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Report on the
Dressing and Metallurgical Treatment
of an
Argentiferous Lead ore. from
Georgetown Colorado. as performed
at the Mining Laboratory of the
M. I. T.

by.

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This ore was taken from one of the veins intersected by the Burleigh Tunnel Georgetown Colorado. The vein is similar in formation, and found in the same crystalline rock; "which are probably of the Laurentian age," as the other veins of ^{that} region, some of which are very rich in silver.

This ore however is one which was considered too poor for working in that locality.

The following are the minerals which were found in the ore.

Coarse and Fine grained Galena

Zinc Blende. (Black)

Pyrites, mostly granular.

Chalcopyrite

Rhodochrosite (in very small quantities)

Feldspar

Mica

Quartz.

The Galena, Zinc Blende, and Pyrites formed the greater part of the ore, the Galena being by far in the greatest quantities.

From inspection of the ore it was evident that it would be advisable to concentrate the Galena into one portion, fit for smelting.

The Zinc Blende into another to be treated by Chlorination Roasting followed by Amalgamation.

And the dust which would result from crushing &c, and would contain portions of all the minerals, ^{to be treated} by gas chlorination: thus making three distinct Metallurgical

operations.

The Dressing of the ore was performed as follows:

Weight of Ore taken = 476 lb. - 14 oz.

The ore was first picked over by hand and all the pure lumps of Galena, ~~ore~~ and galena which had some pyrites but no Zinc Blend attached ^{part.} into one portion, and the other stuff into another, thus making two portions

- | | | |
|--|-----|----|
| (a) Galena + Galena + a little Pyrites | lb | oz |
| | 144 | 14 |
| (b) Zinc Blend &c | 331 | 2 |

Then the Portion (B) was crushed in a Blake's Crusher set at $\frac{3}{8}$ of an inch. and sized with sieves and made ready for jigging. All smaller than $\frac{1}{2}$ of an inch was saved in a separate portion being too small for

jigging.

The sizes obtained for jigging were.

- (1) between $\frac{3}{8}$ and $\frac{1}{4}$ in
- (2) " $\frac{1}{4}$ " $\frac{1}{8}$ "
- (3) $\frac{1}{8}$ " $\frac{1}{20}$ "

The jigging was performed by a hand jigger, and yielded a very good separation of the Galena from the Blende. Four layers were formed in the ^{jigger} Blende, then Pyrites, then Blende and last the gangue.

In scraping out the jigging sieve I made three portions.

- | | | |
|----------------------|----------|--------------------|
| (A) Gangue | Height = | $\frac{11}{2}$ - 2 |
| (B) Blende + Pyrites | " | = 70 - 0 |
| (C) Galena + Pyrites | | = 187 - 2 |

The stuff that was too fine for jigging was then sifted through a 40 mesh sieve, and that which

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went through the sieve formed the portion for the Gas Chlorination Process.

The other portion which consisted of sizes between No and 1/40 ~~of the~~ inch was put over a ^{Rittinger} ~~Freiberg~~ Shaking table.

This galena, that is the pure galena, almost all collected on one side of the table forming a ridge while the Gangue, Zinc Blende and some of the Galena, found its way into the boxes at the end of the table.

There were three of these Boxes and they may be designated as No 1
No. 2 and No 3. 4

No. 1 contained nearly pure Galena,
No. 2 Zinc Blende Pyrites and some Galena. and No 3 Gangue with some Zinc Blende and Pyrites.

The stuff in No 1 was fit for

Smelting, that in No 2 was paused in order to separate the Galena which it might contain.

This ended the dressing of the Ore and yielded the three portions before spoken of.

No I Smelting Portion. consisted of Pure Galena from hand picking + Galena and Pyrites from jigging + Galena from the Freiberg table, the total weight of which was. 342 lbs.

No II Portion for Chlorination Roasting consisted of the Zinc Blende Gangue and Pyrites that was left after separating the Galena. Wt = 92 lbs 10 oz

No III Portion for be treated by Gas chlorination. has been previously stated. Weight = 42 - 13 oz.

The Metallurgical work will be

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described under the above named heads.

No I. There was such a small quantity of the ore that it was thought best to smelt in crucibles.

A Plumbago Crucible, and an Anthracite coal fire were used.

The ore was first ground in a Chillian Mill, so that the largest particles were not more than $\frac{1}{20}$ an inch in size, and then sampled, and a wet assay made.

It was found to contain.

60.00% of Pb

4.48% .. SiO_2

In making up the charge for smelting, the principle observed, was to add enough Fe. to combine with all the sulphur in the

Galena (PbS) and to make a slag of the silica the composition of which should be ($3FeO. 2SiO_2$), an allowance to be made for the other Sulphides which were in the ore.

The charge which seemed to give the best results was as follows.

Ore. 18 lbs.

Fe_3O_4 . 11 - 62

Powdered Anthracite 2 - 702.

The coal being added to reduce the Fe_3O_4 to Fe .

The result of this smelting which gave crude lead containing almost all of the Silver in this portion of the ore was. in wt. 162 lbs.

the loss being ~~account~~ about 33 lbs. of Lead, which is accounted for volatilization and the breaking out.

and certain percent in the Iron matt.

The Lead thus obtained was then refined by melting in a plumbago crucible and skimming and yielded 148 pounds of refined Pb. After Refining the Lead was ready for treatment to obtain the Silver.

The Ore contains $\frac{79}{1000}$ % of Silver or. 23.044 oz to the ton.

The amount in the 342 lbs taken is 3.933 oz.

The Refined Lead contained $\frac{123}{1000}$ % of Silver to the ton or. 35.84 oz, and the Refined Pb should yield 2.64 oz

The silver was extracted from the Silver Lead by Parker. Process.

That is by stirring into the Lead which was melted in a crucible

5 lbs of Melted Zinc, ~~and~~ then
 skimming the Zinc which has
 previously been well mixed with the
 molten lead, and ~~and~~ when cobling
 rises to the surface. These skimmings
 were saved for further treatment
 and the Lead was cast into pigs.

This yielded 103 lbs - 2 oz of
 desilvered lead.

The rest of the lead being with the
 Zinc as the result of skimming.

To obtain the silver from this,
 the Zinc was got rid of by volatiliza-
 tion. and as a result we had a
 very rich silver lead ready for
 Cupellation. This lead contained, as
 calculated from the assay of .078 oz.

The desilvered lead contained
 .638 oz. The great loss of Silver

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Was due to the fact that during the cupellation, the cupel, which was made of bone ash enclosed in a thin sheet iron ring cracked and the lead all ran through into the bottom of furnace, and had to be taken out and purified by remelting and skimming off the mortar and bone ash which rose to the top of the molten metal.

The complete analysis of this portion as well as of the other portions although very important had to be omitted on account of lack of time.

No II Portion for Chlorination.

Roasting followed by Tub Amalgamation.

The Ore was first ground in a Chilean Mill with 10 lbs of NaCl and then sifted through a 60 mesh sieve and the coarser portion reground until it was fine enough to go through a 60 mesh sieve.

This was necessary in order to thoroughly mix the salt, and to have the ore in a condition to roast uniformly.

The ore was then roasted ~~uniformly~~ in two portions in a small Reverberatory furnace. to a dead roast. Each operation taking about 2 hours.

The salt was added to convert the silver which might be in the ore into the state of chloride

Besides the Silver some of the Copper and Iron were also converted into chlorides.

The Roasted ore was then transferred to the ^{amalgamation} tub and made into a semi fluid ~~sand~~ by adding water, and after stirring about 1/2 hour with scraps of metallic iron

2 Kilos of Mercury were added in small portions, by straining it through a thick linen cloth. The paddles were kept revolving about (4) four hours and then on account of the large quantity of amalgam which seemed to have formed on the bolt heads, and other iron of the paddles another Kilos of Mercury was added. This being added in the same manner other ^{portion} and the stirring continued for 2 hours

The Simi flued mud was then all washed away, out of the tub by a powerful jet of water, thus leaving the mercury in the bottom of the tub ready for treatment to obtain the amalgam which it might contain.

The Amalgam was obtained from the Mercury by straining through a piece of Buck's skin. the Mercury passing through and the amalgam remaining on the filter. The mercury which had flowed, was concentrated by agitating in a flask, in a solution which seemed to clean it very well.

The amalgam which adhered to the bolts and scrape of iron was scraped off and put with the pure amalgam.

The results obtained were as follows.

Weight of ore taken 92 lb 1 oz.
containing $\frac{3}{100}$ % of silver or 8.75102 to the
ton. The ore thus contained 0.402502

Weight of Amalgam obtained

Pure: 259.29 grams
impure. 183.50
442.79.

after distillation of the amalgam which
was done in an Iron-retort with a condenser.
The Mercury, driven over and condensed,
weighed 344.

Retort 71.5
415.5.

Thus giving a loss of 27.29 grams of Hg
in the distillation. The mercury which
had been filtered through the Buckskin
was then distilled and there was
a loss of about 30 grammes, in this
case.

The total loss of mercury in the whole operation was 50 grammes.

The amalgam turned out to be mostly copper amalgam, so that it was melted down with 1/2 lb of lead and put with silver lead and treated in the cupellation furnace, with the rich silver lead of the Smelting Portion.

This lead contained, by assay, 0.243 oz of silver.

The Amalgam stuck to the bolts and paddles was all included in that which was distilled in the Retort.

No. III

This portion was first Roasted dead in a small Reverbratory Furnace.

And then Transferred to a jar. for Chlorination. The jar was about half filled with beach pebbles which made a porous bottom then the ore was put in on top and saturated with Chlorine Gas. the chlorine was introduced through ~~the bottom~~ a tube at the bottom of the jar. Owing to the large amount of Zinc in the ore it took an immense amount of Cl_2 gas. to perform the work.

The wt. of the ore taken was 42 lb 13 and it contained $\frac{5}{100}\%$ of silver or 14.585 oz. to the ton. or for the 42-13 or 0.313 oz of silver.

After Saturation and standing over

twenty-four hours. The ore was leached by a solution of hyposulphite of soda.

This solution being made by dissolving 225 grms. of Hyposulphite of Soda in 2.25 litres of water. it being necessary to have a solution of this strength in order to dissolve the chloride of silver which was formed. It was further leached by adding two litres of Water.

The Solution thus obtained contained all the soluble AgCl. and this was precipitated as sulphide by adding a solution of Polysulphide of Sodium to this solution.

The tailings contained $\frac{5}{1000}$ % of Silver or 1.4585 oz to the ton.

June 16th 1874