

real ferric oxide. But at any rate there cannot be much ferrous oxide present, or it would have told more strongly on the iodine result.

Another result which would appear to follow from the reported numbers, is that the loose oxygen is not sufficient to supplement the manganous oxide into binoxide. Taking 4.02 as the correct percentage of loose oxygen, we have for the percentage of—

Manganous oxide,	0.044 × MnO ¹
Real manganese oxide,	0.502 × MnO ₂

Now the oxides MnO, FeO (as above calculated), CaO, MgO as reported under (b), amount in all to 0.197 × R''O.

These may be present in combination with manganese binoxide as components of psilomelanic compounds, leaving a balance of 0.305 × MnO₂ of real uncombined (or hydrated) binoxide of manganese.

I know of no test for discriminating between free manganese binoxide and manganese oxide combined with oxides of the type R''O; what can be done in a case like the one in hand is to determine the exact ratio of the "MnO" present in all to the loose oxygen present. But a complicated complete analysis like the one reported, however carefully done, cannot possibly supply sufficiently exact data for this purpose.

I therefore selected from my stock a nodule which seemed to be exceptionally rich in manganese, and determined, by a specially devised process, the total manganese, as manganous oxide, and (by the ordinary methods) the loose oxygen.

To determine the total manganese, a weighed quantity of homogeneous substance was disintegrated by hydrochloric acid, the iron and alumina precipitated by means of acetate of soda and filtered off, and from the filtrate the manganese precipitated by means of bromine in presence of zinc salt. The precipitate (which contains all the manganese as binoxide) was dissolved by dilute sulphuric acid in an atmosphere of carbonic acid with a known weight of standardized ferrous sulphate and the excess of "ferrosium" titrated by permanganate. That this method, which every chemist will recognise as a slight modification of Kessler's, gives exact results had been proved by a series of experiments on known weights of manganese given as a solution of pure chloride which had been standardized by means of nitrate of silver.

In the analysis of the nodule two determinations gave—

I.	II.	Mean.
16.54	16.30	16.42

per cent. of manganous oxide (present as MnO . O_x). The loose oxygen was found to be as follows:—

		Mean.
Iodine method,	3.775	3.77
Oxalic acid method, ²	3.85	3.90

Dividing by the combining weights we have—

16.42 : 35.5 = 0.4626
3.77 : 8.0 = 0.4712
3.90 : 8.0 = 0.4874

Here the oxygen found is a little more than what would be sufficient to make the manganous oxide into binoxide. Possibly some of the loose oxygen may have been present as peroxide of cobalt (Co₂O₃); but I have had no time yet to inquire further into the matter experimentally. All I can say is that the determinations were made with great care at a time when we had become very familiar with all the manipulations involved, and I think I am safe in asserting that that particular nodule in all probability contains its manganese in the form of binoxide only.

¹ Here, as everywhere, H = 0.5 ∴ MnO = 35.5.

² 0.877 grm. of the substance when decomposed by acid (with ferrous chloride) gave less than 1 mgrm. of carbonic acid.