

however carefully conducted, would not effect a thorough roasting of the pyrites, but produce, as it were—and as can be observed on examination of kiln-burnt mineral—three different stages. One part of it, in the centre of the larger quartz-fragments, is generally but little affected; another part is converted into a lower or mono-sulphide, which, in contact with clayey and siliceous dust, produces hard, glassy slag-coatings on the outside of the stone. The third part, that on the surface of fragments freely exposed to the access of air during burning, is well roasted—*i.e.*, converted into powdery sesquioxide of iron, with its originally-contained gold disseminated through it in microscopical particles. Now, on subsequent crushing and amalgamation of the burnt mineral, the gold of the slightly-affected pyrites cannot, or but very imperfectly, be extracted by the common amalgamating appliances (deep quicksilver troughs, amalgamated copper plates, &c.), whilst that distributed through the monosulphide of iron, the hard slag-coatings, and the iron sesquioxide is to a great extent lost—that of the first body through being too much enveloped, and the monosulphide itself being besides liable to sicken the mercury; that of the hard slag-coating through being glazed over, and is generally with very great difficulty liberated; and, finally, that of the well-roasted mass, on account of its finely-divided state, which renders it liable to be carried off by the stream of water without its having even come into contact with the mercury.

“2. Should the stone contain galena in association with pyrites, not only would the loss of gold be considerably increased, but quicksilver would be lost in notable quantities; the cause of this being the partial reduction or conversion of the galena in contact with the burning fuel into lead, a metal which, as is well known, strongly sickens the mercury. Of course all depends upon the quantity of pyrites and galena contained in the quartz. If this amounted to less than 1 per cent., rendering concentration not profitable, the burning of the quartz previous to crushing would, like that of stone containing no pyrites at all, be advantageous on account of the much easier reduction of the burnt stone, and consequent diminished wear and tear of the crushing machinery. It must, however, be remarked that with any ferruginous quartz there would also be a likelihood of the formation of the above-noted hard slag-coatings over the surface of the fragments, consequently liability to loss of enveloped fine gold particles during crushing.

“Metals found in Pyritous Quartz.”

“Besides gold and silver, the sulphides or ‘pyrites’ found in the auriferous-quartz veins contain other metals, some of which might be economically saved as by-products in a large establishment. At Maldon the pyrites of many of the reefs contains a very considerable quantity of copper, some assays reaching as high as 19 per cent. Others in the same district contain bismuth as sulphide, native metal, and as a native alloy with gold. The other districts are much the same. Nearly all samples of massive pyrites have been found to contain a notable amount of copper, and in many an amount of silver not in alloy with gold. The grey antimony ore of Costerfield was found to contain no less than twelve metals besides antimony—namely, gold, silver, copper, lead, arsenic, bismuth, cadmium, zinc, manganese, chromium, cobalt, and iron. At Dunolly, Burke’s Flat, and St. Arnaud the pyrites contain a large quantity of argentiferous galena.

“Methods of Treatment.”

“Where the mineral to be treated is chiefly a mixture of iron, arsenical, and copper pyrites, the simple addition of salt (chloride of sodium) in the reverberatory furnace will be found to render the copper and silver soluble in water. Particulars of the methods of treatment of the solution will be found in most of the recent metallurgical works. One ingenious method by which salt is saved is to roast the pyrites to about 5 per cent. of sulphur, and then add to it 4 per cent. of salt, and continue the roasting for a few hours. The copper and silver are rendered soluble in water, from which solution they are precipitated as sulphides by sulphuretted hydrogen. The first fifth of the precipitate contains all the silver; this is separated, and the precipitation of the copper continued. The sodium compounds (sulphate of sodium) contained in the solution is converted into sulphide by evaporating it to dryness and igniting with coal-dust in a closed furnace, and the sulphide then serves to supply sulphuretted hydrogen to precipitate a fresh quantity of copper and silver, while it is converted into carbonate of soda by a stream of carbonic acid gas from a lime-kiln.

“Oxidation by Atmospheric Action.”

“In South America the Indians decompose the pyrites by exposing them to atmospheric action. The pyrites are decomposed into basic sulphate of iron, and the gold is liberated so that it may be amalgamated; but by this process several years are required to fully decompose each heap. It is, however, worth considering whether this process of oxidation could not be hastened, so as to make it applicable to our requirements, and enable miners in outlying districts to get the gold from the pyrites not allowed to run to waste with the quartz-tailings. A few inexpensive experiments might be conducted, either by constructing a heap with brushwood so as to allow a free circulation of air, or by making a heap on the principle of a “nitre plantation,” with nitrogenous matter. The latter would seem to have all the necessary conditions—heat, moisture, with air and nitrates to carry on the oxidation.

“Smelting.”

“Smelting pyrites containing galena presents no metallurgical difficulties. Where there is much lead it would probably be the best method, collecting the gold and silver in a lead button; but where lead is absent the process of roasting, extraction of the copper and silver, and amalgamation for the gold, is undoubtedly the most advantageous, as it would allow a number of processes being carried on in one establishment, producing several profitable products.”

“Where antimony is present in large quantity, smelting is also necessary, and a process is patented by us, in connection with Mr. H. Y. L. Brown, for the extraction of gold from auriferous antimony ores. The process consists in passing the same quantity of metallic antimony through