Report on the MINNIE GULCH MINE of the Kittitas Mining Company of Wyoming by R. J. Walter San Juan County San Juan Mining District
GENERAL DESCRIPTION OF THE SAN JUAN REGION.
COLORADO

This district consists of a high, deeply cut volcanic plateau in San Juan, Dolores, La Plata, Hinsdale and Ouray Counties. The precipitous slopes, high ridges, inaccessible outcrops and rigorous climate present great difficulties for prospecting and mining. The geological history of this region is very complex. Immense volcanic beds cover the pre-tertiary surface completely. The Animas Canon cuts thru and exposes various volcanic flows as great blankets.

The typical section consists of Archean schists and gneisses overlain with Algonkian quartzites, then Cambrian, Devonian and Carboniferous sediments and finally the Tertiary flows.

The Carboniferous rocks are separated from the Tertiary by a conglomerate.

About the Kittimao Mine the Tertiary alone is in evidence except for a few modern glacial deposits.

LOCATION

The Kittimao Gulch Mine of the Kittimao Mines Company of Wyoming is situated in the San Juan Mining District, San Juan County, Colorado, eight and one half miles North of Silverton, the County Seat, and three and one-half miles South-east of the Town of Eureka, Colorado.

The mine is on the Kittimao Mountain and is connected with the mill, located at the foot of Kittimao Gulch, by a two mile aerial tram. The mill is one and one half miles South of Eureka in the Animas River Canon, on a spur of The Silverton and Northern Railroad. All shipping is done over this road to Silverton and thence by narrow gauge fifty miles to Durango, the nearest smelting point, or three hundred and four miles to the smelter at Salida, Colorado. Some mine sulphur concentrates are shipped three hundred and eighty miles to the mine smelter at Pueblo. The mine is just five hundred miles from Denver by railroad.

All of the claims owned by the Kittimao Mines Company are located in the Eureka Mining District, San Juan County, Colorado, and are divided into two groups, the Kittimao Group and the Forest Queen Group. In all there are seventy claims and seventy-six acres (In the French placer), totaling seven hundred and ninety acres of land.

The Kittimao Group containing six hundred and fifty acres includes all of the veins of any known value and the claims lie in a solid block seven thousand two hundred feet long by three thousand nine hundred feet wide, traversing Kittimao Mountain in a Northwesterly and Southeasterly direction.

LOCAL GEOLOGICAL CONDITIONS.

Mimie and Battler Gulches are the main drainage courses on the Kittimao property. Both of these Gulches head against the Continental Divide but do not cut down to the San Juan buffs through the development of the structure consisting of the Eureka rhyolite. Eureka rhyolite flow breccia, Burns latite complex and some pyroxene andesites is well shown.

The Eureka rhyolite, the second in the series, is a siliceous flow breccia, containing many small angular inclusions of reddish and
grayish rhyolite together with phenocrysts of the various plagioclases. This flow is very thin and only appears at the mouth of the Gulch.

The Burns latite complex here, is a greenish gray rock of undefined porphyritic texture with a ground mass of patchy microlattices interspersed with orthoclase and quartz. The original ferro-magnesian minerals were augite, hornblende, and biotite, which are now unrecognizable. A small layer of greenish stuff separates the Burns latite from the Burns rhyolite and resembles green hornstone.

The pyroxene andesite is a complex flow and tuff which caps the structure in Minnie Gulch. These rocks are fine grained almost sphenoelastic with light colored phenocrysts.

dipping

A monzonite dyke cuts through Minnie Gulch to the Northwest at a point where the falls occur directly below the tunnel portal. It probably was this dyke that caused the complex faulting evident in the Isabella, Calibre and Stanton veins.

GEOL O GICAL DESCRIPTION OF KITTIMAC MOUNTAIN AND A DESCRIPTION OF THE VEIN SYSTEM.

The geological formation of Kittimac Mountain is briefly: San Juan andesite capping about one thousand feet thick. Below this the Silverton formation about one thousand two hundred feet thick. The section is completed by the San Juan formation or series to unknown depths.

The known veins outcropping are the Little Joe, Youngson, Quartzite Midnight Sun No. 1, Midnight Sun No. 2, Elvis's and London striking Northwesterly and Southwesterly, and the Isabella, Stanton and Calibre veins striking Northwesterly and Southeasterly. The first named group of veins are quartz veins carrying gold and silver.

The latter group consists of sulphide veins containing gold, silver, galena, sphalerite, and chalcopyrite in a tough quartz gangue. The veins are sharply defined and have a clay gouge on both hanging and foot walls.

The Calibre vein outcrops on the property for a distance of six thousand feet and will average ten feet in width.

The Isabella outcrops for a distance of seven thousand feet and varies in width between three and five feet.

The Isabella, Stanton and Calibre veins come together on the Eastern slope of Kittimac Mountain on this property.

The sulphide veins have been opened up at numerous points on the surface by open cuts, shafts, and tunnels. At a point four hundred feet below the crest of the mountain a tunnel on the Isabella vein shows it to be a true fissure vein about eight and one half feet wide at this particular point. This vein carries good values from wall to wall for its entire length.

At another point three hundred feet below the first in a Northwesterly direction, another tunnel on the same vein gave almost identical results as were obtained from the first one.

A tunnel driven in on the Calibre vein, 700 feet from the top of the mountain, shows the Calibre vein to be a true fissure assayng high in gold, thirty feet wide at this point.
Not much attention has yet been paid to the other veins but they show promise of yielding valuable bodies of ore much as the Isabella and Little Joe veins have.

THEORY OF ORE DEPOSITION ON KITTITAS MOUNTAIN.

Ramsden explains the deposition of ores in this district as follows: Surface waters percolating downwards dissolve the alkalies from igneous rocks as sulphides. These alkalies, becoming hotter on approaching the magma, become charged with sulphide and carbonic acids derived from volcanic sources, thus becoming solvents for the metals, silice and line, which were gathered from the more basic portions and silicates and deposited as they higher up. The metals were deposited in the fissure while the penetration of the wall rocks by the sulphurated alkaline solutions changed the iron in the Ferro-magnesium silicates and the potash afterwards went toward the formation of sericite. Carbonates were deposited in the walls due to action of water on lime feldspars, Silicates were set free and removed mostly from the walls. Gold was carried into the walls to some extent.

There are four distinct types of ore deposits, viz: (1) Lodes, (2) Stocks or masses, (3) Metamorphic, (4) Pneumatolytic or Pneumatory. The first includes most of the ore bodies, the second applies more to those deposits around Red Mountain, while those in the Silver Lake Basin come under division (3).

At present the water courses cut by the tunnel and drifts contain much ferrous iron and manganese. These substances are deposited on the walls as red, brown or black oxides.

THE LITTLE JOE FAULT.

The Isabella, Joyce and Calibre veins are all cut by the Little Joe vein as evidenced by the shattered condition of the vein material at each of their respective contacts. The direction of the action or throw of the fault is still open to question. Various explanations have been advanced and a little exploiting done to unravel the extent and scope of the fault. At the junction of the Little Joe and the Isabella veins a "kimmy" of ore, fifteen feet in diameter and twenty-five feet in height was encountered. This ore ran as high as five tenths of an ounce in gold, seventy-five ounces silver, three per cent lead, and a very little zinc and no copper.

In the Joyce and Clark stopes located on the left hand side of the tunnel the ore is high in chalcopyrite with very little sphalerite.

On the right hand side the Isabella stop is in ore that is a heavy galena containing much sphalerite and no copper.

On the surface the Little Joe apparently cuts through the cross veins without any noticeable variation strike, while the cross veins are decidedly bowed one hundred and fifty to two hundred feet to the East from the general trend of the vein.

The Little Joe vein, the primary "lead" assayed some gold in every sample taken while the other veins showed from a trace to one dollar in gold. Where the stopes approach the surface the gold content increases.
The absence of copper and the small percentages of lead and zinc in the Little Joe vein and the above facts show that the Little Joe vein is the younger. There is a possibility of the Little Joe vein having formed first and acting as a barrier across the fissure in which the Isabella vein material was deposited later by two different ground water systems. The brecciated condition of the rock at the contact and the showing out of position of the ores veins show that some later crustal deformation took place after the fissures had been filled.

An intrusive quartz monzonite "boss" shown on the geological map of the U.S.G.S. Silverton folio #120 is in close enough proximity to have a direct bearing on the faulting and fissuring in the areas covered by the Kittimac Mines Company.

DEVELOPMENT AND EQUIPMENT

The property has been prospected in several places by short tunnels and location shafts and cuts. There are two main adits through which all of the subsequent work has been done. These tunnels are seven feet high and seven and one half feet wide in cross section and are both driven along the course of the Little Joe vein. These tunnels are in good order, have perfect drainage, and the timbering is in perfect condition.

The upper tunnel has been abandoned as a working tunnel, all of the equipment, consisting of track and pipe lines, have been taken out. This adit opens up the Little Joe vein for a distance of about nine hundred feet, as is shown on the accompanying sketch. The company will use this tunnel as part of its ventilating system as soon as the raise from the lower level can be completed.

The lower tunnel is situated 180 feet below the upper tunnel on the Little Joe vein. It is through this tunnel that all development work is being done at present and will be done for some time. Over three thousand feet of development, i.e., drifting has been done on this level, all tracked with 12 pound rails and 18 inch gauge. Six inch air lines are run to the breast of the main right and left drifts and up to the tops of the two main stopes.

At a distance of 1046 feet from the portal two drifts were run from the main tunnel, almost at right angles to it. Toward the north, for a distance of six hundred feet, and toward the south for a distance of only fifty feet, until the Little Joe vein was again encountered and the tunnel was continued then along the course of the Little Joe vein about seven hundred feet further. Later a cross-cut was started Southeast from the main tunnel at a point one hundred feet beyond the intersection of the tunnel and the Isabella vein. The object of this cross-cut was to locate the Isabella vein on the South side of the Little Joe vein, which it did, and then a drift was continued along the Isabella vein in a Southeast direction for about six hundred feet.

The point of the intersection of the tunnel and the Isabella vein is locally referred to as the "switch" and for convenience this term will be applied in this writing.

From the portal to the switch the tunnel opens up the Little Joe vein for one thousand feet. In this distance there are three stopes, all very small and are simply mentioned herein with samples taken from them. The first stope, located about three hundred and fifty feet from the portal is forty feet long by forty feet high and is known locally as the Martin stope. The second
The Harper stop, located six hundred feet from the portal of the tunnel, is called the Harper stop. The back of this stop is about twelve feet above the tunnel level. The third stop, called the Kelly stop, is located one thousand feet from the portal and at the point where the tunnel leaves the Little Joe vein. This stop consists of a few rounds of shots being placed in the Little Joe vein on each side of the tunnel. This work was carried to a height of fifteen feet on the South side of the tunnel where a pocket was worked out and back over the top of the tunnel. Some of the best assays I got were from samples taken from the Little Joe vein at the Kelly stop assayed about $50.00 in gold.

From the switch a drift was run on the Isabella vein at a distance of six hundred feet. It was in this drift that the Company first opened up their milling ore and a large stop, starting at the switch and running North-west along the vein some four hundred feet, supplied nearly all of the ore so far milled. This stop is about four hundred feet long by one hundred thirty feet high and varies in thickness from six to eighteen feet. The ore has all been drawn from the end of this stop nearest the switch, but considerable broken ore remains in the stop toward the North end of the drift. This amount of broken ore has been estimated at ten thousand tons. The character of the ore taken from this stop can be seen by looking over assays of samples. The mineral is contained in silicious gangue.

The drift on the South side of the switch follows Southeast along the Isabella vein for a distance of fifty feet from where it strikes off Northwest, following the continuation of the Little Joe vein some seven hundred feet. This tunnel is, at the present time, making considerable water in the breast and as its general direction is toward the Elvin vein, I would rather think that the tunnel here is very close to this vein. As a point along this tunnel, about one hundred feet from the switch, a cross-cut was started Southeast to pick up the Isabella vein again on the South side of the Little Joe. After cutting the Isabella vein a drift followed along this vein for about six hundred feet. The general direction of this tunnel is also in the direction of the Elvin vein and from the indications in the breast a few more feet of work ought to open up that vein. Two hundred feet from where the cross-cut cuts the vein a raise was started and a stop seventy-five feet long by ninety feet high was made with an average width of about seven feet. This stop is full of broken ore clear to the back. The ore in this stop seems to carry more zinc than that opened up in other parts of the same vein.

All of the drifts show numerous veins from a few inches to several feet in thickness, coming into and in many cases cutting through the veins along which the tunnels follow. Practically no development has been done on these cross veins. If they were ever sampled and assayed the records of this work have been lost. An attempt has been made to make these veins found underground, especially those of any size, correspond with the outcrops found on the surface and many of them have been named accordingly. From a careful study of the conditions underground and the plate of the surface made from surveys furnished me by the Company, I am inclined to doubt if this represents the true condition of affairs, but rather that in the case of the majority of veins so far opened by the underground development they either have no outcrops, or those outcrops have not been located. So far none but the Little Joe, and possibly the Elvin vein, lay in the proper position as indicated by their outcrops. The underground veins which have been worked to a considerable extent, and is known as the Isabella, is some two hundred and fifty to three hundred feet to the West of where the croppings would indicate it should be and with the dip of the underground vein almost vertical its crop would never possibly reach the surface outcrop known as the Isabella vein. There is also quite a variation in the strike of the two Isabella veins. The strike of the Isabella vein...
has been determined as being North fifty-three degrees West, while the strike of the underground vein, called the Isabella, is North eighty-two degrees West. The tunnel level at the switch is approximately three hundred feet below the surface.

At the present time the property is equipped to make a daily production of at least one hundred tons of crude ore. The output of this is limited to this amount because of the capacity of the mill, since from all indications with a very small amount of further development, the mine could produce more than double this amount daily.

After having mined the ore it is trimmed in small one man cars, twenty-two and five tenths cubic feet to the car, to the entrance of the tunnel, where is located the crushing plant and head terminal of the aerial tramway and there dumped over a grizzly, have one inch apart, the oversize going into a small bin from where it is fed by hand into a fifteen by nine Blake crusher. The discharge from this crusher is passed over a second one inch grizzly the oversize going to a second crusher, eleven by seven and one-half Simpson. The discharge from this second crusher, together with the undersize from the two grizzlies goes into one of two large storage bins. From these bins the crushed ore is loaded into tram buckets, capacity five hundred pounds each, and transported by means of a Brecher Aerial tram a distance of ten thousand four hundred feet down the mountain to the Kittima Mill, located at the entrance of Minnie Gulch, where it is dumped on the fly into a storage bin. The tram continues on past the mill to a lower terminal located on the railroad spur. The tram is rigged up at the present time to handle ten tons an hour.

Up to this point the ore has been handled dry; but now on water is added to each operation. From the mill bin the ore is passed through three sets of rolls placed in series and before the ore can get out of this closed circuit it is all reduced to pass thru eleven mesh screens. The ore then goes to a hydraulic classifier from where it is distributed to ten concentrating tables of either the Willfley or Card type. The middlings from these ten tables go to a second set of five tables for a second treatment. The middlings from this last set of tables, composed of iron and sand, go to a storage tank from where they are taken out, dried and shipped as second class ore. The concentrates from all of the tables go to another set of storage tanks from which they are taken out, dried, and shipped as first class ore. The tails from all of the tables are run off down the Animas Valley, where the Company owns about seventy acres of patented placer claims which they are using as dumping ground. A one hundred H.P. boiler furnishes steam for drying concentrates and also heating the mill.

The water from the Minnie Gulch furnishes ample water for the milling operations at all times during the year. The water from this creek is caught and held in a large storage tank just above the mill.

The Forest Queen and Iron Monitor Claims, located along the line of the tramway, furnish ample timber for all the mining operations. The timber is loaded on to the tramway at a loading station placed there for the purpose and is transported up to the mine by means of the tram.

So far mining has been carried on by the overhead system. No attempt has been made to sink below the tunnel level. Air drills are used in this work, light hammer drills being used in the stopes and piston drills are used in the tunnel work. Air is furnished for these drills by a compressor 160 feet from tunnel portal.

The compressor which is in A-1 condition is an Imperial type 10 belt driven machine 138910 P.P. compressor built by the Rand Drill Company of New York. The receiver is a four feet by ten foot steel cylinder.
The motive power for the compressor is furnished by an Induction Motor number 18946 Type X, 10-76 A 720 Form k 60 cycles 75 HP. Speed starting compensator for the above induction motor is a 2885168 Type C.M. 211, Torin P. 4 Volts primary 440, secondary 176/324, also built by the General Electric Company.

The two crushers are started by means of an induction Motor #64199, Special number 10670, Type I Class 10 - 60 - 720 Form, 60 cycles, 50 HP, 440 volts 60 cycles, built by the General Electric Company. When the tram is well under way, the motor is cut out and the crushers are run by the excess power formed by gravity tram.

Two 40 H P motors are used to operate the mill. The electricity for the operation of the entire plant is furnished by the Animas Power & Light Company. The lighting of the mine and various buildings and mill is also furnished by this same company. The rates for electricity are about as follows: a fixed charge of $5.25 per H P per month for maximum demand and an energy charge of 13 mills per kilowatt as shown by the meter.

Good steam coal is laid down at the Kittimac Mill at a cost of about $4.50 per ton.

Freight on ore or concentrates running $35.00 to the ton call for the following rates:

- Kittimac Mill to Silverton: $1.25 per ton
- Silverton to Durango: 1.60 per ton

The Eureka Mining District is thoroughly unionized and plenty of labor of good quality can be had close at hand. The wage scale is as follows:

- The cost of operating the mine during 1913 averaged $78.00 per day (24 hours) for labor and the mill about $60.00 per 24 hours for labor.

- The property is well equipped with buildings of all kinds. Located at the mine are a large boarding house (not finished inside); a small boarding house; an assay office; housing for the compressor plant; blacksmith shop; crushing plant and upper tram terminal. Located on the railroad spur are the mill and the lower tram terminal, also an office building and a superintendent's office and house.

**PROPOSED PLAN FOR TREATING KITTIMAC ORES**

It was decided to tear out the three sets of rolls and replace them by two six foot Chilean mills. One of these mills is to be held in reserve or to be used as another unit if the ore developed later warrants this. As present the one unit, which the flow sheet described, will be used. The old tram terminal was changed so that the terminal comes directly over the mill bin instead of being over the shipping bin as before, thus doing away with the "dumping" on the "fly".
The crushed ore from the mine is dumped from the tram buckets into the mill bin. A plunger feed delivers the ore over a ten mesh screen to the six foot Chilean mill. The product from the Chilean mill is pumped to a Whetsel classifier by means of an eight inch spiral pump. The sands from the first spigot are concentrated on three Wilfley sand or "roughing" tables. If there is any oversize material that needs further crushing it is re-elevated to the Chilean mill by means of a six inch spiral pump.

The product from the second spigot goes to two reconstructed Card tables. The product from the third spigot is also concentrated on two Card tables. The fourth spigot supplies either one, two or three tables as required. The slimes are taken out at the start in an eight foot shallow tank.

The lower set of five tables was raised to almost the same level as the second set of seven. With very little excavating under the second set of tables there will be enough room for a Dow system of Agitators preparatory to installation of a cyanide unit.

The slimes from the upper callow tank and the two lower callow tanks go to five card tables which have been equipped with a slimer motion. The final tailings from these slimes will be treated by either of the three methods, according to the values and form in which the metals exist:

1) If they are not worth handling they will be sluiced to the dump.
2) If the values are in the quartz the sands will be treated in the cyanide plant.

The products, the galena and the chalcopyrite, sphalerite and pyrite are collected in bins as shown in the accompanying tracing. The lead concentrate is dewatered, sealed and shipped to the smelter. The Chalcopyrite, sphalerite, pyrite concentrate is partly dewatered by means of a drag conveyor. A large callow tank receives the water overflow. The dewatered product goes to the dryer, which consists of an inclined revolving cylinder with a fire box and hopper at one end. The dry concentrates are elevated to the bins above the three Stiff static machines by a small bucket elevator. The concentrates are screened to three sizes, each size going to its respective machine. The machines are so arranged that there is fall enough for the middlings from the static machines to fall back into the same elevator that elevates product from the dryer.

Using the above methods and judging from experimental treatment of these ores, the three shipping products will consist of:
1) A fifty-five to sixty per cent lead concentrate carrying gold and silver and a little copper;
2) A fifty per cent zinc product carrying a small amount of iron;
3) A twenty to twenty-five per cent copper concentrate carrying the bulk of the iron.

ADDITION.

Since this report was made the Kittitas Mill, Hill and Tram were operated from 1914 to 1917; then leased to Mr. Benton who cleaned out practically all of the stopped ore and a winze was sunk in the ore in the so called Clark stopes.

From 1914 to 1917 the mill shipped some very good high lead concentrates—Copper-Iron concentrates to the Durango Smelter of the A.S. & B. Co. Some shipments of zinc concentrates were made to the Russ Smelter Co.
Since making the above report extensive improvements have been made in milling and metallurgical methods, especially in the treatment of complex sulphide ores, copper, lead, zinc and iron.

The Kittitas Mill with a few alterations can successfully treat the above complex ores.

I had occasion to visit the different plants near Salt Lake, while attending the meeting of the American Institute of Mining and Metallurgical Engineers in September 1925, held at Salt Lake City.

The International Smelting Company plant at Tooele, Utah, are in the market for the above complex ores, and will pay for all the metals, including zinc, which heretofore has been penalized, - this will increase the earning of the mine considerably.

I would advise, before making any extensive alterations, to develop the ore bodies that show on the surface, by connecting both drifts in the tunnel breast, by driving the left drift ahead to cut the right drift, on the same mineralized crevice, to cut the Youngson vein and drive in on this vein to cut the Calibre vein, at a distance of 500 feet, at a depth of about 300 feet from the surface by drifting on this vein, a depth of about 1200 feet below the top of the mountain will be gained from the tunnel level.

I wish to mention that an upraise was made in the lower tunnel at 1000 feet connecting with upper tunnel, making a good ventilation for mine working.

The Calibre vein is over ten feet on the surface and a number of assays were taken showing good values in gold and silver. By driving about 300 feet farther will cut the Stanton vein, 20 feet wide. This vein is parallel with the Calibre vein. This vein carries high values in gold.

From the surface showing, the Youngson vein by driving in on it, to cut the Calibre vein, I am satisfied good ore bodies will be opened up.

Since the above and foregoing report was made, a correct survey of the underground workings and the outcroppings of the Isabella shows that the small sulphide vein encountered in the crosscut described in paragraph 4 on page 4, and paragraph 2 on page 6, was not the Isabella vein proper as described as cut in said paragraphs. It is clearly evident from this accurate survey that the Isabella vein by a series of faulting, which can be observed in the underground workings, has been offset or displaced to the south for a short distance and a crosscut driven from the point where the said sulphide vein was first encountered should cut the Isabella vein proper in less than 100 feet.

The Clark stope on the Isabella vein is about 300 feet in length, and averages six feet in width. - the bottom of the drift from samples taken by me average value in gold, silver, copper and lead, twelve dollars a ton, besides the zinc value. The ore in the Clark stope has been taken out to the upper tunnel.

The mine is equipped with boarding house, transformer house, tramway terminal, two crushers, Blake and Sampson, blacksmith shop, etc. air compressor, power electric, all in good condition.

The main tunnel for one thousand feet, equipped with thirty pound rail, the drifts with twelve pound rail.
I would advise to straighten out the sharp curves, and use storage battery motor for hauling the ore to the crushers.

It is my opinion that with the above mentioned development work done, that from two to five hundred tons of ore a day can be opened up for the mill and smelter.

The best and cheapest methods for the sulphide area with present conditions at mine and mill will be selective flotation, now used at the International Plant at Tooele, Utah, which makes a clean lead product, and a high grade zinc product, also copper and iron product that can be sold separately, or all to the best market.

The silicious area with sulphides, which is the case more or less, can be treated by flotation and tails by Cyanide methods now used.

I have examined a large number of mines and made reports on them for a long time, and from May 1914 to July 1915 was General Manager of the Kittimaoo Mines Company, so had an opportunity to make a complete study of the possibilities of this property.

It is my opinion that the Kittimaoo Group of Mines with competent and economical management will be one of the largest producing and paying properties in the San Juan country.

(Signed) R. J. Walter
Mining and Metallurgical Engineer.