13. *The Sengataki Thermal Spring and Underground Mineral Water at the Foot of Volcano Asama.*

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1. Introduction.

T. Fukutomi[1], quite recently, dealt with the geophysical and geochemical properties of some of the thermal springs in the Idu peninsula. His results elucidate the various interesting relations that hold between the crustal movements, meteorological elements, the orifice temperatures, and the volume of water, while T. Nomitsu[2], who studied the Beppu thermal springs, Kyusyu, has discussed the problem of distribution of the original sources and their geophysical properties. According to T. Fukutomi, the water table of the Rendaidi thermal spring in south Idu underwent a change on the occasion of the earthquake of July 11, 1935. In the light of this phenomenon, it will not be unresonable to suppose that in the neighbourhood of Volcano Asama as well, thermal springs and underground water will undergo changes as the result of volcanic activities.

Information supplied by the villagers living at the foot of the volcano urged us to investigate the thermal springs and underground waters in the neighbourhood of this volcano, Asama, which although very quiet up to 1934, became the scene of violent explosions in 1935 and 1936.

Of the thermal and mineral springs found near the volcano, the writer specially studied the Sengataki thermal spring and the Sengataki underground water by continuous observations of their orifice temperatures and volume of issue. These two original sources of springs are situated in a deep valley, at the distance of 6 km southeast from the crater. Our main object was to ascertain if these springs undergo any change with activities of the volcano, seeing that the results of Noguti's[3]

1) T. FUKUTOMI and M. NAKADA, *Bull. Earthq. Res. Inst.*, **13** (1935), 616; **14** (1936), 259.

2) He reported at the annual meeting of Physico-Mathematical Society of Japan in 1936.

3) K. NOGUTI, 日本化學會誌, **56** (1935), 1495; **57** (1936), 920.

studies are based on too small a number of observations.

2. Distribution of Thermal and Mineral Springs.

In the neighbourhood of volcano Asama, especially at Karuizawa, the popular summer resort, attempts have been made from time to time to locate a thermal spring with high temperature, with which object borings were frequently resorted to, particularly as the thermal springs already known, the Sengataki, Hosino, Siotubo, and Kosé springs, are all under 35°C in orifice temperature.

The topographical distribution of the original sources of these thermal springs and underground water is shown in Fig. 1. As will be

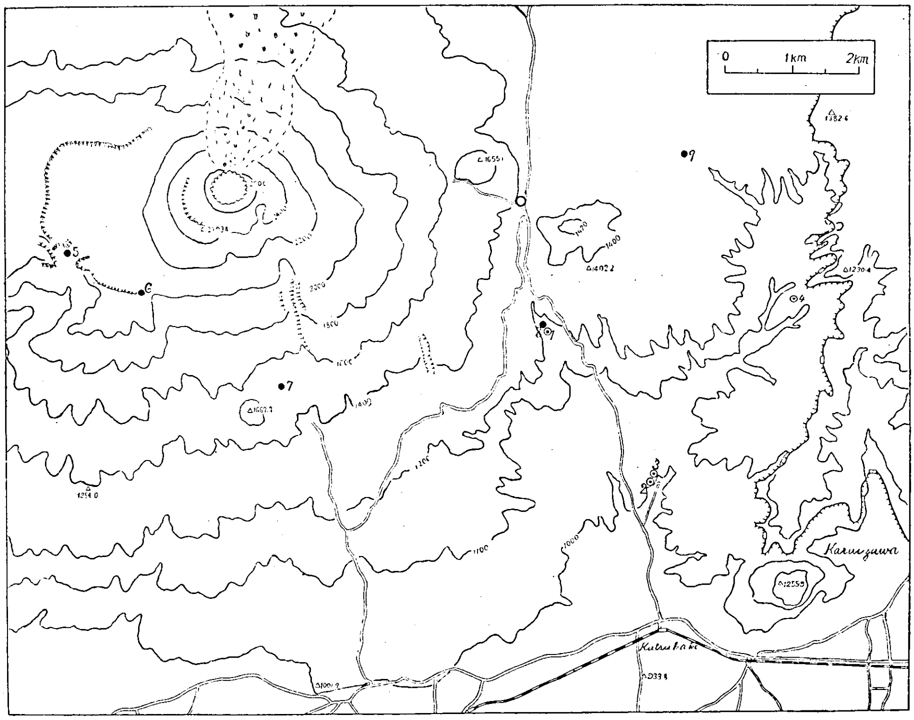

Fig. 1

◎ thermal spring. 1. Sengataki. 2. Hosino. 3. Siotubo. 4. Kosé.
● cold spring.

seen from Fig. 1, cold springs have their origins on the slopes of volcano, where the water table cuts the surface of the ground. Springs 5, 7, and 8 are the sources of the Zyabori, the Nigori, and the Yukawa rivers.

In order to make clear the relation between the situation of spring origins and their heights above sea-level, an E–W section through

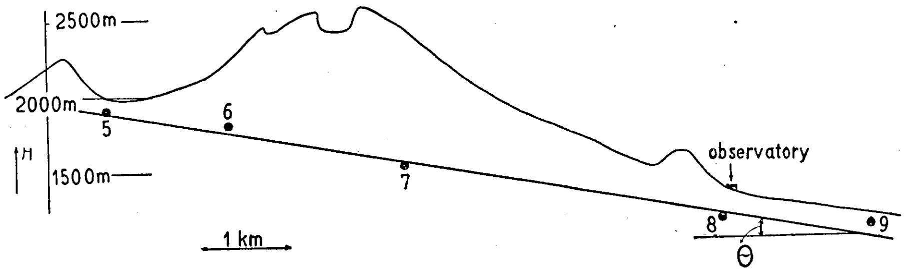

Fig. 2.

E-W section of volcano Asama. H: height above sea-level.

the crater is shown in Fig. 2. The heights of the origins, change linearly toward E–W derection, that is, the water table inclines by about 5° to the east side of the volcano. H. Tsuya[4], Who studied geologically volcano Asama pointed out the same fact in the field investigation in 1932.

3. The Sengataki Thermal Spring and Sengataki Underground Water.

Observations of the orifice temperature and rate of flow of the Sengataki thermal spring and underground water were begun in May, 1934. The thermal spring, which issues from a depth of 100 m below the surface of the ground is brought to the surface by means of iron pipe, for which reason, in its passage to the surface from the bottom, no cold water can mix with it. The temperature of the thermal springs were measured in the pipe 10 m below the head water with a Hg thermometer, at first daily and later weekly. For the orifice temperature of the thermal spring, a gas thermometer recorded automatically, and since the bulb of the gas thermometer was placed 10 m under the head water by means of a connection tube, the record agreed with the temperature 10 m below the water head.

In addition, since May, 1934, the temperature of the Sengataki underground water which issues near the Sengataki thermal spring and the atmospheric temperature at the same time were observed, sometimes personally, and at other times by means of an automatic apparatus.

Table II and Fig. 3 show the temperatures of the Sengataki thermal and cold springs, atmospheric temperature, and an outline of volcanic activities with their dates and times of observation, from which it will

4) H. TSUYA, Reported at the meeting of the Earthquake Research Institute on April 18, 1932.

Table I.

Date	Time	Atmospheric temperature	Ori ce temp. of Sengataki thermal spr.	Temp. of Sengataki underground water	Δy	Remark
1934	h m	°C	°C	°C	°C	
July 11	10 30	20·3	32·5	14·0	0·0	Since autumm of 1931, the volcano had been very inactive, with neither eruption of any violence nor volcanic micro-earthquake.
13	10 30	14·5	33·0	13·5	+0·5	
14	10 20	16·5	33·2	13·3	0·0	
16	11 30	15·1	33·5	13·7	+0·6	
17	10 00	18·2	33·0	14·2	+0·6	
18	10 00	15·7	32·5	13·5	+0·2	
19	11 00	25·6	33·3	14·5	−0·4	
20	11 15	24·0	33·0	15·0	+0·4	
21	10 25	18·0	33·0	14·0	+0·4	
22	10 15	22·2	33·2	14·2	−0·1	
23	10 15	21·5	33·3	14·5	+0·3	
24	10 30	19·0	33·0	14·4	+0·7	
25	9 45	18·8	33·0	14·5	+0·8	
26	10 35	15·6	33·0	13·6	+0·4	
27	10 40	19·2	33·2	14·0	+0·2	
28	10 40	22·4	33·3	14·5	+0·9	
29	10 30	20·5	33·3	14·0	0·0	
30	10 50	18·0	33·1	14·5	+0·9	
31	11 05	17·5	32·6	13·1	−0·4	
Aug. 1	10 15	18·9	33·1	14·0	+0·3	
2	11 20	19·0	33·3	14·3	−0·4	
3	16 00	22·0	33·3	14·5	+0·3	
4	16 25	21·0	33·5	14·2	+0·1	
5	17 00	18·4	33·4	14·0	+0·4	
10	14 00	21·5	33·3	14·5	+0·3	
21	17 00	18·5	33·4	14·0	+0·4	Volcanic micro-earthquakes were observed for the first time on January 2, 1935, and thereafter.
28	10 00	23·0	33·4	14·7	+0·3	
Sept. 4	15 30	16·5	33·3	14·5	+1·2	
11	16 00	16·0	33·4	13·7	+0.5	
18	14 00	15·5	33·4	13·5	+0·4	
25	16 40	11·7	33·4	12·5	0·0	
Oct. 2	16 30	9·2	33·3	12·0	−0·1	
11	15 00	13·4	33·3	12·5	−0·3	
31	14 00	8·7	33·5	10·5	−1·5	
Nov. 7	15 00	10·0	33·3	11·5	−0·7	

(to be continued.)

Table I. (*continued.*)

Date	Time	Atmospheric temperature	Orifice temp. of Sengataki thermal spr.	Temp. of Sengataki underground water	Δy	Remark
1934	h m	°C	°C	°C	°C	
Nov. 13	16 00	1·5	33·3	10·5	−0·3	On April 20, 1935, the violent explosion occurred.
1935						
Aug. 24	15 25	21·0	33·2	14·5	+0·4	On May 5, 11, 15, 16, 21, 22 and 28, the remarkable explosions occurred.
Sept. 1	10 10	15·0	33·2	13·5	+0·4	
7	15 30	21·2	33·2	14·0	−0·1	
15	9 25	11·2	33·2	12·8	+0·4	
27	9 45	16·5	33·2	13·0	−0·3	During April and May the volcano was unusually active, quieting down from the early part of June, but resuming its activities in August.
Oct. 9	13 20	13·0	33·2	11·0	−1·7	
20	15 00	12·8	33·2	11·5	−1·2	
Nov. 1	8 40	5·5	33·1	11·1	−0·3	
15	9 30	4·5	33·2	12·0	+0·7	
26	8 20	3·0	33·1	11·0	0·0	On August 4, 17 and 28, the remarkable eruptions occurred.
Dec. 16	13 40	0·1	33·2	10·0	−0·3	
24	11 05	4·0	33·0	10·5	−0·7	On September 19, and November 7 the violent explosions occurred.
31	11 45	1·5	33·1	10·6	−0·2	
1936						
Jan. 7	11 15	−2·5	33·1	10·5	+0·4	
14	11 20	−1·2	33·2	10·5	+0·2	
21	13 50	−4·0	33·2	9·9	+0·1	
27	14 20	−6·5	33·2	9·5	+0·1	
Feb. 4	11 50	−7·7	33·3	9·0	−0·2	
9	12 45	1·5	33·4	10·6	−0·2	
16	15 00	0·5	33·2	10·1	−0·5	The explosions occurred frequently in February and March in 1936.
25	11 55	−2·5	33·2	10·5	+0·4	
Mar. 2	10 40	−4·5	33·2	9·9	+0·2	
9	13 00	−3·0	33·2	10·3	+0·3	
16	10 40	1·0	33·3	11·0	+0·3	
23	12 05	1·0	33·3	11·2	+0·5	
30	13 50	−3·0	33·2	10·2	+0·2	
Apr. 6	10 50	15·2	33·3	13·0	−0·1	
13	10 50	1·5	33·3	10·5	−0·3	
20	12 00	15·6	33·3	13·5	+0·3	
26	14 15	13·5	33·3	12·2	−0·6	
May 4	15 15	15·3	33·3	12·6	−0·5	
11	8 35	14·5	33·3	12·5	−0·5	
18	9 10	12·0	33·3	12·4	−0·1	

(*to be continued.*)

Table I. (*continued.*)

Date	Time	Atmospheric temperature	Orifice temp. of Sengataki thermal spr.	Temp. of Sengataki underground water	Δy	Remark
1936	h m	°C	°C	°C	°C	
May 22	16 15	14·3	33·2	12·2	−0·7	
30	9 00	11·0	33·2	12·0	−0·4	
June 6	7 40	10·5	33·2	12·4	+0·1	
13	8 45	16·4	33·2	13·5	+0·2	
20	9 00	19·3	33·2	13·0	−0·7	
27	12 50	18·8	33·2	13·0	−0·7	
July 4	10 15	17·0	33·2	13·3	−0·1	
12	14 00	20·5	33·2	12·8	−1·2	
19	10 00	25·2	33·1	13·0	−1·3	
26	14 07	25·2	33·2	13·0	−1·3	
Aug. 2	10 30	21·0	33·2	12·5	−1·3	
18	13 25	25·2	33·2	12·8	−1·9	Until the end of 1936, explosions sometimes occurred.
Sept. 1	10 50	22·8	33·2	13·2	−1·1	
17	13 00	13·0	33·2	12·0	−0·7	
Oct. 1	8 15	11·5	33·1	12·0	−0·4	

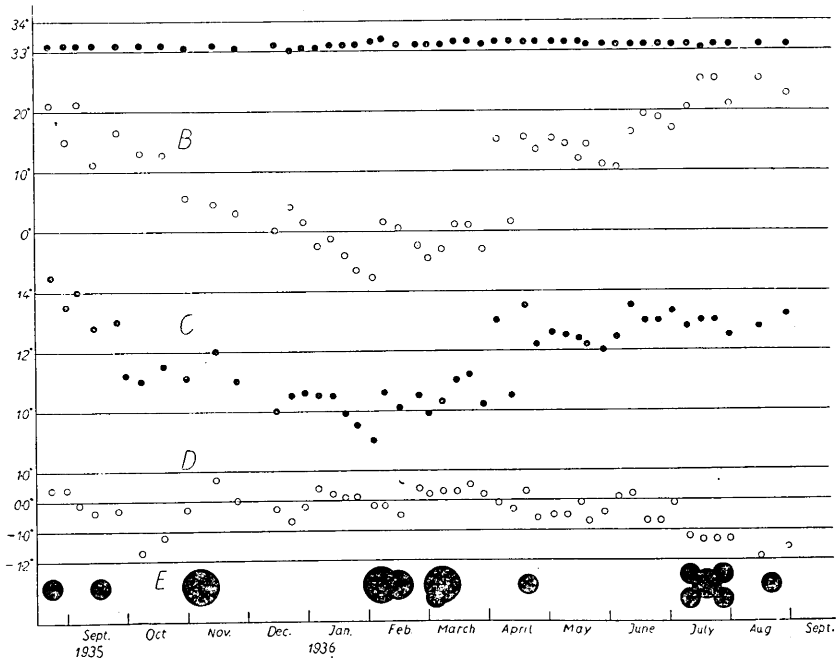

Fig. 3. A; Orifice temperature of Sengataki thermal spring.
B; Atmospheric temperature.
C; Temperature of Sengataki Underground water.
D; $\Delta y = y_o - y_c$.
E; Explosion.

be seen that the temperature of the thermal spring showed no changes, daily nor annually, nor any other changes during the volcano's inactive period of 1934 nor in its active periods in 1935 and 1936, whereas Sengataki, a cold spring, showed 15°C and 10°C as the maximum and minimum temperatures.

As will be seen from Fig. 4, the orifice temperature of the Sengataki cold spring and the atmospheric temperature changes in parallel,

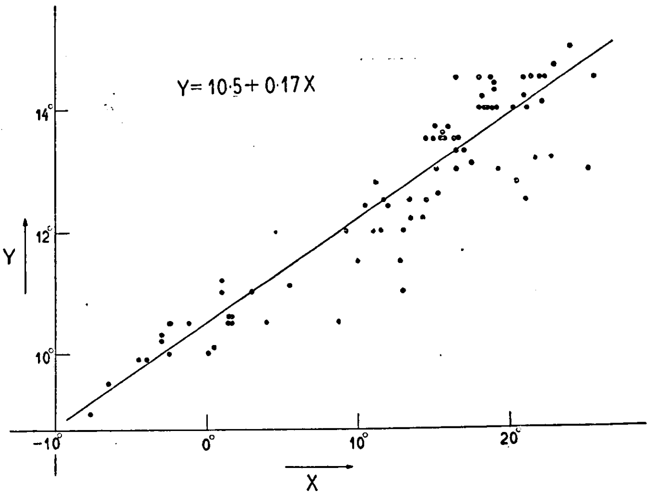

Fig. 4. X; Atmospheric temperature.
Y; Temperature of Sengataki underground water.

the rate of variation in the two temperatures being about 1/6.

The two temperatures are connected by the equation

$$y_c = 10{\cdot}50 + 0{\cdot}17x,$$

where x = atmospheric temperature,
y_c = calculated temperature of the mineral spring,
y_o = observed temperature of the mineral spring,
$\Delta y = y_o - y_c$.

In Table I and Fig. 3, Δy is shown with the other elements, but we cannot find any systematic relation to volcanic activities.

From the results above described, changes in the orifice temperature of a cold spring are not related in any way to volcanic activities but are due to the effect of atmospheric temperature.

As to the Hosino, Siotubo, and Kosé thermal springs, no changes were observed either in the orifice temperature or in the rate of flow.

4. Conclusion.

Although the writer had expected that terrestrial heat in the vicinity of a volcano would change with volcanic activity, as the result of which the temperature of thermal springs would be affected by some variation in volcanic activity, the present observations gave a negative answer.

In his papers on the Rendaidi and other thermal springs, T. Fukutomi[5] concluded that changes in the orifice temperature of thermal springs are due to changes in the intermixture of underground water, escape of heat by conduction, and other causes. The results of our present observations in no way contradict his theory.

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13. 淺間山麓千ヶ瀧溫泉と地下水

地震研究所 水 上 武

1） 淺間火山の火口より 15 粁以内に湧出する溫泉として千ヶ瀧，小瀬，星野，鹽壺の諸溫泉を擧げる事が出來る．此等の溫泉中特に火口に最も近い千ヶ瀧溫泉に就き昭和9年5月より，昭和 11 年 9 月迄，湧出溫度，湧出量の觀測を行つた．

淺間火山は昭和9年は極めて靜穩であつたが昭和 10 年4月以來度々爆發した．火山の靜穩，活動兩期に於いて，山麓溫泉に何等かの異常を期待されたが，湧出量，湧出溫度共に變化が現れなかつた．

2） 淺間火山附近の地下水が地表を切る諸點を調査して見ると地下水面は火山の西側から東側に向つて約 5° の傾斜をしてゐる事が判つた．この事實は津屋博士の調査と一致する．

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5) T. FUKUTOMI, *loc. cit.*