As part of the maintenance, the RGWM,

administrators and developers are expected to respond to the user feedback and resolve issues in a timely manner.

1.7 Summary: What's New for FY2016

In summary, the 1st half FY2016 advances and changes to the RGWM include the following:

- Additional Query to Geological Units Depth Tools includes depth to Salt Formations, Shale Layers, and Depth to the Basement Rock. Revamp tool is more intuitive in finding depth to featured values.
- Reorganization and republishing of mapservices to include additional layers (e.g. Granitic Rock, Depth to Basement Rock, Stress Fields) and reorganized layers (e.g. Sedimentary Basins, SMU Heat Flow Map, Aeromagnetic Map, US Federal Lands)
- Refined attributes of mapservices layers to have a more informative and better user experience using the Identify Tool.
- Added USGS real-time Seismic Data tool. This display the near-real time seismic activity for the globe within the last week.
- Added default regional extents to the Map Extents Tool.
- Added a Launch window to explain the utility of the RGWM. It also allows user to turn off Launch window for future use of the application.
- Added Help and Feedback tool. Users can use this to go to a web based user help guide for the RGWM application and data as well as provide feedback to developers about the application. The tool also provides some general information about the UFD program.
- Added additional hybrid basemaps that include the US Transportation Network layered on either aerial imagery or topographic relief.
- The Banner (top toolbar) look and feel was revamped with more spacing between tools.
- Logos and User Interface were altered to give a more unique UFD feel to the RGWM.
- Help manual was updated to 2016.
- Updated ArcGIS for Server to 10.3.1 on host server.
- Added ArcGIS Desktop 10.4 software to host server to aid in more efficient publishing of mapservices.

1.8 Mid FY2016 Look Ahead

As maintenance and customer support will continue through FY2016, the GeoSE group will focus its efforts on migration of the RGWM Flex version to a JavaScript version for the remaining FY2016. RGVM is built using the open source Esri Application Program Interface

(API). This API uses Adobe Flash ActionScript programming language which will be unsupported on limited bases in the near future by most web browsers in use today. Although Flash technology will still have limited use, the current trend in web map development is to use JavaScript. GeoSE intends to migrate the application to a JavaScript web map application to better insure the longevity of the application for RGWM users in a path forward.

These efforts will only require a makeover of the application itself which includes the user interface and tools within the applications. The JavaScript migration development will require no foreseeable new programming development or server software. Also, the spatial data and mapservices currently published for the RGWM will be used in this application. The application development will be performed either using Notepad++ with debugging console utility or Esri's JavaScript API development sandbox. Resources for techniques, tools, and problem solving forums are provided through web based GitHub and GeoNet which the GeoSE group intends to use for support. As well, members of the GeoSE team have taken training courses in JavaScript and testing other applications similar to RGWM JavaScript developments in anticipation of the RGWM migration.

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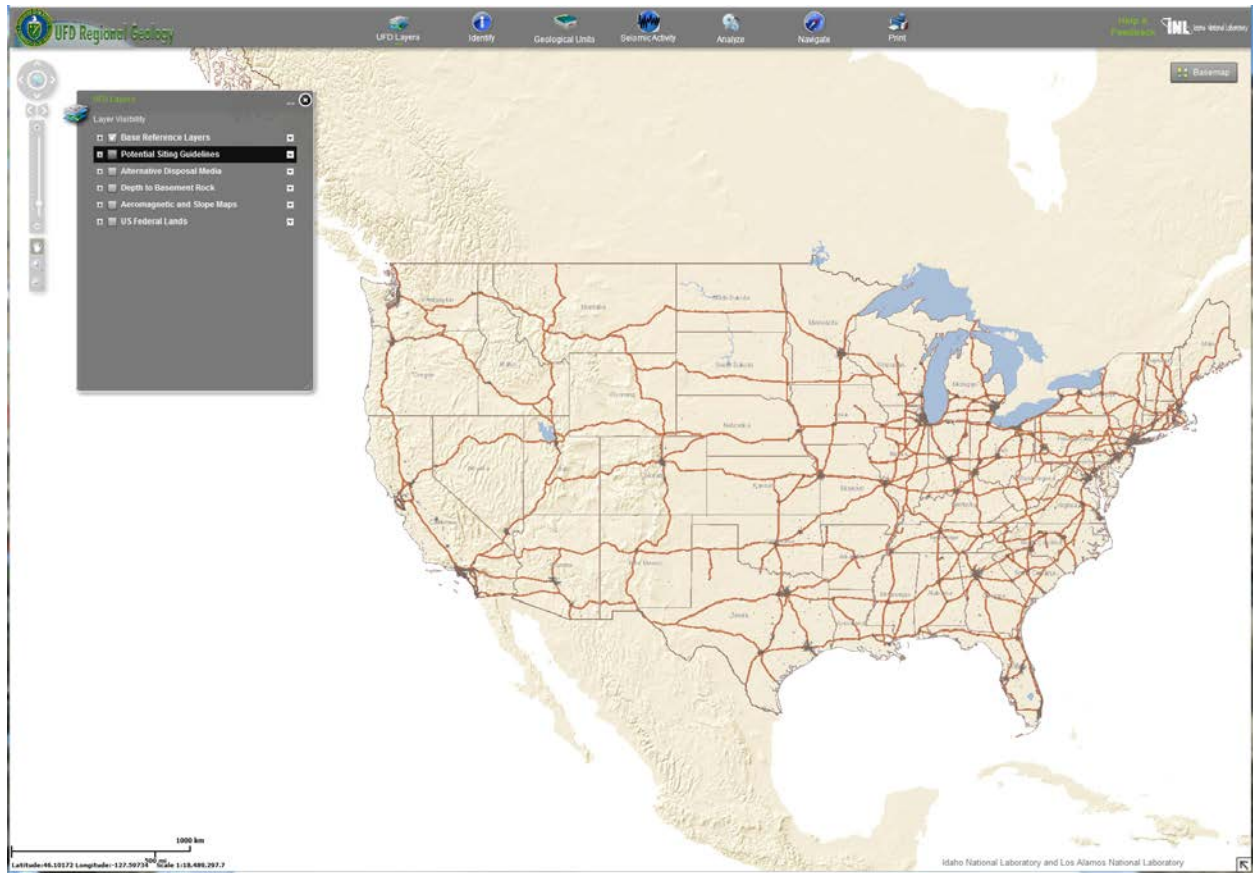


Figure 1. Regional Geology Web Mapping Application.