

Notes on available information regarding the
Niutuozen geothermal area, Hebei
Province, Peoples Republic of China

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NOTES ON AVAILABLE INFORMATION REGARDING THE NIUTUOZHEN GEOTHERMAL AREA, HEBEI PROVINCE, PEOPLES REPUBLIC OF CHINA.

I. REFERENCES NEEDED

Before further work is done on the area the following publications referred to in the literature surveyed need to be obtained, if possible in English:

- 1) "Special papers published in the 1980s" in which "the thermal field's dimensions and its resource base were estimated.", quoted by "The Third Hydrogeologic and Engineering Team under the Bureau of Geology and Mineral Resources of Hebei Province (1987).
- 2) "Recent isotopic studies by Zhou Fu Shan and Cai Guan-Ying (1982)", cited by UNDTCD-AQUATER-ENEL (1984).
- 3) Shen Minzi, Ni Baoling and Hou Fagao (1982): Hydrogen and oxygen isotope study of hydrocirculation in the Tengchong geothermal area, Yunnan Province. Records Geol. Res., 187-191, cited by Zhang Zhifei, Liu Shibin and Zhao Fengsan (1987).
- 4) A good map showing the locations of boreholes.

II. SOME IDEAS GAINED FROM THE AVAILABLE INFORMATION

The water discharge from the wells drawing from the "pore thermal reservoir of Tertiary sediments varies from 6 - 18 l/s, but the artesian capacity of a single well drawing from the "Pre-Tertiary fissure-karst reservoir" is reported as 2-6 l/s with a maximum of 18 l/s (The Third Hydrogeologic and Engineering Team under the Bureau of Geology and Mineral Resources of Hebei Province (1987)).

The four wells for whose water chemical analyses are available (Nos. 5-8) are all in or close to Xiongqian, discharging 3-9 l/s from an artesian flow. The depth of well No. 5 is 1024 m, but the depth of the others is not known. There is no indication of the depth of the producing aquifers, the total dissolved concentration is 2-3000 ppm and the discharge temperature is about 70°C. Thus it seems that their fluid is derived from the Pre-Tertiary fissure-karst thermal reservoir (The Third Hydrogeologic and Engineering Team under the Bureau of Geology and Mineral Resources of Hebei Province (1987)).

Giggenbach (1986) has presented graphical techniques for the evaluation of water-rock equilibrium conditions using the Na, K, Mg and Ca concentrations of discharge waters. His Na-K-Mg diagram is shown in Fig. 1 and the results for wells No. 5,7

and 8 tested. They plot as shallow waters close to the equilibrium curve for these. For this kind of water the most reliable geothermometer tends to be the K/Mg one (Giggenbach 1986) although the Li/Mg one proposed by Kharaka (R.D. Fournier, personal communication) ought to yield similar results. As the reservoir is in a relatively old formation the most likely mineral to control silica concentrations is quartz. Hence the quartz geothermometer should be applicable.

Thus the following geothermometers have been applied to the analytical results for wells 5,7 and 8:

$$\text{K/Mg: } t^{\circ}\text{C} = 4410 / (13.95 - \log(K)^2 / (Mg)) - 273.15 \quad (\text{Giggenbach 1986}).$$

$$\text{Li/Mg: } t^{\circ} = 1900 / (4.67 + \log(Mg)^{0.5} / (Li)) - 273.15 \quad (\text{Kharaka})$$

$$\text{Quartz: } t^{\circ}\text{C} = -42.198 + 0.28831(\text{SiO}_2) - 3.6686 \times 10^{-4}(\text{SiO}_2)^2 + 3.1665 \times 10^{-7}(\text{SiO}_2)^3 + 73.034 \log(\text{SiO}_2) \quad (\text{Fournier \& Potter 1982})$$

$$\text{Chalcedony: } t^{\circ}\text{C} = 1112 / (4.91 - \log(\text{SiO}_2)) - 273.15 \quad (\text{Arnórsson et al 1983})$$

The last one is put in for the sake of reference.

The results are in Table 1. and suggest a base reservoir temperature of 90 - 100°C. Since this is probably a carbonate reservoir the fluid may be approaching equilibrium described in terms of a reaction consisting of the deposition of calcite and the conversion of feldspar to layer silicates. Giggenbach (1986) has suggested the following relationship linking the K and Ca concentrations of the water to the partial pressure of CO₂ in the reservoir:

$$\log P_{\text{CO}_2} = \log(K)^2 / (Ca) - 3.0$$

This equation has been applied to obtain an approximate estimate for the partial pressure of CO₂ in the reservoir and the results are shown in Table 1.

Table 1. Geothermometer temperatures and predicted partial pressure of CO₂ in reservoir(s) supplying wells No. 5,7 and 8 in Niutuozen geothermal area, Hebei province, Peoples Republic of China.

Well No.	t meas °C	t K/Mg °C	t Li/Mg °C	t qz °C	t mean °C (1)	t chal °C	t mean °C (2)	K-Ca P _{CO2} bar
5	66	93	99	88	93	65	86	0.08
7	71.5	98	99	102	100	80	95	0.04
8	73	98	101	92	97	69	90	0.07

t_{mean} (1) is for K/Mg, Li/Mg and quartz temperatures but t_{mean} (2) for these and the chalcedony temperature.

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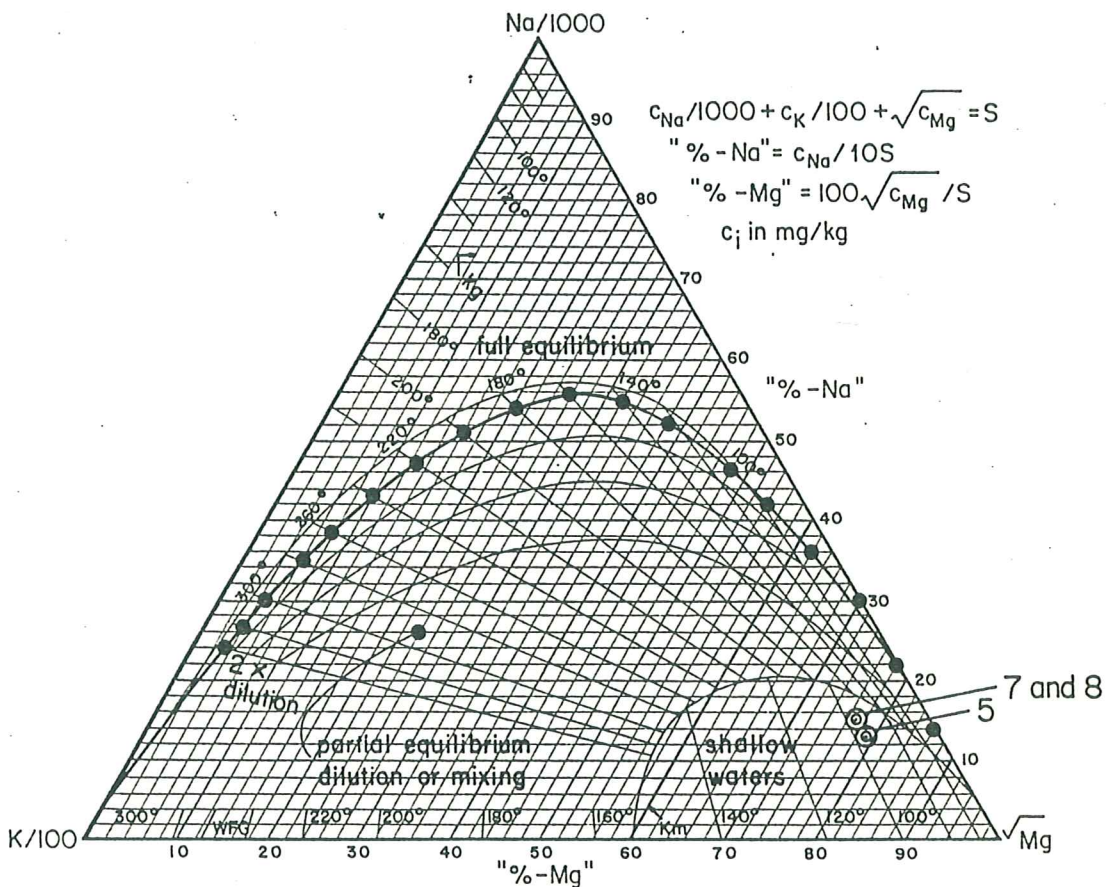


Figure 1. Graphical evaluation of water-rock evaluation temperatures, using relative Na, K and Mg contents of water samples (Giggenbach 1986). The positions of samples from wells No. 5, 7 and 8 in Niutuozen geothermal area are shown.