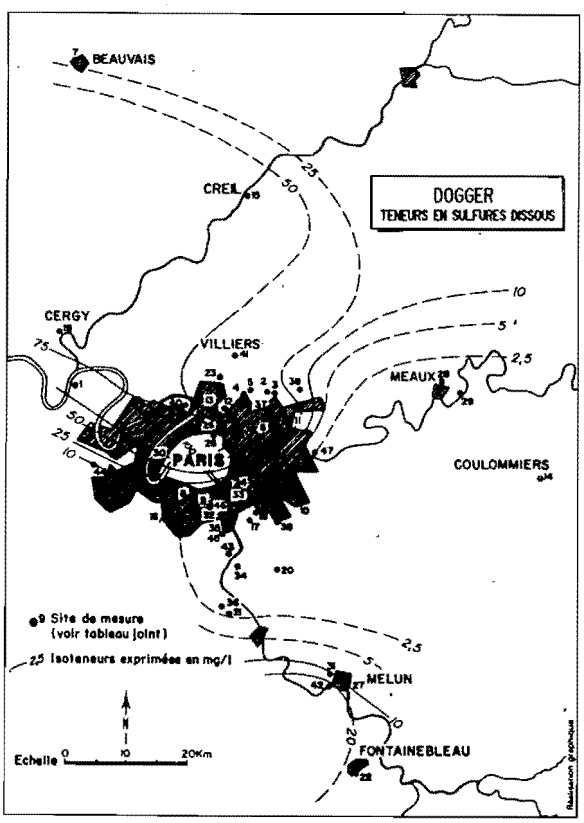
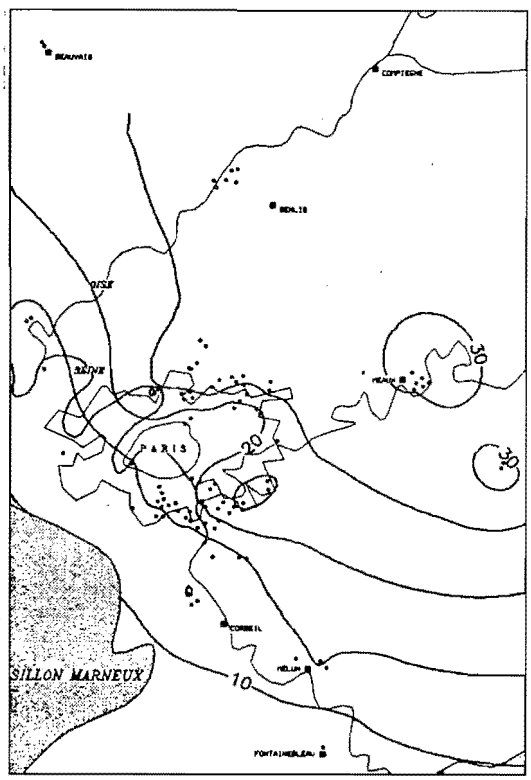
Difficulties occured since 1985. They are mainly due to some economic problems. Among them the most severe being the decrease of the ratio [(Cost of energy)/(Inflation rate)] and the evolution of the references costs of energy. Beside this, some technical problems related to corrosion and sulphides scaling in some parts of the reservoir have appeared during the last three years.

Various research works and demonstration projects are presently carried out in order to solve the technical difficulties. They include :

- Performances evaluation of treatments using chemical additives injected at the bottom of the production wells.
- Studies of corrosion scaling mecanisms.
- Selection of materials
- Controls in experimental loops "in-situ".
- Chemical modelling of water-rock interactions in the reservoir and detailed mapping of the distribution of chemical parameters within the aquifer (cf fig.)



Iso-concentrations in dissolved sulphides (in mg/l)



Isovalues of total salinity (in g/l)

ASPECTS OF EXHAUSTION AND DECLINATION OF THERMAL SPRING RESOURCES IN OBIHIRO URBAN DISTRICT, HOKKAIDO, JAPAN

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Since 1976 the development of thermal springs has been increasing in the Obihiro urban district. Especially since 1980, the digging of orifices of thermal waters has been carried out at a accelerated pace. As a result, by the end of 1987, the orifices of thermal water already dug out numbered 27, of which 22 orifices are currently in use. In addition, there exist 3 orifices now under drilling, 5 orifices waiting for drilling work, and 3 orifices for which the applications for drilling are pending.

As of February 1987, within a radius of 3 km of the JR Obihiro station (42°54' 59.4" N. lat., 143°12'23" E. long.), the following orifices of thermal water exist: 18 orifices in use, 4 out of use, 2 under drilling, 4 waiting for drilling work, and 2 for which applications for drilling are pending.

1. Depth of thermal water orifices

Out of the total of 22 orifices in or out of use, 12 are between a depth of 1,100 to 1,300 m and 9 between 1,300 to 1,650 m.

Judging from the drilling depths, the high temperature deep ground water being extracted exists in the Nukanai Formation (early Pliocene of the Neogene Tertiary Period) and also in the Taiki Formation (late Miocene); extraction is mainly from the former formation.

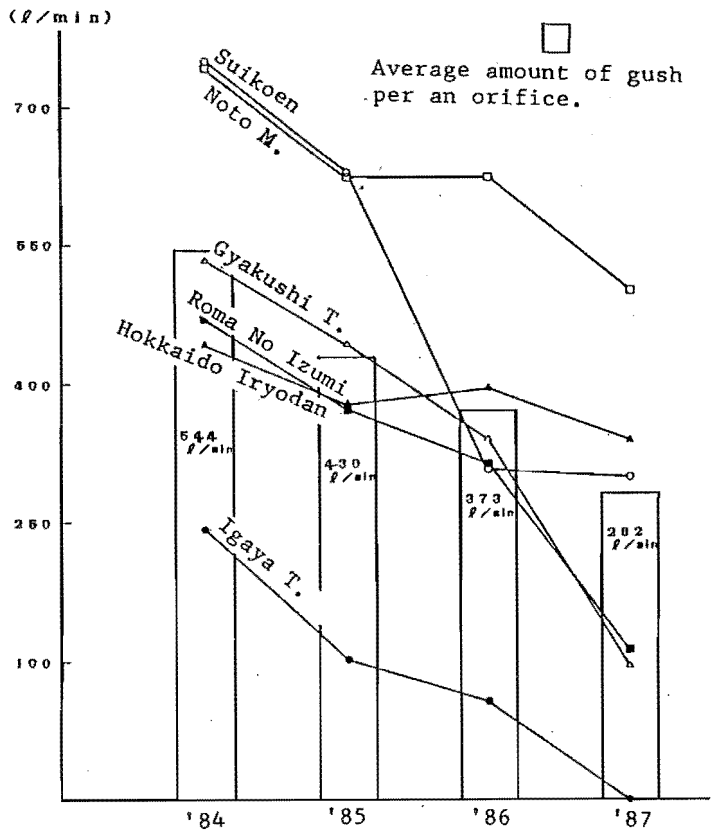

Fig.1 The variation diagram by time elapsed on gush amount of some orifices in Obihiro urban district.

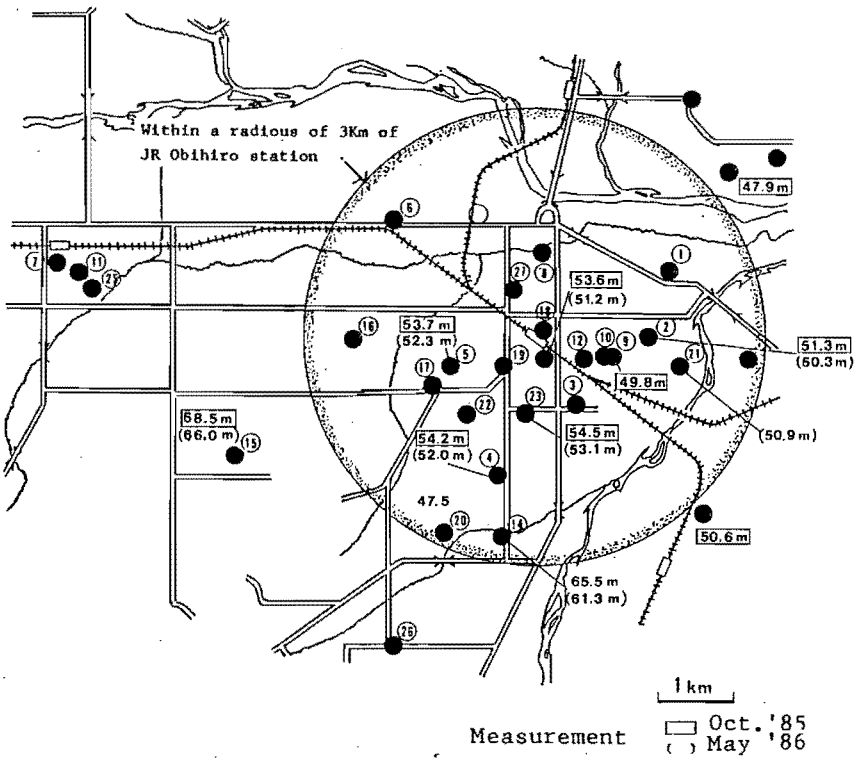

Fig.2 The transition by time elapsed of thermal waters levels on orihices in Obihiro urban district.

2. Lowering of the thermal water level, drop in the thermal water temperature, and decline in the amount of gush

As mentioned before, since the drilling depths of orifices of thermal waters are generally the same, phenomena such as a lowering in the thermal water level, a drop in the thermal water temperature, and a decline in the amount of gush occur as the number of orifices increases.

Although the degree of lowering of the thermal water level differs among orifices, its rate of lowering is generally rapid in all cases. For example (see Fig. 1), in the case of the orifice of Romanoizumi (depth 1,200 m), the thermal water level declined by 7.6 m during the 2 years period from Feb. 1984 to Feb. 1986. Furthermore, as the thermal water level lowered, the amount of gush of thermal water dropped from 468 l/min. in Feb. 1984, to 331 l/min. in Feb. 1986; during the same period, the thermal water temperature also decreased from 45.0 down to 44.1°C.

Moreover, judging from the sea level distribution of the thermal water of existing orifices measured at the Obihiro urban district in Oct. 1985 and May 1986, during this period of 7 months a 1 to 2.5 m decline of the thermal water level was observed as shown in Fig. 2.

From the viewpoint of the relation between the number of orifices and the amount of gush, as the number of orifices increased, the total amount of gush also increased from 1980 to 1984. However, since 1985 the amount of gush did not increase even with the increasing number of orifices.

On the other hand, the amount of gush per orifice was 614 l/min. in 1980, 450 l/min. in 1982, 494 l/min. in 1983, 482 l/min. in 1984, 395 l/min. in 1985, and 311 l/min. in 1986, respectively; thus, except in 1983, the amount of gush per orifice decreased as the number of orifices increased. Furthermore, with the decrease in the amount of gush, the thermal water temperature dropped at every orifice, with the maximum temperature drop being 8°C.

Therefore, as the number of these orifices increases, drying-up and other degradation phenomena - such as lowering of the thermal water level, a decrease in the thermal water

pressure, a drop in the thermal water temperature, and a decline in the amount of gush - are found rapidly progressing in the thermal water resources.

3. Consideration of countermeasures

If the drilling of orifices (thermal waters) in the Obihiro urban district were to be continued recklessly as aforementioned, such phenomena as mutual interference among orifices, lowering of the thermal water level/pressure over a wide area, a decrease in the thermal water temperature and a decline in the amount of gush, would progress at a accelerating pace; thus, it would cause an obvious problem for hot spring gushing in the area.

As countermeasures, the authors consider it necessary to continuously monitor the amount of gushing thermal waters from the existing orifices, thermal water temperature, isopotential level, and shut-in pressure; in addition, 2 to 3 observational wells should be drilled to enable continuous investigation of the isopotential level to clarify the physical condition of the aquifers. The authors also suggest that, on the basis of these data, an initial decision be made on rational intervals for the orifices (thermal water) and the pumping amount prior to the subsequent development of Obihiro in accordance to a plan which would preserve the present conditions of high temperature deep ground water in the Obihiro urban district.

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