



LI. Analysis of a sulphuretted water from the northern part of the Yorkshire Coal-field

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Messrs. Taylor and Martineau, by Mr. J. Blackaller, and dated Real del Monte, Oct. 18, 1826.

"In the early part of May last I had the pleasure of having the erection of the first of your engines at the mine of Moran placed under my direction and superintendence; and on the 12th of August started the same, to the no small surprise and satisfaction of the numerous visitors who had assembled on the occasion. The engine has continued to work beyond our most sanguine expectations, not a thing having failed or required alteration.

"Our foundry has been at work a short time, and we have turned out some decent castings, both in brass and iron."

On the 31st of October, Captain Vetch also writes: "I am happy to state that Moran Mine may now be considered as dry; that is, the water has been sunk to the bottom of the shaft; but it will be necessary by means of flat rods to drain some of the *pozos* (pits or winzes) in the lowest level, to get at the rich ores."

LI. *Analysis of a Sulphuretted Water from the Northern Part of the Yorkshire Coal-field.* By E. S. GEORGE, F.L.S.
*Hon. Mem. Y.P.S.**

THIS mineral water is very extensively employed in the fulling of woollen cloths,—a process to which, from the absence of earthy salts, it is peculiarly adapted. It formerly issued in a considerable spring at the village of Holbeck near Leeds, and was used medicinally: it appears in most cases to rise from a thick bed of shale lying below the flagstone, and so large is the supply that it has been procured in every situation in which borings to a sufficient depth have been made. There are in Leeds near fifty borings, and about 200,000 gallons of the water are pumped up daily. The depth at which the water is procured, from 70 to 200 yards, according to the situation of the well as regards the inclination of the strata. The amount of both gaseous and saline contents varies with the occurrence of higher springs, affected by heavy rains or by sudden elevations of the river Aire.

The water analysed was from Johnson's Well in Campfield, Leeds; the depth of the boring 90 yards: upon the surface is a bed of gravel about four yards thick, communicating with the river Aire, from which the well is about 200 yards distant: the water in the gravel is prevented from mixing with that in

* Read to the Yorksh. Phil. Soc. Jan. 2, 1827; and communicated by the Author.

the boring by a casing of iron pipes descending into a solid stratum of shale.

Analysis.

Specific gravity 1·00155.

The water when taken from the spring appears clear and sparkling, has a considerable sulphuretted odour, slightly blues reddened litmus; reddens turmeric; with solution of soap gives a very slight curdy precipitate. Lime-water occasions a precipitate both before and after ebullition. Oxalate of ammonia no precipitate; in the concentrated water a slight cloudiness. Nitrate of barytes, a precipitate; the addition of a few drops of nitric acid removed nearly the whole with effervescence. Nitrate of silver, a precipitate with an immediate slight discoloration. Ferrocyanate of potash, no precipitate, nor any change of colour. Acetate of lead, a copious precipitate with a brown tinge, before boiling,—a colourless precipitate after ebullition.

Nitro-muriate of platinum does not occasion any precipitate in the concentrated water after boiling. The concentrated water possesses a strong alkaline taste, and deeply reddens turmeric paper: not the slightest cloudiness was perceptible after boiling the water twenty minutes with the addition of carbonate of soda. Phosphate of soda gave no indication of magnesia.

The action of tests shows that sulphuretted hydrogen exists in a gaseous state, that the carbonate, muriate, and sulphate of an alkali are present, and that the alkali is soda; that the water does not contain any metallic salt, any muriate of lime, or any salt of magnesia.

Gaseous contents.

Having ascertained the gases contained in the water to be sulphuretted hydrogen, carburetted hydrogen, oxygen and azote;—a wine gallon of the water was boiled in a proper apparatus, and gave out 12 cubic inches of gas.—The experiment was repeated several times with the same result.

1. To ascertain the amount of sulphuretted hydrogen, exposed a cubic inch of the gas, contained in a graduated glass tube, to contact, by very gentle agitation, with carbonate of lead; (obtained by precipitating [the carbonate of lead] from a solution of acetate of lead by carbonate of ammonia as directed by Dr. Henry, in his excellent paper "On the analysis of coal gas") 0·22 of a cubic inch was absorbed. Having thus separated the sulphuretted hydrogen, agitated the residue in a solution of caustic potash, a further diminution of 0·18 of a cubic inch of carbonic acid gas took place.

2. 0·33 of a cubic inch of the gas, (after the separation of the sulphuretted hydrogen and carbonic acid gases,) was mixed with 0·60 of a cubic inch of nitrous gas: an absorption of 0·10 took place, indicating 0·025 of oxygen gas; and in 1 cubic inch of the gas from the water, 0·045 of oxygen gas.

3. On firing 0·5 of a cubic inch of the unabsorbable gases with 0·575 of oxygen, the carbonic acid produced was 0·20, and the oxygen that had disappeared 0·397; approximating so closely to the quantity of carbonic acid gas produced, and of oxygen gas consumed during the detonation of the carburetted hydrogen gas from stagnant pools, that the composition of the gases may be considered the same; and since that gas produces its own bulk of carbonic acid, the carburetted hydrogen contained in 0·50 of the gas will be 0·20, and in 1 cubic inch of the gas from the water, will be 0·24.

4. After the separation of the excess of oxygen by nitrous gas the residual azote was 0·2625. The gases contained in the water are:

	In one cubic inch of the gas. Cubic Inches.	In a gallon of the water. Cubic Inches.
Carburetted hydrogen	0·24	2·88
Sulphuretted do. . . .	0·22	2·64
Carbonic acid	0·18	2·16
Oxygen	0·045	0·54
Azote	0·315	3·78
	<hr/> 1·000	<hr/> 12·00

Saline contents.

1. Evaporated one wine-gallon of the water gradually to dryness; it did not become in the least turbid: the concentrated liquid tasted strongly alkaline, the solid residue weighed 38·5 grains.

2. Dissolved the 38·5 grains in 8 ounces of distilled water, and boiled a few minutes; a small portion of flocculent matter floated in the solution; separated by subsidence and dried, it weighed 0·3 grains.

3. Into the clear solutions dropped nitrate of barytes as long as any precipitate fell down; collected by subsidence and dried after repeated washings, it weighed 60 grains: this precipitate contained the carbonic and sulphuric acids existing in the water.

4. Upon the precipitate (No. 3.) poured dilute nitric acid: nearly the whole was dissolved with effervescence; the insoluble part when dried weighed 9 grains, and was sulphate of barytes.

5. Into

5. Into the solution after the separation of the precipitate (No. 3.) dropped a solution of nitrate of silver: a precipitate of chloride of silver fell down, weighing after fusion 7·9 grs.

6. Upon the 3 grains insoluble in water (No. 2.) poured dilute nitric acid: the whole was dissolved with effervescence, and was again entirely precipitated by oxalate of ammonia.

The contents of the water are:

Carbonic acid in 51 grains of carbonate of barytes and 0·3 gr. of carbonate of lime . . .	} 11·40
Sulphuric acid in 9 grs. of sulphate of barytes .	
Muriatic acid indicated by 7·9 grs. of chloride of silver	} 1·97
Soda	
Lime	20·48
	·17

Existing in the water as

Carbonate of soda	27·40
Sulphate of soda	5·00
Muriate of soda	4·25
Sulphate of lime	0·41
Loss	1·44

38·50

The loss appears to be partly occasioned by the different hygrometric states of the substances; the salts resulting from evaporation being highly deliquescent, and requiring great care during their evaporation, to prevent the decomposition of the carbonate of soda: while the precipitates of carbonate and sulphate of barytes and chloride of silver, retaining moisture with much less tenacity, were dried at a higher temperature.

It is probable that the soda exists in the water as a bicarbonate, the excess of carbonic acid being given out in the state of gas, during the evaporation required to perform the analysis. The water examined presents two striking peculiarities, the large quantity of carburetted hydrogen, (this gas although supposed to occur in mineral waters, was only very lately proved to exist, by the experiments of Mr. West, on the water of the Crown Spa at Harrogate,) and in the saline contents the large amount of carbonate of soda. I shall not offer any conjectures on its source; but only remark, that I have detected its existence in many waters of the Yorkshire Coal-district.

St. Peter's Hill, Leeds,
Jan. 1, 1827.