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To cite this article: C. Vauquelin (1801) XIII. Analysis of a stone called the gadolinite; with an account of some of the properties of the new earth it contains , Philosophical Magazine Series 1, 8:32, 366-375, DOI: [10.1080/14786440108562658](https://doi.org/10.1080/14786440108562658)

To link to this article: <http://dx.doi.org/10.1080/14786440108562658>

Published online: 25 Jan 2010.

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the tympanum, and communicated the impressions immediately to the internal organ. This not happening for some months after the membrane was destroyed, probably arose from the inflammation of the tympanum confining the stapes, and rendering its vibrations imperfect.

That sounds can be communicated with accuracy by the bones of the skull to the internal organ, when received from solid or liquid substances, has long been well understood.

That the membrana tympani is incapable of perfectly answering this purpose, when sounds are propagated through air, has been a generally received opinion; to refute which, was the object of my former paper. That, in cases in which the membrana tympani has been destroyed, the air is capable of acting with sufficient force upon the stapes to communicate vibrations to it, and to produce on the internal organ the necessary effect for perfect hearing, is completely ascertained by Mr. Cooper's observations.

XIII. *Analysis of a Stone called the Gadolinite; with an Account of some of the Properties of the new Earth it contains.* By C. VAUQUELIN*.

THE number of simple bodies, and particularly that of earths, has been greatly increased within a few years past; and if chemistry go on still thus advancing, it is to be apprehended that the time may arrive when the human mind will not be able to embrace all the combinations produced by the multitude of simple bodies.

But the analogy which exists between certain classes of natural substances, gives chemists reason to suspect that they contain a common generating principle, and affords them a hope that some fortunate chance, or an experiment made by some man of genius, will reduce them all to one single kind, either by disengaging them from those principles which establish differences between them, or by combining these same elements to those which are simple.

* From the *Annales de Chimie*, No. 107.

Till chemical means are brought to that degree of perfection, we must make known those bodies which, on account of their peculiar properties, we cannot refer to any of those already known, and which, till a new order be established, we are obliged to consider as new substances. An attentive examination of their properties is of great importance; for, even though they may be only modifications of bodies already known, it may happen, of which we have many instances, that their qualities may become useful to the arts and to manufactures, and, in any event, it is better to err through excess than deficiency.

With this view I shall here describe, with some details, the properties of a new earth discovered by M. Gadolin, and which has been examined by M. Ekeberg under new points of view.

I shall first give a short description of the stone, and then explain the different processes which I employed to analyse it; and shall conclude with indicating the principal properties that characterise the new earth it contains. The greater part of the observations I shall make on this subject, may have been already published by the chemists above mentioned; but their works being not much known, I have thought it my duty to act in this manner, that the present discovery may be better propagated.

I shall, however, repeat what has been communicated to me by M. Mantley, professor of chemistry at Copenhagen, to whom both Haüy and I are indebted for a large quantity of matter containing this new earth*.

In 1794, M. Gadolin discovered this earth; and his labour on the subject was printed in the *Memoirs of the Academy of Sweden*, and in *Crell's Chemical Annals* for the year 1796. M. Ekeberg, about two years ago, began an analysis of the same stone, and confirmed the results of M. Gadolin. To the new earth he gave the name of *Yttria*, from Ytterley, a place in Sweden, where it is found. A short mention of it was made also in the *Annales de*

* Professor Abildgaard, also, has had the goodness to send me a pretty large quantity of this stone, which enabled me to vary my experiments, and to discover the characterising properties of the new earth it contains.

Chimie, No. 100. This earth, according to him, exists in the gadolinite in the proportion of

	0.47
Accompanied by flux	— 0.25
Oxyd of iron	— 0.18
Alumine	— 0.04

He describes also some of the properties possessed by this new earth when freed from all the bodies united to it in the stone, and which are as follows:—"All its combinations with acids have a sweet taste like that of the salts of lead, but a little more astringent; with the sulphuric and acetic acids it forms crystallisable salts which do not change in the air; with nitric acid it gives a radiating mass, and with the muriatic acid nothing that can crystallise.

Characters of the Stone.

1st, This substance has a black colour, and its dust is of a blackish gray.

2d, Its fracture is absolutely vitreous, like that of glass.

3d, Its specific gravity, ascertained by Häuy, is 4.0497.

4th, It makes the magnetic needle move in a sensible manner.

5th, When exposed to the blow-pipe, it splits into small fragments, which fly to a considerable distance in bright red sparks, which, when they detach themselves, produce a strong crackling noise. What remains of the stone has a grayish-white colour, and does not fuse completely.

6th, When heated with borax it fuses, and communicates to that salt a yellow colour inclining to violet.

7th, A hundred parts of this substance, exposed to heat in a platina crucible, lose eight parts of their weight, and the matter assumes an ochry red colour. If, from the quantity of iron it contains, we estimate the oxygen it must absorb by the operation, we shall find that it has lost about 11 *per cent.*

Phænomena which the Gadolinite exhibits with the Mineral Acids.

The gadolinite (it is by this name I shall distinguish this stone in the course of this memoir,) is attacked by the powerful mineral acids, such as the sulphuric, the nitric, and the muriatic;

muriatic; and, if their action be assisted by a gentle heat, they form a thick jelly of a grayish or yellowish colour. If this kind of jelly be then evaporated to dryness, and the residuum of the evaporation be washed in water, you will obtain filix under the form of a white powder, which, when well washed and brought to a red heat, gives by its weight the proportion in which it exists with the other principles.

The solutions of gadolinite in acids do not all exhibit the same phenomena by evaporation. The sulphuric and muriatic acids retain the iron and the new earth in combination, and nothing but the filix is separated; while, on the contrary, the nitric acid abandons at the same time the filix and the oxyd of iron, which may be easily conceived from the properties of the nitrat of iron.

I took advantage of this property in preference to any other, in order to apply it to the analysis in question.

I dissolved 100 parts of gadolinite in nitric acid sufficiently diluted with water, and subjected it to evaporation, exposing it to a little heat towards the end, to effect a complete decomposition of the nitrat of iron. By re-dissolving it in water, I obtained, combined with the nitric acid and dissolved, the peculiar earth separated from the iron and the filix. While my solution still retained some traces of iron, which I easily perceived either by the reddish colour or by the gallic acid, I again evaporated the liquor to dryness, or I added a drop of ammonia, and the iron was then precipitated under the form of yellowish flakes, which I separated by the filter.

To separate the iron from the filix, I boiled the mixture in muriatic acid a little concentrated; I then diluted the solution with water, and made it pass through the filter, in order that I might collect the filix, and wash it till it was no longer precipitated by ammonia.

In regard to the new earth dissolved in nitric acid, it will be sufficient if it be pure to precipitate it by ammonia, and to wash it to obtain it separate; but having learned, by preliminary trials, that in this state it is mixed with small quantities of lime and magnesia, I was obliged to employ some further means for accomplishing that end.

I never,

I nevertheless began to precipitate it by means of ammonia, which does not precipitate lime. I then poured into the liquor, united to the washings of the precipitate, some drops of a solution of common carbonate of potash, and I obtained the lime combined with the carbonic acid. I redissolved, for the third time, in nitric acid, the earth mixed with the oxyd of manganese, and added, in small quantities at a time, a solution of hydro-sulphuret of potash, in order that I might precipitate only the metallic parts, which, with a little attention, I was able to effect.

I had then the earth alone, so that nothing was necessary to obtain it pure but to precipitate it by ammonia.

Analysis of the Gadolinite by Potash.

I still employed another method, which also succeeded, to separate the different elements which constitute the gadolinite: it consists in fusing it with two parts of caustic potash, washing the mass with boiling water, and filtering the liquor, which has a beautiful green colour.

In evaporating this liquor, the manganese, which gave it its colour, was gradually precipitated under the form of a black powder, which could be easily collected by decanting the supernatant water.

When it is observed that there is no more oxyd of manganese, the liquor must be saturated with nitric acid; on the other hand, the sediment must be put to digest with the same acid much diluted with water: by these means the earth alone dissolves, producing a great deal of heat; and the flint, and the iron too much oxydated, do not dissolve.

This solution with the above liquor, saturated with nitric acid, must be evaporated to dryness, in order that if any parts of iron and flint have remained they may be separated: in other respects the process is the same as before. The latter has the advantage of separating the manganese from the other principles, and of rendering unnecessary an operation the success of which is difficult.

The gadolinite might also, rigorously speaking, be analysed by directly attacking it by the sulphuric and muriatic acids; but as these acids dissolve at the same time, and

without distinction, all the elements which compose this stone, a hydro-sulphuret must be employed to separate the metals; and the just management of this operation is difficult, because the new earth is precipitated by an excess of the re-agent.

By the help of those means, which I have briefly explained, I was able to discover and separate the substances which enter into the composition of the stone called *gadolinite*. These substances are siliceous, black oxyd of iron, lime, oxyd of manganese, and the peculiar earth to which M. Ekeberg has given the name of *Yttria*.

The proportions in which they are found are as follow :

1st, Siliceous	—	—	25·5
2d, Oxyd of iron	—	—	25
3d, Oxyd of manganese	—	—	2
4th, Lime	—	—	2
5th, The new earth, or <i>Yttria</i>			35
			<hr/>
			89·5
		Loss	10·5

These 10·5 form the smallest loss I experienced in the different analyses I made; for I thought it necessary to employ, in constructing this table, the greatest quantities of each of the matters obtained by either of the processes.

I at first thought that this loss arose from some alkaline substances, as is the case in several kinds of stone; but, having treated 100 parts by sulphuric acid, I assured myself that it arose from another cause; for, having precipitated by ammonia all the earthy and metallic matters dissolved in the sulphuric acid, and having brought to a red heat the salt produced by evaporating the liquor to dryness, there remained nothing in the crucible but a little sulphat of lime.

As I suspected that this was occasioned by some volatile substance, I heated, in a platina crucible, 100 parts of the stone reduced to powder, and found that it had decreased eight parts, and that the remainder had assumed a yellowish colour.

The slight effervescence which I had always remarked
when

when the stone was dissolved in acids, induced me to imagine that one part at least of the deficit was owing to the carbonic acid.

To assure myself of it, I introduced into a small phial 100 parts of the matter in powder, and, after preparing a glass tube, destined to convey the gas into the lime-water, I poured into it sulphuric acid diluted with a certain quantity of water; a swelling up and heat were produced, and some air-bubbles passed into the lime-water, by which it was rendered turbid; but the quantity of the precipitate was so small, that it was impossible for me to measure it. As the space, indeed, in the vessels which remained empty was so great, it is probable the greater part of the carbonic acid remained in it.

But this experiment sufficiently proved to me that the 10.5 of loss belonged not merely to the carbonic acid; for, though the space furnished by my vessels was pretty considerable, it would not have been capable of retaining it, and I should also have obtained a greater quantity of calcareous precipitate. In the hope of finding some other substance, which, with carbonic acid, might contribute to form this loss, I put 100 parts in a retort of luted glass, to which I adapted a small receiver, and I exposed it to a strong heat. There appeared in the neck of the retort, and even in the bottle, some small drops of water, the quantity of which was so small that I could not weigh it. But the matter taken from the retort weighed no more than 91 parts. Thus it appeared to me that the loss which I experienced in my analyses is chiefly owing to water and carbonic acid.

Having given the most remarkable characters of the fossil called *gadolinite*, and the processes which appeared to me best adapted for separating its principles, I shall now briefly explain some of the properties exhibited by the new earth extracted from it.

1st, It is perfectly white; but it is pretty difficult to obtain it in that state on account of the oxyd of manganese, which follows it in almost all its combinations.

2d, It has neither flavour nor smell.

3d, It

3d, It is not fusible alone, but with borax it forms a white glass, which is transparent when it has not been added in excess.

4th, It is not sensibly soluble in caustic fixed alkalies: in this it is different from alumine and glucina, which combine with these very easily and in large quantity.

5th, It is soluble in the carbonat of ammonia, but five or six times less so than glucina; that is to say, five or six times more carbonat of ammonia is required to dissolve an equal quantity of yttria.

6th, It combines rapidly with the sulphuric acid, and produces heat in proportion as the union is effected: the salt thence resulting crystallises in small brilliant grains little soluble in water: it appeared to me that more than fifty parts of cold water were necessary to dissolve it, especially when not accompanied with an excess of acid. It has a taste at first astringent, and afterwards sweet, like sugar or salt of lead. This property, though analogous to that of glucina, is, however, so sensibly different from it, that by comparing them they may be easily distinguished.

7th, Its combination with the nitric acid has a more striking favour, but it produces in the mouth an effect of the same nature: it crystallises only with difficulty, and its affinity for water is so great, that it requires some trouble to dry it. During this operation, if it be exposed to too much heat, instead of becoming solid, like the greater part of the salts, it grows soft, and assumes the appearance of thick transparent honey; by cooling, it becomes hard and brittle like a stone; when exposed to the air, it attracts the moisture of it, and becomes soft.

The sulphuric acid, poured into a solution of the nitrat of yttria, forms in it a crystalline precipitate, which is a sulphat of the same earth.

8th, The combination of this earth with the muriatic acid exhibits nearly the same phenomena, in the several experiments I made, as the nitrat above examined: like the nitrat it can be dried with difficulty, it is fusible by a gentle heat, and strongly attracts the moisture of the atmosphere.

9th, Ammonia precipitates yttria earth from the three

combinations above mentioned; lime and barytes produce much more sensibly the same effect.

10th, The oxalic acid, and consequently the oxalat of ammonia, form in its solutions precipitates which have an appearance absolutely similar to that of the muriat of silver: glucina with the oxalic acid forms a very soluble salt—a new difference between these two earths.

11th, Prussiat of potash crystallised and re-dissolved in water occasions, in the solutions of this earth by acids, a white granulated deposit; but this is not the case in solutions of glucina.

12th, The phosphoric acid does not precipitate it from the other acids, but the phosphat of soda separates it under the form of gelatinous white flakes.

13th, It appears to me that it has more affinity for, at least, some of the acids, than glucina has.

14th, It precipitates an infusion of gall-nuts in brown flakes.

From what I have said, a great number of analogies may without doubt be observed between this earth and glucina; but, at the same time, there appear differences which do not permit us to confound these two earths. These differences chiefly are, the insolubility of the yttria and the solubility of glucina in fixed caustic alkalies; the little solubility of the sulphat of the yttria, and the great solubility of glucina, in the sulphuric acid; the difficult solubility of yttria, and the ready solubility of glucina, in carbonat of ammonia; the precipitation of yttria, and non-precipitation of glucina, from their solutions by oxalic acid and the prussiat of potash.

Here then we have nine kinds of earth very distinct by the properties peculiar to each: soon, no doubt, we shall reckon ten, if, as we have reason to preface from the accuracy of M. Tromsdorf, the existence of that which he has lately announced under the name of *august*, in the Saxon beryl, be realised.

These earths will increase in a wonderful manner the number of the saline combinations, which are already very considerable, and will furnish to chemists a multitude of new properties to be studied. It is to be wished that they may find

find some of them applicable to the arts, in order that these discoveries may not remain altogether useless. It is to be wished also, when the properties of this new earth shall be better known, that chemists may give themselves the trouble to change the name of yttria, by which it is now known, and which is derived from Ytterley, the place where it is found, that another derived from its essential properties may be given to it.

I shall conclude with remarking the great difference between the result of M. Ekeberg's analysis and mine. I do not know exactly to what it is owing, but I can assert that, in five analyses which I made of this stone by different processes, I never had less than 12 of loss. I presume that a certain quantity of moisture, and perhaps carbonic acid, remained in the new earth obtained by M. Ekeberg, for it is chiefly in this point that we differ. He found 47.5, and I only from 34 to 35, because I calcined it more strongly.

NEW PUBLICATIONS.

A Manual of a Course of Chemistry; or, a Series of Experiments and Illustrations necessary to form a complete Course of that Science. By J. B. BOUILLON LAGRANGE, Professor in the Central Schools of Paris, &c. Translated from the French, with 17 Plates. 2 Vols. 18 Shillings. Cuthel, and Vernor and Hood, 1800.

[Continued from Page 282.]

IN our last we announced the publication of this useful work, and promised a few extracts. We now subjoin the following.

Citric Acid [Concrete juice of lemons].

Scheele was the first person who found means to obtain the citric acid crystallized, and well separated from the mucilage, which accompanies it in the juices of those fruits that furnish it.

The process for obtaining this acid, according to that chemist, is as follows: Express the juice of lemons, and leave it