ROASTING OF GOLD AND SILVER ORES: AND THE EXTRACTION OF THEIR RESPECTIVE METALS WITHOUT QUICKSILVER

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and "Concentration of all Kinds of Ores."

Illustrated with Numerous Engravings.

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PREFACE.

The publication of this Treatise is due solely to the many inquiries concerning the "Leaching, Solving and Precipitation Process for Silver Ores," now successfully practiced in Sonora, Mexico, where it has been lately introduced by Mr. Ottocar Hofmann.

In consideration of the very important preparation of the ore, before it is subjected to the Solving Process,—namely, the Roasting,—I have thought it proper to devote considerable space to the description of different modifications of this operation, which is regulated by the peculiarity of the ore, and by the subsequent treatment. It is impossible to give any one way which will be suitable in every case; for this reason, and in order to cover all cases as far as possible, a detailed description of different modes of Roasting will not be superfluous.

The Solving Process, as now practiced, is a very economical method for the extraction of silver, for the reason that no quicksilver and no castings are used except what are needed for crushing. Mills in Mexico being dependent on San Francisco for the shoes, dies, gearing, etc., of amalgamating pans, millmen there know how to appreciate a process confined to wooden tubs requiring no power. A comparatively small capital is necessary for building up such works, and hence there is a more reasonable ratio established between the amount of money which must be expended on the works and the real value of the mine, than where other more expensive

machinery is employed,—a circumstance which, being insufficiently regarded, is often the source of failure.

Mr. O. Hofmann commenced first with the "Chlorination Process" (§ 82), but finding great difficulty in obtaining the regular supply of sulphuric acid and manganese from San Francisco, abandoned the chlorination with cold chlorine gas, which is indispensable in the presence of gold. Another difficulty was in obtaining a good article of sulphide of sodium. He tried to extract the potash from ashes, and to use this in place of soda, but decided finally in favor of lime, which is found in abundance. From this the sulphide of calcium is easily manufactured on the spot. Sulphide of calcium was first applied by Kiss (§ 80).

The Solving Process is very simple, and readily performed by common workmen; besides the lime, only brimstone must be provided, in order to prepare the necessary chemicals for solving and precipitation. It is a general but erroneous belief, that the solving is a slow process. An amalgamating pan is charged with 500 to 1,000 pounds of roasted ore, and treated at least six hours, and therefore turns out at most two tons in 24 hours; while a box or vat of proper size used in the Solving Process, can work from four to five tons in the same time.

Only those ores are treated by this process which absolutely require roasting; which, however, with improved furnaces, is not so expensive as it used to be. The chloride ores alone can be leached directly without roasting, and this when there is no other silver combination in them.

G. Kustel.

March, 1870.

I. INTRODUCTION.

Classification of Ores.

1. Ores may be classified: *a.* According to the metal, the extraction of which is principally remunerative; as silver ores, lead ores, copper ores, etc. *b.* According to the metallurgical treatment; as roasting ores, smelting ores, amalgamating ores, etc. *c.* According to the predominant gangue, as calcareous ores, quartzose or ochery ores. *d.* According to the predominant metallic mineral; as sulphuret ores, chloride ores, carbonates, etc.

Important Silver Ores.

2. The most important silver ores are those found in such quantities as to be an object of metallurgical operations. The principal minerals of this kind are the following:

A. Real Silver Ores. a. Sulphuret of Silver, or silver glance, with 87 per cent. of silver. It is of common occurrence, and is the most suitable of the silver sulphurets for pan amalgamation without

roasting. *b. Brittle Silver Ore*, or sulphuret of silver and antimony. This mineral contains 68 per cent. of silver, and is quite common. *c. Polybasite*, sulphuret of silver, antimony and some arsenic, with 75 per cent. of silver. Brittle silver ore and polybasite are both tractable in pans without roasting, although not so readily as the simple sulphuret. All other sulphureted silver ores require roasting. *d. Ruby Silver*. The dark red silver ore, or antimonial variety, with 59 per cent., and the light red silver ore, or arsenical variety, with 65 per cent. of silver, are valuable minerals. They occur quite frequently in Nevada, Idaho, Montana, Mexico, etc. *e. Miargyrite*, sulphuret of silver and antimony; 36.5 per cent. of silver; Idaho, Montana, etc. *f. Stromeyerite*, or silver copper glance, a sulphuret of silver and copper containing up to 53 per cent. of silver; Nevada, Arizona, etc. *g. Horn Silver*, or chloride of silver, with 75 per cent. of silver; occurs massive in White Pine, Nevada; prepared by nature for the pan amalgamation. *h. Stetefeldtite* and *Partzite*, with up to 25 per cent. of silver, are oxide ores which occur very frequently in Nevada, Arizona, etc.

B. Argentiferous Ores. a. Silver-fahl-ore, argentiferous gray copper ore. It contains silver in very variable proportions up to 31 per cent. This ore is quite common, and for this reason is important. It is also one of the most rebellious ores, containing copper, antimony, arsenic, sulphur,

lead, iron, zinc, and sometimes gold and quicksilver. *b. Argentiferous Lead Ores*, galena, or sulphuret of lead, lead glance. Generally, this is not rich in silver, containing from $20 to $60 per ton. Specimens assay sometimes as high as $300. The fine grained variety is generally considered richer than the coarse crystallized kind, but this has not been observed to be the case in Nevada and Arizona. *c. Cerusite*, carbonate of lead. If pure, without admixture of copper and other carbonates, it is poor in silver in most cases. Raw, it amalgamates only too readily in pans. Smelting is the only proper way of treating galena and cerusite. *d. Argentiferous Zincblende.* Sulphuret of zinc. Pure zincblende contains usually only traces of silver; often, however, it assays well, even up to $400 per ton, although no other silver ore can be detected with it. In some mines the argentiferous zincblende prevails, and is the most important ore. It requires a great heat in roasting. *e. Argentiferous Pyrites.* Copper and iron pyrites are poor in silver, but often auriferous. Pyrite is a valuable companion for silver ores which have to be treated by a chloridizing roasting, on account of its amount of sulphur, which is necessary for the decomposition of salt.

Difference between Real Silver Ores and Argentiferous Ores.

3. Real silver ores have mostly an unvariable amount of silver. Real silver minerals admit an