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SALT LAKE WATER.

By Professor J. E. TALMAGE.

AS articles have heretofore appeared in the *Magazine* on the existing Great Salt Lakes,¹ and its predecessor Lake Bonneville,² the writer ventures to present the following additional data regarding the recent and present condition of these briny waters.

From the date of the latest partial analysis reported,³ the lake continued its course of shrinkage until the later months of 1903. During the summer of that year, Saltair pavilion, the most renowned of the lake resorts, was left dry except for pools and playas, nearly half a mile inland, and all other pleasure establishments on the lake shore were abandoned.

The diminished water supply was primarily due to deficient natural precipitation, and incidentally to the fact that irrigation interests robbed the shrunken streams to dryness on the uplands. The autumn of 1903 probably witnessed the lowest level of the Great Salt Lake observed by civilised man; and unfounded fears regarding the imminent dessication of the lake to complete dryness have been loudly voiced in sensational newspaper accounts and through the pages of popular monthlies.

The recorded history of the lake during the period of human occupancy of its valley show minor cycles of rise and fall, each limited to approximately fifteen years; besides these there are to be considered the major cycles of geological significance exemplified by the history of the Pleistocene water body, Lake Bonneville. It appears that for more than fifteen years past the lake has followed the regular downward course incident to its minor cycle of shrinkage. If this be all, the lake may be expected soon to rise; if its major cycle of dessication be involved, it may yet sink to its low level of 1869, or below.⁴ However, the naturally occurring rise in the present upward course of the minor cycle will probably result in an increasing volume for a few years at least.

A sample of the lake brine was taken in October 1903, when the lake was at or near its lowest observed level. The collection was made in the open lake as near as possible to the point at which other samples reported by the writer have been taken. A partial examination by the author yielded the following data:—

| | |
|--|------------------------------|
| Specific gravity of sample, mean of six concordant determinations, by spiral balance, pycnometer, and direct weighing, | 1.2189 |
| Total solids dissolved, mean of four determinations, | 27.5360 per cent. by weight. |

¹ December 1901, pp. 617-644.

² September 1902, pp. 449-471, with maps.

³ September 1901; see this *Magazine*, December 1901, p. 633.

⁴ See this *Magazine*, December 1901, p. 633.

Analysis in part gave the following results as to the composition of solid contents:—

| | Per cent. by weight of lake brine. |
|--|--|
| Magnesium oxide (MgO), ¹ | 2.5111 |
| Calcium oxide (CaO), | 0.1112 |
| SO_4 radical, | 1.8299 |
| Chlorine, | 15.3232 |

The results are averages of two or three determinations in each case.

At the writer's request a more extended examination was undertaken by Mr. William Blum,¹ of the department of chemistry, University of Utah. Mr. Blum reports the following results of duplicate determinations:—

| | Per cent. by weight of sample. | Per cent. of total solids. | Grams per litre. | Grains per imperial gallon. |
|-------------------------|--------------------------------------|----------------------------------|---------------------|-----------------------------------|
| Total solids, | 27.72 | ... | 338.36 | 23685 |
| Chlorine, | 15.27 | 55.09 | 186.390 | 13047 |
| SO_4 radical, | 1.86 | 6.71 | 22.704 | 1589 |
| Magnesium, | 0.155 | 0.56 | 1.892 | 132 |
| Calcium, | 0.045 | 0.16 | 0.549 | 38 |
| Sodium, | 9.58 | 34.55 | 116.93 | 8186 |
| Potassium, | 0.73 | 2.63 | 8.911 | 624 |
| Totals of constituents, | 27.64 | 99.70 | 337.38 | 23616 |

| | Per cent. by weight of sample. | |
|-----------------------------|--------------------------------------|--|
| Bromine, | about 0.001 | Both proved to be present beyond question; quantitative results as to lithium not fully confirmed. |
| Lithium, | „ 0.0009 | |
| Specific gravity of sample, | | 1.22063 |

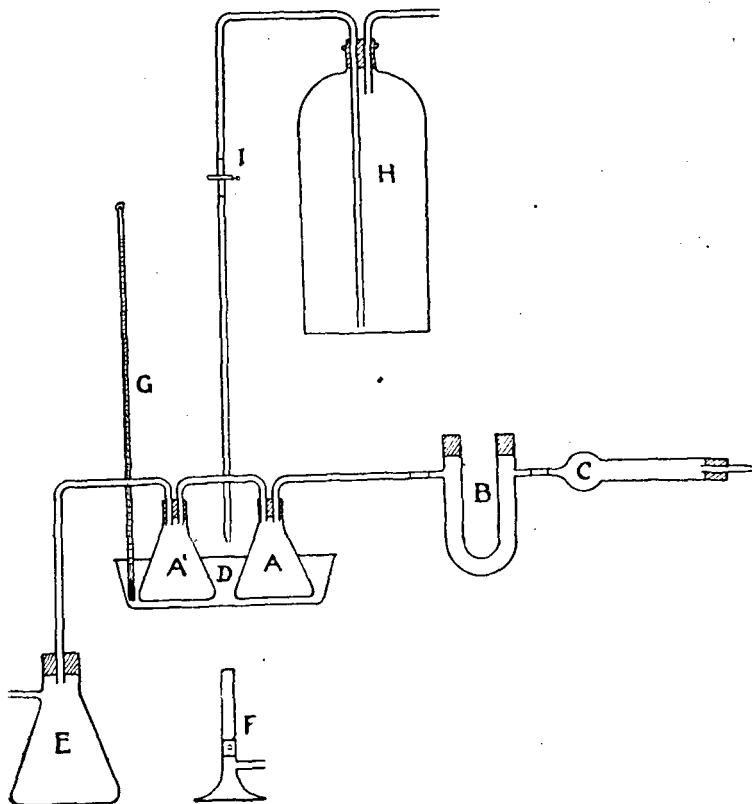
The analyst construes these results as probably indicating the following combinations:—

| | Per cent. by weight of lake brine. |
|---|--|
| Sodium chloride (NaCl), | 23.19 |
| Sodium sulphate (Na_2SO_4), | 1.42 |
| Potassium sulphate (K_2SO_4), | 1.63 |
| Magnesium chloride (MgCl_2), | 0.614 |
| Calcium chloride (CaCl_2), | 0.124 |
| Excess chlorine (Cl), | 0.66 |
| | <hr/> 27.638 <hr/> |

The sample treated by Mr. Blum was taken at the same place and time as was that examined by the writer and referred to above. The two samples were contained in separate bottles, and a slightly higher density as well as a greater yield of solids will be observed in Mr. Blum's results. The results of the separate determinations, however, are fairly concordant.

¹ William Blum, B.Sc., University of Pennsylvania, now of the Faculty University of Utah.

As to the constitution of the lake water in general, it is to be remembered that the winter of 1903-1904, and the spring of 1904, were periods of increased precipitation, and the early summer of 1904 was relatively cool and humid within the hydrographical basin of the lakes. During the early months of the present year most of the contributing streams were pouring torrents into the lake. A sample of water was



Apparatus for determining solids in lake brine.

taken (June 6, 1904) at or near the point of usual collection. This yielded to the writer's examination the following results:—

| | |
|--|-------------------|
| Specific gravity (average of four determinations), | 1'1905. |
| Total solids, | 25'1960 per cent. |

The effect of the influx of spring freshets is plainly shown by a comparison of the samples taken in the autumn and spring respectively.

It may be of interest to know that the determination of the solid contents in a brine like that of the Great Salt Lake is an undertaking

requiring special precaution. The usual method of taking a measured portion of the water under examination and evaporating the same to dryness in an open vessel is wholly unsatisfactory. In the first place, measurements of initial quantities fail to bring results sufficiently concordant; and weighing out the water in open vessels is equally unsatisfactory. The one method found to be reliable by the writer and his associates is that of direct weighing in closed vessels. For the determinations of solids in the lake brine the process described below has been devised; it has proved to be highly satisfactory, and suggests a general application.

Duplicate portions of the brine, each about 10 cc., are weighed in small Erlenmeyer flasks (A and A'); the flasks are tightly corked during the weighing, and the corks are laid aside for further use in the final weighing of the residues. The flasks are connected with U-tube B and bulb-tube C, the former filled with fragments of potassium hydrate, and the latter with pieces of calcium chloride. The flasks thus prepared are set in an open pan D containing a bath of calcium chloride solution; and from the second flask A' a tube leads to the filtering bottle E, which is connected directly with the aspirator or filter pump. The pan D is heated by a burner F, and the temperature of the bath is shown by the thermometer G. The calcium chloride bath in D is of such concentration as to give the required temperature at the boiling point; this degree of concentration is maintained during the operation by a supply of water delivered drop by drop from the elevated reservoir H.

By this arrangement a current of dry air is drawn through the flasks containing the weighed portions of brine; dessication is rapidly accomplished, and the formation of large crystals with liquid inclusions is practically prevented. The purpose of adding the potassium hydrate tube B, as suggested by Mr. Blum, is that of preventing the possible conversion of chlorides into carbonates by the passage of a large volume of air containing carbon dioxide. Experiment has proved that the brine in the second flask is as thoroughly evaporated as is that in A; thus it is possible to make duplicate determinations at one heating.

Calcium chloride solution was chosen for the bath in preference to other liquids with high boiling points, as the adherent chloride can be readily removed from the outside of the flasks at the close of the operation. A temperature of 120°C is found to give constant weight to the residues.

THE RETURN OF THE *SCOTIA*.

On July 21 the *Scotia*, with the members of the Scottish National Antarctic Expedition on board, arrived in the Clyde on her return from the Antarctic, and met with an enthusiastic reception. It will be recollected that the *Scotia* left the Clyde in the early days of November 1902, and arrived at the Falkland Islands on January 6, 1903, her voyage out being fully described in these pages. Leaving the