ELEMENT 61.*

J. ALLEN HARRIS, UNIVERSITY OF ILLINOIS.

In 1919 while studying the arc spectral lines of neodymium and samarium which had been prepared in this laboratory the U. S. Bureau of Standards found 130 lines in the red regions that correspond to no known element.

Following this an extensive search for element No. 61 was commenced by L. F. Yntema, who found 5 new lines in the violet region of the arc spectra of similar materials, but X-ray analysis failed to show any trace of this element.

The present investigation was taken up by the writer in conjunction with Professor Hopkins in 1923.

Previous researches had been carried out using the difference in solubilities of the double magnesium nitrates of the rare earths as a means of separation. In this manner it is quite natural to expect 61 to concentrate in fractions between those of pure neodymium and of pure samarium. Since however all previous attempts by this method, even after exhaustive concentration, had resulted in failure, three possibilities as to this failure presented themselves.

(1) Element 61 is extremely rare, and infinite concentration would therefore be necessary.

(2) The double magnesium nitrate of element 61 concentrates with one of the more plentiful elements on either side of it.

(3) The solubility of the double magnesium nitrate of 61 is entirely unique in falling out of sequence with its cogeners, and hence would not be found in the intermediate fractions of a double magnesium nitrate series.

Of these three possibilities, (2) appeared the most probable. At the same time it seemed to us that if materials free enough from either neodymium or samarium were used, there might be a possibility of bringing out 61 even in a double magnesium nitrate series, but only after considerable fractionation and then only with a great loss of the element.

The action of the double magnesium nitrates favors the assumption that a new element is forcing a spit be-

* Abstract of a thesis.

tween neodymium and samarium and it was from this fact and that of the previous failures in this type of series that the writers assumed that there was very little difference in solubility between either 61 and samarium on the one hand or 61 and neodymium on the other. Such being the case it would be practically impossible, having this more abundant element present to ever concentrate to a point that would give the ratio of 61 to the other materials present large enough to be detected by means of the X-ray. Similarily it was quite reasonable to assume that any absorption bands of the new element might quite easily be masked by the heavy bands of one or more of its cogeners.

In order to test out this theory we assumed that in the case of the double magnesium nitrates it was the neodymium with which the 61 salt was concentrating. Accordingly a series that had been worked over extensively by F. H. Driggs was taken and only those fractions rich in samarium were retained, to continue as the double magnesium nitrate. Thus even though the majority of the missing element might be left in the neodymium rich fractions we should in this way be able to throw whatever amount of 61, there might happen to be, into the less soluble end of the fractions. This was done and extensive fractionation carried out. In the least soluble fraction a concentration of the small amounts of neodymium that was present was obtained, but any absorption bands due to the existence of a new element if present were completely masked by the other spectra.

A second series taken from the above mentioned material was also taken, this being considerably more rich in neodymium than the one previously. In order to obtain a separation of the 61 from the neodymium it was necessary to find a salt which on fractionation would force another element between 61 and 60, and if possible also between 61 and 62. In this an ideal case was found in the bromates, inasmuch as neodymium and samarium are forced apart leaving 61 with elements on either side of it which give little or no absorption in the visual spectrum.

On fractionation of this last we were soon able to pick up a very faint line in the absorption spectrum which did not correspond to any charted line for the two neighboring elements but which had been assigned as a weak line of neodymium. Continued fractionation however brought this line in very strong and in a position in our series where we would expect to find 61 concentrating most. At the same time the wave length of this band corresponds very nicely to what one would expect for 61. Further fractionation yielded two more bands both of which fit nicely into the curve of occurrence of absorption bands, a paper on which is to be published shortly by L. F. Yntema.

Material showing this band most strongly was therefore taken for X-ray analysis, together with the head fraction of the first mentioned series. In this latter fraction no new bands were observed, as would not be expected since the bands due to neodymium would completely mask any other ones present.

In order to verify our suspicions regarding the presence of element No. 61 on our material, and X-ray spectrograph was constructed Lines corresponding within limits of accuracy of our apparatus to the L alpha one and L beta one, of element No. 61 as calculated from Siegbahn's precision values were obtained, from these fractions.

SUMMARY.

Absorption bands have been found in the visual spec trum of solutions of fractions of rare earth materials that can only be due to element No. 61.

X-ray analysis yielded the L alpha one and L beta one lines of element No. 61.

We suggest the name of Illinium for this element, in honour of our state and our university.