

ART. XL.—*On two peculiar products in the Nickel manufacture;*  
by JOSEPH WHARTON.

I.

SEVEN years ago, when I was about to commence operations at Gap Nickel mine and furnace, I noticed among the fragments left by my predecessors a piece of nickel matte which contained occasional plates apparently of a metallic substance, tough, pliable, and elastic; these plates were about as thick as fine writing paper, from  $\frac{1}{16}$  in. to  $\frac{1}{8}$  in. wide and about twice as long. No chemical examination of them was made except a slight qualitative examination showing the presence of nickel, iron, and copper.

Having on several occasions subsequently noticed some tendency to a similar appearance in the matte, I gave directions that, when it should next be observed, a close examination should be made, after the extinction of the furnace producing the peculiar matte, of the solid mass which always remains in the bottom of the furnace.\*

This solid mass consists in part of lumps of ore, flux, and fuel of the first charge, which reached the hearth imperfectly melted or consumed and so remained, and in part of accretions from the thoroughly fused matte which, as the furnace worked, formed a pool over and enclosing those lumps.

\* It should be explained that the furnaces in question are small upright blast furnaces, in which the ores of Gap Mine (Nicolliferous Pyrrhotite with 2 per cent Ni and Co), previously roasted, are smelted for the first time, the product being a matte containing about 12 per cent Ni and Co, with about 4 per cent Cu.

The cavities of such a mass seemed to me favorable for the production of crystals when a tendency to crystallize existed.

Last midsummer very interesting groups of crystals were in fact found upon breaking up one of these masses to fit it for remelting; they were so small, however, that, except for search being made in consequence of the matte of that furnace having exhibited the plates above named, the crystals would probably not have attracted attention.

Some of these crystals are cubical, with a bright metallic luster, the groups closely resembling miniature geodes of galena; others are minute octahedrons, arranged in spiculæ, and in dendritic or plumy forms, resembling the fern-like aggregations of zinc crystals which I sometimes found in the prolongs of my spelter furnaces at Bethlehem, Pa. Specimens of both cubes and octahedrons are forwarded with this paper.

These crystals are very tough, and are highly magnetic. A spicula of the octahedrons can be bent many times without breaking, and one which was floated upon water, after being lifted a few times by a magnet, pointed steadfastly to the north, and showed attraction and repulsion to the poles of a magnet just as a steel magnetic needle would under like circumstances.

A specimen of the octahedral crystals, and a specimen of the granular or almost crystalline solid matter to which they were attached, were submitted for analysis to the chemist of my establishment with the following results:—

	Crystals.		Granular.	
Cu	1·85	0·466	1·74	0·438
Ni and Co	25·22	6·837	28·20	7·640
Fe	64·10	36·622	62·50	35·861
S	8·90	43·925	7·60	43·939
	100·07	1 : 4·93	100·04	1 : 5·78

The subordinate column in each case shows the quantity of S which would be requisite to form, with the metals found, the compounds  $\text{Cu}_2\text{S}$ ,  $\text{Ni}_2$  and  $\text{Co}_2\text{S}$ ,  $\text{FeS}$ ; the ratio, below it, is that of the S found to that thus calculated.

If we conceive the copper to exist as  $\text{Cu}_2\text{S}$ , we then have 89·32 parts Fe, Ni, and Co in combination with 8·43 parts S: taking then the average atomic weight of the metals according to the proportions found, as 56·85, the atomic ratio of the metals to that of the sulphur is as 31·4 to 5·27, corresponding very closely to the formula  $\text{R}_6\text{S}$ .

Should the copper be included in the average, we get the figures R 32·00 S 5·56, indicating, though less accurately, the same formula.

## II.

Desiring last year to make, in a granulated form, an alloy consisting of  $\frac{3}{4}$  nickel,  $\frac{1}{4}$  copper, I caused a mixture of the oxyds of those metals in the due proportions to be heated in closed crucibles with charcoal in a blast furnace; by this means reduction and fusion resulted, and the fused alloy was poured into water at a high white heat.

Among the granulated metal were found large numbers of hollow spheroids varying in size from peas to large chestnuts, many of them imperfect and torn, but many of them tolerably regular in shape, one side being usually bright and smooth, while the other was rough and pimpled.

As, upon crushing these with a hammer, the anvil was moistened, I examined a considerable number of them and found that they were nearly full of water, so that the water distinctly rattled within them when shaken, and showed itself in quantity when the larger spheroids were carefully broken. Fluid metal, poured white hot into water, had formed metallic bulbs filled with water.

For several days I carried some of these bulbs in my pocket, occasionally rattling the water in them, before the manner of their formation occurred to me. My first idea—that drops of metal falling upon the water were flattened by the blow, and that the edges then instantly clasped together and became welded, enclosing water within their grasp—was obviously untenable, for the eye could detect no seam or crevice, and besides, how could water exist as a liquid shut in by walls of this refractory alloy at a welding heat? Apple dumplings are formed in a manner somewhat similar to that, but these bulbs were not so formed.

The true solution is doubtless this: The metal when poured was in a state of ebullition, was giving off gas; not probably metallic vapor, but perhaps carbonic oxyd.

The separate globules into which the thin stream divided upon entering the water, were each emitting gas when contact with the water produced upon their surfaces an impervious film of solid or pasty metal. The continued evolution of gas in the fluid interior of such globules could have then no other effect than to distend the globule into a bulb, whose upper side might well be pimpled by the effort of tiny gas bubbles in the pasty shell to escape upward, while similar tiny bubbles working upward in the crust of the under side would reach the interior cavity, thus leaving the lower surface smooth and bright.

Multitudes of incipient globules were of course torn and distorted by reason of the internal gas finding a vent, and of course any which were rent must necessarily be filled by the water in which they were plunged. Those however in which

the eye found no aperture were doubtless filled, after the coldness of the external water had so contracted the heat-rarified gas as to produce an approximate vacuum within the bulb, by the slow imbibing of water through minute pores to supply that vacuum. That such pores existed was shown by the fact of the bulbs all in time losing their water by exposure to a desiccating atmosphere.

Not all the pots of metal produced when poured, such globules, for not all were in the fit state of ebullition.

The nature of the disengaged gas might perhaps have been determined, if a sufficient quantity had been collected by breaking the globules under a receiver, but this was not done. I send specimens of the globules with this paper.

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