

**RECORDS (ANNUAL REPORT  
PART II) OF THE  
GEOLOGICAL SURVEY  
OF TANGANYIKA**

**VOLUME VI  
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### 13.—HOT SPRINGS INVESTIGATION: PROGRESS REPORT

By T. C. JAMES, *Geologist*

Hot springs have been investigated from time to time since the earliest days of the Geological Survey of Tanganyika, but it was not until 1952 that a systematic investigation was undertaken. The reason for this investigation was that hot springs and carbonatites, and/or younger volcanicity appeared to be related phenomena. When existing information was compiled it became clear that the hot springs of Tanganyika belong to a very definite type and show affinities with a number of well-known occurrences in other parts of the world, e.g., the geysers and fumaroles of the Yellowstone National Park, U.S.A. and of Wairakei, New Zealand.

The Tanganyika hot springs bring to the surface a mixture of brine and gas, the chemical composition of which is found to be similar for most of the occurrences. The solutes of the brines are almost entirely  $\text{Na}^+$ ,  $\text{Cl}^-$ ,  $\text{HCO}_3^-$ ,  $\text{CO}_3^{--}$ ,  $\text{SO}_4^{--}$ , and  $\text{F}^-$ . Temperatures of the brines at the spring vents are  $80^\circ$ – $135^\circ\text{F}$ . The gas is composed of nitrogen and inert gases, helium and carbon dioxide. The concentration of the brines varies from place to place and the three main constituents of the gas may be in different proportions at different occurrences. A total of 14 gas-bearing hot springs are known at present and no doubt more remain to be discovered.

Two factors appear to control the general location of the hot springs. In many instances the springs are found in the vicinity of recent faults and in volcanic regions. The composition of the brines and gas emitted from the springs, together with a number of other geological considerations, leads to the conclusion that the springs are probably due to volcanic emanations and can be regarded as fumarolic.

Samples of gas collected from Nyamosi Hot Spring in North Mara District, and Maji Moto Hot Spring in Musoma District, were found on chemical analysis to contain 18 per cent and 13 per cent, respectively, of helium. These deposits are now under investigation by the United Kingdom Atomic Energy Authority as possible sources of helium.

Samples of gas collected from the Songwe Valley Hot Springs, Mbeya District, contain a maximum of 99.2 per cent carbon dioxide. This deposit is a potential source of carbon dioxide.

Further investigation of the hot springs of Tanganyika may lead to the discovery of sources of brine suitable for the manufacture of salts, and it should be remembered that geothermal steam derived from not dissimilar sources is being utilized in New Zealand for the generation of electrical power.

X.—NEOGENE VOLCANICS—NORTHERN PROVINCE—KILIMANJARO

- K. 53. Nepheline rhomb porphyry. Engare Rungai, 9,800 feet, Kilimanjaro, Degree Square 14 SW. Collected by W. H. Wilcockson, 26/7/53. Analysed by W. H. Herdsman, 16/5/55.
- K. 955. Nepheline rhomb porphyry. N. side of Südost-tal, 15,700 feet, Kilimanjaro, Degree Square 22 NW. Collected by G. P. Leedal, 15/10/53. Analysed by W. H. Herdsman, 30/1/56.
- K. 605. Analcime syenite. Great west notch, 17,640 feet, Kilimanjaro, Degree Square 22 NW. Collected by P. Wilkinson, 11/9/53. Analysed by W. H. Herdsman, 27/1/55.
- K. 128. Aegirine phonolite. Snout of Fürtwängler Glacier, Kibo Caldera, 18,750 feet, Kilimanjaro, Degree Square 22 NW. Collected by P. Wilkinson, 21/7/53. Analysed by W. H. Herdsman, 27/1/55.
- K. 177. Rhomb porphyry with olivine. Vicinity of Peter's Hut, Kilimanjaro, Degree Square 22 NW. Collected by P. Wilkinson, 4/8/53. Analysed by W. H. Herdsman, 16/5/55.
- K. 149. Aegirine phonolite. Ash pit, Kibo, Kilimanjaro, Degree Square 22 NW. Collected by P. Wilkinson, 24/7/53. Analysed by W. H. Herdsman, 27/1/55.
- K. 121. Glassy nepheline rhomb porphyry. Summit Ridge, Kibo, 19,340 feet, Kilimanjaro, Degree Square 22 NW. Collected by P. Wilkinson, 21/7/53. Analysed by W. H. Herdsman, 30/1/56.

X. CONTINUED

	K. 189	K. 173	K. 891	K. 224	K. 592	K. 585
SiO <sub>2</sub>	50.15	49.35	47.93	47.54	42.58	41.57
TiO <sub>2</sub>	1.03	1.96	1.68	2.66	2.04	1.56
Al <sub>2</sub> O <sub>3</sub>	17.82	17.91	19.86	18.32	15.84	19.16
Fe <sub>2</sub> O <sub>3</sub>	3.24	7.96	3.82	8.04	7.62	8.64
FeO	9.36	4.14	6.72	3.06	5.76	4.24
MnO	0.13	0.10	0.16	0.15	0.25	0.18
MgO	4.82	3.92	3.66	3.36	5.04	4.14
CaO	8.34	7.16	7.62	9.33	9.93	9.16
Na <sub>2</sub> O	3.57	4.02	3.97	3.62	3.12	5.03
K <sub>2</sub> O	1.38	1.96	2.04	1.28	0.99	1.22
H <sub>2</sub> O+	0.06	0.94	1.40	0.98	2.12	3.28
H <sub>2</sub> O—	0.24	0.05	0.59	1.09	1.30	1.06
CO <sub>2</sub>	Nil	Nil	Nil	Nil	2.58	Nil
P <sub>2</sub> O <sub>5</sub>	Trace	0.43	0.74	0.67	0.37	0.78
BaO	—	—	—	—	0.06	—
SrO	—	—	—	—	0.19	—
Totals	100.14	99.90	100.19	100.10	99.79	100.02
S.G.	2.852	2.834	2.725	2.847	—	2.53

- K. 189. Olivine trachybasalt. West ridge of Süd-tal, Mawenzi, 14,260 feet, Kilimanjaro, Degree Square 22 NW. Collected by P. Wilkinson, 8/8/53. Analysed by W. H. Herdsman, 18/2/56.
- K. 173. Olivine trachybasalt. Süd-tal 3, Mawenzi, 11,850 feet, Kilimanjaro, Degree Square 22 NW. Collected by P. Wilkinson, 3/8/53. Analysed by W. H. Herdsman, 16/5/55.
- K. 891. Trachybasalt. N. end Shira Ridge, Kilimanjaro, Degree Square 22 NW. Collected by G. P. Leedal, 1/10/53. Analysed by W. H. Herdsman, 30/1/56.
- K. 224. Glassy trachybasalt. Col at head of Süd-tal, S. Mawenzi, 15,150 feet, Kilimanjaro, Degree Square 22 NW. Collected by P. Wilkinson, 13/8/53. Analysed by W. H. Herdsman, 30/1/56.
- K. 592. Analcime-bearing olivine dolerite. Summit of Platzkegel, Shira, Kilimanjaro, Degree Square 22 NW. Collected by P. Wilkinson, 8/9/53. Analysed by W. H. Herdsman, 21/5/56.
- K. 585. Melanephelinite. Shira caldera scarp, Kilimanjaro, Degree Square 22 NW. Collected by P. Wilkinson, 8/9/53. Analysed by W. H. Herdsman, 27/1/55.

APPENDIX C

ANALYSES OF NATURAL GASES AND ACCOMPANYING SPRING WATERS UP TO 1956

During the period 1948 to 1956 eleven gas analyses were made by the Government Chemist, London. Nine of the water analyses were made by the Geological Laboratory Services, Dodoma. In dealing with the composition of material emitted from thermal springs of this type it is essential to consider the composition of spring waters and gases together. The probable composition of solutes in the spring waters are thus shown in the table in the same column beneath the composition of the accompanying gas.

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K. 585
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19.16
8.64
4.24
0.18
4.14
9.16
5.03
1.22
3.28
1.06
Nil
0.78
—
—
100.02
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Collected by G. P.

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njaro, Degree Square 1/56.

NW. Collected by

The gases fall into two groups. Two of them are composed mainly of carbon dioxide. The rest, with the exception of the gas from Lake Manyara, are composed mainly of nitrogen with varying amounts of inert gases. There is reason to believe that the high proportion of hydrocarbons in the Lake Manyara gas is due to contamination near the surface and if this is calculated out the remainder of the gas is mainly nitrogen. Gases intermediate in composition between carbon dioxide and nitrogen types may exist and the gas from Utete might be an intermediate member of the series.

The waters also fall into two groups and can conveniently be considered as sodium carbonate or sodium sulphate waters. In general sodium carbonate waters have a pH of 8 or more and sodium sulphate waters a pH of 7.5 or less. Unfortunately some of the analyses are incomplete and not enough data exists to make an accurate classification. It is found that the proportion of sodium bicarbonate to sodium carbonate is a reflection of the rate of flow of the spring waters, fast flowing springs being high in bicarbonate and standing waters being high in carbonate. The high sodium fluoride content of the waters is noteworthy. The concentration of the solutes in the spring waters varies considerably and a clearer picture is obtained by comparing percentage composition of total solutes found.

There is no correlation between the two groups of gases and the two groups of waters. Thus carbon dioxide or nitrogen gas may be found with either sodium carbonate or sodium sulphate water.

T. C. JAMES

I *Rambo Spring*.—Carbon dioxide gas and sodium carbonate water. Songwe River group of hot springs, 14 miles west of Mbeya, Mbeya District, Degree Square 70 SW. Gas and water collected by T. C. James, 7/12/55. Gas analysed by Government Chemist, London, 4/5/56 (X/5069). Water analysed by R. A. Sutton, (X/5069).

II. *Maji ya Weta Spring*.—Carbon dioxide gas and sodium carbonate water. 4 miles south of Kisaki, Morogoro District, Degree Square 64 SE. Gas collected by T. C. James, 10/10/53. Water collected by W. Bornhardt 18/7/1897. Gas analysed by Government Chemist, London, 29/5/54 (X/3701). Water analysis from Zur Oberflächengestaltung und Geologie Deutsch-Ostafrikas by W. Bornhardt, 1900, Berlin.

III. *Utete Spring*.—Mixed carbon dioxide and nitrogen gas, and sodium sulphate water. 1 mile south-east of Utete, Rufiji District, Degree Square 75 NE. Gas and water collected by W. G. Aitken, 29/9/49. Gas analysed by Government Chemist, London, 3/7/51 (X/2215). Water analysed by J. H. Harris, 24/1/50 (X/2215).

IV. *Kinyoo Spring*.—Nitrogen gas contaminated by hydrocarbons, and sodium carbonate water. Lake Manyara group of springs west of Kiati, Mbulu District, Degree Square 20 SE. Gas and water collected by T. C. James, 11/8/52. Gas analysed by Government Chemist, London, 21/7/53 (X/3213). Water analysed by H. Bassett, 19/3/53 (X/3213).

V. *Kondoa Spring*.—Nitrogen gas and sodium sulphate water. Kondoa Township, Kondoa District, Degree Square 30 SE. Gas collected by W. G. Aitken, 26/3/49. Water collected by T. C. James, 5/11/54. Gas analysed by Government Chemist, London, 21/11/49 (X/2059). Water analysed by R. A. Sutton, 8/12/54 (X/4158).

VI. *Golai Spring*.—Nitrogen gas and sodium carbonate water. North-west side of Lake Balangida, Mbulu District, Degree Square 30 NW. Gas and water collected by T. C. James, 17/8/52. Gas analysed by Government Chemist, London, 21/7/53 (X/3214). Water analysed by R. A. Sutton, June, 1953. (X/3214).

VII. *Uvinza Spring*.—Nitrogen gas and unclassified water. Nyanza Salt Mines, Uvinza, Kigoma District, Degree Square 36 NW. Gas and water collected by J. A. Stevens, 14/8/48. Gas analysed by Government Chemist, London, 15/12/48 (File No. 97/88a). Water analysed by J. A. Stevens, 14/8/48 (JAS/3).

VIII. *Rock of Hades Spring*.—Nitrogen gas and sodium sulphate water. Ivuna Salt Works, Mbeya District, Degree Square 69 NE. Gas and water collected by J. A. Stevens, 10/12/50. Gas analysed by Government Chemist, London, 3/7/51 (X/2622). Water analysed by J. A. Stevens, (X/2622).

IX. *Maji Moto Spring*.—Nitrogen gas and sodium carbonate water. Ngurime, Musoma District, Degree Square 5 SW. Gas and water collected by T. C. James, 26/10/54. Gas analysed by Government Chemist, London, 4/6/55 (X/4158). Water analysed by R. A. Sutton, 22/11/54 (X/4158).

X. *Nyamosi Spring*.—Nitrogen gas and sodium carbonate water. 5 miles north-east of Tarime, North Mara District, Degree Square 5 NW. Gas and water collected by T. C. James, 29/10/54. Gas analysed by Government Chemist, London, 4/6/55 (X/4158). Water analysed by R. A. Sutton, 29/11/54 (X/4158).

XI. *"Eyasi" Spring*.—Nitrogen gas and sodium carbonate water. South-east shore of Lake Eyasi, Mbulu District, Degree Square 20 SW. Gas and water collected by N. J. Guest, 1954. Gas analysed by Government Chemist, London, 4/6/55 (X/4205). Water analysed by R. A. Sutton, 14/1/55 (X/4205).

UP TO 1956

ent Chemist, London  
a. In dealing with the  
sider the composition  
spring waters are thus  
gas.

ANALYSES OF GASES AS VOLUME PER CENT AND OF WATERS IN PARTS PER MILLION

GASES:	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
CO <sub>2</sub> ... ..	97.2	89.9	12.4	0.7	3.9	3.8	1.7	0.8	0.4	0.2	0.2
H <sub>2</sub> S ... ..	n.d.	n.d.	2.5	0.2	—	0.8	—	—	<0.1	<0.1	<0.1
CO ... ..	<0.1	n.d.	—	1.1	n.d.	*	n.d.	—	<0.1	<0.1	<0.1
O <sub>2</sub> ... ..	0.7	0.9	0.2	0.4	2.7	0.4	n.d.	2.1	0.1	0.2	0.8
H <sub>2</sub> ... ..	<0.1	n.d.	—	—	n.d.	—	n.d.	—	<0.1	<0.1	0.2
CH <sub>4</sub> etc. ... ..	<0.1	n.d.	0.8	88.5	n.d.	*	n.d.	5.4	<0.1	0.5*	<0.1
He ... ..	<0.1	0.06	0.25	0.07	0.3	3.7	2.5	4.2	13.2	17.9	5.7
A(Kr, Ne, Xe) ... ..	—	—	—	—	1.0	—	1.2	—	—	—	—
N <sub>2</sub> ... ..	2.1	9.8	83.9	9.0	91.5	91.3	94.6	87.5	86.3	81.2	93.1
WATERS:											
NaCl ... ..	196	292	285	2,965	193	4,320	168,600	2,760	1,920	725	8,490
Na <sub>2</sub> CO <sub>3</sub> ... ..	—	1,106	419	8,510	—	1,900	—	—	940	850	1,730
NaHCO <sub>3</sub> ... ..	2,337	—	—	—	—	2,450	—	—	2,370	2,310	4,630
Na <sub>2</sub> SO <sub>4</sub> ... ..	241	—	373	—	58	1,690	—	790	640	290	1,110
NaF ... ..	18	—	—	—	2	78	—	—	50	50	150
KCl ... ..	218	—	—	—	—	142	5,120	140	—	—	—
K <sub>2</sub> SO <sub>4</sub> ... ..	—	550	—	—	—	—	—	—	—	—	—
CaCl <sub>2</sub> ... ..	—	—	—	—	—	—	1,530	—	—	—	—
CaCO <sub>3</sub> ... ..	—	162	48	—	—	—	130	100	—	—	—
Ca(HCO <sub>3</sub> ) <sub>2</sub> ... ..	100	—	—	—	248	—	—	—	—	—	—
CaSO <sub>4</sub> ... ..	—	—	—	—	—	—	3,570	220	—	—	—
MgCO <sub>3</sub> ... ..	—	110	34	—	—	—	4,060	10	—	—	—
Mg(HCO <sub>3</sub> ) <sub>2</sub> ... ..	35	—	—	—	183	—	—	—	—	—	—
SiO <sub>2</sub> ... ..	90	64	24	110	60	—	—	100	100	90	—
pH ... ..	(8.4)	—	(7.5)	—	(7.5)	—	(7.5)	—	(9.5)	(9.5)	(9.5)

\*Negligible or presence doubtful, within limits of experimental error. n.d. Not detected.

Temperature ... ..	ca 65°C.	72°C.	58°C.	25°C.	ca 25°C.	ca 30°C.	25.5°C.	65.5°C.	57.5°C.	38°C.	—
Estimated flow of water in gallons per hour ... ..	ca 15,000	ca 20,000	10,000	nil	ca 30,000	ca 25	large	ca 1,800	1,800	ca 86	—
Estimated flow of gas in litres per hour ... ..	ca 1,000	small	small	very small	ca 100	very small	very small	small	ca 200	ca 54	—

