PRELIMINARY OBSERVATIONS.

In an extensive acceptation of the word, all waters, except rain water, might be named mineral; for, of necessity, they derive from the strata through which they pass, a certain degree of impregnation. But, in a medical sense, the term is limited to those waters, which, from their degree of impregnation, gaseous contents, or particular temperature, are found to produce some remarkable effect on the human constitution.

The first step in the examination of a mineral water, after having determined its specific gravity, is the application of certain tests or re-agents, with a view to form a general opinion of its composition.

For the information of the general reader, I shall prefix an explanation of such preliminary steps, and of the indications which belong to the respective re-agents that have been employed with the waters treated of in this volume.

The specific gravity of a water will alone enable us to form a good conjecture as to the total quantity of solid matter which it may contain.

Kirwan, in his Treatise on Mineral Waters, gives the following formula for estimating the quantity of solid matter from the specific gravity, which, he states, will generally indicate the proportion within one or two per cent.

"Deduct, from the specific gravity of the water, the number 1000, and multiply the difference by 1·4; the product will represent the quantity of solid contents. It gives the weight of the salts in their most desiccated state, and consequently freed from their water of crystallization. The weight of fixed air must be also included.

Example.—Let the specific gravity of the mineral water be 1·079, and that of distilled water 1·000. Then 1079—1000 × 1·4 = 110·6, or, 100 parts of water of that sp. gr. should, according to Kirwan's rule, contain 110·6 parts of saline matter. He adds " that Brisson found a solution of two ounces of salt in 16 of water to have its specific gravity 1·079: here 18 ounces of the solution held 2 of salt. Now as 18:2 :: 1000: 111·1.

Litmus paper is employed to discover the presence of free acid in water, by which its blue colour is changed to red. This acid is usually the carbonic; but a similar effect takes place from sulphuretted hydrogen. The redness thus produced disappears after exposure to the air for some time, or, is prevented by boiling the water for a few minutes; and in this way the action of these gases may be distinguished from that of the other acids, which permanently redden litmus.

Turmeric and violet papers are delicate tests for detecting uncombined or carbonated alkalies. By these bodies the yellow colour of the former is changed to a reddish brown, and the blue of the latter to a green. A carbonated earth, as, for example, carbonate of lime, has no effect on turmeric, but gives a green hue to the violet, even when its proportion is very minute; such is the great delicacy of this test.

There are other delicate tests for uncombined alkali, of which I may have occasion to make mention.

Tincture of galls, when added to a water containing iron, produces a violet colour, or dark purple, which, by standing, becomes more or less black, according to the quantity of metal contained in solution. If the change of colour be produced previously to the water being boiled, but not afterwards, it is a proof that the iron has been held in solution by a volatile acid, as the carbonic. If, both before and after boiling, the same change be produced, then we infer that the iron is combined with a more fixed, or mineral acid, as it is usually denominated.

Prussiate of potash is also a delicate test for discovering iron when dissolved in a mineral water. The appearance which it presents with this metal, as the impregnation is weak or strong, varies from a pale greenish blue, to a dark Prussian blue colour.

Lime water is rendered turbid by waters which hold carbonic acid in solution. It does also occasion a precipitate with sulphates, and more especially when either sulphate or muriate of magnesia is present. If the precipitate which is produced by this test be soluble with effervescence in muriatic or nitric acid, it may be considered as carbonate of lime, and, consequently, that it has been occasioned by the carbonic acid of the water; but if its solution take place without effervescence, it has been produced by some of the other salts just mentioned

The same may be said if the water give a precipitate with lime water in its natural state, and fail to do this after boiling. In such cases, the precipitation is to be ascribed to the presence of carbonic acid alone; but should the water be sensibly affected by this agent both before and after being boiled, it may be considered that both carbonic acid and some of the salts just stated, are contained in the water. At least, the latter may with much certainty be expected.

*Nitrate of lead** is decomposed by sulphates

* It is to be understood that all the re-agents are to be employed in a liquid state.

and muriates: by the former salts, even though their proportion be small; but not by the latter, unless they are present in considerable quantity. This test also produces a black flaky precipitate, if sulphuretted hydrogen be contained in the water.

The acetate of lead is more usually employed with a water suspected to contain sulphuretted hydrogen. The colour of the precipitate produced by either of these re-agents, varies from pale chocolate brown to deep shades of black, according to the degree of the gaseous impregnation.

Solution of soap is decomposed, and produces a flaky precipitate in any water which contains a considerable proportion of any saline ingredient, and especially by an earthy muriate, or a sulphate.

I may here observe, that the kinds of water which are in domestic use, are commonly divided into *hard* and *soft*; and that this distinction has been deduced from the difficulty or facility with which the respective kind forms an admixture with soap. If difficult, the inference follows that much saline matter is contained. The acid of the salt attracting the alkali of the soap, leaves the oil detached, forming flakes or curds in the water.

Solution of barytes.—The effects of this test are, in some respects, similar to those of lime water, in discovering the presence of carbonic acid. It acts in the same manner, but is more delicate in discovering the presence of any earthy or alkaline sulphate, with which it forms a precipitate; and this precipitate (unlike that produced by lime water) is insoluble in nitric acid.

Subcarbonate of soda forms a precipitate with all the earthy muriates and sulphates, provided they exist in any considerable proportion.

Muriate of lime is decomposed by carbonated alkalies, if they be present in any notable quantity. The precipitate occasioned by a carbonated alkali, is soluble with effervescence in nitric or muriatic acid.

Carbonate of ammonia, and phosphate of soda.—These salts are chiefly employed in conjunction, for the purpose of discovering, in an unequivocal manner, the presence of magnesia. If a precipitate be produced by carbonate of ammonia when added in slight excess, the fluid is to be filtered; and, if then by the addition of phosphate of soda, it yield a further precipitate of a granular appearance, and adhering to the sides of the vessel, it may be considered that a magnesian salt exists in the water. The first precipitate is to be regarded as carbonate of lime; but if none take place from the carbonate of ammonia, the water is to be treated with the addition of phosphate of soda as just stated.

Nitrate of silver is a valuable and most delicate test for detecting the presence of muriatic acid, and all its compounds. A precipitate formed by any of these substances with nitrate of silver, is soluble in pure liquid ammonia.

Liquid ammonia does not decompose salts of lime; but with magnesian salts, a light white flocculent precipitate is produced.

Oxalate of ammonia is affected chiefly by salts of lime; but not (or at least not immediately) by those of magnesia. It is a most delicate test for discovering very minute quantities of lime in every state of combination. It produces a dense white precipitate.

Muriate and nitrate of barytes are excellent re-agents for the discovery of sulphuric acid, and all its compounds. They form, with the sulphuric acid of the salt, a dense precipitate of sulphate of barytes, which is insoluble in nitric acid. Of these tests, the muriate is the most delicate.

I proceed now to my general report of the waters, and commence with those of Buxton.

BUXTON.

Buxton, during many centuries famed for its medicinal springs, distant from London 159 miles, is a considerable village in the north-west part of the county of Derby, bordering upon Cheshire, from which it is separated by a chain of high mountains, intersected by deep ravines. The whole of this angle of Derbyshire constitutes what is called the Peak hundred, a wild mountainous district, thinly inhabited, and presenting a rude character of country. The following may be offered as a brief geological description.

It is in a valley surrounded by hills. Those in the immediate neighbourhood are calcareous, and belong to that class called, in this country, mountain limestone. It is a very ancient formation of rock, enclosing numerous fossil remains of enchrinites, madrepores, &c.; and is also well known here by the name of Derbyshire limestone. It is older than the coal formation which is placed upon it. Some of the hills in the neighbourhood, as Mam Tor, are composed of a sandstone called the mill-stone grit, which is by some considered as one of the beds of the coal series. The mountain limestone is remarkable for containing many very large caverns, the origin of which is uncertain, but which appear to have been occasioned, or at least widened, by subterraneous waters. In the immediate neighbourhood of Buxton, Pool's Hole is the chief; but, a few miles distant, the Peak Cavern, and the Speedwell Mine, are of greater magnitude, and are particularly entitled to admiration. Dr. Short, in his History of Mineral Waters, remarks, that Buxton has long been celebrated for its warm springs, and that they appear to have enjoyed considerable reputation in the cure of various diseases, for a longer period without interruption, than almost any mineral water in the kingdom. As early as the year 1572, a Treatise was written on the virtues of this spring, by a Dr. Jones, of Derby; and it appears at that time to have been a place of great resort from all the neighbouring counties. Several remains of Roman antiquity have also been discovered at, or near, this spot; which makes it probable that this fountain was not unknown to that people.

The water, of which I am about to give the chemical and medical description, rises very freely by numerous fissures through the limestone, as may be distinctly seen in the large public bath when it has been nearly emptied. The well of St. Anne, appropriated for drinking, was many years ago removed, for the sake of convenience, several yards from its former situation. The water is conducted from the spring head through an artificial sandstone channel*: it falls into a large marble basin (called the well), which is enclosed in a handsome stone building, conveniently constructed for the protection of the invalid; open to the air in front, and secured from intrusion, after the regular hours of resort, by an iron gate.

In its passage from the spring it loses five degrees of temperature; being, at the head of the large bath, 82°, but in the basin, 77°†. It also loses a considerable portion of free azotic gas.

CHEMICAL HISTORY.

The water is perfectly transparent, and free from air bubbles. It is destitute of odour, and has no other taste than that of common spring water heated to the same temperature. It does not affect either litmus or turmeric paper. The temperature in the well is 77° Fahr. As the

* Dr. Pearson mentions that the diameter of this artificial semi-cylindrical channel is about four inches. The rate of supply of the water is a gallon in a minute.

† The same author remarks, p. 155, vol. i. that the temperature of St. Anne's well is 81° to 81°¼. I estimated the temperature of the water as it flowed immediately from the pipe, and found it exactly 77°.