Proceedings World Geothermal Congress 2010
Bali, Indonesia, 25-29 April 2010

Construction of Geothermal Information Database for Korea Based on Web GIS

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Keywords: geothermal resource information system, heat property, geothermal gradient, heat flow, heat production

ABSTRACT

In order to build an information infrastructure for the development and application of geothermal energy, KIGAM (Korea Institute of Geoscience and Mineral Resources) is setting up a Web GIS-based database for geothermal resources in Korea. The database of geothermal information includes numerous measurement data from rock samples and boreholes such as thermal properties (rock density, specific heat, thermal diffusivity, thermal conductivity, etc), geothermal gradients, heat production and heat flow. The distribution maps showing thermal conductivity, geothermal gradient, heat flow, and heat production constructed with measurement data are also included to the database. An application system for the database was developed using ArcGIS Server engine software. Users can easily find the geothermal data for the area of interest using the functions on the system's menu such as 'query' and 'analysis.'

1. INTRODUCTION

Thermal properties such as thermal conductivity, geothermal gradient, and heat flow are very important to the development and utilization of geothermal energy for space heating, district heating, and industrial applications. The collection and measurement of thermal properties are often needed to estimate budget and required manpower. The construction of a geothermal information database is required to provide thermal properties to geothermal companies and geothermal researchers. An application system for the Web GIS-based database was developed where the user can easily find the geothermal data of interest.

2. COLLECTION OF DATA

A total of 2163 rock samples were collected in Korea for a geothermal database system. Thermal and physical properties including density, porosity, specific heat, thermal diffusivity, and thermal conductivity were measured in 1516 rock samples (Park *et al.*, 2007). The results of these measurements are illustrated in Figure 1a. Ground surface temperature and bottom-hole temperature were measured in 710 wells with depths greater than 300 m, which led to 710 geothermal gradient data points, as shown in Figure 1b (Kim *et al*., 2002). Heat flow was calculated for a total of 492 points, as illustrated in Figure 1c (Kim, 2004). In addition, a total of 180 heat production values were estimated by chemical analysis and from gamma-ray logs (Figure 1d) (Kim, 2008).

Using a geostatistical interpolation method, we constructed distribution maps of thermal conductivity, thermal gradient, heat flow, and heat production. According to the distribution maps, thermal conductivity ranges from 2.49 to 5.42 W/mK; geothermal gradient ranges from 18.6 to 62.3 ℃/㎞; heat flow ranges from 28.0 to 127.4 ㎽/㎡; heat production ranges from 0.18 to 5.70 μW/㎥, as can be seen in Figure 2. Using these data sets, the temperature and heat content were estimated at different depths. At a depth of 5 km, the temperature range was estimated to be 63.1-171.6℃, and the total heat content was estimated to be 1.01×10^{23} J (Park, 2008).

3. DEVELOPMENT OF GEOTHERMAL INFORMATION SYSTEM

The geothermal database was divided into four groups by role and data type. Group 1 includes the data measured from rock samples, such as thermal properties (rock density, specific heat, thermal diffusivity, thermal conductivity, etc), geothermal gradient, heat production and heat flow. Group 2 includes the geologic map, fault map, tectonic boundary map, and administrative map. Group 3 includes thematic maps of thermal conductivity, geothermal gradient, heat flow, heat production and heat content. Group 4 includes road maps, river maps, DEM data and satellite images.

The geothermal information system was developed with basic functions based on Web GIS such as map display, data query, map printing and analysis. Data query is used for finding measurement data for regions of interest. The boundary options of this function include administrator districts, coordinates and box drawing, as shown in Figure 3. The query results are saved as a figure or as spreadsheet data. Estimates can also be found by query for regions without measurement data on the thematic maps, as illustrated in Figure 4.

The analysis menu consists of four submenus: 'statistical analysis', 'profile analysis', 'relationship analysis' and 'regional analysis'. Statistical analysis shows the statistical information of selected data such as average, maximum, minimum, variance and histograms. Profile analysis can be used to plot specified values with distance along the specified track on the thematic map (Figure 5). Relationship analysis shows relationships between two selected parameters in Groups 1 or 3 using graphs. The regional analysis function can be used to generate thematic maps that display the selected data for a specified region and lithology, as shown in Figure 6.

4. CONCLUSION

A Web GIS-based geothermal information system was developed to make Korean geothermal data including thermal properties readily available, thus stimulating geothermal development there. Users can easily find geothermal information on target areas using the Internet and save the results as a figure or as spreadsheet data.

Currently, the geothermal information system is being improved for advanced analysis, higher data precision, and data standardization.

ACKNOWLEDGEMENT

This work is supported by KEMCO (Korea Energy Management Corporation) funding to KIGAM.

REFERENCES

Kim, H.C., Lee, S. and Song, M.Y.: Relationship analysis between lithology, geological time and geothermal gradient of South Korea, *Econ. Environ. Geol*., **35**, (2002), 163-170.

Kim, H.C., Lee, S. and Song, M.Y.: Geological characteristics and heat flow relationship in South Korea, *Econ. Environ. Geol*., **37**, (2004), 391-400.

Kim, H.C.: Interpretation of geothermal anomaly using heat flow and geological data in South Korea, *Ph.D. thesis*, Chungnam National University, KOREA (2004).

Kim, J.C.: Distribution of heat production in Korea, *Master thesis*, Kongju National University, KOREA (2008).

Park, J.M., Kim, H.C., Lee, Y. and Song, M.Y.: A study on thermal properties of rocks from Gyeonggi-do, Gangwon-do, Chungchung-do, *Korea. Econ. Environ. Geol.*, 40, (2007), 761-769.

Park, S.H.: Geothermal Resource Assessment in Korea, *Master thesis*, Kongju National University, KOREA (2008).

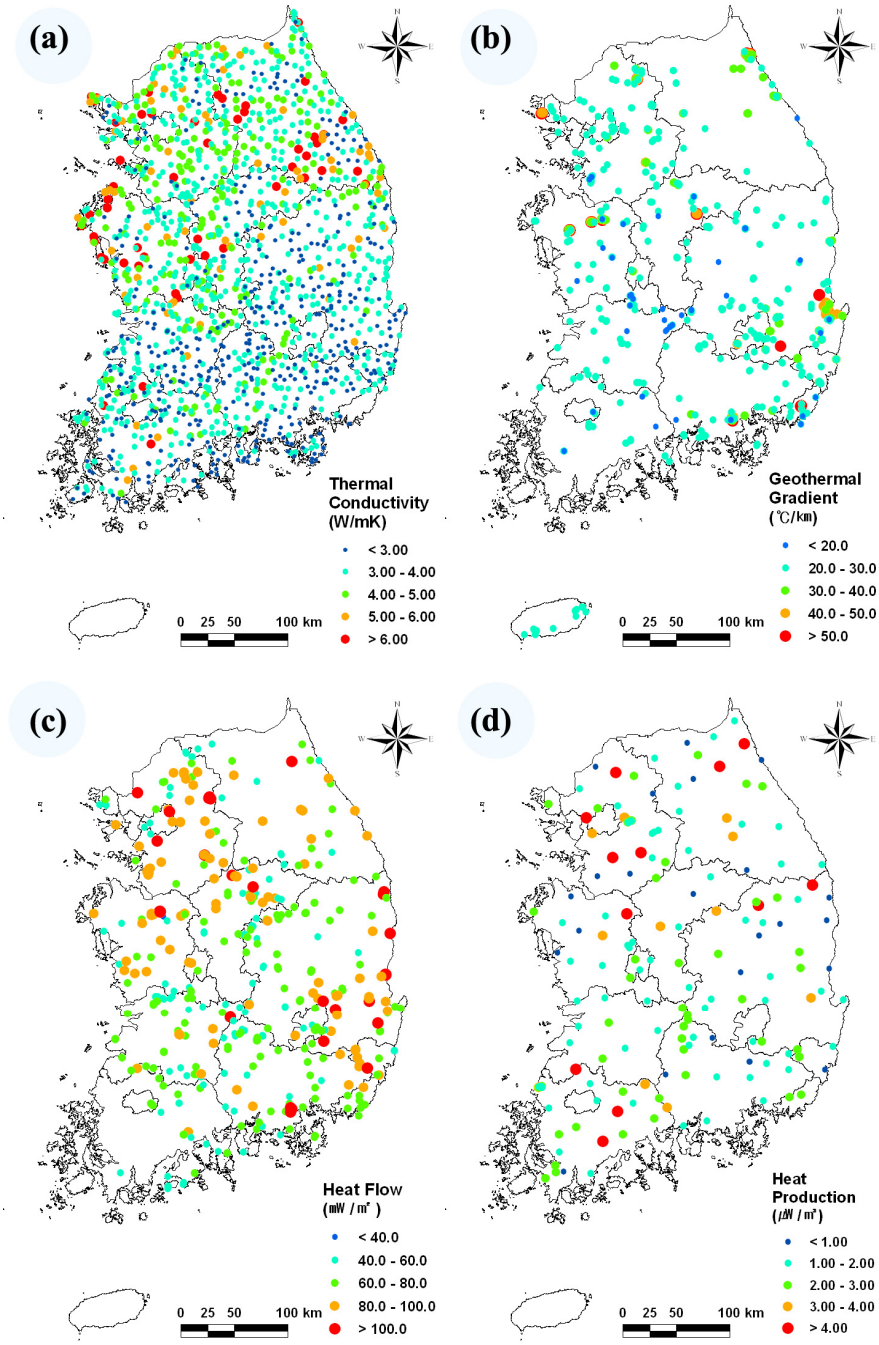

Figure 1: Location maps of (a) thermal conductivity, (b) geothermal gradient, (c) heat flow and (d) heat production.

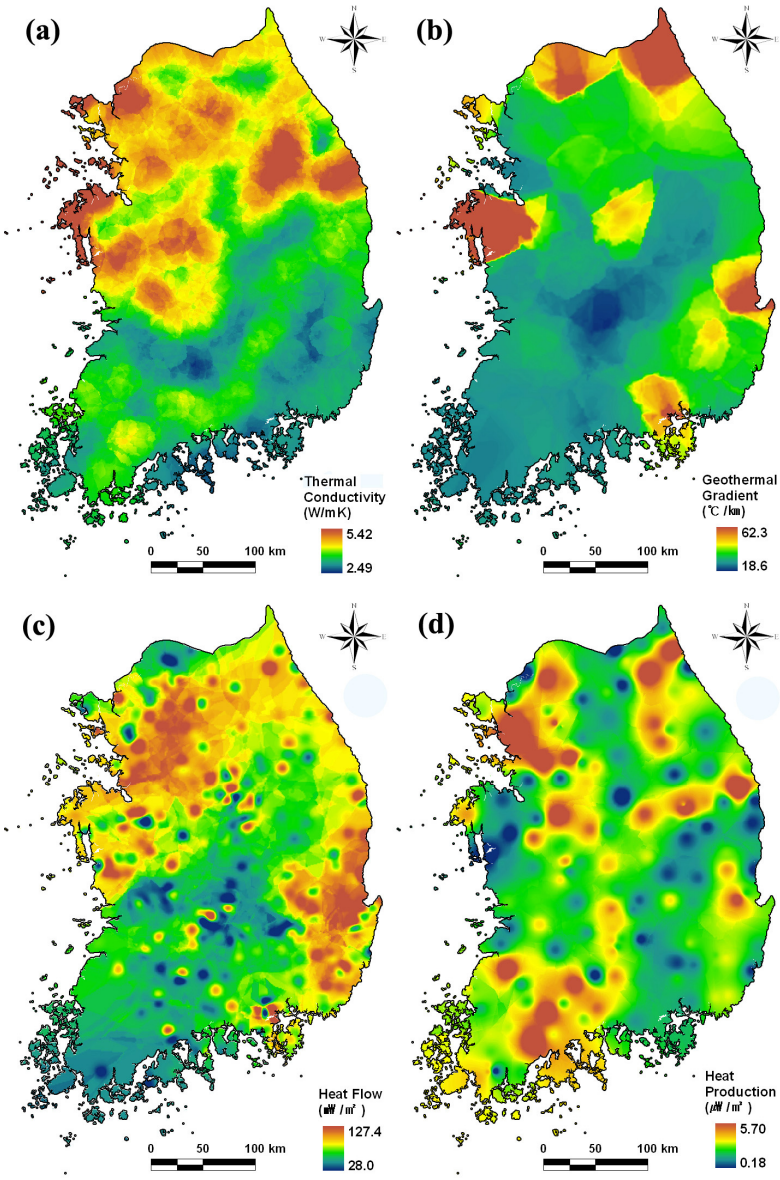

Figure 2: Thematic maps of (a) thermal conductivity, (b) geothermal gradient, (c) heat flow and (d) heat production.

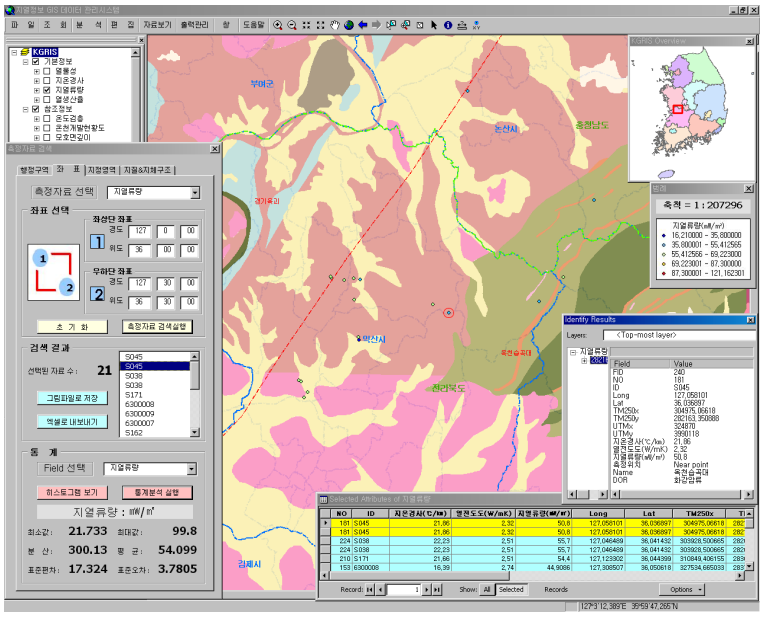

Figure 3: Illustration of the Data Query function using specified coordinates.

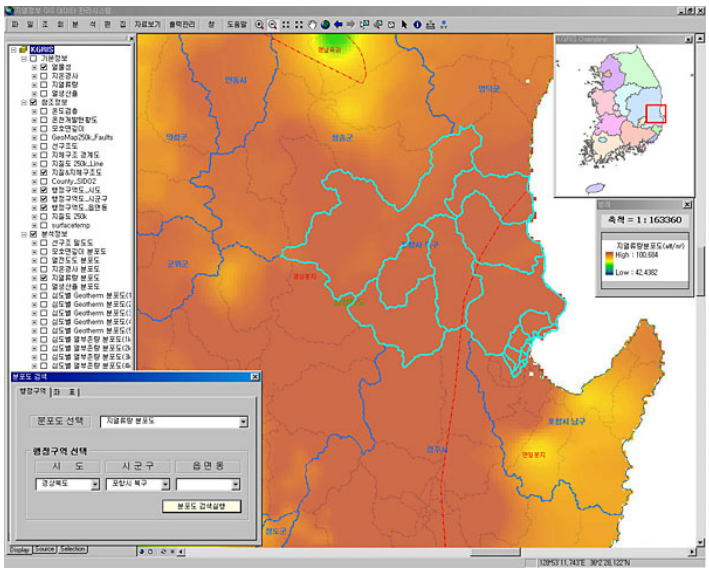

Figure 4: Illustration of the Query function being used to display estimated data on thematic maps by administrative district

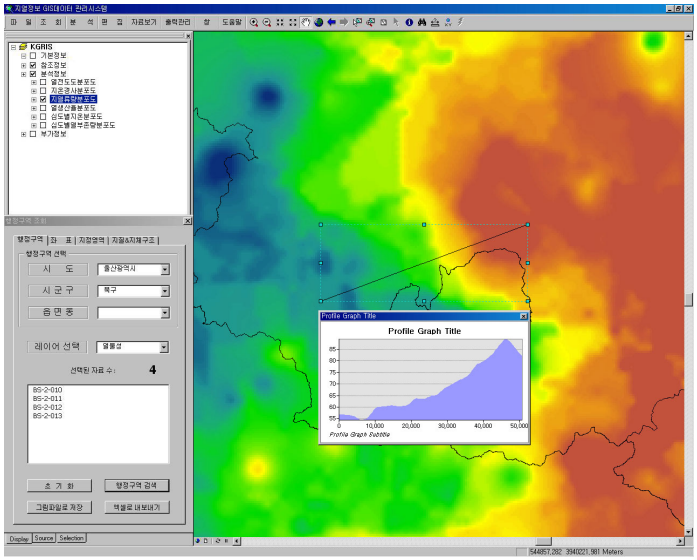

Figure 5: Illustration of the Profile analysis function

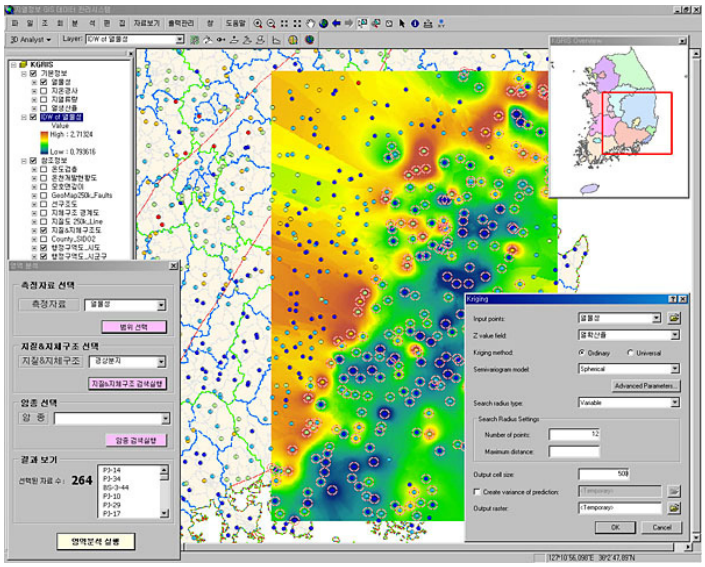

Figure 6: Illustration of the Regional analysis function