ON A CHALYBEATE WATER AND SALINE DEPOSIT FROM
SOUTHBOURNE-ON-SEA.

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SOUTHBOURNE-ON-SEA is situate towards the eastern extremity of Bournemouth Bay, and was founded some thirteen years ago by Dr. T. A. Compton, a retired physician, formerly of Bournemouth. It is a remarkably healthful and charming table-land, with full southern exposure.

During the excavations which were recently made for the foundations of a Sea-wall and Esplanade, which are constructed seven feet in and below a bed of solid greyish black clay, and about ten or eleven feet (on an average) below the upper surface of the sandy beach, there was discovered a spring of water, which was thought by the workmen to be derived from the sea by permeation through the clay at high tide. Dr. Compton was led, however, to form a different opinion, in which he was confirmed by tasting the water, which has an inky taste, not shared by any of the spring waters above the surface level of the beach; and having sunk a well about 20 feet north of the Sea-wall, samples of the water and a saline deposit found upon the clay were sent to me for analysis, the results of which Dr. Compton has very kindly allowed me to publish in this communication.

The saline deposit strikingly resembled alkali waste, in appearance, but it was more sand-like in character, being impregnated with green and yellow granules.

From the analytical results the composition of the deposit was calculated as follows : —

<i>Analysis.</i>				
Chloride of Sodium	(NaCl)	..	..	1·54
Sulphate of Sodium	(Na ₂ SO ₄)	..	..	5·69
Sulphate of Potassium	(K ₂ SO ₄)	..	..	·33
Sulphate of Calcium	(CaSO ₄)	..	..	1·00
Ferrous Sulphate	(FeSO ₄)	..	..	5·46
Ferric Sulphate	(Fe ₂ 3SO ₄)	..	..	4·82
Sulphate of Aluminium	(Al ₂ 3SO ₄)	..	..	11·23
Water	(H ₂ O)	..	..	13·73
Organic and undetermined matter		..	..	·64
				———— = 44·44 % soluble matters
Ferric Oxide	(Fe ₂ O ₃)	..	..	4·72
Alumina	(Al ₂ O ₃)	..	..	1·24
Silica (sand)	(SiO ₂)	..	..	46·68
Organic matter		..	..	2·92 = 55·56 % insoluble matters
				———— ————
				100·00 100·00

Magnesium was present only in traces; nitrates were absent; other metals were absent.

The water was quite clear when first received, but after opening the bottles, upon standing, it threw down a heavy deposit. In reaction the water was acid.

<i>Analysis.</i>					<i>Grains per gallon.</i>	
The total solid residue dry at 100° C. amounted to					..	275·00
Loss on ignition of residue					..	44·96
Chloride of Sodium	(NaCl)	..	..	..	..	19·16
Sulphate of Sodium	(Na ₂ SO ₄)	..	..	..	..	56·75
Sulphate of Calcium	(CaSO ₄)	..	..	..	..	13 72
Ferrous Sulphate	(FeSO ₄)	..	..	..	..	33·49
Ferric Sulphate	(Fe ₂ 3SO ₄)	..	..	..	..	65·80
Ferric Oxide	(Fe ₂ O ₃)	..	..	..	..	5·40
Sulphate of Aluminium	(Al ₂ 3SO ₄)	..	..	..	..	27·47
Silica	(SiO ₂)	..	..	..	..	6·75
Traces of Nitrates, Nitrites, Potassium and Magnesium					..	273·50

The water contained no free ammonia, and the albumenoid ammonia amounted to 0·05 part per 100,000.

I have not made an examination of the clay underlying the sand through which this water wells, but there can be no doubt that this chalybeate water results from the action of fresh water upon a ferruginous and aluminous soil, containing also much silica, the large amount of which substance held in solution, is possibly due to the acids which are generated in the slow decay of substances of an animal and vegetable character, and which are well known to exercise a powerful solvent action upon silica.

It may be of interest to compare the composition of the Southbourne "Chalybeate" water with some other ferruginous waters, which have been analysed and are known to be of medicinal value.

There is a spring at Trefiew (on the left bank of the Conway, about $2\frac{1}{2}$ miles from Llanrwst) which yields water, valued as a remedy in the treatment of certain diseases of the digestive organs and the skin, which, according to the analysis of T. Carnelly,* contains 286 grains of ferrous sulphate, and 95 grains of sulphate of aluminium per gallon: it is free from ferric sulphate, but contains 10.99 grains SiO_2 per gallon. In this instance there is no difficulty in accounting for the composition of the water, for "the mountains, at the base of which the wells are situated, consist chiefly of beds of limestone, ironstone, alum, slate, and iron pyrites, together with varying proportions of silicates, very much fractured and disintegrated, forming the northern extremity of the Bala or Caradoc beds. Up in the mountains and on these beds lie some small lakes, from which the springs are supposed to derive their principal supply of water, which, after percolating through the above beds and dissolving large quantities of their constituents, finds its exit near the base of the mountain, Alcae Coch, where it issues from the slate bed (Black Band), and between it and the ironstone."

The Orchard Alum Spring yields water containing, according to the analysis of Dr. Thresh,† among other constituents:—

$\text{Fe}_2 \text{SO}_4$	=	174.426	grains per gallon.
$\text{Fe}_2 \text{O}_3$	=	6.275	" "
$\text{Al}_2 \text{SO}_4$	=	72.908	" "
Fe SO_4	=	1.596	" "
$\text{Na}_2 \text{SO}_4$	=	.537	" "
Mg SO_4	=	21.055	" "
Ca SO_4	=	14.381	" "
Si O_2	=	5.776	" "

This spring originates in a disused coal mine, near the summit of Axe Edge, the highest point in the Peak district. The water is used as a vermifuge, and as an external application for various skin diseases. Dr. Thresh writes:—"We have not far to look for the source of the more abundant constituents. The spring arises, or rather issues, from the hillside, immediately above the upper surface of the millstone grit formation, which is here exposed and forms the bed of the rivulet into which the water flows. Overlying the sandstone is a layer of aluminous shale, of a blue grey colour, and doubtless, by the action of the air and water, this suffers such decomposition as to produce the soluble salts found in the spring. The exposed edges of this shale are encrusted with ferric oxide, and here and there, after rain, the water dripping off is seen to be distinctly coloured."

Dr. Thresh adds, that on the opposite side of the hill the water flowing from a similar mine contains 50 grains of crystallised ferrous sulphate to the gallon, with only a trace of ferric salt.

* *Chem. News*, Vol. xxi., p. 27.

† *Chem. News*, Vol. xvi., p. 226.

The Flitwick natural water contains, according to the analysis of Dr. Redwood,* 144 grains of oxide and carbonate of iron, and as much as 59·2 grains of the sulphates of magnesium and sodium. In this case “the surrounding country is flat, and is constituted principally by an undrained valley, the surface of which consists of a crumbly black peat that readily dries, and that is remarkable in containing a large quantity of ‘meadow’ or ‘bog iron ore,’ while underneath the peat, there lies, in the immediate vicinity of the well, a stratum of marly clay, and under this again is a deep stratum of sand, known to geologists as the lower green sand, and which ordinarily underlies the chalk. This green sand, which belongs to the Oolitic or Jurassic period, is known to be rich in iron shale, and to be studded with ferruginous nodules, while it owes its colouration to the silicate of iron that enters into its composition.”

As regards the Southbourne Chalybeate water, there can be no doubt of the history of its formation from a chemical point of view, and judging from the absence of magnesium, and the small amount of chlorides present, it may be safely concluded that it is derived by the action of fresh water (not sea water) upon ferruginous and aluminous deposits. The formation of ferrous sulphate from pyrites, by the action of water and air, is generally represented by the equation—

and the sulphuric acid thus set free, by its action upon clay and other bases, will produce the sulphates of aluminium and calcium. The sulphate of sodium may possibly be derived by the action of sulphuric acid upon common salt, and its large amount reminds one of the Cheltenham spring water, in which sulphate and chloride of sodium are the predominating constituents. The ferric sulphate is produced by the further oxidation of pyrites, as suggested by Dr. Thresh in the equation—

and by the action of ferric sulphate upon calcic carbonate, ferric oxide and basic ferric sulphate would result coincidentally with calcic sulphate.

The medicinal properties of the Southbourne mineral water must be of a pronounced and valuable character, superior to those of the Trefew water, since it contains a considerable quantity of ferric sulphate, and at the same time smaller quantities of ferrous sulphate and sulphate of aluminium; superior to the Orchard Alum spring, because, while sufficiently ferruginous, it contains far less sulphate of aluminum, which is an undesirable constituent, and superior to the Flitwick water, inasmuch as it contains twice as much silica, a constituent which is highly prized in the treatment of some diseases. The large amount of sulphate of sodium which the water contains is calculated to obviate certain secondary effects, which the salts of iron and aluminium might otherwise produce in the system.

Dr. Hermann Weber considers that the Southbourne water, properly diluted, “would be likely to act beneficially in many cases of anæmia,” particularly if the dilution be effected by admixture with Apollinaris, Vichy, or Vals water. There can be no doubt, also, that in the treatment of other diseases this newly discovered chalybeate

* Quoted in a Paper by Dr. R. T. Cooper, in the *Monthly Homœopathic Review*, November 1, 1884.

water may be prescribed with great advantage. It is fortunate, moreover, that the locality of the spring is so healthful and beautiful in itself, and this combination of circumstances should secure to Southbourne a great deal of the patronage that has hitherto been extended—almost exclusively—to continental towns. Apart from the medicinal value of its chalybeate spring water, Southbourne offers many advantages to persons suffering from anæmia and lung complaints, for the table-land air is pure and bracing, and the place is surrounded by pine woods, which give to the atmosphere at once a fragrance and a chemical potency for effecting beneficial changes in the sick and jaded.

As regards the supply of the spring water it is difficult to speak with any certainty at present, but the amount is apparently very considerable. The one well which has been sunk is seven feet in diameter, and is thickly cemented at the sides, so that the supply comes only from the bottom. When it contains a depth of five feet of the water, and this is pumped out, it fills again in course of a few hours. None of the water apparently comes from above the clay bed, but it commences to flow about two feet below it, and so far as can be judged the greater quantity flows in five feet below it.