MINING.

THE CHEMISTRY OF GOSSAN.

Written for the Engineering and Mining Journal by Stephen H. Emmens

(Continued.)

The heat produced is that corresponding to 3 molecules of ferrous sulphate, viz.....3 × 93,200		279,600
The heat absorbed is:		
1 Molecule of ferrous sulphide.....	23,780	
1 Molecule of ferric sulphate.....	224,970	
		248,751
Gain.....		30,850

We see that the ferric sulphate becomes reduced to ferrous sulphate again. This latter absorbs a fresh quantity of oxygen from the air and charges to ferric sulphate which, in its turn, attacks additional ferrous sulphide, and this process goes on until all the maracasite is dissolved away from the vein.

Next comes the turn of the pyrite, which, by precisely similar actions and reactions, is dissolved. The pyrrhotite follows in like manner.

We now arrive at the chalcopyrite. The mineral when analyzed shows a composition corresponding to $Cu_2 Fe_2 S_4$. What may be the precise arrangement of these molecules none as yet know; but it is customary and convenient, and, for the purpose of this discussion, not misleading, to consider the structure as a combination of one molecule of cuprous sulphide (chalcocite) with one of ferric sulphide, thus, $Cu_2 S\ Fe_2 S_3$. Here, then, part of the mineral consists of an iron sulphide, which, of course, is attacked and dissolved by the ferric sulphate left from the destruction of the sulphides previously dissolved.

The bornite ($3\ Cu_2 S.\ Fe_2 S_3$) and folgerite ($Ni\ Fe\ S$) are then robbed of their contained iron sulphides; and the ore in the vein is reduced to an aggregation of millerite, chalcocite, galena and blende. These minerals, we have already seen, are subject to attack by the atmosphere in the order here given; and we must now enquire whether they can also be attacked by ferric sulphate: and, if so, whether in the same or any other order.

In the case of millerite the equation of attack, if attack be possible, will evidently be

$$Ni\ S + Fe_2 (SO_4)_3 = 3\ Ni SO_4 + 2\ Fe SO_4 \times S$$

the heat balance sheet of which is:

Cr.	1 molecule of nickel sulphate	86,950	
	2 molecule of ferrous sulphate	186,400	
			273,350
Dr.	1 molecule of nickel sulphide	19,400	
	2 molecule of ferric sulphate	224,970	
			244,370
Gain			28,980

from which we see that one molecule of ferric sulphate will dissolve one of nickel sulphide producing one molecule of nickel sulphate, two of ferrous sulphate and one of sulphur. In like manner, the reaction with chalcocite, galena and blende are as follows:

$$Cu_2 S + 2\ Fe_2 (SO_4)_3 = 2\ Cu SO_4 + 4\ Fe SO_4 + S$$
$$Pb S + Fe_2 (SO_4)_3 = Pb SO_4 + 2\ Fe SO_4 + S$$
$$Zn S + Fe_2 (SO_4)_3 = Zn SO_4 + 2\ Fe SO_4 + S$$

while the respective gains of heat are: chalcocite, 14,510; galena, 14,800; blende, 25,940.

The conclusion we arrive at is, therefore, that ferric sulphate will attack all the remaining ores in the following order: 1. Millerite; 2 Blende; 3. Galena; 4. Chalcocite; and as the reaction is of the same character as in the case of the iron sulphides, it is evident that in the course of time the whole of the ores will be dissolved away and the gangue of the vein will alone remain.

But gossan consists of ferric hydrate in addition to gangue, while the reactions above set forth do not show any separation of that substance. Some further explanation is therefore needed. In the first place, it must be remembered that after the disappearance of the ore a certain quantity of ferrous sulphate will remain. This will absorb oxygen from the air but will have no further supply of free sulphuric acid or free sulphur capable of being converted thereinto. Accordingly, part of the ferric oxide produced will be unable to find enough sulphuric acid for the production of normal ferric sulphate. It will therefore be partly precipitated, thus,

$$12\ Fe SO_4 + 6O + H_2 O = 4\ Fe_2 (SO_4)_3 + 2\ Fe_2 O_3 . H_2 O$$

and it will partly form a basic bisulphate, as follows:

$$6\ Fe SO_4 + O_3 = 3\ Fe_2 O_2 (SO_3)_2$$

This bisulphate forms an insoluble yellow substance, and is precipitated with the ferric hydrate. It is found, together with coquimbite (a solidified form of normal ferric sulphate), in considerable quantities in the province of Coquimbo, Chili, and is regarded as having been produced by the weathering of iron pyrites.

(To be continued.)