1926

Mining methods at the Higueras district, State of Coahuila, Mexico

Harry Herbert Hughes

MINING METHODS AT THE HIGUERAS DISTRICT, STATE OF COAHUILA, MEXICO.

BY

HARRY HERBERT HUGHES, JR.

A

THESIS

submitted to the faculty of the

SCHOOL OF MINES AND METALLURGY OF THE UNIVERSITY OF MISSOURI

in partial fulfillment of the work required for the

Degree of

ENGINEER OF MINES

Rolla, Mo.

1926.

Approved by C.P. Forbes

Professor of Mining.

CONTENTS

ILLUSTRATIONS

INTRODUCTION

The Higueras district, in the State of Coahuila, Mexico, is little known even in Mexico; and it is probably safe to say that not one out of every hundred engineers in the United States has even heard of it. This is easily accounted for by the fact that the district is small and relatively unimportant economically. Also, as one becomes more accustomed to think of mines, such as some of the big copper deposits, with productions running into thousands of tons daily, there is a tendency to pass over the small ones, giving them only a passing thought, if that. Though there have been, and still are, many mines with productions of only a hundred or so tons per day which are giving larger returns on their investments than are some of the larger producers.

The Higueras district has not produced more than a million and a half tons of ore; but when we consider that there are only four mines in the district; that most of this tonnage has come from two of them; and that the average grade of the ore was no lower than 25% lead and 250 grams silver, we are apt to respect it more in spite of its size.

From the viewpoint of the miner, however, there are some things in the district which are of much

greater interest than profits. Among these the most important is the evolution of the system of mining from what it was in the early days of the camp, when there were the large high-grade orebodies to be mined, to the present system which is in use in mining the low-grade remains of the mines. This point alone would be excuse enough for another paper to be added to the already long list of "Mining Methods".

The camp is relatively young. That is to say it was not worked by the Aztecs or Spanish Conquerors; and there is little romance connected with it in the way of fabulously rich bonanzas. The first ore was mined about 1902, production reached its peak about 1918; and has been steadily declining since, until at present the camp is almost abandoned.

The only two producing mines at the moment are Paloma, and Cabrillas; and they have always been the largest producers. For this reason, and because the writer is more familiar with them, these two will furnish most of the material for the discussion of the district. Except for mechanical equipment however, they are quite representative of the whole camp.

Higueras is located 3 kilometers from the main line of the Laredo - Mexico City railroad, about seventy-

five kilometers from Monterrey, Nuevo Leon; and thirty-five kilometers from Saltillo, the capital of the State of Coahuila. The ores are all shipped to Monterrey for smelting. This proximity to the market, as well as the fact that there is a plentiful supply of cheap native timber in the hills back of the camp have been the deciding factors in allowing the profitable extraction of the low-grade ores in the last seven years.

GEOLOGY

In the Paloma and Cabrillas mines there are some local geological phenomena which are admittedly more difficult of solution than any in the other sixteen mines which are scattered all over Mexico, and owned by the operating Company. Partly because the writer does not understand these phenomena himself; and also because a detailled discussion of the geology is not warranted here only the general features will be given.

The Higueras district is in a branch range of the Sierra Madre Oriental; and as far as stratigraphy is concerned the ore-bearing horizons are the same as those of most of the silver-lead limestone replacement deposits of Northern Mexico. At Higueras the rock of the ore horizon is called dolomite; and though it is not a true dolomite it carries from 15% to 23% MgO. In the majority

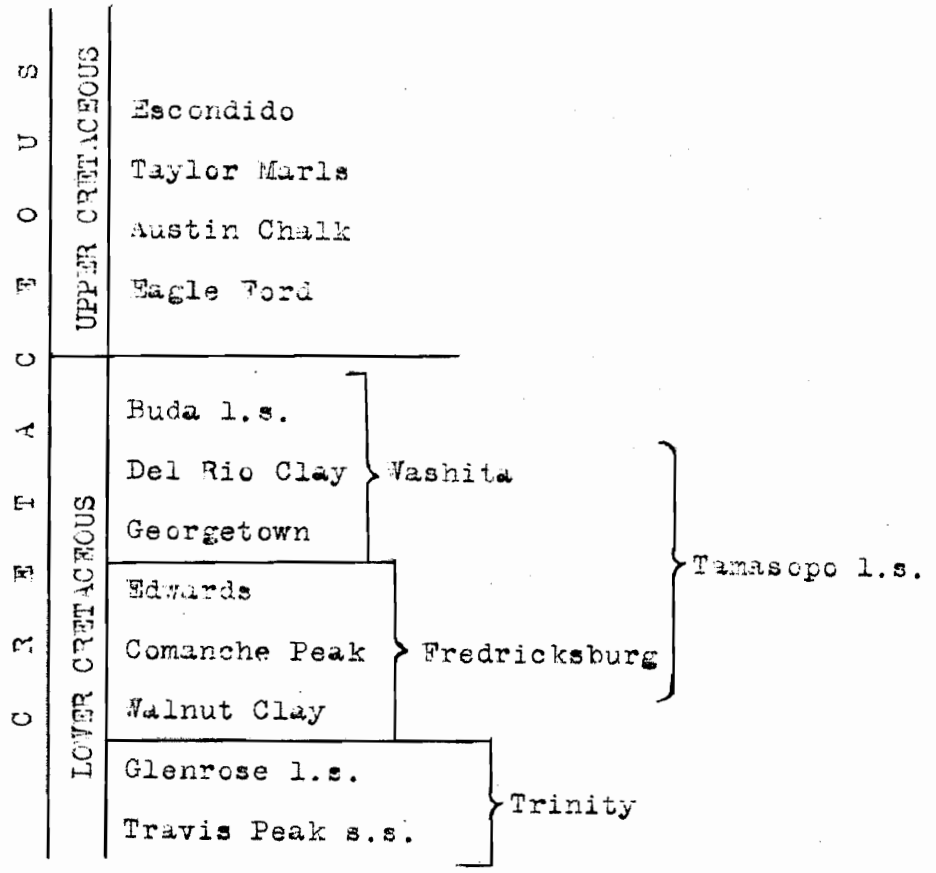

Figure 1. Geologic Column

of the camps of Northern Mexico the same ore horizon is called fossil limestone; tho in many cases there is an appreciable amount of MgO present.

In age the rocks of Higueras belong to the Lower Cretaceous series. The ore-bearing formations are probably in the Edwards member which is near the base of what is known as the Tamasopo limestone. This includes

the Washita and Fredricksburg groups. Figure 1. shows this section of the geologic column. No igneous rocks have been found in the district.

The mineralized area is about three kilometers long by one wide; the longer side striking N 70° E. In the western 3/4 of the camp the beds have been folded to form an almost perfect anticline, with the axis having the strike just mentioned. The central part has been eroded away so that at the west end of the Paloma mine a cross section is exposed at the surface. This is shown in the photograph, Figure 2. The red lines outline the folded dolomite. The brown lines indicate where the overlying lime has been eroded away.

Figure 2. Paloma anticline as seen at surface

All of the known mineralization in the Paloma mine (as well as that in the Higueras mine, which is at the extreme west end of the district) occurs in the north limb of the anticline; and has had a vertical extent of marginal ore of 250 meters; though the lower 70 meters were zinc ore.

The ore occurs in what is known as the upper dolomite which is from 40 to 70 meters thick. About 175 meters below this in the geologic column is what is called the lower dolomite, this being only from 2 to 10 mts. thick. It has no known importance as an ore horizon.

At the east end of the camp is the Cabrillas mine; and here the ore has been found only in the south limb of the anticline. This section of the district, however represents a shear zone; and there is so much complicated faulting in it that there is no certainty as to just what has taken place.

In the upper part of the anticline the beds have a dip of approximately 60°, which gradually flattens until in the lower part, where the zinc bodies were found, the dip is only about 30°.

The zonal theory of deposition and subsequent alteration is borne out nicely at Higueras, there being three distinct and well defined zones of mineralization.

In the upper one we have the rich oxidized lead ores, carrying only a small amount of zinc. Immediately below this there is a zone of rich oxidized zinc ore; and lower still is a zone of iron and zinc, and in places copper, all as unaltered sulphides.

Although there have been mined many large bodies of 40% zinc ore, this metal has been relatively unimportant in the district; and we are mostly concerned with the lead.

In the zone of high lead ore the dolomite has been almost completely replaced for a distance vertically of about 180 meters. This has resulted in tremendous bodies of iron oxides in which are scattered the concentrated bodies of marginal lead ores like plums in a pudding. Though the lead bodies are not always as well defined as are the plums in the pudding; nor so regular in size. It is impossible to find a sample of the iron oxides which will not assay at least 1% or 2% lead; and there are several large areas which will run 7% to 8%; but since this is not marginal ore today they are not classed as orebodies.

EXPLORATION

From what has just been said about the occurrence of the ore in the replaced dolomite it can readily

be imagined that exploration in the iron bodies is relatively simple and fairly cheap. The iron is soft and drifting can be done with a pick; only an ocassional shot is needed to loosen the ground. The principal item of cost is timber. The ground will never stand for any length of time; and in places is so loose and heavy that spiling becomes necessary. The finding of ore by this means of exploration is simple because there is usually some indication to follow: a stringer of ore, or one of several varieties of the iron which are indicative of ore in the vicinity. And drifting or raising in this soft material has another advantage which is being used today: the muck from advances is used for fill. This will be spoken of again when we come to stoping.

In the early days of the camp this kind of exploration was not done as extensively as it is today; but it would not be fair to the operators of those days to criticize them for not having done more of it. It simply was not necessary then. They had the hearts of all the best orebodies to mine; and in them more ore than they could take out.

Exploration in the unreplaced dolomite is costly and slow. Drifting in it can be done much cheaper by hand than with machines; and there is not a great deal

of difference in speed. Due to the tough and vuggy character of the rock, deep holes are not feasable; and it is almost impossible to shoot a complete round of holes and get a good break. Holes are seldom put in more than a meter; and it has been found that 60% gelatin dynamite gives the best results.

The diamond drill has been used some in the district; but to little advantage. Practically all of the sulphide bodies found on the lower levels of the mines have been blocked out and sampled by the core drill; but these were known not to be of commercial grade, so the information secured can only be classed as academic; and no credit should be given to the drill for it. The writer knows of not a single orebody that has been found with a diamond drill in the district.

If the data collected by the drill could be depended on; and if it were properly recorded, there could be much valuable geological information correlated. But with native drill runners no confidence can be placed in the logs of the holes. And they have been recorded in such a careless fashion that one cannot plot the doubtful information which they give. Very little diamond drilling is being done at present.

There is another system of exploration which is carried on in the district; and this has been quite

prolific of good ore in the last five years. This consists of a re-exploration of the old stopes, the idea being to find either pillars of ore which were left in place; or sections of stopes which had caved before being mined out. Information is gotten from an old miner or contractor as to where a block of ore was left, or where a stope caved; and a drift is spiled in to the point designated. Most of this work is slow, costly and dangerous, for some of the old fills are heavy and treacherous. But in spite of the fact that in about fifty per cent of the work done no ore is found, the exploration as a whole pays.

In this work the Superintendents and Foremen deserve no credit for finding ore, except that in many instances some tact is required to keep the confidence of the natives so that they will part with their information. Some judgement is also necessary at times to tell whether a man really knows where ore is or only wants a contract. Just one chance is given to find ore, however; and failure eliminates a man as a contractor.

SAMPLING AND ESTIMATING

The ore is so easy to distinguish from the barren iron that after one has been in the mines for only a few months he can tell at a glance within two

or three per cent of what a given sample will assay in lead. For this reason sampling does not claim the importance that it does in some camps; nor has it become the science that it is elsewhere. More important than sampling is the watching of the miners to see that they do not deliberately mine the low-grade borders of the stopes for ore. As a check on them for this the custom is for the foremen to take stope samples, the assays of which are compared with those of the car samples.

The low-grade areas in the large iron bodies are now carefully sampled and recorded on assay maps. This has only been the practice during the last two years, however; and was started so that there will be a record of this class of material for future reference in calculating the possible tonnage of ore of milling grade. It would have saved some prospecting which has been done recently if this recording had been done in past years. Though as we have said before, the low-grade sections were not prospected as completely as they are today.

Estimation of ore reserves is a delicate problem and can never be done with any degree of certainty. Even when ore has been blocked out and completely developed, it is an estimation of tonnage rather than the calculation which it should be. In estimating ore reserves

the ore is classed as positive and probable; but the probable ore usually represents what one hopes it will be.

In figuring tonnage from the volume of a block of ore, the specific gravity is taken as 3.0 (2.7 is a much closer figure; but the 3.0 is general practice here); and then 40% is deducted from the total tonnage to allow for included waste and voids. This also helps to correct the large figure used for the specific gravity.

FORMER STOPING METHODS

Higueras differs from most of the silver-lead limestone replacement deposits of Northern Mexico in that all of the ground is heavy; so that the greatest problem in mining is one of supporting the stopes during extraction.

In the early days of the camp square-setting was the standard method of timbering, the usual size of the sticks used was 10 X 10 inches; though some timbers as large as 14 X 14 inches and 16 X 16 inches were used.

Most of the fill was gotten into the stopes through raises put up to the surface. That waste could not be gotten in fast enough to keep up with mining is evidenced by the fact that at times a whole floor would be left open and a new one started above before filling the one

below. This practice is not to be recommended in any case; but under the peculiar conditions here it made the mining positively dangerous (a number of men are still buried in several of the stopes).

The men still like to talk of how, when the camp was booming, easy the mining was. They brag about the way one could in those days stick his pick in the back of a stope and have the pure sand carbonate run for hours. And by considering the Mexican's natural aversion to work and disregard of consequence it is not hard to imagine that this was done at every opportunity. The result is also quite apparent: the void left from the ore having run out, even if only a small one, was untimbered; and the ground being soft would start to crumble, thus loosening the surrounding country and making the whole stope take weight.

If a stope was lost in this way it would be opened up from the sides and the best ore that could be reached taken out. It sometimes happened though that the ground outside of the caved area was too loose to allow mining after the stope had caved; and in this case the stope was pulled. Usually at first pure waste would come out, then all ore; and lastly ore mixed with waste. The stope would then be abandoned even tho much good ore

probably remained in it.

That some of this practice was inefficient, costly and dangerous is quite true; but we must remember that in those days they had so much ore that the inefficiency did not matter; the grade was so high that even with high costs a good margin of profits remained; and with some Divine providence looking after him danger means very little to the Mexican. He is always taking foolish risks; which is what gives him the undeserved reputation of being a good miner.

PRESENT STOPING METHODS

Conditions in the camp have changed in the last few years. There are no more large virgin orebodies, and the grade of the remaining ore is lower. These facts together with the increased cost of labor and supplies have made necessary changes in methods in order that the mines can continue to operate with profits.

No doubt some of the present methods could have been used to advantage in the early days; but others of them are adapted only to a reduced scale of operation and some have been developed to re-mine the old stopes.

Overhand or breast stoping is still the system in use; but instead of the square sets, light native

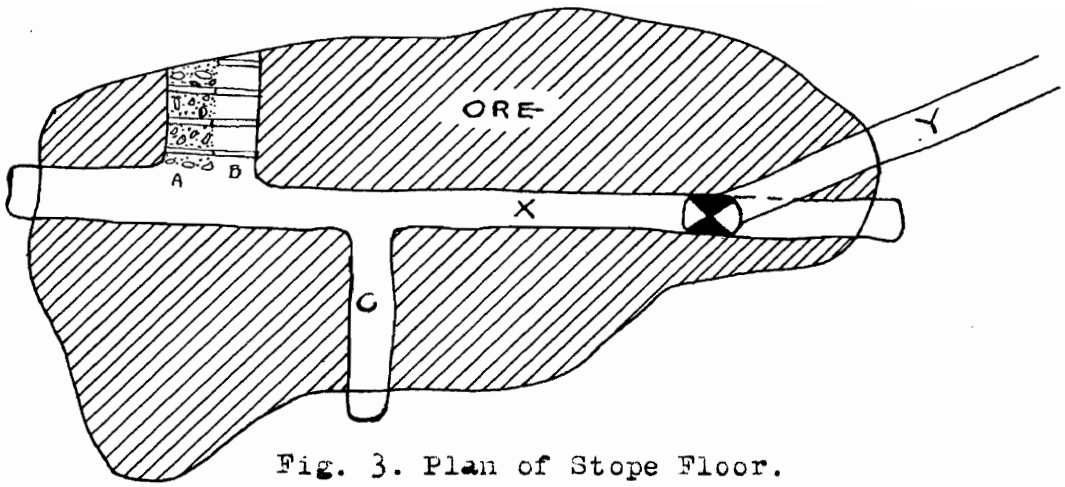

Fig. 3. Plan of Stope Floor.

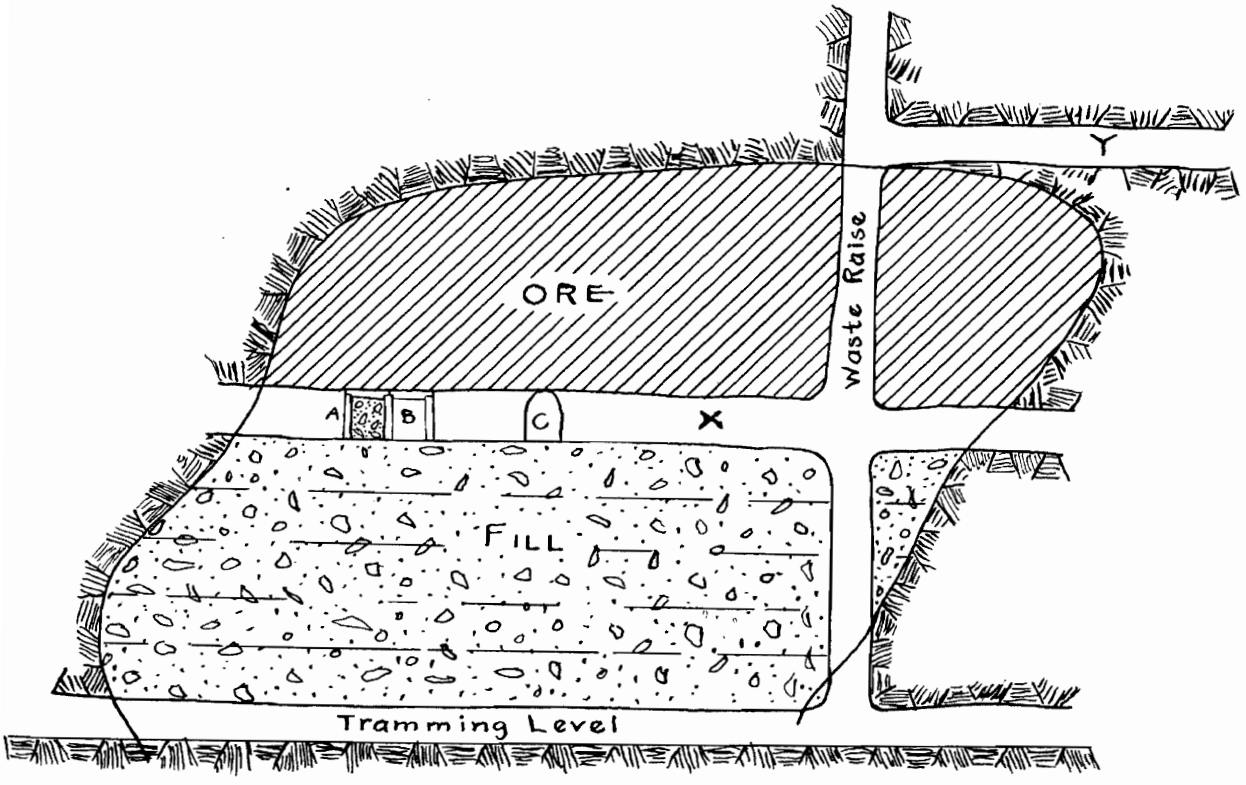

Fig. 4. Section through Orebody.

timber is used in the form of drift sets and half-sets. Five and six inch round sticks are the usual sizes for the posts and caps; and they are only framed so that the cap will set on the post. Very little spragging is necessary.

A better idea can perhaps be gotten of the stoping operation by following through the various parts step by step. It will be clearer to refer to the sketches in Figures 3 and 4 as we go along. The stope has been mined up to floor "X" in the section. To take out this floor a drift is first run out from the raise to the limits of the ore ("X" Fig. 3). Cross cuts are then driven to the walls as at "A" and "C". These are located wherever convenient, and are timbered with the drift sets. Unless the ground is very heavy these cross cuts are left open while another cut the width of a drift is taken out next to the first ones (Cross cut "B") For the second and succeeding cuts only a cap and one post are needed to complete the set; the post from the previous cut being used for one in the second. With two cuts open and supported only by the timbers, the first one is filled, after which a new cut is made next to the second. Under no circumstances are more than two cuts left unfilled while the third is being opened;

and if the ground is particularly heavy the first one is filled before the second is started. In this case the second is started as if it were a new cross cut next to the first. This still allows the use of one of the posts already in place to complete the new set by putting in only a cap and one new post (providing of course that the old post is still in good condition).

The entire operation is repeated as long as ore remains in the floor. It is usually carried on on both sides of the drift; and at times the cuts are opened at two or more places along it. Figure 5 is a photograph taken in ine of the stope haulage-drifts. In this drift the ground took no weight; so that very little reinforcing was necessary.

Figure 5. Haulage Drift in Stope.

Fill is introduced into the stope through the waste raise shown in the section, Figure 4. These raises usually extend to some level above where some waste is available (they also serve as manways); but a considerable quantity of fill comes from exploration drifts such as "Y". These make for both cheap prospecting and cheap fill.

With the filling following so closely after mining it will be noted that the waste needs to be gotten into the stope at frequent intervals; and the arrangement does not permit of stoping and filling at the same time. For this reason the work is usually arranged so that ore is broken on one shift and the cuts filled on the next.

The advantages in the use of the small timbers over the standard square sets are two: increased safety and lower cost. The small timbers are safer because they are only required to support a very small portion of the stope. The fill takes most of the weight

There are no records of costs of timbering in the old days; but we can figure what it would cost to use the square sets today. Assuming that the sill floor and first row of sets are in place, there are needed for each succeeding set a post, a cap and a girt. These would cost now, including framing and placing, $16.85 pesos (the peso is worth 50 cents in U.S. currency);

from which would come about 15 tons. Thus the cost per ton would be $1.12 pesos for timbering. Three of the half sets being used now cost $10.75 pesos, in place. From the space they support 12 tons are produced, which makes the cost per ton 90 centavos; so that a saving of 22 centavos per ton is effected by the use of the lighter timber.

Probably 10% of the timber used in stoping is recovered and used a second time. Contractors are paid almost as much to recover a set as to put in a new one. This encourages them to pull out the used posts; and the expense is well worth the money to the companies.

In re-mining the old caved stopes there is no standard practice. They usually require more and heavier timber; it is often necessary to spile through the caved ore; and frequently screening and sorting are resorted to to separate waste and ore. All of this naturally results in higher costs; but the added expenditures are warranted because of the higher grade of the ore extracted.

Some of these caved stopes are easier to mine now, however, after a lapse of eight or ten years, than they would have been immediately after they caved. This is because in some cases the stopes have settled; and

the ore has packed so tightly that it will stand for a short time with only the drift sets and a few pieces of lagging to keep it from sloughing down. The stopes are found in this condition more often when the caved ore is mixed with waste; the waste in these instances being a clay or gouge, and carrying some moisture. This condition of course facilitates mining and saves considerable timber; though more care is needed to separate the ore and waste.

MAINTENANCE

With many of the level drifts in the soft iron, and many passing through old stopes, maintenance becomes an item of importance. In many of the drifts where ventilation is poor the timbers last only a few months. And in the moving ground, when the timbers begin to take weight size is of little importance in resisting it. For this service it has been found that it pays to use American pine timber, even though the cost of it is somewhat higher than that of the native stock. The sizes used are a little larger than the native material used in stoping, 7 and 8 inch round posts being the average measurments. The American variety is better than the native because it has a straighter grain, fewer knots, and is better seasoned. If the

ground is not too heavy the larger size lasts somewhat longer; and where the air is bad the well-seasoned wood resists rot much longer than the green native timber.

Maintenance in the stopes sometimes mounts to a considerable figure also. The haulage drift of each floor ("A" Fig. 3) in the stope must be kept open until the floor is completely mined out. On the average probably as many more sets are needed to reinforce the drift as were at first put in. That is, if there were thirty sets used in a thirty meter drift when it was first opened, there would probably be thirty more sets used to keep the drift in good condition until it should be filled to open the floor above. This though is only a general figure; and holds only for a floor which will not have taken much weight. There have been cases where the sets have been put in skin to skin; and at other times under favorable conditions no reinforcing is necessary. Figure 6 is a photograph of a new set replacing an old one which has taken too much weight. Note the end of plank spiling.

MINE OPENINGS

The topography of the district lends itself to adit levels; so this is the principal opening in the camp. All of the mines have at least one adit; and two

Fig. 6. New Set Replacing One That Had Failed.

of them have as many as five each.

The lowest level of the Paloma and Cabrillas mines is an adit, which has a total length of more than two kilometers. It is interesting to note that this was driven to cut, in depth, the orebodies which had been opened on the upper levels. At the elevation of this adit, however, the mineralization was found to be only barren iron sulphides. But the work was not all with-

out value for the adit has served as a motor haulage level for both mines.

Inside the mines and connecting all levels are numbers of raises and winzes which are used for ore and waste passes as well as manways. A few of these are in rock, and are without timbering; but the great majority are through the old stopes or soft iron and are timbered from level to level. They are, almost without exception, of only one compartment even though they are practically all used as chutes and manways at the same time. To go up or down it is necessary to get the attention of the trammer when he arrives at the chute and caution him not to dump a car until the clear signal is given.

The size of these raises is standard throughout the camp, being 2 feet 8 inches square in the clear. (Note how the metric system is used in Mexico except in carpinter and machine shop work). They are timbered with cribbing cut from the same stock as that used in the stope sets. Figure 7 shows the way the cribbing is framed and put in place. These were put together on the surface to photograph because of the difficulty of getting a good view underground. Note the way the sticks are cut, i.e., that they are notched only

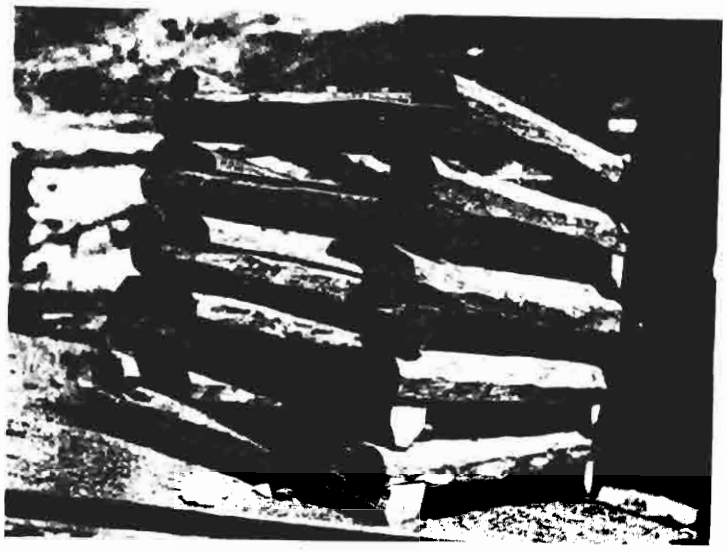

Fig. 7. Photograph showing type of cribbing and method of framing.

on one side, so that each round is a unit in itself. This has one advantage which offsets any objections one can make to it. If the ground through which the raise passes moves, as it often does, the rings of cribbing can adjust themselves to the movement without splitting as they would be apt to do if they were interlocked at the joints.

In addition to these raises and winzes which connect level with level, and the stopes with levels, each mine has a main ore pass which extends from the upper levels to the lowest or haulage level; and is connected with all those intermediate to them.

In the Cabrillas mine this main pass drops the ore vertically 200 meters. The lower 135 meters of the opening is divided into chute and manway compartments; so, to keep the terrific impact of the falling ore from tearing out the divider timbers, two sets of breaker-bars have been installed to arrest the fall of the ore. Though even with these a divider and two sections of plank with it are ocassionally torn out.

These main ore passes, where they go through the heavy ground in the upper levels (in the lower levels they are all in solid rock), are timbered with 8 X 8 inch cribbing set skin to skin; and are also lined with plank or steel plates from old car bodies.

TRAMMING AND HAULAGE

In the stopes wheelbarrows are used altogether in tramming the broken ore to the level chutes. (The drift shown in Fig. 5 happened to be on a main level; hence the track in it). The size of the stopes which are being mined now, and the temporary character of the stope floors would not warrant the installation of track in them. In the early days of the mines track was sometimes laid in the larger stopes; but it is to be doubted that this was good practice even in the largest of them.

After the ore is thrown into the level chutes from the stopes, it is trammed to the main ore pass

where it falls to the main haulage level. From here it goes to the surface bins.

On the tramming levels the track is 18 inch gauge with 12 and 16 pound rails the usual weights in use. 12 cubic feet end-dump cars are standard all over the district for underground service.

In the Paloma and Cabrillas mines motor haulage is the method used to convey the ore to the surface. For the track 40 pound rails are used with a 24 inch gauge. A six-ton, double motor, 250 volt D.C. trolley type locomotive is giving excellent service. It will bring out of the adit, ten of the 40 cubic feet side-dump cars loaded. Or rather it will take the ten in empty; for the heavy grades (in places) limit the size of the trains of empties.

Before the electric haulage system was installed a five-ton gasoline locomotive was experimented with; but gave only negative results. The machine was powered with a four cylinder engine; and theoretically should have pulled almost as much as the electric locomotive does now. In actual practice however, the gasoline motor would take in only four empty cars. Also it was continually out of order; and several times the train crew was gassed in the mine from the exhaust of

the engine. So it cannot be said that the gasoline locomotive was even a partial success.

HOISTING AND PUMPING

After describing the ore passes and adit levels it is hardly worth while to say that hoisting and pumping are of no importance in the district. No ore is hoisted at all, except in the rare instances of where an orebody is opened from above before it can be connected with a lower level. And then the ore is only hoisted to the tramming level. To do this a hand windlass is usually the hoisting equipment; though Little Tugger air hoists have been used, as well as portable electric hoists of the same type. The amount of ore hoisted, however, is negligible and hardly needs to be considered.

Before the lower adit levels were driven the ores were all hoisted, and each mine in the camp had the same kind of hoist: a 25 h.p. gasoline variety. At present the only hoist in use in the camp, besides the small auxiliary ones inside the mines, is on a surface incline; and is used for hoisting timber.

Pumping is not, nor has it ever been any more of a problem than hoisting. In the first days of the mines water was found in the underhand workings; but

usually in such small quantities that it could be bailed out. One can see lying around the surface the remains of one or two old Cameron sinkers; but it has been so long since they were in use that they are now only a mass of rust. The lowest adits now drain all of the upper workings; but there is so little water coming from them that it is collected and piped out to the surface for cooling the power plants, and the general use of the people of the camp. And in the hot summer months there is always a shortage of it.

SURFACE HANDLING OF ORES

At the Paloma and Cabrillas mines, when the ore is brought to the surface by the motor, it is dumped into bins which have a total capacity of 500 tons; and are a part of the upper terminal of a Leschen aerial tramway. This carries the ore, by gravity, the three kilometers from the mines to the railroad. Here at the discharge terminal of the tram, are five more bins of 100 tons capacity each. From these the ore is loaded directly into the cars for shipment to the smelter. At this lower tram terminal the ore is dumped over grizzlies with one-inch openings and the coarse and fines are shipped separately. This is done to save sintering charges on the coarse ore.

One of the outside properties has track laid from its mine dump to the Paloma surface bins; and this mine's ores are shipped over the tramway. The other mines of the camp, when they operate, get their ores to the railroad on burros.

POWER PLANTS

When the camp was first opened, and for several years after, the only power plants were the gasoline hoisting units, and one or two steam boilers for running the pumps. The smaller mines never developed to the point where more mechanical equipment was necessary. But the Paloma and Cabrillas properties when in their prime had a steam turbine plant which drove an alternating current generator. The plant was at the railroad; and the current was transmitted to the mines at a pressure of 2300 volts. When production fell off this plant was dismantled and sent to another of the Company's holdings.

Since then the power has been generated by two, 14" Class N-SGL Chicago Pneumatic Fuel Oil Driven Compressors. One was used as a compressor for a time; but the other has always had the air cylinder disconnected, the machine being used as a prime mover to run the 250-volt, 140-ampere d.c. generator which furnishes

power for the motor haulage and inclined surface hoist.

The one which was used as a compressor gave very good service; but with air lines 1 1/2 and 2 kilometers long there were always large losses from leaks and friction; and it was with difficulty that sufficient pressure could be gotten to a face to operate a drill. This together with the character of the dolomite, which we mentioned under Exploration, led to a gradual disuse of the compressor.

There is always a face to be driven by machines, however; and the layout which follows was recently devised to do away with the long air lines. The air cylinder of the compressor was disconnected as in the other machine; and the engine was belted to a 37.5 k.v.a. alternator. The 3-phase current from this is taken into the mine at a potential of 2300 volts through a steel-armored, standard underground cable. Inside the mine, near the point where the air is to be delivered (a suitable spot can always be found within two or three hundred meters) is set up a 145 cu. ft. portable compressor driven by a 25 h.p., 440 volt motor. At the compressor the voltage is stepped down through a bank of three single-phase, 10 k.w. transformers to the required 440. With the three 10 k.w. transformers there is left enough

surplus power to run a portable electric hoist when needed.

In addition to the two power units just mentioned there is a four cylinder, 16 h.p. automobile type gasoline engine which is direct-connected to a 10 k.w., 110-volt d.c., over-compound-wound generator which furnishes power for diamond drilling. (It also lights the camp). When first installed this was set up underground near the drill, and the exhaust was led up a raise thru which the air was upcast. But the air reversed one day and the exhaust gassed the operator, so it was necessary to remove the engine to the surface. This location is unsatisfactory though, on account of the high line-loss resulting from the transmission of only 110 volts on small wire. It is proposed to put a 440-volt motor (a.c) on the diamond drill and use the same power as that for the compressor; but this has not been done yet.

OPERATING DATA AND COSTS

The following data is for the year 1925; and is from operations at the Paloma and Cabrillas mines.

Costs in the table below are per metric ton of ore mined; and are expressed in per cent of total cost.

ACCOUNT	PER CENT
Extraction	27.0
Prospecting	32.3
Development	0.8
Maintenance	7.8
Transportation	5.8
General expense	16.7
Plant and Equipment	1.0
Taxes	8.6
Total	100.0

Development includes only work done in ore to open the body. Transportation includes motor haulage, aerial tram and loading in railroad cars. General expense includes Utilities, Surface expenses, Assaying, Surveying, Administration and Hospital. Plant and Equipment includes repairs and upkeep on power plants.

The total labor cost was 65.0% of the total cost of mining. The remaining 35.0% included 26.4% for supplies and the 8.6% for taxes.

Tons produced/ man/ hour (all underground and surface) for all labor	0.034
Tons produced/ man/ hour, for all underground labor	0.038
Tons produced/ man/ hour, for all surface labor	0.18
Man-hours/ ton for all underground and surface	29.4
Man-hours/ ton for all underground	26.3
Man-hours/ ton for all surface	5.55

The amount of dynamite used in stoping is negligible. The dynamite used per meter of advance in the dolomite was 6.3 kilograms.

All work in the mine and the operation of the aerial tram is done on contract.

The average wage for contract labor was $2.22 pesos/ day

The average wage for surface labor was $1.99 pesos/ day.

LABOR

Last -- but by no means of least importance -- we come to the labor question; or problem, for such it has become. The success of any business or industry depends largely on the labor which does the actual producing; and this is especially true of mining. The following remarks apply specifically to the Higueras district; but will hold for all of the Republic of Mexico.

In the "good old days" before the Madero revolution of 1910, a peon was a peon; and he did an honest day's work. Perhaps he did it because he knew he had to or lose his job and starve. But for whatever reason he did it, he did it well. And as long as he made enough for his daily frijoles, his weekly drunk and a new blanket a year he was satisfied; and a more contented type of humanity never existed.

Then came ten years of revolutions; and during

these the peon learned that he had "rights". And with this learning he acquired the discontent of civilization. This of course has been aggravated by the baiting of the Bolsheviks who have found in Mexico a fertile field for the spreading of their propaganda. They have even insinuated themselves into the government, until at present it is almost controlled by those who have only a mistrust for Capital.

Labor laws have been passed, having in view the protection of the laborer; and though something of this sort was needed in the country, many of these laws are so radical that it is impossible to comply with them and they are evaded by one subterfuge or another.

The new conditions have made the laborer not only discontented but also jealous of his rights; and all the time it is becoming more difficult to handle him. Besides this, there prevails all over the country an alarming scarcity of men who are willing to work in the mines.

There are also more laws under consideration, which, if passed, will make it almost impossible for the mines to operate.

To the question "where will it all end" one can only reply with the typical Mexican answer: a shrug of the shoulders and the proverbial "Quien sabe".

H. H. Hughes Jr.

INDEX