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GEOTHERMAL EXPLORATION IN THE SENGAN AREA, AKITA AND IWATE PREFECTURES, NORTHEAST JAPAN

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ABSTRACT

The Sengan area is located in Akita and Iwate Prefectures in the northern part of Northeast Japan.

In this area, there are active volcanoes, hot springs, fumaroles and three geothermal power plants at Matukawa, Onuma and Kakkonda. Geothermal explorations have been carried out with various kind of surface surveys and many structural borings in this area.

At first, the wide-ranged and deep geothermal reservoir was expected to be in Neogene formations, and hopeful heat source was also expected to be the magma chamber related to the Tamagawa Welded Tuff (Early Quaternary Pyroclastics). However, the 1,500m class structural borings proved that the heat potential of this area is low than the expected heat potential. Therefore, the studied area was spread to the north part where Quaternary andesite are distributed. These explorations revealed that young volcanoes (Mt. Akita-Yake-Yama and Mt. Hachimantai volcanoes) are expected to be the heat source of this geothermal system.

INTRODUCTION

The Ministry of International Trade and Industry (MITI) has conducted the project, Confirmation Study of the Effectiveness of Prospecting Techniques for Deep Geothermal Resources and Development, since 1980.

The New Energy Development Organization (NEDO) and the Geological Survey of Japan (GSJ) have cooperated with the headquarters of the Sunshine Project, research and development project of new energy, of MITI. The purpose of this project is to establish available prospecting techniques for deep geothermal resource.

For this purpose, the Sengan area and Kurikoma area (in Miyagi prefecture) are selected as two different geothermal model fields. In the Sengan area in the northern part of Northeast Japan, the Tamagawa Welded Tuff was supposed to be the cap rocks for the geothermal reservoirs. In the Kurikoma area in the central part of Northeast Japan, the geothermal reservoir were supposed to be capped with self-sealing alteration zones, and situated in the collapse caldera.

The overall study schedule appear in Table 1.

This paper summarizes the results of surface surveys and subsurface explorations carried out in the Sengan area (Fig.1).

Details			FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987	FY 1988
Sengan area	Ground surveys	Refraction (medium explosions surveys)		←							
		Magnetotelluric (MT) surveys		←			←	→			
		Electircal exploration		←				→			
	Well surveys	200 m class well (heat flow) surveys		←	→						
		400-800 m class well (heat flow) surveys			←			→			
		1,500 m class well serveys (structural drilling)			←		→				
		3,000 m class well surverys (structural drilling)							←	→	
Kurikoma area	Ground surveys	Thermal image surveys	←								
		Magnetotelluric (MT) surveys		←			←				
		Electrical exploration		←							
	Well surveys	1,500 m class well surveys (structural drilling)		←				→			
		3,000 m class well surveys (structural drilling)								←	→
Development of high accuracy MT exploration technology							←	→	←	→	

Table 1. Study Schedule

GEOLOGY AND GEOLOGICAL STRUCTURE

The geological succession in this area is summarized as follows. This area is underlain by Pre-Tertiary basement, Tertiary formations, Early Pleistocene Acidic Pyroclastics and Late Quaternary Andesitic Volcanics. The basemant is composed of Paleozoic sedimentary rocks intruded by Cretaceous granitic pultons. The Tertiary formations include volcanic rocks and marine sedimentary rocks. The volcanic rocks have been affected by regional hydrothermal alteration and are usually referred to as "Green Tuff". The Early Pleistocene Acidic Pyroclastics, the Tamagawa Welded Tuff is divided into the Kowasegawa Tuff and Ishigedozawa Formation (Tamanyu,1985). The Quaternary Andestic Volcanics have been regionally divided into six groups: Mt. Hachimantai, Mt. Akita-Yake-Yama, Mt. Iwate-San, Mt. Akita-Komagatake, Mt. Moriyoshi-Yama and Mt. Kayodake (Kawano and Aoki,1959).

The geological structures in this area are characterized by the presences of the Hanawa graben in the northern part, Obonai basin in the southern part and a caldera structure in the mid-western part, which accompanied with large amount of acidic welded tuffs of the Tamagawa Welded Tuff.

The distribution of the Tamagawa Welded Tuff indicates that there are three depression structure in the surveyed area, and these depressions, which are bordered by the faults of N-S, E-W and NE-SW trend, are filled with the lower Kowasegawa Tuff, upper Kowasegawa Tuff and Ishigedozawa Formation, respctivery.

The Tertiary tectonic movement of this area were characterized by the formation of the horst and graben.

The alteration zones found in this area consist of partial acidic alteration zone in the volcanic ejecta from Mt. Akita-Yake-Yama (white), and alteration zone due to hot neutral or alkaline water (green) distributed in the Tamagawa Welded Tuff and Tertiary formations.

GEOTHERMAL SYSTEM

Isotherm contour map at sea level are shown in Fig.2.

From the feature of the isotherm contour map, that we recognize is as follows; the high temperature regions are elongnated from Mt. Akita-Yake-Yama to Mt. Hachimantai in the northern part of this area. The smaller high temperature zones extend toward south-east, southwest and north from these main regions.

The high temperature zone which extends northward is supposed to be genetically related with the Hanawa depressin zone.

The pattern of heat-flow is simillar to that of temperature. The high heat-flow regions is nearly identical with the deep high temperature regions.

From the viewpoint of these temperature and heat-flow distributions and geological structures, it is expected that the high temperature and high heat-flow regions are related with the faults and fractures. The relatively high temperature zone is situtated on the marginal faults of the depression filled with the Kowasegawa Tuff. The low

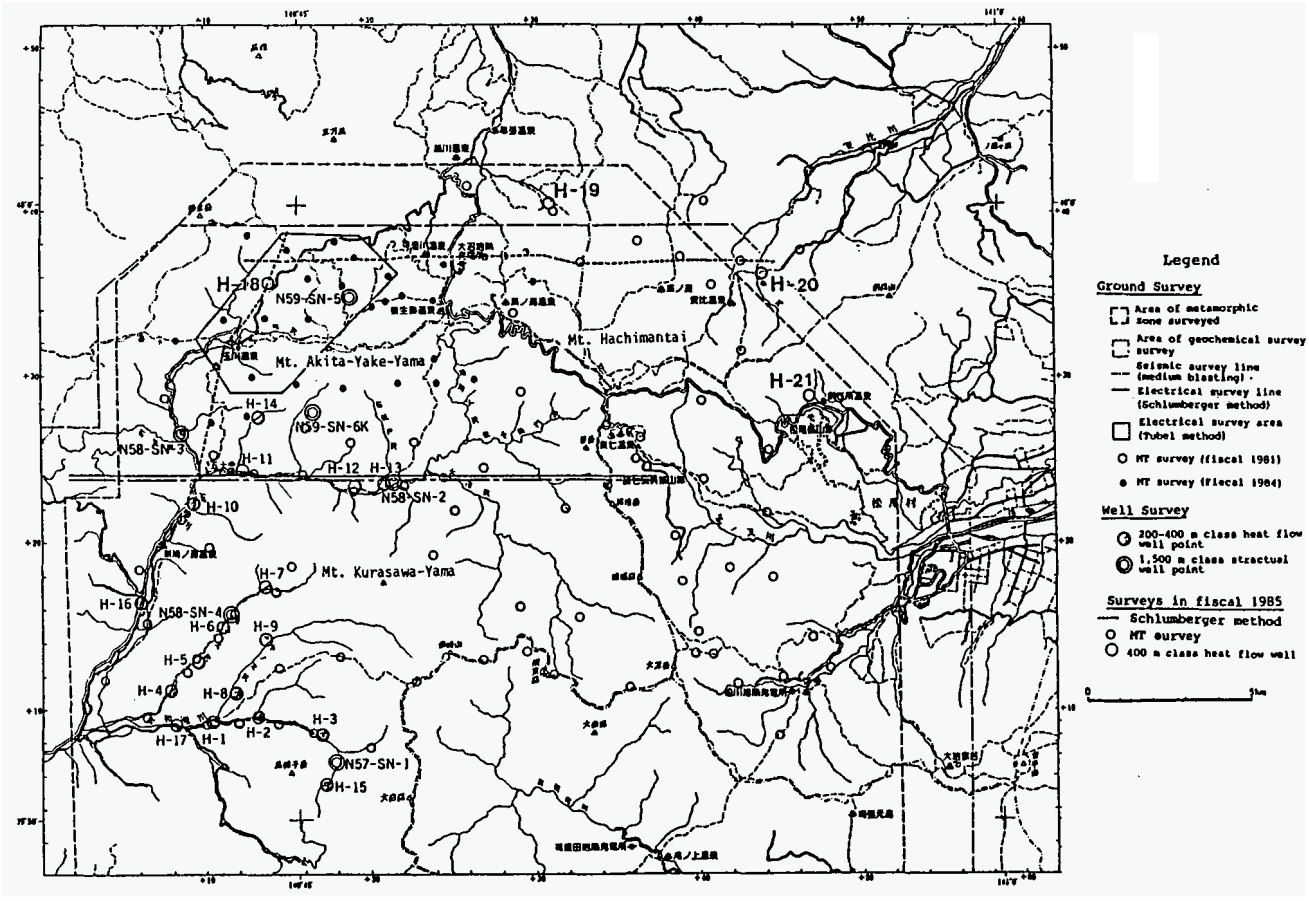

Fig. 1. Surveyed Location Map, the Sengan area

temperature zone is situtated in the caldera (Tamagawa Caldera) filled with the Kowasegawa Tuff.

The high temperature zone, the eastern part of N59–SN–5, is situtated in the extention of the N–S trending fault which borders the west margin of the Hanawa depression zone.

The conceptual model of the geothermal system in this area is shown in Fig.3.
The boreholes in the Tamagawa Caldera made clear that the bottom of the caldera have already cooled down and cannot afford the active geothermal system in the caldera (Tamanyu,1985). The boreholes of the northern part in this area confirmed the high temperature zone in the vicinity of Mt. Akita–Yake–Yama. The N–S trending fault which borders the western part of the Hanawa depression zone is continuous to Mt. Akita-Yake–Yama. The fault is supposed to be the path for the geothermal fluids and gasses. The Ishigedozawa Formation (lake deposit) under Mt. Akita–Yake-Yama is supposed to play a part of the cap rocks for the geothermal reservoirs.

CONCLUSION

1). The geological structure of this area is characterized by the existence of the Latest Tertiary to Quaternary three depressions, evidenced by distributions of the Kowasegawa Tuff and Ishigedozawa Formation and Tertiary graben structures extending in the N–S direction.

2). The high temperature and high heat - flow regions are formed in the vicinity of Mt. Akita–Yake–Yama and Mt. Hachimantai. These high temperature areas are thought to be formed along the fault and fracture zones of Tertiary and Quaternary ages.

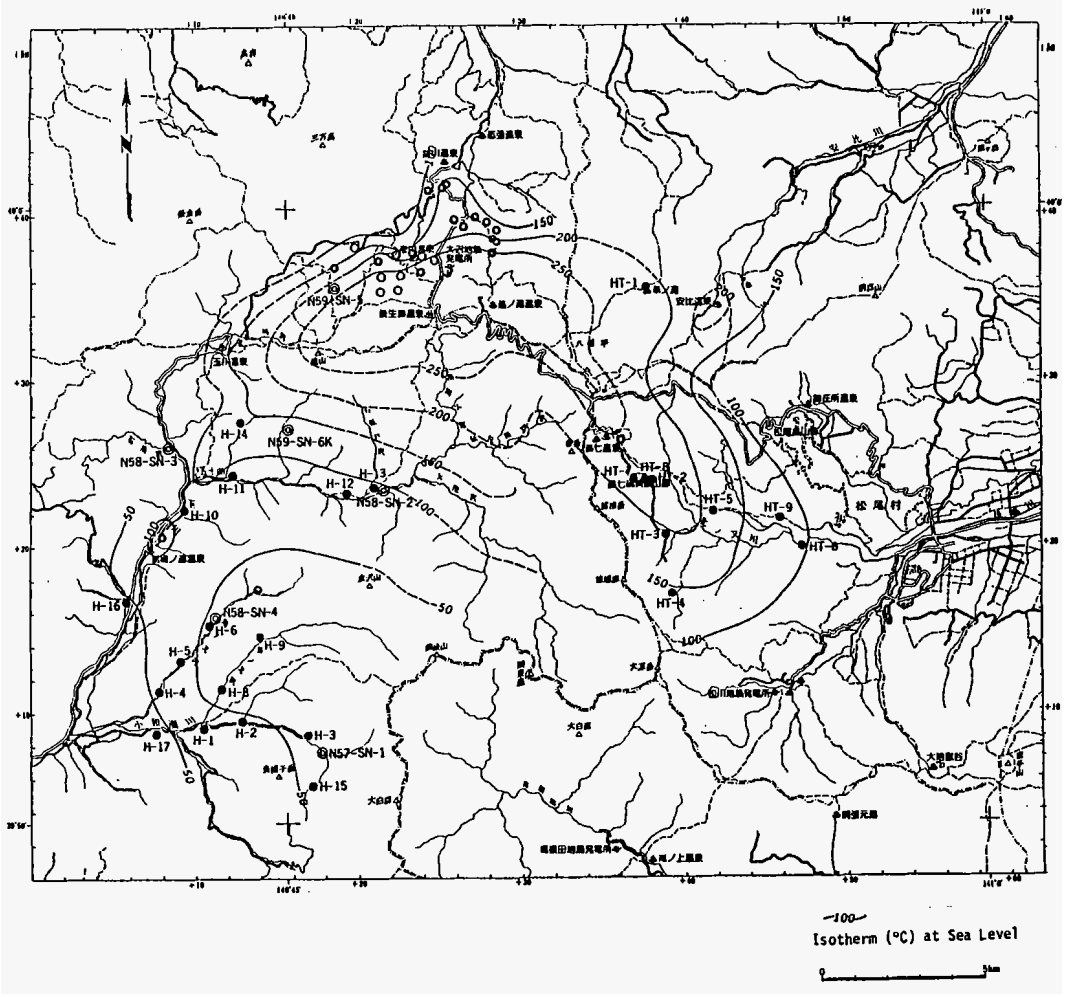

Fig. 2. Isotherm Contour Map, the Sengan area

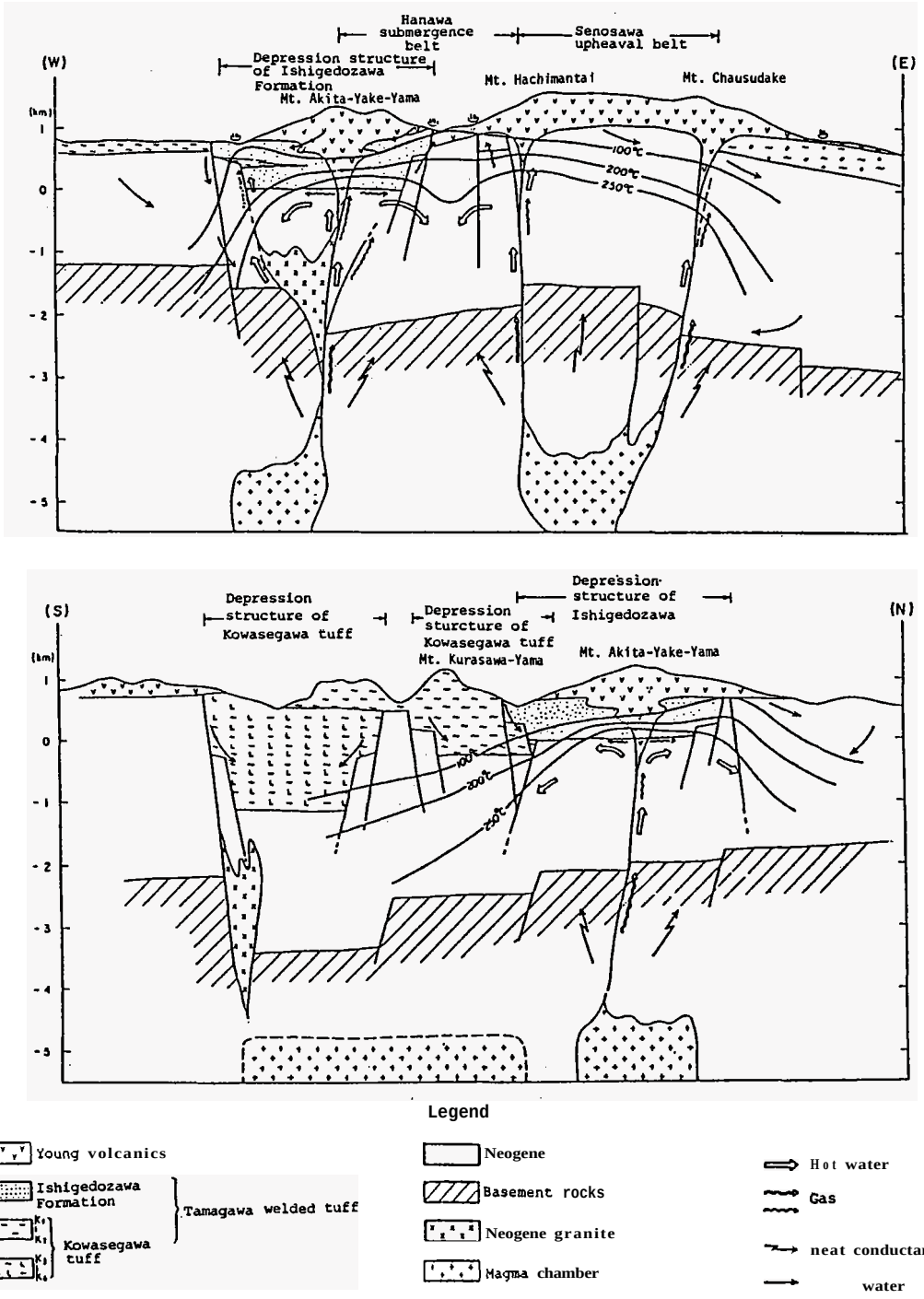

Fig. 3. Conceptual Model **of** the Geothermal System in the Sengan area

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