

ART. XXXIV.—*Note on a New Radio-Active Element*;
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IN an earlier paper* the results of some experiments were described which indicated the separation of the parent of radium from a solution of a uranium mineral. Some pure thorium nitrate was added to a solution obtained by treating a kilogram of carnotite ore with dilute hydrochloric acid and, after the removal of the substances precipitated by hydrogen sulphide, the thorium was precipitated as oxalate. The oxalates were converted into nitrates, the precipitation with oxalic acid was repeated and the substances were converted into chlorides. Measurements of the amount of radium emanation produced by the solution of these chlorides showed that in a period of 193 days the amount of radium present had more than doubled, and it was therefore evident that the process described had separated the immediate parent of radium from the uranium mineral.

From a number of earlier experiments I had found that after this treatment the thorium salt contains a radio-active body which retains its activity without apparent alteration in the course of several years. As it was easily proved that this substance was not radium, uranium or polonium, it was therefore assumed to be actinium, Debierne† having stated that the chemical properties of actinium are similar to those of thorium. Moreover, it had been found that small amounts of an emanation which completely lost its activity in less than half a minute were evolved from the oxides of the thorium treated in this manner. I therefore suggested that actinium was the parent of radium and the intermediate product between uranium and radium.

Rutherford, using a commercial preparation of actinium, has recently obtained results‡ which prove that the immediate parent of radium is distinct from actinium itself although it is present in his actinium preparation. He states that the parent substance can be separated from actinium by precipitation with ammonium sulphide.

For the past ten months I have been continuing my experiments with the object of determining definitely the radio-active properties and chemical behavior of the radium parent. As sources of material I have used carnotite, Joachimsthal pitchblende, gummite, uranophane and a specimen of very pure uraninite from North Carolina.

In confirmation of Rutherford's statement it has been found

* This Journal, xxii, 537, 1906.

† Nature, lxxvi, 126, 1907.

‡ C. R., cxxx, 906, 1900.

that the rate of production of radium in solutions of the parent is not affected appreciably by the presence of radio-actinium and its products. Continued observations of the growth of radium in my original solution indicate that the rate of production of radium has been constant, within the limits of experimental error, for a period of over 500 days. Using one of my own preparations, I have been unable to repeat the separation of the radium parent from actinium by the ammonium sulphide treatment which Rutherford has described. With pure, freshly-prepared ammonium sulphide no separation could be detected. The radium parent can, however, be quite completely separated from actinium by precipitation with sodium thiosulphate, under the conditions usual for the precipitation of thorium. As ammonium sulphide readily changes into ammonium thiosulphate, it would appear probable that the separation noticed by Rutherford was due to the latter compound.

An interesting and important relation has been observed between the growth of radium and the activity of the substances other than thorium in my solutions containing the radium parent. This proportionality is most striking in those solutions containing the more completely purified salts. More significant still is the fact that this radio-active constituent does not appear to possess any of the characteristic properties of the recognized radio-active elements. Less than half a gram of thorium oxide containing an amount of this new body having an activity about equal to that of five grams of uranium did not produce sufficient actinium emanation to permit its detection in a sensitive electroscope, although under the conditions of experiment the thorium emanation evolved could be detected and measured without difficulty.

That the active substance is not actinium was also demonstrated by the fact that from a solution over five months old, containing about 3 grams of thorium and a quantity of the new substance with an activity equal to that of about 35 grams of uranium, no active substances other than thorium products could be separated by precipitation of the earths with ammonia, by the formation of finely divided sulphur from sodium thiosulphate or by the precipitation of considerable quantities of barium sulphate in the solution. The first process should have separated actinium X and the last two should have separated radio-actinium had these products been present.

The behavior of the oxides obtained by strongly igniting the hydroxides precipitated by ammonia from a solution similar to the above is also significant. The activities of these oxides remain nearly constant for long periods, showing only a slight initial rise corresponding to the formation of thorium X in the thorium present. No rise corresponding to the formation of

actinium X can be observed, but if actinium were present a separation of this product would be expected.

The most conclusive proof that the substance described is a new radio-active element is furnished by the properties of its α -radiation. The α -rays which it emits are much more readily absorbed by aluminium than the α -rays from polonium, with which it has been directly compared. Their range in air as determined by the scintillation method appears to be less than 3 centimeters, which is less than the range of the α -particle from any other known radio-active element. The new substance also gives out a β -radiation which is less penetrating and more easily absorbed than that from uranium, the value found for the coefficient of absorption being about 1.8 aluminium.

Experiments which have been carried out with a view to obtaining a quantitative separation of this new element from small quantities of very pure uraninite have given results which are in good agreement with one another and which indicate that the activity of the new element in equilibrium with radium is about 0.8 of the activity of the radium itself with which it is associated. This is about the value to be expected if the new substance is intermediate between uranium and radium when the range of α -particles in air is taken into consideration. It is very likely that this radio-active element is present in Debierne's actinium preparations and in some of Giesel's "emanium" compounds which have been put on the market by the Chininfabrik, Braunschweig, especially in the former, and its presence may perhaps explain the confusion which has resulted from Debierne's earlier assertions that actinium accompanied thorium as opposed to Giesel's positive statements to the contrary.*

Strong evidence has, therefore, been obtained of the existence in uranium minerals of a new radio-active element, which emits both α and β radiations, which produces no emanation and which resembles thorium in its chemical properties. It is without doubt a disintegration product of uranium and is in all probability the immediate parent of radium. The name "Ionium" is proposed for this new substance, a name derived from the word "ion". This name is believed to be appropriate because of the ionizing action which it possesses in common with the other elements which emit α -radiations.

Further experiments are in progress which it is hoped will afford additional information as to the properties and chemical behavior of this new body.

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New Haven, Conn., Sept. 21, 1907.

*Chem. Berichte, xl, 3011, 1907.