

14½ tons of ore were handled per man per day. Counting the total force of the smelter, the sample mill requires 10 men for unloading and crushing ore, sampling and distributing same into ore mixtures, and loading the shipping matte, engineers, foremen, 1 blacksmith with a helper, 1 carpenter, besides 8 more men, making the total number of men employed, including foremen, 47, which at 422.5 tons of ore put through daily, makes 9 tons of ore handled and smelted for every man employed, which I believe is a record.

As for the character of the Mother Lode ore, it may be classified into limy, iron and sulphur ores, and it is desirable for the smelting to have reserves of these different kinds to help out at times, when in the daily tonnage from the mine too much of one or the other sort is on hand. I give below the assay and analysis of three large lots of these different ores:

- Sample of Irony ore from 1,000 tons lot.
- Sample of Limy ore from 1,600 tons lot.
- Sample of Sulphur ore from 120 tons lot.

	a. Irony	b. Limy	c. Sulphur.
Copper	2.8 %	2.2 %	2.7 %
Gold	0.11 ozs.	0.09 ozs.	0.15 ozs.
Silver	0.58 ozs.	0.43 ozs.	0.15 ozs.
Insoluble	28.7%	35.2%	29.8%
Fused silica	16.9%	29.2%	24.5%
Iron	32.7%	14.7%	17.5%
Lime	5.6%	19.8%	16.0%
Sulphur	3.7%	5.3%	13.7%

The character of these ores is not only self-fluxing but at times rather basic. I have therefore sometimes smelted to advantage as much as 5% to 6% of straight quartz ores with them.

Before starting up the furnace, I had my doubts whether I could make higher grade matte than 30 to 35% copper, without resorting to roasting the ore, but I found by actual practice, what I had hoped, that the iron variety, which is magnetic oxide of iron (Fe^3O_4), in smelting and reducing its iron to Fe^2O^3 for the slag, gives off 1 atom of oxygen for every molecule of Fe^3O_4 , and this oxygen acts as a powerful desulphurizer, so that I have, in fact, burned off as much as 85% to 90% of the sulphur in the charge at times. I have aimed at making a 45% to 50 copper matte, but sometimes it has come out as high as over 60% copper, through having had rather much of the iron ore in the charge. I may mention, in connection with making this high grade copper matte, an interesting fact, viz.: that whenever the matte begins to come up to 53% copper and above, the gold will "lock up" in the furnace in the metallic copper bottoms which form. One week when making 58% to 63% copper matte I had gold locked up to the value of \$6,000 in the furnace bottom; the next week I had sulphur ores with which I could get the matte down to 45% copper, and I then got all the gold out in five days. Silver does not behave in this way.

The Mother Lode ore is exceptionally free from arsenic and antimony and behaves quite differently to certain other British Columbia ores which carry quite an amount of these metals, and in running which I have found metallic copper and speiss separate out as soon as the matte came up to 47%, causing much trouble in filling up the tap-hole and threatening in this way to plug up the furnace. To obviate this I have found it necessary, elsewhere, to change the

trapped spot to the ordinary way of stopping up the tap-hole with clay and when the bottom was rising up inside the tap-jacket I used to blow the furnace for five minutes and the blast, following through, melted the gathering metallics and speiss. With the Mother Lode ore, however, I have made as high as 67% copper matte in the blast furnace, using a trapped blast, without filling the tap-hole with metallic copper.

For its size (42 inches by 150 inches at tuyeres), I think this furnace has the best record so far for large tonnage and at the same time cleanness of slags made. The coarseness of the ore has a great deal to do with tonnage, and to some extent clean slags, as was discovered when we began to crush it to a 5-inch size, instead of from 2 to 3 inches as at first. A couple of per cent. of silica, more or less, in the slag does not slacken these big furnaces up as quickly as it does smaller ones; neither is high lime as bad. What I have found troublesome, raising the copper in the slag, and making it heavy with a poor separation of the matte, is when the iron in the slag comes up to 30% and 32%, and silica at the same time is low, say 2½% to 30%.

I give below examples of some different kinds of slag made, with the corresponding tonnage.

Nov. 7th, 1900—Slag: $\text{SiO}_2=42.7\%$; Fe, 21.1%; $\text{CaO}=20.0\%$, and Cu 0.33%; matte, 44% Cu; furnace smelted 393 tons of ore.

April 1st, 1901—Slag: $\text{SiO}_2=33.8\%$; Fe=25.4%; $\text{CaO}=25.7\%$, and Cu=0.25%; matte went 49% Cu; tonnage 402 tons of ore; high lime has a tendency to make the slags free from Cu.

July 7th, 1901—Slag: $\text{SiO}_2=30.9\%$; Fe=32.5%; $\text{CaO}=16.8\%$; Cu=0.44%; matte, 53% Cu; tonnage, 399 tons.

January 10th, 1902, (when the furnace put through 459 tons of ore) slag: $\text{SiO}_2=37.8\%$; Fe=24.5%; $\text{CaO}=20.9\%$, and Cu=0.35%; matte, 49% Cu.

We make slag assays for copper twice a day, but do not make it by the generally adopted colorimetric method, which, as a rule, gives too low results and deceives the metallurgist, making him believe and tell others that he makes cleaner slags than he does. The slag samples are taken every hour, chilled in water, and the day and night shifts kept apart. Two grammes are taken for the determination, dissolved in hydronitro-chloric acid evaporated with H_2SO_4 diluted, and the copper precipitated with hyposulphite of sodium solution; the Cu_2S is dissolved in HNO_3 and titrated with KCy ; this determination takes somewhat over two hours, but it is correct and reliable, and it will check, as I have proved, to one hundredth of one per cent. (0.01%) of copper. Where you have very little copper in your charge, it is important to have accurate determinations of your slags, and to keep them low in copper, as 0.1 of one per cent. makes quite an item. These daily slags are then put together, and once weekly an average assay of them all is made for gold, silver and copper. The slags, as a rule, have been very clean, as follows:

Copper, varying between 0.30 and 0.037 per cent.

Gold, varying between 0.0025 and 0.0035 ozs.

Silver, varying between 0.04 and 0.07 ozs.

Of course more copper in the slag is allowable in making 50% Cu matte, than in making 30% Cu