

# EXPLORATION AND DEVELOPMENT OF GEOTHERMAL WATER RESOURCES FOR AGRICULTURAL USE IN HOKURIKU DISTRICT

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The relation between geothermal gradients and the geology is investigated in Hokuriku district, Central Japan. Geothermal gradients are mainly inferred from reviewing borehole logs for hot springs. These are classified into the following five groups according to geological distribution.

- 1) Large geothermal gradients ( $0.06 \sim 0.10^{\circ}\text{C}/\text{m}$ ) with some hot springs arround the Recent volcanoes, forming mountains.
- 2) Mostly large geothermal gradients ( $0.04 \sim 0.10^{\circ}\text{C}/\text{m}$ ) with some hot springs on the granitic rocks, forming moutains.
- 3) Moderate to large geothermal gradients ( $0.04 \sim 0.10^{\circ}\text{C}/\text{m}$ ) with many hot springs on the Neogene volcanics and so on, forming low mountains and hills. It is thought that these areas have been lifting up in the Recent.
- 4) Moderate to small geothermal gradients (less than  $0.04^{\circ}\text{C}/\text{m}$ ) on the allviums and thick sedimentary rocks in the Neogene. It is thought that these areas have been sinking in the Recent. Occasionally hot springs are obtained by drilling more than 1,000m deep.
- 5) Mostly small geothermal gradients (less than  $0.03^{\circ}\text{C}/\text{m}$ ) with rare hot springs on the strata in the Paleogene, the Mesozoic and the Paleozoic and metamorphic rocks (schist and gneiss).

## THE PRESENT STATUS OF EXPLOITATION OF DOGGER FOR DIRECT USE OF GEOTHERMAL ENERGY IN FRANCE

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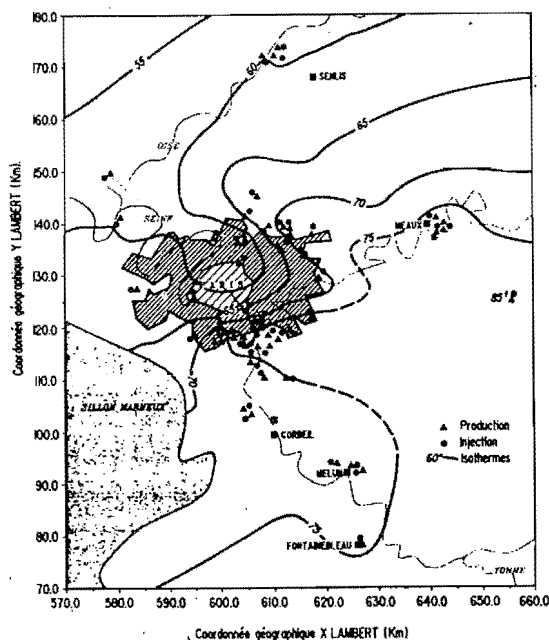
The Dogger reservoir in France is mainly exploited in the central part of the Parisian basin. 54 power plants using the doublet's technic were built, mainly in 1979 - 1984, on a surface of approximatively  $10^4$  km<sup>2</sup>.

They produce a mean of 10 MW thermal each used for space heating and they allow a total petroleum saving of 200.000 E.P.T. (Equivalent Petroleum Tonnes) each year.

The reservoir is inside carbonates rocks, situated at a mean depth of 1 800 m. The fluid has a mean temperature of 75°C and a total salinity between 6 and 35 g/l. The temperature, except some local anomalies, depends mainly from depth with a general gradient of 3.5°C/100 m.

Three main producing levels are exploited. They have a total thickness of around 150 m inside which the production is in fact concentrated through 8 to 12 thin separated layers. The addition of the thickness of these effectively producing layers gives a total of 15 to 30 m.

The total transmissivity of the exploited parts of the reservoir varies between 20 and 110 D.m, from S.W. to N.E.. The total transmissivity presents a general correlation with the total salinity, the most producing wells giving the most salted waters.



Isovalues of temperatures  
(in °C)