

and copper they contain. The manufacturers, who only buy them for the sulphur they contain, sell the roasted mineral to works at which the copper is extracted. Such an establishment has been founded by F. Claudet and J. A. Philips, at Widness, near Liverpool.

“Spanish and Portuguese pyrites vary little in their composition. The following is a fair average from the mines of San Domingo, which furnish about half the pyrites used:—

“Sulphur	...	...	...	...	...	49·00
Arsenic	...	...	...	...	...	0·47
Iron	...	...	...	...	...	43·55
Copper	...	...	...	...	...	3·20
Zinc	...	...	...	...	...	0·35
Lead	...	...	...	...	...	0·93
Lime	...	...	...	...	...	0·10
Water	...	...	...	...	...	0·70
Quartz residue	...	...	...	...	...	0·63
Oxygen and loss	...	...	...	...	...	1·07
						100·00

“In the last item (1·07) are comprised traces of a great number of metals.

“These pyrites, after being roasted in the manufacture of sulphuric acid, form the material treated for the extraction of copper. They contain, with slight variations—

“Sulphur	...	...	...	...	...	3·76
Arsenic	...	...	...	...	...	0·25
Iron	...	...	...	...	...	58·25
Copper	...	...	...	...	...	4·14
Zinc	...	...	...	...	...	0·37
Cobalt	...	...	...	...	...	Traces
Silver	...	...	...	...	...	Traces
Lead	...	...	...	...	...	1·14
Lime	...	...	...	...	...	0·25
Insoluble residue	...	...	...	...	...	1·06
Water	...	...	...	...	...	3·85
Oxygen and loss	...	...	...	...	...	26·93
						100·00

“The traces of silver amount to from 20 to 28 grammes per ton, according to assay, and can be extracted with profit by the process now to be described.

“The pyritous residues are first pounded and sifted, and are then roasted in a reverberatory furnace, at a very low temperature, with chloride of sodium. The oxidation of the metallic sulphides and the decomposition of the chloride of sodium which follows give rise to the formation of sulphate of soda and soluble chloride of copper. When it is found by assay that the mineral has been sufficiently roasted, and has become cool enough, it is placed in a large wooden tub with a double bottom, forming a filter, and is several times washed with water slightly acidulated with H. Cl. until the copper is removed. The insoluble residue remaining in the tub consists almost entirely of oxide of iron, and has about the following constituents, according to analysis:—

“Sesquioxide iron	...	...	...	...	...	96·20*
Sulphate of lead	...	...	...	...	...	0·86
Copper	...	...	...	...	...	0·18
Cobalt	...	...	...	...	...	Traces
Alumina	...	...	...	...	...	0·45
Lime	...	...	...	...	...	0·46
Soda	...	...	...	...	...	0·10
Phosphoric acid	...	...	...	...	...	0·00
Arsenic acid	...	...	...	...	...	Traces
Sulphuric acid	...	...	...	...	...	0·49
Sulphur	...	...	...	...	...	0·16
Chlorine	...	...	...	...	...	0·03
Silica	...	...	...	...	...	1·22
						100·15

“This oxide of iron, on account of the uniformity of its composition, is sold to the ironworkers, where it is used with advantage to line the puddling furnaces. The washings from which the copper has to be recovered are poured into other tubs previously supplied with pieces of iron. Chloride of iron is thus formed, and metallic copper precipitated, taking with it the small quantity of silver contained in the liquid. The precipitated copper is then melted and refined, to bring it to the state of merchant copper. The liquid from which the copper has been separated still contains salts of iron and the alkalis, which are lost; but, in the subsequent operations adopted in our works, we obtain on the one hand sulphate of soda nearly absolutely pure; and, on the other, oxide of iron in a state of very fine division, suitable for polishing glass. The liquor, before the precipitation of the copper by the iron, contains, as stated, silver dissolved in the state of chloride. This cannot be extracted by precipitation with metallic copper, for, the silver being soluble in a mixture of chloride of sodium and bichloride of copper, the precipitation cannot take place until all the bichloride is reduced to the state of protochloride by the metallic copper added. Then the most minute quantity of silver is wholly precipitated by the excess of copper, but also with some protochloride of copper,

* = iron, 67·35.