Proc. 12th New Zealand Geothermal Workshop 1990

GEOTHERMAL MODELS FOR THE HOHI, THE SENGAN AND THE KURIKOMA AREAS IN JAPAN

Shiro Tamanyu

Geothermal Research Department, Geological Survey of Japan
1-1-3 Higashi, Tsukuba, Ibaraki, 305 Japan

ABSTRACT

Many deep bore holes have been drilled at the Hohi, the Sengan and the Kurikoma geothermal areas for the deep geothermal energy exploration by the Ministry of International Trade and Industry in Japan. The modelling for these geothermal areas have been investigated based on the data integration of various kind of surveys and well loggings.

The Hohi area is made clear that subsurface temperature contours are concordant with subsurface relief of the pre-Tertiary basement, and the surveyed area can be divided into discharged, recharged and conductive zones according to difference of permeability and exsistence of cap rocks.

The Sengan area is made clear that subsurface high temperature zones are concordant with distribution zones of young Qurternary volcanics, and the surveyed area can be divided into discharged and conductive zones.

The Kurikoma area is made clear that subsurface thermal structure is changed from shallow to deep part,, and the surveyed area can be divided into discharged and recharged areas except the surrounding conductive zones.

INTRODUCTION

In order to promote large scale development of geothermal energy, two big projects were carried out by GSJ (Geological Survey of Japan) and NEDO (New Energy Development Organization) at the Hohi, the Sengan and the Kurikoma geothermal fields (Fig. 1). These fields were selected as the model fields of imperfect cap rock - horst graben structure typed, perfect cap rock - caldera structure typed and non cap rock - fractured basement typed geothermal systems respectively. Surface surveys were applied to assume subsurface geothermal structure. and the result of the assumption was examined by shallow to deep drillings. Final geothermal models were investigated through data integration and refinement of intial models on the view point of three dimensions and historical development.

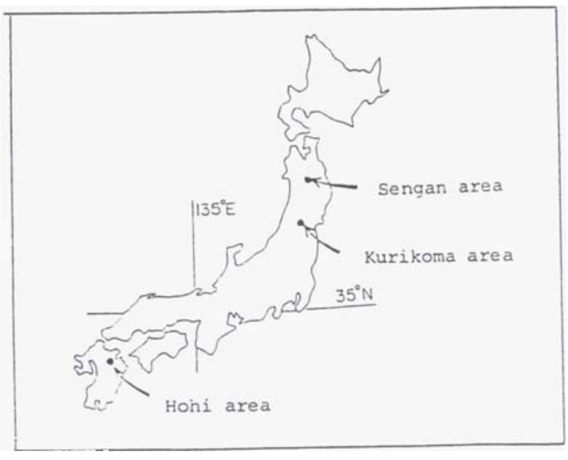


Figure 1. Index map of the studied area.

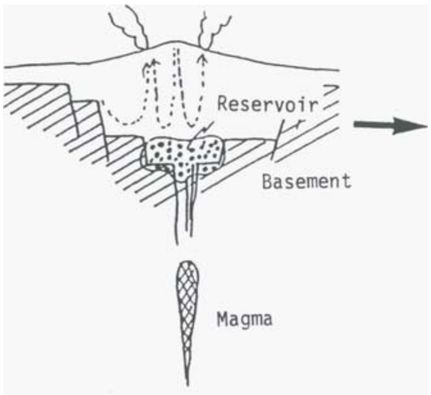
GEOTHERMAL MODELLING

<Hohi area>

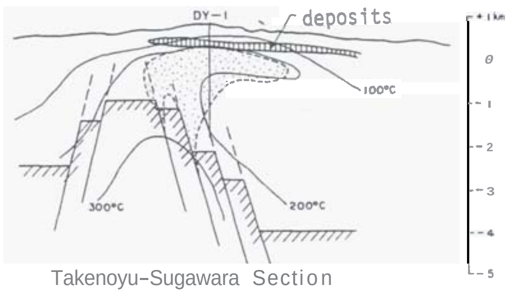
Geological and geothermal informations about the Hohi geothermal area and its environs were compiled as a map sheet (Research group for the geological map of Hohi Geothermal Area. 1982). and research products were summarized in the GSJ report (Hase et al. 1985). Many surface surveys and drillings have been carried out for the deep geothermal energy exploration project "Environmental assessment, of large scale power generation using deep geothermal reservoir" (1978-1985) in this area. The result of this project was summarized in the project final report by MITI (MITI, 1987). The number of bore holes except for 80 m deep heat holes, reached a total of 2%. These are made up of 10 holes of 500 m deep structural wells, 7 holes of about 1500 m deep structural wells. and 5 holes of about 3000 m deep geothermal test wells. The temperature gradient curves of all drill holes in this area including drill holes for other projects were summarized as Fig. 2.

This area was initially assumed that the imperfect cap rocks covered all over the area and subsurface structure was characterized by horst-graben structure. As the result of this project, the final model is described as follows (Fig. 3). This area can be divided into discharged, recharged and conductive zones separately according to the characteristic patterns of temperature gradient curves of drill holes. This can be interpreted that the discharged zone is covered tightly with Pleistocene impermeable lacustritie sediments. and the recharged zone is covered with permeable Pleistocene volcanics. The degree of permeability seems to be mainly controlled by formation permeability except the deep part of the steep transitional zone from shallow to deep basement where seems to be mainly controlled by fracture permeability. The surface geothermal manifestation and exploited shallow geothermal reservoir systems (Otake and Hacchobaru power stations) are situated at the area where the position of basement rocks is shallow in the form of horst. Its reason was revealed that subsurface temperature contours were concordant with top relief of pre-Tertiary basement. The most important target of this project, the deep geothermal reservoir which was expected at the deeper parts than 2000 m in depth, was not proved in shallow basement of horst because of low permeability, but proved in deep Miocene volcanic formation around the transitional zone from shallow to deep basements.

Initial Model



Final Model



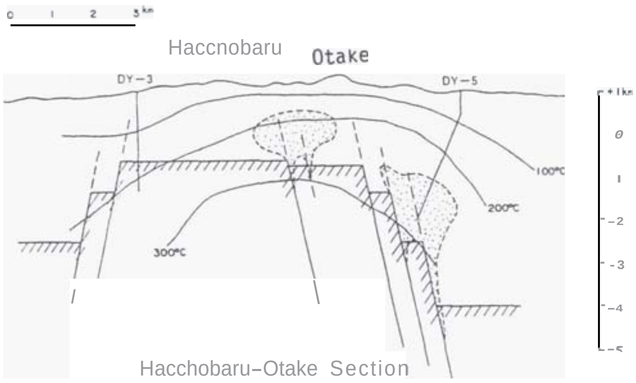


Fig. 3. Comparison between initial and final models in the Hohi area

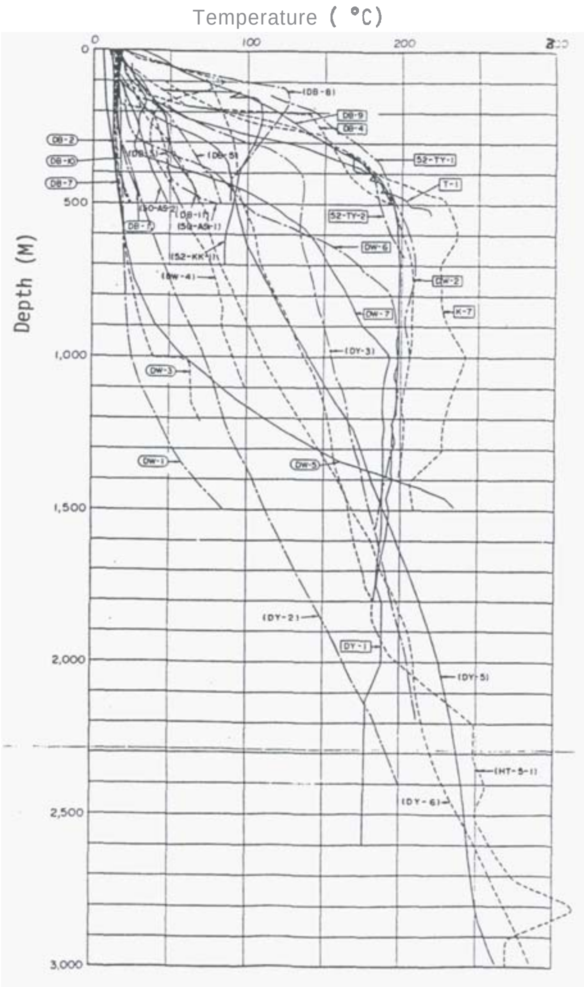


Fig. 2. Temperature logging curves in the Hohi area

<SENGAN>

The Sengan area and its environs include conspicuous geothermal surface manifestations and three geothermal power plants at Matsukawa, Onuma and Kakkonda. Geological and geothermal informations about the Sengan and its environs were compiled as a map sheet (Research group for the geological map of Sengan Geothermal Area, 1985), and research products were summarized in the CSJ report (Kimbara and Hase. 1987). Many surface surveys and drillings have been carried out in the project "Confirmation study of the effectiveness of prospecting techniques for deep geothermal resources"(1980-1988). The results of this project was summarized in the final reports by GSJ and NEDO respectively (CSJ, 1989, NEDO, 1990). The number of bore holes drrlled at this projects are 28 holes except for shallow heat holes. These are made up of 21 heat, holes ranging from 200 m to 400 m in depth, 6 deep structural wells ranging from 1500 m to 2000 m in depth, and one test well of 2500 m 'in depth. The temperature gradient curves of all drill holes in this field including drill holes for other projects were summarized as Fig. 4.

This area was initially assumed that the impermeable cap rocks covered all over the area and subsurface structure was characterised by caldera structure. The Tamagawa caldera was expected at first to have large geothermal system because of thick cap rocks and big volume of erupted welded tuffs although there was few geothermal manifestation and age of volcanism was fairly old. As the result of this project, the final model is described as follows (Fig. 5). This area can be divided into discharged and conductive zones except recharged zone of northern edge, based on the Patterns of temperature gradient curves of drill holes. This can be interpreted that discharaed zone s covered with Pleistocene impermeable lacustrine sediments and

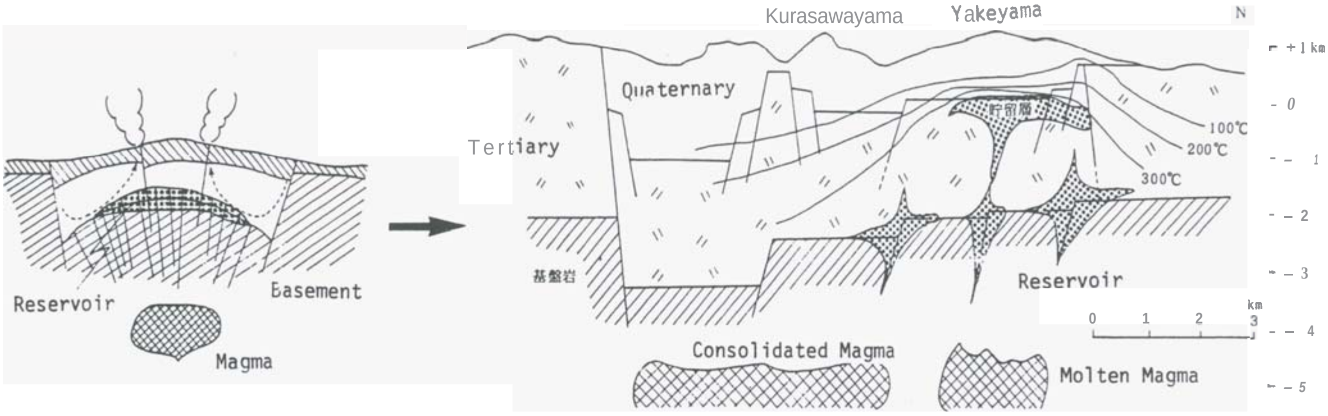
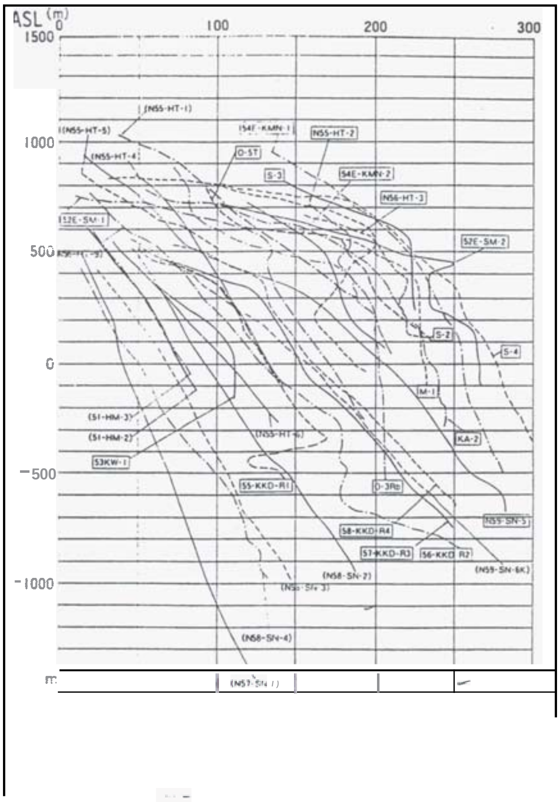


Fig. 5. Comparison between initial and



conductive zone is covered with thick Plio-Pleistocene welded tuffs. The surface geothermal manifestation and exploited shallow geothermal reservoir systems (Onuma, Matsukawa and Kakkonda power stations) are situated near the young Quaternary volcanoes. The deep geothermal reservoir was not proved in the caldera fill deposits and Tertiary formations at the Tamagawa caldera because of low heat potentiality, but proved in the fractures of the pre-Tertiary granitic basement or Tertiary granitic intrusion under the shallow geothermal reservoir at the Sumikawa near the Onuma power station.

<kurikoma area>

In extent of the Kurikoma area is corresponded to the extensive area from Yuzawa-Okachi in northern part to Narugo in southern part. But, main target of this project was limited to the Onikobe caldera in the central part of the Kurikoma area. The Onikobe geothermal power plant is located at the center of the Onikobe caldera. Geological and geothermal information about the Kurikoma geothermal area and its environs were compiled as a map sheet (Research group for the geological map of Kurikoma geothermal area, 1986), and research products were summarized in the GSJ report. (Yamada and Hase, 1988). Many surface surveys and drillings of 6 structural wells of 1500 m deep have been carried out here for the

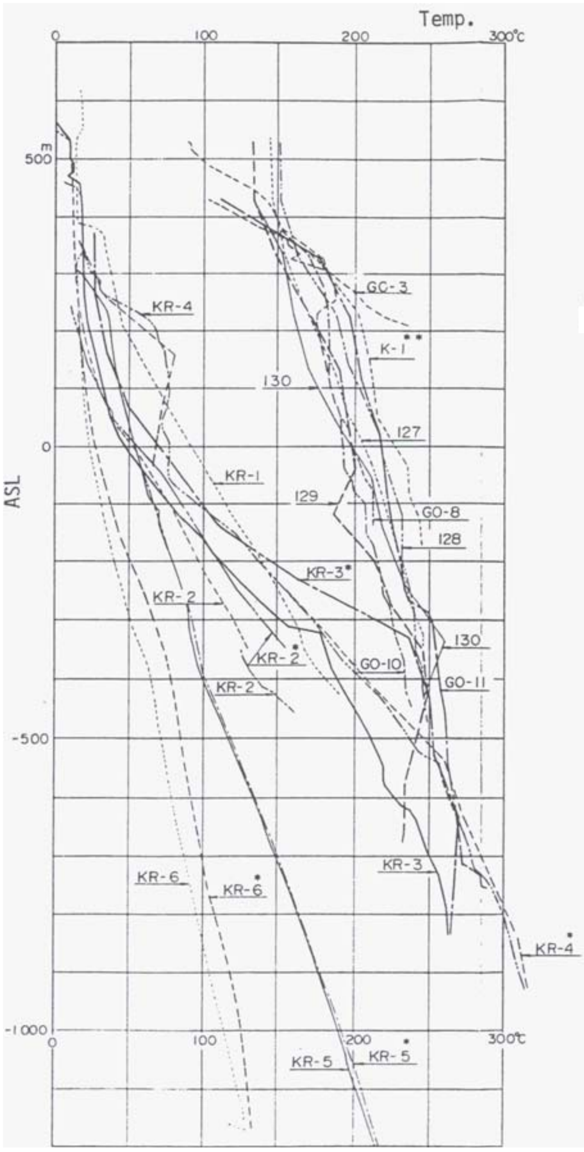


Fig. 6. Temperature logging curves in the Kurikoma area.

Initial Model Final Model

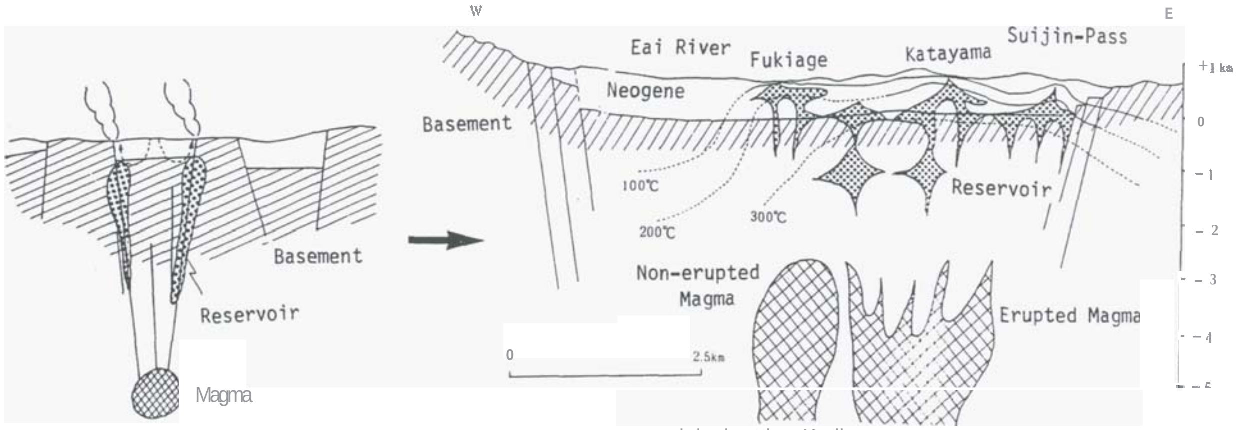


Fig. 7. Comparison between initial and final models in the Kurikoma area,

project "Confirmation study of the effectiveness of prospecting techniques for deep geothermal resources" (1980-1988). The results of this project was summarized in the final reports by GSJ and NEDO respectively (GSJ,1989, NEDO, 1989). The temperature gradient curves of all drill holes in this area including drill holes for other projects were summarized as Fig. 6.

This area was initially assumed that there was no cap rocks all over the area, and subsurface structure was characterized by tectonically fractured basemental rocks under the bottom of the Onikobe caldera. As the result of the project, the final model is described as follows (Fig. 7). This area can be divided into discharged and recharged zones except marginal conductive zones, based on the patterns of temperature gradient curves of drill holes. This can be interpreted that discharged zone was naturally formed in the shape of chimney without cap rock, and recharged flows were induced by mass balance at the surrounding mountainous zones.

ACKNOWLEDGEMENTS

The above mentioned two projects were carried out cooperatively by GSJ and NEDO as a part, of the Sunshine project of MITI. This paper was based on the results of the projects. I express my gratitude to Drs. Junji Suyama, Toshiaki Sawa, Kiyoshi Sumi, Keiichi Yamada, Kenzo Baba, Katsuro Ogawa, Kenji Okabe, Hirokazu Hase. Keiji Kimbara, Masayori Kawamura. Shinichiro Takagi, Eizo Yamada and Tetsuro Noda who were engaged in the project managements, and also to all other members who participated in these projects.

REFERENCES

Geological Survey of Japan, 1989. Synthetic evaluation report on the confirmation study of the effectiveness of prospecting techniques for deep geothermal resources (Sengan and kurikoma). 74P.

Hase, H., Ogawa, k. and Kimbara, K., 1985. Research in the Hohi geothermal area: outline and summary. Report. Geol.Surv.Japan, no. 264, p. 11-29.

Kimbara, k. and Hase, H., 1987. Summary of the researches in the Sengan geothermal area. northern Japan. Report. Geol.Surv.Japan, no. 266, p. 9-24.

Ministry of International Trade and Industry,1987. Synthetic evaluation report on the environmental assessment, of large scale power generation using deep geothermal reservoir (Hohi area). 117P.

New Energy Development Organization, 1989. Synthetic analytical report on the confirmation study of the effectiveness of prospecting techniques for deep geothermal resources, and its diagram collection. 438P.

Research group for the geological map of Hohi geothermal area. 1982. Map sheet and explanatory text of the geological map of Hohi geothermal area, scale 1:100,000. Miscellaneous Map Series (21-1), Geol.Surv.Japan, 23P.

Research group for the geological map of Sengan geothermal area, 1985. Map sheet and explanatory text of the geological map of Sengan geothermal area, scale 1:100,000. Miscellaneous Map Series (21-2), Ceol.Surv.Japan, 23P.

Research group for the geological map of Kurikoma geothermal area, 1986. Map sheet and explanatory text of the geological map of kurikoma geothermal area. scale 1:100,000. Miscellaneous Map Series (21-3), Geol.Surv.Japan, 26P.

Yamada, E. and Hase. H., 1988. Results of researches in the Kurikoma geothermal arca, Northeast. Japan: an overview. Report. Geol.Surv.Japan, no.268, p. 7-18.