XI. *Experiments on Allanite, a new Mineral from Greenland. By* THOMAS THOMSON, M. D. F. R. S. E. *Fellow of the Imperial Chirurgo-Medical Academy of Petersburgh.*

[*Read Nov.* 5. 1810.]

ABOUT three years ago, a Daniſh veſſel * was brought into Leith as a prize. Among other articles, ſhe contained a ſmall collection of minerals, which were purchaſed by THOMAS ALLAN, Eſq; and Colonel IMRIE, both members of this Society. The country from which theſe minerals had been brought was not known for certain; but as the collection abounded in Cryolite, it was conjectured, with very conſiderable probability, that they had been collected in Greenland.

AMONG the remarkable minerals in this collection, there was one, which, from its correſpondence with Gadolinite, as deſcribed in the different mineralogical works, particularly attracted the attention of Mr ALLAN. Confirmed in the idea of its being a variety of that mineral, by the opinion of Count BOURNON, added to ſome experiments made by Dr WOLLASTON, he was induced to give the deſcription which has ſince been publiſhed in a preceding part of the preſent volume.

ABOUT a year ago, Mr ALLAN, who has greatly diſtinguiſhed himſelf by his ardent zeal for the progreſs of mineralogy in all

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* DER FRUHLING, Captain JACOB KETELSON, captured, on her passage from Iceland to Copenhagen.

its branches, favoured me with ſome ſpecimens of this curious mineral, and requeſted me to examine its compoſition,—a requeſt which I agreed to with pleaſure, becauſe I expected to obtain from it a quantity of *yttria*, an earth which I had been long anxious to examine, but had not been able to procure a ſufficient quantity of the Swediſh Gadolinite for my purpoſe. The object of this paper, is to communicate the reſult of my experiments to the Royal Society,—experiments which cannot appear with ſuch propriety any where as in their Tranſactions, as they already contain a paper by Mr ALLAN on the mineral in queſtion.

I. DESCRIPTION.

I AM fortunately enabled to give a fuller and more accurate deſcription of this mineral than that which formerly appeared, Mr ALLAN having, ſince that time, diſcovered an additional quantity of it, among which, he not only found freſher and better characteriſed fragments, but alſo ſome entire cryſtals. In its compoſition, it approaches moſt nearly to Cerite, but it differs from it ſo much in its external characters, that it muſt be conſidered as a diſtinct ſpecies. I have therefore taken the liberty to give it the name of *Allanite*, in honour of Mr ALLAN, to whom we are in reality indebted for the diſcovery of its peculiar nature.

ALLANITE occurs maſſive and diſſeminated, in irregular maſſes, mixed with black mica and felſpar; alſo cryſtalliſed; the varieties obſerved are,

1. A four-ſided oblique priſm, meaſuring 117° and 63°.
2. A ſix-ſided priſm, acuminated with pyramids of four ſides, ſet on the two adjoining oppoſite planes. Theſe laſt are ſo minute as to be incapable of meaſurement. But, as nearly as the eye can determine, the form reſembles *Fig.* 1.; the priſm of which has two right angles, and four meaſuring 135°.

3. A

PLATE X.

Fig. 1.

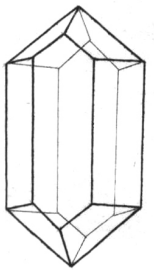
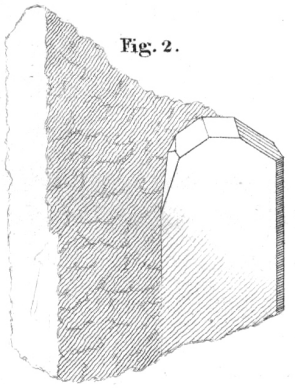


Fig. 2.



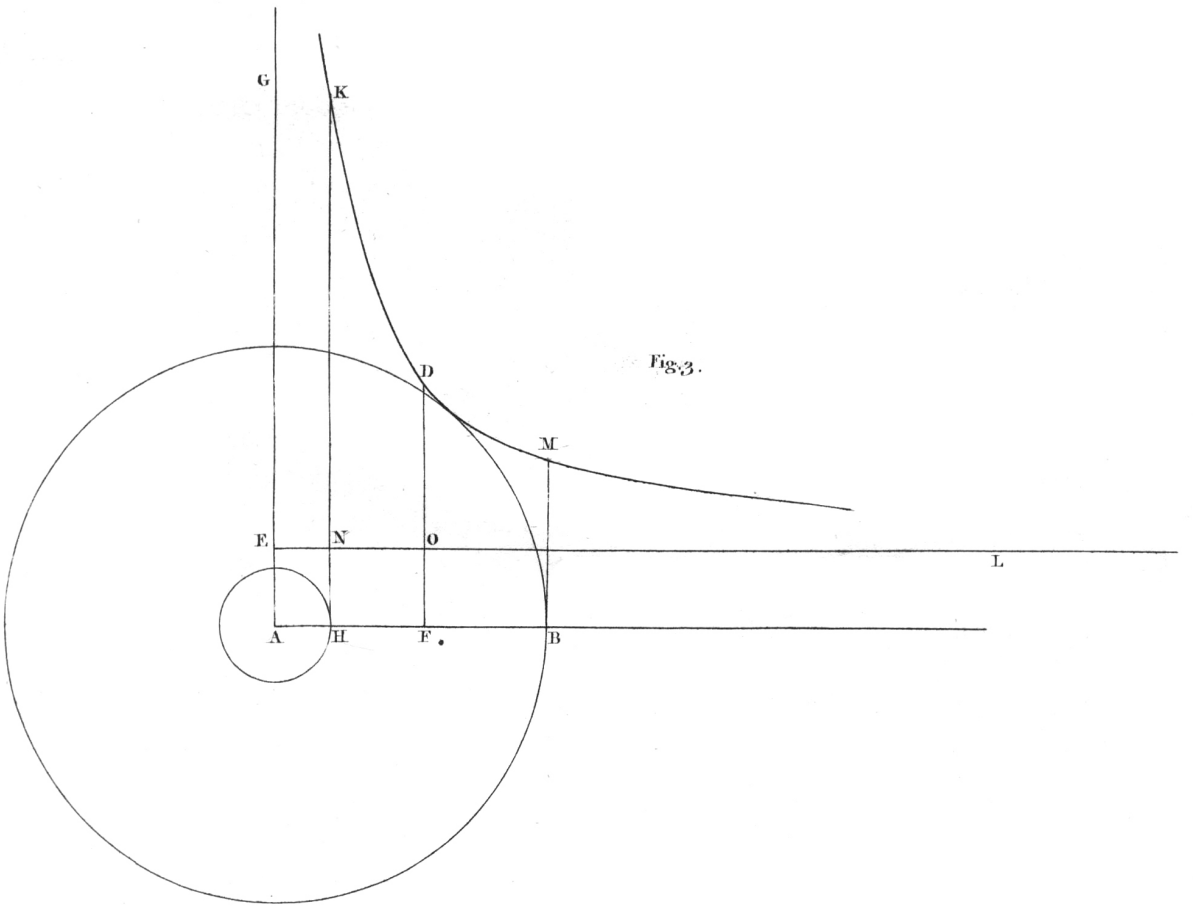


Fig. 3.

3. A flat priſm, with the acute angle of 63° replaced by one plane, and terminated by an acumination, having three principal facettes ſet on the larger lateral planes, with which the centre one meaſures 125° and 55°. Of this ſpecimen, an engraving is given in the annexed Plate, *Fig.* 2.

SPECIFIC gravity, according to my experiments, 3·533. The ſpecimen appears to be nearly, though not abſolutely, pure. This ſubſtance, however, is ſo very much mixed with mica, that no reliance can be placed on any of the trials which have been made. Count BOURNON, ſurpriſed at the low ſpecific gravity noted by Mr ALLAN, which was 3.480, broke down one of the ſpecimens which had been ſent him, in order to procure the ſubſtance in the pureſt ſtate poſſible, and the reſult of four experiments was as follows, 4.001
3·797
3·654
3.119
In a ſubſequent experiment of Mr ALLAN's, he found it 3.665. From theſe it appears, that the ſubſtance is not in a pure ſtate. Its colour is ſo entirely the ſame with the mica, with which it is accompanied, that it is only by mechanical attrition that they can be ſeparated.

COLOUR, browniſh-black.

EXTERNAL luſtre, dull; internal, ſhining and reſinous, ſlightly inclining to metallic.

FRACTURE, ſmall conchoidal.

FRAGMENTS, indeterminate, ſharp-edged.

OPAKE.

SEMI-HARD in a high degree. Does not ſcratch quartz nor felſpar, but ſcratches hornblende and crown-glaſs.

BRITTLE.

EASILY

EASILY frangible.

POWDER, dark greeniſh-grey.

BEFORE the blow-pipe it froths, and melts imperfectly into a brown ſcoria.

GELATINISES in nitric acid. In a ſtrong red heat it loſes 3.98 *per cent.* of its weight.

II. EXPERIMENTS TO ASCERTAIN ITS COMPOSITION.

MY firſt experiments were made, on the ſuppoſition that the mineral was a variety of gadolinite, and were pretty much in the ſtyle of thoſe previouſly made on that ſubſtance by EKEBERG, KLAPROTH, and VAUQUELIN.

1. 100 grains of the mineral, previouſly reduced to a fine powder in an agate mortar, were digeſted repeatedly on a ſand bath in muriatic acid, till the liquid ceaſed to have any action on it. The undiſſolved reſidue was ſilica, mixed with ſome fragments of mica. When heated to redneſs, it weighed 33.4 grains.

2. THE muriatic acid ſolution was evaporated almoſt to dryneſs, to get rid of the exceſs of acid, diſſolved in a large quantity of water, mixed with a conſiderable exceſs of carbonate of ammonia, and boiled for a few minutes. By this treatment, the whole contents of the mineral were precipitated in the ſtate of a yellowiſh powder, which was ſeparated by the filtre, and boiled, while ſtill moiſt, in potaſh-ley. A ſmall portion of it only was diſſolved. The potaſh-ley was ſeparated from the undiſſolved portion by the filtre, and mixed with a ſolution of ſal ammoniac, by means of which a white powder precipitated from it. This white matter being heated to redneſs, weighed 7.9 grains. It was digeſted in ſulphuric acid, but 3.76 grains refuſed to diſſolve. This portion poſſeſſed the properties of ſilica. The diſſolved portion being mixed with a few drops of ſulphate

ſulphate of potaſh, ſhot into cryſtals of alum. It was therefore alumina, and amounted to 4.14 grains.

3. THE yellow matter which refuſed to diſſolve in the potaſh-ley, was mixed with nitric acid. An efferveſcence took place, but the liquid remained muddy, till it was expoſed to heat, when a clear reddiſh-brown ſolution was effected. This ſolution was evaporated to dryneſs, and kept for a few minutes in the temperature of about 400°, to peroxidize the iron, and render it inſoluble. A ſufficient quantity of water was then poured on it, and digeſted on it for half-an-hour, on the ſand-bath. The whole was then thrown upon a filtre. The dark red matter which remained on the filtre, was drenched in oil, and heated to redneſs, in a covered crucible. It was then black, and attracted by the magnet; but had not exactly the appearance of oxide of iron. It weighed 42.4 grains.

4. THE liquid which paſſed through the filtre, had not the ſweet taſte which I expected, but a ſlightly bitter one, ſimilar to a weak ſolution of nitrate of lime. Hence it was clear, that no yttria was preſent, as there ought to have been, had the mineral contained that earth. This liquid being mixed with carbonate of ammonia, a white powder precipitated, which, after being dried in a red heat, weighed 17 grains. It diſſolved in acids with efferveſcence; the ſolution was precipitated white by oxalate of ammonia, but not by pure ammonia. When diſſolved in ſulphuric acid, and evaporated to dryneſs, a light white matter remained, taſteleſs, and hardly ſoluble in water. Theſe properties indicate carbonate of lime. Now, 17 grains of carbonate of lime are equivalent to about 9.23 grains of lime.

5. FROM

5. FROM the preceding analyſis, ſuppoſing it accurate, it followed, that the mineral was compoſed of

Silica, - - -	37.16
Lime, - - -	9.23
Alumina, - - -	4.14
Oxide of iron, - - -	42.40
Volatile matter, - -	3.98
	96.91
Loſs, - - -	3.09
	100.00

But the appearance of the ſuppoſed oxide of iron, induced me to ſuſpect, that it did not conſiſt wholly of that metal. I thought it even conceivable, that the yttria which the mineral contained, might have been rendered inſoluble by the application of too much heat, and might have been concealed by the iron with which it was mixed. A number of experiments, which it is needleſs to ſpecify, ſoon convinced me, that, beſides iron, there was likewiſe another ſubſtance preſent, which poſſeſſed properties different from any that I had been in the habit of examining. It poſſeſſed one property at leaſt in common with yttria; its ſolution in acids had a ſweet taſte; but few of its other properties had any reſemblance to thoſe which the chemiſts to whom we are indebted for our knowledge of yttria, have particulariſed. But as I had never myſelf made any experiments on yttria, I was rather at a loſs what concluſion to draw. From this uncertainty, I was relieved by Mr ALLAN, who had the goodneſs to give me a ſmall fragment of gadolinite, which had been received directly from Mr EKEBERG. From this I extracted about 10 grains of yttria; and upon comparing its properties with thoſe of the ſubſtance in queſtion, I found

found them quite different. Convinced by theſe experiments, that the mineral contained no yttria, but that one of its conſtituents was a ſubſtance with which I was ſtill unacquainted, I had recourſe to the following mode of analyſis, in order to obtain this ſubſtance in a pure ſtate.

III. Analysis of allanite.

1. 100 grains of the mineral, previouſly reduced to a fine powder, were digeſted in hot nitric acid till nothing more could be diſſolved. The undiſſolved reſidue, which was ſilica, mixed with ſome ſcales of mica, weighed, after being heated to redneſs, 35.4 grains.

2. The nitric acid ſolution was tranſparent, and of a light-brown colour. When ſtrongly concentrated by evaporation, to get rid of the exceſs of acid, and ſet aſide in an open capſule, it concreted into a whitiſh ſolid matter, conſiſting chiefly of ſoft cryſtals, nearly colourleſs, having only a ſlight tinge of yellow. Theſe cryſtals being left expoſed to the air, became gradually moiſt, but did not ſpeedily deliqueſce. The whole was therefore diſſolved in water, and the exceſs of acid, which was ſtill preſent, carefully neutraliſed with ammonia. By this treatment, the ſolution acquired a much deeper brown colour; but ſtill continued tranſparent. Succinate of ammonia was then dropped in with caution. A copious reddiſh-brown precipitate fell, which being waſhed, dried, and heated to redneſs in a covered crucible, weighed 25.4 grains. It poſſeſſed all the characters of black oxide of iron. For it was attracted by the magnet, completely ſoluble in muriatic acid, and the ſolution was not precipitated by oxalate of ammonia.

3. The liquid being ſtill of a brown colour, I conceived it not to be completely free from iron. On this account, an ad-

PLATE XI.

Fig. 1.

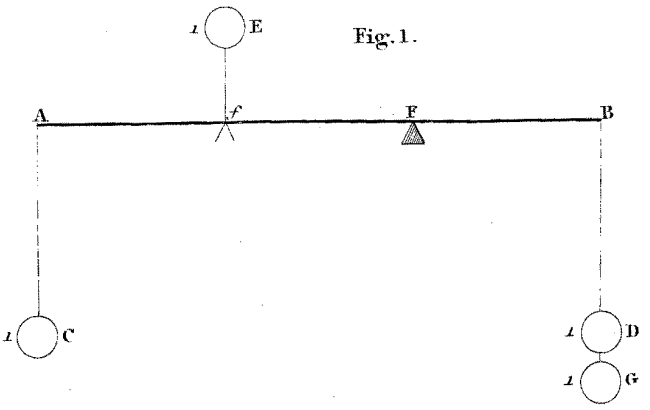


Fig. 2. N.o 1.

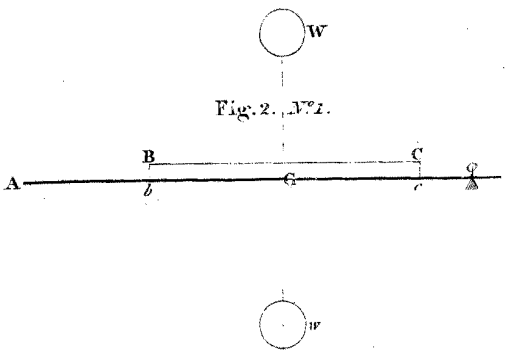


Fig. 2. N.o 2.

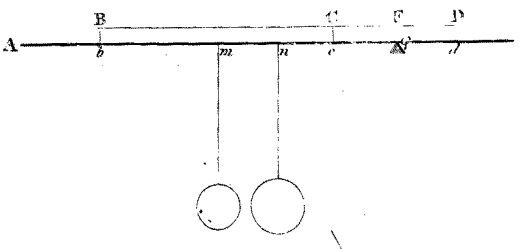


Fig. 3.

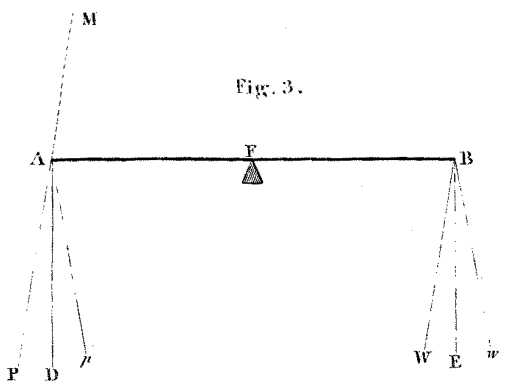
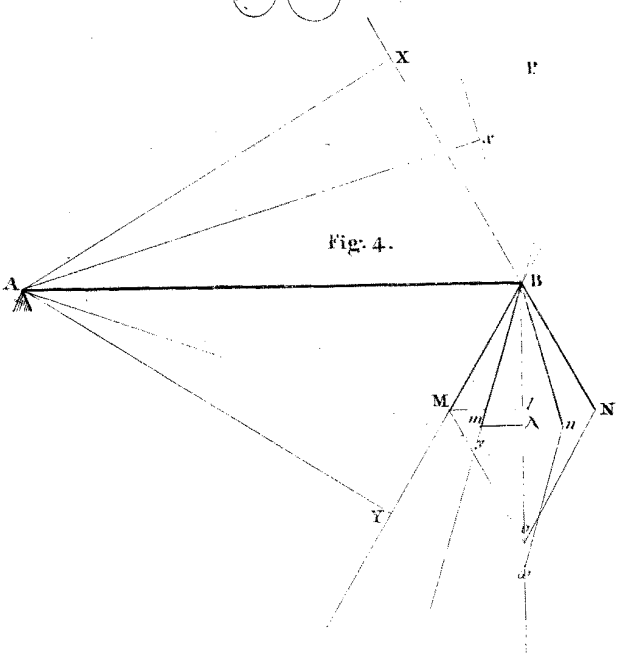


Fig. 4.



ditional quantity of ſuccinate of ammonia was adde. And we precipitate fell; but inſtead of the dark reddiſh-brown colour, which characterizes ſuccinate of iron, it had a beautiful fleſh-red colour, which it retained after being dried in the open air. When heated to redneſs in a covered crucible, it became black, and had ſome reſemblance to gunpowder. It weighed 7.2 grains.

4. THIS ſubſtance attracted my peculiar attention, in conſequence of its appearance. I found it to poſſeſs the following characters:

a. IT was taſteleſs, and not in the leaſt attracted by the magnet, except a few atoms, which were eaſily ſeparated from the reſt.

b. IT was inſoluble in water, and not ſenſibly acted on when boiled in ſulphuric, nitric, muriatic, or nitro-muriatic acid.

c. BEFORE the blow-pipe it melted with borax and microcoſmic ſalt, and formed with both a colourleſs bead. With carbonate of ſoda it formed a dark-red opake bead.

d. WHEN heated to redneſs with potaſh, and digeſted in water, ſnuff-coloured flocks remained undiſſolved, which gradually ſubſided to the bottom. The liquid being ſeparated, and examined, was found to contain nothing but potaſh. When muriatic acid was poured upon the ſnuff-coloured flocks, a ſlight effervescence took place, and when heat was applied, the whole diſſolved. The ſolution was tranſparent, and of a yellow colour, with a ſlight tint of green. When evaporated to dryneſs, to get rid of the exceſs of acid, a beautiful yellow matter gradually ſeparated. Water boiled upon this matter diſſolved the whole. The taſte of the ſolution was aſtringent, with a ſlight metallic flavour, by no means unpleaſant, and no ſweetneſs was perceptible.

e. A

e. A PORTION of the black powder being expoſed to a red heat for an hour, in an open crucible, became reddiſh-brown, and loſt ſomewhat of its weight. In this altered ſtate, it was ſoluble by means of heat, though with difficulty, both in nitric and ſulphuric acids. The ſolutions had a reddiſh-brown colour, a ſlight metallic aſtringent taſte, but no ſweetneſs.

f. THE ſolution of this matter in nitric and muriatic acid, when examined by re-agents, exhibited the following phenomena:

(1.) With pruſſiate of potaſh, it threw down a white precipitate in flocks. It ſoon ſubſided; readily diſſolved in nitric acid; the ſolution was green.
(2.) Pruſſiate of mercury. A light yellow precipitate, ſoluble in nitric acid.
(3.) Infuſion of nut galls. No change.
(4.) Gallic acid. No change.
(5.) Oxalate of ammonia. No change.
(6.) Tartrate of potaſh. No change.
(7.) Phoſphate of ſoda. No change.
(8.) Hydro-ſulphuret of ammonia. Copious black flocks. Liquor remains tranſparent.
(9.) Arſeniate of potaſh. A white precipitate.
(10.) Potaſh. - - - } Copious yellow-coloured
(11.) Carbonate of ſoda. - } flocks; readily diſſolved in
(12.) Carbonate of ammonia. } nitric acid.
(13.) Succinate of ammonia. A white precipitate.
(14.) Benzoate of potaſh. A white precipitate.
(15.) A plate of zinc being put into the ſolution in muriatic acid, became black, and threw down a black powder, which was inſoluble in ſulphuric, nitric, muriatic, nitro-muriatic, acetic, and phoſphoric acids, in every

temperature, whether theſe acids were concentrated or diluted.

(16.) A plate of tin put into the nitric ſolution, occaſioned no change.

(17.) A portion being incloſed in a charcoal crucible, and expoſed for an hour to the heat of a forge, was not reduced to a metallic button, nor could any trace of it be detected when the crucible was examined.

THESE properties were all that the ſmall quantity of the matter in my poſſeſſion enabled me to aſcertain. They unequivocally point out a metallic oxide. Upon comparing them with the properties of all the metallic oxides known, none will be found with which this matter exactly agrees. Cerium is the metal, the oxides of which approach the neareſt. The colour is nearly the ſame, and both are precipitated white by pruſſiate of potaſh, ſuccinate of ammonia, and benzoate of potaſh. But, in other reſpects, the two ſubſtances differ entirely. Oxide of cerium is precipitated white by oxalate of ammonia and tartrate of potaſh; our oxide is not precipitated at all: Oxide of cerium is precipitated white by hydro-ſulphuret of ammonia; while our oxide is precipitated black: Oxide of cerium is not precipitated by zinc, while our oxide is thrown down black. There are other differences between the two, but thoſe which I have juſt mentioned are the moſt ſtriking.

THESE properties induced me to conſider the ſubſtance which I had obtained from the Greenland mineral as the oxide of a metal hitherto unknown; and I propoſed to diſtinguiſh it by the name of *Junonium*.

IN the experiments above detailed, I had expended almoſt all the oxide of *Junonium* which I had in my poſſeſſion, taking it for granted that I could eaſily procure more of it from the Green-

land

land mineral. But, ſoon after, I was informed by Dr WOLLASTON, to whom I had ſent a ſpecimen of the mineral, that he had not been able to obtain any of my ſuppoſed Junonium in his trials. This induced me to repeat the analyſis no leſs than three times, and in neither caſe was I able to procure any more of the ſubſtance which I have deſcribed above. Thus, it has been out of my power, to verify the preceding details, and to put the exiſtence of a new metal in the mineral beyond doubt. At the ſame time, I may be allowed to ſay, that the above experiments were made with every poſſible attention on my part, and moſt of them were repeated, at leaſt a dozen times. I have no doubt myſelf of their accuracy; but think that the exiſtence of a new metal can hardly be admitted, without ſtronger proofs than the ſolitary analyſis which I have performed.

5. THE liquid, thus freed from iron and junonium, was ſuperſaturated with pure ammonia. A greyiſh-white gelatinous matter precipitated. It was ſeparated by the filtre, and became gradually darker coloured when drying. This matter, after being expoſed to a red heat, weighed about 38 grains. When boiled in potaſh-ley, 4.1 grains were diſſolved, of a ſubſtance which, ſeparated in the uſual way, exhibited the properties of alumina.

6. THE remaining 33.9 grains were again diſſolved in muriatic acid, and precipitated by pure ammonia. The precipitate was ſeparated by the filtre, and allowed to dry ſpontaneouſly in the open air. It aſſumed an appearance very much reſembling gum-arabic, being ſemi-tranſparent, and of a brown colour. When dried upon the ſand-bath, it became very dark-brown, broke with a vitreous fracture, and ſtill retained a ſmall degree of tranſparency. It was taſteleſs, felt gritty between the teeth, and was eaſily reduced to powder. It effervеſced in ſulphuric, nitric, muriatic, and acetic acids, and a ſolution of it

was

was effected in each by means of heat, though not without conſiderable difficulty. The ſolutions had an auſtere, and ſlightly ſweetiſh taſte. When examined by re-agents, they exhibited the following properties:

(1.) Pruſſiate of potaſh. A white precipitate.
(2.) Oxalate of ammonia. A white precipitate.
(3.) Tartrate of potaſh. A white precipitate.
(4.) Hydroſulphuret of potaſh. A white precipitate.
(5.) Phoſphate of ſoda. A white precipitate.
(6.) Arſeniate of potaſh. A white precipitate.
(7.) Potaſh and its carbonate. A white precipitate.
(8.) Carbonate of ammonia. A white precipitate.
(9.) Ammonia. A white gelatinous precipitate.
(10.) A plate of zinc. No change.

THESE properties indicated Oxide of Cerium. I was therefore diſpoſed to conſider the ſubſtance which I had obtained as oxide of cerium. But on peruſing the accounts of that ſubſtance, given by the celebrated chemiſts to whoſe labours we are indebted for our knowledge of it, there were ſeveral circumſtances of ambiguity which occurred. My powder was diſſolved in acids with much greater difficulty than appeared to be the caſe with oxide of cerium. The colour of my oxide, when obtained from oxalate, by expoſing it to a red heat, was much lighter, and more inclined to yellow, than the oxide of cerium.

IN this uncertainty, Dr WOLLASTON, to whom I communicated my difficulties, offered to ſend me down a ſpecimen of the mineral called *cerite*, that I might extract from it real oxide of cerium, and compare my oxide with it. This offer I thankfully

fully accepted *; and upon comparing the properties of my oxide with thoſe of oxide of cerium extracted from *cerite*, I was fully ſatisfied that they were identical. The more difficult ſolubility of mine, was owing to the method I had employed to procure it, and to the ſtrong heat to which I had ſubjected it; whereas the oxide of cerium from cerite had been examined in the ſtate of carbonate.

7. IN the many experiments made upon this powder, and upon oxide of cerium from cerite, I repeated every thing that had been eſtabliſhed by BERZELIUS and HISINGER, KLAPROTH and VAUQUELIN, and had an opportunity of obſerving many particulars which they have not noticed. It may be worth while, therefore, without repeating the details of theſe chemiſts, to mention a few circumſtances, which will be found uſeful in examining this hitherto ſcarce oxide.

a. THE precipitate occaſioned by oxalate of ammonia is at firſt in white flocks, not unlike that of muriate of ſilver, but it ſoon aſſumes a pulverulent form. It diſſolves readily in nitric acid, without the aſſiſtance of heat. The ſame remark applies to the precipitate thrown down by tartrate of potaſh. But tartrate of cerium is much more ſoluble in acids than the oxalate.

b. THE

* THE ſpecimen of cerite which I analiſed, was ſo much mixed with actinolite, that the ſtatement of the reſults which I obtained cannot be of much importance. The ſpecific gravity of the ſpecimen was 4.149. I found it compoſed as follows:

A white powder, left by muriatic acid, and preſumed to be ſilica,	47.3
Red oxide of cerium,	44.
Iron,	4.
Volatile matter,	3.
Loſs,	1.7
	100.0

b. THE ſolution of cerium in acetic acid is precipitated grey by infuſion of nut-galls. Cerium is precipitated likewiſe by the ſame re-agent from other acids, provided the ſolution contain no exceſs of acid. This fact was firſt obſerved by Dr WOLLASTON, who communicated it to me laſt ſummer. I immediately repeated his experiments with ſucceſs.

c. CERIUM is not precipitated from its ſolution in acids by a plate of zinc. In ſome caſes, indeed, I have obtained a yellowiſh-red powder, which was thrown down very ſlowly. But it proved, on examination, to conſiſt almoſt entirely of red oxide of iron, and of courſe only appeared when the ſolution of cerium was contaminated with iron.

d. THE ſolutions of cerium in acids have an aſtringent taſte, with a perceptible ſweetneſs, which, however, is different from the ſweetneſs which ſome of the ſolutions of iron in acids poſſeſs.

e. THE muriate and ſulphate of cerium readily cryſtalliſe; but I could not ſucceed in obtaining cryſtals of nitrate of cerium.

f. THE beſt way of obtaining pure oxide of cerium, is to precipitate the ſolution by oxalate of ammonia, waſh the precipitate well, and expoſe it to a red heat. The powder obtained by this proceſs is always red; but it varies very much in its ſhade, and its beauty, according to circumſtances. This powder always contains carbonic acid.

g. I CONSIDER the following as the eſſential characters of cerium. The ſolution has a ſweet aſtringent taſte: It is precipitated white by pruſſiate of potaſh, oxalate of ammonia, tartrate of potaſh, carbonate of potaſh, carbonate of ammonia, ſuccinate of ammonia, benzoate of potaſh, and hydroſulphuret of ammonia: The precipitates are re-diſſolved by nitric or muriatic acids:

acids: Ammonia throws it down in gelatinous flocks: Zinc does not precipitate it at all.

b. THE white oxide of cerium, mentioned by HISINGER and BERZELIUS, and described by VAUQUELIN, did not present itself to me in any of my experiments; unless the white flocks precipitated by ammonia from the original solution be considered as white oxide. They became brown on drying, and when heated to redness, were certainly converted into red oxide.

As cerium, as well as iron, is precipitated by succinate of ammonia, the preceding method of separating the two from each other was not unexceptionable. Accordingly, in some subsequent analyses, I separated the cerium by means of oxalate of ammonia, before I precipitated the iron. I found that the proportions obtained by the analysis above described, were so near accuracy that no material alteration is necessary.

8. THE liquid, thus freed from iron, alumina, and cerium, was mixed with carbonate of soda. It precipitated a quantity of carbonate of lime, which amounted, as before, to about 17 grains, indicating 9.2 grains of lime.

FROM the preceding analysis, which was repeated no less than three times, a different method being employed in each, the constituents of allanite are as follows:

Silica, - - -	35.4
Lime, - - -	9.2
Alumina, - -	4.1
Oxide of iron, - -	25.4
Oxide of cerium, - -	33.9
Volatile matter, - -	4.
	112.0

I omit the 7 grains of junonium, becauſe I only detected it in one ſpecimen of allanite. The exceſs of weight in the preceding numbers, is to be aſcribed chiefly to the carbonic acid combined with the oxide of cerium, from which it was not completely freed by a red heat. I have reaſon to believe, too, that the proportion of iron is not quite ſo much as 25.5 grains. For, in another analyſis, I obtained only 18 grains, and in a third 20 grains. Some of the cerium was perhaps precipitated along with it in the preceding analyſis, and thus its weight was apparently increaſed.