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GEYSERS IN CHINA

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Abstract

In this paper, we shall introduce the geysers in China to earth scientists.

During the reconnaissance in Qinghai-Xizang Plateau, six active geyser areas, some inactive geysers and some man-made geysering wells were found. This paper brings together most aspects of geyser activity, including behavoiral characteristics, earthquakes effect on it, some man-made geysers and the prospect for development.

Introduction

Geysers are spectacular hydrothermal events. Before 1974, we knew nothing about geysers in China. Although T. G. Montgomeric started off Xigaze, passed through Namuling County, crossed over Nyainqentanglha Range, and then arrived Nam lakeshore in 1871-1872. On the way, he pays special attention to the numerous not springs with sulfurous, in some cases thrown up to 40 or 60 feet, and say they remind one of the Geysers of Iceland. He did not give a positive assessment. Among the 5 thermal areas visited so far, there are 2 boiling springs: Bibilong and Sedang, the landscape there remains as before. During the geothermal reconnaissance in Qinghai-Xizang Plateau, some geyser areas were found. The location and general characteristics are shown in Table and Fig.1.

Table 1. Summary of Chinese geysers

Name	Location	°N'	°E'	Altitude m	Numb. of Gevs.	T°C	Comments
Dagajia	Angren County, Xizang	29 31	85 40	5080	4	85	Both banks of a wide valley along a roughly NS trends of tension fault, U. Cretaceous Flysch.
Chabu	Xietong-men County, Xizang	29 45	88 20	4800	2	86	a wide Valley with N-S trend, U. Cretaceous Granite.
Gulu	Damxung County, Xizang	30 52	91 36	4700	2	86	a wide valley parallel with a fault of N-S trend, Granite.
Gudui	Cuomei County, Xizang	28 31	91 52	4600	1	86.5	Fault (N-S and E-W) interesction, Triassic Flysch Sediments.
Chaluo	Batang County, Sichuan	30 24.3	99 23.1	3600	4	88.5	Located at the junctions of two Sets of faults with N-S and NE trends, Triassic volcanic-sedi-ments.
Balazhang	Longling County, Yunnan	24 37	98 38	1280	1	98	Arched fault passed through the deeper metomorphic stratum.

1. Behavioral characteristic of some geysers

No one geyser looks or acts the same as any other. Each one has its own arrangement of reservoir and tubes, water supply and heat source. In the power and beaty of Chinese geysers, Dagajia area surpasses any other (Tong et al, 1981).

Dagajia: The thermal manifestations are issued on the silica terrace with 15–20 m above river level. There are 1000m long and 500--1200 m wide of terrace, which was deeply eroded by the Doxungzangbo River, the largest tributary of Yarlung Zangbo River. Surface manifestations are mainly boiling springs and hot pools, only four of which are geysers. The largest with a round fountain of 30 cm is situated on the right bank. Its activity is in disorder and has bimodal eruption patterns. It appears two types of eruptions: the most frequnt occuring several min interval, jetting water 5 to 10 min; a more forceful one several seconds to minutes, shooting water to heights of 20 m. The temperature of hot water is 84°C at interval and 85°C at jetting.

The second to the north of first is located on the precitous bank with 2 m above river level. It erupts to a height of about 20 m lasting 25 min, at interval of 36 hr. The geyser, which is inclined 45°, spurted to the opposite bank and is alike a silver bridge arched across the ricer. The third near the second is located on a silica cone with 1m high. The interval is about 5–6 hr. The fourth is opposite second and jet plays to a height of only 1 m.

Chabu: There are 200 springs including boiling springs, hot marsh and geysers. Two geysers are situated on the top of silica terrace. The vent is two fissures of 2 m long taking "L" shape, where there are frequent activity only along E-W branches, having 208 times jetting water in 24 hr. Every time lasted 4–5 sin at interval of 2–3 min. The height of jetting water is generally about 5–6 m, but is most violent at midnight having 7 m. The another is to south of 20 m and its height of jetting water is only 30–40 cm.

Gulu: In this area, there is a geyser on the top of the largest silica cone. Its vent shows funnel shape with depth of 30 cm and a diameter of 55 cm, the decreasing to 10–20 cm. The jet plays to a height of only 7 m. Its eruptions came at 20–48 min, each one lasting 32 to 72 min, based on 45 times observation on the 8th July 1975. The character of the variation of temperature with time at 1m depth shows in the Fig.2. At the interval, the temperature of water is less than the local boiling temperature (84.3°C). The rise in temperature preceding the eruption begins 35 min ahead of the eruption. At eruption, the temperature has reached 88°C, 4°C hotter than at level closses to the surface, then runs down by seep. It is almost alike to old Faithful (Rinehart, 1980).

Chaluo: The geothermal area, roughlly 1000 m by 200 m, issues four geysers and other manifestations: fumaroles, many boiling springs and thermal springs. The temperature of issued hot water is about 88.5°C. One geyser is located at the silica sinter and others on the debris fans. Their eruptions of all geysers are compound multipolar. One has 8 times of large eruption, 190 times medium one, and more than 2000 times small eruptions in 24 hr. Every large eruption to a height of 2–4.5 m lasts 15–20 min, between which thereare medium eruption to a height of 40 cm. At interval of every medium eruptions, the geyser is not clam, there are mary small eruptions to a height of 20 cm, lasting 10 sec and having interval of 40–50 sec.

At Gudui and Balaahang, both geysers are very small.

Geysers could be divide into pool, pipe or complex systems (Rinehart, 1980). The active geysers in China are all geysering from a pipe. Data of the precise natures of geyser reservoir is very limited because they reside mostly out of view underground. Zhang et al (1982) noted that the reservoir of some geysers might be come from the hydrothermal explosive craters.

2. Earthquakes effects on geyser activity

All of these geysers are located in tectonically active areas, they are subjected to the stress changes preceding, occurring at time of, and following earthquakes activity. Due to absent of the long-term monitoring, no data detailed are available on it3 performance shortly before and after many earthquakes, but we can know something from local people.

In Dagajia, present a hot water pool was a pool geyser with bigrous eruption which disappeared many years ago. Of late years, the

largest geyser occured owing to an earthquake.

In chabu, about 24 years ago, the main geyser was located at NW 100 m of present geyser which was a common boiling spring. In 1952, some scientific explorers have ever been there, the geyser had eruption for 4 times in 24 hr to a height of 10 m. During 1954 and 1955, the high tide of eruptions had reached. From 1956 to 1957, an earthquake had occured to the north of Xietongmen County, its intensity nearby Chabu geyser came up to 4 to 5 grade. After 1960, main geyser migrated to present site.

In addition, there were four geysers in Qucai hydrothermal area which disappeared because of Damxung earthquake (M=8). Before Nov. 1974, there were geysering activity in Semi boiling spring, Nan muling County.

Balazhang boiling spring *is* located in Longling County, West Yunnan. A small geyser on a silica terrace has induced by Longling earthquakes (M=7.4) on 29th May 1976. It erupts to a height of 1m with 40° 'angle of inclination gently to NNW330 for 30 sec on an interval of 1 min. This new geyser is issueing from a fissure on an older silica sinter, which occured by the Longling earthquake' (Liu, 1982).

Perhaps, earthquake can reduce load in an instant on the upper reservoir of instable high-temperature geothermal system or form fissure and fracture plane to cripple the resistance to deformation in cap rock. High-temperature hydrothermal system is very sensitive to any changes of these effects which are important induced factors to promoto the variations of theirs.

3. Some man-made geysers

Four wells that have been drilled in Yangbajain field have turned into geysers, they are Y-2, Y-3, Y-7 and Y-22, of which Y-7 is typical. Y-7 well was drilled to depth of about 603 m. The well is steel cased to a depth of about 278 m, the top 22 m *being* 50 cm casing, upper 58 m being $13^3/8$" casing, and lower to 277 m being $9^5/8$" casing. Based on the measurement of temperature on 13th Sept. 1978, the temperature at wellhead was 82.7°C to 85.3°C, the maximum temperature of 111°C could be encountered at a depth of 120 m, then the temperature went down to 100°C toward depth of well. It erupts about 17 min for one cycle, playing for about 5 min to a height of 30 m, when the value on wellhead was full opened. When the opened valve was less than 1/3 of diameter of casing, the geyser activity was stoped and turned to continued spirt.

The total measured discharge of water during an eruption was 2884 lit. The average rate of discharge was 576.8 l/min at the eruption, but recharge from naked hole was only 169.6 l/min. Perhaps, the rate of discharge was obviously much larger than that of rechage that could be the decisive factor to form geyser well. (Zhang Zhifei et al 1982).

4. The prospects for development

The compositions of the mineral matter dissolved waters taken from geyser areas in China are listed in Table 2.

Table 2. The compositions of hot water from Chinese geysers

Name	PH	Na	K	Ca	Mg	Li	Rb	CS	NH_4	CO_3	HCO_3
Dagajia	9.1	365	41	7.2	1.87	7.25	0.8	6.45	1.2	234	261
Chabu	8.75	415	50	13.2	2.08	12.6	0.75	0	1.66	120	331
Gulu	8.0	1050	117	13.7	54.1	25.2	2.75	5.7	0.28	179.9	1160
Gudui	8.78	700	85	4.6	1.0	27.4	1.6	8.0	3.0	141.6	459.2
Chaluo		332	26.8	2.0	0	?	?	?	?	153	503
Balazhang	9.6	218	17.8	0.28	0.4	2.	0.5	1.0	-	113.1	329.4

Continue

SO	Cl	F	SiO_2	HBO_2	As	TDS
132	165	25	22.7	440	5.4	1.57
104	287	8.6	94.9	173	2.2	1.43
94.6	899	0	123.5	205	0.99	3.93
162.2	745.6	13	362	470	2.2	3.32
?	43.9	?	316	13.1	?	?
51.2	6.33	23	225	15.5	0.125	0.84

Average subsurface water temperature determined from Na-K-Ca geothermometery, accessible resource base (Q) and electrical energy () of some geyser areas are listed in

Table 3.

Table 3.

Name	T(Na-K-Ca)C	Q(10^{18}cal)	E(MW.100years)
Chabu	215	1.1	36
Gudui	270	3.2	127
Gulu	225	0.7	23

(After Zhang et al, in press)

These areas are important energy resource to generate electric power, because they are close the load centre, Chabu being 90 km to the north of Xigaze, the second city of Xizang, the Gudui being 110 km to the south of Zetang, and Gulu being near the future Qinghai-Xizang Railway. But some geyser areas are scenically gogeous. For tourists and scientists alike, they are the most spectacular geothermal areaa. With the exception of Balazhang, as other areas are sparasely populater, there have been little effort to study or develop the potential resource that exist there.

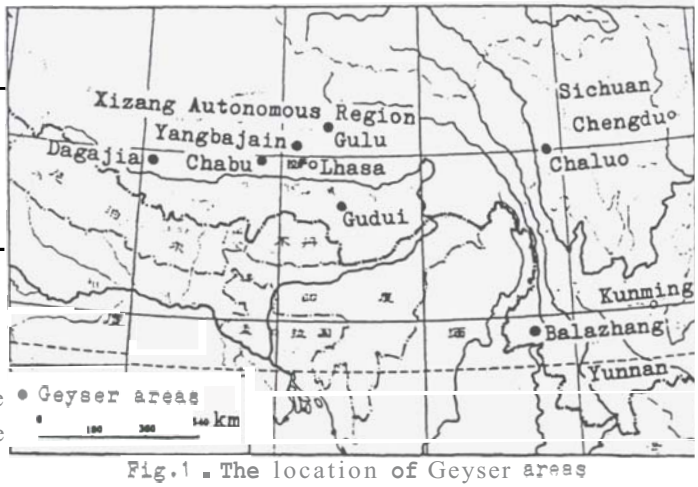

Fig.1 . The location of Geyser areas in China.

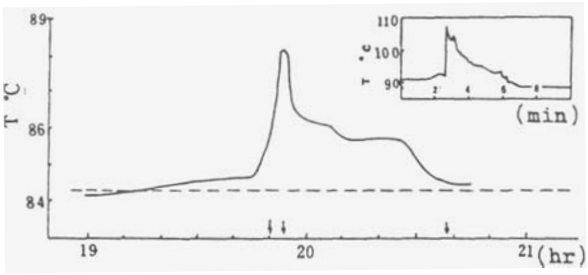

Fig.2. Temperature of ejected water during eruption of Gulu geyser. The small one at right upper corner shows the Old Faithful (after Rinehart

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