
I.

PAPERS OF THE PHYSICAL CLASS.

I. ACCOUNT of a MINERAL from STRONTIAN, and of a peculiar Species of EARTH which it contains. By THOMAS CHARLES HOPE, M. D. F. R. S. EDIN. Professor of Medicine in the University of Glasgow, and Physician to the Glasgow Royal Infirmary.

[Read Nov. 4. 1793.]

THE mineral, of which I have the honour to lay an account before the Society, was brought to Edinburgh in considerable quantity about six years ago by a dealer in fossils, though indeed it had found its way, long before this period, into one or two collections.

By some it was mistaken for fluor. Its great specific gravity, its fibrous appearance, and its quality of forming an insoluble substance with sulphuric acid, made it generally be received as the native carbonate of barytes. From a few experiments, I was led at that time to entertain some doubt of its being any form of barytes; and for several years, when I filled the chemical chair in the University of Glasgow, I used, when I exhibited the mineral itself, to mention in my lectures such of its properties as I had discovered, and which indicated that it did not belong to the barytic genus. Towards the end of the year

1791, I commenced and executed a series of experiments, the detail of which I laid before the College Literary Society of this place in March 1792. These not only satisfied me that I had been right in my conjecture, which was, that this mineral differs from aerated barytes, but also gave reason to imagine, that it contains a peculiar and hitherto unknown kind of earth. Other experiments, more lately performed, strongly confirm, and perhaps I may add, establish this notion.

Dr CRAWFORD, having remarked the conspicuous difference in the form of the crystals of the muriate of this fossil and of the muriate of barytes, and in their solubilities in water, has thrown out a conjecture to the same purpose, at the end of his paper on the Muriated Barytes, in the second volume of the London Medical Communications.

2. THE mineral of which I have been speaking, I am informed, is found in the lead mine of Strontian in Argyleshire. It lies imbedded in the metalliferous vein, scattered among the ore and the different species of spar that are most commonly met with in such situations. I have specimens in which portions of lead-ore are attached to this mineral, and others in which it, calcareous and ponderous spars, are intermingled in large and considerable masses.

More obvious Qualities.

3. THE appearance of this fossil varies in different samples. It universally possesses the sparry structure, and sometimes bears a strong resemblance to some sorts of calcareous or fluor spars. Its texture is commonly fibrous. The fibres sometimes are slender, and in close contact with each other, so as to give the mass a considerable degree of compactness. At other times the fibres are much more gross, and assume a kind of columnar appearance. The fibres or columns have, in the greater number of specimens, a degree of divergency, issuing as radii from

a centre. The uniformity of this radiation is frequently interrupted by the fibres proceeding from different points of convergence, crossing and intersecting each other. Occasionally on the surface, but more frequently in vacuities within the mass, the mineral is discovered shooting into slender prismatic or columnar crystals of various lengths. Some of these end obtusely, others of them in a sharp point; they are generally striated, and have six sides. I have seen these crystals traversing the cavities in the form of the finest and most delicate spiculæ, and when disposed in a radiated form, equalling in delicacy, and resembling in appearance, the most exquisite zeolites. In other portions, the striated fibrous contexture is scarcely discernible. Sometimes the Strontian spar is transparent and colourless, more commonly it has a tinge of yellow or green, and some diversity is observable in the depth of the tint.

4. IT is not so hard as to scintillate; it may be scratched by a knife; it readily yields to the stroke of the hammer; it has no particular fracture, though it commonly breaks along the direction of the fibres.

5. IT is a heavy species of spar, having a specific gravity, going between 3.650 and 3.726.

Chemical Qualities.

6. THIS mineral to the taste is insipid, and is only in a small degree soluble in water. I boiled ten grains of it, reduced to a very fine powder, in four ounces of distilled water for some time; about two grains and a half were dissolved.

7. IT is powerfully attacked by several of the acids, and a solution takes place in some of them. This is accompanied by a lively and brisk effervescence, which in this as in every other instance, proceeds from the disengagement of an aerial fluid.

8. THE gas that arises during a solution of this mineral in muriatic acid, extinguishes the flame of a candle, and is absorbed

forbed by water. The water thereby acquires the taste of water impregnated with fixed air or carbonic acid, and the property of precipitating lime-water and of redissolving the precipitate when added to excess; from which circumstances I infer, that the elastic fluid that is disengaged is carbonic acid gas.

9. To discover how much of this acid it contains, I dissolved in diluted muriatic acid 960 grains, using every precaution to prevent any thing but elastic fluid from escaping during the effervescence. The diminution of weight that took place amounted to 290 grains. This corresponds with the result of several other experiments made with the same intention. This spar consequently contains 30.2 *per cent.* of carbonic acid.

10. HAVING premised thus much with regard to the action of acids in general on the fossil, and concerning its composition, I shall delay mentioning its habitudes with each till I have detailed the effects of heat upon it.

11. WHEN heat is applied to the Strontian spar, it crackles a little, and as the temperature increases it loses its transparency, becomes white, opaque, and in some measure friable. It requires, however, a very strong fire to produce any further change.

12. I PUT two pieces, weighing together 320 grains, into a small crucible, and inverting another over it, I placed it in an open fire. In this situation it remained for three hours, the fire being good, and at different times animated by means of bellows. These pieces retained their form; they were white, opaque and brittle, and had lost only two grains of their weight. Their chemical properties were unaltered.

13. A VERY vehement heat occasions remarkable changes. A small mass was inclosed in a crucible, made of pure Stourbridge clay, already prepared for forming glass-house pots, having a lid fitted to it of the same materials. The crucible, gradually heated, was kept for forty-five minutes in the intense heat excited by the well managed fire of a smith's forge. At

the expiration of this time, the crucible itself became soft. and from being turned in the fire was distorted in its shape. On examination after cooling, part of the spar was found to have undergone fusion, and was converted into a glass of a bottle-green colour. The vitrified portion occupied the surface; the internal part was to appearance similar to the result of the last experiment, but it felt much lighter. It now had an acrimonious taste; it attracted water with great avidity, and imbibed it with a hissing noise; it was rendered soluble in this fluid. The loss of weight which the spar sustains when the action of the fire has produced its fullest effect, amounts to 38.79 *per cent.* When a little water is poured on the calcined mineral, it swells, bursts with a hissing noise, and becomes hot with more rapidity and in a greater degree than lime; like it, it falls into a dry powder, but the particles are not so fine.

THE powder unites with acids into the same sort of compounds as before, but no effervescence attends the combination. When the glass is dropped into muriatic acid, it is slowly acted upon; at length a jelly is formed, which becomes perfectly fluid on the addition of water, a minute portion of powdery matter, which probably comes from the crucible, remaining undissolved. If the calcined spar be left exposed to the atmospheric air, in the course of twenty-four hours, it swells, cracks and crumbles into powder, at the same time attracting carbonic acid, and becoming effervescent.

14. UNDER the blowpipe the spar becomes white and opaque, and loses a part of its carbonic acid. I have not been able to vitrify it *per se*. With borax, mineral alkali and microsmic salt, it melts readily into a white vitreous matter. An effervescence attends the fusion, particularly when borax is employed.

15. It appears from the experiments already recited, that the Strontian mineral loses a greater weight when subjected to heat than during solution in acids. This must be ascribed to the expulsion of moisture in the one case, and the retention of it in the
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the other. The difference marks the quantity of water which enters into the composition of the spar. By heat 38.79 *per cent.* is expelled, while there is a loss by solution of 30.20.

HENCE 100 parts contain of earthy basis,		61.21
carbonic acid,	-	30.20
water,	-	8.59
		<hr/>
		100

16. As I hope to be able to render it probable, that this earthy basis differs from any of the hitherto known species of earth, I shall, to save circumlocution hereafter, take the liberty of calling it by the name of *Strontites*; by which I wish to be understood to mean the earthy matter in a state of purity, in the same way as lime and barytes denote the pure earthy bases of calcareous spar and of aerated barytes.

17. Of the qualities of the *Strontites* it will be proper to add some more particulars.

STRONTITES has a pungent acrid taste. When brayed in a mortar, the subtle powder that arises is penetrating and offensive to the nostrils and lungs. It is soluble in water in the proportion nearly of 2.7 grains to the ounce, at temperature 60. The solution is clear and transparent, possessing a strong taste, not unlike that of lime water; it changes to a green, papers stained with the juice of violets or radishes. On exposure to the air, strontitic water quickly acquires a crust on the surface, in consequence of the earth attracting carbonic acid and becoming insoluble.

18. Hot water dissolves a much larger quantity than cold, and deposits the *Strontites* as it cools in the form of colourless and transparent crystals. The most ready way of obtaining these is to pour a quantity of boiling water into a Florence flask, and then to throw in the recently calcined spar in small pieces. After the ebullition that ensues has ceased, shake the flask well,

and place it so that it shall cool slowly and without disturbance. The crystals will be found attached to the inside of the vessel, shooting beautifully through the water to the length of an inch or more. The form of the crystal is abundantly distinct; it is a thin quadrangular plate, which is sometimes square, though more frequently a parallelogram; the largest of them seldom exceed a quarter of an inch in length, and that is usually somewhat more than their breadth. Sometimes the edges of the plates are plain, oftener they present two facets meeting like the roof of a house. They, for the most part, adhere to each other in such a manner as to form a thin plate an inch or more in length, and half an inch in breadth, the margin being irregular from projecting rectangles, the whole terminated by a regular crystal. Sometimes the plates are thicker, and form solid parallelepipeds, and occasionally are seen perfect cubes.

19. IN the course of exposure to the air for a few hours, these crystals cease to be transparent; they become white, powdery and effervescent. The gain of carbonic acid does not compensate the loss of humidity; for they suffer a diminution of weight which amounts to nearly 10 *per cent.* To preserve them, we must have recourse to phials very closely corked. When subjected to heat, they lose the superficial moisture with a hissing noise; as the heat approaches to near a dull red, they undergo fusion, which seems to be of the watery kind; for as soon as all the humidity is dissipated, there remains a white powder that resists an extreme degree of heat. Water enters largely into their composition; 100 grains of them lost by the expulsion of the moisture, 68 grains. Water dissolves them but slowly, particularly when they have not been bruised, in the proportion of 8.5 grains to the ounce at temperature 60. An ounce of water, in a heat sufficient to keep the solution boiling, dissolved no less than 218 grains. This is an astonishing degree of solubility in an earthy matter, and affords a distinguishing feature of Strontites. These solutions are possessed of all the

properties of Strontitic water above recounted. In acids the crystals are dissolved without effervescence, and there result the same products as when the native mineral is employed.

20. WHEN I first observed the Strontites in a state of crystallization, I imagined it was the only earth that could, in consequence of its greater solubility in warm than in cold water, be obtained in this form, and I noted this property as characteristic of it. I have however been so fortunate as likewise to procure crystals of barytes.

HABITUDES OF STRONTIAN MINERAL WITH ACIDS.

With Sulphuric Acid.

21. WHEN a solid piece of spar is dropped into sulphuric acid, a few air bubbles arise, but these soon cease, and the mass remains undissolved. If, however, the spar be first reduced into fine powder, and then added to the acid in small portions, an effervescence takes place, a combination is formed, and the compound falls to the bottom. The acid, in very minute quantity, renders Strontitic water turbid, which arises from the formation of the fulphate.

22. THE fulphate of Strontites is in the form of a white powder. It has no taste, and very little solubility in water. I boiled one grain for some minutes in four ounces of distilled water, half a grain was dissolved. The solution became turbid on the addition of the carbonate of potash, of barytic water, and of muriate of barytes. Sulphuric acid, when aided by heat, readily dissolves it. An effusion of water causes the acid to part with the earthy salt.

With

With Nitrous Acid.

23. WHEN the nitrous acid in its strongest state is poured on a mass of native carbonate of Strontites, no action ensues ; but if some water be added, the acid commences to act with energy, and a solution, attended with a brisk effervescence, is the consequence. Very little will be dissolved, though the spar be finely powdered, if the acid be highly concentrated. A small increase of temperature, it may be remarked, enables the strong acid to attack the solid spar, and to accomplish the solution. If you employ an acid previously diluted, the ebullition instantly begins ; for this purpose, an equal quantity of water at least must be mixed with the acid. If much less be added, the effervescence and solution will commence, but they will both soon cease. When the quantity of water is sufficient, the acid free from adulteration, and the spar pure, no residuum is left, and a clear and transparent solution is obtained ; but if somewhat less of the water be employed, the salt that is formed by the union of the acid and earth immediately assumes a solid crystalline form. It was by a solution carried on in this manner that I procured the most regular, though by no means the largest crystals of this nitrate.

24. THE solution has a strong pungent taste. It is perfectly neutral, and readily by evaporation yields crystals. These are rarely produced in so regular a manner that their form can be easily ascertained. By a slow and spontaneous evaporation, crystals were formed that were hexagonal truncated pyramids. The most perfect crystals, obtained in the way a little ago described, were octohedral, consisting of two four sided pyramids united by their bases. Sometimes the apex is truncated, and the crystals terminate like a wedge ; often likewise the angles are truncated in different degrees, which gives a considerable variety to the shape of the crystals.

25. THIS salt is very soluble in water. One ounce of distilled water at temperature 60 dissolved an equal weight. With the aid of a boiling heat, the same quantity dissolved one ounce, seven drachms and fourteen grains. The solution, saturated in a boiling heat, parts not with the salt immediately on cooling, but deposits it slowly in the form of a confused mass of crystals. The nitrate of Strontites in a dry air loses its water of crystallization and effloresces; in a moist, it attracts humidity, and runs *per deliquium*.

26. THIS, as all other nitrates, deflagrates on hot coals. Subjected to heat in a crucible, it decrepitates gently, and then melts. When the heat rises to redness, it begins to boil, and the acid is dissipated. If a combustible substance be at this time brought into contact with it, a deflagration, with a very beautiful vivid red flame, is produced. By the operation of the heat, the salt suffers a complete decomposition, the acid is expelled, and the earth remains in a state of purity, unless inflammable matter has gotten access to it, in which case it will prove a carbonate.

With Muriatic Acid.

27. VERY similar phenomena to those already described, as attending the action of nitrous acid on the Strontian spar, are exhibited on pouring muriatic acid on this substance. When the acid is concentrated, and the spar is in solid pieces, no action whatever, or very little, takes place. The effervescence is brisk, and the solution rapid, when the acid is diluted with about an equal weight of water. A gentle heat, applied to the strong acid, has the same effect as dilution.

28. THE solution in the weak acid is transparent and free from colour, and affords crystals most readily. On dissipating part of the fluid by heat, and permitting the rest to cool, the muriatic salt crystallizes in a beautiful manner. The crystals
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are delicate slender prisms, sometimes two inches long, having a soft silky appearance. If the refrigeration has been very gradual, the prisms will be formed less delicate, and of a more distinguishable shape. All of them are hexagonal, some having all their sides equal, others having two broad sides, with two intervening narrow ones, while another sort is seen with three broad alternating with three narrow sides. At one time they end abruptly, at another an obtuse trihedral pyramid terminates them, and now and then they are seen pointed like a needle.

29. By the facility of crystallization, and by the peculiar form of the crystals, this earthy salt may be easily detected wherever it exists in solution. For this purpose, put a few drops on a plate of glass, and the muriate will soon discover itself by shooting into its long slender needles, which are often disposed in a radiated form.

30. THESE crystals, after they are thoroughly dried, suffer little change from exposure to air, yet when the atmosphere is greatly loaded with moisture, they are apt to deliquesce. Their solubility in water is great. At temperature 60, one ounce of distilled water is capable of dissolving one ounce, four drachms and one scruple. To the same quantity of distilled water, kept boiling on a sand bath, I added in successive portions four ounces of the salt, which became fluid, and I imagine I might have added any quantity more with the same event, as the temperature of the solution, when boiling, seems sufficient to enable the water of crystallization itself to dissolve the saline matter.

31. If into a saturated solution, some strong muriatic acid be thrown, a precipitation instantly happens. The matter that falls down is the salt in small needle form crystals, and the separation of them from the water arises from the force with which the acid attracts the fluid, being greater than that exerted by the salt to retain its solvent.

32. THE

32. THE taste of the salt is peculiar, sharp and penetrating. When urged quickly by heat, the muriate of Strontites undergoes the aqueous fusion, and by losing the water of crystallization, and with it 42 *per cent.* of its weight, becomes a white powder, which, as soon as the crucible is heated to redness, melts. A quantity of this salt was kept in the red heat of a strong open fire, occasionally enlivened by bellows, for above an hour. It had been in perfect fusion, yet its acid was not expelled. It could not, however, when contained in a small spoon of platina placed upon charcoal, endure, without decomposition, the stronger heat excited by the blowpipe.

With Acetous Acid.

33. ORDINARY distilled vinegar dissolves the Strontian fossil, after being reduced to a very fine powder, but with no great energy. An effervescence, as usual, accompanies the dissolution. The liquid acetite is transparent, and without colour. It changes, though slowly, the colour of violet test papers to a green. By spontaneous evaporation, it dries up into a friable salt, composed of minute crystals.

THESE are persistent, though exposed to the atmosphere. They render green the vegetable colours. They seem to be nearly equally soluble in hot and cold water; for a quantity of water, kept in a state of ebullition, which dissolved them at the rate of 196 grains *per ounce*, deposited no crystals on cooling.

With Oxalic Acid.

34. THE Strontian mineral must be in fine powder, else it will remain untouched by this acid. When finely pulverized spar is thrown into oxalic acid, an oxalate of little solubility is generated, which falls to the bottom of the vessel, under the
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form of a white powder. This acid, poured into Strontitic water, unites with the earth, and precipitates with it.

35. THIS is one of the most insipid, and one of the most insoluble of the combinations into which Strontites enters. Ten grains were boiled in four ounces of distilled water for some minutes, there remained undissolved fully nine grains. The clear liquor had the flightest possible degree of milkiness produced in it, on the addition of sulphuric acid, or of carbonate of potash. By heat the oxalic acid is destroyed, and the earth remains partly pure and partly united to carbonic acid.

With Tartarous Acid.

36. WITH this acid the mineral exhibits appearances nearly similar to those now described. There is however, for a short period, an extremely feeble effervescence. Here I may remark, that for the sake of promoting the union of Strontites with the weaker acids, I frequently employ what I call the artificial carbonate of Strontites, by which I mean this earth precipitated from an acid by an effervescent alkali. On this powder the acid of tartar acts with vigour. When dropped into Strontitic water, it carries down the Strontites in union with it.

37. THE tartrate is nearly insipid. I boiled ten grains of it in four ounces of distilled water; six grains were dissolved. This solution, after it had stood some weeks in a close phial, deposited during frosty weather several small but very regular crystals, the form of which is a triangular table, having the edges and angles sharp and well defined. These crystals undergo no alteration from exposure to the air. When acted upon by heat, they at first swell and are puffed up after the manner of borax, and at length with ignition lose their acid, which is the first change that the powdery tartrate suffers under similar treatment.

With

With Fluoric Acid.

38. SCARCELY any perceivable effervescence happens when Strontian spar is thrown into acid of fluor. It is brisk if the artificial carbonate be used, but little is dissolved, as the fluuate falls to the bottom. Fluor acid occasions a milkiness in Strontitic water by the formation of a fluuate, which is possessed of nearly the same solubility as the preceding.

With Phosphoric Acid.

39. THIS acid attacks the spar, though in a solid form, but the progress of the effervescence and solution is excessively slow. A bit, weighing two or three grains, was not completely dissolved in twenty-four hours, though the disengagement of carbonic acid went on without interruption. The solution continues clear as long as the acid is considerably in excess; but as soon as the point of saturation approaches, it becomes thick, from the deposition of a white powdery phosphate. When the acid of phosphorus is dropped into Strontitic water, a precipitate appears, which is redissolved when the acid comes to be redundant. The phosphate, if perfectly neutral, has little solubility in water. Ten grains of it, treated with four ounces of boiling distilled water, left a residuum of nine grains.

With Succinic Acid.

40. THE acid of amber, dissolved in water, assaults, but with no remarkable activity, the artificial carbonate of Strontites. A clear solution results, which, by spontaneous evaporation, yields a crystalline succinate, which is persistent in the air.

With Acid of Arsenic.

41. THE arsenic acid dissolves with tardiness small but solid pieces of the fossil. With the artificial carbonate the effervescence is lively. In either case, the compound continues dissolved till the acid is almost saturated, when the liquor grows thick, from the deposition of a white powder, which is the arsenicate. A precipitate is formed by pouring Strontitic water on acid of arsenic; but agitation makes it disappear. This happens till the acid is nearly saturated; after which the precipitate will not be taken up, unless upon the addition of such a quantity of acid as shall make it predominate. The arsenic acid being dropped into Strontitic water, a copious precipitate descends to the bottom, which vanishes when the acid comes to prevail.

42. HAVING diluted a quantity of this acid with about twice its volume of water, I threw into it the artificial carbonate to nearly perfect saturation. A clear solution resulted, which evaporated on a plate of glass, gave a gelatinous substance, that by longer exposure to the air dried into a white powder. Crystalline forms showed themselves on the inside of a glass, which contained some of the solution after it had stood for some time. It is somewhat curious, and deserving of notice, that this solution lets fall the greater part of the arsenicate it contains as soon as it is made to boil by the application of heat.

THE arsenicate fully neutralized is only in a small degree soluble in water; an ounce of which, when boiling, takes up rather more than a grain.

With Boracic Acid.

43. To the acid of borax dissolved in hot water, I added a minute portion of artificial carbonate of Strontites; a slight

effervescence and solution took place ; and this happened when similar sparing quantities were thrown in for two or three times, after which the powder united with gentle effervescence, and fell to the bottom. I poured Strontitic water into a similar solution of the acid ; at first no disturbance of transparency was observable, but when the point of saturation was not far distant, a copious precipitate appeared. This I washed with cold water, that seems to act little upon it, and dissolved it in boiling, of which it requires about an hundred and thirty times its own weight. The solution changes to a green, the colour of paper stained with the juice of violets.

With Carbonic Acid.

44. THE combination of Strontites with carbonic acid we have in the Strontian mineral, the properties of which I have been detailing. The earth, soluble in water, becomes scarcely so by uniting with this acid. With an excess of acid its solubility increases considerably, as is the case with barytes and lime. The solution of Strontites is precipitated by water impregnated with carbonic acid, and the precipitate is redissolved by the addition of more of the same fluid.

45. STRONTITES, and all its combinations, possess a remarkable property, and one which I long considered as peculiar to them : I allude to the quality of tinging the flame of combustible bodies of a red colour. The muriate has this power in the most eminent degree. Its effects are well exhibited by putting a portion of the salt on the wick of a candle ; it causes the flame to assume a beautiful deep blood-red colour. All the other compounds, and Strontites itself, occasion more or less of the same appearance. The nitrate approaches the nearest to the muriate ; and it is in consequence of this property that the deflagration of this salt with an inflammable substance exhibits so brilliant and vivid a red flame. It is a pretty experiment to extinguish

subtle powder, and is what I have hitherto denominated the artificial carbonate. In diluted muriatic acid, I dissolved 200 grains of Strontian mineral, and then added salt of tartar, which had run *per deliquium* as long as it occasioned any precipitate. By the test of sulphuric acid, I discovered that the alkali had separated the whole of the earth, which was well washed, and afterwards dried before a fire, being towards the conclusion of the exsiccation brought very near the bars; it weighed 198 grains. This *deficit* of two grains I ascribe to accidental loss, as during washing, by adhering to the filter, &c. The artificial carbonate possesses all the chemical qualities of the native, with this difference, that it parts with its acid more readily when urged by heat.

48. THE prussiate of potash and of lime did not disturb the transparency of a solution of a pure colourless mass of Strontian mineral in nitric acid. Sometimes, however, these substances threw down from solutions in the muriatic acid a sparing precipitate of a blue colour, which denotes the existence of a minute portion of iron in some specimens. The precipitate is most abundant when a coloured spar has been employed; whence I conclude, that the colour which the spar occasionally exhibits is adventitious, and is owing to the iron it contains.

49. WITH sulphur, Strontites combines into an hepar. Equal weights of calcined Strontian mineral and flowers of sulphur were triturated together, and exposed to heat in a covered crucible. The heat was continued till a few minutes after the blue flame had ceased to appear at the chinks of the cover. The mass had been in fusion. Being pulverised, part was thrown into muriatic acid; an effervescence ensued, and the hepatic odour became offensive. Boiling water was poured on the remaining portion; a yellow-coloured fluid resulted, which was decomposed by acids, and gave with acetite of lead a very abundant black precipitate. In the humid way likewise a hepar may be formed. On a mixture of equal parts of flowers
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of sulphur and crystals of Strontites, I poured some hot water, which I caused to boil for some time. A liquid hepatic of a dark yellowish brown colour, was the product, and showed the same qualities as the preceding.

50. CRYSTALS of Strontites were dissolved, but sparingly by alcohol. The tincture was of a yellow colour, and burned with a reddish flame.

51. HAVING detailed all the properties of the Strontian mineral, and of its earthy base, with which I have made myself acquainted, my next object shall be to consider, and, if possible, to determine, whether this earth be really different and distinct from all those that are already known. There are two kinds to which the Strontitic basis bears in its properties no inconsiderable resemblance, I mean barytes and lime; yet it seems to me to differ as much from both of them as they differ the one from the other. In external appearance, it must be acknowledged, some similarity is observable among the native carbonates of these earths. The Strontian fossil resembles most the barytic spar. Indeed this is so much the case, that many persons admitted it into their collections as the aerated barytes. Nay, a French chemist of some note, M. PELLETIER, informs us, that having analyzed a mass, which he received from the Honourable Mr GREVILLE, he did not publish the result, for the reason, “*qu'elle ne m'avoit fourni rien de particulier* *.”

52. THESE two productions of nature agree in exceeding other earthy spars in specific gravity; in retaining their carbonic acid, unless when urged by a very intense heat; in dissolving when caustic in water; in affording the pure earth in crystals; in dissolving in acids with nearly similar phenomena; in forming salts of difficult solubility with several of the acids, and crystallizable ones with the nitric and muriatic. In these respects a strong analogy prevails between them, yet it is but an analogy; for in the points now enumerated,

*. Ann. de Chem. t. 10. p. 188.

enumerated, as well as in others, a considerable difference actually prevails.

53. THEIR specific gravities differ, that of native carbonate of barytes being 4.338, while that of Strontitic spar goes from 3.650 to 3.726. The last mentioned parts with its acid somewhat more readily, and without being fused itself, or acting so powerfully on the clay of the crucible; and when calcined it imbibes moisture with much greater avidity, splitting with more heat and noise. There subsists a greater difference between the solubility of pure Strontites in hot and cold water than of barytes*; moreover, the forms of their crystals disagree widely. Strontites generates with sulphuric acid a less ponderous and more soluble earthy salt than barytes. It is true that both barytes and Strontites form crystallizable salts when combined with nitric or muriatic acids, but the crystals have no similarity either in property or aspect. Those, into the composition of which Strontites enters, suffer changes from exposure to the air, which do not happen to the nitrate or muriate of barytes, and they are vastly more soluble in water. In the figure of the crystals also the difference is very remarkable. A strong and weighty argument in favour of the distinct nature of these earths is furnished by the circumstance, that solutions of Strontites in acids suffer no decomposition from prussiate of lime or potash; for here I put out of consideration the change that is occasionally produced when the minute portion of iron is present; while, as every body knows, a prominent and discriminating feature of barytes is its precipitation by either of these substances. A mark of distinction not less decided is the quality that Strontites and its compounds possess of tinging the flame of combustible bodies of a red colour; a property that does

* I have, since this paper was read, discovered that the difference of solubility of barytes in hot and in cold water is fully as remarkable as that of Strontites. This mark of distinction consequently must be rejected.

does not belong to barytes, the muriate of which gives a very faint greenish hue. To these add, what assuredly carries great weight with it, that these substances do by no means agree in the order of their attractions. On the whole, I think it abundantly manifest, that the fossil from Strontian is not aerated barytes, and that it has not this earth for its basis.

54. It has been above remarked, that this mineral occasionally assumes the appearance of some sorts of calcareous spar; and it has likewise been noticed, that some analogy prevails between the properties of their component earths. In no circumstance does this appear so strongly as in the quality of tinging flame, which I have discovered to belong also to the compounds of lime, though in a much smaller degree. The muriate of lime gives the flame of a candle, when applied in the manner formerly described, a red colour, which is considerably less vivid and brilliant than that produced by muriate of Strontites, and short of that occasioned by the nitrate of this substance. It is easy, however, to show, that Strontites and lime materially differ. The specific gravity of the Strontian far exceeds that of calcareous spar, which is commonly about 2.700. The former retains its carbonic acid much more obstinately in the fire. But the incomparably greater solubility of the pure earth in hot water, and its crystallizing, are characters of themselves sufficient to discriminate Strontites from lime, and I shall only further observe, that Strontites forms a less soluble compound with sulphuric acid, yields a crystallizable nitrate and muriate, and displays a power of attraction different from lime; whence I reckon it certain, that the earth of Strontian mineral is not lime.

55. I NEED not draw a parallel between the appearance and properties of this fossil and any of the other earthy bodies, as it is not in the most distant degree like any of them.

56. It perhaps deserves notice, that the mineral I have been treating of, though different from the native carbonates of barytes.

rytes and lime, holds a sort of intermediate space, and forms a kind of link between them. To illustrate what I mean, I may observe, that in specific gravity, fusibility, capability of decomposition by heat, and in the solubility of the compounds it forms, it stands in the middle. Thus, heavier than calcareous and lighter than barytic spar, it is more easily melted than the one, less so than the other. When subjected to heat, it parts with its carbonic acid more readily than barytes, less so than lime. The sulphate, nitrate and muriate of it are all more soluble than the same salts of barytes, and less soluble than those of lime. In one respect indeed it exceeds both, and that is, solubility in hot water, which perhaps is so great as may make some persons, over fond of nice distinctions, deny it a place among the earths altogether*.

57. THIS kind of intermediate situation shall perchance induce some to imagine, that this earth is a peculiar combination of the other two. At first, I confess, when this idea suggested itself to me, I did not deem it improbable; but now, after full investigation, I must reject the notion. This, I hope, I do with good reason, since I have found that, like the acknowledged simple earths, this substance bears repeated solutions, crystallizations and precipitations, without showing the smallest disposition to a separation of principles; and since the means that disunite an artificial mixture of the two earths, such as dissolving in muriatic acid and crystallizing, or precipitating by prussiate of potash or lime, have no effect in occasioning a disjunction of its parts.

58. As the earthy basis of the Strontian spar possesses remarkable qualities that are peculiar to it, and forms with acids combinations unlike those generated by the known earths, and differs from all of them in the order of its attractions, I cannot hesitate to conclude, that it is an earth *sui generis*, a new
 2 and

* *Vide* note to 53.

and distinct genus. It belongs decidedly to the ancient order of them called alkaline or absorbent, of which the most abundant species, the calcareous earth, has been long known. To my illustrious master in chemistry, Dr BLACK, we are indebted for establishing the distinct nature of magnesia. Dr GAHN and Mr SCHEELE have the merit of discovering barytes.

59. CONSIDERING it as a peculiar earth, I thought it necessary to give it a name: I have called it *Strontites*, from the place where it was found; a mode of derivation, in my opinion, fully as proper as from any quality it may possess, which is the present fashion. My reason is, that I think there is less chance of discovering two new earths in the same spot, than of finding two possessed of the same property any where. The denomination, however, is of little moment, provided it be well understood what it is intended to denote, and there be no room for mistake.

60. To complete the history of Strontites, it remains for me to state what I have discovered respecting the order of its attractions. I shall begin with pointing out the order in which the principal acids attract it, and then I shall show the place due to its attraction among those of other substances for acids.

61. SULPHURIC acid attracts Strontites with the greatest force; for when added to a solution of the nitrate, muriate, tartrate, arsenicate, succinate, fluuate, acetite and borate, it instantly causes a disturbance of transparency, and a white precipitate falls to the bottom. When poured upon the oxalate, which is scarcely soluble in water, and permitted to remain for some hours upon it, this acid expels the oxalic, and takes its place. I may here remark, that the precipitates formed by the sulphuric acid do not descend so rapidly as the ponderous sulphate of barytes; they have oftentimes in their fall more the appearance of sulphate of lime. On this account, Strontites, though a good one, is by no means so delicate a test of the presence of this acid as barytes, nor can it be employed altogether

with the same advantage in the purification of nitric and muriatic acids from the sulphuric.

62. THE acid of fugar, or oxalic acid, follows the sulphuric. This acid takes the new earth from all the solutions above mentioned, and with it falls in a powdery form, excepting from the fluat. It is a curious fact, that the oxalate is soluble in muriatic acid with partial decomposition. I obtained an oxalate by dropping the acid of fugar into muriate of Strontites, which I washed well with cold water, and dried. I then introduced it into muriatic acid, that did not dissolve it till a very little distilled water was added. The solution, in a few hours, had deposited a small quantity of crystals, which I dried on blotting paper. They were persistent in the air, they dissolved in water, and imparted to it the taste of oxalic acid. This fluid was not disturbed in its transparency by sulphuric acid, and it occasioned in lime water a copious precipitate of very little solubility; whence I inferred these crystals were oxalic acid, and their form did not contradict the conclusion. On evaporating the liquor from which they had been deposited, I procured a powdery oxalate and crystallized muriate. The reason of this partial decomposition I cannot at present assign; it cannot be explained in the same way that the partial decomposition of sulphate of potash or soda by nitric or muriatic acid is accounted for.

63. THE third place belongs to the tartarous acid, which decomposes and causes a milkiness in the solutions of the earth in nitric, muriatic, succinic, arsenic, boracic and acetous acids.

64. THEN comes the acid of fluor, which precipitates the earth from its solution in all the acids I have tried, excepting the three already mentioned as exceeding it in force. It is remarkable, that a solution of fluat is not rendered turbid by oxalic acid, though it be certain, that the oxalic has the stronger attraction; perhaps a triple compound is formed.

65. NITRIC

65. NITRIC acid holds the next place. When this acid, in a state of concentration, is poured into a saturated solution of the muriate, a precipitate immediately descends. This consists of minute crystals of the nitrate. An affusion of water restores fluidity. The liquor on evaporation affords the nitrate in crystals.

66. MURIATIC acid, as usual, succeeds the nitric. As it forms a very soluble compound with Strontites, the decompositions accomplished by it are made apparent by evaporation. The phosphate of Strontites is dissolved readily by this acid. The liquor, when the moisture is dissipated by a very gentle heat, yields crystals of the muriate and phosphoric acid in a concrete state. The arsenicate is taken up still more readily; and from the solution, by an evaporation not pushed so far as to deprive the arsenic acid of its humidity, are obtained crystals of the muriate. The borate dissolved in this acid exhibits phenomena similar to the phosphate. By adding this acid to the acetite, and evaporating, we get the muriate.

SUCCINIC acid, if it do not rank before the two last mentioned acids, without doubt, holds the place immediately following.

67. PHOSPHORIC acid comes next in order. It makes no change in the combinations containing any of the acids already noticed, but instantly throws down a precipitate from the acetite, arsenicate and borate. With regard to the two last of these, care must be taken not to add more phosphoric acid than is sufficient, else the precipitate will be instantly redissolved, and will elude observation.

68. AFTER phosphoric stands acetic acid, which unquestionably has a feebler attraction than any of the preceding, and I think a greater than the acid of arsenic, because this acid, dropped into the acetite, disturbs not the transparency. Boracic acid follows the arsenic, and last of all comes carbonic

nic acid, which is expelled by all the others, as appears from the narration already given.

Order of Attractions among the Principal Acids for Strontites.

STRONTITES.

Sulphuric acid.

Oxalic.

Tartarous.

Fluoric.

Nitric.

Muriatic.

Succinic.

Phosphoric.

Acetous.

Arsenic.

Boracic.

Carbonic.

69. THE attraction of the new earth for acids ranks high. For sulphuric acid, barytes has unquestionably a stronger attraction than Strontites. I added barytic water to a solution of sulphate of Strontites; and though only an extremely minute portion of this earthy salt be contained in the fluid, yet an immediate milkiness and precipitation was the consequence. This earth however comes next; for I find that, when I pour Strontitic water into solutions of sulphate of potass, of soda, or of lime, the liquor becomes turbid, and the Strontitic sulphate falls to the bottom.

70. I HAVE not ascertained how the attraction of Strontites stands with oxalic acid further than that the force of its attraction for this acid is superior to that of potass, and consequently of all those substances that are inferior to it.

71. THE earth attracts tartarous acid more forcibly than alkalis do. Add Strontitic water to tartrate of potash, and tartrate of Strontites will descend; but its attraction is weaker than that of barytes or lime, for the solutions of either of these earths renders tartrate of Strontites turbid. The same place is due to this earth in its attraction for fluoric acid as with acid of tartar; barytes and lime exceed it, potash is feebler.

72. WITH respect to nitric and muriatic acids, the order seems somewhat different. Here fixed alkalis appear to predominate. Yet of this, after several trials, I was somewhat uncertain, in consequence of peculiar phenomena that occur. When absolutely caustic potash is dropped into a diluted solution of muriate of Strontites, transparent crystalline flakes appear; but long before all the earth is disengaged, the alkali ceases to occasion more precipitation, and it may be afterwards added in quantity, without producing any visible effect. If, however, an effervescent alkali be now poured in, a copious curdy precipitate will be formed. Two hundred grains of Strontian spar were dissolved in muriatic acid. To the solution, diluted with more than an equal quantity of distilled water, I added potash, till it no longer occasioned deposition. I permitted the precipitate to subside, and then poured in some potash, which caused no visible change. The clear liquor was decanted off, and the remaining portion filtered. The precipitate, when collected and weighed, amounted only to 24 grains. With the clear liquor, I mixed carbonate of potash, and I obtained an abundant white precipitate. This I washed, and dried by a gentle heat; it weighed 170 grains. On another occasion, I dissolved a similar quantity of the mineral in the same acid, and after dilution I added the alkali very slowly. The matter separated assumed the form of quadrilateral lamellar crystals, some of which, unattached to any others, showed the wedge-shaped margin like an ordinary crystal of Strontites; frequently they adhered to each other, sometimes appearing in arboresecent figures..

figures. I continued to pour in potass as long as any precipitation followed, and I certainly consumed more alkali than would have been sufficient to saturate the whole of the acid. The crystalline deposit, when dried quickly, effervesced very feebly with muriatic acid; it was much more abundant than the former; it weighed 74 grains. From the supernatant liquor, carbonate of potass separated effervescent Strontites to the amount, when dry, of 132 grains. The matter thrown down by potass, when dissolved in muriatic acid, crystallizes in every respect like ordinary muriated Strontites. It is also soluble in water, and generates Strontitic water. From these experiments it appears, that potass precipitates only a portion of the Strontites, which is in the state of crystals, and that this portion is variable in quantity, which I imagine in some measure depends upon the state of dilution. How this comes to pass it is not easy to say. I am disposed to ascribe it either to the production of a triple compound, or to the solubility of Strontites in pure alkali. The weight of the two precipitates, in neither experiment, exactly amounted to that of the spar employed; nor was this to be expected. In the former it was deficient by six grains, in the latter it exceeded by as much. The deficit of the one may arise in part from the loss of matter adhering to the filter, but principally from the heat employed in drying, expelling too much moisture from the first precipitate. *A priori*, it might be imagined, that there should always be a deficiency, since part of the earth is disengaged in its pure state, as invariably happens with lime. Instead of this, however, in the latter experiment there was rather an increase of weight. This I impute to the crystalline form in which the Strontites is separated; for in this state it is united to a greater weight of water than it contains of both carbonic acid and water when it is effervescent.

73. THE impracticability of precipitating all the Strontites from muriatic acid, suggested some doubts whether the alkali

really possessed a stronger attraction or not. These were removed by the result of the following experiments: I dissolved a quantity of nitrate of potash in boiling water, and threw in some masses of recently calcined Strontites. The heat generated commenced an ebullition, which I prolonged by the heat of a sand bath, the mouth of the flask being stopped by a perforated cork. During the cooling, crystals of Strontites were deposited. I next dissipated by boiling much of the water of the clear fluid, managing the operation so that the atmospheric air should have as little access as possible. By this process I obtained crystals of nitre, intermixed with a small quantity of crystallized Strontites. I performed a similar experiment with a solution of muriate of soda, and the result only differed in this, that the crystals of common salt were deposited during the evaporation of the liquor, and those of Strontites, for the second time, during the subsequent refrigeration; whence the inference is deducible, that Strontites cannot detach the nitric or muriatic acid from the alkalis with which they are united in saltpetre and sea salt.

74. THE attraction of barytes for muriatic acid exceeds that of the new earth. To a solution of Strontitic muriate I added some native carbonate of barytes lately calcined and reduced to fine powder. Soon marks of decomposition were apparent, and the liquor consisted of muriate of barytes. Muriated barytes, on the other hand, suffers no change from the earth I have been describing. The attraction of lime for this acid is feebler than that of Strontites. Muriate of lime became muriate of Strontites, some time after I had introduced the powder of calcined Strontian spar into it. Ammoniac was instantly disengaged from the muriatic acid by Strontites.

75. POTASS attracts acetous acid more forcibly than Strontites, and dislodges it.

76. PHOSPHORIC acid is one of those that prefer Strontites to alkalis. Strontitic water immediately causes a precipitation in:

in phosphate of potash or soda. Strontites in its turn gives place to lime and barytes.

77. THE same order as in the preceding is observed with regard to the acid of arsenic.

78. BORATE of Strontites suffers no visible change from lime-water or potash, but is turned muddy instantly by barytic water. A solution of borax is decomposed by dissolved Strontites.

79. THE attraction of Strontites for carbonic acid is powerful. It renders mild alkalis caustic, and becomes thereby itself a carbonate. I was desirous of determining the relative attractions of barytes, lime and Strontites for this acid, but found it not an easy matter. The difficulty proceeds from all the three being entirely or nearly equal in power. BERGMAN was not able to decide between the two first of them. In hopes of ascertaining this point, with artificial carbonate of Strontites in subtile powder, I mixed a quantity of barytic and of lime water, and kept them in phials accurately closed. I had the bottles shaken very often during a week. At the expiration of this time, I decanted carefully from both the supernatant fluid, and saturated it with marine acid. The liquor of the one, treated in this manner, gave, on evaporation, muriate of barytes; from the other I obtained muriate of lime. These experiments seem to show, that Strontites will not yield carbonic acid to either of these earths. Again, when Strontitic water, poured upon the carbonates of barytes and of lime, is managed in the same manner as the former, the clear liquors, saturated with the same acid, afford, both of them, muriate of Strontites. This earth consequently had not taken the fixed air from either. Since then neither lime nor barytes can attract carbonic acid from Strontites, and since this acid will not desert either of these to combine with Strontites, I am led to the conclusion, that the forces of their attraction are equal, or very nearly so. This also appears from the following experiments: Into a mixture

ture of nearly equal parts of Strontitic and barytic waters, I threw distilled water impregnated with a quantity of fixed air less than was sufficient to saturate either of the earths. I shook the whole well for some time, in the expectation that the earth, whose attraction preponderated, would attach to itself all the acid, and become insoluble. On examination, however, I found, that the precipitate consisted of the carbonates of both. When a solution of lime, instead of barytes was used, the event was similar.

80. *STRONTITES* precipitates metallic calces from their solutions in acids, but with no particular phenomena. When Strontitic water is poured into a solution of muriate of mercury, a brownish yellow precipitate, like to that produced by barytic or lime water, presents itself. The same fluid causes a dark green precipitate in sulphate of iron, a greyish white in sulphate of zinc, a light blue in sulphate of copper, and a white one in acetite of lead.

TABLE to show the Place due to Strontites in the Order of Attractions.

<i>Sulphuric Acid.</i>	<i>Oxalic.</i>	<i>Tartarous.</i>	<i>Fluoric.</i>	<i>Nitric.</i>
Barytes	Barytes	Lime	Lime	Barytes
Strontites	Lime	Barytes	Barytes	Potafs
Potafs	Strontites	Strontites	Strontites	Soda
Soda	Potafs	Potafs	Potafs	Strontites
Lime	Soda	Soda	Soda	Lime
<i>Muriatic.</i>	<i>Phosphoric.</i>	<i>Arsenic.</i>	<i>Boracic.</i>	<i>Carbonic.</i>
Barytes	Lime	Lime	Barytes	Lime Barytes Strontites
Potafs	Barytes	Barytes	Lime	Potafs
Soda	Strontites	Strontites	Strontites	Soda
Strontites	Potafs	Potafs	Potafs	
Lime	Soda	Soda	Soda	

To make a small addition to the history of barytes, and to correct a mistake that has prevailed respecting the native combination with carbonic acid, I beg leave to add a few words.

1. ALL the chemists who have made native carbonate of barytes the subject of their experiments, concur in asserting, that the carbonic acid cannot be disengaged from it by heat alone; and upon this supposed fact, a theory of pretty extensive application has been founded. Dr WITHERING, in his admirable paper, *Phil. Transf.* vol. lxxiv. p. 298. says, "It is very remarkable, that the terra ponderosa spar in its native state will not burn to lime. When urged with a stronger fire, it melts and unites to the crucible, but does not become caustic." "May we not conjecture then, that as caustic lime cannot unite to fixed air without the intervention of moisture, and as this spar seems to contain no water in its composition, that it is the want of water which prevents the fixed air assuming its elastic aerial state." This supposition becomes, in his opinion, still more probable from the circumstance, that the artificial aerated terra ponderosa, which contains water, loses its fixed air by the action of heat.

2. Dr PRIESTLEY adopted this notion, and adds his testimony to the fact upon which it rests. In the *Phil. Transf.* vol. lxxviii. p. 152. we have the following words: "Terra ponderosa aerata gives no fixed air by mere heat. But I find, that when steam is sent over it in a red heat in an earthen tube, fixed air is produced with the greatest rapidity, and in the same quantity, as when it is dissolved in spirit of salt, and making the experiment with the greatest care, I find that fixed air
" consists

" consists of about half its weight of water." From these observations Dr PRIESTLEY infers, that water enters into the composition of fixed air, nay, that it is this ingredient which is essential to the æriform condition of the acid. He extends the idea to all aerial fluids, and hence draws a futile argument against Mr CAVENDISH's glorious discovery of the composition of water.

3. IT is unnecessary to transcribe the words of Mr WATT *junior*, who speaks on the authority of Mr JOSIAH WEDGEWOOD *junior*, to nearly the same purpose, or those of M. SAGE, FOURCROY and PELLETIER, who strangely assert, that this substance is absolutely unchangeable by heat.

4. FROM this general opinion, however, I am obliged to dissent, having found, that the fixed air can be expelled from the native aerated barytes by heat alone, if sufficiently intense; a circumstance that must prove fatal to the theory founded on its supposed impracticability. The heat which answers this purpose is that of a smith's forge, when the fire is skilfully managed. By its assistance, I have oftentimes deprived the barytic spar of its acid either entirely or nearly so.

5. I NEED not detail the particulars of more than of one experiment. In several trials, however, it may not be improper to remark, I was disappointed, in consequence of the barytes, vehemently heated, acting as a flux on the clay of the crucible, corroding holes in it and making its escape, leaving as its only vestige a green-coloured vitreous glazing on the inside of the crucible. At first I employed crucibles made of pure Stourbridge clay, but was, from the circumstance this moment mentioned, obliged to have recourse to those composed of black lead, which are able to resist and confine the heated spar; yet sometimes I succeeded even with those of clay.

6. A SOLID and pure mass of the spar, weighing 338.4 grains, was put into a black lead crucible, having a lid of the

same substance fitted to it. The crucible, gradually heated, was kept in the strong fire of a smith's forge for the space of half an hour, when it became very soft. On breaking it after it had cooled, indubitable proofs appeared of the mass having undergone complete fusion. From being previously angulated, it now accommodated itself to the shape of the crucible, and encrusted the bottom and sides of it a little way up. The crust externally, where it slightly adhered to the crucible, was of a dark greyish colour, internally it had a greenish shade. The matter was light, spongy and porous like pumice stone, and being carefully collected weighed only 261 grains. The spar had therefore lost 77.4 grains, which is at the rate of 23 *per cent.* nearly.

7. THE calcined mass imbibed water with a hissing noise and considerable increase of temperature, but without swelling or splitting like lime, and was soluble in this fluid. On dropping it into diluted muriatic acid, a very slight effervescence took place; but this soon ceased, and the dissolution proceeded in perfect quiet. The solution had a greenish cast.

8. FROM another mass, weighing 530.5 grains, I expelled 136.5 grains or 25.60 *per cent.* and still it was not altogether non-effervescent. I however obtained it once absolutely caustic or free from carbonic acid, having employed a crucible of Stourbridge clay, which endures a stronger heat than the black lead. But I could not in this case ascertain the loss of weight, as part of the mass had escaped through a hole it had made for itself.

9. EVEN by the common blowpipe and candle, a part of the acid may be disengaged. Supposing that the heat excited by this instrument, employed in the usual way, would be very inadequate to produce the desired effect, I tried pure air, in the manner I had seen M. LAVOISIER use it. This mode consists in directing a stream of oxygenous gas against ignited charcoal, and

and produces an extreme intensity of heat. By this heat the spar was rapidly melted, but sinking into the pores of the charcoal, it eluded further impression. I then had recourse to the ordinary blowpipe. The small mass readily melted, and on being kept in fusion for some time, boiled with so much violence as to scatter around it minute particles of the liquid matter. After two or three minutes, it was kept fluid with more difficulty; and, finally, it covered the surface of the charcoal with a thin powdery crust. Though it still effervesced briskly with muriatic acid, a portion of the fixed air had been separated; for a part of it, thrown into distilled water, imparted to it the power of changing to a green violet test-papers, and the water acquired a crust on its surface from exposure to the air.

10. THESE experiments, I hope, satisfactorily show, that the native carbonate of barytes can be decomposed by heat alone, and further afford proof of the insufficiency of the theory that has been deduced from the supposed impossibility of accomplishing it.

11. I HAVE found that barytes is vastly more soluble in hot than in cold water, and that it is deposited from the former in the state of crystals. To obtain these I commonly employ the calcined barytic spar, and the mode I follow consists in throwing into water, that has just ceased to boil, some pieces of a recently burned mass. The heat that is generated causes the water to boil, and I prolong the ebullition for a little time. The clear part of the liquor being decanted off and permitted to cool, deposits sooner or later a quantity of crystals. The shape and appearance of these vary considerably, according to the rapidity with which they have been formed, and this depends upon the greater or smaller quantity taken up by the hot water over what can be retained by it when cold; the most saturated yielding crystals the most speedily, the less so not for several days.

12. THE

12. THE crystal in its perfect condition seems to be a flattened hexagonal prism, having two broad sides, with two intervening narrow ones, and terminated at either end by a quadrangular pyramid, which, in some cases, constitutes the larger part of the crystal. When the crystallization goes on at great leisure, the crystals are often distinct and solid, of no inconsiderable magnitude; but more commonly with a quicker deposition, they are more slender and delicate, and are attached to each other in such a manner as to assume a foliaceous form of beautiful appearance, resembling some of the fern tribe in their pinnated fronds, to speak botanically; but in this arrangement, a considerable diversity occasionally happens.

13. THE crystals obtained from calcined barytic spar, in the manner now described, dissolve in water, and impart the qualities of barytic water; they change vegetable colours to a green, they unite with acids without effervescence, and generate with the muriatic and sulphuric, compounds similar to the sulphate and muriate of barytes; hence I infer they consist of pure barytes.

14. THESE crystals are perfectly transparent and colourless, but when exposed to the air, become white, opaque and effervescent, losing during this change nearly 30 *per cent.* of their weight. Subjected to the heat of boiling water, they undergo the aqueous fusion and become fluid; from which state, if allowed to cool slowly, they concrete into a solid crystalline mass. When a stronger heat is applied, and continued till all the moisture is dissipated, there remains a white powder, lighter by one half than the crystals employed, which, urged by the heat produced by the blowpipe, is melted with more difficulty than the native carbonate.

15. THE solubility of these crystals in water surprised me a good deal. One ounce of distilled water at temperature 60, dissolves almost twenty-five grains, while boiling water appears to

be capable of dissolving any quantity of them, however great. This arises from the circumstance, that the earth becomes so extremely soluble at an elevated temperature, that the water of crystallization itself, which scarcely surpasses the weight of the barytes, when heated to the two hundred and twelfth degree, is able to accomplish the solution of the earth without the assistance of more fluid.

16. IN this amazing solubility barytes and Strontites nearly agree, but materially differ from lime, which, so far as I can discover, is dissolved as sparingly by hot water as it is by cold.