

THE BASIC CHARACTERISTICS OF GEOTHERMAL RESOURCES IN XINJIANG, CHINA

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ABSTRACT

Geothermal resources is one of the mane mineral resources in Xinjiang, and this report introduces the basic information on the distribution and the amount of hot springs and the characteristics of their hydro-chemical types, trace element concentration and temperature etc. The development and problem of geothermal resources in future are discussed.

1. BASIC CHARACTERISTICS

Xinjiang is located in the western part of China (Fig. 1). Its area is 1.66 million sq km². From north to south there are Altay, Tianshan and Kunlun mountains, among which there are two big basins of Jungar and Tarim. The geothermal is one of maple mineral resources in Xinjiang. Most of geothermal resources distribute along mountain series in Xinjiang. Great deep faults and tectonic movement of Cenozoic Era had been developed, which supplied better geological background for formation and reservoir of geothermal resources. (Fig. 2)

1.1 Geothermal Characteristics Of Mountain Area

According to survey data, 79 geothermal occurrences have been found, among them there are 66 hot springs, 7 steam springs and 6 hot wells. Most of their temperatures are less than 60°C, generally 25-55 °C, the highest 72 °C. Hot spring flow is generally 1.5-30 m³/h, maxim 72 m³/h. Hot water mineralization of 71% of them are less than 1 g/L. the others' are in 1-3 g/L. The mineralization distribution in the regional area is the highest in south Tianshan and the lowest in Altay. The adequate chemical types are as following: HCO₃SO₄-Na type in Altay, SO₄.HCO₃-Na or SO₄.CL-Na, CL.SO₄-Na.Ca in Tianshan and SO₄.HCO₃-Na or HCO₃.SO₄-Na in Kunlun (Table. 1).

The hot water contains trace elements fluorine (F), lithium (Li), boron (B), arsenic (As), strontium (Sr), iodine (I), manganese (Mn), aluminum (Al), copper

(Cu), zinc (Zn), chromium (Cr), cadmium (Cd), molybdenum (Mo), selenium (Se) etc. and nitrogen gas, sulfureted hydrogen, oxygen, methane as well as radioactive components such as uranium (U), radium (Ra), thorium, radon (Rn).

According to the chemical analysis of 45 geothermal occurrences, the silicic acid content of 70% of them is more than 25mg/L, in which 50% of them the silicic acid is more than 50mg/L. F concentration of them usually is 1mg/L, in which 62% of them F are more than 2mg/L. The radon concentration of Alashan hot spring located in Fuhai county, Altay region is 451.6 ± 108.7 eman/L, which is rare strong radioactive water.

1.2 Geothermal Characteristics Of Basin-Plain Area

In the basin-plain region hot water is found in oil-boreholes and some supplying water-wells that distribute along the margin of Jungar basin, Tarim basin, To-ha basin and Bole rift. Those hot-water occurrences belong to hot-layer-reservoir type except in Bole rift. Their formation is related to deep and great faults. The hot-layer-reservoirs are made of Paleozoic and Mesozoic sand and volcanic clastic rock. The buried depth is usually under 2000m. The bottom temperature of borehole is 50-90 centigrade. The maxim is 172.5 centigrade. The average temperature gradient is 1.5-2.9 °C /h.m. Hot water contains Sr, B, Li, F, de-silicic-acid more. For example in the hot-water-well 25 of kelamayi: silicic acid 167.37mg/L, I 7mg/L; hot-water-well 89: silicic acid

33.4mg/L, F 4.01mg/g, Sr 4.096mg/L, Li 0.382mg/L, Boron acid 5.6mg/L, U $28.7 \pm \text{ug/L}$, Ra 36.4Bq/L, radon $297.6 \pm 37.7\text{Bq/L}$.

According to the data of oil-boreholes and geothermal exploration, basin-plain region having hot water in Xinjiang is divided into six geothermal appearing areas (zones) (Table. 2).

There are seven steam springs in Xinjiang, which are special type of geothermal resources. They distribute in Jurassic coal strata along two sides of Tianshan. The formation of them is related to naturally burning coal. The characteristics of their chemical and physical are seen Table 3 and Table 4.

According to the statistic of 51 hot springs, the natural heat discharge is $2.7 \times 10^{-7} \text{J/s}$ that is equal to standard coal $2.944 \times 10^{-7} \text{t/a}$.

2. THE EXPLORATION AND DEVELOPMENT STATUS OF GEOTHERMAL RESOURCES

By now the exploration and utilization of geothermal resources in Xinjiang is still in primary stage. Geothermal survey extent corresponds to regional geothermal survey level in 80s'. Utilization of geothermal resources is limited to cure diseases. 10 hot-spring hospitals have been founded. For instant, Shuimegou hot spring, aided by Japanese government, has been built to be modern synthetical hospital of recuperation and curing. The building area is 11770 m². However, Most of hot springs have not been used because of located in mountains and having difficult traffic conditions.

3. THE EXPLORATION AND UTILIZATION OF XINJIANG GEOTHERMAL RESOURCES IN FUTURE

With the developing the western of China, the exploitation and utilization of Xinjiang geothermal resources will play a great role in economic development. Some geothermal resources with better exploitation and utilization conditions distribute in important economic zones of Xinjiang, which is the basic for exploiting and utilizing geothermal resources. According to Xinjiang's economic development program, combined with the economic

basic of local government, geothermal resources are exploited and utilized in the economic development zone of Tianshan north slope and in the economic development districts by the centers of Yili, Kashgar, Kuerl and Bole. In those areas or around cities agriculture and vice-product basement and the multi-function system for treating, bathing, heating, touring and entertainment etc. will be built and use geothermal resources. Eight geothermal-appeared zones are chosen for exploitation and utilization of geothermal resources (Table. 5).

4. PROBLEMS AND SUGGESTIONS OF DEVELOPMENT OF GEOTHERMAL RESOURCES

The utilization of the geothermal resources in Xinjiang still remains in a pretty low level at this moment. Only a little of them has been developed for medical treating and bathing use. For the geothermal resources produced in plain areas and other fields of utilization such as agriculture, industrial production, house heating, power generation and some useful elements extracting are almost blankets. For Xinjiang, the main problems to be solved for geothermal development are:

- 1) lack of enough study on the forming conditions, regulations of distribution and the life span of the geothermal resources;
- 2) low level of exploration and exploitation due to the backward means and technology;
- 3) only a few fields be involved in the geothermal utilization
- 4) compared with coal, oil and gas, the geothermal resource is a clearer one. Exploiting geothermal resource in those regions, which are rich in geothermal and shortage of coal and oil and gas and difficult and remote in the traffic, is considered.
- 5) in the development process, geothermal resource should be used synthetically such as touring, drying, heating, curing and planting etc.
- 6) there is no any active volcano in Xinjiang.

REFERENCE

1. Proceedings of THE 2ND TIANJIN GEOTHERMAL WORKSHOP 1993.



Fig. 1 Map of China

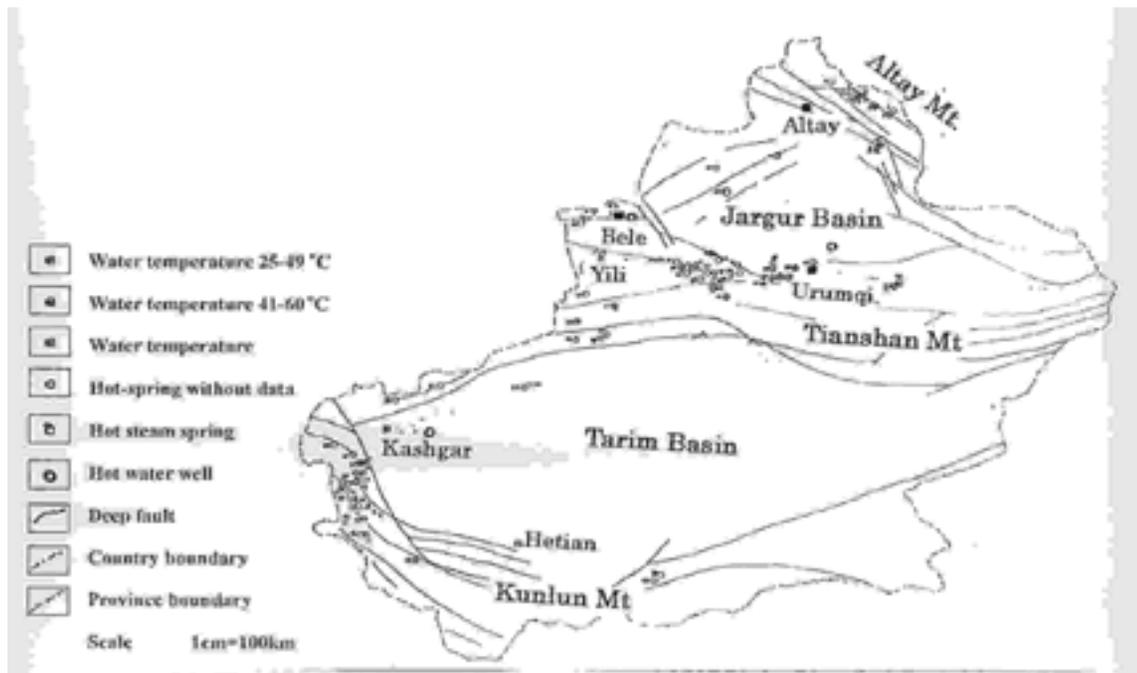


Fig. 2 The distribution map of geothermal resources related with deep faults

Table. 1 The Characteristics of Geothermal Resources in Mountainous Region

Geography unit	Hot water activity extension	Hot-spring occurrences	Temperature(⁰ C)	Flow (L/s)	Water chemical feature	
					Mineralization (g/L)	Water chemical type
Altay mountain region	Strong belt	8	32-41.5, the highest 52	0.4-1.79, max. 6.18	0.14-0.30	HCO ₃ SO ₄ -Na
West Jungar mountain region	Weak belt	1	33	0.24	1.29	SO ₄ CL-Na Ca
Tianshan mountain region	North Tianshan stronger belt	28	30-50, the highest 54.5	3.33-5.56, max. 20.0	0.3-0.99, max. 7.92	SO ₂ HCO ₃ -Na SO ₄ CL-Na Ca
	Middle Tianshan strong belt	3	44-54	0.53-1.19	0.54-0.85	SO ₄ CL-Na
	South Tianshan belt	7	25-30, the highest 66	1.44-7, max.13	1-4.4, max 138.8	CL SO ₄ -Na Ca
Kunlun mountain region	West Kunlun strong belt	17	40-60, the highest 72	1.39-8.33, max. 12	0.3-0.9	SO ₄ HCO ₃ -Na HCO ₃ SO ₄ -Na
	East Kunlun weak belt	2	39	4	9.41	CL SO ₄ HCO ₃ Na

Table. 2 The Geothermal Characters of Plain Area in Basins

Geography unit	Appeared Geothermal area	Stratum symbol	Temperature-Measured wells	Drill depth (m)	Drill Bottom temperature (⁰ C)	Average geothermal gradient (⁰ C/hm)
Jungar basin	West edge	C.P.T	9	2264-4374	53.7-93.4	2.1-2.7
	East edge	C.P	6	1861-3210	51.4-93.8	2.6-2.9
	South edge	Q.N	20	250-550	17-21	1.5
Tarim basin	North-west margin	P.J.K.E	8	2330-5710	68.5-172.5	1.67-2.85
	South-west margin	C.K.N	9	2600-5525	76.5-155	1.35-2.4
Bole rift	Center-lined belt	r ₄	>50	40-90	11-37.1	

Table. 3 The Characters of Hot Steam Springs in Xinjiang

Spring name	Occurrence Era	Amount	Temperature	Remark
Hefeng	J _{2X}	10	50-62.5	Sulphuric smell
Changji	J _{2X}	20	45-95	Boiling sound
Yili	J ₂	>10	100-187	Boiling sound
Wensu		1	40-60	
Luntai	J _{2X}	20	89-96	Sulphuric smell
Hutubi-1	J _{2X}	6	70	Sulphuric smell
Hutubi-2	J _{2X}	2	53-62	Sulphuric smell

Table. 4 Gas Component of Changji Hot Steam Springs

Gas Component (%) Sampling number	O ₂	N ₂	CO ₂	Ar
	No.1	18.09	74.90	3.02
No.2	21.90	78.88	1.90	0.38

Table. 5 The Geothermal Resources Characteristics of Distribution Areas for Exploitation and Utilization

Distribution area of geothermal resource	Water temperature (°C)	Flow amount (L/s)	Mineralization (g/L)	Beneficial elements for medicine	Exploitation and utilization
Urumqi belt	25-32.5	0.075-1.3	5.0-4.5	Sr, F, Ba, H ₂ S, HBO ₂	Hospital for Medicine treating
Tianshan north slope belt	31-57	1-20	0.18-0.38	F, H ₂ SiO ₃ , HBO ₂ , Rn	Hospital for Medicine treating
Bele rift belt	32-65	2.1-18	0.42-2.2	F, H ₂ S, HBO ₂ , H ₂ SiO ₃ , Rn	Hospital for Medicine treating
Yili rift belt	54	0.53	0.85	F	Medicine treating and food processing
Kuerl anormal belt	24	4.5	1.65	F	Not being used
Tashikugan belt	57-65	1-5	1.12-2.66	H ₂ SiO ₃ , F, HBO ₂ , Fe	Medicine treating
Jiashi anormal area	24-42				Not being used
Alashan hot springs	25-52	2.5	0.23	F, Rn, H ₂ SiO ₃	Medicine treating