TEMPERATURE GRADIENT MAP OF THE HAKKODA GEOTHERMAL AREA

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Ninety-nine boreholes temperature log data in the Hakkoda geothermal area were gathered. The data were obtained from many kinds of boreholes of geothermal and mineral exploration and hot spring prospecting. Standing time of temperature logging of geothermal exploration was 24 hours or more, but most of hot spring data has no description of standing time. In addition, Depths of logging range from several tens to 1500 meters depth. Therefore, reliability of the data is not uniform. We divided the data into six classes based on the depth and condition of logging such as standing time and stability of the data. Cosidering reliability of the data, we drawn the temperature gradient contour lines by hand(Figure 1).

Background temperature gradient of the map ranges from 40°C/km to 50°C/km, and high temperature gradient regions over 100 °C/km occur over the Hakkoda volcanoes(which is a Quaternary volcano group) and the Okiura and Aoni hot springs. The value of the background corresponds to the average temperature gradient of the backarc side of the Japanese Islands(Okubo et al., in press).

Figure 2 shows the relation between anion indexes and temperature gradients. High anion index values indicate high probability of heat sources. High temperature gradient zones roughly correspond to anion index value highs. Figure 3 shows the relation between gravity map and temperature gradients. Gravity highs occur around the Hakkoda volcanoes, while gravity lows occur to the west of the volcanoes. That is, a north-south trending gravity changing area extends on the west edge of the volcanoes. This suggests that faults or tectonic lines can occur. A high temperature zone extends north on the north-west of the volcanoes, which correlates well to the gravity changing area. Movement of geothermal fluid may be controlled by the faults or tectonic lines.

The map of temperature gradient certainly reveals the subsurface temperature between the ground surface and several kilometers depth and is appropriate to assess geothermal resources and to choose promising area in a reconnaissance stage. Borehole data of hot springs without any description of temperature logs are usefull only if measured depths are sufficiently deep.

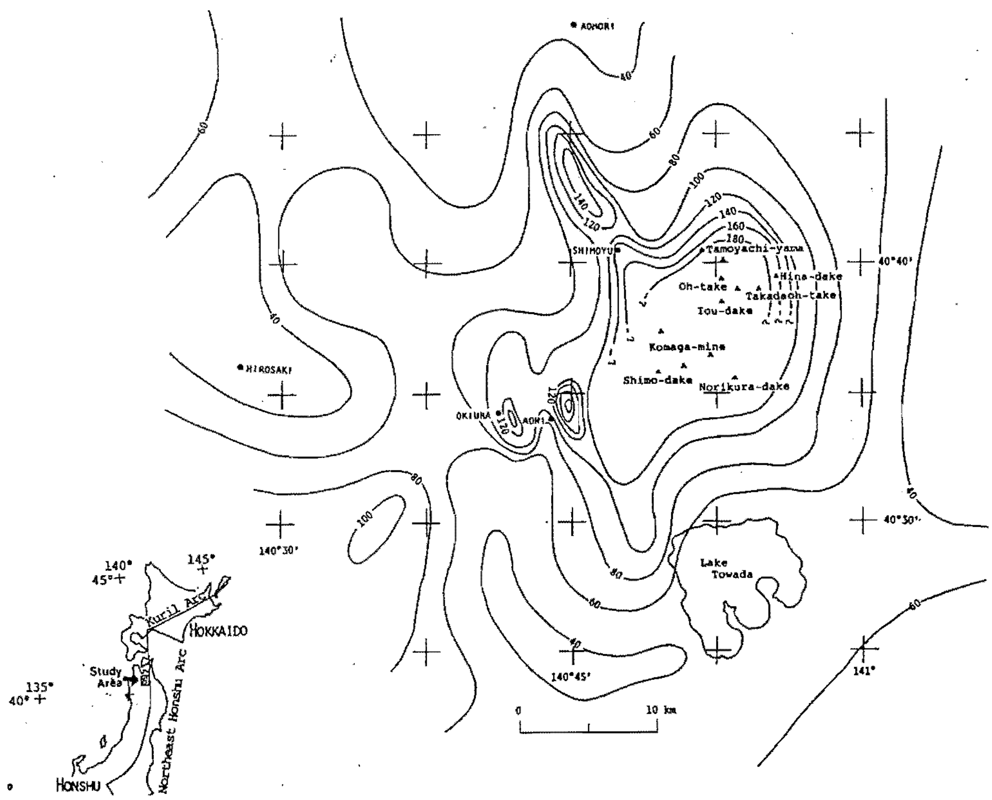

Fig.1 Temperature gradient map of the Hakkoda volcanoes. Contour interval is 20°C/km. Solid triangles indicate summits of the Hakkoda volacanoes.

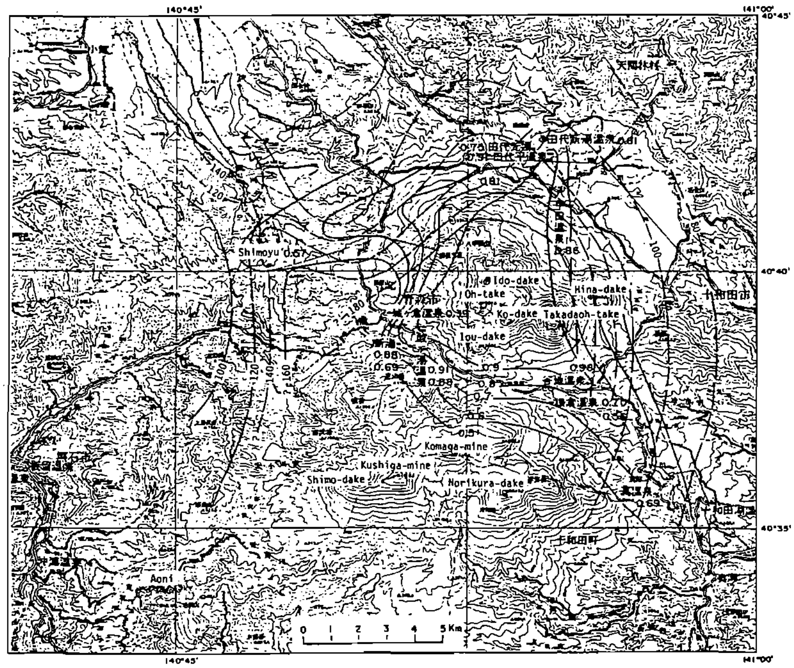

Fig.2 Comparison of anion index map(solid curves; New Energy Development Organization, 1986a) with temperature gardient map(broken curves).

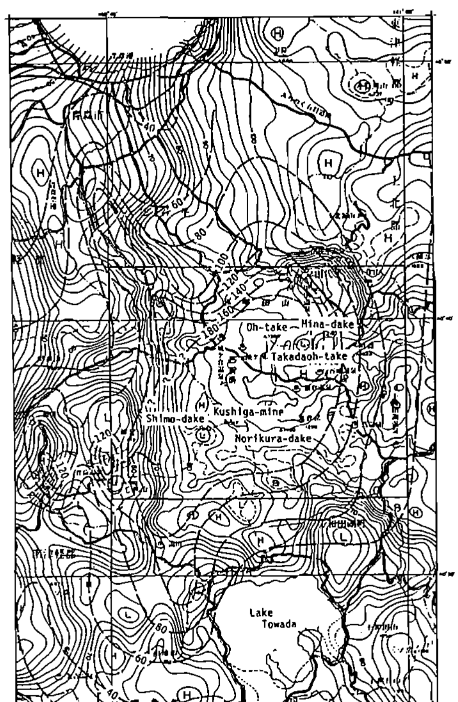

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Fig.3 Comparison between Bouguer anomaly reduced at a density of 2.30 g/cm^3(solid curves; New Energy Development Organization, 1986b), and temperature gradient(broken curves) Contour values of Bouguer anomaly are in unit of mGal.

GROUND ELECTRIC CURRRENT AT GEOTHERMAL AREA

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1. The classification of ground electric current

The main factors of generation of the ground electric current are classfied as next table.

- Earth Current
  - Ionosphere
  - Lightning discharge
- Natural Current
  - Ground water and spring
  - Mineral deposit and Geological structure
  - Earthquake and Volcanic activity
  - Precipitation and wind
- *Geothermal Electric Current
  - Hot spring, Fumarole and Geyser
- Artificial Electric Current (Stray Current)
  - Power electric transmission
  - Electric train and Electric machinery
  - Corrosion current and Electrolytic corrosion

2 The methods of mesurement

The methods of mesurement are the next two kinds.

- (A) Self potential (SP) method
  - Equipotential map method
  - Electric potential gradient method
  - Method of electrostatic field vector (plane)
  - Three dimensions method (plane and direction of underground)
- (B) Spectrum method
  - Mesurement of spectra of current
  - Mesurement of orbit of every frequency

3 Goshogake Geothermal Area, Akita Prefecture, Northern Japan

In Gôshogake Geothermal Area, there are a number of boiling springs nonerupting spring, fumaroles and mud pots. And there is a geyser in a hot pool. Estimation of heat dischareges and analyse of chemical compositon at this area were made by Dr. K. Yuhara, Dr. S. Ehara et al in 1983. Fig. 1 shows the distribution of 1m dpth temperature.

And Mesurements of geothermal seismic noise wer made in the same area by Dr. S. EHARA et al in 1983.

We made mesurements of geothermal electric current in same geothermal area in 1987 and 1988.

4 Geothermal Electric Current

The causes of generation of geothermal electric current are illustrated with four patterns of Fig. 2.

Theoretically, they are caused by streaming potential, that is, electrostatic field takes rise in stationary flow state of water, vapour and gas, besids, the time variation of geothermal electric current takes rise in geysering action or pulsation of springs and fumaroles.

5 Results of observation

Fig. 3 shows observation points and Fig. 4 shows vectors of electric potential gradient by SP method in geothermal area. Fig. 5 and Fig. 6 show points appeared predominant frequency of spectra of geothermal electric current by spectrum method and orbit of same current, respectively, in geothremal area.

The directions of vector seem to indicate the opposite direction to the high temperature spot in geothermal area. As to spectrum of every points, the predominant frequencies BA, A, B and C type arrange in the order of higher temperature spot. The distribution of orbit of geothermal current is not clear about the physical meaning.

6 Conclusion

The generations of geothermal electric current appear clearly in the geothermal area. The explanation of generation mechanism will bring about a large profit to the prospecting of geothermal area.

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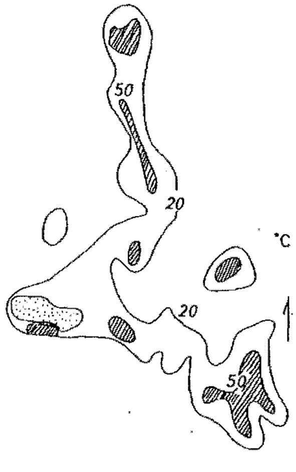

Fig. 1 Distribution of temperatures at 1 m depth observed in Goshogake geothermal area in 1981. Unit:℃

K. YUHARA et al (1985)

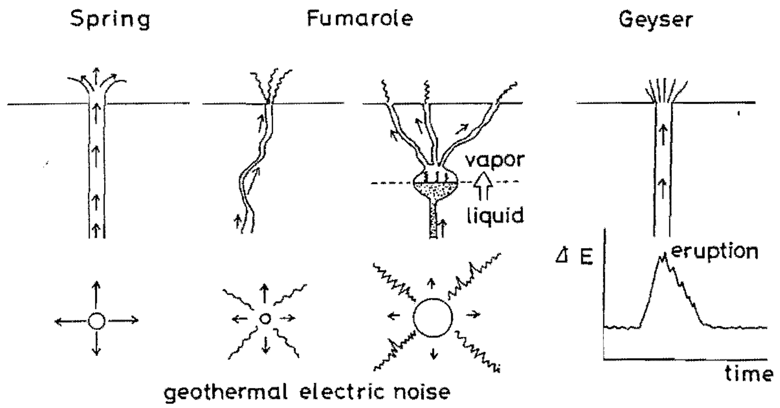

Fig. 2 Generation of geothermal electric noise

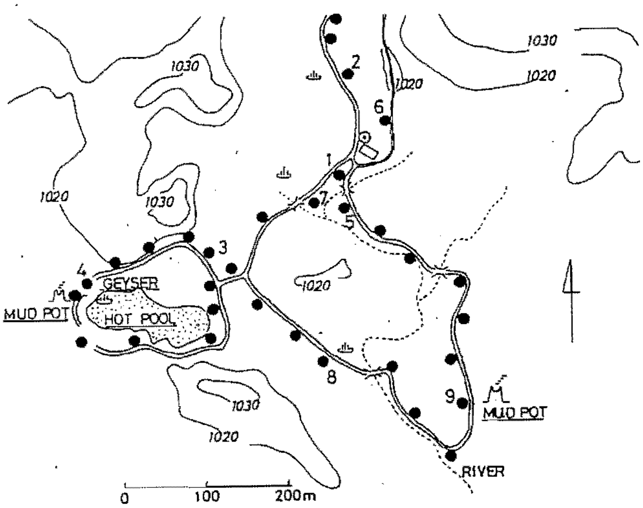

Fig. 3 Observation points in Goshogake geothermal area in 1987 and 1988

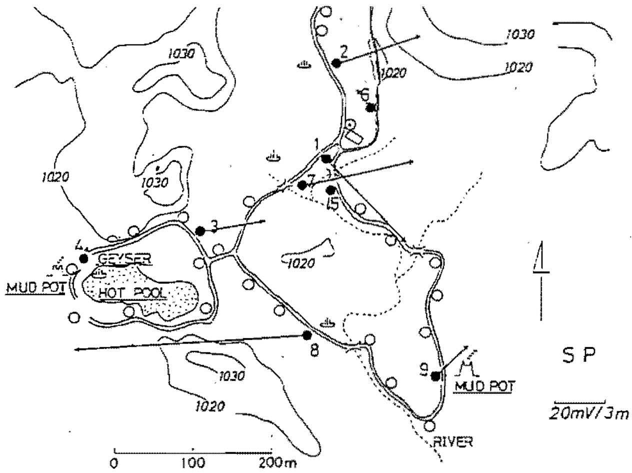

Fig. 4 Vector of SP in 1987

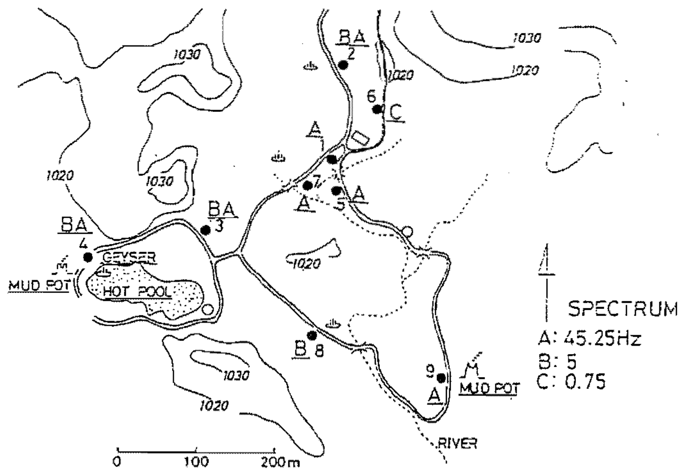

Fig. 5 Geothermal electric spectrum in 1987

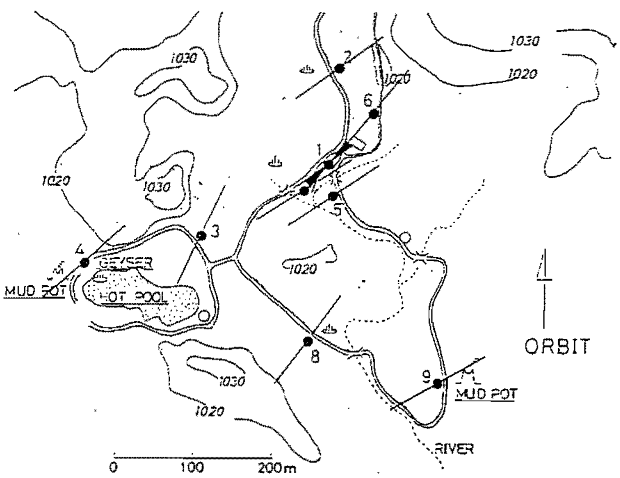

Fig. 6 Orbit of predominant frequency of geothermal electric noise in 1987