

have been due to any of the causes which might possibly affect it, to-wit: (1) Want of size; (2) any personal equation of the observer; (3) improved instrumental or atmospheric means; (4) distance (all these are negatived by their striking conspicuousness); (5)

phase; (6) regular seasonal change, and last (7) uni-hemispheric seasonal change.

It will be perceived that the proof that these canals are *novae* has been possible, and only possible, through the long systematic work done on the planet here for

the last fifteen years. Without such a complete system of records the certainty that the canals in question were new canals to Mars could not have been reached.

Lowell Observatory, Flagstaff, A. T.

P O L O N I U M.

SOME NEWLY DISCOVERED PROPERTIES.

BY MDME. P. CURIE AND A. DEBIERNE.

It is known that among the new and strongly radio-active bodies polonium was the first to be discovered. Many efforts have been made already to isolate this substance and to characterize it as a chemical element, but in spite of the great activity of the product obtained this result has not yet been achieved. According to the theory of radio-active transformations the quantity* of polonium present in radio-active minerals must be very small. According to this theory polonium is looked upon as a descendant of radium, and the relative proportion of these substances in radio-active equilibria is equal to the ratio of their mean lives. The mean life of radium being about 5,300 times greater than that of polonium, and radium being found in pitchblende in about the proportion of 0.2 gramme per ton, it is seen that the same mineral cannot contain more than about 0.04 milligramme of polonium per ton. Many problems of supreme importance in radio-activity are connected with the isolation of polonium. This body is an unstable element which apparently represents the last radio-active term in the series derived from radium; we may therefore hope to show the formation of an inactive element derived from polonium. Moreover, polonium giving rise to an emission of α rays should produce helium, and this production not yet having been observed, it is important to ascertain if there really is in this a fact incompatible with theory.

We have undertaken recently a chemical research with a view of preparing polonium in a concentrated state. This was performed on several tons of residues from the uranium mineral which were at our disposal for this purpose. The mineral was treated with warm strong hydrochloric acid, which has the effect of dissolving polonium almost completely. The solution, which contains no radium, was submitted in a factory to operations having for their object the extraction of its active matter. This treatment, which was done under our direction and which will be described in a more extended memoir, furnished about 200 grammes of about a substance having a mean activity about 3,500 times that of uranium, and which contained chiefly copper, bismuth, uranium, lead, and arsenic; its activity was due to polonium. We sought to purify this material by treatment in our laboratory.

For this purpose the hydrochloric solution was precipitated with ammonia, to remove copper, and the precipitated hydrates were boiled in a solution of soda to dissolve the lead; they were mixed next with a warm solution of ammonium carbonate to dissolve the uranium. All these operations were repeated several times. The insoluble carbonates finally obtained were dissolved in hydrochloric acid, and the solution was precipitated with stannous chloride. These operations together were very successful, the original activity being found in the final precipitate in a sufficiently complete manner, which we verified by appropriate weighings.

The precipitate, which weighed about 1 gramme, was redissolved, and the hydrochloric solution was precipitated by sulphureted hydrogen. The sulphides were washed with sodium sulphide, then redissolved, and the solution was reprecipitated with stannous chloride; the resulting precipitate weighed a few milligrammes. Spectrum analysis, effected on this material, showed the presence of a diversity of elements—mercury, silver, tin, gold, palladium, rhodium, platinum, lead, zinc, barium, calcium, and aluminium; some of these elements being derived from the vessels employed. On attempting to purify the active matter we encountered great difficulties, and we found it very difficult to obtain without loss a substance of a more simple composition. Thus, on trying to separate lead by treatment with potash we found that a large part of the polonium passed into solution, although we were able to utilize without danger the same reaction in the presence of elements insoluble under these conditions. From this alkaline solution, polonium can only be reprecipitated by the addition of an alkaline sulphide. The reactions which we always found to be trustworthy are: Precipitation as sulphide from an acid or alkaline solution, and precipitation with stannous chloride. We also have found that polonium is easily deposited by electrolysis, and this method may

be utilized for a quantitative separation when we wish to extract polonium from an acid solution, but at the same time other metals, such as gold, platinum, mercury, etc., are deposited. After many experiments the activity was concentrated in about 2 milligrammes of matter.

The activity was measured by an electric method. For this purpose a known and very small portion of the solution was evaporated on a thin plate of glass, and the absolute value of the saturation current obtained with this plate was measured in an appropriate apparatus. Knowing the value of the charge of a gaseous ion (4.7×10^{-10} E. S. units) and the number of ions produced by an α particle of polonium along its complete path (about 1.6×10^5), we can calculate the number of α particles emitted per second. Knowing, moreover, the speed of decay of polonium (a reduction to one-half in 140 days) and the number of molecules contained in a molecule-gramme (about 6×10^{23}) we can calculate the amount of polonium present, its atomic weight being supposed to be near 200. We also can calculate the amount of helium which is formed in a given time, assuming that each α particle is an atom of helium.

In this way we found that the quantity of polonium obtained would be about 0.1 milligramme; this quantity is what ought to be found according to theory, in 2 tons of good pitchblende. Our active matter therefore might contain several per cents of polonium, so that spectrum analysis might be attempted with some chance of success. Many spark spectra were obtained and photographed; unfortunately each of these operations involved a considerable loss of material.

The appearance of the spectrum is complicated; many elements being present, gold, platinum, mercury, palladium, rhodium, and iridium. Some spectra also showed the presence of alkaline earthy metals, which came probably from the attack of the vessels employed; these were removed by electrolysis. After a careful examination of the different spectra and the identification as complete as possible of known lines by their wave lengths (records of Exner and Haschek, Watts), or by comparison spectra obtained with the same spectrograph, some lines were left which might be attributed reasonably to polonium. The wave lengths of these lines are:

Weak	4,642.0
Rather strong	4,170.5
Weak	3,913.6
Very weak	3,652.1

The following lines are of doubtful origin:

Medium, may be a parasitic line.....	4,651.5
Medium, may be identical with the aluminium line 3,961.7.....	3,961.5
Weak, may be identical with the platinum line 3,668.6.....	3,668.5

The accuracy of these measurements is pretty good, the error probably not exceeding 0.3 Angström unit. For the identification of the lines we not only considered the wave length, but also the relative intensity.

We hope to examine the spectrum again when the polonium has disappeared; this will allow us to form a definite opinion on the attribution of the lines indicated above. We also may hope to see the spectrum of the element formed at the expense of polonium. According to theory this element should be lead; lead is not entirely absent from our product, but its spectrum is very faint.

We have observed that the active substance obtained does not give rise to induced radio-activity, nor to any appreciable emission of penetrating rays. We have observed also an extremely minute disengagement of radium emanation.

A portion of the solution was utilized for the study of the gas disengaged. The solution was introduced into a quartz tube, which itself was placed in an apparatus which could be completely freed from air. The solution disengages much gas; it is easy to observe the continuous formation of gas bubbles, proving the decomposition of water; this decomposition must be attributed to the action of the α rays of polonium. The gases disengaged are almost totally absorbed by the action of heated copper and oxide of

copper, of potash, and phosphoric anhydride. The slight gaseous residue was collected and examined by one of us by the method formerly used for the examination of the gases disengaged by actinium and radium (Debiere, Comptes Rendus, 195, 1909). This residue is sensibly pure helium; its complete spectrum was observed, and the volume measured. The volume was equal to 1.3 cubic millimeter at atmospheric pressure, the accumulation having been going on for 100 days. This volume is very near that predicted by theory, which is 1.6 cubic millimeter. The fact of the production of helium from polonium is therefore established, with the predicted order of magnitude. We propose to make as accurate as possible a determination of this volume, together with experiments on the numeration of the α particles emitted, so as to obtain the value of the number of molecules contained in a molecule-gramme. This direct method seems particularly advantageous when using a solution of polonium, as in that case the α particles are completely absorbed by the liquid.

In the course of our experiments a curious effect of the rays was observed. The polonium was kept dry in a small quartz capsule. This capsule was found to be cracked in a large number of places under the substance. The production of these cracks may be attributed to electric discharges.

An abundant disengagement of ozone was noticed generally in the neighborhood of the substance.—Comptes Rendus, cl., pp. 386-389, February 14th, 1910.

A NEW APPLICATION OF ALTERNATING CURRENTS OF HIGH TENSION.

THE Textile World Record describes a new process for removing the electrical charge which textile fibers and fabrics acquire in the operations of spinning and weaving. It is a well-known fact that wool, silk, and other textiles, under the influence of pressure and friction, acquire an electric charge, which they retain persistently. In wool-working establishments this electrification of the material causes several grave inconveniences. In spinning, the strands, having electrical charges of the same design, repel each other, so that, instead of lying parallel in the yarn, they protrude in loops. The electrification also causes adjacent strands to become entangled and torn. The individual fibers of the strands exhibit similar peculiarities. Instead of lying smoothly they separate widely, and give the yarn a rough and irregular character. The electricity developed in shearing the cloth is another source of annoyance. The clippings and dust acquire an electric charge opposite to that of the cloth, and consequently adhere to it. These troubles are most marked on bright winter mornings, when the dryness of the air favors the retention of the charge. The only remedy that has hitherto been found at all effective is the production of moist and hot air in the factory. The use of this expedient produces an almost insufferable temperature, and the result has become more and more unsatisfactory with the steady increase in the velocity of the machines.

Chapman, an American inventor, has devised an entirely new method of obviating all of these difficulties. The most important part of his apparatus is a steel tube about $1\frac{1}{2}$ inch in diameter, which is slit longitudinally and incloses a well-insulated cable, which is traversed by an alternating electric current. The slit in the tube is filled by insulating porcelain buttons almost in contact with each other. The electric current ionizes the air around the tube to a distance of several inches, and the magnetic forces developed by the alternating current causes a continuous and rapid motion of positive and negative ions in directions at right angles to the tube. In the course of this movement, the fabrics come into contact with oppositely charged ions and thus lose their charge, while the ions which carry charges similar to that of the fabric are repelled. As an alternating current is used, both positive and negative charges are dissipated in this way. The process has already been used in America. It possesses an especial advantage from the hygienic point of view, as it not only avoids the heating and moistening of the air, but it actually disinfects the air by the production of ozone.—Umschau.