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THE FEASIBILITY TO GENERATE ELECTRICITY USING GEOTHERMAL RESOURCES IN DAXING COUNTY OF BEIJING

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ABSTRACT

The geothermal reservoir in Caiyu County of Beijing is mainly dolomite of Jixian Wumishan group with depth shallower than 4000 meters and areas about 50 km^2. The newest exploration well of 3600 meters completed in April 2010 showed the geothermal water is artesian with about 1500 m^3/day and measured temperature of 103 □ on the surface. This geothermal field was planned to provide district heating for the residents alongside bathing and swimming, aquaculture, agricultural, industrial, etc. With the discovery of geothermal more than 100 □, it is encouraged to generate power with this low enthalpy geothermal energy, with which to demonstrate geothermal power in the capital of China, Beijing. This paper will analyze the geological, hydrological conditions, chemical contents, and other influential factors and discuss the problems to be solved, and so on.

GENERAL INSTRUCTIONS

Geothermal water in Caiyu County of Beijing, with great advantages, such as high temperature, large water output, good water quality artesian and containing a lot of natural gas.
It is very suitable for development and utilization, including geothermal energy (and natural gas) electricity generation, heating and cooling, bathing and swimming, tourism, aquaculture, agricultural, industrial and so on and fully focus on the cascade of energy use(by Ke, B.L.).

REGIONAL GEOLOGICAL AND GEOTHERMAL FEATURES IN CAIYU COUNTY

Caiyu County is located in Langgu Sag, which is in the north of Jizhong depression, Lixian-Niubaotun Fault and Daxing Uplift in the west, Wuqing Sag in the east, Niutuozhen Uplift and Baxian Sag in the south and Dachang Sag in the north, shown in Figure 1.

Lixian-Niubaotun Fault is the important factor for controlling Langgu Sag, with mechanism: strike NE 40-70°, dip SE30°-50°.

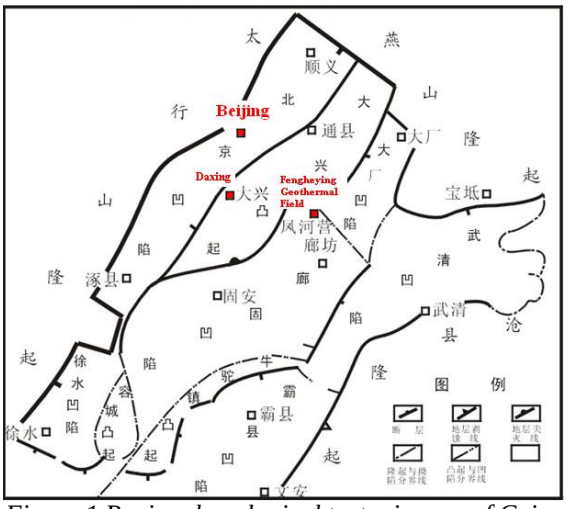

Figure 1 Regional geological tectonic map of Caiyu geothermal field

Tongbaizhen Fault and Fengheying fault are the important factor affecting geothermal development in the work area (by Bureau G. M. R. B).
Tongbaizhen Fault, one of long-term large faults in Langgu depression, is located in the south of Fengheying buried hill structure. It is a reverse normal fault dipping to the southeast. As an important pathway for heat transfer, it makes the temperature gradient at the top cover of Fengheying buried hill structure as high as 4 ℃/100m. In addition, there is an oil and gas-bearing reservoir in Minghuazhen group, because Ordovician strata is connected with Shasan formation, which is oil source bed, at the fault, and the gas is easily migrated up in the fractured zone.
Fengheying Fault, the main fault in the buried hill structure, is a reverse normal fault which trends to the northwest. The amount of vertical displacement of the fault 250-350 m. Fengheying buried hill is divided into two parts by the fault. The southern part is a semi-circular nose-like structure, and the shallow depth is 3050 m, while the deepest is 5100 m. The

northern part is a massive structure, and the top surface depth is 3150 m in the shallow and 4200 m in the deep.

Fengheying Fault is a fault with buried hill inside, developed From Paleozoic to the end of Mesozoic, leading to extreme development of fracture in buried hill, and it is important to control the oil, gas and geothermal water in the fault.

GEOTHERMAL GEOLOGICAL CONDITIONS

The hot water and heat transfer structure

Tongbaizhen Fault and Fengheying Fault are the important channel to transfer the heat and water underground to the shallow stratum. They are the major thermal conductivity structure in the area. (Figure 1)

The heat storage cap

A good cap rock is another important factor to form the heat storage, playing a temperature-keeping role and stopping the infiltration of cold water in the shallow.

It is shown from regional stratigraphic data that the thickness of the cap rock is about 3300m, including Quaternary, Tertiary, Carboniferous-Permian, Ordovician, Cambrian and Qingbaikou System.

The heat reservoir

By the exploration work, it is found that the geothermal reservoir in Caiyu County of Beijing is mainly dolomite of Jixian Mishan group with depth shallower than 4000 meters and areas about 50 km^2. Because of the fractured karst, the reservoir is rich of hot water between the depth 3358m and 3623m. and is the most important heat reservoir in Beijing.

THE ACTUAL DRILLING SITUATION OF WELL XING-9#

The exploration Well Xing-9# of 3623m completed in April 2010 was rated as excellent wells. It is shown the geothermal water is artesian with about 1441.3m^3/day and measured temperature of 103 □ on the surface (by PiLing, E. C. L.).

The hot water and heat transfer structure

As previously stated, Tongbaizhen Fault and Fengheying Fault are near the Well Xing-9#, they are the important channel to transfer the heat and water underground to the shallow stratum.

The heat storage cap

The thickness of the cap rock is 3358m from the exploration Well Xing-9#, including Quaternary, Tertiary, Carboniferous-Permian, Ordovician, Cambrian and Qingbaikou System. Thick cap rock and high geothermal gradient make the geothermal reservoir cap an ideal thermal reservoir cover.

The heat reservoir

By the exploration work, it is found that the geothermal reservoir in Caiyu County of Beijing is mainly dolomite of Jixian Mishan group with depth shallower than 4000 meters and areas about 50 km^2. Because of the fractured karst, the reservoir is rich of hot water between the depth 3358m and 3623m, and is the most important heat reservoir in Beijing.

By comparison of the he well log data and the actual drilling data, Wumishan dolomite in Jixian System is the hot water reservoir. The apparent thickness of the reservoir in the well is 265 m, containing four sections: 3383-3394 m, 3463-3470 m, 3476-3488 m, and 3533-3544 m, respectively.

WATER QUALITY ANALYSIS

According to rules requirements (by General A. Q. S.), *Geologic exploration specification of natural mineral water (GB/T 13727-92)*, it was evaluated that chloride ion (Cl^-) content is 3.38 × 10^3mg/l, and the milligram equivalent percentage is 95.50%; sodium ions ($Na^{+)}$ content of 2.33 × 10^3mg/l, milligram equivalent percentage is 92.2%. Based on Shukaliefu classification Method, the hydrochemistry characteristic is Cl-Na type. The mineral salinity of hot water is 6.70 × 10^3mg/l, PH value is 7.84, and total hardness is 209mg/l (for calcium carbonate). It is of a high salinity, neutral, slightly hard water, as in Table 1.

Table1 the ion content of hot water of Well Xing-9#

Possitive ion			Negative ion		
Ion	Content ρ□B□/□ mg/L□	Milligram equivalent percentage x□l/zBz±□%	Ion	Content ρ（B）/（mg/L）	Milligram equivalent percentage x（l/z$B^{z\pm}$） %
K^+	156	3.7	HCO^{3-}	592	9.1
Na^+	2.33×10^3	92.2	CO_3^{2-}	0.0	
Ca^{2+}	57.5	2.6	Cl^-	3.38×10^3	89.4
Mg^{2+}	15.8	1.2	SO_4^{2-}	51.4	1.0
NH^{4+}	6.50	0.3	F^-	10.0	0.5
Fe^{2+}+Fe^{3+}	0.600		NO_3^-	< 0.05	
Total	2.56×10^{-3}	100	Total	4.04×10^{-3}	100

THE FEASIBILITY TO GENERATE ELECTRICITY AND TECHNICAL DIFFICULTIES

Geothermal resources in Caiyu County are mainly distributed in Fengheying and the surrounding areas.

The main heat reservoir is dolomite of Jixian System Wumishan Group, and its burial depth is less than 4000m with an area of about 50km^2. The geothermal water is artesian with about 1500 m^3/day and measured temperature of 103 □ on the surface. The amount of insoluble gas (natural gas) produced is as much as 80% insoluble gas, and its calorific value is very high.

According to exploration results of Well Xing-9$^{\#}$, the maximum temperature may reach 120 ℃ in Caiyu, and the water/gas production in a single well could reach 2000 m^3. Based on the above parameters, if the geothermal resources can be all developed (including natural gas resources), a calculation shows that 6-8million m^2 building can be heated by the geothermal energy winter and 1.8-2.4 million m^2 building cooling in summer. Moreover, a geothermal power plant with generation capacity of 10-15MW can be installed, with at least 50-100 million kWh annual power generation.

How ever, there are some technical difficulties to generate power by geothermal energy in Caiyu:

The treatment of scale

Because of the high Salinity, Geothermal water is easily scaled in the pipe. The method of treatment should be taken into account (surface and underground).

Separating method of gas and water

The amount of natural gas is so large that can be used for heating and power generation. The technical of separating gas from water is very important, including the apparatus, the place of gas-water separator and the way to transport gas after separation.

Geothermal water use patterns

Geothermal source water transports directly to the end of the demand area, or transferring indirectly into the end of demand areas after the heat exchanger near the well.

Geothermal power generation method

The method of geothermal power generation determines the energy using efficiency, Rankine cycle and Kalina cycle have both advantages and disadvantages for geothermal power generation.

Natural gas power generation

Distributed or centralized power generation, gas turbines or gas engines.

Recharge of ground water

To ensure the sustainable use of geothermal resources, ground water recharge is very important. However, how to reduce the cost and how to improve the recharge capacity are the contradictory elements.

Fracture acidizing technology

Fracture acidizing technology is crucial to improve well productivity of water/gas of geothermal wells, the technical parameters is in need.

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