CHEMISTRY

The First of The Rare Earths

"A Classic of Science"

The Discovery of Yttrium Introduced Chemists to a Puzzling Group of Closely Related Chemical Elements

FERNERE UNTERSUCHUNGEN DER SCHWARZEN STEINART VON YTTERBY UND DER IN DERSELBEN GEFUNDENEN EIGENTHUMLICHEN ERDE. (*Further Investigation of the Black Mineral from Ytterby and the Peculiar Earth found in it*). *By A. G. Edeberg. In Chemische Annalen* (*Crell*). *Helmstädt* (*Germany*), 1799. *Translated for the* SCIENCE NEWS LETTER *by Helen M. Davis.*

PROF. GADOLIN, in the Transactions of the Royal Academy of Science (Stockholm) for the year 1794, second quarter, has described an investigation of a black mineral from the Ytterby quarries in Rosslagen, and at the same time the announcement of the chemical analysis by which he accomplished the discovery of a new and hitherto unknown earth. It seemed necessary to determine the properties of this earth, in order to decide upon its identity and its differences from those already known. Yet with the caution which only older and more experienced analysts have, it was given a place as a true earth, without any reservation or more exact knowledge. Upon getting the opportunity, I have also subjected this material to analysis, and there seems to me no longer any doubt that it should have this place.

Captain Arrhenius, whose enthusiasm for science gave Prof. Gadolin the opportunity to investigate this material, is also the one who has put me in the way of being a collaborator in the discovery. Such a beautiful piece of the mineral was sent me by him that after breaking it up I could select little pieces free from feldspar for analysis. Since Prof. Gadolin did not have this advantage, the proportion of constituents in my determination must naturally be somewhat different from that given by him. For it is clear, that the included feldspar would increase the percentage of silica and alumina, at the expense of the other substances.

Upon a weighed sample of the mineral was poured 16 times as much pure muriatic acid, and the mixture was held at gentle ebullition until the soluble part was extracted, and the clay remained as a white, cheesy mass. After drying and ignition, this weighed 25 parts, and with soda gave a glass bead before the blowpipe, which remained clear upon cooling.

From the filtered solution, which appeared lemon yellow in the cold and bright green when warm, there was precipitated with caustic sal volatile (ammonium carbonate) a dirty-brownish earth. After this was separated by filtration, the liquid gave no precipitate with carbonated sal volatile, and yielded upon evaporation pure sal ammoniac (ammonium chloride). The reserved dirty precipitate, while still moist, was put into a caustic potash solution and heated with it for some time, when the insoluble part was separated.

The potash-soluble part was saturated with nitric acid, which made it turbid, but it was cleared again by an excess of acid. It was then precipitated with carbonated sal volatile, and the alumina thus obtained weighed, after ignition, only 4½ parts.

What was left from the potash solution was dissolved in dilute sulphuric acid. After evaporation to dryness, the residue was strongly ignited, until it had taken on a red color through and through. Then it was digested with water and filtered, when a bright red iron ochre remained on the filter paper, which, after strong ignition weighed 18 parts. The reason for this procedure is easy to see. The sulphuric acid solution contains the new earth, together with iron, and the question is, how can they be separated from each other? This, I thought, could most conveniently be done by ignition, because vitriol loses its acid thus, and, by analogy, it was to be expected that the compound of the earth with sulphuric acid would remain undecomposed, which indeed occurred.

The filtered solution was slowly evaporated, and it appeared that the compound of the earth with sulphuric acid could crystallize into beautiful crystals, of which the most conspicuous were nearly half as large as raisin seeds. As the solution shrank, the crystals became finer and the form less easily distinguished, until the last looked just like a powder. After all the salt was dissolved in water again, the earth was precipitated with carbonated sal volatile, ignited and weighed. It was found to amount to 47½ parts . . . .

Properties of the Element

From the experiments which I have made with the earth, I will, to avoid diffuseness, omit those which agree with Prof. Gadolin's own, and merely state those which I regard as contributing to further description of the material.

All moistened and dissolved compounds of this earth with an acid have a very sweet taste, like solutions of lead, not so unpleasant but more sharp and astringent. Its compound with acetic acid is, in my opinion, fully as sweet as sugar of lead . . . .

I find nothing to hinder me from believing that the properties and characteristics of this earth are just as well defined as those of any hitherto known; as proof I will enumerate several especially striking reactions by which this substance can be distinguished from others. It is distinguished from barytes in that it gives a soluble salt with sulphuric acid, and can not be made to crystallize with nitric and muriatic acids. From lime by its crystals with suphuric and acetic acids. From magnesia in the same way, and from all three by this, that they are precipitated by caustic sal volatile. From alumina, in that it is not dissolved by

caustic potash lye, and gives with acetic acid a salt stable in air. From silica, aside from its solubility in acids, because it can be dissolved again from the ignited carbonate in the wet as well as in the dry way . . . . Its reaction with carbonic acid differentiates it from zircon, not to mention its taste and the crystals of its neutral salt. It cannot be confused with strontia, which forms a most difficultly soluble compound with sulphuric acid, and one capable of crystalization with nitric and muriatic acids. Also it does not correspond especially with *Australerde*, which can be dissolved in no acid except muriatic, and in that not without boiling. It thus takes its proper and deserved place in the system of natural elements, as a simple and independent earth.

It must therefore be named, and it seems most fitting that it should be named from the place where it was first discovered, because neither the name of the discoverer nor that of the mineral are sufficiently short for forming a name for common speech. But it can be called Ytter-earth, in Latin Yttria, which is free from all ambiguity and confusion both in meaning and spelling. The mineral itself should no longer be called pitchstone, for that has an entirely different meaning, since substances dug up elsewhere are so named, but it should be called *Yttersteín.*

In regard to the opinions as to the use of the discovery of a new earth, I cannot quite agree with Prof. Gadolin, for Yttria has such clear and definite properties. By complicated and troublesome investigation it may be possible at another time to achieve much understanding and profit. Is baryta not indispensable now in manufacturing many substances, and necessary in analysis, and what need does it not fill in medicine! That Yttria, whose acid solutions have such a characteristic taste, may also find a use in medicine is perhaps not such an untruthful possibility.

What may be discovered through further research upon the nature of this earth and its behavior toward other bodies, I leave for the future to show.

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PHYSICS

Gap in Einstein Theory Filled By New View of Physics

A GREAT defect in the Einstein relativity theory, till now ignored, has just been illuminated in the Orient by Dr. William Band of the Yenching University, Peiping, China. Dr. Band's new theory will be announced in a communication in the next issue of the *Physical Review* of the American Physical Society.

The two great branches of modern theoretical physics, relativity and the new quantum mechanics of atoms, until now working independently, may be harmonized by Dr. Band's new system. At present either planets or atoms act in the same way, according to the relativity theory of Einstein. Actually the facts of atomic physics on which the quantum theory is built are in complete contradiction to this idea.

"Relativity," says Dr. Band, "requires an added postulate over and above the postulates made by Einstein at the foundation of the theory."

This additional assumption is that the events of which the world is composed occupy some space and time, and are not infinitely small "point-events" as required by Einstein.

Otherwise, stated Dr. Band:

"General relativity is logically unsatisfactory because it bases measurement on infinitesimals and absolute infinitesimals do not exist. In applying the relativity to experience, we have to decide arbitrarily what shall be small."

Actually the small scale structure of matter does not really allow this choice: electrons and atoms are things having perfectly definite size.

Dr. Band's daring attempt to solve this fundamental problem is based on the work of Prof. A. N. Whitehead, professor of philosophy at Harvard University. Prof. Whitehead, himself a mathematician, has devoted much thought to constructing a theory of nature that will include all branches of science within its scope. This is the first attempt to bring Whitehead's concepts into the form of a definite physical theory.

The speeding atoms, electrons and light waves, that are spoken of together in the language of atomic physics as "wave-particles" are still further transformed in the new scheme emanating from China. "Transmitted possibilities," Dr. Band calls them as if to emphasize the increasing immateriality of what was called the physical world.

In agreement with this Dr. Band finds that "the existence of the particle is by no means a necessity." In conclusion, he decides that "it is possible by recognizing a logical weakness of relativity to deduce from the most natural additional hypothesis to remove this weakness, the essential basis of the new quantum theory."

Science News Letter, May 16, 1931

MEDICINE

Reversed Blood Flow Relieves Gangrene

AN UNUSUAL case in which the flow of blood in a patient's hands and feet has been reversed for twenty years has just been reported to the American Medical Association by Dr. Bertram M. Bernheim of Baltimore.

The operation was performed to relieve gangrene which developed as a result of Raynaud's disease, an ailment affecting the smallest arteries and veins. When circulation in these is affected, as in Raynaud's disease, the tissues supplied by them do not get proper nourishment and die.

To correct this condition, Dr. Bernheim performed an operation linking an artery to a vein in the patient's left leg. The blood, which could not get down the diseased artery to the left foot and toes, was able to flow down the vein to the foot. Normally, of course, blood flows out from the heart in the arteries and back through the veins. This reversal of blood flow was successful in relieving the gangrene and pain of Raynaud's disease in the left foot. Later, when the other foot was attacked, and still later when the disease began to affect the hands, operations were performed to reverse the circulation in these members.

The patient, who was 26 years old at the time of the first operation, is now about 45 and in excellent health generally, Dr. Bernheim found on examination nearly 20 years after her last operation. However, pain has returned and gangrene set in again in the remaining toes of the feet and in one finger. The reason for this cannot be determined, nor can the final outcome of the case be predicted, Dr. Bernheim stated. The openings from arteries to veins in the arms appear still to exist and have probably prolonged the patient's life and health for many years.

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