Effect of the Rain on the Composition of the Hot Springs of Yunohanazawa, Hakone.

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In the previous paper,[1] the author reported the seasonal variations of radium, vanadium, chromium and molybdenum contents of the hot springs of Yunohanazawa, Hakone, Kanagawa Prefecture. The author found that it was beyond doubt that there were variations of composition as a result of abundant rain. In the present paper, the author describes the effect of the rain on the composition of the hot springs of Yunohanazawa.

The rainfall, water level, water temperature, *p*H, total residue, acidity, iron, manganese, sulphate and hydrogen sulphide were measured every day for six weeks. The methods of experiment will be briefly described.

(a) *Total residue.* A 100 ml. portion of the mineral water was evaporated to complete dryness, heated to 130°C. and weighed.

(b) *Acidity.* Acidity was determined by titration with standard solution of sodium carbonate using phenol red as the indicator.

(c) *Iron.* A 10 ml. portion of the mineral water was boiled with few drops of nitric acid and the potassium thiocyanate solution was added. The red colour was compared with that obtained with standard iron solution.

(d) *Manganese.* Nitric acid, phosphoric acid and potassium periodate were added to 20 ml. of the mineral water, and boiled for few minutes. The reddish violet colour was compared with that obtained with standard manganese solution.

(e) *Sulphate.* Sulphate was determined colorimetrically using barium chloride and potassium chromate.

(f) *Hydrogen sulphide.* A measured excess of iodine solution was added to the mineral water and titrated back to the end point with thiosulphate.

The results are collected in Table 1 and Table 2.

The results of the observation show that the hot springs of Yunohanazawa are affected strongly by the rainfall and that the salt content increases as a result of abundant rain. The changes of discharge, total residue, iron and sulphate content are noticed immediately after a rainstorm, whereas *p*H and acidity show the maximum values some time later. The changes of manganese and hydrogen sulphide is not so marked as that of iron. The Kōbō-yu spring is affected more strongly by the rainfall than the Gongen-yu spring. The maximum value of discharge and the minimum value of water temperature occurred immediately after heavy rains.

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Table 1. Effect of the rain on the composition of the Gongen-Yu spring.

Date	Rain-fall	Water-level (cm.)	Tem-perature (°C.)	*p*H	Total Residue (g./l.)	Fe (g./l.)	Mn (g./l.)	SO_4 (g./l.)	Acidity (N)	H_2S (g./l.)
July 31	0.2	17	48.5(29.0)	2.65		0.0014	0.0011	0.70	0.011	0.141
Aug. 1	14.2	17	48.8(26.1)	2.7		0.0023	0.0009	0.70	0.012	0.125
2	0.9	17	48.6(23.2)	2.75		0.0011	0.0010	0.71	0.012	0.144
3	8.9	17	49.0(22.0)	2.7		0.0012	0.0009	0.72	0.013	0.158
4	8.0	17	49.0(21.2)	2.75		0.0010	0.0010	0.69	0.013	0.148
5	11.0	17	48.9(20.2)	2.7		0.0010	0.0010	0.72	0.012	0.146
6	17.6	17	49.0(22.1)	2.7		0.0015	0.0010	0.72	0.013	0.132
7	2.45	17	49.0(26.0)	2.75		0.0036	0.0011	0.72	0.012	0.128
8	1.35	17	49.0(24.0)	2.75		0.0014	0.0010	0.71	0.012	0.135
9	0.8	17	49.0(24.0)	2.7		0.0011	0.0011	0.80	0.013	0.134
10	10.1	17	49.0(23.8)	2.75		0.0014	0.0011	0.80	0.011	0.132
11	6.0	17	49.0(24.0)	2.7		0.0016	0.0011	0.69	0.013	0.139
12	1.4	17	49.2(24.0)	2.75		0.0020	0.0010	0.74	0.012	0 146
13	4.0	17	49.0(24.0)	2.75		0.0021	0.0010	0.78	0.012	0.141
14	9.6	17	49.0(24.0)	2.75		0.0009	0.0010	0.76	0.012	0.139
15	2.0	17	49.3(24.0)	2.7		0.0009	0.0010	0.75	0.012	0 138
16	—	17	49.0(22.0)	2.7		0.0006	0.0011	0.75	0.012	0.117
17	—	17	49.0(22.5)	2.75	1.35	0.0012	0.0011	0.76	0.012	0.145
18	74.0	17	49.0(23.0)	2.75	1.32	0.0016	0.0010	0.74	0.013	0.134
19	76.4	17	49.1(19.5)	2.6	—	0.0016	0.0009	0.74	0.013	0.137
20	90.5	26	49.2(19.5)	2.6	1.32	0.0026	0.0009	0.82	0.013	0.141
21	1.5	26	49.6(23.8)	2.6	1.73	0.0099	0.0010	1.12	0.014	0.121
22	0.9	26	50.3(24.8)	2.6	—	0.0097	0.0009	1.14	0.016	0.141
23	—	26	50.5(20.5)	2.6	—	0.0087	0.0009	1.07	0.016	0.142
24	10.0	26	50.8(20.8)	2.55	1.23	0.0078	0.0009	1.07	0.016	0.129
25	4.5	26	50.7(22.0)	2.55	1.31	0.0072	0.0009	1.05	0.016	0.115
26	2.5	26	50.8(20.0)	2.55	—	0.0072	0.0009	1.03	0.017	0.108
27	5.5	27	51.0(21.1)	2.5	1.05	0.0068	0.0010	0.97	0.017	0.117
28	0.8	26	51.0(21.1)	2.5	1.00	0.0059	0.0011	0.89	0.017	0.114
29	6.3	26	51.0(19.2)	2.55		0.0054	0.0011	0.84	0.017	0.138
30	—	25	51.3(21.8)	2.6		0.0043	0.0010	0.84	0.017	0.119
31	—	25	51.4(22.0)	2.6		0.0041	0.0010	0.84	0.016	0.121
Sept. 1	—	25	51.6(21.0)	2.6		0.0034	0.0010	0.82	0.017	0.127
2	—	25	51.6(19.0)	2.6		0.0030	0.0010	0.79	0.016	0.107
3	—	24	51.8(19.2)	2.6		0.0018	0.0011	0.74	0.016	0.100
4	—	23	51.7(19.0)	2.6		0.0017	—	0.74	0.016	0.117
5	—	22	51.6(18.0)	2.6		0.0020	—	0.68	0.016	0.119
6	—	21	51.5(20.5)	2.7		0.0012	—	0.68	0.016	0.116
7	—	21	51.6(22.0)	2.7		0.0015	—	0.68	0.016	0.113
8	7.3	20	51.5(21.0)	2.6		0.0015	—	0.88	0.015	0.127
9	—	19	51.6(20.8)	2.6		0.0023	—	0.94	0.015	0.128

Table 2. Effect of the rain on the composition of the Kōbō-Yu spring.

Date	Rainfall	Discharge in l./min.	Temperature (°C.)	*p*H	H_2S (g./l.)
July 31	0.2		45.5(29.0)	2.8	0.079
Aug. 1	14.2	14.5	45.8(26.1)	2.7	0.079
2	0.9	14.3	45.8(23.2)	2.7	0.078
3	8.9	13.4	45.5(22.0)	2.6	0.080
4	8.0	13.4	45.5(21.2)	2.75	0.081
5	11.0	12.0	45.5(20.2)	2.75	0.078
6	17.6	11.4	45.5(22.1)	2.7	0.082
7	2.45	9.6	45.7(26.0)	2.65	0.072
8	1.35	12.0	45.8(24.0)	2.7	0.062
9	0.8	9.1	45.6(24.0)	2.7	0.058
10	10.1	10.5	45.5(23.8)	2.7	0.065
11	6.0	10.9	45.5(24.0)	2.8	0.065
12	1.4	10.9	45.4(24.0)	2.7	0.074
13	4.0	9.9	45.0(24.0)	2.7	0.068
14	9.6	9.5	45.4(24.0)	2.7	0.076
15	2.0	9.1	45.3(24.0)	2.7	0.063
16	—	8.4	45.1(22.0)	2.7	0.064
17	—	8.0	45.2(22.5)	2.7	0.053
18	74.0	7.6	45.2(22.5)	2.7	0.079
19	76.4	20.8	44.2(19.5)	2.7	0.083
20	90.5	33.4	43.5(19.5)	2.65	0.077
21	1.5	45.6	43.5(23.8)	2.7	0.079
22	0.9	47.5	44.8(24.8)	2.7	0.101
23	—	44.5	45.2(20.5)	2.65	0.104
24	10.0	42.1	45.5(20.8)	2.6	0.093
25	4.5	40.0	45.6(22.0)	2.6	0.092
26	2.5	39.8	46.0(20.0)	2.6	0.091
27	5.5	38.5	46.0(21.1)	2.6	0.086
28	0.8	37.7	46.0(21.1)	2.6	0.094
29	6 3	35.4	46.1(19.2)	2.6	0.093
30	—	31.4	46.3(21.8)	2.6	0.093
31	—	30.2	46.5(22.0)	2.6	0.090
Sept. 1	—	29.3	46.9(21.0)	2.7	0.090
2	—	29.0	47.0(19.0)	2.7	0.089
3	—	28.6	47.0(19.2)	2.7	0.096
4	—	27.8	47.0(19.0)	2.7	0.101
5	—	28.0	47.0(18.0)	2.7	0.110
6	—	27.0	47.0(20.5)	2.7	0.099
7	—	27.8	47.0(22.0)	2.7	0.099
8	7.3	26.4	47.0(21.0)	2.7	0.098
9	—	25.6	47.0(20.8)	2.7	0.106

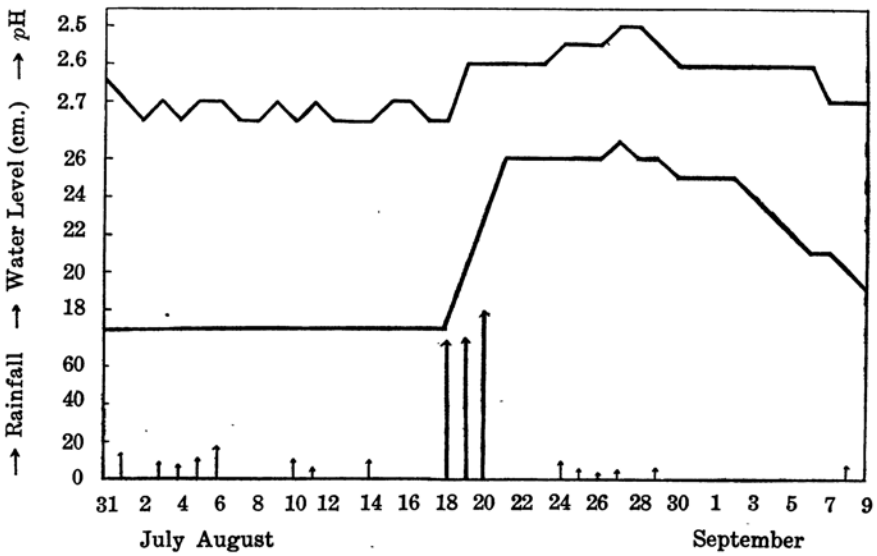

Fig. 1. Effect of the Rain on the Water Level and *p*H of the Gongen-Yu Spring.

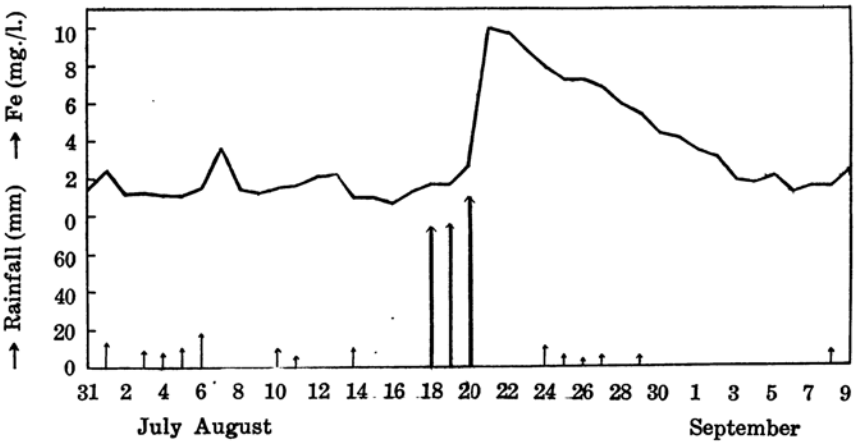

Fig. 2. Effect of the Rain on the Iron Content of the Gongen-Yu Spring.

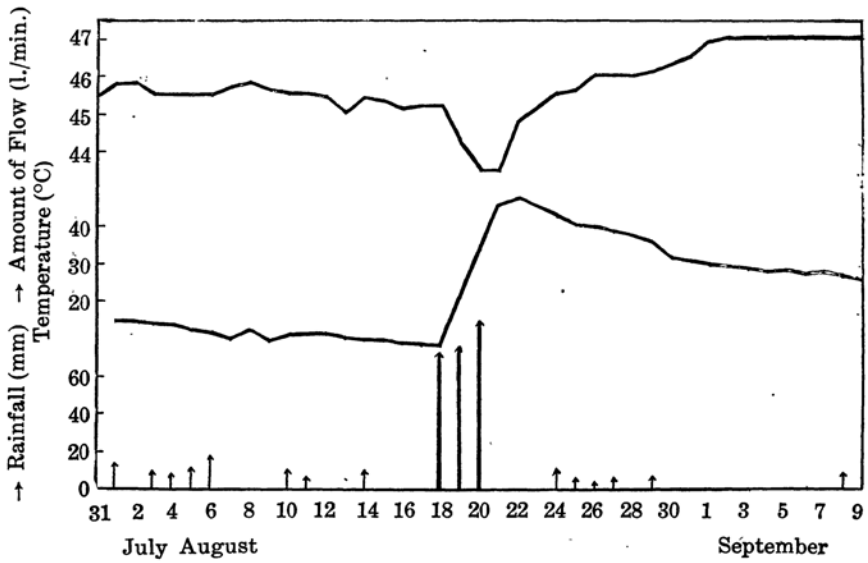

Fig. 3. Effect of the Rain on the Discharge and Temperature of the Kōbō-Yu Spring.

Summary.

The effect of the rain on the composition of the hot springs of Yunohanazawa was studied and it was found that the springs vary in composition according to the amount of rain falling.

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