



XLIII. On the combination of silicium with platina; and on its presence in steel

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On the Combination of Silicium with Platina, &c. 185

The results in one view are as follow : Apparent time.

Beginning of the eclipse at Greenwich, Nov.	28	^{n.} 21	^{h.} 58	^{m.} 57	^{s.} 77
Greatest obscuration .. ..	..	23	4	15	06
Apparent conjunction .. ..	..	23	5	30	74
End of the eclipse	29	0	11	30	46

Digits eclipsed at greatest obscuration, on } ^{n.} 6 37 49-08
the north part of the sun's disc,

The moon will make the first impression on the sun's west limb at 35° 22' 29" from his zenith.

In your Magazine for April last, I observed a remark respecting the probability of an error of 6' in the place of the moon's node as given in the Nautical Almanack for 1821, 1822, and 1823. This induced me to make a calculation of the lunar eclipse of the 6th instant; and in comparing the elements as obtained by interpolation from the Naut. Alm. with those found by calculation from the tables, I found the results differed very little. But on further consideration, it occurs to me that the error alluded to must be in the longitude of the node, as given for every 6th day, page 3, of each month: and it would appear that the computers of this part of the work have neglected a certain quantity which is applied to the supplement of the node in Burckhardt's tables, to make the equations additive.

I am, sir, yours respectfully,

Aberdeen, Feb. 15, 1822.

GEO. INNES.

XLIII. On the Combination of Silicium with Platina; and on its Presence in Steel. By J. B. BOUSSINGAULT.*

IT was lately announced by M. Prechtel of Vienna, that he had succeeded in melting platina, in refractory crucibles, with an intense fire; and I therefore hoped (having access to the wind-furnace of the laboratory of the School of Mines, in which coke is used for fuel) to be able to accomplish the fusion of this metal: but the results were different from what I expected.

Of the Fusion of Platina.

One gramme of platina was placed in a plain earthen crucible; and a like quantity was put into a crucible lined with charcoal, and was covered with charcoal powder.

The two crucibles were set in a wind-furnance, and exposed for three hours to a very violent heat. (Under the same circumstances M. Leboulanger succeeded in fusing a perfect button of manganese.)

* From the *Annales de Chimie et de Physique*.

The platina in the plain crucible did not melt ; it only acquired a greater lustre. That in the charcoal crucible was completely melted into a button.

These experiments were repeated several times, and always with similar results ; and the metal was fused much more readily when covered with charcoal powder.

It was perceived, that the melted platina gained a small increase of weight in the process, showing its combination with some substance, which was naturally concluded to be charcoal, since it was every where in contact with this body.

The melted platina exhibits the following properties : Its aspect is greyish-white ; it is with difficulty cut with a knife, does not easily yield to the file ; its specific gravity is 20·5. In the cold it flattens a little under the hammer, but it soon cracks and presents a granulated fracture. When hammered at a cherry-red heat it becomes grained ; at a very low red it slightly flattens, and then cracks. It does not in any degree alter its temper by heating and gradual cooling. Exposed to the blast of a forge-furnace, it was not even softened. As this method was not sufficient to drive off the supposed carbon in its composition, it was cemented for an hour with oxide of manganese ; but the button of platina lost none of its properties, and remained equally refractory ; and I then began to doubt of the presence of carbon, which I had taken for granted. It was, therefore, important to examine whether platina would, like iron, combine with charcoal by cementation. For this purpose I stratified slips of platina with powder of wood-charcoal in a crucible, which was heated very strongly for four hours, but to a degree short of the melting point of platina thus circumstanced. On examination, the platina was found to have lost part of its lustre, and its surface presented small inequalities, like blistered steel. Its specific gravity was from 17·5 to 18. It acquired in the process a considerable hardness, so as easily to scratch pure platina, and even iron, but not steel. Its hardness was not increased by quenching in cold water. It had gained by cementation, as well as by fusion, a small increase of weight. Perhaps this process might be of some use in the arts, either in cutlery, or particularly in gun-making, where the softness of common platina is complained of.

Examination of the melted and cemented Platina.

Eighty grammes of this platina were treated with aqua-regia. The solution was more difficult than with pure platina. No trace of carbonaceous residue appeared during solution ; but, as it proceeded, there was observed a transparent jelly, which covered the bits of platina, and rendered the solution more difficult. By long digestion and much shaking, the whole, or nearly so, was dissolved :

dissolved: this was evaporated, and the dry salt redissolved in water, leaving a white powder behind.

This powder was then heated in a silver crucible with three parts of potash, in which it readily melted, and the alkaline mass easily and totally dissolved in water, with the exception of some minute fragments of platina separable by the filter. Sulphuric acid poured into the filtered fluid gave a white gelatinous precipitate, which was evidently silex. It is probable, therefore, that the wood-charcoal (which yields by combustion 2 or 3 per cent. of ash, chiefly siliceous) furnishes the silex that unites with the platina during the cementation, probably in the form of silicium, every circumstance being favourable for the reduction of the silex into its metallic basis. The silicium is not furnished by the crucible, for the cementation of the platina takes place equally well when a pretty large crucible is employed, and stuffed full of charcoal, with only a small cavity in the middle of it, to receive platina. The increase of weight thus acquired by the platina is very trifling. It is necessary not to use too much platina relatively to the quantity of charcoal, otherwise the fusion goes on very imperfectly, or not at all.

To ascertain further, whether the wood-charcoal furnished the silex, I repeated the experiment, using lamp-black instead of common charcoal; but the platina returned from the crucible unchanged, and quite ductile.

To judge of the quantity of silicium absorbed by the platina in the above-mentioned process, I took in one experiment exactly five grammes of platina, and after fusion the button weighed 5·025. One gramme of this button gave on analysis ·010 of silex. If the silex were in the state of earth in the metallic button, one gramme should have yielded only ·005, and therefore we must admit that it alloys with the platina in the state of silicium, and that it absorbs ·005 (or its own weight) of oxygen by solution in aqua-regia, whereby it passes into the state of silex. These are the proportions which I have assumed in calculating that of silicium as it enters into the composition of steel.

On Silicium in Steel.

The conversion of iron into steel is attributed to carbon alone; and this opinion, supported by the experiments of Monge, Berthollet, and Vandermonde, has been generally adopted by all chemists who have turned their attention to this subject. It is true that carbon is always found in steel; but another product, silex, which is as constantly obtained in the analysis of steel, and sometimes in as large a quantity as the carbon, has been usually considered as accidental. I have, therefore, expressly sought for

the silex in the analysis which I have made of several of the products of the foundry of La Berardiere.

I dissolved the steel in sulphuric acid, diluted with six times its weight of water. The insoluble residue was then dried, weighed, and burned, and the proportion of carbon was inferred by the loss in burning. It deserves to be noticed that this carbonaceous residue takes fire long before the platina crucible is red-hot; sometimes even when it is no hotter than the hand can bear. The residue after combustion was then digested with dilute muriatic acid, which dissolved the metallic oxides, leaving the silex pure, which last was then calcined and weighed when warm.

In this procedure the estimate of carbon is far from being rigorously accurate, but my principal object was directed to that of the silex. Experiments were made with four different samples, namely, 1st. Iron (*derive*); 2d. Cemented steel; 3d. Cast-steel; 4th. Steel from Monkland near Glasgow, made with Danemora Swedish iron.

The products were as follow :

No.	Iron.	Carbon.	Silicium.	Mang. & Copper.
1,	99·825	..... a trace	0·175	..... a trace
2,	99·325	..... 0·450	0·225	..... ditto
3,	99·442	..... 0·333	0·225	..... ditto
4,	99·375	..... 0·500	0·125	..... ditto

It appears, therefore, that during the cementation of iron into steel, it absorbs a small quantity of silicium as well as carbon; but I state this with some doubt, as it requires a greater number of analyses with the same iron both before and after cementation.

The combination of iron with silicium was long ago hinted at by Clouet. He says expressly that iron combines with glass; and of all the experiments that could be imagined to prove the property possessed by silicium to convert iron into steel, none would be more conclusive than that of this eminent chemist; but such is the force of preconceived opinion, that he interpreted his result in favour of carbon.—His process was, to melt soft iron with a mixture of clay and chalk, and it turned out good cast-steel: and being satisfied that steel must contain carbon, he inferred that his product contained it, and explained its presence from the decomposition of the carbonic acid of the chalk by the iron at a high temperature, without ever ascertaining by analysis whether carbon was really present in his steel.

To be satisfied of this fact, I repeated Clouet's process, following with scrupulous accuracy the description which he has given in his report to the Institute. (*Journal des Mines* XVIII.)

The

The iron which I employed was first assayed by digestion in dilute sulphuric acid, in which it dissolved without leaving any sensible quantity of residue.

The crucible was put into the forge at seven o'clock. At eight, the fusion being complete, I cast the metallic contents; the crucible having stood so well that it might have served a second time. Having thus obtained a quantity of Clouet's steel, I proceeded to examine its properties.

It yields to the file, and is forged with more difficulty than the steel of La Berardiere. It shows no spot after nitric acid has stood on its polished surface. It dissolved with difficulty in dilute sulphuric acid, preserving its metallic brightness all the time. The residue was very bulky, and proved to be siliceous quite pure and white, being in the proportion of 1·6 per cent. of the iron employed, 0·8 of silicium.

This steel, therefore, consists simply of 99·2 of iron, and 0·8 of silicium, without a particle of carbon: nevertheless the name of steel can hardly be denied to it, since it has the characteristic property of having its temper hardened by heating and sudden quenching in water. It may, therefore, be maintained that, for the conversion of iron into steel, silicium appears at least as essential as carbon, since we have none without the former; but we have one species without the carbon. Our knowledge on the subject, however, is too limited to enable us to deny the utility of carbon in steel, which perhaps is necessary to make it more easily wrought; and in fact all the kinds of steel that are employed contain carbon, whilst no use is made of that of Clouet.

Of Cast-Iron.

The fusibility of iron is shown by melting the metal in a Hessian crucible in a forge-heat. It may be questioned, however, whether the metal is pure iron.

Ten grammes of small nails were cut in pieces, half of them were dissolved in dilute sulphuric acid without leaving the smallest residue: the other half were melted in a Hessian crucible, yielding a well-fused and very brilliant button. This was more difficult to file and to forge than the iron which furnished it; like Clouet's steel, it preserved its metallic brilliancy during its solution in dilute acid; and it left behind a very white bulky residue of pure siliceous. The melted button was, therefore, composed of 99·46 per cent. of iron, and the siliceous obtained by solution was 1·08, being equal to 0·54 of silicium. This melted iron, therefore, has the greatest analogy with the cast-steel of Clouet: but in the latter case the clay and the chalk with which the iron is covered, form a siliceous envelope, in which the metal is kept immersed,

immersed, and which easily dissolves the oxide of iron formed by the decomposition of the silex, thereby facilitating the reduction. Whereas, when the iron is fused by itself, the silex can only be furnished by the crucible, to which it coheres with considerable force; and the oxide of iron, as it forms, soaks into the crucible, and serves to protect the earth from the contact of the metal; which is doubtless the cause why the conversion into steel cannot be completed without the presence of a glass.

We cannot, therefore, judge of the degree of heat required for the fusion of iron in a Hessian crucible, since it appears demonstrated that at a very high heat iron reduces silex, and combines with the silicium thus produced into a compound more fusible than iron *per se*. On the other hand, when platina is heated with silicium already formed, it unites with it into a more fusible compound; but if this metal does not melt by itself in a Hessian crucible, it is because it has so little affinity for oxygen, that it has not, like iron, the property of decomposing silex.

Though we cannot fix the degree of fusion of pure iron, any more than that of platina or of manganese, we may at least determine their relative fusibilities when in contact with charcoal or silicium, or both together; which, in a crucible lined with charcoal, is in the following order; namely, iron, platina, and manganese: and if we admit it to be probable that this is the real order of fusibility when they are pure, it will follow that manganese is a more refractory metal than platina.

XLIV. *Account of the Levelling taken from the Trigonometrical Station on Rumbles Moor and the Observatory, to the Canal, and ultimately to the Irish Sea; being a Continuation of the Article given in our last Number, p. 130. By A CORRESPONDENT.*

To Dr. Tilloch.

SIR, — **T**HE usual method of measuring the fall of a declivity is by means of a telescopic level placed between two staves marked with feet and inches, with a little additional apparatus to enable the observer to raise or depress the cross wires to the nearest *inch* on the first erected staff, and also to alter the height of the one in advance until a particular inch is covered by the telescope (by which means the fractional parts of inches and the use of the sliding vanes may be avoided):—a more accurate method could not be devised. It must, however, be found extremely tedious in practice, and the more so in proportion to the abruptness of the descent. Wishing if possible to avoid any errors of an optical nature,