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OF TANGANYIKA

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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 carbonatization 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 Na+, -Cl, -HCO3, -CO32-, -SO4, and -F. Temperatures of the brines at the spring vents are 80°-135°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 Map Moto Hot Spring in Musoma District, were found on chemical analysis to contain 18 per cent and 15 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.
APPENDIX C

ANALYSES OF NATURAL GASES AND ACCOMPANYING SPRING WATERS UP TO 1936

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 then shown in the table in the same column beneath the composition of the accompanying gas.
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 Utea 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. Rombo 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/3569). Water analysed by R. A. Sutton, OX (5065).

II. Maji ya Weta Spring.—Carbon dioxide gas and sodium carbonate water. 4 miles south of Kitavi, 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 Oberflächenuntersuchungen und Geologie Deutsch-Ostafrikas by W. Bornhardt, 1900, Berlin.


X. Nyamwe Spring.—Nitrogen gas and sodium carbonate water. 5 miles north-east of Tarime, North Mara District, Degree Square 3 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).

### Analyses of Gases as Volume per Cent and of Waters in Parts per Million

<table>
<thead>
<tr>
<th>Gases:</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>VIII</th>
<th>IX</th>
<th>X</th>
<th>XI</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{CO}_2 )</td>
<td>97.2</td>
<td>89.9</td>
<td>12.4</td>
<td>0.7</td>
<td>5.9</td>
<td>3.8</td>
<td>1.7</td>
<td>0.8</td>
<td>0.4</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>( \text{H}_2 )</td>
<td>n.d.</td>
<td>n.d.</td>
<td>0.2</td>
<td>0.2</td>
<td>n.d.</td>
<td>n.d.</td>
<td>n.d.</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>( \text{O}_2 )</td>
<td>0.7</td>
<td>0.9</td>
<td>0.2</td>
<td>0.4</td>
<td>2.7</td>
<td>0.4</td>
<td>n.d.</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>( \text{N}_2 )</td>
<td>0.06</td>
<td>0.06</td>
<td>0.25</td>
<td>0.07</td>
<td>0.3</td>
<td>3.7</td>
<td>2.5</td>
<td>4.2</td>
<td>13.2</td>
<td>17.9</td>
<td>5.7</td>
</tr>
<tr>
<td>( \text{A(Kr, Na, Xe)} )</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
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<tr>
<td><strong>Waters:</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>( \text{NaCl} )</td>
<td>196</td>
<td>292</td>
<td>285</td>
<td>2,965</td>
<td>2,965</td>
<td>193</td>
<td>4,320</td>
<td>168,600</td>
<td>2,760</td>
<td>1,920</td>
<td>1,920</td>
</tr>
<tr>
<td>( \text{Na}_2\text{CO}_3 )</td>
<td>1,106</td>
<td>419</td>
<td>8,510</td>
<td>2,700</td>
<td>1,900</td>
<td>1,900</td>
<td>790</td>
<td>640</td>
<td>430</td>
<td>370</td>
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<tr>
<td>( \text{NaHCO}_3 )</td>
<td>2,337</td>
<td>-</td>
<td>5,250</td>
<td>2,450</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>( \text{Na}_2\text{SO}_4 )</td>
<td>241</td>
<td>373</td>
<td>58</td>
<td>1,690</td>
<td>1,690</td>
<td>2,700</td>
<td>1,900</td>
<td>1,900</td>
<td>1,900</td>
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<tr>
<td>( \text{NaF} )</td>
<td>18</td>
<td>-</td>
<td>2</td>
<td>78</td>
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<td>78</td>
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<tr>
<td>( \text{KCl} )</td>
<td>218</td>
<td>550</td>
<td>-</td>
<td>142</td>
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<tr>
<td>( \text{K}_2\text{SO}_4 )</td>
<td>50</td>
<td>50</td>
<td>-</td>
<td>1,500</td>
<td>1,500</td>
<td>1,500</td>
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<td>( \text{CaCl}_2 )</td>
<td>162</td>
<td>48</td>
<td>-</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td></td>
</tr>
<tr>
<td>( \text{CaCO}_3 )</td>
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<td>100</td>
<td>48</td>
<td>130</td>
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<td>130</td>
<td>130</td>
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<tr>
<td>( \text{Ca(HCO}_3)_2 )</td>
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<td>100</td>
<td>100</td>
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<td>100</td>
<td>100</td>
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<td>100</td>
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<tr>
<td>( \text{MgSO}_4 )</td>
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<td>35</td>
<td>35</td>
<td>35</td>
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<td>35</td>
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<td>35</td>
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</tr>
<tr>
<td>( \text{MgCO}_3 )</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
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<td>100</td>
<td>100</td>
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</tr>
<tr>
<td>( \text{SiO}_2 )</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td><strong>pH</strong></td>
<td>9.8</td>
<td>9.8</td>
<td>9.8</td>
<td>9.8</td>
<td>9.8</td>
<td>9.8</td>
<td>9.8</td>
<td>9.8</td>
<td>9.8</td>
<td>9.8</td>
<td></td>
</tr>
</tbody>
</table>

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

**Temperature:**
- ca 65°C.
- 72°C.
- 58°C.
- ca 25°C.
- ca 30°C.
- ca 35°C.
- 57.5°C.
- 38°C.

**Estimated flow of water in gallons per hour:**
- ca 15,000
- ca 20,000
- 10,000

**Estimated flow of gas in litres per hour:**
- ca 1,000
- small
- very small

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*Note: The table includes various gases and waters, along with their concentrations expressed as volume per cent and parts per million. The data is organized in a tabular format, showing concentrations for different gases and waters, with some values marked as negligible or presence doubtful within the limits of experimental error. Additional data includes temperature and estimated flow rates of water and gas.*

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