INTERPRETATION OF HEAT FLOW CHARACTERISTICS OF KOREA

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ABSTRACT

A total of 359 heat flow values have been estimated in Korea since 1970. The mean geothermal gradient of Korea is 25.1 °C/km; the mean heat flow of Korea is 60±11 mW/m^2. High heat flow values appear in Asan, Boryeong, Yuseong, Jinan, Uljin, Pohang, Busan, Pocheon, Sokcho, Chungju, and Suanbo. Those high heat flow areas are in agreement with the locations of hot springs in Korea. The southeastern part of Korea shows high heat flow distribution that is likely to be associated with the faults (Yangsan fault, Milyang fault, Moryang fault, Dongrae fault and so on). Those faults probably play as a conduit for geothermal fluids.

Using a GIS software, we investigated the relationship between geological information (rock type, geological time, Moho depth) and surface heat flow. In the aspect of the lithology, there is no significant heat flow difference in different rock types. The area of sedimentary rock shows heat flow of 71 mW/m^2, the sedimentary/volcanic rock area 68 mW/m^2, the plutonic rock area 67 mW/m^2, and the metamorphic rock area 62 mW/m^2. In the geological time sequence, the Cenozoic strata contains heat flow of 78 mW/m^2, the Mesozoic 68 mW/m^2, the Paleozoic strata 65 mW/m^2, the Proterozoic strata 67 mW/m^2, and the Archean strata 62 mW/m^2. In terms of Moho depth, the shallow Moho depth area tends to have higher heat flow values than the area of the thick crust.

Keywords: heat flow, geothermal gradient, fault, GIS, Korea

1. INTRODUCTION

As to the history of the geothermal study in Korea, both Chang et al. (1970) and Mizutani et al. (1970) who led the " Korea-Japan cooperation research for Columbo Plan" began to work on heat flow in Korea. In this time, 18 heat flow data were estimated mainly at mine deposit areas. Additionally, Suh(1976) estimated 17 heat flow values, which make total 35 heat flow values. Lim et al. (1989; 1996; 1997) and Yum et al. (1997) published a study on the regional pattern of heat flow in the Korea and added heat flow values. Korea Institute of Geoscience and Mineral Resources (KIGAM) has estimated 217 heat flow values from 1989 until 1997 to make total 248 values (Fig. 1-a). Also, KIGAM has estimated 111 new heat flow values since 1998. As a result, a total of 359 heat flow values have been estimated in Korea since 1970 (Fig. 1-b). Here we construct and analyze a new heat flow map of Korea using a total 359 heat flow values.

2. HEAT FLOW AND ITS INTERPRETATION

In the new heat flow map(Fig. 1(b)), the mean geothermal gradient of Korea is 25.1 °C/km; the mean heat flow of Korea is 60±11 mW/m^2. The heat flow distribution (~90mW/m^2) of the southeastern part of Korea has been changed significantly as compared with old heat flow map(Fig 1(a)). This high heat flow shown in the southeastern part of Korea seems to be related with Yangsan Fault which is the main fault of the southeastern part of Korea. High heat flow values appear in Asan, Boryeong, Yuseong, Jinan, Uljin, Pohang, Busan, Pocheon, Sokcho, Chungju, and Suanbo. Those areas with high heat flow values are in agreement with the locations of hot springs in Korea.

For the analysis of relationship between heat flow values and geological information, geothermal data was constructed to spatial D/B using a GIS software. The geothermal spatial D/B consists of identification number (ID), name (SN), longitude (Long.), latidude (Lat.), thermal gradient (Gr.), thermal conductivity (Cond.), heat flow (HF), and reference (Ref.). The spatial D/B is of ArcView shape format with point attribute, while the geological map is of ArcView shape format with polygon attribute. The heat flow data distribution with geological map was made to thematic map using ArcView. The Moho depth map of Korea published by Kim et al. (2003) using Bouguer gravity was constructed to spatial D/B also. Thematic map of Moho depth was also made using ArcView. Using overlay analysis with heat flow values and geological thematic map, we investigated the relationship between geological information (rock type, geological time, Moho depth) and surface heat flow (Fig. 2, 3, 4). In the aspect of the lithology, there is no significant heat flow difference

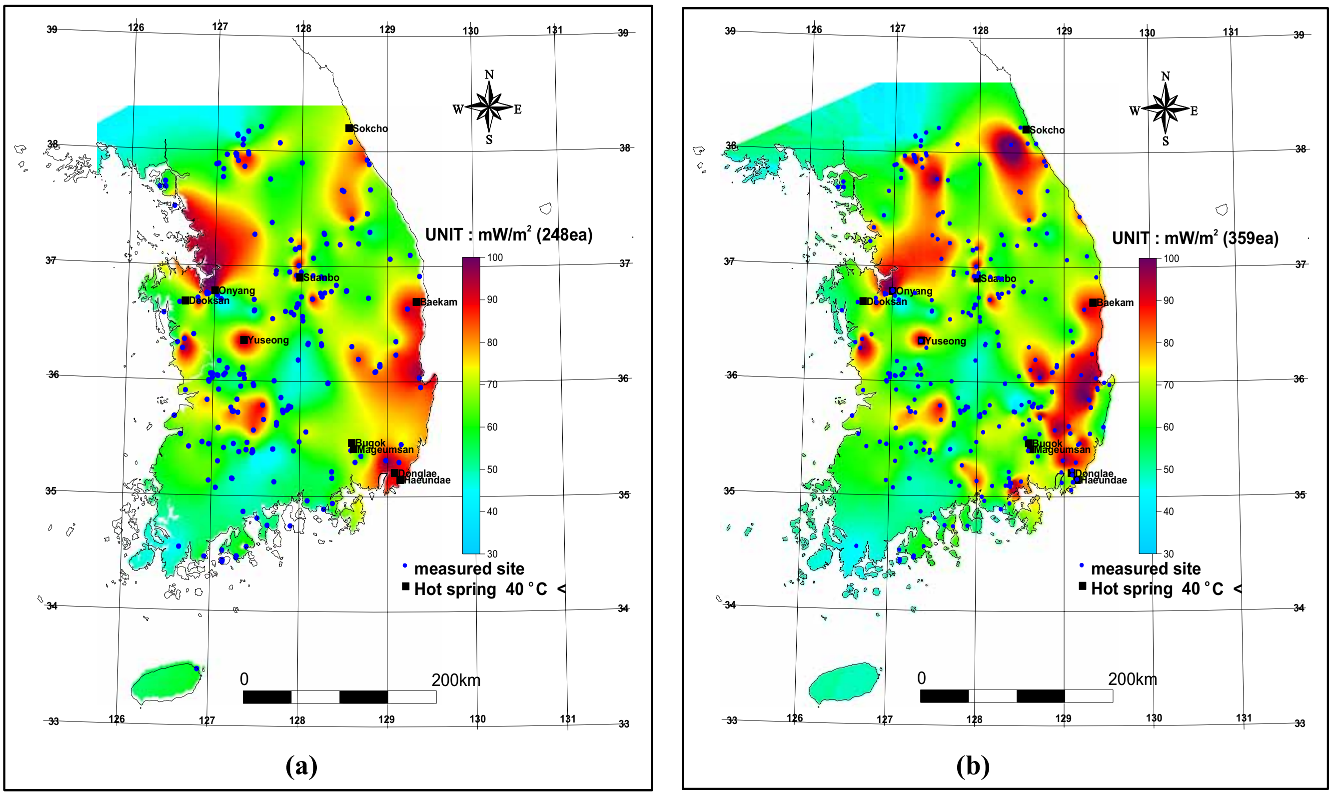


Figure 1. (a) The heat flow map of Korea before the year of 2006 using 248 heat flow data. (b) The heat flow map of Korea using 359 heat flow data in 2006.

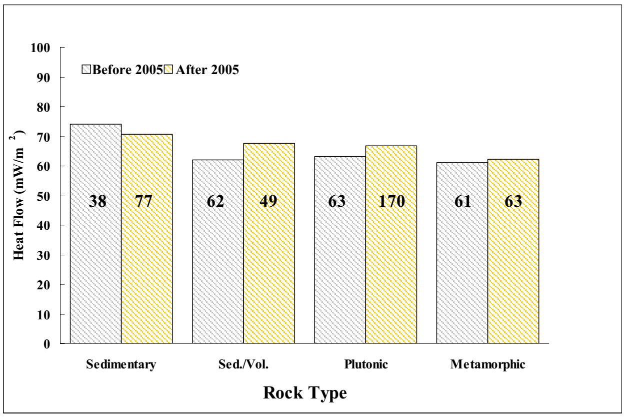


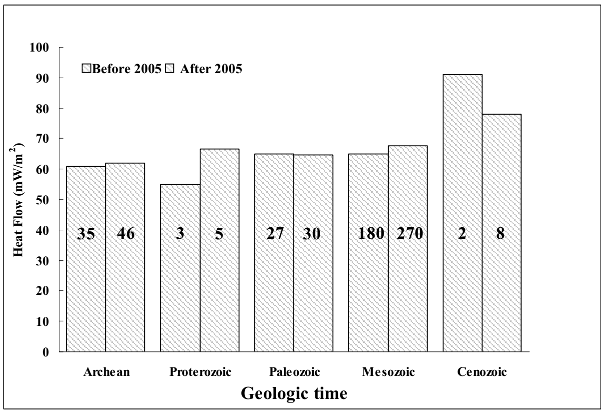
Figure 2. Relationship between heat flow and lithology

Geological Time	Heat Flow (mW/m^2)		Number of data		Standard deviation	
Year	2004	2005	2004	2005	2004	2005
Sedimentary	74	71	38	77	14	17
Sed./Vol.	62	68	62	49	14	15
Plutonic	63	67	63	170	12	15
Metamorphic	61	62	61	63	15	16

in different rock types (fig. 2). The area of sedimentary rock shows heat flow of 71 mW/m^2, the sedimentary/volcanic rock area 68 mW/m^2, the plutonic rock area 67 mW/m^2, and the metamorphic rock area 62 mW/m^2.

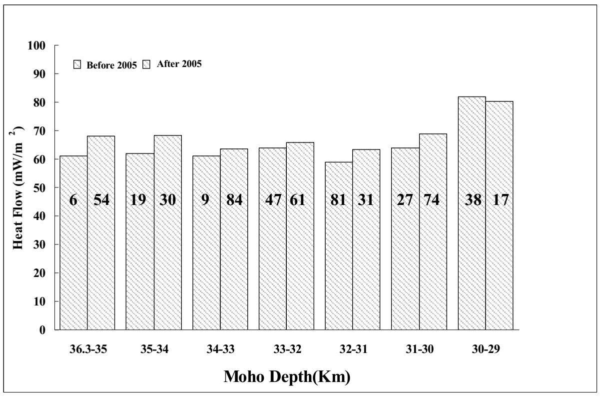
In the geological time sequence, the Cenozoic strata contains heat flow of 78 mW/m^2, the Mesozoic 68 mW/m^2, the Paleozoic strata 65 mW/m^2, the Proterozoic strata 67 mW/m^2, and the Archean strata 62 mW/m^2 (Fig. 3).

Mean surface heat flow progressively increases towards younger sequence. In terms of Moho depth, the shallow Moho depth area tends to have higher heat flow values than the area of the thick crust (Fig. 4).



Geological Time	Heat Flow (mW/m^2)		Number of data		Standard deviation	
Year	2004	2005	2004	2005	2004	2005
Archean	61	62	35	46	14	15
Proterozoic	55	67	3	5	8	17
Paleozoic	65	65	27	30	14	14
Mesozoic	65	68	180	270	14	16
Cenozoic	91	78	2	8	10	15

Figure 3. Relationship between heat flow and geological time.



Geological Time	Heat Flow (mW/m^2)		Number of data		Standard deviation	
Year	2004	2005	2004	2005	2004	2005
36.3-35	61	68	6	54	12	15
35-34	62	68	19	30	14	19
34-33	61	64	9	84	11	15
33-32	64	66	47	61	13	14
32-31	59	63	81	39	14	15
31-30	64	69	27	74	13	16
30-29	82	80	38	17	15	13

Figure 4. Relationship between heat flow and Moho depth

3. CONCLUSION

In Korea, the high heat flow shown in the southeastern part of Korea seems to be related with Yangsan Fault which is the main fault of the southeastern part of Korea. Heat may be transferred by water convection through the Yangsan fault. The other high heat flow values appear in Asan, Boryeong, Yuseong, Jinan, Uljin, Pohang, Busan, Pocheon, Sokcho, Chungju, and Suanbo. Those locations are hot spring areas.

On view point of geological characteristics, young strata have higher heat flow values than old strata. Sedimentary area show high heat flow. The regions of the thin crust tend to show higher heat flow values than the regions of the thick crust. In the future, more geological and geophysical information is required to analyze and interpret heat flow values in Korea.

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