Eulogy to

Jilly Foster Iron Mine

Nov. 9, 1883.
The Jilly Foster Iron Mine.

[Notes made by the Mining Engineers of 84 from the Mass. Institute of Technology during their excursion of Nov. 9, 1883.

Location.
This mine is situated 2 miles south of Brewster, N.Y., on the N.Y. City & Northern R.R. The post office address is "Jilly Foster P.O., Putnam C.W., N.Y." The superintendent is Andrew Cargriff; the mining engineer is Lewis G. Engle, a graduate of the Columbia School of Mines.

Minerals.
Country Rock. This is called "banded" gneiss and is very hard. It is mixed with more or less serpentine.
Other Minerals. Besides gneiss and serpentine, we found calcite, magnesium dolomite, and the easily decomposed - fuchsite and pyrite.
One. This is magnetic oxide, Fe3O4. The bed is a lenticular mass of a meniscus-like shape, part of which has been dislocated and folded over by the occurrence of a fault. The concave side of the meniscus forms the footwall which has a dip of about 65°.

The Mine.
The old mine was an open pit. Now there are three shafts running down against the footwall. Two or three shafts start from the bottom of the old pit, the third starts from the top of a high point of land to the northward of the other two. There are 5 levels - the 100', 200', 300', 400', 500' level.
The entrances at the cut into forming the 150' level are on the sides of the pit forming the old mine. The two hundred (200') foot-level is about 35' below the bottom of the old pit. A short 4'5" shaft connects this level with the pit. The greater part of work appeared to be carried on on the 200' to 500' level.

The latter is not yet fully explored, but the drifts along the footwall and the perpendicular side drifts were being opened up.

Timbering

Only timber was fitted in the drifts along the footwall. This consisted of trapezoidal frames of 3"x4" scantling, curved on the sides along with many timber laid longitudinally. The frames are called "sets." At intervals on the one side of the main drift, perpendicular side drifts are run from the axis of the "rooms" between the pillars to the opposite wall of country rock. And the ends of these side drifts are connected on their side also; so that the Engineer knows exactly the extent of the ore deposits on each level. Adjacent to these side drifts one small timbered channel called "platts" (?) through which the ore may be removed by way of the main gallery.

Pumping

The bottom of the ore pit is on a level with Crater Lake when the latter is at high water mark. When the water is high the mine is situated on a perpendicular jetting into this lake. A good deal of water flows into the mine from the interstices between the alvatos. In the 200' shaft near the 200' level a dam has been built to keep the water from flowing to the bottom of the mine and entailing a greater expenditure of power in removing it.
They are now pumping about 10,000 gallons per day into a reservoir on the hill where it is allowed to percolate or filter through a brick partition wall into another walled compartment from whence it is lead down for use in the boiler.

A Cornish lifting pump elevates the water from the bottom of the mine to the reservoir and is so arranged that water can be pumped from any level. A large pump in pit near the pump shaft connected with the pumps pit & receives the water pumped by small pumps from secondary pumps along the drifts. The small pumps are driven by compressed air received from above.

The question of how deep they can go evidently depends upon whether they can afford to pump. It is proposed to put in concrete pillars to sustain the rock and remove the pillars of ore that now support it. The concrete will cost, as we understand, about 40 per cubic yard.

Ventilation. This is done through the shafts by natural ventilation. In winter the air passes down by way of the two shafts in the bottom of the old mine and up out through the 2nd shaft on the hill top.

In summer the currents are reversed & the air passes down the higher shaft which contains a larger column of cool, and consequently heavier air that sinks down in its effort to establish an equilibrium. This sinking down drives the air up the other shafts in endeavoring to establish equality of pressure, but as fast as the air in the other columns rises to the surface it is held by the sun & warmer surrounding atmosphere.
and expands & rises. His expansion diminishes the pressure on the base of the shorter column of air at the longer column of the work shaft in its effort to supply this deficiency produces the upward currents which continue until the atmospheric conditions are reversed. The temperature of the air below the surface is higher than the temperature of the air outside, when the hig shaft again has the upward current.

The exhaust from the compressed air furnishes the Rand drills & small pumps also serves to assist in the ventilation.

Hoeising.

This is done by means of the hoisting column of wire rope actuated by an engine at the top of the adit about 60 yards from the dumping tower. From the latter an inclined tramway or the slope of the bed (6°) leads to the bottom of the shaft. The ore is brought from the different "plats" and "rooms" in small boiler iron cars running upon rails laid along the foot wall adits & lateral galleries to the foot of the shaft where it is loaded into skip attached to the wire rope. The "skips" are of boiler iron, treepointed in longitudinal section. They are about 6 ft long & will hold 4 men standing upon the bottom, provided the ore is not too large. The skip, when they arrive at the surface are dumped into reversible platform cars by an ingenious automatic arrangement. These cars are weighed empty, then filled as above stated, weighed again; the ore is then sorted by hand & broken up ready for the furnace & all rock or waste removed. The cars are again weighed with the clean ore; the difference in weight gives the lead in sorting & picking ore.
The hoisting drum runs loose upon a sleeve in housing the empty lift; its motion being controlled by a lever brake. In hoisting the drum is firmly locked to the sleeve by a friction clutch whose umbrelliform arms are extended radially against the wooden blocks that press against the interior cylindrical surface of the drum to constrain it to revolve with the sleeve.

These radially arms of the clutch are extended by a conicere frustum pressed inward by a toggle-joint operated by a long lever.

The hoisting is done by pneumatic signals. An air line leads from the engine room to the bottom of the shaft. At the intersection with each level is a piston about 6" in diameter and 18" stroke. The piston is operated by hand. A stroke of the piston transmits an air pulse through the line to the surface; this pulse acts upon a very small piston attached to the hammer of a signal bell. Hence every wave of pulse of air sends through the pipe gives a stroke upon the bell.

Lighting.

This is done by the ordinary miner's lamps hooked to the hat of the bearer, and by lanterns. But electric lights are about to be put in.

Method of Working.

The shaft is sunk down along the face wall until the point selected for the new level is reached and then the main drift or adit is driven along the face wall in both directions from the
foot of the shaft... and the ore sent up by skips until space is obtained for easy working.

A chamber is excavated in front of the shaft & a large pit for the main "platt" is sunk in the floor to collect the water from the level. As soon as the main footwall drift reaches a point directly under the axis of the room above a side drift is driven perpendicular to the one but until the hanging wall is reached the "platt" are excavated along side each side drift opening into the main drift & the lateral drift connected by a gallery along the hanging wall.

The sets or frames are placed in position and the timbers laid on and the widening of the room at the head of the "platt" on each side of the side drift goes on on the ore being thrown when the timbers of the main gallery get room to work in. A man shaft is left against the foot wall opposite the side drift to allow the miners to climb up to work on the ore above the gallery after the platt & side drift heads are filled with the - Round drills are set to work drilling holes for blasting after hand of forward of the ore blasted down. Then they wrought this work out another blast which faces on the first & raises the surface high enough to now the walls to prepare for another blast. This is repeated until the room is blasted out to a height of 60' to 75'... and then the ore is removed through the platt & side drift. During this process the ore is being continually removed...
Through the "platt" as the ore blasted down, being loose fills more space than when in its normal position. The amount removed is never enough to interfere with the miners' work in reaching the ore overhead. Blasting is done twice daily at 11:00 A.M. and 5:00 P.M. and the shifts are run night and day. The length of a shift is practically 10 hours each.

Dynamite No. 3 is used for blasting purposes. More ore is left in the pillars than is removed from the rooms. The latter are arranged one above the other in the different levels.

**Method of Payment.**

The miners are paid by the cut and excavated, but the price was not ascertained. The work is done by contract with the miners, which diminishes the cost of superintendence. Monthly ore measurements of the amount excavated are made by the engineer and plotted on his map. The results of this survey govern the payments to the contracting miners. The ore is said to cost about $1.25 per ton put on the cars.

**Exploration and Prospecting.**

This is done with a No. 7 Prospecting drill, hydraulic head, made by the American Diamond Rock Boring Co. of N.B. This drill will bore vertically, horizontally, or in any direction a distance of 80 feet. Its weight rests upon it about 1350 lbs. Heaviest piece packed for shipments 450 lbs. 2 inches 13 1/8". Cost about $3000.
This drill is fitted with an annular core bit armed with diamonds, it is provided with a core lifter which brings out the core and informs the engineer exactly what he has passed through. The details concerning this drill will form the subject of a future paper.

Power.

This is furnished by an engine for hoisting material and one for compressing air. The compressed air is stored in a vertical boiler via a cylindrical receiver at 60 lbs. pressure by 2 horizontal direct-acting air pumps. The air cylinders are lubricated with a little water. A strong wire pipe conveys the compressed air down into the mine by the Hand drills and small pumps. The boiler is protected by sheeting or covering of any kind. The Scranton Coal & Iron Co. own the mine & will not care for the loss of fuel caused by excessive

Remarks.

This is said to be the most valuable coal mined in Scranton, Penn., & mixed with other coals to make still tolerable by the Pennsylvania people. These notes are necessarily incomplete on account of the limited time—3 hours—at our disposal.

Respectfully submitted.

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Prof. of Mining
natric + other minerals, all argentiferous, being often or even generally found in one gangue. No definite rules or theory can be laid down for working; rather one must find in each case by actual experiment, what combination of chemicals - time - degree of pulverization etc. fits his particular case.

Chloride of copper seems to be the vehicle which carries the chlorine of the salt to the silver. This either furnished by Sulphate of copper or, if the ore contain copper, it may come from the ore itself if proper chemicals are used in the pan. For instance Carbonate of copper + Sulfuric Acid, is a combination often used. This we know, that copper is with one or two exceptions demanded - and is in all cases beneficial - but we must not have too much of it; why? Because the amount of metallic copper precipitated by the iron pan will then be found in the amalgam to an injurious extent and Chloride of mercury will be formed.

The chemicals commonly used in the Whelan-Rainey + Hepburn pans are: Salt or Sal Ammoniac, Sulfate of Copper, commonly called Blue Stone, Sulfuric Acid = the iron of the pan itself; heat and water. These are used always in large excess of the amounts pointed out by the chemical combination of the elements.

* Sulphur + chlorides can be amalgamated without heat.
Mercury is used as a convenient collector of the silver. It perhaps causes the decomposition of the Ag Cl, but the metallic copper would do the same from the solution of Ag Cl which must exist in the great excess of NaCl solution. So would the iron on the hydrogen gas that must be to some extent formed by the action of Sulphuric Acid on iron; probably all these causes work more or less together and get the desired result. Vigorous metallic silver readily to amalgamate at once with our mercury.

The pan is a machine which carries on two operations at once. By it pulvérizes the ore to a much finer pulp than the battery could, at little outlay in time and money, while so doing, it agitates thoroughly, mingling the ore with the chemicals used, thus enabling them to react. When sufficient time has elapsed to complete the grinding in, the smaller is raised and chemical action alone goes on.

Experience teaches us that if the quicksilver be ground it will berubbed into fine particles which will not reuniite, but will float away in the water. We also learn that certain Chlorides, notably that of Manganese, readily decompose and yield Cl to the Mercury - the presence of lime has a like ill effect in floating. The quicksilver - the presence of clay is troublesome as it mechanically carries off Ag. Moreover, covers & protects ore particles from certain
with the chemicals. Too great heat is thought to result in a loss of Berg. too little heat is believed to allow a base-union to be formed and certainly causes a loss in time. As hot as the water can bear for about a quarter of a minute is called the right temperature.

A general knowledge of chemistry together with the habit of taking careful notes mentally or otherwise are the main stays of the amalgamator. Knowing the chemical and mechanical properties of his ore and gangue a few intelligently directed experiments will generally point out a formula for the case in hand. Most mills contain several plans so that differently proportioned charges can be tried at once and the most successful one adopted for the run.

The following has been found to work very well practically and covers a range of ore assaying from say 20 to 80 ounces per ton as far as silver alone is concerned.

10 of ore = 60 lbs salt.
15 "  Bluestone
3 "  Sulfuric Acid.

The Bluestone is generally kept on hand dissolved in a saturated solution and measured into the pans in such quantities as to make the right amount of solid sulphate for each charge. The salt is usually dumped into pans first in a dry condition and as soon as
The pan is started. The Blue Stone is put in after the Salt is supposed to be thoroughly dissolved + the sulphuric acid, highly diluted, not even strong enough to cause pain to the tongue goes in next. The pan is then left to grind for the allotted time; then is added the Mercury, the smelter being raised.

There is generally used about one fifth as much mercury as ore in the first charge of a pan. When the pan is "washed down" or discharged, probably one half the Hg flows out with the pulp & the remainder stays between the dies; in each succeeding charge one half as much mercury is used as in the first, the object being to leave the spaces between the dies full of Hg, which is not removed until the amalgam formed is very thick or the run of ore is completed. A four foot pan will then claim about 100 lbs of Hg at first charge and 75 lbs. at each succeeding charge. Such a pan will take from 600 to 1000 lbs of ore; the amount is dependent on the bulk, greater or less, of the ore and the ease or difficulty with which it can be ground & stirred.

In discharging the pan the lower hauling is drawn + everything above the dies is run directly into the settling apparatus, where the tailings are washed away from the amalgam; the upper discharge holes of a pan render it possible to use the pan itself as if it were a "dolly tub" when desirable.
In making up experimental charges it seems best to begin with the largest amounts of chemicals and keep reducing until the minimums are attained which will answer the purpose. It is quite frequently found to pay better to produce a somewhat base mudlum than a very fine one, it being possible often to extract a higher % of the silver if some lead - antimony or copper goes with it - more cheaply than if these metals be entirely excluded from the amalgam. Amalgams undoubtedly more readily take up gold or silver than pure quicksilver does. Much is claimed for sodium amalgam - much may be gained by it perhaps if we can afford to keep sodium amalgam constantly in the pan - but it seems that an ounce of sodium in a hundred pounds or so of mercury under water must soon be oxidized out - can then serve no other purpose than to form soap with the grease which may be, generally in present.

The presence of finely divided iron in the pan coming from its own wear + tear + that of the battery is also an argument against sodium amalgam; this iron cannot be got rid of practically and sometimes causes much trouble by entangling minute globules of Mg. from which it is almost impossible to separate it - sometimes masses of apparently valuable amalgam are found on retorting.
leave nothing but new sodium can certainly aid this state of things rather than hinder it. The occurrence of this iron amalgam, if it may be so called for lack of a better name is most common and it is hardly known what causes it save that the iron has been in some way made so clean that the mercury adheres to it and then the coated particles readily agglomerate on the sides of the pan often become regularly plated with amalgam. I have not attempted to give reaction because it is in my mind a matter of doubt whether we yet know what the reactions are save in a few cases of simple ones.

The following actual examples may be of interest:

For assaying on an average 4.5 ounce Character: Pyrrhotite Carex. 5 lb. Red Ore. Chemicals per ton in about equal proportions 50 lb. salt, 12 " Bstone, 3 " Sulph. Acid

Yielded 70 to 80% of fire away 2 hr grinding 2 amalgam

Or assaying 325 oz. per ton. Same character as above but 100 lb. salt, 12 " Bstone, larger fragments of Carex 90 " Bstone. Yield 75% 5 " H2O4 time grinding 2 hrs. Amalgamating 4 hrs.

14 for Wheeler pans speeded to 60 revolutions per minute
Slit Battery 0% opening as new
The above written quantities of chemicals cover a range of ore from 10 to probably 50 or even 100 ounces of silver in assay = white. In general the ore as fed to the pans contains various silver minerals so that it has been found impossible to make any fixed scientific rules relating to this method = Sulphuric acid Black Sulphuric in process of melting slowly will greatly aid the process include Oxalic acid Sulphuric acid. The state above it is known that pure sulphuric or chloride of silver when ground continuously in iron pan H.C. being present will eventually amalgamate without the aid of chemical but the presence of the chemicals undoubtedly hasten the process.
Influence in each case =

The Salt, blue lime, and sulphuric acid are added next, and the muller being let down the grinding is kept up as long as until the desired fineness is obtained or until the economy of the case demands that it be stopped. Quicksilver is now added in such quantity that about 1/4 of it shall lie between the chier and the remaining half, mills with the help of the quicksilver, the muller is to be driven just before adding it to the pan left to work until the amalgamation is completed. The pan is kept hot by a steam bottom or by introducing live steam through a nozzle. The temperature is generally fixed as that which a man can just bear for about a minute when dipping the finger in the amalgam.

To be 10 Salt to be a common
10 to 15 Bluestone Em Mostert
2 to 3 Sulphuric Acid of Mixture

Blue lime being added in solution

+ Acid much diluted

1/2 hour in an ordinary time if force necessary.
Washoe Process for the Amalgamation of Silver Ores.

This process consists in the grinding of the ore into the finest state of subdivision attainable in suitably arranged iron pans, such as Bolchees, Nannys, or Reelums, and subsequently treating it with appropriate chemicals in order to convert the silver into combinations which will be decomposed readily by zinc or copper into metallic silver which will then be amalgamated by mercury.

The chemicals used are Salt Hall or Old Ammonia - Sulphate of Copper - Sulphuric Acid - proportioned the proportions of each varying with the richness and character of the ore.

The zenith of the process is generally to charge the pan with water - the miller being in motion, running in a four foot pan at about 50 to 60 revolutions - the water being allowed to play just over the miller which is usually some what before the stiffer than the body of the miller. When the pulp until the right consistency is obtained - a miller to be-maintained by
The pan is finally discharged into settlers by pulling the lowest plug and allowing everything above the die to move; there will remain the Hg between the die and at each successive charge of the pan 1/4 as much quick as in first charge.

An ordinary lift pan takes about 1/10 the quick at first change, 7/10 at each succeeding one.