ON THE POSSIBLE RADIOACTIVITY OF ERBIUM, POTASSIUM AND RUBIDIUM.

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THE work of Thomson, Campbell, Wood, McClennan and others indicate that potassium and probably rubidium is radioactive. McClennan and Kennedy[1] have studied various potassium, sodium, lithium, rubidium, cæsium and ammonium salts and find that only potassium salts are appreciably active, the cæsium and rubidium salts giving but a very slight indication of radioactivity. The potassium cyanide salts investigated by them showed an activity roughly proportional to the potassium content (the potassium content was very small in some of the samples called potassium cyanide). Levin and Ruer[2] find by the photographic method that potassium salts emit radiations that are about a thousandth as effective in making a photographic impression as the β radiations from uranium. They find that metallic lead affects a photographic plate about as much as the potassium salts.

In work upon the radioactivity of ordinary substances the electrical method is sensitive and rapid but requires a great deal of attention. The photographic method requires but slight attention and long periods of time. For these reasons the photographic method has been used by the writer in making a preliminary examination of the possible radioactivity of a large number of salts. The effects upon the photographic plate may be due sometimes to chemical action as well as to radioactive emanations or radiations. But by the use of screens it is possible in many cases to decide between these two causes. When there is no photographic impression after a long exposure of at least six months it is certain that the substance does not emit any β-like radiations as strong as the radiations from most potassium salts.

Several years before his death Professor Rowland collected several minerals and salts of the rarer elements and through the kindness

[1] Phil. Mag., No. 93, p. 377, 1908.
[2] Phys. Zeit., No. 8, p. 248, 1908.

of Professor Ames these were placed at the writer's disposal. An investigation of the possible radioactivity of these salts has been made by the photographic method. The work is being continued by electrical methods.

The substances examined include salts of potassium, zirconium, cæsium, lead, bismuth, yttrium, tungsten, sodium, molybdenum, niobium, rubidium, erbium, tantalum, lanthanum, vanadium, neodymium, præsodymium and ruthenium. Most of these salts were collected by Professor Rowland at least fifteen years ago.

The method of investigation consists in exposing "Seeds' Dry Plates" for about six months to the salts. The salt is usually placed in a dish and covered with a screen containing several openings. Above this screen is the photographic plate, the film side being next the salt. As many of the salts had been in cork-stoppered bottles for years, there was usually not much danger of chemical action although in several instances this trouble occurred. The plates used were probably not as sensitive as those used by Levin and Ruer. Intense impressions were however obtained in 30 hours by exposing the plates to uranyl chloride or uranyl nitrate. The method of developing is the same as that used by Jones and Anderson.[1]

Potassium Salts. — Potassium cyanide (purchased for photographic purposes) gave a considerable impression in an exposure of 150 days. Thin aluminium foil (.00156 cm. thick) did not cut off much of the radiation. Thicker aluminium foil (.006 cm. thick) cut off at least half of the rays. A sample of potassium benzoate (Rowland collection) exposed for 150 days produced but a very slight impression. Potassium citrate (Rowland collection) exposed 160 days produced a slight effect which was not absorbed by the thin aluminium foil, but was by sheet iron (.04 cm. thick). Potassium urate (R. col.) shows practically no effect after an exposure of 150 days. Potassium carbonate (R. col.) gave a strong photographic impression after an exposure of 160 days. The radiations were cut off by sheet iron. On the other hand, potassium carbonate recently purchased for photographic work (Mallinckrodt) showed practically no activity. The same was true of a sample of potassium chromate (R. col.) which was exposed 150 days.

[1] Carnegie Publication, No. 110, p. 7.

Lead. — Several pieces of lead used by the writer[1] to screen electroscopes were tested. The length of exposure was 150 days. When the surface of the lead was bright and when near the photographic film, the action upon the plate was usually very intense and of a spotted nature. When the lead was at a centimeter's distance from the plate the impression was very weak. It seems that this effect cannot be produced by rays like the β rays from uranium. They may be δ-like rays or the effect may be due to chemical action, Lead chloride (R. col.) was found to be inactive. Lead peroxide (R. col. Merck.) gave a slight impression in 150 days. The radiations were cut off by thin aluminium foil.

Zirconium chlorate (R. col.) and zirconium oxide (R. col.) gave no photographic impressions. The former was exposed 160 days and the latter 100 days. Cæsium, bismuth chloride and sticks of tellurium gave negative results after exposures of 160 days.

A plate was placed in a box containing mercury. The plate was quite black on developing, the part of the plate in the mercury being less black however than the part that was exposed only to the mercury vapor.

Three yttrium compounds belonging to the Rowland collection were tried — these being yttrium sulphate, yttrocerite and yttrium oxalate. The lengths of exposure were 110, 150 and 110 days respectively. No impression was produced upon the photographic film.

The following substances belonging to the Rowland collection were exposed for 110 days with negative results, oxide of tungsten, tungstate of ammonia, tantalic oxide, molybdenum metal (powdered), sodic molybdenate, ammonium molybdenate, niobic acid, Gadolenite (No. E_1G_2), vanadium chloride, cerium sulphate, neodymium oxide, præsodymium oxide, ruthenium "residues" and iridium metal. The quantity of several of these compounds was so small, however, that unless they were quite active, no impression upon a photographic plate would be made.

A sample of "erbium chloride" gave a very strong impression after an exposure of 110 days. This salt was in the Rowland collection. Several years ago the University purchased some "erbium metal" from the Harrington Brothers, London. This also gave a very

[1] PHYS. REV., p. 43, July, 1908.

strong photographic impression. The "erbium chloride" is known to contain a large amount of erbium as it has been used for spectroscopic work. The absorption spectra of the powdered "erbium metal" did not show any trace of the erbium spectrum. How much erbium is present the writer does not know.

Lanthanum chlorate and sulphate gave negative results. The absorption spectra of these salts showed the presence of neodymium in large amounts.

Samarkite "oxides from sodic sulphite" showed no radioactivity. Samarkite earth and monazite sand (Barker Co., N. C.) showed a very marked radioactivity. These minerals belonged to the Rowland collection.

Rubidium chloride after an exposure of 110 hours gave a slight photographic impression. Rubidium chlorate in 110 hours gave a very strong impression.

In several instances the photographic plates were supported by pine or oak blocks. In every case it was found that these darkened the plate and this darkening spread out as a cloud for several millimeters from the parts of the plate touching the plate. The effect of the wood was very small when it was a few millimeters from the plate.

Summary.

Various "new" and "old" potassium salts have been found to give a photographic impression after long exposures. This action has been found to be quite small for other potassium salts.

Erbium and rubidium salts were found to act in a similar way to potassium salts. This indicates that erbium, rubidium and potassium may be radioactive. The fact that so many rubidium and potassium salts from widely different sources possess this activity seems to show that it is not due to an impurity.

Lead and wood also give photographic impressions but these seem to differ in their cause from the impressions produced by erbium and potassium.

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