III. *Account of a Mineral from Orkney.* By THOMAS STEWART TRAILL, M. D. F. R. S. EDIN.

(*Read April 21. 1817.*)

WHILE examining an abandoned lead-mine in the vicinity of Stromness, in the year 1803, I found a mineral which, from its weight and appearance, I supposed to be carbonate of barytes. A few hasty experiments soon convinced me that it was a different substance; but circumstances occurring which prevented a more accurate investigation, the mineral lay neglected among the duplicates of my collection till last autumn, when having mentioned my doubts and conjectures respecting it to my friend Dr MURRAY of Edinburgh, I was strongly urged by that gentleman to undertake its analysis. During his short visit to Liverpool, a few preliminary experiments were begun, from which it appeared, that the mineral contained carbonate of strontia, and I have since completed its chemical examination.

I may here observe, that a specimen having previously been submitted to several very able mineralogists, they were unable, from its external characters, to ascertain its nature; a circumstance which affords a fresh proof of the necessity of uniting chemical investigations to a knowledge of the external appearance of mineral bodies.

External Characters of the Mineral.

Its colour in the fresh fracture is greyish-white, passing into pale yellowish-white, where it approaches the surface of the specimen, which is weathered.

It occurs in masses, of various sizes, dispersed, along with lead-glance, in a species of coarse slate, which may perhaps be considered as shale passing into clay-slate*. This rock appears to rest on mica-slate, which is in connection with gneiss and small-grained granite, rocks which occur in no other part of the Orkney Islands constituting mountain masses. The mineral perhaps may occur crystallised, for it has a distinct crystalline texture; but the specimens I found were so much acted on by the weather, that no trace of crystalline figure is discernible.

The lustre is shining and pearly in the principal fracture; glistening and resinous in the cross-fracture. The weathered surface is earthy and dull.

The principal fracture is radiated, somewhat diverging; the cross fracture is uneven, approaching to splintery. The mineral is translucent where fresh, but opaque externally.

It is soft; so as easily to be scratched by a knife; it scratches calc-spar, but not fluor-spar.

It is rather brittle, and easily frangible.

It is heavy. Its specific gravity is 3.7, or more accurately 3703, to water as 1000.

Chemical

* I here state my own impression at the time when the mineral was found: but Professor JAMESON, to whose authority I pay the greatest deference, has observed, in a work long ago printed, that the rocks in that neighbourhood consist of a mineral "*intermediate between shistose and indurated clay.*"—*Mineralogy of the Scottish Isles*, vol. ii. p. 233.

Chemical Characters.

It is insoluble, or nearly so, in water.

It effervesces briskly with acids, and is partly dissolved.

It is infusible before the common blowpipe, and resists the ordinary temperature of a smith's forge, when subjected to it in a crucible; but loses in weight, becomes white, and more hard than before. This process rendered it partly soluble in water, to which it imparted an acrid taste, alkaline qualities, and the odour of sulphuretted hydrogen.

A fragment of the mineral, thrown into strong sulphuric acid, effervesced, and formed a white powder of little solubility.

With concentrated nitric and muriatic acids there was, at first, a brisk effervescence, which soon ceased; but was repeatedly renewed, on successive additions of small quantities of water. In both cases a portion was dissolved; the solution was transparent and colourless, and crystallizable on evaporation.

On adding prussiate of potassa and iron to the muriatic solution, no change was at first perceptible; but after some time, a faint bluish tinge might be distinguished. By digesting muriatic acid on the insoluble residue, a deep blue colour was obtained on the addition of the same re-agent.

Chemical Examination of the Mineral.

The preliminary experiments by which its chemical characters were ascertained, shewed that it was resolvable by the action of muriatic acid into gaseous, liquid, and solid substances, each of which became the subject of investigation.

A.

The gas disengaged was found by experiment to be carbonic acid.

B.

1. The muriatic solution, when separated by the filter from the undissolved residue, was evaporated to dryness, and crystallised from a fresh solution in water*. The crystals were slender prisms, with two of the lateral planes broader than the rest; were persistent in the air, and had all the chemical characters of muriate of strontia. Their solution was not precipitable by ammonia, but potassa separates a portion of the earth with the peculiar phenomena detailed in Dr HOPE's valuable paper in volume iv. *Phil. Trans. Edin.*

2. The nitric solutions gave small brilliant crystalline flakes; and these were also formed on the addition of nitric acid to the muriatic solution, but were speedily dissolved on the addition of water.

3. In order to satisfy myself still farther that the muriatic salt had a base of strontia, a very dilute solution of sulphate of soda was dropt into a concentrated muriatic solution of the mineral; but no precipitate was formed: when the sulphate was less diluted, a precipitate fell, though less copious than when added to a similar solution of muriate of barytes, but more abundant than with muriate of lime.

4. After separating, by successive crystallizations, the crystals from the muriatic solution, a small quantity of an acrid
and

* The first addition of water caused a considerable evolution of caloric.

and very deliquescent salt remained in the bottom of the capsule. It was decomposed by oxalate of potassa, when a highly insoluble substance, not soluble in excess of oxalic acid, was obtained. Calcination, and the action of sulphuric acid, proved that the oxalate of lime had been formed.

5. The greyish-white powder, which remained after the calcination of the oxalate, was wholly soluble in water, and formed a bulky precipitate with sulphuric acid. The washings of this precipitate were not rendered turbid by phosphate of ammonia, nor was any change produced by the muriate of ammonia. These experiments shew that the muriatic solution of the mineral contained no magnesia, nor argil, nor any appreciable quantity of iron.

The peculiarity attending the action of concentrated nitric and muratic acids on the mineral is worthy of notice, as affording an additional diagnostic mark between carbonate of strontia and carbonate of barytes. It will be recollected that those acids acted *at first* upon the mineral from Orkney, but that the effervescence soon ceased, unless water were added. In order to compare the two carbonates more accurately, the following experiments were instituted.

a. A fragment of native carbonate of strontia from Strontian was thrown into muriatic acid ; a strong effervescence ensued, but soon ceased : it was however immediately renewed on the addition of water ; just as had happened with the mineral from Stromness.

b. Into a portion of the same acid was dropt a fragment of carbonate of barytes from Anglezark, which had been entirely freed from loose particles ; no effervescence took place, until water was added ; but when a portion of the same specimen, reduced to powder, was thrown into a fresh portion of the acid, effervescence instantly commenced.

c. A

c. A solid fragment of Carrara marble was attacked and dissolved by a portion of the same acid, without the addition of water.

Hence we may consider carbonate of strontia intermediate, in its habitudes with this acid, between carbonate of barytes and carbonate of lime ; and these peculiarities afford an easy method of distinguishing these three native carbonates from each other.

From the preceding experiments we may conclude, that the portion of the mineral from Orkney, which is soluble in muriatic acid, consists of carbonate of strontia, a little carbonate of lime, and a minute trace of iron.

C.

The undissolved residue of the former experiments had a yellowish-white colour, and was totally insoluble in water. The calcination of a portion of the mineral had shewn that sulphur entered into its composition, as sulphuretted hydrogen was given out on the addition of water. The probable origin of this had been the decomposition of a sulphate. No trace of a sulphate had appeared in the acid solutions, and therefore we may conclude that the sulphate exists in the insoluble residue.

1. A portion of this residue was boiled with a concentrated solution of carbonate of potassa in a silver vessel. It was then washed to free it from alkali ; and on finding that it had become partly soluble in muriatic acid with effervescence, the process was severaltimes repeated, and thus the greatest part of the residue was rendered soluble in muriatic acid. What remained in the last process, was soluble in boiling sulphuric acid, from which it separated on cooling in acicular crystals.

2. The

2. The water employed to wash the powder C. 1. was evaporated, and crystals of sulphate of potassa were formed.

3. The muriatic solution (C. 1.) obtained by decomposing the sulphate by carbonate of potassa, when evaporated, yielded tabular crystals, persistent in the air, which, placed in the wick of a candle, tinged its flame of a yellow or greenish-yellow hue; and when dissolved in water afforded an instant precipitate with sulphuric acid, and with the most diluted solutions of sulphate of soda.

4. Another portion of the insoluble residue was boiled with eight parts of concentrated sulphuric acid in a platina cup, and was wholly dissolved; but on cooling, it separated in acicular crystals around the edge of the containing vessel. These crystals were acidulous, even when dipt into water, which resolved them immediately into an insipid powder which was a neutral sulphate. When exposed to the air this powder was more slowly formed.

5. A third portion of the insoluble residue was digested with muriatic acid, under the idea that its colour indicated the presence of iron. The acid became of a yellowish colour, and afforded a rich blue precipitate with prussian alkali.

These experiments prove, that the residue consists chiefly of Sulphate of Barytes. In C. 1. the process of KLAPROTH was employed; and at each successive step, fresh portions of the sulphate were decomposed, by the united affinities of sulphuric acid for potassa, and of carbonic acid for barytes. In C. 4. MORETTI's process was followed*, and, to verify his results, comparative experiments were tried.

a. Artificial sulphate of strontia was boiled in a platina crucible with 8 parts of concentrated sulphuric acid; a perfect solution

* See THOMSON's *Annals*, vol. iv. 395.

lution took place; the liquor was poured into a glass capsule, and put aside in a cool place; no crystals appeared in 12 hours; but after several hours a thin ring of amorphous sulphate was deposited around the margin of the liquid, probably owing to the absorption of water from the air. The insoluble neutral sulphate was however immediately precipitated from the solution by the addition of water.

b. Artificial sulphate of barytes was treated in the same manner; a perfect solution was obtained; and the liquid soon began to form crystals around the edge of the capsule. When the air of the room is dry, the crystals though small are pretty distinct prisms, promiscuously aggregated. They are super-sulphates, agreeing in their properties with what is stated above (a).

c. Fragments of a transparent crystal of sulphate of strontia from Bristol, reduced to powder, presented exactly similar results with the artificial sulphate (a); and a portion of a colourless crystal of sulphate of barytes from Dufton near Appleby, was acted on precisely as the artificial sulphate (b).

In the mineral from Orkney, the whole of the residue insoluble in nitric and muriatic acids, was dissolved by boiling sulphuric acid; which shews that there is no silica present.

The blue precipitate, by prussian alkali, from the muriatic acid digested on the residue, shews that oxyde of iron is united to the sulphate.

The mineral, then, consists of *carbonate of strontia*, *carbonate of lime*, *sulphate of barytes*, and a *little oxyde of iron*. We have yet to ascertain the proportions in which these ingredients enter into its composition.

D.

To ascertain the quantity of carbonic acid is important, as it will enable us to verify the other results.

100 grains carefully selected from the purest and most solid parts of the specimen were broken into small fragments, and dropt in succession into a flask, containing a cubic inch of muriatic acid diluted with two parts of water, which had been previously poised in a delicate balance. Each fragment was suffered to part with its carbonic acid before another was added, lest the violence of the effervescence should dissipate any portion of the liquid in the flask. After all effervescence had ceased for some hours, the flask was again accurately weighed; when it was found to have lost 21.1 grains. As this part of the process requires peculiar attention, the experiment was repeated; and the average of three trials gave 21 grains as the quantity of Carbonic Acid in the mineral.

This result cannot be far from the truth, as it was the same when nitric acid was employed.

E.

To ascertain the quantity of strontia and lime, several experiments were undertaken.

1. The muriatic solution D. was evaporated to dryness, in order to expel the excess of acid. The saline mass was dissolved in water, and slowly evaporated; the crystals of muriate of strontia were successively separated; but the results of several repetitions of the process not coinciding, a different method was employed to separate the muriates of strontia and lime.

2. The nitric solution of the mineral was evaporated to dryness, dissolved again in water, and slowly crystallized. The crystals were digested with strong alcohol, by which nitrate of lime is dissolved, but not nitrate of strontia. The crystals were washed by the affusion of alcohol; and thus the two salts were completely separated.

3. The quantity of strontia in the mineral could be ascertained by weighing the nitrate; but there appears to me less certainty in weighing crystals which contain water, and which are very soluble, than in reducing the earthy or other base to the state of an insoluble compound, that may be moderately heated without loss of weight, and the constituents of which are well known. Sulphuric acid was therefore added, in excess, to precipitate all the strontia, and the liquid being evaporated to dryness in the capsule in which the precipitation was effected, and heated in a platina crucible to expel excess of acid, and water, afforded 84.6 grains of sulphate of strontia, which, by Dr WOLLASTON's excellent scale, is equivalent to 68.6 grains of Carbonate of Strontites.

4. The alcoholic solution (E. 2.) was evaporated, and afforded a tenacious paste, which, when dissolved in water, precipitated by carbonate of soda, washed and dried, weighed 2.6 grains; this, then, gives us the quantity of the Carbonate of Lime which enters into the composition of the mineral.

When we compare these results, with the quantity of carbonic acid in the mineral, we find an agreement as exact as the nature of such researches will permit: for

68.6 carbonate of strontites contains	19.60 carbonic acid ;
2.6 carbonate of lime contains	1.14 carbonic acid
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	20.74

or the difference amounts only to 0.26 *per cent.*

F.

The examination of the insoluble residue was attempted, by boiling it with carbonate of potassa, in a silver vessel; but as only a portion was thus decomposed at each boiling, I thought it best to attempt it in the dry way.

Having

Having found in some previous experiments that some iron adhered to the insoluble residue,

1. It was digested with muriatic acid, which became of a yellowish hue, and along with the iron took up a portion of the earthy matter; but this was precipitated on the addition of water. Its solution was concentrated, and precipitated by succinate of potassa. The precipitate, washed, dried, and heated to redness in a platina crucible, afforded 0.1 grain, or nearly so, of red Oxyde of Iron.

2. The residue of the mineral was now mixt with three times its weight of lamp-black, made into a paste with oil, and subjected in a black-lead crucible for two hours, to the heat of a smith's forge. The contents of the crucible were then thrown into muriatic acid, which produced a brisk effervescence: the muriatic solution was precipitated by sulphuric acid; it was then evaporated and heated, to expel the excess of acid, and what water might adhere to it, and when weighed = 27.5 grains.

The residue then consists of	27.5 sulphate of barytes,
And	0.1 oxyde of iron.
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	27.6

In 100 grains, therefore, of the mineral from Orkney, we have

68.6 carbonate of strontites.
27.5 sulphate of barytes.
2.6 carbonate of lime.
0.1 oxyde of iron.
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98.8
1.2 loss (probably water).
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100.0

A question may here arise, whether these ingredients are chemically combined, or only in a state of mechanical admixture in the mineral? The homogeneous appearance, and crystalline texture of this substance, and the nearly uniform proportions of the ingredients obtained from it, by different experiments, would lead to the conclusion that the mineral in question is a chemical compound. These, however, may be the result of an intimate mechanical mixture of the earthy salts of which it is composed.

The iron appears to be united by affinity to the sulphate of barytes, as it is not separated in any considerable degree during the solution of the carbonates in diluted muriatic and nitric acids; but requires for its separation from the sulphate of barytes, digestion in one of those acids, after the separation of the more soluble ingredients.

The existence of carbonate of lime in this mineral is interesting. In this particular it accords with what has been observed by SCHMEISSER, THOMSON, and STROMEYER, in native carbonate of Strontia. It is remarkable, that the portion of carbonate of lime in the Orkney mineral, is not very different from the quantity of carbonate of strontia in Arragonite; a circumstance which renders it probable, that the carbonate of lime is in a state of chemical union with the carbonate of strontia.

Should this substance be regarded as a variety of Strontianite, or as a distinct mineral species? If the latter conjecture be entertained, it will be necessary to give it a name; which may be derived, either from its composition, as BARY-STRONTIANITE, or from its locality, as STROMNITE.