

hydrochloric acid extracts when volatilised in a powerful electric spark, with and without the use of a condenser, and also in the electric arc, failed to give conclusive evidence, and in many cases even any indication of the presence of elements which subsequent analysis proved to be present. The various products of the preliminary examination were of course examined spectroscopically, and by the accurate measurement of the various characteristic lines, positive proof was obtained of the presence of a number of elements, which were present in so small quantity that their identification at that stage by other analytical methods would have been very difficult if not impossible. Amongst these may be mentioned—Lithium, Potassium, Barium, Strontium, Zinc, Thallium, and Titanium. Throughout the course of the final analyses spectroscopic measurements were made whenever practicable. The measurements were made with a Dewar and Liveing direct vision spectroscope, and in order to obtain the necessary data for the conversion into wave-lengths of the micrometer readings of this instrument, careful measurements were made of eighty bright lines characteristic of twenty different elements.

Qualitative Analysis.

150 grammes of the finely-powdered nodules were boiled in a large new Berlin porcelain basin with specially-prepared perfectly pure hydrochloric acid. After prolonged treatment the whole was evaporated to dryness, in order to separate any silica which might have gone into solution. The dry mass was then moistened with strong hydrochloric acid, and subsequently digested with dilute hydrochloric acid, and the solution filtered from the insoluble residue (A), which was thoroughly washed, dried, bottled, and weighed.

Through the solution a current of pure sulphuretted hydrogen gas was passed for two days, after which the small precipitate that had gradually formed was collected on a small filter, washed with water containing a little sulphuretted hydrogen, dried, bottled, and weighed (B).

The filtrate from B was boiled to drive off the excess of sulphuretted hydrogen, and after cooling mixed with a little sulphuric acid and about one-third of its volume of alcohol.

After standing for some days the small precipitate which had formed was collected on a small filter, washed, dried, bottled, and weighed (C).

The alcohol in the filtrate from C was then boiled off, and excess of pure oxalic acid added. An extremely small precipitate separated out on prolonged standing. It was collected on a small filter, ignited. The ignited precipitate weighed little more than one milligramme (D).

The filtrate from D was nearly neutralised with ammonia, whereupon a considerable precipitation took place, accompanied obviously by absorption of oxygen from the air. The precipitate (E) was collected on a filter, and washed with hot water.

A further precipitate (F) was obtained by prolonged exposure of the solution to the air. The filtered solution was then acidified with hydrochloric acid, and the oxalic acid present destroyed by addition of pure recrystallised potassium permanganate.

To the solution thus obtained ammonia and ammonium sulphide were added to precipitate the metals of the iron group. The bulky precipitate was collected on two large filters, and washed with water containing ammonium sulphide. The filtrate was evaporated to dryness in large platinum basins, and the residue gently ignited, in order to drive off ammoniacal salts. The residue was bottled (G).

The iron group precipitate was treated in a closed flask with 5 per cent. hydrochloric acid, prepared by diluting 20 per cent. acid with sulphuretted hydrogen water. After standing two days the undissolved residue was filtered off and washed with hot water containing a little sulphuretted hydrogen, dried, bottled, and weighed (H).