

their plan, but nothing is said as regards the evidence of the materials for a construction of this vault. For further details we must wait for the complete description of the results of their survey.

ON A PRINCIPAL CAUSE OF THE SALTNESS OF THE DEAD SEA.

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THE saltness of the Dead Sea has been ascribed to two causes :— (1) The accumulation of chlorides derived from the rocks of the Holy Land by solvent denudation, and (2) the cutting off of an arm of the Red Sea by the rising of Palestine in past ages,¹ with, in each case, the subsequent concentration of the solution by evaporation. There is a third cause, which is probably more important than either, viz., the atmospheric transportation of salt from the Mediterranean. The circulation of salt is a reality which must be taken into account. Brought from the sea by winds and falling in the rain, the salt is carried back to the sea by rivers, except in cases of inland lakes without outlet, where the saline solution remains for evaporation, and I have shown that in the case of an inland Pennine reservoir such a cause would produce a water as salt as that of the Dead Sea in a fraction of the time usually assigned to the Pleistocene Age.²

For the purpose of the present paper analyses of rainwater from the Holy Land are wanting ; as, however, they are not at present available, I assume that the rain, like that of other lands,³ is charged with salt to a degree which varies in a direct manner with the velocity of the winds coming from the sea ; it then only remains to show that the rocks are not abnormally salt bearing.

I have had forwarded to me by the Palestine Exploration Fund specimens of the rocks on which Jerusalem is built as samples of

¹ Hull, *The Phys. Geol. of Arabia Petraea and Palestine*, pp. 119 and 120.

² *Geol. Mag.*, October, 1901, p. 446 ; also compare J. G. Goodechild, *Trans. Geol. Soc. of Glasgow*, vol. xi, Part I, p. 84 (1898).

³ *Proceedings of the Yorks. Geol. and Polytechnic Soc.*, vol. xiv, Part III, pp. 403-408.

Palestine rocks. They are limestones of various compositions, and the amount of common salt, calculated from the chlorine I have found in them, is given in the following table:—

Description of Limestone.	Per cent. of Chlorine.	Calculated per cent. of Common Salt.
1. Kakule	0·025	0·041
2. Nahre	0·001	0·002
3. Meleke	0·006	0·010
4. Misse (yehudi)	0·005	0·008
5. Misse (helu)	0·0015	0·002
6. Misse (achmar)	0·001	0·002
Average	—	0·01

The salt contained in these rocks, except in the case of Kakule limestone, is no greater in amount than that found in the limestones of other lands, which similarly approximate to a general average of 0·01 per cent. of chlorine. This amount of chlorine would be quite inadequate to account for the salt in the Dead Sea. By a technical argument, based on the amount of chlorine in a rock and its rate of denudation, I have shown¹ that the salt yielded to rivers from this source is not a ninety-ninth of that which has been supplied by rain-water. Nor would the saltiness of the Dead Sea be fully accounted for if a marine area had been cut off during the rising of the land, as the initial saltiness thus acquired would only be about a fourth of that subsequently attained to, and moreover in this condition of saturation it has been for an unknown length of time continuously precipitating its excess of salt. Hull observes²:—"The increase of saltiness in the waters of the Dead Sea has probably been very slow, and dates back from its earliest condition when its waters stretched for a distance of about 200 miles from north to south. While the uprising of the land and the sinking down of the Jordan Arabah depression were in progress during the Miocene period, some of the waters of the outer ocean, themselves salt, were probably enclosed and retained; but from the

¹ *Chemical News*, vol. lxxxiii, p. 301, and *Geol. Mag.*, October, 1901, p. 447.

² *Op. cit.*, p. 120.

occurrence of the shells in the marls in the Arabah Valley, it would appear that when the waters of the great inland lake were at their maximum elevation, they were sufficiently fresh to allow of the presence of molluscous life. This would be during the Pluvial epoch, but at the stage represented by the salt beds of Jebel Usdum, the waters, which were then 600 feet higher than at present, must have been saturated with chloride of sodium." One may add that the intensity of meteorological conditions in the past geological history of Palestine have been much more severe than those now obtaining,¹ and the atmospheric transportation of salt would be correspondingly greater. Some of the salt then accumulated has been left by the dwindling waters of the Dead Sea in areas to the north and south, notably in Jebel Usdum, and the highly brackish rivulets which come from these neighbourhoods now are but contributing again what long ago came from more distant sources.

I find confirmation of the theory in the fact that the ratio of the chlorine to the bromine in the waters of the Dead Sea is approximately the same as that for these two elements in the Mediterranean Sea.²

In conclusion, I have to offer my best thanks to Mr. Walter Morrison, J.P., of Malham, and Mr. George Armstrong for the privilege of having been enabled to examine the rocks from Palestine which are mentioned in this paper.

¹ Tristram, *The Land of Israel*, p. 320.

² *Proceedings of the Yorks. Geol. and Polytechnic Soc.*, vol. xiv, Part III, p. 408 (1902).