



# XVIII. On the existence of titanitic acid in hessian crucibles

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in the directions of the axes, and of the three lines *o A* respectively, will be

$$\frac{d\xi}{dt} \frac{d\eta}{dt} \frac{d}{dt} \quad \text{and} \quad \frac{ds''}{dt} \frac{ds''}{dt} \frac{ds'''}{dt},$$

and, we have also

$$w^2 = \left(\frac{d\xi}{dt}\right)^2 + \left(\frac{d\eta}{dt}\right)^2 + \left(\frac{d\zeta}{dt}\right)^2 = \left(\frac{ds'}{dt}\right)^2 + \left(\frac{ds''}{dt}\right)^2 + \left(\frac{ds'''}{dt}\right)^2 \quad (41.)$$

[To be continued.]

XVIII. *On the Existence of Titanic Acid in Hessian Crucibles.*

By MR. R. H. BRETT and MR. GOLDING BIRD.

*To the Editors of the Philosophical Magazine and Journal.*

GENTLEMEN,

WHILE repeating some experiments lately published on the presence of titanium in organic matter, especially in the renal capsules\*, we observed that when an alkaline carbonate was exposed to heat in Hessian crucibles, a fused mass was obtained, which was yellow while hot, but white and opake when cold; on dissolving this fused mass in dilute hydrochloric acid and mixing the solution with hydrosulphuret of ammonia, a deep olive green precipitate was obtained, which, when dried and ignited, yielded a white powder, insoluble in the dilute acids. These reactions so exactly resembling those yielded by titaniferous substances, we were induced to suspect the presence of titanium in the clay of which the crucibles were formed. To determine this with accuracy we undertook an analytical examination of the several varieties of Hessian crucibles usually met with, and we found them all to consist of (in variable proportions) silicic acid, titanic acid, alumina, and peroxide of iron, with traces of magnesia and manganese, and occasionally of lime.

The quantity of titanic acid present differed considerably in different specimens, in some not amounting to more than  $3\frac{1}{2}$  or 4 per cent., and in some few even to as much as 25 or 30: it was exceedingly rare to meet with so much as 25 per cent.; those crucibles that contained that quantity were generally small, very thin, brittle, and studded with numerous black semimetallic-looking specks. The quantity of peroxide of iron present was small compared to that of titanic acid, and they were by no means in the proportions in which they exist either in the iserine or in the menachanite, to the presence of which

\* See our last volume, p. 398.—EDIT.

forms of titaniferous sand we at first were inclined to believe the presence of titanium was owing, this opinion appearing to be corroborated by our noticing that in those crucibles in which the black specks (above referred to) were most numerous, the quantity of titanium appeared to be the greatest. The source of that metal in these crucibles must still remain a question.

We subjoin an outline of the process we followed in the analysis of these crucibles, as we believe that the (hitherto unlooked for) presence of titanium in these articles of chemical research to be of some importance in analytical chemistry.

1. A portion of a crucible was reduced to fine powder in an agate mortar, then carefully mingled with three times its weight of carbonate of potass in a platinum crucible; the latter was then exposed to a red heat until all effervescence had ceased; the heat was then raised to whiteness so as to ensure perfect decomposition of the silicious body. The fused mass while hot was yellow; on cooling, however, it became greyish and opaque.

2. The crucible being wiped from the adhering ashes was placed in a glass cylinder, covered with distilled water; hydrochloric acid was then poured in and the cylinder closed with a watch-glass. After some hours the fused mass was entirely *dissolved* or loosened out of the crucible; the latter was removed, rinsed with distilled water, the washings being added to the solution, which was nearly limpid, (a few light flakes of silicic acid were in suspension,) a little nitric acid was added, and the whole evaporated to dryness; the residue was diffused through a considerable quantity of distilled water and thrown on a filter: the silicic acid thus separated was washed with distilled water until the last portions of fluid ceased to affect nitrate of silver; it was then dried, ignited, and weighed.

3. The filtered liquor with the washings was evaporated over a steam-bath to half a pint, a few grains of sugar added (to reduce the manganese to protoxide and thus render it soluble in an ammoniacal salt), and ammonia poured in to supersaturation: a copious gelatinous precipitate fell, which was collected on a filter, washed with a dilute solution of muriate of ammonia, and thoroughly dried on a sand-bath.

4. The dried precipitate thus obtained, consisting of titanous acid, alumina, and peroxide of iron, was boiled in hydrochloric acid, which dissolved the alumina and iron; the insoluble titanous acid was then washed, ignited, and weighed.

5. The acid solution of alumina and iron was mixed with an excess of caustic potass and boiled: the peroxide of iron thus separated was then ignited and weighed.

6. The alumina was next obtained by boiling the alkaline solution with an excess of muriate of ammonia for some time: the resulting gelatinous precipitate was washed, ignited, and weighed.

7. The liquor (3.) from which the titanac acid, alumina, and peroxide of iron were separated, contained traces of magnesia and manganese.

The results obtained by examining several specimens, differed very considerably, as may be seen by comparing together the following results of four analyses:

	1st.	2nd.	3rd.	4th.
Silicic acid.....	75.1	70.0	68.0	66.0
Titanic acid .....	3.5	5.3	8.0	21.0
Alumina.....	15.0	18.7	18.0	8.0
Peroxide of iron.....	2.8	3.0	5.0	4.0
Magnesia .....	1.4	0.6	} 0.3	} traces
Oxide of manganese .....	.8	1.2		
	98.6	98.8	99.3	99.0
Loss .....	1.4	1.2	.7	1.
	100.	100.	100.	100.

In a very few specimens we have found the titanac acid to be present in very minute quantities, and in one or two only we could not succeed in detecting any. It is a very difficult matter to free the titanac acid from the peroxide of iron, the last traces of which adhere exceedingly obstinately to the acid; the process recommended by Berzelius, viz. adding tartaric acid to the acid solution of the mixed oxides and the subsequent precipitation of the iron by hydrosulphuret of ammonia, by no means succeeding perfectly. The use of oxalic acid for the purpose of precipitating the titanium and leaving the iron in solution is not more efficient, as the precipitate is found to be contaminated with a considerable quantity of peroxide of iron. The following is the process we prefer for the purpose of obtaining the titanium, free from iron. Ignite a mixture of carbonate of potass and powdered Hessian crucibles; digest the mass thus obtained in warm water for some time: this aqueous solution yields a very slight grass-green tinge with hydrosulphuret of ammonia. Dissolve the portion insoluble in water in hydrochloric acid, with the assistance of a gentle heat; dilute and filter the acid solution and wash the residue on the filter; when the acid has almost entirely passed the filter, the washings become opaline. The filtered fluid is then to be nearly neutralized with ammonia, and hydrosulphuret of ammonia added: a deep green precipitate falls, which is to be collected on a filter and washed with a di-

lute solution of muriate of ammonia. This precipitate is almost black in the mass, but when spread over the surface of white porcelain or paper, it appears of a fine sap-green; by exposure to the air it becomes nearly white on the surface, which discoloration speedily extends to some depth, (if all the hydrosulphuret has not been washed away, this change does not take place until after some time); it is then to be dried on a sand-bath and digested in weak hydrochloric acid, by which almost all the sulphuret of iron is removed; the insoluble portion is then to be again dried and ignited, in a platinum capsule over the circular-wick spirit-lamp (or if in considerable quantity, on a platinum tray in a small muffle); a cream-coloured powder is thus obtained, still containing a minute portion of iron, which may be got rid of by mixing it with muriate of ammonia, and exposing it for some time to a temperature below ignition. The titanous acid thus procured is tolerably pure.

In conclusion we would wish to remark that titanium appears to be more generally diffused through the mineral kingdom than is generally stated (in chemical works), as appears particularly from the following passage in Thénard's *Traité de Chimie*: "Le deutoxide de fer se rencontre sous forme de sables. Ces sables contiennent ordinairement de l'oxide de titane ou de l'oxide de chrome en combinaison avec l'oxide de fer. M. Descotils a retiré jusqu'à 30 parties de titane de 100 parties de sables ferrugineux de Saint-Quay, département des Côtes du Nord. M. Robiquet l'a rencontré dans le deutoxide de fer des roches steatiteuses de la Corse."

Guy's Hospital, Dec. 26th, 1834.

XIX. *On some Elementary Applications of Abel's Theorem.*  
By J. W. LUBBOCK, Esq., V.P. & Treas. R.S.\*

ABEL, in the third volume of Crelle's Journal, gave a theorem, which constitutes one of the most remarkable discoveries ever made in analysis, by which the methods of finding the sum of certain definite integrals were greatly extended. Cut off in the prime of life†, it was not given to the mathematician of Christiania to pursue the career which is opened to analysts by the theorem in question, or to illustrate its application by examples. This has been done to a certain extent by Legendre in the third Supplement of his work entitled *Théorie des Fonctions Elliptiques* ‡. As, however, no notice of this theorem has yet appeared in any work in the En-

\* Communicated by the Author.

† [See Phil. Mag. and Annals, N.S. vol. vii. p. 77.—EDIT.]

‡ [See Lond. and Edinb. Phil. Mag., vol. iv. p. 143.—EDIT.]