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Mineral Springs in the Southern Part of Ōsaka Prefecture

By

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With 3 Tables and 1 Text-figure

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ABSTRACT: The analytical data obtained after the appointed rule by some authors including the present writer for more than twenty springs situating within the geologically characteristic area in the southern part of Ōsaka Prefecture and the relations of specific constituents such as carbon dioxide and hydrogen sulfide to their sources have been disputed with respect to the geologic environments.

CONTENTS

I. INTRODUCTION

As regards the carbonic acid-bearing mineral springs locating within the area along the Izumi Mountain-range, SENO (1957) was of opinion that 'the cold springs rich in the totalized carbon dioxide, though without any relation to Cl^- and SO_4^{2-}, reveal the distribution along the Median Dislocation Line running across Kii Peninsula. Those with the similar character are also found scattered in such occurrences as situate along the structural line in Awaji Island and in Shikoku. In these cases, carbon dioxide in gaseous state may be freed from the depth of the earth in no connection with spring source and with volcanic activity'. It is really the fact that there are many occurrences of well-water with abundance of carbon dioxide gas collected for industrial purpose, as are well known for its production, for example, at Amami- and Hirano-Tansan K. K. At the same time, the mineral springs containing hydrogen sulfide beside carbonic acid are also found distributing within the related area. Taking account of this, the present report will be referred to their distribution in relation to geology and the sources, from which carbon dioxide and hydrogen sulfide are probably being derived, specifically within the area locating along, Izumi Mountain-range in Osaka Prefecture and in its eastern extension situating in the western part of Nara Prefecture, exclusive of those distributing in the furthermore eastern part and in the part west of Awaji Island.

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It is to be added to with the deepest grief that the author has heard of the decease of Dr. K. SENO during this work.

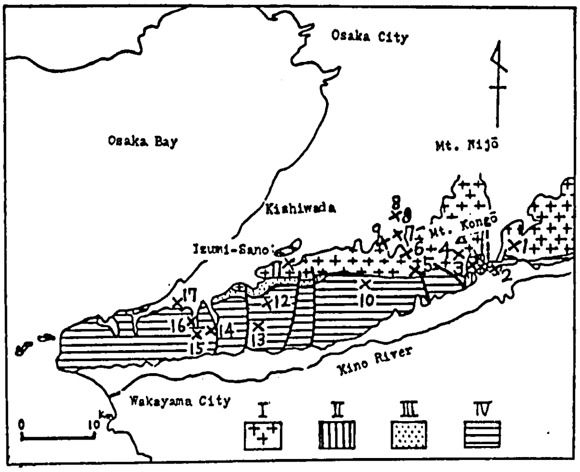
II. OCCURRENCE

The Izumi sandstone group mainly composing the Izumi Mountain-range situating in the southern part of Ōsaka Prefecture comes into contact with the spotted schist of Sangun Metamorphics and the Kinokawa diluvial terrace with faults in the eastern area of its southern part, directly with the alluvial sediments with unconformities in its western area, with the Kashio gneiss or the Ryōke rocks with faults or uncomformities in the eastern area of its northern part and with the Sen-nan acidic rocks or directly with the alluvial deposits with unconformities in its western area. All members other than the alluvial deposits are of course found covered with the Ōsaka formation or the diluvial beds.

The Izumi Mountain-range is generally confined to the area locating from the southern side of the hilly land covered with a part of the Ōsaka formation distributing around the Ōsaka plain and the diluvial beds to the southern limit of the Izumi sandstone group and thus considered geologically to be composed of the Izumi sandstone group, the Kashio gneiss, the Ryōke granitic rocks and the Sen-nan acidic rocks. The area defined here as the southern part of Ōsaka Prefecture includes the southernmost part of the Ōsaka formation because of its thin occurrence on the Ryōke granitic rocks and the Izumi Mountain-range together with the area comprised topographically in the Kongō Mountain-range with NS trend on account of being geologically combined as the eastern extension of the Izumi samdstone group in Nara Prefecture.

The mineral springs in question distribute merely within the area limited to above but not on the fractured zone of the Median Dislocation Line, as are shown in Fig. 1 and Table 1.

These involve the legally still not appointed ones, the practically still not used, those under boring and so on, most of which are from the respectively more



I Ryōke granitic rocks II Kashio gneissic rocks
III Sen-nan acidic rocks IV Izumi sandstone group

1∼17 representing the sources of the springs (similar to those shown in Table 1)

FIG. 1. Distribution of the mineral springs in the southern part of Ōsaka Prefecture.

sources and a part of which are being pumped up because of their scarcity in spouting amount. To be remarked is that the Ishibotoke group, locating in the surroundings of Ishibotoke and Kagata in Kawachi-Nagano City, that are now being worked by use of the lift with the industrial purpose for carbonic acid gas, amount to more than twenty, some of which reveal the bubbling due to the intense spouting.

III. CHEMICAL COMPOSITIONS

As for the chemical compositions of the mineral springs, the data for analyses put into operation in 1932, 1940, 1954 and 1957, those obtained before the World War II, though still not re-examined after the War, and those determined after the present rule are listed in Table 2. Those recalculated for free carbon dioxide, total carbonates, hydrogen sulfide plus thiosulfric acid from the analyses mentioned above and those for partial analyses given by AKATSUKA and IMAI (1959) are summarized in Table 3. In the case of Yamanakakei spring, hydrogen sulfide is, though estimated as 0.595 mg/kg by UEJI (1959), confirmed also by the present writer and in 'Mineral Resources in Japan' dealt with as is contained, not described as to its analysis in the same book probably because of its scarcity.

At any rate, inspection of the tables clearly indicates that those occurring in the related area are cold springs, characterized with abundance of carbonic acid,

Table 1 Mineral Springs and Their Qualities

Mineral spring	Location	Quality	Country rock	Remarks
1 Kuzu (葛)	Furuhata, Gose City, Nara Pref.	bearing iron carbonate	Granitic gneiss	still not used
2 Kitauchi (北宇智)	Uchitani, 〃 〃	carbonate	Izumi group	〃
3 Mizusawa (水沢)	Kamino-machi, Gojô City, Nara Pref.	carbonate	〃	for bathing
4 Kawakami (川上)	Ishimigawa, Kawachi-Nagano City, Ôsaka Pref.	bearing iron carbonate	Granitic gneiss	still not used
5 Amami (天見)	Amami, 〃 〃	hypocarbonate with carbonate	〃	for bathing
6 Ishibotoke (石仏) group	Ishibotoke, 〃 〃	salt with carbonate	〃	for industry
7 Takahashi (高橋) No. 1	Kojio-chô, 〃 〃	carbonate	〃	under boring
8 Nagano (長野) No. 1	Nagano-chô, 〃 〃	salt with carbonate	〃	for bathing
9 Sakai (酒井) No. 1	Hino, 〃 〃	carbonate	〃	under boring
10 Takihata (滝畑)	Takihata, 〃 〃	hydrogen sulfide	Izumi group	still not used
11 Okumizumayama (奥水間山) No. 1	Kizumi, Kaizuka City, 〃	hypocarbonate with carbonate	Granitic gneiss	for bathing
12 Inunaki (犬鳴) No. 1	Ôki, Izumi-Sano City, 〃	hydrogen sulfide	Izumi group	〃
13 Kuratani (倉谷)	Nishiyamada, Ikeda-mura, Naka-gun, Wakayama Pref.	〃	〃	〃
14 Kusuhata (楠畑)	Kusuhata, Sen-nan-chô, Sen-nan-gun, Ôsaka Pref.	〃	〃	still not used
15 Sakaidani (境谷)	Sakaidani, Iwate-chô, Naka-gun, Wakayama Pref.	〃	〃	for bathing
16 Yamanakakei (山中渓)	Yamanaka, Higashi-tottori-mura, Sen-nan-gun, Ôsaka Pref.	〃	〃	〃
17 Ogawa (小川)	Jinenda, 〃 〃 〃	〃	〃	〃

Table 2 Chemical Analyses of the Mineral Springs in the Southern Part of Ōsaka Prefecture

Mineral spring	Analysed in	Temp.(Atm.) °C	pH	S. G.	Re	H^+	K^+	Na^+	NH_4^+	Ca^{2+}	Mg^{2+}	Fe^{2+}	Mn^{2+}	Al^{3+}
Mizusawa	1960 (1)	15.0(29.0)	5.6	1.0002	473.0	—	18.52	61.88	0.200	115.5	1.912	14.11	—	0.281
Kawakami	1937 (4)			1.0005	280.	—	0.801	5.035	0.35	32.14	4.191	23.44	—	—
Amami No. 1	1955 (2)	9.8(10.5)	6.2	1.001	1894.	—	5.992	460.3	0.497	260.7	29.60	3.939	0.250	0.025
〃 No. 2	1959 (1)	20.0(26.0)	5.8	1.0013	1243.	—	302.85	349.85	0.15	184.91	19.63	13.88	1.705	5.36
〃 No. 3	1959 (1)	17.5(28.0)	5.8	1.0008	1265.	—	200.43	520.43	1.15	107.07	34.36	10.07	1.136	1.34
Hirano No. 5	1953 (2)	18.0(21.0)	6.8	1.018	23590.	—	112.3	5926.	—	1736.	677.8	35.42	—	—
〃 No. 6	1957 (2)	17.4(20.4)	6.1	0.9939	19447.	—	96.58	5325.	0.8049	1021.	396.9	95.53	tr	0.3018
〃 No. 7	1956 (2)	16.9(20.8)	6.3	0.9851	9392.	—	40.61	2311.	0.3045	593.5	210.8	56.69	—	0.2284
〃 No. 8	1960 (2)	18.4(33.4)	6.6	1.0070	19730.	tr	44.06	5653.	7.598	1018.	228.9	44.0	0.5960	1.490
〃 No. 16	1962 (2)	18.7(27.2)	6.5	1.0599	21941.	tr	45.51	6858.	—	554.0	779.4	39.36	1.250	0.4718
Amami E	1957 (2)	19.2(13.8)	6.2	1.0000	4058.	—	11.0	724.2	1.613	448.6	138.6	15.64	tr	0.195
〃 F	1958 (2)	20.4(23.2)	6.0	1.0032	2979.	—	9.029	643.6	0.940	318.0	92.29	30.26	0.211	0.381
〃 L	1959 (1)	19.0(15.9)	6.2	1.0025	2396.	—	6.14	479.86	0.862	280.63	63.9	18.04	0.165	0.352
〃 M	1959 (1)	18.2(22.0)	6.5	1.0085	25379.	—	743.6	6152.	7.734	1008.	809.2	73.24	0.624	4.957
〃 N	1959 (1)	18.0(30.5)	5.2	1.0024	345.8	—	3.503	86.037	—	45.880	5.649	17.215	0.012	0.037
〃 P	1960 (1)	16.5(16.2)	6.4	1.0102	21602.	—	421.5	6923.	10.40	914.2	371.4	37.09	0.7876	4.178
〃 Q	1960 (1)	18.0(33.0)	6.4	1.0026	4725.	0.0004	63.49	819.4	0.8750	552.4	109.3	61.93	4.208	12.50
〃 R	1961 (1)	18.3(7.4)	6.5	1.0056	7580.	0.0003	368.6	2334.	2.011	554.1	101.5	36.76	0.503	0.050
〃 S	1962 (1)	18.4(18.0)	5.9	1.0006	2096.	0.0013	43.88	535.5	5.200	135.4	5.712	16.52	—	0.050
Nagano No. 1	1961 (2)	16.6(32.2)	6.4	1.009	14.183	tr	28.74	3645.	—	544.3	609.8	17.75	—	—
Inunaki No. 1	1957 (2)	14.0(13.0)	8.5		254.8	—	0.501	86.0	0.369	1.518	0.5	7.640	—	—
Kuratani	1955 (3)	19.0(28.0)		1.0009	368.2	—	3.72	124.82	—	6.28	8.9	tr	—	—
Ogawa	1956 (2)	13.0(22.0)	7.8	1.0003	337.5	—	2.801	92.87	0.193	15.79	2.642	0.120	0.110	0.20
Yamanakakei	1952 (5)	16.	7.93		259.					10.8	1.3	10.2		
〃	1952 (5)	16.	8.25		196.					2.5	0.9	49.7		

(1) Analyst: S. Itō, H. Imai and K. Akatsuka, Ōsaka University of Liberal Arts and Education.
(2) Rep. No. 4, Hyg. Inst. Ōsaka Pref.
(3) Analyst: Hygienic Institute of Wakayama Pref.
(4) Chemical analyses of the mineral springs in Japan (in Japanese) (1940)
(5) Mineral resources in Japan (in Japanese) VI-a (1957)

TABLE 2 (continued)

Cl^-	HSO_4^-	SO_4^{2-}	$S_2O_3^{2-}$	$H_2PO_4^-$	HPO_4^{2-}	HCO_3^-	CO_3^{2-}	HS^-	$HSiO_3^-$	BO_2^-	OH^-	HBO_2	H_2SiO_3	CO_2	H_2S
13.47	—	65.36	—	—	—	481.7	—	—	—	—	—	5.108	79.59	1008.	—
5.797	—	71.15	—	—	—	85.54	—	—	—	—	—	—	51.97	1261.	—
539.4	—	21.8	—	—	0.123	1227.	—	—	—	—	—	49.44	55.93	612.3	—
430.47	—	25.4	—	—	1.708	1335.	—	—	—	—	—	2.127	84.17	1226.	—
457.59	—	17.27	—	—	0.246	1419.41	—	—	—	—	—	1.41	66.03	1441.	—
11333.	—	—	—	—	—	5159.	—	—	—	—	—	—	246.1	637.5	—
9443.	—	9.732	—	—	—	3329.	—	—	—	—	—	197.5	1.234	1559.	—
3842.	—	9.232	—	—	—	2577.	—	—	—	—	—	0.4898	124.6	1960.	—
8896.	—	14.46	—	tr	0.8255	4124.	tr	—	tr	0.7408	—	316.4	124.3	2479.	—
11450.	—	1.287	—	—	—	4250.	1.002	—	tr	tr	—	255.0	88.00	2555.	—
1415.0	—	16.42	—	—	—	1585.	—	—	—	—	—	0.0568	159.6	3901.	—
973.3	—	9.773	—	—	21.70	1059.	—	—	—	—	—	85.47	156.8	1737.	—
707.8	—	8.45	—	—	18.98	1250.	—	—	—	—	—	25.41	124.5	1116.	—
12223.	—	61.87	—	—	—	3743.	—	—	—	—	—	—	99.36	2057.	—
135.071	—	1.208	—	—	1.979	207.44	—	—	—	—	—	0.781	67.923	1573.8	—
11715.	—	15.10	—	—	—	3641.	—	—	—	—	—	5.363	134.8	1642.	—
1382.	—	14.50	—	0.3103	15.32	2231.	—	—	0.0694	0.0171	—	9.891	139.1	1829.	—
3634.	—	13.72	—	—	—	2579.	0.492	—	0.092	0.013	—	11.16	143.1	1984.	—
697.8	0.010	4.445	—	—	—	1083.	—	—	0.024	0.005	—	2.099	115.9	1504.	—
7010.	—	—	—	—	—	2411.	0.5701	—	tr	tr	—	65.13	63.38	1449.	—
5.716	—	12.02	0.731	—	—	150.2	35.47	2.943	—	—	0.408	4.703	22.29	—	—
10.295	—	72.012	—	—	—	109.19	—	13.844	—	—	—	—	19.04	tr	2.6
5.948	—	23.80	0.356	—	1.242	267.1	2.576	—	—	—	—	1.24	18.89	27.73	1.271
7.8		24.6													
8.8		10.5													

(Unit: mg/kg)

divided into those with small amounts of hydrogen sulfide (more than 7 in pH) and those without its trace (less than 7 in pH).

TABLE 3 CARBONIC ACIDS AND SULFIDES

Mineral spring	Temp.(Atm.) °C	pH	Free gas of CO_2	Total CO_2	Total sulfide(2)	Total sulfur(3)
1 Kuzu	16.1(27.8)	6.0	1857.6	2800.	—	—
Kuzu Middle School	19.0(28.0)	6.4	375.4	772.1	—	—
2 Kitauchi	18.0(30.0)	6.4	830.7	1693.7	—	—
3 Mizusawa	15.0(29.0)	5.6	1008.	1355.3	—	—
4 Kawakami			1261.	1322.6	—	—
5 Amami No. 1	9.8(10.5)	6.2	612.3	1497.0	—	—
No. 2	20.0(26.0)	5.8	1226.	2203.	—	—
No. 3	17.5(28.0)	5.8	1441.	2464.	—	—
6 Ishibotoke Hirano No. 5	18.0(21.0)	6.8	637.5	4357.	—	—
No. 16	18.7(27.2)	6.5	2555.	5620.	—	—
Amami No. M	18.2(22.0)	6.5	2057.	4756.	—	—
No. N	18.0(30.5)	5.2	1573.8	1723.3	—	—
8 Nagano No. 1	16.6(32.2)	6.4	1449.	3188.	—	—
10 Takihata	19.5(25.8)	9.0	—	109.2	0.357	0.336
11 Inunaki No. 1	14.0(13.0)	8.5	—	134.0	0.043	3.072
13 Kuratani	19.0(28.0)	8.0	tr	78.7	16.91	15.91
14 Kusuhata	15.8(27.2)	7.4	tr	73.2	0.493	0.464
15 Sakaidani I	17.0(24.0)	8.5	—	81.9	2.023	1.904
II	16.2(25.8)	8.6	—	91.7	1.224	1.151
16 Yamanakakei(1)					0.595	0.560
17 Ogawa	13.0(22.0)	7.8	27.73	222.3	1.271	1.298

(1) given by Dr. T. Ueji, with obscurity for carbonic acid. (Unit: mg/kg)
(2) determined iodimetrically.
(3) representing hydrogen sulfide plus thiosulfric acid.

IV. CONSIDERATION

Carbonate-rich springs distributing with EW trend near the Izumi Mountain-range in the southern part of Ōsaka Prefecture are found locating within a zone with certain width from the Median Dislocation Line, coming out from the fissures, formed later than those related to the main movement, of the basement rocks. That the sources for carbon dioxide gas are, as has already been pointed out by Seno, to be distinguished from those for spring water is easily deducible from an example obtained at Takahashi No. 1 spring, in the depth of which carbon dioxide gas only is observed isolated in spite of being aimed at the increase of spring water in amount. Details of geochemical consideration as to this point will be disputed in the future.

Carbon dioxide gas is, according to SENO's view, genetically inferred in no direct relation to volcanic activity. Although Mt. Nabe composed of the volcanics belonging to the 'Setouchi Volcanic Zone' situates at Kawai-chō in Kishiwada City not distant from the northern side of the related area, it is still difficult to connect the genesis of carbon dioxide with its post activity. On the other hand, the relation to the Sen-nan acidic volcanics appearing in the northern part of the related area is mentionable due to their correlatibility to the rhyolitic rocks occurring in the neighborhood of the Arima spring group with similar qualities. Since their interrelation in Arima however remains yet to be surely proved and a lot of the mineral springs abundant in total carbonates are obtainable similarly in the eastern and wastern areas far distant from the location of the Sen-nan acidic rocks, the connection of their post activity with the origin of carbon dioxide is still hardly ascertainable.

Besides, it is well known that the Kashio gneissic rocks developing within the inner zone along the Median Dislocation Line might have, in parts, been suffered by severe carbonatization and have hitherto been genetically subjected to miscellaneous views, of which some related their genesis to metamorphism of the Ryōke granitic rocks through dynamic effects (the Median Dislocation Line-constructing movement) and SUGIYAMA defined them as a sort of orthotectonite intruding later than consolidation of the Ryōke granitic rocks. The present writer however is of opinion against that referred simply to tectonite, even if the respective activities are not directly combined with each other. Outside of this relation, carbonatization appearing on certain parts of the Kashio gneissic rocks is considered as a part of such agencies as might have been subsequent to the activity of the very gneissic rocks, though not confined only to their own post activity, and taken part in cementation of the conglomerate in the Izumi group fractured through the movement of the Median Dislocation Line and in filling of the faults and fissures formed simultaneously. The recent spouting of carbon dioxide gas may hence be connected with a sequence of the similar carbonatization continued up to now through the surrounding unfixed fissures. This theory is seemingly in good harmony with the distribution of the related springs within the limited zone situating along the Median Dislocation Line, whereas there are no data proving this concretely. At any rate, the fact is that the springs under consideration distribute in an intimate relation to occurrence of the Kashio gneissic rocks.

In addition to this, the springs found in the rocks other than the Izumi group indicate no contents of sulfide determined through iodimetry and those occurring, even if within the part of the Izumi group, in the eastern half of the area are also so. This may suggest that the mineral springs in this area originally contain none of sulfide. On the other hand, the Izumi group composed of sandstone and conglomerate within the area in question reveals such a thickness as increases in the western and central parts, under which the Asenotani shale member bearing the sapropelic matters is hidden, and decreases in the eastern part without the same member. Notable is the agreement of locations of sulfide-bearing springs with that of this member. The Ogawa spring coming out seemingly from the alluvial deposit is also that from the related member lying in the depth on the spot. It appears common that the springs passing through the Asenotani shale member always contain hydrogen sulfide accompanied with few amount of carbon dioxide and those in the other parts display a character with no content of sulfide.

It thus results in that the mineral springs distributing within the area concerned are classified originally into the carbonate-bearing ones, some of which may get to include hydrogen sulfide originated from the sapropelic substances through passing into the Asenotani member comprising the latter.

V. Summary

It seems general that plenty of mineral springs predominant in the totals of carbon dioxide and carbonate are apt to occur within the zone situating along the Median Dislocation Line. In the area confined to the southern part of Ōsaka Prefecture, those are found scattered with a width along the Izumi Mountain-range probably in no direct relation to the special line mentioned above but ascribable to production in such condition that most of carbon dioxide are now being freed through the specific fractures as a sort of the post-activity, continued up to the present, of so-called Kashio gneissic rocks distributing in a close connection with each other.

As regards the chemical compositions, the springs under consideration are dividable into the one containing certain amount of the sulfides determined through iodimetry and the other without their traces. Noteworthy is that those belonging to the former are often found within the area composed of the Asenotani shale member, abundant in the sapropelic matters, in the Izumi sandstone group while those grouped into the latter are likely to running-out through the parts without any organic substances.

These mineral springs in the area concerned are originally characterized with their quality bearing no trace of the sulfides, most or some part of which may therefore be supplied from the organic sources comprised in the related member.

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