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Icelandic Geothermal Database; An Online Interactive Map Interface

Steinunn Hauksdóttir[1], Helga Tulinius[2] and Bjarni Reyr Kristjánsson[1]

[1] ISOR, Iceland GeoSurvey[1], Orkugardur, Grensásvegi 9, 108 Reykjavik, Iceland

[2] Orkustofnun, Orkugardur, Grensásvegi 9, 108 Reykjavik, Iceland

sth@isor.is, htul@os.is, brk@isor.is

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ABSTRACT

ISOR (Iceland GeoSurvey) and Orkustofnun together manage a database on energy research and utilization. The database includes datasets describing natural geothermal activity and utilization of geothermal energy in Iceland; a geothermal database.

The dataset describing geothermal fields includes: name, location, maximum temperature, maximum flow as well as classifications based on temperature and form of activity. Geothermal fields comprise one or many sites, wells or hot springs. The datasets for hot springs include: name, location, temperature, flow, photos, list of references and list of chemical analyses. Similarly for geothermal wells the dataset includes; name and location, year and purpose of drilling, photos, list of well measurements, chemical analyses and references.

The objective of the Gagnavefsja interactive map interface is to create a common application management system to manage the repository of the Oracle database and to serve as a data portal using ArcSDE and ArcIMS (Internet Map Server) software (ESRI webpage).

The map interface is designed with various user groups in mind; a) the scientists at Orkustofnun and Iceland GeoSurvey, to search and access the data and to perform in-depth analysis, b) the public, which is allowed to search the datasets using an interactive map of Iceland, c) the power companies and district heating services, to access and view raw data, interpretations and reports involving utilization monitoring and research of geothermal reservoirs and d) students at the United Nations University Geothermal Programme, hosted at Orkustofnun.

This paper describes the datasets including the geothermal data, the Gagnavefsja interface with tools for viewing and manipulating the map display, as well as the applications of the interface today and in the future.

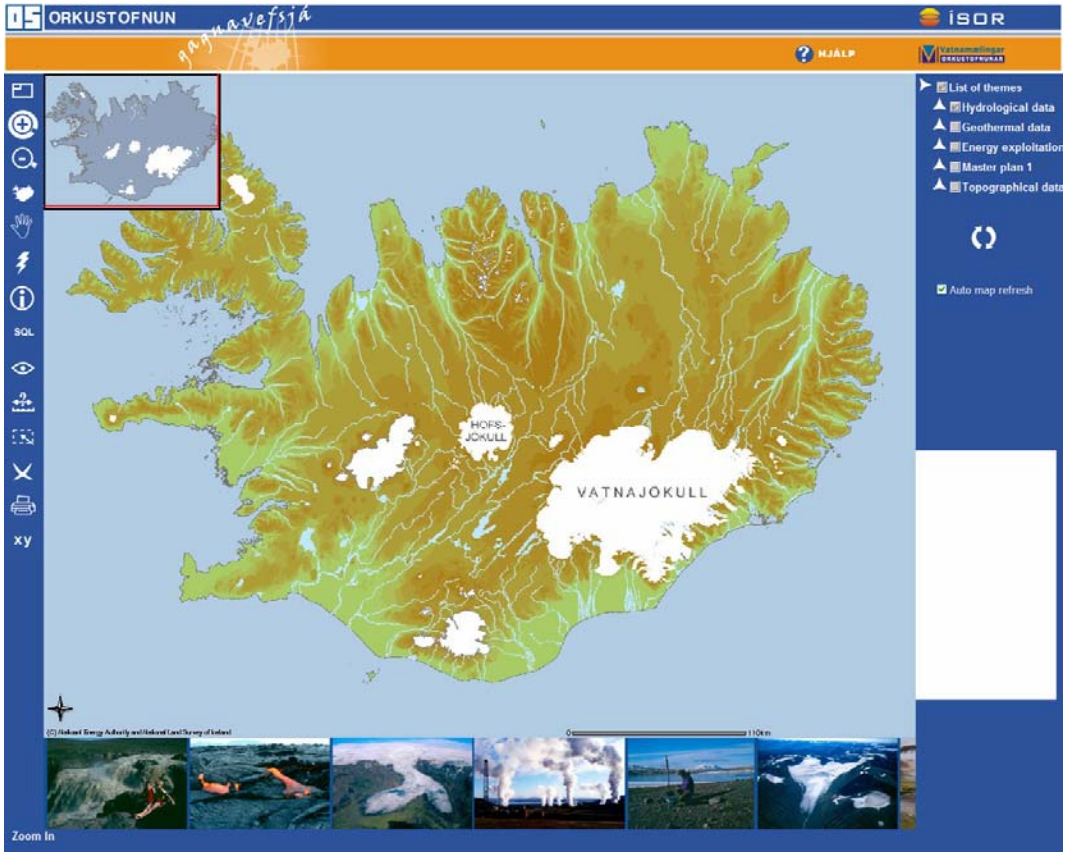

Figure 1. The Gagnavefsja interface.

1. INTRODUCTION

Orkustofnun (National Energy Authority) works under the auspices of The Ministries of Industry and Commerce according to the law of Orkustofnun (no. 87/2003) and the Electricity Act (no. 65/2003). The responsibilities of Orkustofnun include: a) to conduct research on energy issues, accumulate information, and maintain a database of knowledge on energy resources, b) to collect basic data on hydrological conditions, on the hydrological budget of Iceland's freshwater and geothermal resources, as well as to collect data on various natural and environmental processes, c) to disseminate knowledge on the exploration and exploitation of geothermal resources to developing nations, d) to execute administrative functions on behalf of the Icelandic government and serve as a governmental advisor on energy issues and d) to provide the Ministry of Industry with advice on licenses granted for exploitation and research of energy and mineral resources.

Orkustofnun and its predecessor (State Electricity Authority) have collected Icelandic geothermal reservoir data for over 50 years. Currently, Orkustofnun manages the repository together with ISOR (Iceland Geosurvey; the former GeoScience Division of Orkustofnun) in a relational Oracle database. The work has been ongoing since 1989, but there is still a significant amount of data that is not yet available in structured datasets in the database. Iceland GeoSurvey is a service and research institute providing specialist services to the Icelandic power industry, the Icelandic government and foreign companies, in particular in the field of geothermal sciences and utilization. Data acquired by Iceland GeoSurvey for the power industry companies is stored in the database according to an agreement between Orkustofnun, ISOR and the customer respectively. The database therefore includes comprehensive data on exploration, drilling, geothermal system management and exploitation.

Gagnavefsja 1.0, the first edition of an online interactive map interface, was launched in March 2004 (Figure 1). This interface makes it possible for all geographically located data in the database to be accessed and information on the data to be viewed and/or downloaded. The applications of Gagnavefsja include: visualizing the data, enhanced capabilities to analyze data in a spatial context and to combine spatial selection with relational database query.

In addition to geothermal data the Gagnavefsja interface also includes layers describing hydrological data (supervised by the Hydrological Service of Orkustofnun) and topographical data.

The government of Iceland has initiated a Master Plan for the utilization of hydroelectric and geothermal energy resources in which many of proposed power projects have been evaluated. This information along with planned utilization and abandoned projects is compiled in the database and accessable with Gagnavefsja.

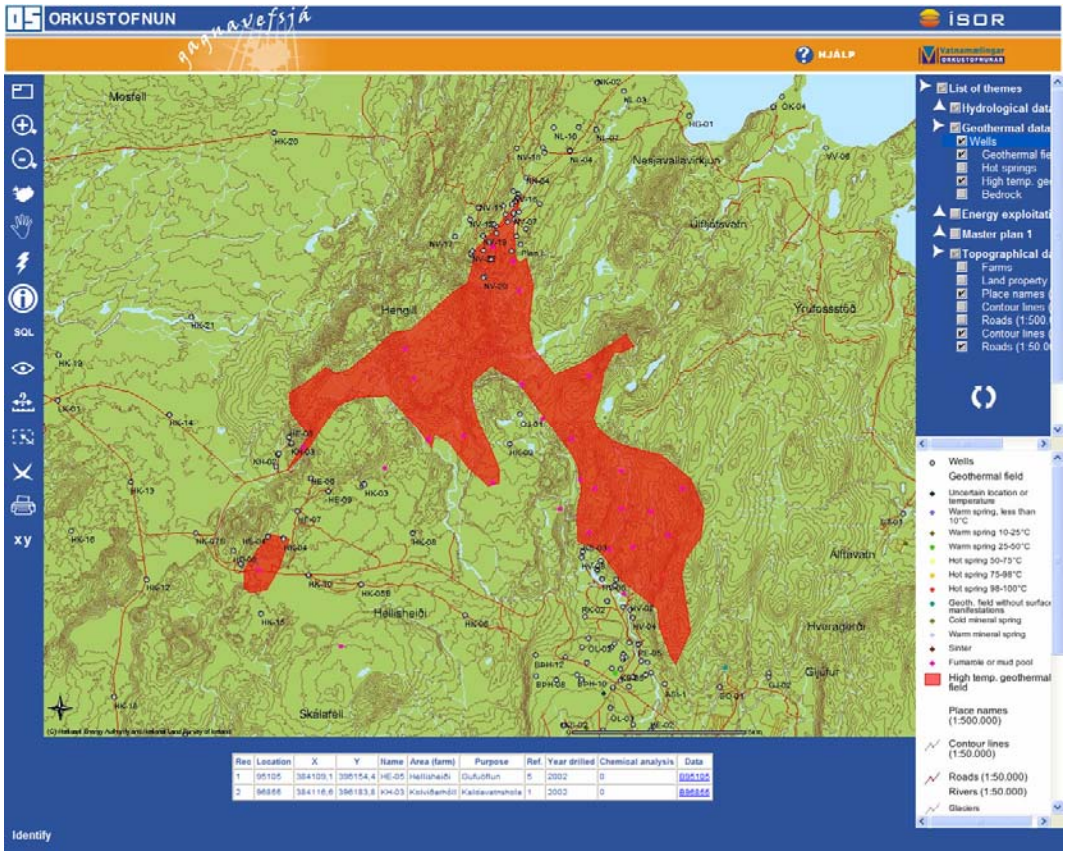

Figure 2. Gagnavefsja showing layers of wells, high and low temperature geothermal fields with rivers, lakes and roads from the Hengill area. The attribute table below the map contains a hyperlink for further data access and downloading (Björnsson G. et al., 2005).

2. THE DATABASE

The database of ISOR and Orkustofnun is managed by an Oracle relational database, where the data is linked to geographical coordinates, points or areas. ArcIMS layers are created from the different datasets from the database tables. The layers in Gagnavefsja describing geothermal resources and utilization are:

Geothermal field. The attributes include: coordinates, name, geographical location (farm(s)), county, maximum flow and temperature.

Hot springs. The attributes include: coordinates, name, geothermal field, temperature and flow.

Wells. The attributes include: coordinates, name, area (farm), geothermal field, purpose of drilling (e.g. production, exploration, reinjection), year drilled, depth, well measurements, number of references and number of chemical analyses.

District heating systems. The entity is the company utilizing geothermal energy and the attributes include: coordinates, geothermal area utilized, wells/springs utilized, installed MWt, temperature in wells/springs and in distribution system, total length of distribution system and population served by system.

Swimming pools. The entity is a swimming pool and its attributes include: coordinates, name, energy used, year of construction, cubic measure, area as well as technical attributes concerning water use and setup.

Power plants: The is a the power plant producing electricity to the national grid and its attributes include; coordinates, name, geothermal area, operating company, year of installation, installed MW and the production last year.

3. THE INTERFACE

Gagnavefsja was developed as an Internet based query tool to provide a platform for accessing, searching and analyzing data from the database.

The software is running on a Windows 2003 server. From the Oracle database the datasets are converted into shapefiles with ArcSDE, and with ArcIMS the layer can be queried to return a subset of tables or features viewed on topographical maps (Figure 3). The Gagnavefsja interface is accessible from the websites of Iceland GeoSurvey (www.isor.is) and Orkustofnun (www.os.is). For the most part, the design of Gagnavefsja is based on standard views from ArcIMS, but considerable effort was put into making it representative of the companies as well as making the tools easy to use. On the left side of the interface are the different tools used to make queries and to make spatial selections on the map. The tool functions are as follows:


Toggle the overview map. By clicking the mouse on the overview map the user can move between areas.


Zoom in. The area of interest is enlarged by clicking on one point for a preset zoom or holding the right mouse button to form a box outlining the area of interest. The box will appear in red on the overview map.


Zoom out. The user makes the area of interest larger with a mouse-click or by drawing a box around the area to zoom out from.


Zoom out to full map extent (the basemap of Iceland).


Pan to see adjacent area. By holding the right mouse button down while moving it, the map can be scanned in any direction.


Hyperlink. The tool activates webpages linked to points, lines or fields on the map interface.


Identify. Attributes of selected locations in an active layer can be viewed by using this tool.

Query. Tool for building queries to search the database.


Find. Tool for searching the database by using simple text strings.


Select by rectangle. For an active layer this tool makes it possible to select more than one location and attribute table is displayed automatically.


Measure. A tool for measuring distances on the maps.


Clear selection.


Print. This tool makes the view, map and legend ready for printing and allows for adding a header to the map.

Copy coordinates. By clicking the mouse on the map interface the coordinates (Lambert conical and geographical) become available for copying in a separate window.

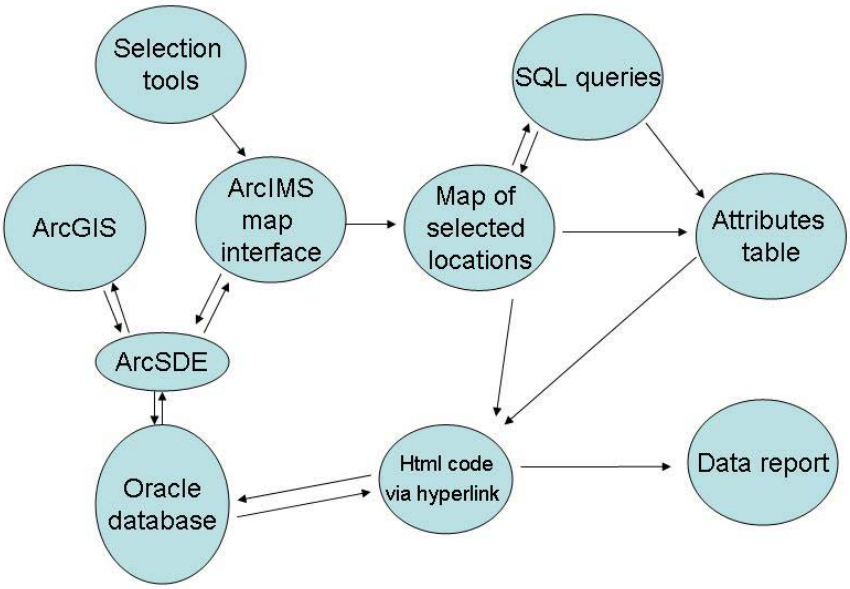

Figure 3. Flow chart describing the components and processes involved in the Gagnavefsja interface.

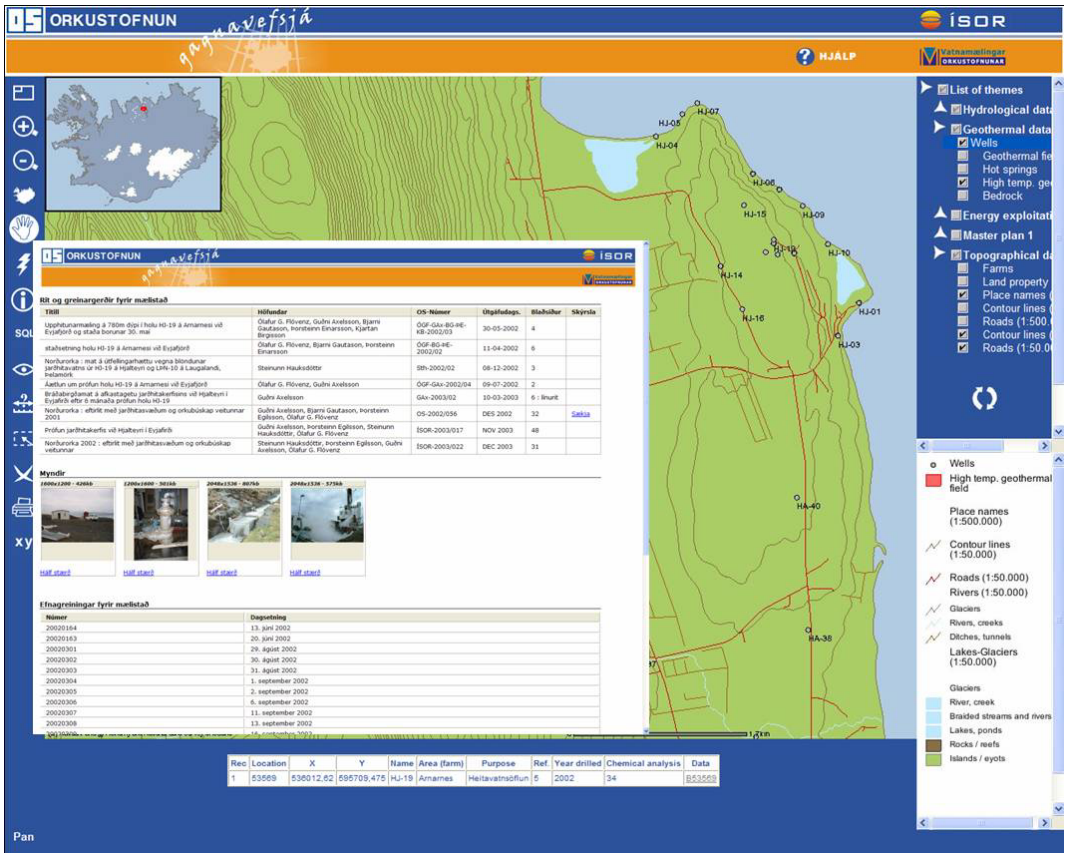

Figure 4. The interface showing the location of wells at Hjalteyri geothermal field and further information to be accessed from the database (Axelsson G. et al. 2005).

For the layers describing locations of wells and hot springs the dataset retrieved by the information tool also includes a column labelled 'Data' (figure 4). This is a hyperlink to a webpage where further information on selected locations can be viewed and downloaded, including photographs, a list of chemical analyses, a list of references, and a link to available *pdf* files of published reports. The *html* code involved was constructed using Microsoft Visual Basic and allows direct access to the Oracle database. Figure 4 shows the Gagnavefsja interface with the layer of wells visible and active. The figure shows the area of the Hjalteyri low temperature geothermal field including a list of references, photos and list of chemcical analyses from production well HJ-19. One of the references can be downloaded as a *pdf* file.

The Gagnavefsja interface also includes layers describing data from other parts of the database, and therefore it is easy to display diverse datasets simultaneously, e.g. hydrology (rivers, lakes and glaciers) with geothermal energy utilization in relation to the data on geothermal resources. There are also layers available showing topography, roads and farms, to make the maps easier to read and more informative.

4. APPLICATIONS AND FUTURE DEVELOPMENTS

To date the geothermal data in the database of ISOR and Orkustofnun has been accessed by different platforms, which have been specially designed for the purpose of each dataset, e.g. chemical analyses. As an Internet-based query tool, Gagnavefsja will serve as an portal to search, analyse and compile data. The visualization of locations is believed to help scientific analysis, and as data is increasingly being compiled and used via the Internet this will also aid scientists working in the field. The use of the map interface rquires no knowledge of the SQL query language and a selection on the map interface makes it possible to combine spatial selection with relational database query. An important advantage of the application of Gagnavefsja is the time saved by having a single interface to acquire information on available data in the database.

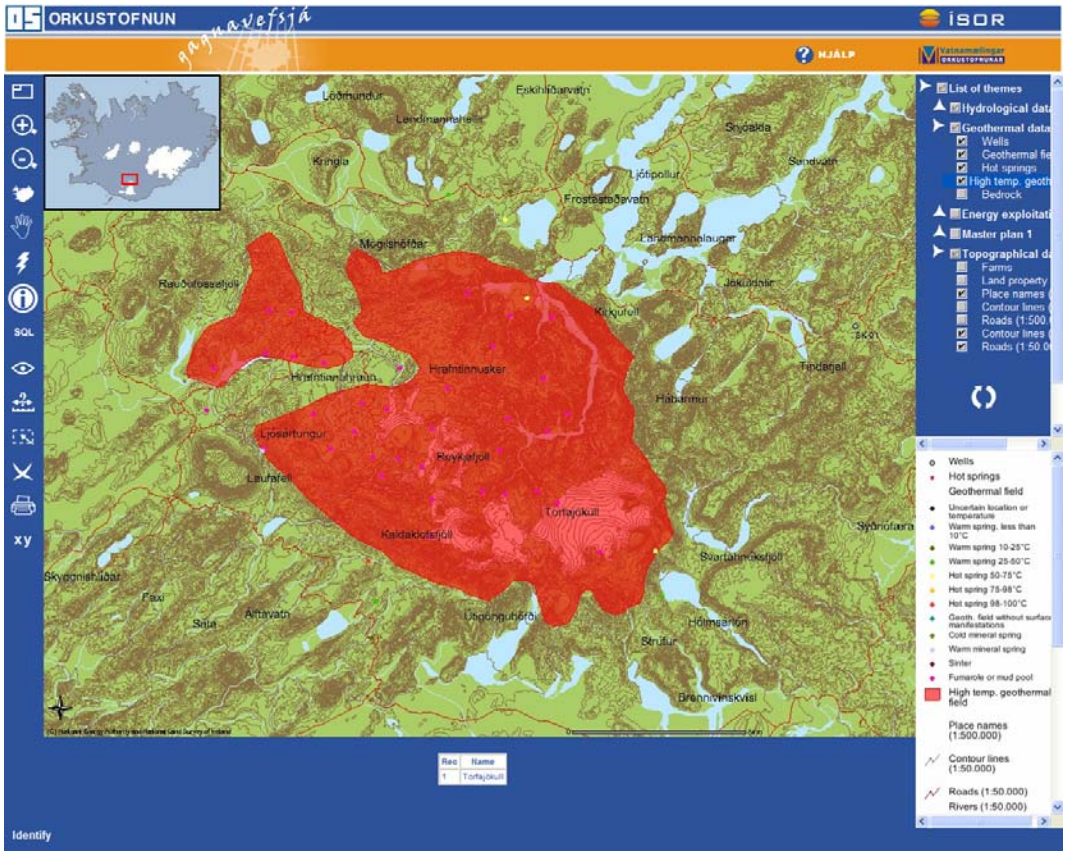

Figure 5. The Torfajökull geothermal area based on distribution of surface manifestations (Fridleifsson G.O. and Sæmundsson, K. 2005).

The fundamental requirement for using Gagnavefsja as the tool for data processing and searching is that all data has to be linked to geographical coordinates. This work is still in progress for data related to e.g. well logging, geological maps, subsets of chemical analyses of geothermal fluids as well as analyses of cuttings and precipitates.

Gagnavefsja gives the public access to the data compiled by Iceland GeoSurvey and Orkustofnun on geothermal resources and utilization as well as potential areas of geothermal exploitation (Figure 5). Data being compiled by ISOR and Orkustofnun using public funds is made accessible as visualizations of locations where data were collected as well as actual downloading of data, maps, pictures and reports. Similar work is now in progress in other research institutes and companies, e.g. Vedurstofan (Meterological Institute), Landsvirkjun (National Power Company), Vegagerdin (Public Roads Administration) and cooperation and data exchange between these companies will increase the application possibilities for such interfaces

significantly. A similar interface has been developed by the municipal of Reykjavik, Borgarvefsja (City Webview) using a joint GIS system of the technical departments of the city.

For ISOR, the Gagnavefsja interface provides an opportunity to service the customers with a direct link from the database. If requested, data aquired by ISOR will be accessible to the customer via the Internet at all times. The data can be accessed in the format preferred by the customer and all reports published will be easily viewed and downloaded.

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