LXXI.—*Researches on Moorland Waters. Part II. On the Origin of the Combined Chlorine.*

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GIVEN a reservoir of water of a capacity of $640\frac{1}{2}$ million gallons, with a chlorine figure of 1.188 per 100,000 and therefore containing 55 tons of common salt continually being carried away and continually being replenished, with a gathering ground on a saltless area of Millstone Grit and Yoredale Rocks, the question not unnaturally arises, Where does all the salt come from? Such are the conditions at Widdop, on the Yorkshire border, some 7 miles from Burnley, and 12 miles from Halifax at an altitude of 1050 feet above sea level. The problem, which had presented itself to me for some time, acquired an added interest last year from its bearing on chemico-geological speculation (compare July "On the Geological Age of the Earth," *B. A. Report*, 1900, pp. 369—379).

To arrive at an answer, chlorine determinations of the reservoir water have been made weekly during the winter months 1900—1901 and compared with the figures yielded by water from a rain-gauge kept near the reservoir. The estimations were made with silver nitrate and potassium chromate without previous concentration, as occasionally less than 10 c.c. of water was available for a test. During the period of testing, one large sample of water was kept for chlorine estimations as a check against the variable data which follow, and at the same time samples were examined from four other gathering grounds to the East; daily tests were also made of the Halifax rainfall collected at Belle Vue Museum. The Widdop figures are given on p. 674.

During the week ending December 24th there was a violent storm from the S.W., presumably bearing salt spray from the Irish Sea, about 40 miles away. Some of the other high figures are, perhaps, to be accounted for by salt-charged, fine dust being brought down by comparatively light rains, that is, a low rainfall. It appears highly probable that the influence of Lancashire towns is a negligible quantity, because the ground investigated, like others far removed from all possibility of town influence, is included in the Yorkshire unit iso-chlor area (Ackroyd, *B. A. Report*, 1900, p. 695). The high chlorine figures also synchronise with similarly high chlorine figures obtained for the other gathering grounds further east in the course of the work.

The conclusions to be drawn are :

1. That the combined chlorine in the reservoir water is wholly derived from rain-water.

Week ending	Chlorine, parts per 100,000.		Rainfall in inches.
	In reservoir water.	In rain-gauge water.	
1900 :			
November 12.....	1·2	0·8	2·05
„ 26.....	1·0	1·0	0·87
December 3.....	1·0	0·5	1·29
„ 10.....	—	0·2	1·23
„ 17.....	1·1	0·2	0·51
„ 24.....	1·15	3·3	0·45
„ 31.....	1·1	1·1	2·20
1901 :			
January 7.....	1·2	1·2	0·02
„ 14.....	1·3	6·5	0·15
„ 21.....	1·25	0·85	1·15
„ 28.....	1·25	1·75	1·55
February 4.....	(?) 1·4	0·8	0·44
„ 11.....	1·2	1·75	0·09
„ 18.....	1·3	—	—
Average	1·188	1·53	

2. That the quantity of chlorine, 1·188 parts per 100,000, in so large a body of reservoir water closely approximates to a yearly average for the rainfall of the gathering grounds, it being so much in excess as is due to concentration arising from evaporation. Deducting 10 per cent. for evaporation and calculating for a rainfall of 43·17 inches, it is equal to an annual deposit of 172·3 lbs. of common salt per acre.

3. That the chlorine in the winter rainfall is in excess of the average for other seasons of the year, as has been found in other parts of the country (Kinch, *Trans.*, 1883, 51, 94; Lawes, Gilbert, and Warrington, *J. Roy. Agric. Soc. Eng.*, 1883, [ii], 19, 313, quoted by Kinch).

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