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GEOLOGY
ELY DISTRICT

HAND.

Nevada

From
THE WHITE PINE NEWS
August 4, 1894

ROBINSON MINING DISTRICT

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A Description of Its Extent and Resources.

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Robinson Mining District is situated in White Pine county, Nevada, one hundred and fifty miles south of the Central Pacific Railroad, in the Egan range of mountains, near the town of Ely, the county seat.

The mines of this district were, some of them, located as early as 1869, about the time of the discovery of the celebrated White Pine mining district. They were at first believed to be silver-lead mines and were worked for that kind of mineral. A smelting furnace was erected for the purpose of working the ores, and considerable of it was reduced in that way, but at that early day smelting had not got to that degree of perfection that it has since attained, and this process was abandoned.

From the surface indications and the distinct character of ore found in this district it is the judgment of many that there are two ore veins that are separated by Robinson canyon. The vein on the north side of the canyon contains ore that is valuable largely in silver, lead and very little gold, while the vein on the south side of the canyon contains ore that is valuable largely in gold and very little lead and silver. This is not the case in each instance as the mines that are situated next to the canyon on the north side are, some of them, very similar to those on the south side of the canyon. This is expecially true of the mines located east of the Great Western, while those lying further to the north and higher on the mountain are of the silver-lead character. It may be that the gold vein, or the vein on the south side of the canyon is separated, and forms a spur, or at this point, becomes wider and extends further to the north and beyond the canyon.

Before proceeding further in this description it will be well to state that the ore zone passes through the district in a north-westerly and south-easterly direction and Robinson canyon cuts through the district in a south-easterly course near the middle of the ore zone.

Returning again to the work done in the early days of the district, while they were prospecting chiefly for silver and lead it was discovered that the lead bullion carried a large amount of gold. Upon investigation it was found that the

AULTMAN MINE

Was furnishing the greater portion of this valuable metal. The ore of this mine was of such character that it could not be reduced rapidly, it being decomposed quartz, a large portion of which was clay, which baffled the most experienced smelters of the camp. It was at last concluded to abandon this mine so far as smelting ore was concerned; they however worked the property in pursuit of lead, which was not found in paying quantities, but they did develop a large vein of ore carrying gold. The mine was left in this condition until 1887, when Messrs. Underhill, McOmie and others secured a lease upon the mine and worked the property for a number of years. They constructed a mill of ten stamps capacity and reduced the ore by crushing and passing the same over copper-silvered plates. The process was incomplete and the loss too great to make it profitable. Under this lease they developed large quantities of ore that can be made profitable by working on a large scale and with a complete milling plant. It would be difficult to estimate the amount of ore developed in the Aultman, it not being sufficiently blocked out, but there are large quantities of the average value of $8 per ton in gold. This is the property of Governor McKinley, Geo. D. Saxton and Marshall Barbour of Canton, Ohio, who own a number of patented mines in the district, of which further mention will be made in this article. The Aultman is situated on the south side of the canyon on what is known as Aultman Hill. Just below and adjoining the Aultman on the north is the

JOANA MINE

Whose rich ore attracted so much attention about three years ago. It is separated from the Aultman by a small porphyry dyke. The late A. R. Watson was the original locator, and through his energy the mine was opened and developed. While Mr. Watson operated the mine about fifteen hundred feet of tunnels, drifts and openings were made. The ledge was stripped and exposed on the west end of the mine for a distance of three hundred feet which showed the ledge to be very large. One of the principal openings, the one leading to what is known as the cave, is reached through a tunnel sixty feet in length, at which point a cave was encountered and the ore vein was also reached. From this point an incline forty-five feet in depth was sunk. At the bottom of the incline a drift was driven one hundred and twenty-five feet to the east, and also another thirty-five feet to the north. Several cross-cuts were made at different places, all of which are in ore of good grade. To the west of the work in the cave are other extensive works, in which a large amount of drifting and sinking has been done and a quantity of good ore was exposed. A great many tons of ore were milled from this portion of the mine with fair results. From a statement of facts regarding the Joana mine, prepared by the Hon. Thos. Wren of Eureka, Nevada, the following quotation is made: "The ore was reduced at a small ten stamp water mill at the town of Ely, about three miles from the mine. The mill is poorly constructed and the only appliances for saving gold were copper plates.

Less than one-half the gold was saved by this mode of working, as was shown by constant assays of the tailings. Approximately seven dollars a ton was saved by this process, as shown by the returns by Watson under oath to the assessor of White Pine county, for the purpose of taxation. This would give, adding the gold lost in the tailings, an average of fourteen dollars a ton in the ore worked. The amount taken out in the aggregate was something over fifteen thousand dollars. The exact figures are on record in the office of the assessor of White Pine county." Some distance further to the west there is a tunnel one hundred and fifty feet in length that cross-cuts the ledge. The whole length of the tunnel is in ledge matter. Some time ago this tunnel was sampled in sections by an experienced sampler, the average of the different samples taken giving $4.15 in gold. There have been various estimates of the amount of ore in sight. It would be difficult indeed for all estimates to be made with any degree of accuracy. Some, however, have shown more than fifteen thousand tons of the average value of $12.50 per ton. The gold is free but the clay and oxide of iron require more than the ordinary plate process for saving the gold.

The Joana mine has been unfortunate, it has suffered as many mines have before it. When the first great strike was made, and it was known that it was a mine of unusual merit, litigation began which ran through the courts for a term of several years at great expense and annoyance to the owner. The property was tied up and could not be untied until the judgment of the court was had. During this litigation a number of mining men visited the Joana at various times and made examinations of the property. It is generally believed that the property met their expectations and was satisfactory; but the law suits stood in the way until all were tired out. Had it not been for this unfortunate affair it would no doubt, be one of the large producers of the day, and the district of Robinson would be in quite a different condition.

The Joana mine is now the property of Messrs. Hilp, Wren, Cheney, Sadler and Jackson. These gentlemen own a number of mines in the district.

JOANA NO. 2

The property of Messrs. Ostergard, House, Lawson, Hilp and others adjoins the Joana on the west. There has been considerable work done, but not sufficient to develop the value of the claim. In the deepest working they have some good ore, the same as the Joana in character. Out of a number of tons milled from this property $4 per ton in gold was saved.

CHAINMAN GROUP

The property of Messrs. Lyons, McGill, McOmie and Underhill, is situated on Aultman hill, adjoining the Aultman mine on the west and the Joana No. 2 on the south. The group is composed of five mines, which are the Chainman, Chainman Gore, Turkey V Southern Cross -- all adjacent to other. The development work upon the group is mostly done upon the Chainman and Chainman Gore mines. The entrance to the mine is through a large tunnel, which taps the ledge at a point 500 feet from the mouth of the tunnel, and 125 feet from the surface. At the point of intersection made by the tunnel and ledge a lateral drift has been run to the west a distance of 300 feet; also, a lateral drift has been run to the east 75 feet to a winze which extends down to a second or lower level of the mine, a distance of 100 feet below the tunnel or first level Thus it will be seen the total depth at this point is 227 feet. Going back to a point where the lateral drift west leaves the tunnel a distance of sixty feet to west in the drift a crosscut has been made to the south, and an opening to the north at the same point, which shows the ledge at this point to be thirty feet wide. Forty feet further to the west, in the lateral drift, there is a stope to the south where some ore has been extracted and reduced at the Chainman mill, which averaged $11 per ton. There is an opening to the surface a distance of something more than 100 feet through the roof of the stope, which is in ore all the way. On the opposite side of the drift there is a crosscut to the north. The distance taken from the back of the stope and to the end of the crosscut shows the ledge to be 42 feet wide. The ore stope extends along the lateral drift to the west, a distance of fifty feet to another crosscut to the north, and shows the ledge to be twenty-four feet wide. The crosscut is not entirely across the ledge. An average gives $6.50 gold per ton. Fifty feet further west in the lateral drift another crosscut is made to the north twenty-eight feet; also to the south a distance of eighty feet. The crosscut to the south has not extended entirely across the ledge. The average value of the north crosscut is $16 per ton in gold. The average in the south crosscut is $6 per ton in gold. The ledge at this point is shown to be 108 feet wide. Twenty feet further west in the lateral drift is an incline shaft which is the working shaft of the mine, which extends to the surface where there is a Common Sense whim erected; that ~~the~~ incline also extends down to the second level. The later drift has been driven several feet further west. All of these workings are in ore.

Beginning at the intersection of the incline with the second level, a drift has been run west a distance of 65 feet all in ore. Another has been run south for some distance in ore, and another east at a distance of 120 feet the ledge is crosscut 45 feet to the south in $10 gold ore. This crosscut did not reach the wall. One hundred and thirty-five feet further east, on the east drift the ledge is again crosscut to the south a distance of 35 feet in $8 gold ore. Thirty-five feet further east the ledge is again crosscut to the south a distance of 40 feet in $8 gold ore. At a distance of 20 feet further east in the east drift, the winze to the upper level is reached, which is referred to above. At the bottom of this winze a drift leads to the north 28 feet, cutting through a small point of lime and opens again into a large chamber from which a large quantity of ore has been stoped. This stope extends 200 to the northwest and 20 feet southeast, and to the level above. The ore taken from this portion of the mine was high grade. Samples can be had running into the thousands, but the average would probably reach $35 to $40 per ton. There have been several thousand tons of this ore worked at the Chainman mill. There still remains several thousand tons of same quality in the mine. There is no indication of the south wall of the mine having been reached; it is also questionable whether the northwest has been reached. It is the common opinion that the south or hanging wall is shale, and that the north or foot wall is porphyry. Through the mine in many places bunches of lime are found; but thus far they have been but bunches, ore being found on each side of the lime. The ore in the Chainman group is similar to that in the Aultman and Joana mines, possibly not so free as that in the last named mine. The reduction of this ore has all been with the ordinary stamp mill, using copper plates for saving the gold. The last work showed a saving of about 60 per cent of the gold, while at the beginning but 40 per cent was saved. A considerable portion of the gold that is not free is found in a white carbonate of lead, and another portion is found in a heavy black iron, either of which can be readily saved by concentration. The cyanide process has been used upon the tailings at the Chainman mill. The tailings carrying some free gold, and gold alloyed with the carbonate of lead, makes the process fall short of being a success.

The Chainman ledge passes through the entire length of the Ch inman mine to the west end of the location and continue on its westward course through the Turkey and V mines. These mines are but little prospected, and nothing is known of their value except that they are on the extension of the Chainman and Aultman lode. The same can be said of the Southern Cross mine. There is some more work done upon the Southern Cross. Samples taken from one of the shafts assayed $27 per ton. Between the Southern Cross and the Chainman mines lies the

THE GOLDEN REVENUE

The property of Messrs. Simpon, Campton, Harris and others. There is a shaft and other workings upon the mine that expose a large vein of ore that assays $5 to the ton in gold. The deepest workings are about 175 feet, where the ore is found at the bottom; but very little prospecting has been done. West of the Golden Revenue and South of the Chainman lies the

ELY MINE

The property of General Thomas and F. M. Clark. The workings consist of a tunnel 40 feet long, at the end of which a shaft is sunk inthe ledge, which is about six feet wide and assays $5 per ton in gold. The ledge can be traced the entire length of the mine. South of the Ely and to the western end lies

THE MOHAWK

The property of General Thomas and F. M. Clerk. The workings consist of a tunnel 40 feet long, at the end of which a shaft 30 feet deep and an open cut upon the mine in which ore has been developed that assays $10 per ton in gold. West of the Chainman group lies the

ROB ROY MINE

The property of Captain Carpenter, Hilp and others. The claim has been developed by a series of tunnels in which some very good ore has been found. Owing to the presence of water near the surface the ore is not free, but is in a sulphurate form. The owners have expended at least five thousand dollars on the property. Adjoining the Rob Roy on the west is

THE LOS ANGELES

The property of Wm. Watson, Leach Bros. and others. There is a shaft and tunnel upon the mine on which the owners have done considerable work and exposed some ore. A general sample taken assayed $75 per ton in gold. A lot of second-class ore worked at the Chainman mill yielded $4 in gold. South of the Rob Roy mine lies

CHIEF OF THE HILL

Owned by Samuel Parkinson and others. The owners have done some work on the mine and developed some ore.

Adjoining the Los Angeles mine on the West is the Saxton, the property of Governor McKinley and others. At this point the ledge is very strong. Croppings are found high above the surface in many places over the mines. The prospect is covered by U. S. patent and has remained idle for many years. A sample taken from one of the old shafts upon the ledge assayed $18 in gold. The ore is free and of the same character found in the above described mines. This is considered to be one of the best locations in the district. West of the Saxton is

THE AURORA GROUP

Owned by Messrs. Graham, Williamson and Rockhill. The group is composed of four mines, the Katy G., Emma G, Oregon and Mount Morgan. The working consists of a tunnel 112 feet long and a shaft 35 feet deep and a tunnel 75 feet long. At the shaft there is a body of very good ore assaying $7 per ton in free gold. The ledge is seven feet wide, and in some places very strong. The croppings assay $10 in gold. Like the Saxton this property has great merit, the ledge being very strong and well defined. It is understood in this vicinity that this property is under bond to New York parties.

The Rosebud mine is to the west of the Aurora group and is the property of Mr. Rockhill. There is a shaft upon this mine 40 feet deep and a tunnel 100 feet long which expose ore worth $5 per ton in gold.

Continuing to the southward on the main mineral belt, but a great many locations are passed over, all of which have some work done upon them and show more or less gold. They are but slightly prospected, and nothing can be said as to their value, except that they all show the same ledge matter and are of the character that is found in the previously described mines. The ledge is very prominent and can be readily traced the entire distance to the

GOLD HILL

Group, located upon a hill by that name, about two and one-half mines distant from the Aurora group, and is the property of Messrs. Williamson and Rutledge. The locations of this group are the Gold Hill, Gold Hill No. 2 and May. There is a shaft forty feet deep on this group of mines that shows ore its entire depth. The ledge at this point is six feet wide, assaying $10 in gold. There is an immense outcrop of the ledge all over the hill from which good results are obtained with a pan. The ore is harder, the quartz not so much decomposed, and does not contain so much iron and lead as some of the other mines.

South of and adjacent to the Gold Hill group is the Hell in the Hill mine, owned by Thos. Rockhill and Newton Boyd. There is an incline upon this mine 62 feet deep which shows the ledge to be about six feet wide at a depth of 35 feet. At this point the incline has left the ore, the ledge continues to the bottom of the shaft but is not the same grade. Fifty tons of ore taken from this shaft assayed $27 in gold to the ton. The ore is the same in character as the Gold Hill, does not show as much gold in panning, but is remarkably regular in assaying. The ledge is very prominent and crops out at several points on the mine.

There are a number of other locations upon Gold Hill. The principal ones are the City of New York, owned by Messrs. Ostigard, Moore and Weber. They have a shaft 70 feet deep, a drift has been run 30 feet from the bottom of the shaft which is all in ore assaying $7 per ton in gold.

The Hickory, lying north of the Hell in the Hill, belonging to Capt. Harmon and Capt. Carpenter, has a shaft 35 feet deep in ore.

North of the Gold Hill mine some distance is the Midnight and Phoinix locations, owned by D. C. McDonald, Jas. P. McOmie, J. B. Simpson and others. There is a shaft on this mine 90 feet deep which taps a strong ledge six feet wide of ore assaying $18 in gold. A small streak of ore in the ledge assays $450 in gold and 67 per cent. lead.

East of the Midnight a short distance is the October location, the property of Messrs. Simpson and Rynearson. The mine was worked in the early days of Robinson at which time a deep shaft was sunk and some ore was extracted which was principally silver carrying but little gold.

Journeying to the north-west the ledge makes a turn more to the south. There are locations most of the way upon which some prospecting has been done which all show gold. At a distance of about two miles the Magna Charter is reached, the property of Thos. Rockhill and others. The ore is of an entire different character, resembling the ore of the north ledge, carrying silver, lead and gold. The ore runs about 30 per cent. lead, 3 ounces silver and $2 in gold. The ledge is three feet wide at a depth of 40 feet. Two miles west of the Magna Charter the

WEST CAMP

mines are reached. These mines were worked in the early seventies. The ore found here is different in character from the mines already described, some of them carrying copper in large quantities. The principal mines of this vicinity are the Boulder and Boss, the property of John Daly, upon which there has been considerable work done. On the former there is a shaft and open cut. Ores taken from these workings and shipped for reduction assayed $50 in silver and 47 per cent. lead. The latter claim (Boss) has a deep shaft out of which some high grade silver-lead ore has been extracted.

The Ragsdale and Rockhill mine in the vicinity shows a vein two feet wide at a depth of 87 feet, which assays 50 per cent. lead, 18 ounces silver and $50 gold.

Messrs Hilp, Wren and others own several mines in this locality, the principal ones being the Pilot Knob, carrying gold; the Emma, carrying gold, silver and lead; the Mannouth, Monitor, Star and Star of the West, all carrying copper and ores worked for that metal. The ore was reduced at a local copper smelting furnace and gave good results.

West camp is at the extreme north-west end of the mineral belt and upon the summit of the range.

Returning to the Aultman mine the

GOLDEN FLEECE

Lies just to the east and adjoining the Aultman. It is the property of Thos. Rockhill and the Ragsdale estate. The work consists of two tunnels and a shaft. The ore assays 30 ounces silver and $10 gold.

South of the Golden Fleece and east of the Southern Cross, is the Golden West, but little prospected and is owned by Williamson and Simpson.

North of the Golden Fleece is the Golden Wedge, owned by Messrs. Thompson & Weber, which is also but little prospected. There is some ore upon it that shows gold.

North of the Golden Wedge is the Thoroughbred, belonging to Wm. Watson and others. It has a shaft fifty feet deep which exposes good ore.

Adjoining the Joana on the north and east is the

FLORIDA

Group, the property of D. C. McDonald and John F. Cupid. The group includes the Florida, Dauntless and Quadrant, which extends across Robinson canyon to the north. Upon the Florida in the middle of the Robinson canyon, the owners have sunk a shaft 87 feet deep, they drifted north 25 feet and sunk again at the end of the drift 55 feet, making a total depth of 142 feet. The bottom of the shaft is at the footwall of the ledge. They then crosscut 30 feet reaching the hanging wall, showing the ledge in the bottom to be 30 feet wide. There is also an open fissure that exposes the ledge latterly for one hundred and fifty feet. The ore in these workings assay from $4 to $13 per ton in gold. Two hundred feet to the north of the shaft just described there is another shaft in the croppings of the ledge 25 feet deep in which there is eight feet of ore that assays $5 per ton in gold. The ledge is traced through the full length of the Florida and across the Dauntless. Upon the Dauntless there are three tunnels, one of which is 115 feet cutting the ledge; one is 68 feet long cutting the ledge, and one 30 feet which has not yet reached the ledge. The ore assays $8.75 per ton and carries some copper.

Upon the east extension of the Golden Fleece is the Lone Star, the property of Messrs. Hayes & Berry, on which there is a shaft 15 feet deep in ore.

Journeying along the ledge to the east a number of locations are passed which are but little prospected. At a distance of one and one-half miles the General Logan mine is located, the property of Messrs. House, Morris, Hilp and others. There is a tunnel 75 feet long and a shaft 30 feet deep on the claim which exposes ore assaying $7 per ton.

South of the General Logan is the May Day, the property of Messrs. House, Morris and others. There is a tunnel on this mine 120 feet long and an incline in the tunnel 20 feet deep in ore that assays $6 per ton in gold and sixty ounces in silver. Some high grade ore is also found in the May Day. These mines are upon the extreme southeast end of the mineral belt and are about one mile west of the town of Ely.

One mile up Robinson canyon from the town of Ely, and upon the north side of the canyon is Maggie hill, from which point the description of the north ledge will be taken up. The principal mines on this hill are the Mohee group and the Maggie group. The Mohee group is the property of D. C. McDonald and J. F. Cupid The workings consist of a shaft 35 feet deep, an incline 20 feet deep and a shaft 20 feet deep. The ore assays $4 in gold per ton, come of which carries 40 per cent. copper.

Down the hill and to the south of the Mohee is the Maggie group, owned by Messrs. Lyons & McOmie. The work consists of several small shafts or openings. The ledge in places is about ten feet wide. Some of the ore pans as high as $12 per ton in gold, most of it being free.

East of Maggie Hill are a number of locations that cover the ledge almost to the town of Ely. Some of them prospect well.

West from the Maggie Hill are a number of locations. Some of them are the Florida Tunnel, Yankee Blade and Buckeye Fraction, owned by Fred Clark and others.

About one half mile from Maggie Hill is the Robust mine, owned by Messrs. Riepe & Thomas. This mine is about 3,000 feet south-east from the Joana. There is a shaft 60 feet deep and a drift 22 feet. Both shaft and drift are all in ore. The ledge is six feet wide and assays $12 per ton in gold. About 150 tons of this ore is extracted and upon the dumps at the mine. Some estimates show a thousand tons in sight.

Passing along the ledge to the west numerous locations are seen. The Blackstone, Ohio and Union, carrying gold, silver and lead, are the property of Governor McKinley and others. All have work upon them and expose considerable ore.

North of the last named mines are the Rip Van Winkle and Edna, owned by Messrs. Simpson, Lyons and McOmie. These mines have shafts and open cuts upon them, the greatest depth attained being 25 feet. The Rip Van Winkle ore carries gold and silver about equal. The Edno ore assays from $5 to $80 in free gold.

South of the Union and Ohio is the Cloud and the Gold Bug. The latter is owned by Messrs. Weber and Ostergard, in which quite a body of $10 ore is found.

West of the Ohio is the Great Western the property of Messrs. Hilp, Wren and others. The works aggregate 400 feet and some good ore i s exposed.

West of the Great Western lies the Commodore, Issacs, Hicks, Eliza, Bullion and Springville, the property of Governor McKinley and others. These mines were all worked in early days and produced most of the bullion at that time. The ore was silver, gold, and lead.

Crossing Robinson canyon again to the south are a number of mines located upon a high mountain lying between Robinson canyon and a large canyon coming into Robinson canyon from the south, known as the canyon leading to White River. Here are found the Hidden Treasure, belonging to McDonald and Cupid; the Ontario, Point, Sheba and Shife belonging to Messrs. Hilp, Wren and others, and some locations belonging to John Farrel. There has been a large amount of work done upon this mountain and several shipments of ore have been extracted. The ore is silver, gold and lead.

West from this mountain about two miles distant is the property of Messrs. Jackson and Kind of Eureka, known as Key Stone from which a large quantity of ore has been extracted and reduced. A number of shipments were sent to the Eureka furnaces for treatment which yielded about two hundred dollars per ton in silver. There was also a lot of this ore reduced at the Monitor mill, Steptoe creek, and another lot was reduced at the Chainman mill. Afterward the parties owning the property erected a mill at the mine and reduced some of the ore. The process they employed was the lixivation process to which the ore readily yielded. The mine is still in good condition to produce. Owing to the present low price of silver the owners deem it best to await a change.

In addition to the lode claims there are within the limits of the District

PLACER MINES

About one-fourth of a mile from the town of Ely in the mouth of Robinson canyon. The Robinson Canyon Consolidated Mining Company has located about 10,000 feet of ground extending up the canyon to a point above the Joana mine, which is located as placer ground. The property is worked through shafts -- six in number. The bed rock is found at an average depth of seventy feet. On the bed rock from two to eight feet of gravel is found which carries gold. It is coarse and easily saved in an ordinary sluice box, which method is used by the Company in the spring of the year, when there is surface water running down the canyon. Several runs have been made in this way. The Company is now arrenging to put in dry separators, when they expect the property will be made pay.

The Maud S. placer claim adjoins the property last described, and extends up the canyon and includes twenty acres within its boundaries. It is owned by J. B. Williamson and in all respects is like the property of the Robinson Canyon Consolidated Placer Mining Company.

It will be seen from the above description that the mineral belt extends from the May Day mine on the south-east to the mines at West Camp on the north-west end, covering a distance of about eight miles in length. The width of the belt varies some. At places it is fully a mile wide, and at no place is it less than half a mile. Mineral can be found on all portions of the belt. There are many locations in the district that have not been mentioned in this article. However a sufficient number has been, to give the reader a general idea of its magnitude.

Nature has done her part for the success of the camp. The ore is very soft, most of it can be mined without blasting, thereby saving a great expense. There are numerous springs in the district that can be used at the mines, and at the town of Ely there is a large stream of pure water that is not effected by frost or by hot and dry seasons. The hills are covered with an abundance of timber, suitable for mining and fuel. Good wagon roads are built to all portions of the district, and all the mines are easy of access. All that is required for a live and booming camp is money, and he who invests will reap the reward.

DIAGNOSTIC MINERALS OF THE VARIOUS ROCK FORMATIONS

IN THE KIMBERLY DISTRICT

by J. H. Courtright.

The following is a brief summary of information obtained thru the examination of exposures on the surface and underground, and from churn drill sludge samples. The minerals were identified by microscopic observation of crushed rock or of panned concentrates of same. In cases where the heavy minerals are of very sparse distribution (such as the zircon in porphyry) gravity concentration is the most reliable method. Clove oil is the emersion media commonly used:

ELY LIMESTONE

Fresh. Mainly calcite, chert common, minor amounts of detrital quartz and zircon common. Sandstone horizons may be present.

Lightly metamorphosed. Mainly calcite plus variable amounts of amphibole as colorless, elongated prisms or needles. The amphibole closely resembles tremolite, however analyses show considerable alumina (H.S.937, 938) and the mineral may be the aluminous amphibole, pargasite.

Strongly metamorphosed. Quartz, garnet, pyroxene (diopside), amphibole (tremolite or actinolite), chlorite, epidote, apatite. The percentages of these minerals present may vary considerably from place to place. For instance, in certain areas the rock is almost wholly composed of diopside, or of quartz and garnet, or of amphibole and quartz.

Silicified limestone. This formation is roughly one to three hundred feet in thickness and extends, according to churndrill information, from the Veteran to the west end of the Emma. It occupies a position immediately beneath the partly silicified Rib Hill Sandstone. It is composed essentially of chalcedony or very fine grained quartz, low temperature type. A mosaic texture (similar to chert) is common. Zircon (detrital) is generally sparse to absent, but may be abundant in a few horizons. The silica may be of supergene origin.

Kaolinized Limestone. Limestone is either wholly or partly replaced by clay (halloysite?). Churn drill samples should be examined before panning, otherwise clay may be entirely washed out. Siderite common in Richard, Alpha and east Tonopah areas. A few detrital minerals, such as zircon and quartz are often present. Amphibole (tremolite or pargasite) common in Richard clay.

RIB HILL SANDSTONE

Fresh. Mainly detrital quartz, det. zircon sparse to abundant, apatite sparse, tourmaline rare. Numerous limey beds (calcite) present.

Silicified. Remnants of sandstone texture show in fragments, det. zircon sparse to abundant, some fine grained quartz (type found in silic. limestone) may be present.

Diagnostic Minerals of the Various Rock Formations in the Kimberly District.

PILOT SHALE

Fresh. Mainly lime or clay shale, calcite fairly common, detrital quartz and zircon rare.

Metamorphosed. Composed essentially of hornfels, garnet and diopside common. Detrital zircon rare. Andalusite common in shale of Morris 850 level.

CHAINMAN SHALE

Fresh. Mainly lime or clay shale, detrital zircon and quartz common, also calcite. More or less quartzite may be present.

Metamorphosed. Hornfels, garnet, quartz, pyroxene, epidote, andalusite, sillimanite. Detrital zircon may or may not occur. In section of Chainman near Emma Shaft upper half is essentially limey, lower half sandy.

May be intimately intruded with porphyry near contacts -- or partially assimilated (?). In such cases (north wall Copper Flat Pit) euhedral zircon and feldspar will be present with above listed minerals.

JOANA LIMESTONE

Mainly coarse calcite, chert sparse to absent.

MONZONITE PORPHYRY

Euhedral zircon invariably present, apatite common. Sphene and rutile common. Zircon sometimes has corroded appearance and may be mistaken for detrital type.

RHYOLITE

Euhedral zircon sparse to absent. Clear or smoky quartz phenocrysts always present -- the only reliable diagnostic feature.

Rhyolite breccia may contain fragments of several of the various rocks -- for example, a specimen of the pipe-like breccia body at 25 Drift in the Morris contained both detrital (derived from sandy shale) and euhedral zircon.

TABLE OF DIAGNOSTIC HEAVY MINERALS---NON-METALLIC

		Zircon		Garnet	Diopside Actinolite Tremolite	Apatite	Epidote	Andalucite Sillimanite	Sphene Rutile	Tourmaline	Hornblende	Siderite			
		Eub	Det												
SANDSTONE	Fr		+	± Det.	± Sp.	± Det		± Sp.	± Sp.	± Sp. Det					
Rib Hill	Min		+	± Det.	?	?				?					
LIMESTONE	Fr		*1												
Ely	Min		*1	± *3	± *5	+	±					± *9			
SHALE	Fr		*2												
Chainman	Min		*2	± *4	± *6	+	±	+							
LIMESTONE	Fr														
Joana	Min				± *7		?								
SHALE	Fr														
Pilot	Min			±	4	±	±	±							
PORPHYRY	Fr	+				+	± *8 Sp		+		+				
	Min	+		?		+			+						
RHYOLITE	Fr	±									±				
	Min														

1. Ely Ls. contains a few sandy beds---Psuedo Rib Hill ss occurs on Rib Hill, in Richard Mine.
2. Ch. Sh. contains numerous sandy beds---discontinuous.
3. Heavy garnetized zones very common in met. ls.
4. Garnet abundant in intercalated lime beds---more prominent in upper half, KCC pit area.
5. Nearly always present in met ls, however some mineralized and subsequently altered ls contain mainly clay and quartz with but traces of the actinolite-diopside assemblage--Tonopah Pit
6. Present in met. calcareous beds.
7. Very minor amounts have been noted.
8. Found in P? in pipeline excavation under highway near hospital.
9. Abundant in Richard and Alpha, also found in East Tonopah.

E. N. Pennebaker, Chief Geologist — Kimberly, Nevada

Howard D. Smith, President — August 21, 1929

CHARACTER OF COPPER MINERALIZATION IN ELY DISTRICT

The question has been repeatedly brought forward as to whether the Ely District, and the Kimberly area in particular, was one of primary copper mineralization and whether such mineralization gave origin to high-grade deposits of chalcopyrite. After study over a period of a year and a half, I can emphatically state that there is clear and abundant evidence to indicate the primary character of the ore deposition, and there is satisfactory evidence to indicate that certain of these deposits were of high tenor. In these views I am corroborated by Mr. Joralemon and Mr. Halin.

The close accordance of the Alpha oxidized ore-shoots with controlling geologic structure argues that the copper values are now found close to the original sites of deposition. That is to say, the primary ore was oxidized essentially in place, and the downward migration of the copper is to be measured only in tens of feet rather than hundreds of feet. Thus it appears that the grade of the oxide stopes is only slightly higher (one or two percent) than the primary ore before oxidation. "Chalcopyrite boxwork" in oxidized material shows that the primary copper mineral was chalcopyrite. It follows that primary high-grade chalcopyrite ore is to be expected in depth.

The same features are exhibited in the Richard oxide orebody, and the same conclusions may be reasonably drawn. Very little of the Richard sulphide orebody has been exposed for examination, but I do not believe the copper in the secondary chalcocite there deposited has been moved a great distance. The general structural relations of this orebody negative the view that the copper was collected over a large area, was transported a considerable distance, and there deposited. I believe the copper was moved from a closely adjacent site of primary chalcopyrite deposition.

The leached outcrops over the Old Glory deposit show undoubted evidence of the former presence of chalcopyrite. This has been leached and the copper carried downward several hundred feet where it was deposited as secondary chalcocite to form ore.

High-grade primary chalcopyrite ore is found in the Taylor mine where limestone adjacent to porphyry has been mineralized. Recent drilling in the Miranda-April Fool area has shown primary chalcopyrite porphyry ore with a grade of 2.04% Cu.

E. N. Pennebaker, Chief Geologist

Howard D. Smith, President

Kimberly, Nevada

August 21, 1929

CHALCOCITE ORE IN RICHARD MINE

Examination of the sulphide ore cut in diamond drill hole R.L. #32 shows the copper to be carried by chalcocite which I believe to be secondary in origin. This hole was drilled from the 600 level to the southwest from the shaft. From 148 to 150 feet the core assayed 9.02% copper.

CONSOLIDATED COPPERMINES CORPORATION

MEMORANDUM

FROM Howard D. Smith, President

TO E. N. Pennebaker, Chief Geologist

CITY New York, N. Y.

DATE August 26, 1929.

SUBJECT CHARACTER OF COPPER MINERALIZATION IN ELY DISTRICT

Your letter of August 21st, on the above subject, is very interesting. I showed it to Fred Searles this morning and he said it did not mean much to him as he never doubted the things you speak of.

I think that there is something left out of the second paragraph of this letter in connedtion with how deep the downward migration of copper has gone, where you speak of it only to be measured in tens of feet rather than hundreds of feet. There are large masses of limonite which I recall seeing on the 12th and 13th levels years ago and I think you will find that some of the copper solutions have migrated quite a distance and, to quote Professor Lawson, we should find some marked secondary enrichment. How do you feel about this?

The recollection of Professor Lawson, with regard to chalcopyrite ore, of course I would not think extended to any considerable tonnage or grade figures. He just happened along, as I understand it, near the collar of the shaft and saw the same. What was the character tonnage and grade of Nevada's ore from the Cumberland Ely?

You might write the Professor yourself, % Geological Survey, Ottawa, Canada, and I am sure he would be glad to reply as he seemed much interested in your work for Coppermines.

Howard D. Smith

HDS:AG

E. N. Pennebaker, Chief Geologist — Kimberly, Nevada

J. B. Haffner, General Manager — December 31, 1930

GEOLOGY AND EXPLORATION OF THE RUTH-MINNESOTA AREA

INTRODUCTION

The Ruth-Minnesota area lies in the eastern copper-bearing zone of the district. Here the feeding channelway for the introduction of intrusive porphyries and mineralizing solutions runs north and south through the ore-bearing ground of the Nevada Consolidated Copper Company and dips westerly into Coppermines holdings. These conditions continue as far west as the western end of the Minnesota Claim where the Keystone Fault Zone forms a structural break between the eastern zone and the central zone. The central zone includes what we call the Townsite Area (Ruth) and the Eureka (Ely Central) Area. On the west it is delimited by the Eureka Fault.

The formations present in the Ruth-Minnesota area are Rib Hill Sandstone, Ely Limestone, Chainman Shale, "Ore" Porphyry, and "Peanut" Porphyry. Rhyolite and rhyolite breccia occur in very minor amounts.

THE CONTROLLING FAULTS

Both intrusion of porphyry and subsequent mineralization have been controlled by fault structures that were existent prior to the porphyry emplacement. That is, faulting blocked out the ground and porphyry welled up along certain fault zones. Nearer the surface it bulged out and was confined within fault-bounded blocks. The porphyry was cooled and shattered and mineralizing solutions followed the same course, which lead them through the porphyry and caused the porphyry to be mineralized. After the mineralization of the porphyry, movement again occurred along the old fault lines and smoothed off the edges of the porphyry blocks.

The Ruth-Minnesota area shows an intricate fault pattern. The structural boundary to the west is formed by a broad, branching zone of north-south faults that pass near the Star Pointer Shaft. To the north this system (called the Keystone Fault) passes beneath the Mollie Gibson Dump.

The eastern side of the Ruth Mine block is bounded at the surface by a strong east-dipping fault that curves to the northwest and passes through the Hayes Claim (Queen Fault). The High Grade Fault branches off this and continues southerly into the Ruth Mine. The Tail Track Fault branches off the High Grade Fault and continues southwesterly toward the Star Pointer Shaft.

The North Wall Fault runs in a general east-west direction through the ground and forms the northern boundary to the porphyry intrusion. It is apparently offset by the High Grade Fault.

The South Wall Fault is an east-west segment between the Queen and High Grade Faults that delimits the Ruth Mine porphyry to the south.

The general pattern is that of a north-south branching fault system with connecting east-west shear planes.

THE PORPHYRY INTRUSIVES

The most important body of porphyry in the area is that lying east of the High Grade Fault, in which the Ruth Mine is located. Its general form is that of a mushroom split in half down the stem, and the half tilted so that the stem slopes down to the west at 30°. The Ruth Mine is in the flare above the stem. The stem itself grows in Coppermines ground.

The porphyry is bounded on the north by the North Wall Fault. This dips southerly at 60° through the upper levels of the Ruth Mine but flattens off somewhat near the 900 Level. The south margin is at the South Wall Fault, which dips north at 60° and also flattens at depth. These two faults converge going east and pinch off the porphyry underground.

The western edge is at the High Grade Fault itself. This runs north-south with a 45° westerly dip above the 500 Level and a 30° dip below.

This body of porphyry will be called the Ruth intrusive and is divisible into two porphyry types. One variety will be termed "Ore" Porphyry and the other Mineralized "Peanut" Porphyry.

The ore porphyry is the usual type so designated in this district. Its appearance is fine-grained, and it shows severe alteration with abundant sericite, kaolin, and quartz. The dark-colored minerals have been largely removed and chalcocite, chalcopyrite, and pyrite have been introduced.

The peanut porphyry is a darker and fresher appearing rock. It is mostly rather fine-grained and in general appearance commonly resembles an altered sedimentary rock. Black mica has been developed by alteration, and silicification is rather extensive. Mineralization in this variety of porphyry has been widespread and moderately severe. The copper content, largely due to chalcopyrite (this will be later verified by microscopic work), is approximately 0.75%.

The mineralized peanut porphyry forms a basal shell to the Ruth intrusive. The contact between the two porphyries could not be studied carefully because of caved ground and poor exposures in the Ruth Mine. Toward the contact the peanut porphyry becomes heavily silicified, and a black "gumbo" is known to occur between the silicified phase and the ore porphyry. These relations are similar to those shown in the Emma Nevada Mine.

From the information at hand, two theories can be advanced as to the age relations of the two porphyry varieties: (1) That the "peanut" type is younger in age, although belonging to the same magmatic sequence, and has been intruded principally around the lower margin of the ore porphyry with a few small dikes following to the surface along fault lines. (2) That the "peanut" type is merely a somewhat coarser basal segregation of the Ruth intrusive body. The first theory is better supported by the evidence at hand.

In any event it is clear in the Ruth Mine that both porphyries preceded the mineralization and metallization episodes. This is different from our earlier ideas gained by study of the Emma Nevada Mine.

The contact zone between the two porphyries dips irregularly westward at a flat angle so that the stoping width of ore porphyry progressively diminishes toward the 900 Level of the Ruth Mine. Below that level our churn drill holes show that the ore porphyry continues downward as a thick dike parallel the High Grade Fault.

The Ruth intrusive described above lies east of the High Grade Fault and is delimited by that fault along its western margin. West of the High Grade Fault, and in its hanging wall, are several irregular bodies of ore porphyry intruded into Rib Hill Sandstone and Ely Limestone.

THE INTRUDED SEDIMENTARY ROCKS

East of the High Grade Fault, where the Ruth intrusive was emplaced, the sediments have been arched into an anticlinal fold with a general east-west axis. Fracturing of the brittle Chainman Shale (really an argillite) along the anticlinal crest has helped localize the porphyry intrusion.

West of the fault, sandstone and limestone show a synclinal fold badly cut up by faulting.

THE MINERALIZATION

The High Grade Fault has also had a pronounced control over mineralization. The ore porphyry to the east has been rather evenly charged with pyrite and chalcopyrite. The peanut porphyry basement has been similarly mineralized, but to a less degree.

Secondary enrichment has added an important amount of chalcocite to the ore porphyry above the 900 Level of the Ruth Mine. At about the elevation of the 900 Level, my guess is that approximately one-fourth to one-third of the copper is carried by secondary chalcocite. This will be verified by microscopic study.

West of the High Grade Fault in the Ruth Mine lies a considerable prism of Ely Limestone. This rests directly upon ore porphyry with the fault as the plane of contact. The limestone is heavily mineralized for a stope length of a thousand feet parallel and adjacent to the fault. Abundant secondary enrichment by chalcocite has been largely effective in forming what is locally known as the "high grade stope".

Along its strike toward the north the high grade stope is cut off by the curving Tail Track Fault which brings in ore porphyry and sandstone in the Minnesota. This ore porphyry, in common with other ore porphyry bodies west and above the High Grade Fault, is erratically mineralized with generally small bodies of secondary chalcocite.

THE HIGH GRADE FAULT AS THE MASTER FISSURE

From the above discussion it will be noted that the High Grade Fault is the important structural break that profoundly affects sedimentary rock structure, porphyry intrusion, and mineralization. The ground east of this fault, and in its footwall, differs considerably in all these respects from the ground to the west.

A study of sections through the area shows conclusively, I believe, that the High Grade Fault has been the avenue of passage through which the porphyry intrusion has made its way. A study of the form and distribution of the mineralization likewise points to the same channel as the vent up which the metalliferous solutions were propelled. This arrangement of intrusive and hydrothermal features is a clear example of the "pot hole structure" or "mineralization focus". The North Wall and South Wall Faults limit the High Grade Fault channelway to the north and to the south and give it the "pot hole" or concentric shape.

EXPLORATION POSSIBILITIES

The High Grade Fault and its copper-bearing footwall dip directly into Coppermines' Minnesota Claim from the Ruth Mine. The peanut porphyry has squeezed in toward the High Grade Fault so that the mineralizing channelway becomes narrower with depth. Our recent deep drilling has shown that the mineralized ore porphyry continues into the Minnesota Claim below the High Grade Fault. Hole E-249, now being drilled, shows that the copper content increases toward the north and that magnetite is more abundant in the mineralized porphyry. I believe that we are approaching an area of more intense mineralization as we drill toward the intersection of the High Grade and North Wall Faults.

From all information at hand, I believe it certain that the High Grade Fault and its mineralized footwall will continue downward at depth and dip westerly through practically the entire Minnesota Claim. Near the western end of the Minnesota it will meet the Keystone Fault. What effect the Keystone Fault will have on the western dip of the mineralized zone, I do not know. We have no underground information here, and the surface is badly masked by dumps and grading. My impression is that the Keystone Fault is likewise pre-porphyry and pre-mineral in age and that the porphyry and mineralizing channel will continue at depth across it and through the Townsite Area of the central unexplored zone toward the Pit.

The northern limit of the mineralization, in the Ruth-Minnesota Area, will be defined by the position of the North Wall Fault. This is not now known exactly, but a favorable element exists in a known tendency to flare northward as it approaches the High Grade Fault. That is to say, the flattening of its southward dip diminishes as the High Grade Fault is approached.

EXPLORATION PROCEDURE

Eventually exploration by deep drilling must be carried westerly through the entire Minnesota Claim. However, for the immediate future churn drilling must be conducted so as to yield the maximum information regarding structure in order that future work may be effectively and cheaply planned.

Drilling toward the west will be progressively deeper because of the westerly dip of the High Grade Fault. This is in part offset by the westerly topographic slope. At the west end of the Minnesota Claim the top of the ore will be between 1000 and 1100 feet deep. We should be able to drill 1500 to 1600 feet with ease, and our present churn drilling equipment is entirely inadequate for this in the type of ground encountered. A drilling rig of the standard type will be necessary to gain this depth without costly and time-consuming delays. The hole being drilled at present should reach a depth of 1350 feet near the east end of the Minnesota Claim, but it is doubtful if it will get down 1100 feet.

In view of the stoping operations now being carried on in the Ruth Mine, it is advisable to drill the next hole as far east of E-249 as surface caving cracks permit. Otherwise the surface may be destroyed before we get a hole into this area. It will be shallower drilling to the ore here, which will help considerably with our present equipment, and I believe we shall gain some valuable information in regard to the position and attitude of the North Wall Fault.

Drilling should then be continued northerly until the mineralization is limited by the North Wall Fault. After that our procedure will be to move to the west.

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Three geologic sections accompany this memorandum to show the relation of the features above described. A plan map gives the approximate position of the proposed churn drill hole east of E-249.

ENP-S

J. H. Courtright, Asst. Chief Geologist

Kenyon Richard, Chief Geologist

Kimberly, Nevada

October 2, 1945 ✓

GENERAL GEOLOGICAL REPORT --- RICHARD MINE

The Richard oxide copper deposit occurs within a series of overturned limestone beds (Ely) about 1000 feet south of the disseminated sulphide ores in monzonite porphyry. The major portion of the deposit lies between 600 and 800 feet below the surface; lateral dimensions are roughly 200 by 400 feet. The Alpha, another oxide deposit in the flanking sedimentaries, is located 2000 feet northwest.

ROCK TYPES

Limestone. Approximately 500 feet of the Ely limestone formation (Pennsylvanian) is exposed by mine openings in and around the ore deposit. The rock is generally medium gray with numerous sand and chert horizons. The sandy beds contain a maximum of 10% detrital quartz grains in a matrix of calcium carbonate; detrital zircon crystals are usually abundant. Chert occurs as nodules and bands two to three inches in thickness and represents from 10% to 30% of the rock material in certain beds.

Three prominent black marker beds varying from 20 to 40 feet in thickness have been mapped within the ore zone. The upper (stratigraphically) two have the darkest appearance and contain numerous fossils, chiefly coral. The form of these faunal remains is well preserved within the clay which has replaced the encasing limestone. All three beds are slightly sandy and contain moderate amounts of chert. The dark coloration, due perhaps to carbonaceous material, appears to be accentuated somewhat by mineralization and alteration characteristic of the ore zone, the contrast with adjoining grey beds is less sharp within the fresh limestones of the wallrocks.

Monzonite Porphyry. The porphyry occurs as narrow dikes one to three feet in width intruded along the west-dipping fault planes. The general appearance is similar to that of the ore-type porphyry of the district -- a soft, light grey mass with no granitic texture discernible. Nearly all ferromagnesian minerals appear to have been altered. Occasionally less altered portions show remnants of the large orthoclase phenocrysts. Disseminated pyrite is present thruout, except where oxidized to limonite.

A thin section (#393) of the less altered rock shows a few euhedral orthoclase crystals with numerous partially altered ferromagnesian minerals. The groundmass appears as a confused aggregate of rather low birefringent material with indices slightly below the balsam. This material is mainly feldspar plus some clay (?). Zircon is present as an accessory.

Analyses of altered porphyry --- Richard: SiO_2 - 49.40, Al_2O_3 --21.09, Fe--7.40, CaO -- .70, MgO--.80,

Analyses of porphyry ore -- Copper Flat Mine (Spencer): SiO_2 -- 64.73, Al_2O_3 -14.41, MgO--.76, CaO--.44, Fe--2.89.

A comparison of the two samples above indicates that the Richard porphyry has undergone alteration similar to that of the ore type porphyry in respect to the loss of Ca and Mg. The higher alumina content and lower silica may be due to some "kaolinization" process similar to that which formed the clay of the ore material.

Rhyolite. This rock, later than the porphyry, occurs as large irregular masses around the eastern margin of the deposit and occasionally as narrow dikes within the ore. The rhyolite intruding the eastern part of the deposit represents the western end of the large intrusive mass which penetrates the southern margin of the Emma porphyry ore body.

The narrow dikes are often difficult to recognize as they contain fair amounts of delafossite and have the same general appearance as the ore. The presence of a few clear quartz phenocrysts, however, usually serves as a means of identification. A sample taken from a narrow dike contained: SiO_2 --46.20, Al_2O_3 --31.17, Fe--3.40, CaO--.80, MgO--.68, Cu--2.48. No analyses of the fresh, unaltered rhyolite are available, but rhyolites in general usually contain not over 15% alumina and around 60% silica. Thus, as in the case of the porphyry, a process of "kaolinization" appears to have taken place.

ORE

General description. The average ore, composed essentially of clay carrying 4--5% Cu, has a grey, mottled appearance, an effect which on close inspection is seen to be produced by the variations in distribution and size of the small black oxide globules in a rather soft, light grey matrix. Some areas resemble black pepper on cottage cheese. Minor amounts of limonite are present as light brown stains and streaks. Irregular masses of white opaque or light blue translucent clay are not uncommon. The latter usually contains relatively few of the black oxide particles.

The clay minerals occur as metasomatic replacements of both fresh and lightly metasomatized limestones, the latter characterized by a light sprinkling of pyrite and lime-silicates. Sedimentary features such as bedding laminations, chert bands and fossils are quite often well preserved.

Following is a typical smelter analysis: Au --.002, Ag--.010, Cu--4.56, SiO_2 --46.7, Al_2O_3 --17.8, Fe--8.6, CaO--1.1, S--.20, H_2O --14.57. Approximate mineral percentages indicated: Clay--50% (including H_2O), silica (as chert) 15%, as detrital sand - 5%, Delafossite--11%, Limonite and Siderite--7%, Tremolite(?) 4%, H_2O - 5%.

A selected sample of ore containing no visible chert or siderite and only a trace of limonite, gave the following: SiO_2 --33.80, Al_2O_3 - 40.86, CaO --1.70, MgO--1.87, Fe--6.20, Cu--5.85. Assuming the clay to be essentially halloysite (SiO_2 --43.5, Al_2O_3--37.8), this test shows an excess of alumina. Some alumina-silica hydrogel may be present and provide the additional alumina.

Compared to the smelter analysis the above test shows a much higher ratio of alumina to silica. To account for this difference something like 15% silica as chert must be present in the average ore. With the exception of a very few narrow veins of chalcedony, no quartz mineral has been recognized in the ore other than the chert, and a few detrital quartz sand grains. The latter may be responsible for possibly 4% or 5% of the silica.

ORE MINERALS

Delafossite. This mineral, a black oxide of copper and iron, (Cu_2O, Fe_2O_3) is by far the most abundant of the ore minerals. It occurs as small globules averaging about one mm. in diameter in a matrix of light grey to white clay. Size range includes diameters from .1 mm to 10 mm. Occasionally the mineral is present as small irregular masses or veinlets.

Micro...Polished surfaces (Fig.1) show the spherules to be composed of alternating soft and hard concentric layers; the hard material is crystalline with radial arrangement clearly evident. The softer layers do not polish well, but a decrease in crystal size is noticeable along the edges of the hard material; they are considered to be zones of finely crystalline delafossite. Spherules often contain partially replaced grains of native copper or pyrite, or composite grains of covellite and pyrite, or quartz grains.

Chem---While the delafossite globules appear to be relatively pure, it was found that a considerable residue of clay was present after solution in HCl. The following is an analysis of black globules from which all visible clay had been removed: Cu--25.9%, Fe--21.60%, SiO_2--16.90%, Al_2O_3--18.35%. This test indicates a mixture containing approximately 60% delafossite and 40% clay (including water).

Tenorite. While this mineral (black oxide of copper) may be a minor constituent of the ores, no tests were found which would produce positive identification. The above analysis of delafossite globules shows 25.9% Cu, 21.60% Fe. Comparing this ratio to that of the copper and iron in the formula for pure delafossite, it is apparent that the former contains about 6% more copper. This additional 6% may well be present as tenorite (CuO).

Native Copper. This mineral occurs in all sizes from microscopic grains to irregular masses weighing several pounds. Hair-like growths and dendritic crystalline forms are fairly common; spear-shaped forms are somewhat rare. In certain black beds of "kaolinized" limestone native and cuprite are the only copper minerals recognized. A chert nodule (fig.2) which has been replaced by clay contained a radial arrangement of native copper.

In the southern portion of the mine typical black oxide ore carries little more than a trace of native while in the northern part the native (and cuprite) accounts for 25% to 50% of the value.

Cuprite. This mineral occurs as irregular masses and as euhedral crystals.

Of the latter the octahedron is the common form; its luster is adamantine to submetallic. The hair-like form, chalcotrichite, is somewhat rare. The cuprite is closely associated with the native copper, the former partially coating or completely enclosing the latter in many specimens. Quite often cuprite crystals, in clusters or individuals are found attached to native. In the "C" black bed octahedrons over ½ inch in diameter were found as constituents of a clay gouge along a bedding fault. Here, a few of the cuprite octahedrons were replaced by spongy native copper.

Azurite. Azurite is found massive, but more often crystalline. The common form is a cluster or rosette of elongated, chisel pointed blades, about ½ inch in diameter. In economic quantities azurite is found only at, or near, the upper margins of black oxide ores where it is commonly associated with limonite and siderite. One exception to this was noted in 817 stope where a sandy bed contained 10% copper as carbonate (mainly azurite as fine particles).

Malachite. This mineral is found in minute quantities as soft or earthy masses, stalactitic forms or thin coatings on native copper. It is usually associated with azurite and limonite, and is of little or no economic importance as a constituent of the ore.

GANGUE MINERALS

Clay. By far the most abundant of the various gangue materials, the clay occurs as a replacement of both fresh and lightly metasomatized limestone. A. Pabst of U.C. examined X-ray patterns of the ore and tentatively classified the clay as an impure halloysite.

Micro...Thin sections of typical ore (Fig.3) show delafossite, a crystalline clay mineral, amphibole (pargasite?), limonite, detrital quartz and zircon in a matrix of amorphous, colorless material having an approximate mean index of 1.557. According to Winchell the index of halloysite varies with the water content. The above index was determined by oil emersion of material exposed to room temperatures (70 degrees) for several days.

Segregations of relatively pure clay occur as white to light blue masses (sub-translucent before drying) within the ore. This type is more commonly found above the ore in the low grade (1--3% Cu) zones, especially in the central and northern areas of the deposit. It replaces chert (fig.4) and occasionally forms narrow veins cutting the chert (~~fig.5~~). A white, sticky variety occurs as coatings or fillings in siderite cavities. Sparse delafossite is usually present. The white, soft, sticky clays and the dense, brittle clays show common optical properties. The indices are variable but usually range around 1.5468-- occasionally as low as 1.526. They are in part isotropic, but mainly anisotropic with low birefringence (plus or minus .003). Fragments extinguish as sharply as quartz and exhibit biaxial figures. The anisotropism may be due to strain.

Chemical analysis of the dense light blue clay (H.S.980), 41.20 silica, 38.82 alumina, shows a lower ratio of alumina to silica than the typical ore material, 33.80 silica, 40.86 alumina. As a possible explanation it is suggested that the "excess" alumina of the latter combined with the silica present (chert, quartz) to form the segregations of more pure clay. In addition, perhaps, the crystalline clay was completely altered to halloysite. In the typical ore the additional alumina may be present as a hydrogel of some sort. The formation of the more pure clay is considered to be the later part of a process of alteration accompanying the oxidation of the deposit.

Amphibole. The mineral tentatively classified as the aluminous amphibole pargasite is found in the clay ores and also in the lightly metasomatized limestones of the wall rock in the northern portion of the deposit. Megascopically, it appears as tiny lath-like, light gray to white crystalls scattered thru the rock; unusual concentrations are occasionally found as replacements of thin beds.

Micro...It appears as individual, elongated, colorless prisms at random orientation and as sheaf-like aggregates. The approximate indices are, na--1.605, ny--1.62. Elongation is positive and maximum extinction angles range from 16 to 38 degrees in various specimens. No satisfactory interference figure was obtained. The crystals are often partially replaced by clay and (or) siderite. In T.S.394 the clay appears to be replacing the amphibole.

An analysis of material containing about 25% clay (estimate made on oil emersion of powdered rock) (H.S.874) and 75% amphibole (16 deg.ext.) gave the following: SiO_2 -- 45.40, Al_2O_3, CaO -- 8.70, MgO --3.94, Fe --1.80. These results (plus a following analysis) indicate an alumina, magnesia, calcium oxide ratio of 2-1-2 contained in the amphibole. Analyses of three fresh limestone specimens (H.S.936, 937, 938) showed an alumina content varying from 4% to 6% and a magnesia content of from 1% to 3%. Thin sections of these rocks contained no visible minerals other than calcite and amphibole. The maximum extinction angle of the latter was 38 degrees. In a good many specimens the mineral closely resembles (and may be) tremolite. It is quite possible that the variable optical properties (extinction angle) coincide with variations in chemical content.

In respect to the district in general, the aluminous (?) amphibole is the most widespread product of pyrometasomatism, forming an aureole around the more intensely altered sediments of the disseminated copper sulphide zone. The limestones of this inner zone are completely replaced by quartz and "contact" silicates.

Crystalline clay. The mineral is a prominent constituent of the soft, friable gangue material found in the average ore. It is very sparse to absent in the dense, compact, white to light blue clay masses. The crystals are too small to be seen megascopically.

Micro...It appears as a felted mass of colorless, small (.004 mm. average thickness) elongated flakes or shreds embedded in an amorphous material previously described as halloysite. Extinction is parallel; elongation, positive; indices, 1.535--1.58 to 1.59. Birefringent colors are low (white) due to the extremely small size of the crystal plates. A thin section (#467) of a limestone-clay contact showed the crystals replacing the limestone as flakes and shreds along the rhombic cleavage of the calcite. The crystalline clay in turn appears to have been partially altered to halloysite.

Most abundant occurrences are near fresh limestone contacts along the underside of the deposit. The mineral closely resembles hydromuscovite or sericite; however, chemical analyses failed to show potassium. Thus, it is most likely a crystalline clay mineral.

Siderite. This mineral occurs as massive replacement of the limestone. It is of widespread distribution but is found mainly around the margins of the ore body as zones as much as 40 feet in thickness. However, some aluminum silicate was deposited along with the iron carbonate, as shown by the following typical analysis of what microscopically appeared to be pure siderite: SiO_2--9.20, Al_2O_3--14.77, CaO--4.90, MgO--2.17, Fe-33.00. Approximate mineral percentages: siderite--65%, clay (including some aluminum oxide?)--23%, calcite--9%, amphibole (?)--3%.

Numerous cavitites with more or less limonite are characteristically present in the siderite. Occasionally these cavities show a regular pattern, i.e., siderite boxwork. A clean surface on the siderite presents a dull, dark greenish-grey colored, fine grained or dense appearance. Vugs sometimes contain thin mammillary deposits of the vitreous, translucent variety.

Micro...Thin sections show a compact mass of microcrystalline iron carbonate. A few crystals of amphibole are present with good evidence of an earlier age relationship. The clay minerals whose presence is indicated by analysis are not visible under ordinary powers of magnification.

A polished surface (P.S.567) of siderite contains veinlets of fine grained quartz or chalcedony. Pyrite and an unidentified metallic mineral were present in the vein. The quartz and pyrite here are definitely later than the siderite, and are therefore quite likely supergene.

MISCELLANEOUS MINERALS

Gypsum. This mineral occurs around the margins of the clay body as euhedral, clear, transparent crystals (selenite) in cavities or pockets in the limestone. The mineral is most abundant immediately beneath the ore deposit where descending sulphate waters have contacted the calcium carbonate of the unaltered rock. Crystals are found in all sizes, up to 10 inches in length and 2 inches in thickness. The form is usually simple, swallow-tail twins being common. Occasionally the crystals are clouded black with carbonaceous material and contain inclusions of cuprite and native copper.

Pyrite. The mineral occurs in minor quantities as single crystals or small masses in the lightly metasomatized limestone wall rocks of the northern portion of the deposit; it is rare to absent in the relatively "fresh" limestone of the southern part. The monzonite porphry dikes, intruded along fault planes within the deposit and beyond the margins, invariably contain rather even disseminations of pyrite, except where oxidized.

Sphalerite and Fluorite. These minerals occur sparingly as narrow veins in the metasomatized limestone of the northern portion of the deposit. Pyrite and chalcocite are commonly associated with them. In one instance a 2 inch vein of sphalerite (with pyrite, fluorite and chalcocite) was found in a small remnant of the metasomatised limestone within the ore body. Here, "kaolinisation" and the subsequent deposition of delafossite appears to be definitely later than the sphalerite and associated minerals.

<u>Chlorite</u>. A chloritic mineral occurs as a dark green stain and as irregularmasses in the metasomatised limestones around the margins of the clay body. Pyrite is a common associate.

ENVIRONMENT

Churn Drill Hole F-506, which is located in the southern part of the mine, passed thru about 200 feet of sandstone (from the surface downward), 240 feet of silicified, somewhat sandy limestone, 200 feet of "kaolinised" limestone and into fresh limestone at the bottom. The ore occurred in the lower part of the "kaolinised" limestone, immediately above the fresh limestone contact. Although sludge boards and detailed geologic logs are lacking for all the old holes drilled in and around the deposit, the above is considered to be representative of the rock sequence throughout the ore zone.

The ore deposit as a whole rakes at a low angle to the southwest and lies directly across the outer limit of metamorphism in the limestone.

Silicification in the sandy limestone is known to extend from the Veteran to the west end of the Emma. Thin sections of this material show an occasional grain of detrital quartz or zircon in a matrix of fine grained, low temperature type quartz. The silicification may be supergene, -- see paragraph under "Siderite".

OXIDATION RELATED TO ROCK TYPES AND STRUCTURE

In the disseminated copper sulphide ores of the porphyry and metamorphosed limestone leaching has occurred in the upper two to three hundred feet of rock material. At and below this base of oxidation chalcocite has been deposited-- mainly on, or as replacements of, chalcopyrite. Doubtless a relatively stable water table existed for some time. The porphyry and the metamorphosed limestone of the "contact zone" have a tendency to hold the surface waters -- faults and fractures are sealed to some extent by gouge and by mineralisation. In contrast, the unaltered limestone (and sandstone) contain open fractures thru which the meteoric waters may readily pass. Thus a <u>draining off</u> has occurred at the margin of the more impermeable rocks. Examples of such water table differentials are found in the bulletin on the Tintic Dist. (Prof. Paper 107, page 20, section thru the Swansea & Sunbeam shafts, also on page 221, a section thru the Lower Mammoth Mine). In the latter relatively deep oxidation associated with clay occurs in the limestone along a monzonite contact.

It is concluded that the circulation of meteoric waters down the contact between the rocks of the disseminated copper belt and the unaltered limestones effected the transportation of both the clay and the copper from the upper part of the primary zone to a position well below and somewhat south of the same primary zone.

STRUCTURE

General control of clay and ore deposition has been effected by a series of west-dipping normal faults. This system of roughly parallel structures is composed of three individuals and strikes NE thru the south end of the deposit and NW at the north end, forming an irregular, cresont-shaped pattern (see 50 scale plan map). Narrow monzonite porphyry dikes have intruded in and along the fault planes removing the gouge and obscuring to some extent, in places, the exact trend of the faults. A minor amount of post-porphyry movement has occurred.

In the southern portion numerous bedding slips (NW strike, NE dip) offset the NE faults a few feet. In some cases movement has been resumed or continued on the NE faults with a resulting sharp warp in their planes at junctures with the bedding faults. Farther north the faults describe a gentle arc and become less sharply defined--appear to split up or feather out. The total normal stratigraphic separation on the three faults as measured on the black marker beds is well over 200 feet.

COPPER MINERALIZATION

In a general way ore deposition has followed the west-dipping faults, migrating downward along favorable beds and bedding faults. A rude checker-board pattern has been formed by selective mineralization of the offset segments of the various beds. The black carbonaceous beds, although replaced by clay minerals, have been avoided by the delafossite. However, native copper and cuprite often occur in these beds in quantities sufficient to make ore. This copper, which may have been precipitated by carbonaceous material, is confined mainly to the upper or hangingwall portions of the black beds. It should be noted that the black beds are somewhat more dense and brittle than the light colored beds. They may have been relatively impervious at the time of delafossite mineralization, but as the water table receded below the deposit open fractures were filled with native and cuprite. The fractures in the more competent black beds may have been open previous to mineralization of any kind, but the deposition of the delafossite was a process of replacement rather than cavity filling.

In the northern part of the deposit sharp control of ore deposition is less evident. The ores were originally of lower grade (2-3% Cu) but much greater in extent than the small, well defined bodies of the south end. Around the bottom of the "half-bowl" structure formed by the warped fault planes, a 10 to 20 foot zone of 5 to 6% ore occurs-- a result of enrichment thru deposition of finely divided native and cuprite. This condition exists only in a general way; locally, delafossite may be present in sufficient quantities to make ore (plus 4.0% Cu). Notable amounts of native are often found along fault zones and in the chloritic material occurring at the contact between the clay and the lightly metasomatised limestone of the wall rocks.

GENESIS

In a general way the question of origin involves two somewhat diverse theories: (1) the copper and gangue minerals were derived from a remote source and emplaced in their present position thru the circulation of meteoric waters, (2) the deposit represents a body of primary copper minerals, oxidized essentially in place.

The first stated theory is considered to have by far the greatest weight of evidence in its favor. In a discussion of such a genesis one of the most important factors is the position of the deposit---at the margin of the intensely metamorphosed limestone and porphyry mass where relatively deep circulation of ground waters has occurred. The locus of the primary ores which provided the copper is somewhat obscure. It may have been within the limestone that is now silicified or within the overlying sandstones, or within porphyry or sediments now eroded away. The latter seems the most likely source.

The aluminous silicate which replaced the limestone and formed the clay bodies was probably derived from the rocks containing the primary copper minerals. Ross and Kerr (USGS Prof. paper 185) consider halloysite to be of supergene origin in all cases. They find also that the mineral is not truly amorphous, but is made up of crystals too small for microscopic observation. They state that one important mode of formation is thru the action of cold acid waters (sulphuric acid derived from oxidation of pyritic deposits) on aluminous rocks. G.F.Loughlin (USGS Prof. paper 107, Tintic Dist.) in describing the Dragon Iron Mines, states that the kaolin, leached from the hydrothermally altered volcanics, replaced the underlying limestone.

The clays in the Richard mine were probably formed by a similar process, but the sandstones overlying the deposit could hardly be considered as the source of the aluminous silicate. The possibility does exist, however, that the silica and alumina were leached from the monzonite porphyry and metamorphosed limestone to the north and were carried southward down the fresh limestone contacts. These waters (originally acidic, but later becoming neutral or alkaline) could have effected a metasomatic replacement of the limestone by aluminous silicates. The copper was probably transported by the same solutions. Thus an acid solution carrying, at one time or another, copper, iron, oxygen, silica and alumina, was necessary to the formation of the deposit on a wholly supergene basis.

The form of the clay deposit also strongly suggests a supergene origin, namely, the relatively broad lateral extent, the undulating bottom contacts (section # 1), and the pocket-like form of the various individual ore bodies.

Siderite, as well as clay, has replaced the limestone; however, the age relationship is not clear. Since the siderite occurs commonly at the margins of the clay bodies, it may be logically assumed that the siderite is later. Evidently some aluminum silicate was present in the solutions which formed the iron carbonate as this substance is contained in all samples analyzed. The siderite occurs in significant quantities in only two localities: beneath the ore body in the northern portion of the deposit and along the western margin of the south end. A large part of the latter zone contains little or no siderite in the footwall. It is concluded, therefore, that the formation of the siderite was not closely related to the deposition of the black oxide copper ores, but was formed, for the most part, somewhat later.

During or following the formation of the clay body, copper bearing solutions circulating below the water table, soaked thru the clay and deposited the delafossite in rather even dissemination. Although no information is available at the present on the chemical nature of such a process, it is suggested that the neutralizing effect of the clay on acid solutions may have caused the deposition of the delafossite. Certain beds were more favorable than others. This may be a matter of permeability in some cases, such as the black beds. In other instances bedding faults appear to have deflected the solutions. In addition to the foregoing, various beds of limestone were unreplaced by the clay and were thus impermeable. Certainly, the delafossite possessed a strong affinity for the clay. That it did not completely replace the clay but formed a solid solution is evidenced by analyses previously mentioned. Possibly, this same relationship may exist in the case of the siderite and clay.

Minor amounts of pyrite present in the ore (mainly in the northern part) have been partially replaced by chalcocite. In places, such as around the outer margins of the porphyry dikes, the pyrite has been oxidized to limonite. Occasionally a particle of chalcocite (or covellite) was found enclosed in the delafossite; however, there is no evidence of replacement. Often quartz grains or other particles of gangue form centers in the delafossite globules; thus, the chalcocite is considered to be merely incidental. Larger masses of chalcocite observed showed no evidence of being associated with the delafossite. It is concluded that the chalcocite and the delafossite were derived from the same solutions, and that in the absence of pyrite, delafossite was formed.

Conditions somewhat analogous are believed to have existed in the Richard Sulphide body in limestone, located a short distance north and 200 feet above the Richard Oxide. Here, chalcocite occurred in a heavy concentration of pyrite. However, below the pyrite oxides were found. Thus, descending solutions lost only a part of their copper in the pyrite zone and continued downward to form oxides in a sulphide-free environment.

As stated previously, the pyritic porphyry dikes contain no primary and but small amounts of secondary copper (as chalcocite), while the rhyolite dikes are quite often well impregnated with delafossite. A possible explanation lies in the fact that the rhyolite has been more thoroughly "kaolinized" than the porphyry. A definite preference of the black oxide for clay is demonstrated by the fact that the limestone inclusions (subsequently "kaolinized") in porphyry dike margins carry significant concentrations of delafossite. In addition, the porphyry appears to have been somewhat less permeable since chalcocite on pyrite commonly occurs only at the margins of the dikes.

As erosion progressed and the water table was lowered, <u>oxidation</u> and <u>leaching</u> penetrated the upper portions of the deposit, taking the copper of the delafossite (and chalcocite) into solution. Some of the iron may have been precipitated as the ferric hydrate, limonite, the balance was probably carried downward to form siderite at the limestone-clay contacts. A part of the copper formed carbonates, the rest was carried downward to form native and cuprite. In the south end of the mine the deposits of native and cuprite occur in the black carbonaceous beds <u>immediately beneath</u> zones of leaching characterized by abundant limonite and sparse copper carbonates. In the northern part of the deposit black oxide ores of low tenor have been enriched appreciably by native and cuprite. These minerals have been deposited chiefly near the siderite contact at the bottom of the "half-bowl" structure. Here, as in the southwest part (the siderite is not prominent in the southeast area), the siderite and native (and cuprite) appear to be related to the oxidation and leaching processes which followed down after the rece ding water table.

Evidence against the theory of "oxidation in place" is found in the extremely low gold content of the ores. Thruout the district the primary copper (chalcopyrite) contains gold in a ratio which varies little-- 1.0% Cu to .01 Au. Gold assays of Richard Oxide ore (4.5% Cu) run from .001 to .002 Au -- amounts that can be found anywhere in the lightly mineralized limestones or porphyries. The Alpha, an oxide deposit very similar to the Richard, contained like amounts of gold.

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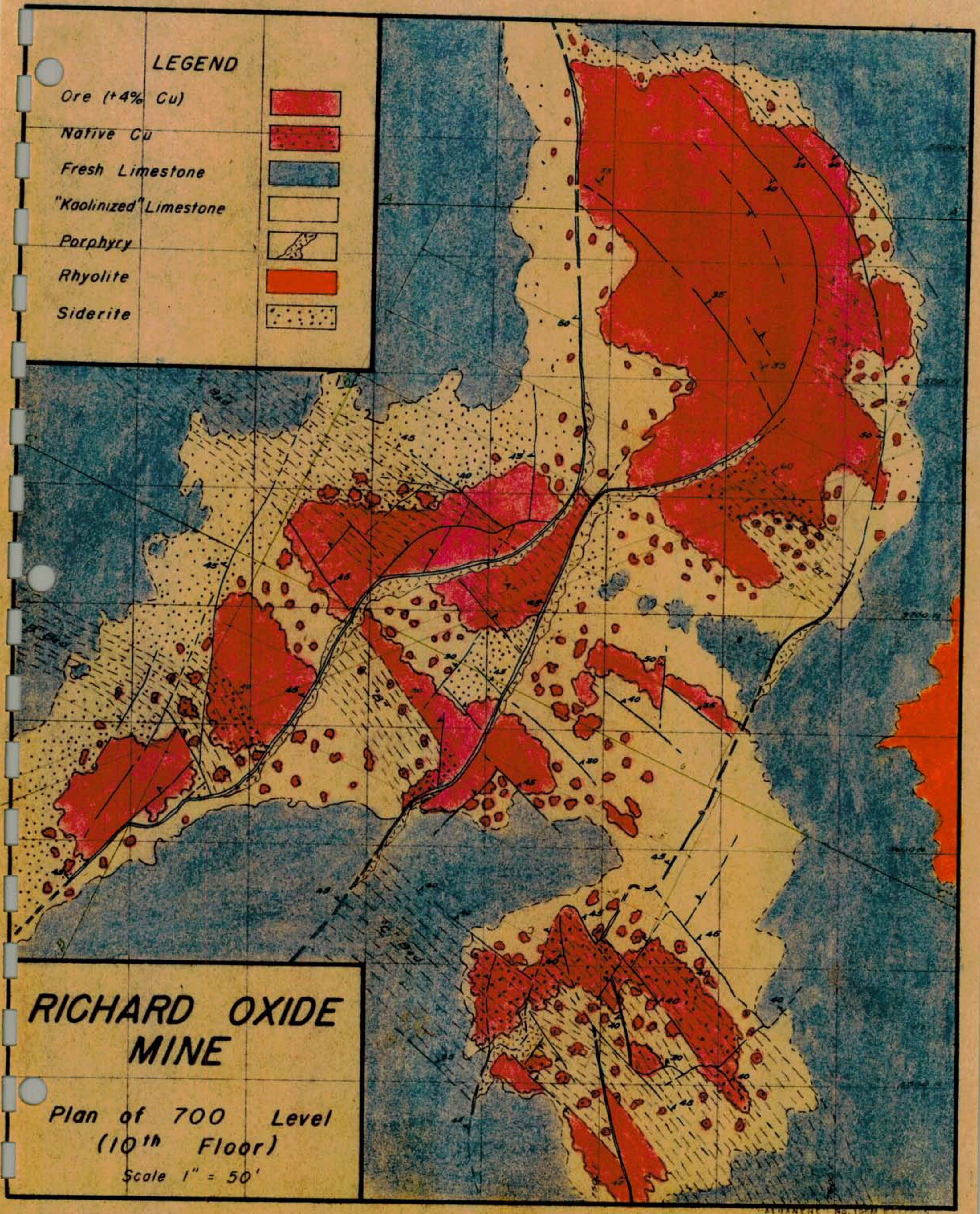
The strongest points in favor of a hypogene origin with oxidation in place are found in, (1) the structural control evident in the deposition of the ores, (2) the selective replacement and mineralization of certain favorable beds, (3) the rather even distribution of the delafossite within various ore bodies (absence of concentration on the surface of structures such as fault planes, footwall fresh limestone contacts, etc.). While (1) and (2) are generally considered features distinctive of hypogene deposits, under the unique conditions which existed in the Richard deposit such features may well have been present in a supergene process. Commonly, supergene deposition of copper is controlled by the position of the water table. In the deposit under discussion the water table was steeply inclined with a more or less continuous downward movement of water, simulating, to some extent, hypogene conditions. In the metasomatic replacement of the limestone by the clay minerals the faults as well as the physical and/or chemical nature of the beds exerted considerable influence. In the case of the deposition of the delafossite, structural control is less evident. The clay bodies, in the manner of a sponge, "soaked up" the copper bearing solutions uniformly, and a more or less uniform distribution of the delafossite resulted. This even distribution is, however, only a local condition; some "kaolinized limestone" beds are low in grade, others are completely barren of copper. It is not clear whether this selective mineralization of beds is due to physical or chemical characteristics.

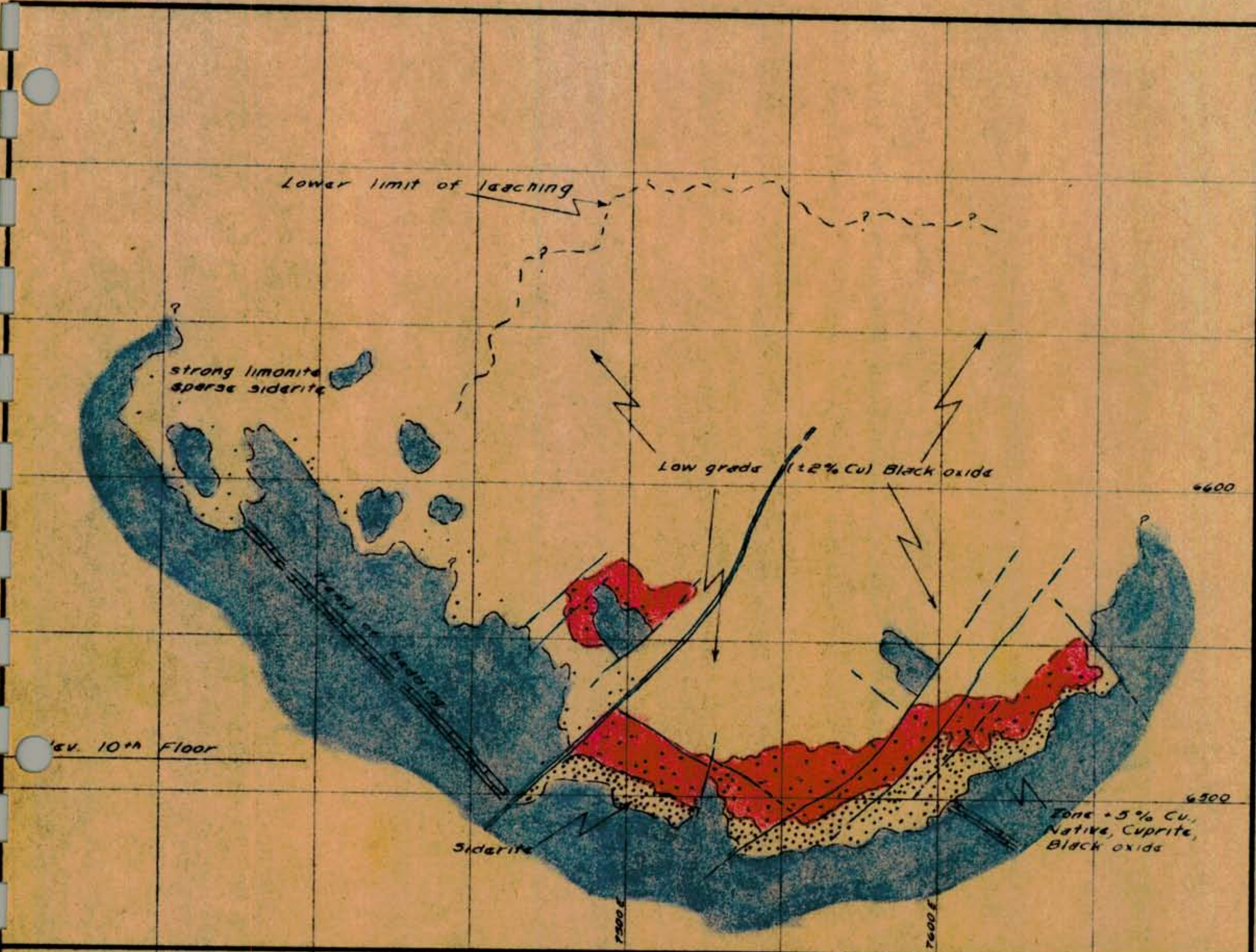
JHC/mc



RICHARD OXIDE MINE

Plan of 700 Level (10th Floor)

Scale 1" = 50'



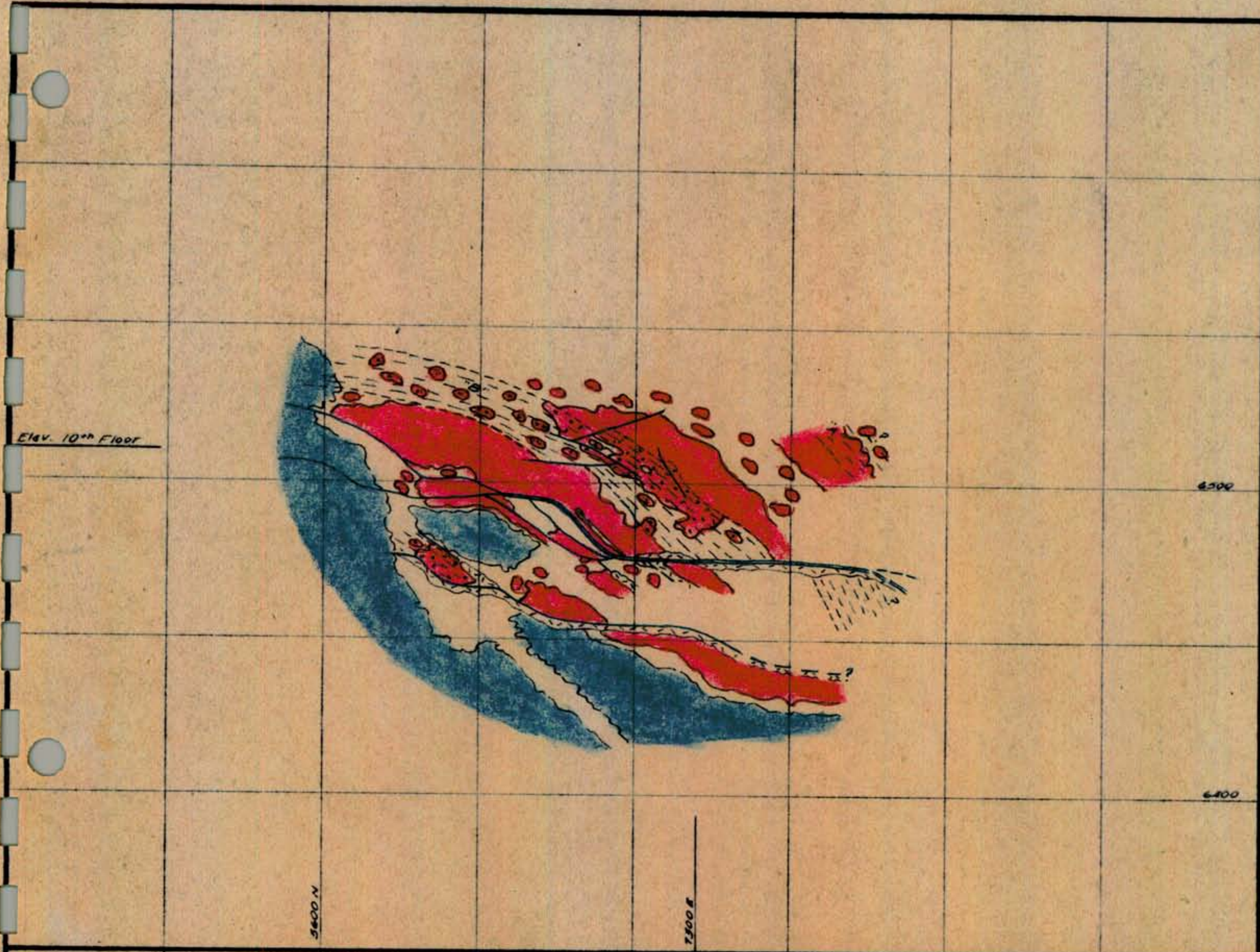
RICHARD OXIDE MINE

SECTION A-A'

Look North

Scale 1" = 50'

Showing ore body formed by native copper and cuprite enrichment around bottom of clay body containing low grade disseminations of black oxide (delafossite).

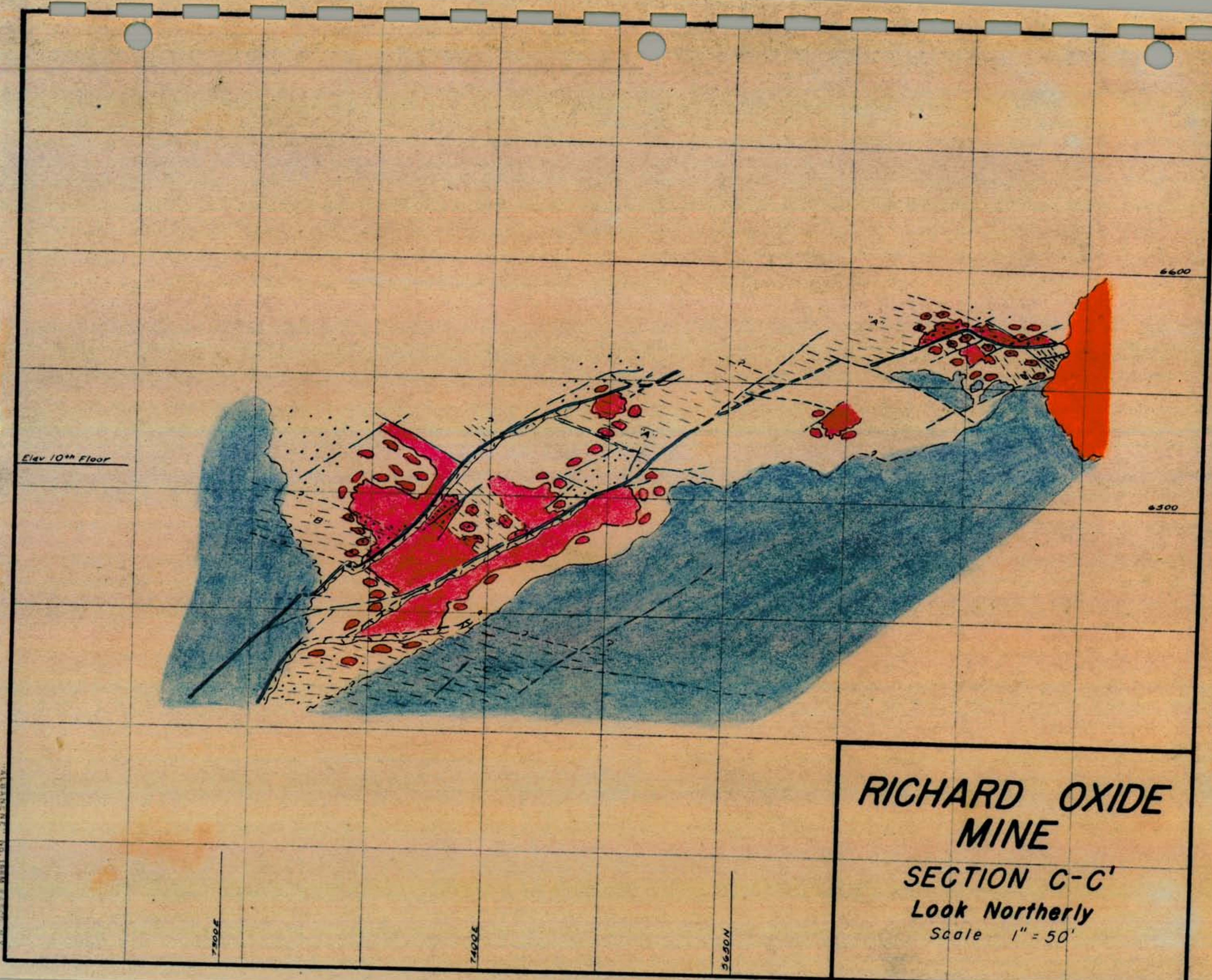


RICHARD OXIDE MINE

SECTION B-B'

Look Westerly

Scale 1" = 50'



RICHARD OXIDE MINE

SECTION C-C'

Look Northerly

Scale 1" = 50'

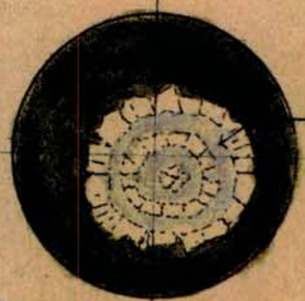


Fig. 1. Polished surface delafossite spherule in clay. X 80

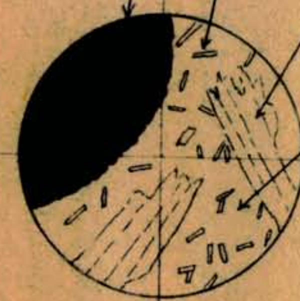


Fig. 3. Thin section of typical ore, northern portion of deposit. X 360

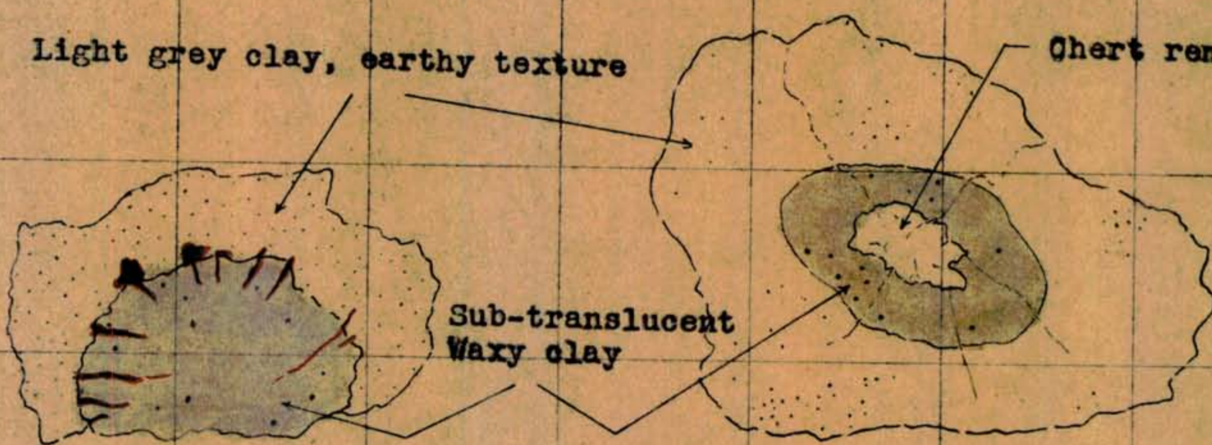


Fig. 2. Sketch showing radial arrangement of native copper in clay "nodule". Natural size. Distribution of delafossite shown by black dots.

Fig. 4. Sketch showing partial replacement of chert nodule by sub-translucent waxy lustered clay. Natural size.

J. H. C. 10/10/45

GEOLOGY AND ORE DEPOSITS

OF THE

LANE VALLEY AREA

SUMMARY OF RECOMMENDED EXPLORATION

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1. The extensive body of ore porphyry at and adjacent to the Bunker Hill, Triangle, Los Angeles, and Turkey claims should receive thorough exploration by churn drilling for primary disseminated copper ore. This offers an opportunity to develop a substantial enough tonnage to warrant an independent production unit.

2. It is recommended that the Joana tunnel be driven south to test the gold possibilities of the Southern Cross claim. This will require only a moderate amount of work, and a footage estimate can be given shortly from the results of a survey now under way.

3. A churn drill hole is needed north of the Chainman shafts to explore a down-dropped fault block for a segment of the Chainman mine mineralized beds.

4. Short churn drill holes are recommended north of Lane Valley to search for gold ore near the Blackstone, Vesta, and Shale claims. This should be postponed until we have acquired certain additional ground.

5. Churn drilling south of the Chainman mine on the August (old Ely) claim would show the advisability of opening up the Chainman mine.

6. When our holdings are better consolidated in the vicinity of the Mt. Morgan claim, considerable exploration by churn drills will be warranted there.

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GEOLOGY AND ORE DEPOSITS
OF THE
LANE VALLEY AREA

GENERAL GEOLOGY

INTRODUCTION:

The area herein described runs from the Kimbley Hill porphyry deposit easterly up to the McDonald-Ely property. In a northerly direction it extends to an east-west line running through the Ohio and Steele claims. Its southern boundary lies just north of Saxton Peak. This embraces a parcel of ground lying mostly to the south of Lane Valley, except in the eastern portion where an important area falls on the north side. In an east-west direction this comprises a distance only a little under two miles; the north-south extent is about one mile.

It is to be emphasized that this area is a direct continuation of the principal zone of mineralization of the Robinson Mining District. Within its confines four types of mineralization are portrayed:
(1) The ore porphyry zone is well displayed in an intrusive body of more than substantial dimensions. (2) Siliceous gold ore follows the Chainman shale contacts and has been responsible for much past activity near Lane City. These two types have been studied by us in detail. The following phase of mineralizing activity will be given careful attention during the coming month. (3) Copper deposits in limestone appear in both the Ely and Nevada limestone formations. (4) Small lead-silver deposits have been developed in the Ely limestone. These do not appear important and will be studied at a later date.

GENERAL STRUCTURE:

As field mapping progresses it is becoming increasingly more apparent that the central and eastern parts of the district are zoned by great north-south normal faults into alternate raised and lowered blocks. These run parallel with the Eagan Range front and are an expression of a tensional pull outward and away from the range in an east-west direction. The upthrown blocks have been more deeply eroded, and in them older formations have been exposed.

The Lane Valley area dealt with here lies wholly within an upthrown block, when considered with respect to the rocks to the west. Its western margin is defined by the Jupiter fault. This is shown on the accompanying map where it runs through the Sunrise, Spionkop, Turkoy, and Cumberland claims. The structural division on the east is placed at the Joana fault which passes through the Accident and Justice claims north of the valley and frays into a horsetail pattern on the south side in the Southern Cross and Golden Fleece claims. To the east the Joana fault brings in older formations, principally the Nevada limestone, representing a block of yet greater upthrow.

Within what is here termed the Lane Valley block, the structure is pronouncedly anticlinal. The valley itself has been cut down approximately along the axis of a low arch whose flanks extend back shown near the Ely Hidden Treasure group where an important fault forms a rather close division.

So far as now determined, all faults in the area are pre-porphyry in age and therefor antidate both hydrothermal alteration and mineralization phenomena. They have served as "guiding structures" and thus have aided and bounded the porphyry in its emplacement.

The ore porphyry is very pronouncedly intruded into the Chainman shale along and close by the anticlinal crest. The peanut porphyry extends into the northern flank where it is guided by both steep faults and flat bedding to give bodies of complicated form.

Rhyolite is only sparingly present in the area mapped. A short, dike-like body appears in the Commodore claim. A sill is noted in the Joana limestone near the base of the bluff in front of the Chainman mine. Rhyolite breccia, so common in the western part of the district, has not been identified.

DETAILED STRUCTURE:

The major anticline of the Lane Valley block trends about N 80° W. It continues regularly as far west as the Saxton claim where a pronounced southward bulge appears. This gives the effect of a subsidiary anticlinal nose with approximate north-south axis jutting out from the major fold. This bulge is aided by movement along the Saxton fault, which cuts diagonally through the Saxton claim. This southward swing of the shale is termed the "Mt. Morgan Re-entrant". The corresponding northward swing of the Ely limestone, aided in form by faulting and distortion in the Rob Roy claim, is called the "Saxton Salient". These distortions of the regular structure appear to have had an important effect in localizing mineralization.

East of the Saxton Salient on the south side of the valley the structure appears quite regular with the formations dipping at a fairly uniform and flat angle to the south. To the west the beds show considerable distortion with minor folds and faults and steepening of the bedding just south of the ore porphyry.

Shearing approximately parallel with the bedding appears to be important but is difficult to evaluate from surface study and limited underground exposures. It seems to be most important near the Saxton mine where several lines can be definitely traced.

North of Lane Valley the formations dip in general to the north into the hills. Complications exist due to minor folds and faults as well as large intrusions of peanut porphyry. A fault intersection of major importance has produced a down-dropped block of Rib Hill sandstone north of the Ohio claim and east of the Steele claim.

Other details of structure will be taken up under the consideration of various mines and prospects.

MINERALIZATION AND ORE DEPOSITS

GENERAL:

Study of the mineralization in the Lane Valley area leads to the view that this action has been as vigorous here as in any other part of the district. To the casual observer the great display of so-called "jasperoid" ledges is absent, and the effects of hydrothermal alteration appear less than farther to the west. Our work has shown that the bulk of the "jasperoid" is merely recrystallized Rib Hill sandstone with, in general, only a slight or moderate introduction of hydrothermal silica. It forms particularly well where ore porphyry has been emplaced beneath a sandstone roof, which is the general rule west of the Jupiter fault. It likewise forms far out from the main ore zone where metamorphism has not been generally severe.

It is clear that the Lane Valley block was hoisted up to the east before igneous intrusion and mineralization took place. Hence these phenomena affected a lower stratigraphic horizon than much of the ground to the west. It is probable that such alteration did not reach up into the Rib Hill sandstone, and, in any event, vigorous erosion has stripped away this overlying formation. Examination of the rocks actually displayed near Lane Valley adjacent to the main ore zone shows that their alteration is comparable in intensity to the alteration of similar horizons farther west. And finally, it should be pointed out that the degree of alteration of flanking rocks is not, in this district, a criterion to the strength of metallization.

The development of the Robinson Mining District was begun in the Lane Valley area where gold was actively sought. This lead principally to the discovery of the Chainman gold mine. Minor prospecting was done, and the Saxton and Revenue deposits were indicated. A few pockets of lead-silver ore were stoped, and glaring copper stains in limestone were followed by tunnels and short shafts here and there. None of the ground has been adequately prospected, and the neglect of this area is outstanding. However, the siliceous gold ore does not commonly proclaim its presence at the surface. It generally lies on bedding that does not outcrop, and gold mineralization only reaches the surface in a few places where cross-faults have guided a small portion of the mineralization upward. The ore porphyry has simply been neglected. A few short churn drill holes have been put down, but the absence of chalcocite in sufficient amount was no doubt too discouraging. No attempt has ever been made to drill for deep primary porphyry ore, which we now know forms the bulk of the disseminated copper ore of the district.

ORE PORPHYRY ZONE:

The ore porphyry zone follows directly from Kimberly, the pit, and Ruth into the Lane Valley area. Ore porphyry does not continuously outcrop throughout this zone, but the alignment of the various intrusive bodies is remarkably straight. Within the Lane Valley block there are two bodies of ore porphyry that outcrop with substantial size. Between these two, several smaller bodies appear in a manner that suggests more continuity at depth.

The westernmost belongs to the Nevada Consolidated Copper Company and is known as the Kimbley Hill porphyry. It covers parts of the Sunbeam, Sunrise, Spionkop, Kimbley, Turkoy, and Witch claims. I believe it to be only partially developed by churn drilling, and it is my understanding that one or two million tons at a little better than 1.1% copper have been discovered. The type of leached outcrop suggests that a part of the copper values is carried by secondary chalcocite. I feel sure that at least the southern part of the porphyry mass has not been carefully prospected for deeper primary ore.

The easternmost body of substantial size is now owned by Coppermines. It is about 3700 feet long in an east-west direction with about 2500 feet showing severe and typical alteration. Its width is about 1000 feet at the surface. Its appearance is entirely similar to ore porphyry above producing mines in the district. Where exposed throughout over 900 feet in the Smokey tunnel below the zone of oxidation, it appears as a typical ore porphyry. Severe silicification accompanied by abundant sericite mica and pyrite is prominent. In addition to the character and severity of alteration, the following criteria appear important as accompanying phenomena to primary copper mineralization in the porphyry:

Exotic Copper: In the Emma Nevada mine there is a definite zone where copper mineralization follows fractures up and out of the structural limits of the primary ore body into an upper zone foreign to the main site of primary deposition. This "exotic" copper has been affected by surface solutions to give upper zones of chalcocite enrichment, in some places of commercial importance. The same feature is to be noted in the Smokey tunnel where fractures in the ore porphyry carry considerable chalcocite.

Copper in Flanking Limestone: Where the Saxton Salient has brought the Ely limestone close in to the ore porphyry, copper showings exist at the surface. A similar zoning is noted near the porphyry mines.

Associated Gold: The Lane Valley ore porphyry, as shown by the Smokey tunnel, carries minor gold values of about the same tenor as the porphyry ore.

So far we have no information regarding the depth to which this ore porphyry will extend and the attitude of its walls. We expect to obtain valuable information regarding the latter from the Smokey tunnel.

I strongly urge that churn drill exploration be undertaken in this body of ore porphyry with the expectation of finding primary chalcopyrite ore at depth. The only dubious point is the downward extension of the porphyry mass to sufficient depth, and this can only be told by drilling.

It is a highly important fact that no sizeable body of ore porphyry in the district, where adequately explored, has failed to yield disseminated copper ore except in zones where late rhyolite intrusions have come in and virtually destroyed the ore. The general scarcity of rhyolite in this area thus adds favorability.

GOLD DEPOSITS:

Siliceous gold ore represents a widespread type of mineralization in the Lane Valley area. So far it has been mined entirely from the zone of oxidation above the present ground-water level. Its general appearance is a porous, spongy mass of silica varying in color from pure white to dark gray and in some localities stained red or brown from iron oxide. The silica content varies from about 70% in the Revenue mine to better than 90% in the Saxton, making it valuable as a smelter flux. The alumina runs from 5% down to a negligible quantity. Moisture varies between 5 and 20 per cent. Spencer states that yellow and gray coloring in the Chainman ore is due to the presence of oxidized lead minerals.

Adjacent to and west of the Lane Valley ore porphyry the gold ore is carried by beds at and near the top of the Chainman shale (in the Rob Roy, Los Angeles, and Saxton claims and westward). East of the ore porphyry, gold ore has been formed in the lowermost beds of the Chainman shale immediately above the Joana limestone. The mineralization in the upper Chainman shale appears to range through a moderate thickness of beds of somewhat varying lithology; mineralization in lower beds is more strictly confined.

Gold ore in the western belt appears localized in zones of minor structural complexity near pronounced deformation of the major structure. Thus the Saxton ore shoots occur at minor bends in the bedding at the northwest corner of the Saxton Salient. The Rob Roy shoot appears in the northeast corner of the same feature in a minor fault block structure. Gold ore to the east, on the lower Chainman contact, has formed on a more regular structure as regards folds, although cross-fault structures are abundant.

Development to date has shown that the silicified beds of the western belt are not continuous. Silicification pinches and swells on the bedding. Nor is the gold ore coextensive with the spongy silicification but occurs as isolated shoots within the silicified beds. In the eastern belt present development suggests that the mineralization is more regular, but sufficient work has not been done to prove this point.

The amount by which the tenor of the ore has been raised by oxidation and enrichment is debatable. This is an important question as the gold-bearing beds undoubtedly extend into the sulphide zone on dip and in certain minor fault blocks. I believe that an important amount of the gold seggregation is undoubtedly due to primary deposition and am opposed to the view that it has traveled a considerable distance in meteoric waters and has been deposited in a limited area from an extensive gathering ground. However, the grade of the primary ore has been importantly raised by oxidation which has clearly removed a considerable amount of pyrite to form a spongy ore. This removal of heavy material with the gold remaining constant or being slightly concentrated by gravity would raise the tenor by an important amount. It is certain that below a certain horizon the spongy siliceous ore will change to a compact ore heavy in marcasite and grading into a pyrite-rich type. This change will mark the position of an old water table; the present ground water can be either above or below this. Hence, a doubt exists both as to grade and character of the gold ore where exploration is carried on in depth.

GEOLOGY OF THE LOS ANGELES-SAXTON MINE:

The Los Angeles-Saxton mine is situated in the western zone of gold mineralization in the upper beds (Transitional Series) of the Chainman shale. It lies immediately south of the main intrusion of ore porphyry where the northward bulge of the Saxton Salient has brought the Transitional Series in close to the porphyry intrusion. The general east-west strike of the beds makes a sharp turn near the McDonald shaft to the south. The dips are moderately steep but flatten off rather rapidly to the south and east. The sharp turn in the bedding with accompanying minor distortions in an alternating group of sedimentary beds of varying structural capacities very strikingly forms the locus of mineralization.

The mine workings show that the spongy silicification appears to follow the bedding rather closely. I believe that additional study may show that it is more closely controlled by shear zones running at a very sharp angle to the bedding as is the case in the Alpha mine. The "ore beds" do not appear continuously silicified, but the best silicification occurs at major and minor bends in their strike where plunging synclinal troughs have been formed. Zones of limonite and of clay have developed along the beds so as to make the spongy silica discontinuous along its strike. About 600 feet along the strike of the beds has been prospected.

Gold mineralization is not coextensive with the spongy silicification but is likewise best developed at bends in the bedding. Exploration of unflexed beds from the Los Angeles tunnel has exposed typical spongy silica low in gold. The thickness of mineable beds in the old stopes varies between 5 and 35 feet. Our shipment records show that 1319 tons with an average grade of 1.787 oz. Au. have been shipped by leasers. The ore is a white or slightly iron-stained spongy silica from which a considerable amount of pyrite has undoubtedly been removed. The ore bed commonly rests upon a footwall heavily impregnated with marcasite, and in many places the change to marcasite is exceptionally sharp.

The 120 and 200 levels of the Saxton mine show that the ore beds have very probably been fed by a steep mineralizing fissure that passes through the McKinley shaft and from which a small amount of good ore has been taken.

The lowermost level of the mine (at about the 300 or 350 foot interval) is now under water and cannot be examined.

Considerable ore at a grade of about $10. remains in the mine and its stoping should lead to important extensions. Several other pieces of prospecting have been indicated by our study, but they are best delayed until the mine is in production.

GEOLOGY OF THE ROB ROY TUNNELS:

The Rob Roy Tunnel No. 1 is a prospect situated 900 feet due east of the Los Angeles shaft. It is at the northeast corner of the Saxton Salient where the Ely limestone bends back to the south due to a combination of fold and fault distortions. The mineralized beds developed lie in a minor fault block and appear to be in a somewhat lower stratigraphic horizon than the ore bed of the Los Angeles-Saxton workings. Gold ore has been developed along the bedding for a strike length of 90 feet with a thickness varying between 5 and 20 feet. At the west end of the stope the mineralized bed is cut off by the Rob Roy fault and is offset about 130 feet to the north.

The Rob Roy ore is more generally iron-stained than ore in the Saxton mine. Shipments by leasers show a grade between $6. and $15. One 9-foot sample that we have taken across the bedding carries 5.38 oz. Au.

We are now cleaning out an old tunnel that heads toward the Rob Roy beds where they are offset. A tongue of ore porphyry has appeared in the tunnel and may cut off the possibilities of the ground if it be extensive.

PROSPECTS IN THE MOUNT MORGAN RE-ENTRANT:

Due east of the Saxton mine the Chainman-Ely contact makes a sharp loop to the south where the subsidiary anticlinal noose juts out from the major structure. Within this loop lie the Mt. Morgan, Diamond, Challenge (Roy Neil), Aurora, and Rosa Lee claims. The general structure within the loop is complicated by faults and minor folding, and alteration of the upper beds of the Chainman shale is fairly widespread.

Gold mineralization should occur in such a zone of structural distortion, and its existence in some of the minor workings adds much interest to this scantily prospected area.

I believe this ground to warrant considerable attention in the future when our holdings have been better consolidated. In view of the general flat dip of the beds and the difficulty of securing favorable tunnel sites, I believe that preliminary prospecting should be done by short churn drill holes (about 400 feet, or less, deep). These will give us valuable information on the type of alteration of the shale and an approximation of the gold content.

In the mines and prospects described above, the Chainman shale is mineralized at and near its top, and nowhere in what I have called the "western gold zone" (west of the Rob Roy tunnels) is its lower contact with the Joana limestone exposed. This lower contact carries gold in the Chainman and Revenue mines and is the mineralized horizon of the "eastern gold zone". It should be prospected by churn drilling in the western zone at favorable localities.

THE JUPITER MINE:

The Jupiter mine is situated at the western end of the western gold zone in the Cumberland-Ely group of the Nevada Consolidated Copper Company. Leasers are now actively mining at a rate of 40 or 50 tons a day with a grade that is said to average $6. or $7. per ton. I have not yet examined the underground workings, but the surface geology shows the mineralization is at or near the top of the Chainman shale and is apparently associated with a steep shear zone standing at an acute angle to the bedding. The mineralized zone appears extensive, and I believe it will extend into our Rosa Lee claim. Minor workings have exposed spongy silica along the trend of the zone in this claim.

The following mines and prospects are in the eastern gold zone where the base of the Chainman shale is mineralized. The structural line of demarcation between the two zones has not been identified with certainty but is believed to be a minor fault striking to the northeast and located at the eastern edge of the porphyry in the Chainman claim.

GEOLOGY OF THE REVENUE MINE:

The Revenue mine, located in the Golden Revenue claim, is actively producing at a rate of about 100 tons per day. Over 10,000 tons have been mined by the company now in charge since February or March of this year. I believe the average grade of this ore to have been $6. or $7. per ton as a general rule with occasional shipments of better grade. I have been informed that the grade for June, 1931, was around $4.

Because of faulting, the ore beds at the base of the Chainman shale are not exposed at the surface, and the shale directly above the ore is comparatively fresh and unaltered and resembles that exposed on the surface. The relatively fresh shale on the surface and in the upper part of the formation gives no suggestion of the highly altered material that occurs along the Chainman-Joana contact. Any occurrence of Chainman shale in this eastern gold zone is, therefore, potentially gold-bearing at its base.

The Revenue gold ores are confined almost entirely to the base of the Chainman shale. Locally, the underlying Joana limestone, which is highly altered to limonitic material, carries a small amount of gold near the shale contact. The thickness of the ore beds immediately above the Joana limestone varies but should average about 10 feet. A smaller ore bed, which lies stratigraphically about 30 feet above the Joana limestone, was cut by the Revenue shaft. No work has been done on this bed, but where it is exposed in the shaft it is less than 5 feet thick.

The ores are replacement deposits following the stratification of the Chainman shale. They are siliceous and have a spongy or sandy appearance; usually, they are quite free from limonite. Residuals of the original rock found in the ore indicate that the ores were formed along shaley limestone beds at the base of the Chainman formation.

In the Revenue mine the Chainman shale and the Joana limestone have a general southerly dip of about 25 degrees. This is in agreement with the attitude of the beds on the surface. Underground the Chainman shale beds, although maintaining a general southerly dip, are warped so as to form imperfect dome-like structures. These domes are irregular and vary greatly in size. The ore beds follow this warping in the shale. Although the attitude of the Joana limestone cannot be determined with certainty, it is believed that the beds have a regular southerly dip and are not warped as are the Chainman beds immediately above. The top of the Joana limestone, upon which the Chainman shale lies, however, is very irregular, forming a a hill and valley type of surface. The depressions or valleys in the limestone are filled with a jumble of shale fragments; whereas the higher points or hills are directly below the domes in the shale. It is believed that the doming and warping in the shale is the result of slumping into caves and openings formed in the Joana limestone by solutions moving along the shale-limestone contact.

Caves and slump breccia in all stages of formation may be seen on the lower level of the Revenue mine. An open cave into which there has been no slumping occurs in the first crosscut to the northwest. This cave is below a dome which is being mined from the upper level. Collapse of this cave would have formed a depression rather than a dome in the shale above. Fifty feet farther toward the southwest there is a cave which has been partially filled with limestone blocks and shale fragments. The flank of one of the domes above dips toward this cave. Since the drifts on both levels have been driven along the depressions in the limestone, slump breccia is common throughout the mine.

The breccia consists of a jumble of chiefly shale fragments of all sizes. They may be either soft and altered or quite fresh. In places the fragments are loose and uncemented; in other places the openings between them are filled with sandy material which is commonly well stratified.

In the Revenue mine the slump breccia should be of assistance in prospecting along the Chainman shale-Joana limestone contact, especially where the Joana limestone is highly altered and difficult to recognize.

The following theory is advanced to explain the origin of the slump breccia. The gold mineralization was accompanied by considerable pyrite. The pyrite was taken into solution by ground-water to give an acid solution, and such ground-water descended to the upper surface of the Joana limestone along which it flowed and formed solution caves. The acid solutions were eventually neutralized and deposited their iron as shown by the heavy development of limonite in the limestone exposed underground. The brittle, fractured shale then slumped into the solution cavities, and in certain places the beds were down-warped toward the slump breccia to give imperfect dome-like minor structure and considerable minor irregularity in the attitude of the beds. In some instances the slumping has been sufficient to destroy the ore bed. The presence of slump breccia appears to mark a depression in the warped shale beds, and prospecting upward and away from the breccia should be helpful in exploration.

The Revenue mine has been closely developed over an area 300 feet square. The southerly dip of the beds should carry the mineralization downward to the south with minor interruptions due to slump breccia and gaps in the primary mineralization. The ore beds strike easterly toward the Chainman mine stopes with only a distance of about 150 feet between.

I believe there to be excellent possibilities in following the gold mineralization down the dip to the south. The only dubious point is the position of the sulphide zone where the oxidized character of the ore will cease, pyrite will become heavy to abundant, and the gold tenor will decrease unless primary mineralization is there stronger.

EXTENSION INTO THE SOUTHERN CROSS CLAIM:

There are no workings in an easterly direction from the Revenue shaft toward the Southern Cross claim. Surface study shows that the

Chainman shale continues eastward from the Revenue into this claim, and the ore-bearing beds should likewise persist into it. It appears that the direct continuity of the Revenue ore into the Southern Cross may be interrupted by slump breccia.

The Joana tunnel heads south toward this ground through the Joana limestone but was turned to the southeast before cutting the strike fault that brings in the Revenue mineralized block. A short amount of drifting in this tunnel toward the south should cut the fault and expose the mineralized block. Raises or winzes may then be necessary to select the proper horizon. This appears to be an excellent piece of work.

GEOLOGY OF THE CHAINMAN MINE:

Very little authentic information regarding the local geology of the Chainman mine can now be obtained. Data from Spencer and the general position of the mine with respect to the Revenue show that the base of the Chainman shale is mineralized. Spencer states that there are two mineralized horizons, one at the top of the Joana limestone and the other 20 or 30 feet higher in the Chainman shale. Mineralization in the upper bed apparently continues farthest south. The ore bodies are said to have been from 8 to 10 feet thick in most places. The better ores consist of spongy siliceous material that is gray or yellow from the presence of oxidized lead minerals, according to Spencer. Iron-stained material is said to be generally somewhat lower in precious metals. Spencer states that the general run of the ore appears to have been worth from $8. to $12. (in gold and silver) with certain stopes going as high as $90.

Due to faulting, the Chainman mine ore beds, like the same beds in the Revenue, do not outcrop. The fault carries some mineralization, and prospecting down this led to the mineralized beds. In general, the bedding appears to dip to the south and west. Spencer's account emphasizes the western dip in the mine, and he says that in detail the strata are warped or corrugated parallel with axes which plunge toward the west dip. Some of this may be due to slumping, as was noted in the Revenue mine.

There is no reason why the gold ore should not continue down the general dip to the south. Minor workings have extended into the old Ely claim (now designated on new maps as the August), and old assay maps show excellent combined gold and silver values. Oxidized gold ore should continue down the dip to the sulphide zone.

Immediately north of the old Chainman shaft a northwesterly strike fault has dropped the beds downward and has thus lowered the ore-bearing horizon. To the best of my knowledge, no work has been done in this attractive block of ground. It may be that some information gained during the production of the Chainman mine indicated that this block lay below the oxidized zone. In any event, some exploration is warranted, and a churn drill hole is recommended to test the ground.

GOLD PROSPECTS NORTH OF LANE VALLEY:

Chainman shale outcrops north of Lane Valley in the Silver State, Blackstone, Shale, Vesta, and adjacent claims. We believe it to belong to the same structural block as the Chainman and Revenue mines where the base of the Chainman shale is mineralized. The base of the Chainman does not outcrop here except in a minor upthrown fault block of very limited exposure. A few samples taken near the top of the limestone show small gold values.

I believe this ground to have good possibilities for gold and have recommended that certain claims be acquired in order to consolidate our holdings. Preliminary exploration should be conducted by churn drilling.

CONCLUSIONS ON THE GOLD MINERALIZATION:

In the eastern gold zone where the base of the Chainman shale carries gold the ore-bearing horizons do not outcrop as a general rule. Prospecting down scantily mineralized faults has lead to the ore beds. Hence, a considerable area has been left unexplored. The beds have not been thoroughly explored down the dip, probably due to gaps in the primary mineralization and due to interruption in continuity caused by slump breccia. Considerable attractive prospecting is warranted here. The only dubious point is where and in what manner the oxidized ore will change to a sulphide character.

In the western gold zone the upper beds of the Chainman shale are gold-bearing in discontinuous stretches and the lower contact is not exposed. Future development should test the lower beds by churn drilling. In a structural block of ground called the Mt. Morgan Re-entrant more thorough prospecting of the upper beds is needed.

METHOD OF PROSPECTING:

Under the foregoing recommendations for prospecting, several churn drill holes for gold ore have been advised as preliminary exploration. Due to the flat or moderately flat bedding, tunnels are in general unsatisfactory and vertical exploration is necessary. I believe that prospect shafts would be so slow and expensive that the adequate exploration of the gold zones would be discouraged. Churn drill holes should indicate the important stratigraphic horizons very closely and will give at least an approximation of the gold content. Then shafts and underground workings can be put down in the most favorable areas. I doubt if it would be necessary to drill many holes below 500 feet depth.

FUTURE STUDIES IN THE LANE VALLEY AREA:

Limestone copper deposits have not been considered in this report because our work has been concentrated to date on gold and porphyry ore occurrences. Study in the immediate future will cover the copper mineralization in limestone. This is best displayed at the surface in an elongated zone running easterly from the Ely Northern and McDonald-Ely groups through the Nevada limestone. It marks the main extension of the principal zone of mineralization of the district. The Smokey tunnel now being repaired should give us good information regarding this type of mineralization.

ENP-S
Kimberly, Nevada,
July 14, 1931.

E. N. Pennebaker

LEGEND

SEDIMENTARY ROCKS

Alluvium

Rib Hill Ss.

Ely Limestone

Chainman Shale

Joana Limestone

Pilot Shale

Nevada Limestone

IGNEOUS ROCKS

"Ore" Porphyry

"Peanut" Porphyry

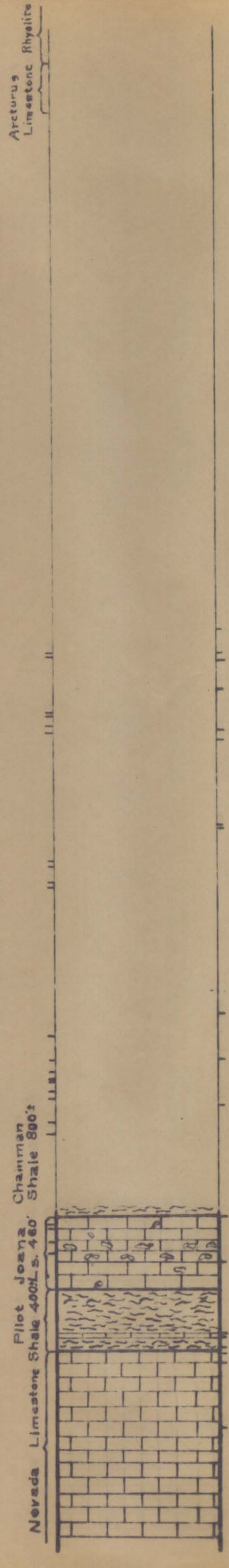
Faults

Sedimentary Contacts


ELY COPPER CO
SAVAGE 4111
CANYON No2 4002
RATTLER 4111
LEAD
BULLION 59
GOLDEN RULE No4
ELAINE 4002
ELIJAH 43
HOAN 3625
RAND PLACER
NEVADA NORTHERN R.R.
ELY-HIDDEN TREASURE CON. CO.
POINT 3168
JEM No4
YELLOWSTONE 51
SUMPTER 3226
LANE VALLEY AREA
CONSOLIDATED COPPERMINES CORP.
NORTHERN No1 2812
GREAT NORTHERN 2812
CASTLE
FORTRESS
MILLARD 3937
ISSACS 44
STEEL
SCORPIAN PLACER
RALSTON No2 2791
YOLO NEVADA 2789
MAGNUSON 3397
LANE
TIGER 2802
SMOKEY DEV CO
CONSOLIDATED COPPER CORPORATION
ELY WITCH
COPPER CO
FEDERAL ELY CO
MISSING LINK 3242
TEMPEST 4110
GRAHAM No3 3244
CHALLENGE
KATIE G 3205
DIAMOND 3199
AURORA 3205
MT MORGAN 3205
ROSA
CUMBERLAND
JUPITER 2678
COMBINATION 2678
CUMBERLAND 2678
WILLIAMS
ELY TAYLOR
ELY REVENUE COPPER CO
ELY NEVADA COPPER CO
MOHAWK 3339
REVENUE 3627
YELLOW BOY 3627
NEW BOY 3999
NELLIS M
WHITE PINE
TIP TOP 2979
EAST RABBIT 2979
CUMBERLAND ELY CO
ALPHA 2979
BAXTON PEAK 7945 FEET
SUMMIT 3627
EUREKA 3627
COLORADO 3627
HAWKEYE 3999
KELLY-BEACH ET-AL
CONTACT 3999
EXCELSIOR 3627
IRON MINE OF NEVADA
CLEAR GRIT
ST LAWRENCE
MOTHER LODE No1
MOTHER LODE No2
CLEAR GRIT No2
BELL 3998
FRANCES
ONEIDA
PETERS
PARROT
VERMONT
HAVANA
TEMPLE No5 2996
TEMPLE No6 2996
TEMPLE No7 2996
TEMPLE No8 2996
TEMPLE No3 2996
TEMPLE No4 2996
WINDSOR No1
ORIOLE 2996
FAMOUS 2996
RED BIRD
NORTHERN 2771
BULLY BOY 3407
CITY OF NEW YORK 3345
SUNSET 3347
KIMBLEY 2380
SUNBEAM 3347
EUREKA
SPECIFIC 47
LAST HOPE 2380
TURKEY 380
COLUMBIA 2380
SOPHIE 3347
VESTA
SHALE
WESTERN 3546
ELY

Plate V

GEOLOGIC COLUMN from ARCTURUS to NEVADA LIMESTONE showing HORIZONS FAVORABLE to KNOWN COPPER, LEAD, and GOLD ORE.



Copper

Lead

Gold

Scale in Feet.

Sevastepol; Munroe above flat fault.

Richards Sulphide

Lower workings, Matilda Lode.
Upper workings, Matilda Lode.

Richards Oxide

Alpha 650-1400 Levels

Munroe below flat fault.

Veteran*

Eldorado*

Alpha below 1400 ?

Ruth

Miscellaneous, Lane City*
Elijah
Isaacs
Union*

Ely Witch

Saxton*

Chainman - Revenue*

Old Glory
Pilot Knob*

Taylor

Probable position
Mitchell copper.*

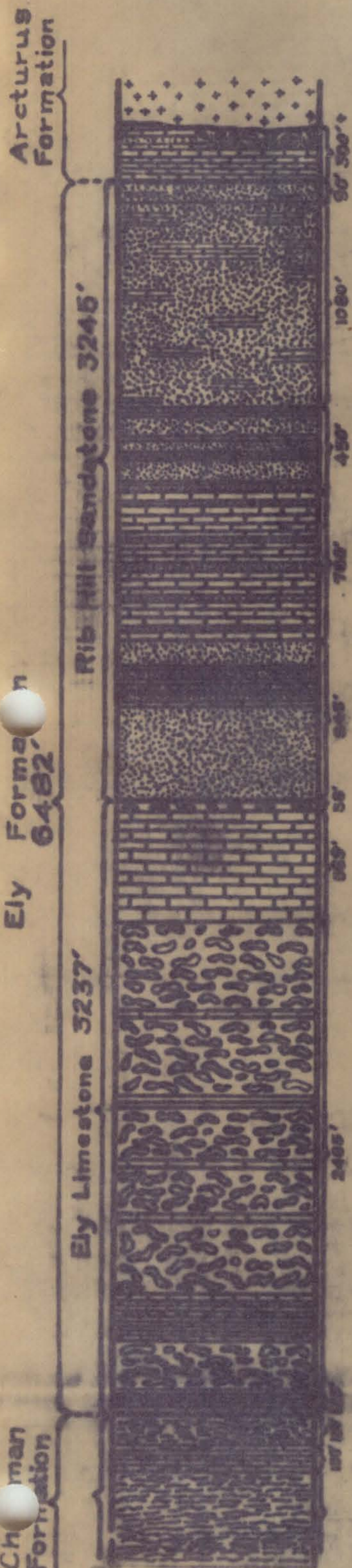
* See text.

Consolidated Coppermines Corp., Kimberly, Nevada.
Geological Department November 1928.
Drawn by:- E.H.R. Checked: R.B. No. Z 10.

GENERALIZED COLUMN THROUGH THE ELY FORMATION

showing

MAJOR SUBDIVISIONS OF THE ELY LIMESTONE AND RIB HILL SANDSTONE.



Rhyolite and tuff.

Thin bedded dense gray limestone; locally small nodular chert that weathers pink. Sandy layers sparse.

Brilliant brick red and yellow sandstone.

Mottled gray, yellow, and brick red sandstone with irregular and discontinuous gray limestone beds.

Yellow and Indian red sandstone with thin intercalated gray-blue limestone beds.

Massive gray-blue limestone with intercalated sandstone beds.

Yellow and Indian red sandstone with sparse, thin gray limestone beds.

Contact cherts.

Upper massive blue limestone.

Scale 1" = 1000'.

500 0 250 500 750 1000

Cherty limestones with intercalated massive blue limestone beds.

Lower thin-bedded limestone.

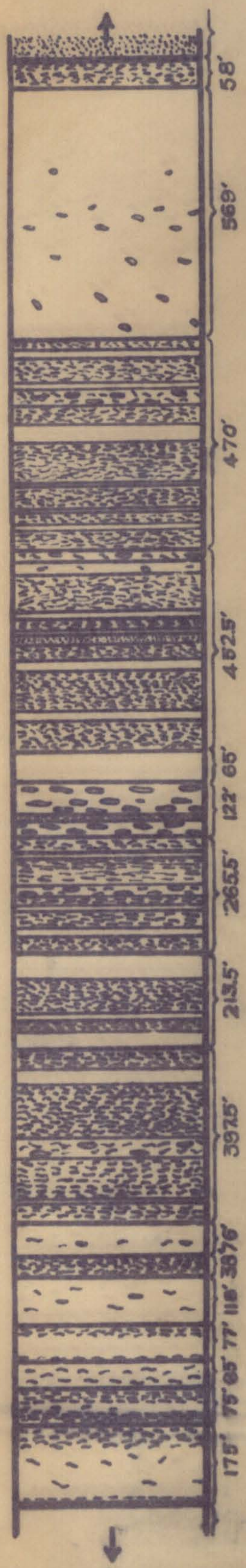
Shale.

Thin-bedded limestone and shale.

Shale.

Consolidated Coppermines Corporation.
Geological Dept. November 1928.
Drawn by: EHR. Checked: No. Z.6

Plate II.



Rib Hill Sandstone
Contact Cherts
Upper Massive Limestone
Matilda Cherts
Upper Mud Cherts
Mineral Chief Massives
Coarse Banded Cherts
Skylark Cherts
Big Bend Massives & Wavy Chert Series
Lower Mud Cherts
Upper Lane City Cliffs
Upper Lane City Cherts
Lower Lane City Cliffs.
Semi-Massive, Dark Shaly Series
Marble Beds.
Basal Cherts
Lower Thin Bedded Limestone.
Chainman Shale

GENERALIZED COLUMN

through

the

ELY LIMESTONE

Scale 1" = 400'

100 50 0 100 200 300 400 500

To accompany report by
R.B., November, 1928.

Consolidated Coppermines Corporation.
Geological Dept. November 1928.
Drawn by: E.H.R. Checked: No. 24

FROM

CITY Kimberly, Nevada

DATE February 14, 1929.

SUBJECT The Footwall Fault of the Morris-Brooks Area.

Purpose of the Report:

The purpose of this report is to indicate the age and character of the footwall fault, studied in the Morris-Brooks Mine and to present evidence in support of my conclusions regarding the fault.

General Character and Age of the Footwall Fault:

The footwall fault is evidently a post primary ore fault, the main branch of which (in the Morris-Brooks Area) follows the footwall of a much larger pre-porphyry fault zone along which porphyry has been intruded. Joana limestone forms the footwall and the Rib Hill Sandstone forms the hanging wall. at the surface Chainman Shale, Ely Limestone, and about 300 feet of the Rib Hill Sandstone are missing, indicating a displacement of approximately 4300 feet. Post ore displacemtne is not determinable from the data in hand but probably represents less than twenty percent of the pre-ore displacement.

Post mineral movement occurs along the footwall, in the footwall limestone of this zone of pre-porphyry faulting and intrusion, and in the porphyry. The fault zone strikes generally in a N. W. - S. E. direction and dips to the S. W. at 40° to 60°. The zone of crusing and shearing in the limestone varies from two to ten feet, the effect in the porphyry was apparently more extensive, indicated by numerous post-ore slips far within the porphyry mass and the general crushed and fractured condition of the porphyry. The slips in the porphyry have a trend approximately paralleling the fault. Pre-ore adjustment along the zone of prophyry intrusion is indicated by the intense crushing of the porphyry prior to the invasion of the mineralizing solutions which deposited pyrite, chalcopyrite, minor amounts of other metalic minerals, and silica. The effect of these invading solutions was to intensely metamorphose the porphyry and produce a metallized silicified mass.

Joana limestone forms the footwall and porphyry the hanging wall of the fault in the Morris-Brooks area. Farther east on the Humbug Claim a fault has been located which is apparently the continuation of the fault in the Morris-Brooks area or an important branch. This portion of the fault has Chainman Shale and peanut porphyry on the footwall and Rib Hill Sandstone on the hanging wall. This fault strikes N80°E and dips 42° south.

The fault has been traced on the 360 level from the Morris Mine into the Brooks Mine. The projection of the fault after leaving Brooks 360-1W lies to the north of B-360-1W. The fault apparently crosses Brooks A drift but

FROM

CITY Kimberly, Nevada.

DATE February 14, 1929.

SUBJECT The Footwall Fault of the Morris-Brooks Area. (cont.)

observations could not be made which definitely proved this point.

On the 570 level of the Morris-Brooks Mine the footwall fault is not as prominent as on the M-360. Projecting it from points of the M-260 and M-360 through points in churn drill holes the fault should cross the M-570 ore drift between M-570-17 and 27. Near 1711 - M-570 ore drift a fractured and sheared zone fifteen to twenty feet wide crosses the drift dipping S. W. 65° to 70°. West of this zone the limestone is intensely altered and mineralized: to the east it is quite fresh and lacking in mineralization. Some rhyolite occurs along the hanging wall of this zone. This zone is near the projection of the footwall fault to the 570 level and resembles it in being the boundary between altered mineralized limestone and fresh limestone. Shearing is not so prominent in this zone as on the M-360. This may be due to the abundant N-S fracturing in this area which may have tended to distribute much adjustment along this zone and obscure the extent of the movement. Apparently this represents the downward extension of the footwall fault, fresh unmineralized limestone forming the footwall and highly mineralized altered limestone the hanging wall. The footwall limestone is Joana but the horizon to which the hanging wall formation belongs has not yet been determined.

Rhyolite along the Contact:

Rhyolite was intruded after the principle movement along this zone had begun but before its completion. This is indicated by the sheared condition of portions of the rhyolite masses. Two facies of rhyolite are most common, the highly porphyritic (nevadite) type which predominates and the dense green and brown obsidian. The obsidian occurs sheared and mixed in with the sheared limestone along the fault. Nevadite was sheared, but never to such an extent that fragments became isolated in gouge of another rock type. The greater size of the nevadite intrusions was probably a factor in keeping them intact. In some places the nevadite has broken away from the fault and irregularly intruded the hanging wall porphyry. The intrusion of both facies of rhyolite was probably contemporaneous and occurred in the late stage of adjustment along the fault.

Mineralization along the Fault:

The crushed sheared zone in the limestone varies from two to ten feet in width. Because of the incompetent nature of the porphyry it is difficult to say how far the shearing was active in that material. The fault gouge and breccia consist of crushed and sheared limestone and porphyry.

FROM

CITY Kimberly Nevada

DATE February 14, 1929.

SUBJECT

The Footwall Fault of the Morris-Brooks Area. (cont.)

The limestone predominates. Minor amounts of sheared rhyolite occur in the fault. In the fault zone we find rhyolite, barren limesonte, brecciated mineralized limestone, crushed and sheared porphyry, and gouge developed from any of these. The principle minerals noted in the material making up the fault breccia were pyrite, chalcopyrite, chalcocite, and magnetite. Occassionally the chalcopyrite and chalcocite show fracturing and smearing. This is especially noticeable of chalcocite. There is no indication that any of the minerals mentioned above were introduced after faulting began.

Values due to supergene solutions are absent or if present, in quanties so minute that they can not be detected by megascopic means along the fault zone at depth. They are most likely present in the oxidized zone near the surface.

Summary:

1. The fault is post ore, generally following the foot-wall of a zone of pre-porphyry faulting, subsequently the zone of porphyry intrusion.

2. Rhyolite intrusions occur along the fault. These have suffered minor crushing and shearing. They were probably intruded during the late stage of adjustment along this zone.

3. The fault carries mineralized fault breccia. There is no disseminated primary sulphides in the gouge and values due to supergene solutions are absent. Supergene mineralization may occur at higher elevations along the fault in the oxidized zone.

4- Faulting evidently began before the porphyry intrusion. It continued after the emplacement of porphyry and ore, and evidences of later movement are to be seen in the post-ore rhyolite.

ROCK FORMATIONS SOUTH OF EMMA NEVADA MINE

In the area to be explored by rotary drilling, three types of rocks occur. In addition, two other types may appear.

On the surface is rhyolite, and this type is expected to extend downward approximately 700 feet. Below this is the copper-bearing zone of ore porphyry, 75 feet to 200 feet thick. Underneath the ore is a rock locally called peanut porphyry in which the hole will be stopped.

RHYOLITE.

There are about six principal varieties of rhyolite. These are divided into two groups, called rhyolite and rhyolite breccia.

The rhyolite is a hard, dense rock, sometimes glassy in appearance. It is generally white, gray, or pink in color. It is speckled with small crystals, which may be very abundant or very scarce in number. Certain of these crystals give the easiest way of determining what the rock is. The most helpful of these are small coal-black to gray, shiny quartz crystals. Sometimes a very few dark-brown mica flakes are found.

The rhyolite breccia is made up of chunks of various kinds of rhyolite along with chunks of porphyry, sandstone, and limestone. It is much softer than the rhyolite described above. Generally, it carries black quartz crystals which serve to distinguish it. In some areas it consists principally of black or brown volcanic glass.

Rhyolite breccia generally occurs just above the ore in the area to be drilled. From 25 feet to 100 feet above the ore an important change takes place in the breccia. Here it carries chunks of ore porphyry which in turn carry abundant crystals of pyrite. The appearance of shiny, brassy-yellow, metallic pyrite crystals means that the ore zone is not far away.

ORE PORPHYRY.

The contact between the rhyolite breccia cap-rock and the ore is marked by about 10 feet of badly caving ground.

The ore porphyry is a rock related to a fine-grained granite, but it has been so badly altered that it looks more like a coarse-grained sand cemented by small glassy quartz veins. It carries abundant specks and veinlets of pyrite and the copper mineral chalcopyrite. These are metallic and yellow and heavy.

Near the bottom of the ore, the ore porphyry becomes full of black streaks and at the very bottom there is from 1 to 5 feet of black tough gange. Also, near the bottom the ore is very quartzy and small flakes of shiny, blue-black molybdenite may appear.

PEANUT PORPHYRY.

Underneath the ore is a considerable thickness of peanut porphyry. This is generally barren and drilling is stopped when it is reached. In a few areas it carries ore, and in such an event would be drilled.

Where fresh, the peanut porphyry looks like a granite with large square crystals of pink or white feldspar. Underneath the ore it may look decidedly different due to alteration. Sometimes it is solid, glassy quartz. Again it shows as a dark gray rock with quartz veinlets. In some areas it is solid black magnetite. Generally the appearance of tiny magnetite crystals means that peanut porphyry has been cut.

SANDSTONE.

Sandstone may appear as chunks in the rhyolite breccia or it might come in under the rhyolite in place of the ore. It is usually white to yellow and medium-grained.

LIMESTONE.

Limestone, or shale, may appear under the rhyolite or under the ore. It is usually so altered and full of pyrite, quartz and garnet that it is the hardest rock to recognize. It is greenish-black in color.

E. N. Pennebaker, Chief Geologist — Kimberly, Nevada

J. B. Haffner, General Manager — April 15, 1932

MINERALOGY OF CONCENTRATING ORES - SUMMARY OF INVESTIGATION

GENERAL CHARACTER AND UNIFORMITY OF ORES

The mineralized porphyry that constitutes the bulk of the disseminated copper ore of the Robinson Mining District carries chalcopyrite and pyrite as the predominant metallic minerals. With these are associated minor amounts of magnetite and molybdenite, and an extremely minute amount of pyrrhotite may be present. Chalcocite, covellite, and secondary bornite appear in certain areas, but ore in which they are abundant is to be considered as an exception rather than the rule when referring to relative tonnages. A minor amount of primary bornite is present along the south fringe of the Emma Nevada ore body and throughout the Morris-Brooks mine. Magnetite is generally a minor constituent except in certain specimens in the Ora claim and in churn drill composites from the northwestern area of the Pit.

Areas in which chalcocite and covellite are in sufficient abundance to be a factor in the milling process are as follows:

1 - Morris mine above the 360 level.
2 - Eastern portion of Brooks mine above the 360 level.
3 - In the Emma Nevada mine only where extensive overdrawing or where funnelling brings in segments of an upper, generally isolated layer with chalcocite-covellite mineralization.
4 - Ore from the Ruth mine presumably carries abundant chalcocite. Specimens are not available for us to make a detailed analysis.
5 - Ore from our Old Glory mine carried abundant chalcocite. Very likely the Veteran ore was similar in mineralogy.

SUMMARY OF AREAS

Morris Mine

Along the north edge of the mine and above the 360 level, chalcocite and covellite contribute an important but variable amount of copper to the ore. Such ore is chiefly tributary to raises on the 260 level and to raises located on Drift 1W on the 360 level. Examination shows that chalcopyrite varies from 39% to 99% by volume of the total copper-bearing minerals. The remainder is chiefly chalcocite and covellite of varying ratios. Minor amounts of oxidized copper minerals appeared in the Morris ore during the course of mining.

Ore tributary to the 570 level of the Morris mine shows 98 or 99% by volume of the total copper-bearing minerals is chalcopyrite. The ore is entirely similar to the main ore zone of the Emma Nevada mine.

A minor amount of primary bornite appears throughout the Morris area.

Brooks Mine

Additional work has been done on the Brooks ore since my report of March 24, 1932. The following is a summary of results:

Twenty-two bricquettes, representing 13 churn drill holes that cut the Brooks ore body, were prepared and examined. With reference to the mineralogy, the ore body above the 360 level may be considered in two parts: western and eastern.

The eastern portion lies east of coordinate 7600E and includes mine blocks IV, V, and VI. Five of the holes examined cut ore above the 360 level in this area. Most of these show chalcocite present in important but highly variable amounts.

The western portion lies west of coordinate 7600E and includes mine blocks I, II, and III. Three of the holes examined cut ore tributary to the 360 level in this area. These show that chalcopyrite makes up 98 or 99% by volume of the total copper-bearing minerals present. Excellent ore was noted during the mining of this ground.

Ore tributary to the 570 level of the Brooks mine shows 99% chalcopyrite.

A minor amount of primary bornite appears throughout the Brooks area.

Emma Nevada Mine

Block I:

As a general average, chalcopyrite makes up 98 or 99% of the bulk of the copper- bearing minerals in the main ore zone. The remaining minerals are covellite, chalcocite, and bornite. Among these, covellite predominates, and bornite is the least abundant.

In the southern part of the block, the main ore zone is overlaid by waste consisting principally of rhyolite. Above this rhyolite there is an irregular, discontinuous band of low-grade ore in porphyry. This band carries abundant covellite, chalcocite, and bornite. Here the amount of chalcopyrite is variable and is commonly subordinate to the other copper-bearing minerals. The amount of waste separating this from the main ore zone below is such that the upper band is not intentionally drawn into the chutes during mining. It only appears in some overdrawn areas, or in places where the character of the ground makes the control of drawing difficult. Examination of settlement samples and daily station samples shows that very little chalcocite and covellite are added in this manner, as a general rule.

Block II:

From 98 to 99% of the copper-bearing minerals is represented by chalcopyrite. The mineralogy of the ore is entirely similar to that in Block I.

Western Extension of Emma Nevada:

This area, developed during the past few years, was noted at the time of drilling to carry chalcopyrite almost exclusively as an ore mineral. Microscopic examination of samples from one drill hole showed 100% chalcopyrite.

At certain places within the Western Extension, low-grade chalcocite ore overlies the chalcopyrite (main) ore zone. We can expect some of this to enter the chutes when certain of the raises are overdrawn, but the general mineralogical character of the mill heads should suffer little change from this.

Eastern Emma Nevada Area and West End of Pit:

Personal observations in the west end of the Pit and underground in the Emma Nevada show that few other copper-bearing minerals than chalcopyrite appear in the ore.

This was checked microscopically as follows:

Ten bricquettes, representing 6 churn drill holes in this area, were prepared and examined. Eight of these showed 99 to 100% chalcopyrite. The remaining two carried 85% chalcopyrite by volume with chalcocite, covellite, and bornite making up the remainder.

Miscellaneous specimens taken from the 8 level at the west end of the Pit showed 99½ to 100% chalcopyrite. The remainder of the copper is carried by chalcopyrite.

Liberty Pit

Ora Claim:

Ore from the Ora claim was given a particularly close examination. Since my report of March 24, 1932, six bricquettes representing three churn drill holes were examined. These show

99 to 100% chalcopyrite. Four specimens taken in the field show 100% chalcopyrite. As a general average the ore shows 99 - 100% chalcopyrite; the remaining 1% by volume is made up of covellite and chalcocite.

East End of Pit:

A series of specimens along the 7 level was taken at intervals of 50 feet along a course 800 feet in length. These average 99.8% chalcopyrite by volume. The minerals covellite, chalcocite, and bornite are generally negligible or absent. Where present, covellite appears to predominate.

South Side of Pit:

Two miscellaneous specimens show 100% chalcopyrite.

Summary of Pit:

Inasmuch as the Pit is so large, it would take many months to prepare enough briequettes to cover it thoroughly. From my personal observations within the Pit, checked by our recent microscopic work, I feel sure that the material we have studied is representative of the great majority of the ore at and below the 7 level (and at and below the 5 level in the Ora claim). At present I know of no area that shows abundant chalcocite, with the possible exception of the immediate footwall of the Sulphide Fault near the upper levels (in the vicinity of the Westphalia claim). The chalcocite ore described so freely in old geologic reports (referring especially to the Eureka Pit) cannot now be checked.

ENP-S

R. N. Pennebaker, Chief Geologist — Kimberly, Nevada

J. B. Haffner, General Manager — March 24, 1932

MINERALOGY OF CONCENTRATING ORES - MORRIS-BROOKS MINE

Detailed microscopic examination has been made of the ore of the Morris-Brooks mine to determine the kind and proportion of the copper-bearing minerals present. The following types of samples were examined: (1) composites of churn drill samples, (2) lot samples for a few months, (3) miscellaneous specimens collected from drifts and raises during the early part of 1929.

Morris Mine

Along the north edge of the mine and above the 360 level, chalcocite and covellite contribute an important but variable amount of copper to the ore. Such ore is chiefly tributary to raises on the 260 level and to raises located on Drift 1W on the 360 level. Examination of churn drill composites shows that chalcopyrite varies from 39% to 99% by volume of the total copper minerals. The remainder is chiefly chalcocite and covellite, of varying ratios. Examination of miscellaneous specimens also shows that chalcocite and covellite are here important copper-bearing minerals.

Examination of composites of settlement samples gave the following results:

Period	% Vol. Chalcopyrite	% Vol. Chalcocite Covellite & Bornite	% of Production From Morris Mine
Dec. 1928	90	10	82.8
Jan. 1929	88	12	86.7
April 1929	82	18	77.5
May 1929	90	10	73.2

In the above, covellite is relatively twice as abundant as chalcocite, and the amount of bornite is relatively unimportant.

The above only gives an approximate picture of the mineral content of Morris ore because these settlement samples also carry a portion of Brooks ore (principally from sub-level Blocks V and VI).

Minor amounts of oxidized copper minerals appeared in the Morris ore during the course of mining.

Ore tributary to the 570 level of the Morris mine shows 98 or 99% by volume of the total copper-bearing minerals is chalcopyrite. The ore is entirely similar to the main ore zone of the Emma Nevada mine.

E. N. Pennebaker, Chief Geologist Kimberly, Nevada

J. B. Haffner, General Manager March 24, 1932

MINERALOGY OF CONCENTRATING ORES - NORRIS-BROOKS MINE

Brooks Mine

Churn drill composites represent the only material now available by which to judge the character of the Brooks ore.

In the eastern portion of the mine (in the vicinity of which we did some sub-level stoping) chalcocite and covellite make up an important, but extremely variable, amount of the copper-bearing minerals. This was verified by observation during the course of mining.

In the western part of the Brooks mine (where we carried on considerable stoping from the end of 1926 to March, 1928, and later) chalcopyrite forms 98 or 99% by volume of the total copper-bearing minerals.

ENP-S

E. N. Pennebaker, Chief Geologist — Kimberly, Nevada

J. B. Haffner, General Manager — March 21, 1932

MINERALOGY OF CONCENTRATING ORES - EMMA NEVADA MINE

Detailed microscopic examination has been made of the ore of Blocks I and II of the Emma Nevada mine to determine the kind and proportion of the copper-bearing minerals present. Estimates of percentage have been made by grain counts with the aid of an ocular grid. The following types of samples were examined: (1) composites of churn drill samples, (2) composites of McGill settlement samples by months, (3) daily station (production) samples.

BLOCK I

Churn Drill Composites:

Samples of six churn drill holes within the block were prepared. Samples for each hole were segregated into groups where changes in mineralogy were expected. Composites were made of each group, and fourteen bricquettes were prepared and polished for examination with the reflecting microscope.

The main ore zone thus examined shows that 99% by volume of the copper-bearing minerals consists of chalcopyrite. The remaining 1% consists of covellite, chalcocite, and bornite. Of the latter, covellite appears to predominate over chalcocite, and bornite is the least abundant.

In the southern part of the block, the main ore zone is overlaid by waste consisting principally of rhyolite. Above this rhyolite there is an irregular band of low-grade ore in porphyry. This band carries abundant covellite, chalcocite, and bornite. Here the amount of chalcopyrite is variable and is commonly subordinate to the other copper-bearing minerals. The amount of waste separating this from the main ore zone below is such that the upper band is not drawn into the chutes during mining. It might only appear in some overdrawn areas, or where pronounced funnelling took place.

In the northern part of the block, the top of the main ore zone carries somewhat less chalcopyrite (95%) in one hole.

McGill Settlement Sample Composites:

Settlement samples of lots for the last half of 1931 were available for microscopic examination. Composites were made up covering each month and bricquettes were prepared for microscopic examination.

Period	% Vol. Chalcopyrite	% Vol. Covellite, Chalcocite & Bornite
July 1931	96	4
Aug. 1931	98	2
Sept. 1931	98	2
Oct. 1931	99	1
Nov. 1931	99	1
Dec. 1931	98	2
Average	98	2

The variation appears to be due to overdrawing, which probably drew in some of the upper chalcocite, covellite, and bornite, during July especially.

Daily Station Samples:

During January and February, 1932, daily station samples were examined with the following results:

Date	% Vol. Chalcopyrite	% Vol. Covellite, Chalcocite & Bornite
Jan. 24	98	2
" 25	99	1
" 26	99	1
" 27	98	2
" 28	99	1
" 29	99	1
" 30	98	2
" 31	99	1
Feb. 1	99	1
" 9	99	1
" 10	99	1
" 11	99	1
" 12	99	1
" 13	99	1
" 14	99	1
" 15	99	1

Summary of Block I:

As a general average, chalcopyrite makes up 98 or 99% of the bulk of the copper-bearing minerals. The remaining minerals are covellite, chalcocite, and bornite. Among these, covellite predominates. A decrease of a very few per cent in the amount of chalcopyrite may be expected where overdrawing is excessive in certain areas.

BLOCK II

Only one churn drill hole falls in the area mined as Block II. This shows 99% chalcopyrite.

A few settlement lot samples were available and gave the following results upon examination:

Period	% Vol. Chalcopyrite	% Vol. Covellite Chalcocite & Bornite
Lot Sample, May 1929	98	2
" " June 1929	99	1
" " July 1929	99	1

Samples from Block II show the same ratios and are entirely consistent with results obtained from Block I.

GENERAL SUMMARY OF EMMA NEVADA MINE

From our experience in drilling other parts of the ore body and from observations underground, I see no reason to expect any pronounced variation in the mineralogical character of the ore. The southern fringe of the orebody, as now developed in the eastern part, carries a minor amount of primary bornite. Other than this, I know of no changes.

ENP-S

E. N. Pennebaker, Chief Geologist — Kimberly, Nevada

J. B. Haffner, General Manager — March 25, 1932

MINERALOGY OF CONCENTRATING ORE - LIBERTY PIT - EAST END

A series of specimens was taken at the east end of the Liberty Pit along the 7 level. They were taken at intervals of 50 feet and cover a course of 800 feet in length. The bank was dug into to secure fresh material and several pounds of sample were taken. Most of the sample was crushed and panned to secure the metallic minerals for the preparation of briquettes. Specimens of rock fragments were also ground and polished. 17 briquettes and 19 rock surfaces were prepared and examined. The material represents mineralization in both "peanut" and "ore" porphyry.

The following results were obtained by microscopic examination:

Specimen Number	% Vol. Chalcopyrite	% Vol. Covellite, Chalcocite & Bornite
P- 6	100	
P- 7	99½	½ of 1%
P- 8	99½	½ of 1%
P- 9	100	
P-10	100	
P-11	100	
P-12	100	
P-13	100	
P-14	98	2
P-15	100	
P-16	100	
P-17	100	
P-18	100	
P-19	100	
P-20	100	
P-21	100	
P-22	100	

SUMMARY

In this area the minerals covellite, chalcocite, and bornite are generally negligible or absent. When present, covellite appears to predominate.

In specimen No. P-14 about 25% of the chalcopyrite grains are coated by extremely minute rims of covellite and chalcocite.

The ore is entirely similar to the main ore zone of the Emma Nevada Mine.

ENP-S

R.B. Sprague, Geologist — Kimberly, Nevada

P.J. Johnson, Chief Chemist — February 12, 1944

COPPER MINERAL CONTENT OF McGILL MILL PRODUCTS TAKEN FEBRUARY 9, 1944.

The following tables give the volume percentages of the various copper minerals and mineral combinations indicated by the study of briquettes.

Discrete grains of the various copper minerals generally occur in the larger size ranges. The composite chalcopyrite grains are combined with pyrite, quartz, and magnetite, in that order of abundance. Chalcocite and covellite in composite grains are confined largely to coatings on pyrite with occasional coatings on quartz. Grains with chalcopyrite cores and chalcocite rims probably should be considered as chalcocite since all fractures in these grains are filled with chalcocite.

Sample #2 - "Total Middlings."

Chalcopyrite	68.04%
Chalcocite	17.59%
Chalcopyrite composite grains	5.86%
Covellite	3.52%
Chalcocite rims, chalcopyrite cores	2.35%
Chalcocite Composite Grains	1.47%
Covellite composite grains	1.17%
	100.00%

Sample #4 - "Tailings Rougher - Final."

Chalcopyrite	65.73%
Chalcopyrite composite grains	15.02%
Chalcocite rims, chalcopyrite cores	9.40%
Chalcocite	7.51%
Chalcocite composite grains	1.41%
Covellite composite grains	.94%
	100.01%

In this sample the discrete grains of chalcopyrite are mainly in the upper size range of the sulfide grains present. The chalcopyrite composite grains are also generally large, and their exposed surface is commonly ±50% chalcopyrite. Occasionally small grains of chalcopyrite are completely enclosed in quartz or pyrite.

Sample #5 - "Final Cleaner Tails. This mineral has been floated once."

Chalcopyrite	66.67%
Chalcocite	13.04%
Covellite	7.25%
Chalcocite rims, chalcopyrite cores	5.80%
Chalcopyrite composite grains	4.35%
Covellite composite grains	2.54%
Chalcocite composite grains	.36%
	100.01%

R.B. Sprague, Geologist — Kimberly, Nevada

P.J. Johnson, Chief Chemist — February 12, 1944

COPPER MINERAL CONTENT OF McGILL MILL PRODUCTS TAKEN FEBRUARY 9, 1944.

Sample #6 - "Tails from Primary Cleaner. Floated once."

Chalcopyrite	80.30%
Chalcocite	7.43%
Chalcocite rims, chalcopyrite cores	5.95%
Covellite	5.95%
Covellite composite grains	.37%
	99.88%

Sample #7 - "Concentrates from #1 Rougher."

Chalcopyrite	78.52%
Chalcocite	9.24%
Chalcocite rims, chalcopyrite cores	4.62%
Covellite	3.70%
Chalcocite rims, chalcopyrite cores	2.31%
Covellite composite grains	1.62%
	100.01%

RBS:wm

R. B. Sprague

E. N. Pennebaker, Chief Geologist — Kimberly, Nevada

J. B. Haffner, General Manager — March 24, 1932

MINERALOGY OF CONCENTRATING ORES - LIBERTY PIT - ORA CLAIM

The following samples from the Ora claim were examined microscopically to determine the kind and proportion of the copper-bearing minerals present:

Samples for Main Metallurgical Tests:

"Ora Bank" Sample: Taken in February, 1931, from near tunnel just below 8 level.

Shows chalcopyrite as the only copper-bearing mineral present.

"Ora Bottom" Sample:

Shows 99.9% chalcopyrite and 1/10 of 1% covellite. Composite from 8 pits on 10 level.

Lot Samples:

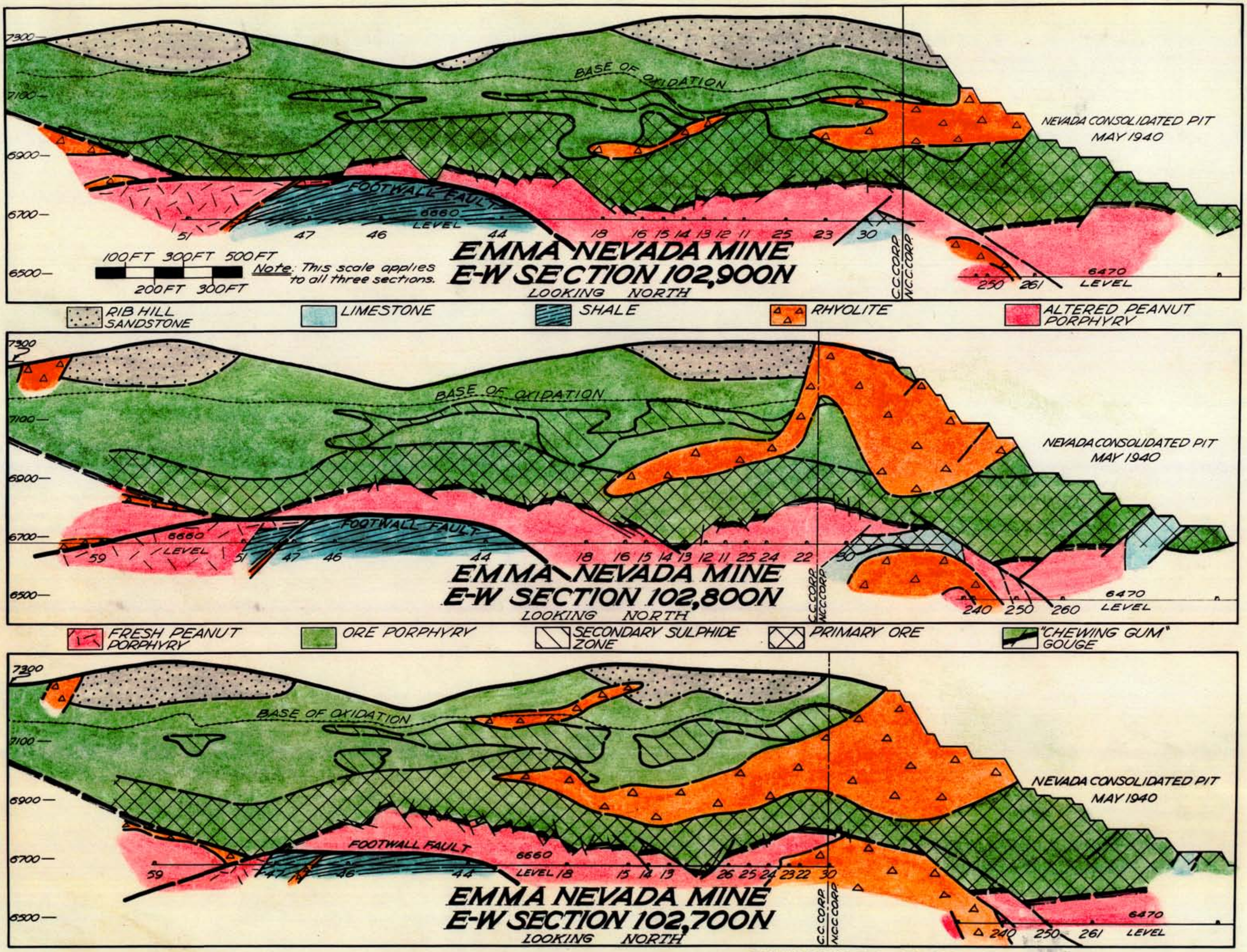
A series of lot samples said to represent about 1,000 cars of 1928 production was segregated out by P. J. Johnson. These were examined with the following results:

Lot No.	% Vol. Chalcopyrite	Date Sampled at McGill
10	99½% plus	3/28/28
27	100 %	4/23/28
34	100 %	5/ 8/28
47	100 %	6/29/28
48	99½% plus	6/30/28
52	99 %	7/ 7/28

Summary:

Samples examined from the Ora claim show a strictly chalcopyrite-pyrite ore. The amount of covellite and chalcocite is from 1% to nil. The ore is entirely similar to the main ore zone of the Emma Nevada ore body.

ENP-S



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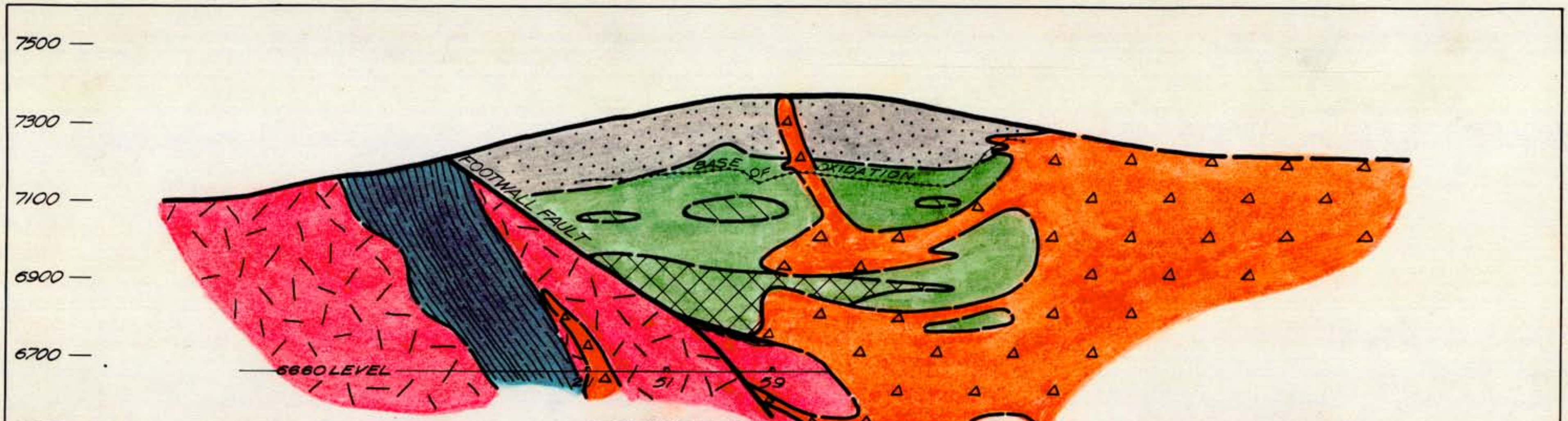
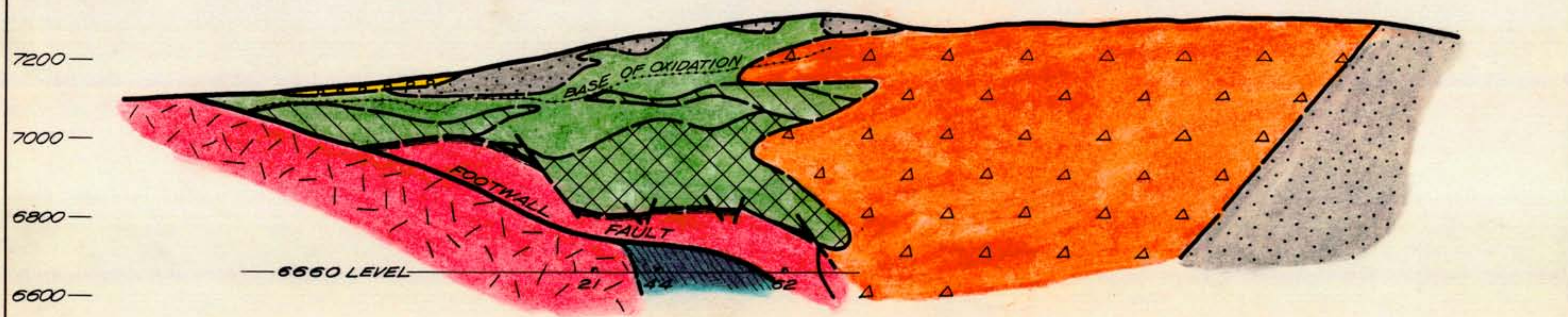


EMMA NEVADA MINE
N-S SECTION 98330E
LOOKING EAST

QUARTERNARY ALLUVIUM	SHALE	FRESH PEANUT PORPHYRY	SECONDARY SULPHIDE ZONE	ORE PORPHYRY
RIB HILL SANDSTONE	RHYOLITE	ALTERED PEANUT PORPHYRY	PORPHYRY ORE	"CHEWING GUM" GOUGE



EMMA NEVADA MINE
N-S SECTION 99400E
LOOKING EAST

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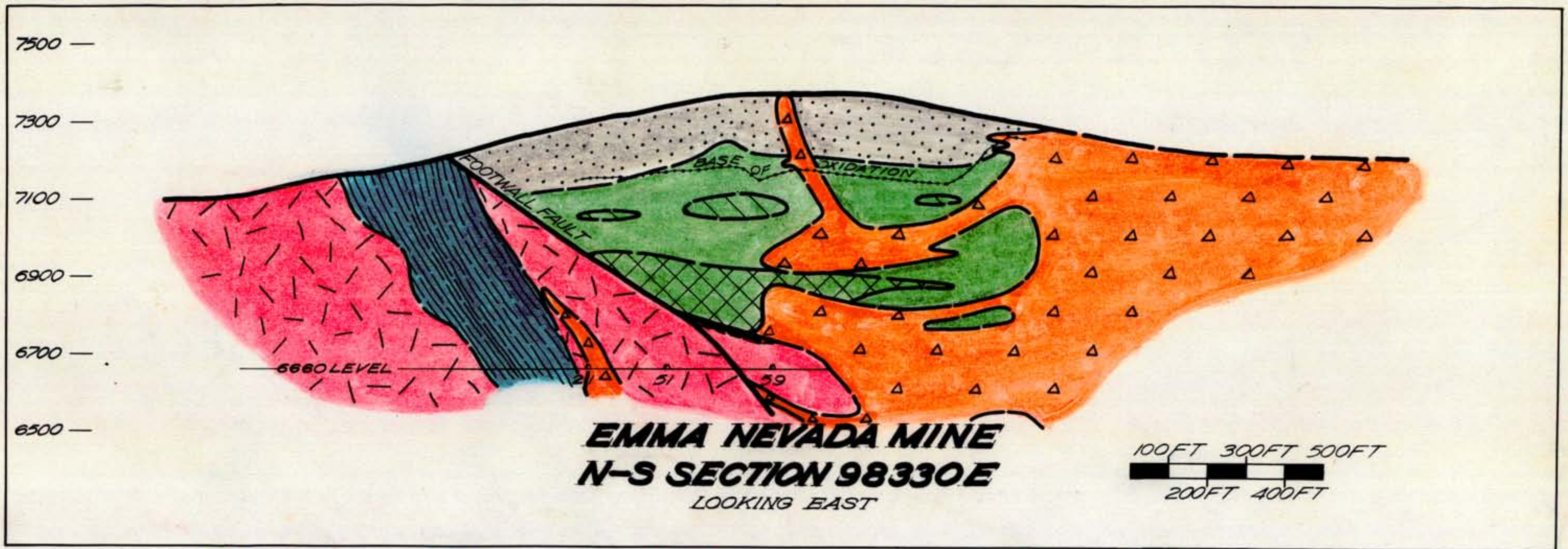

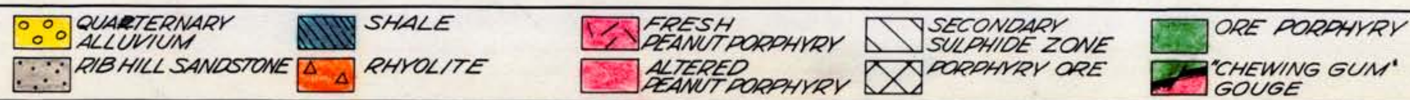

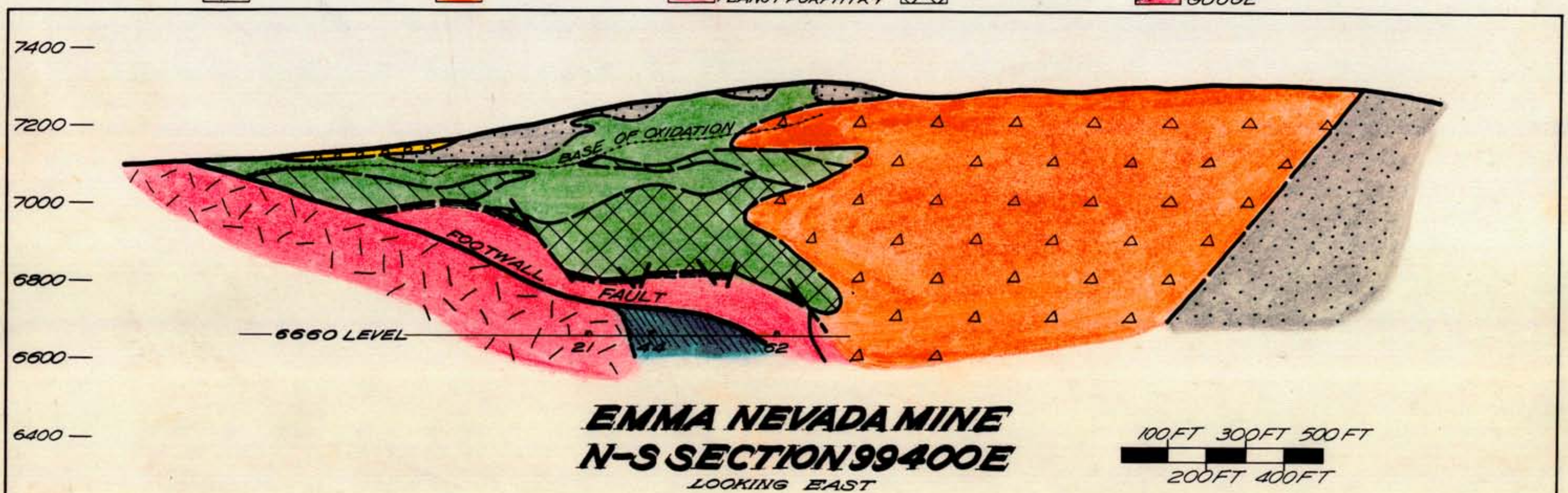

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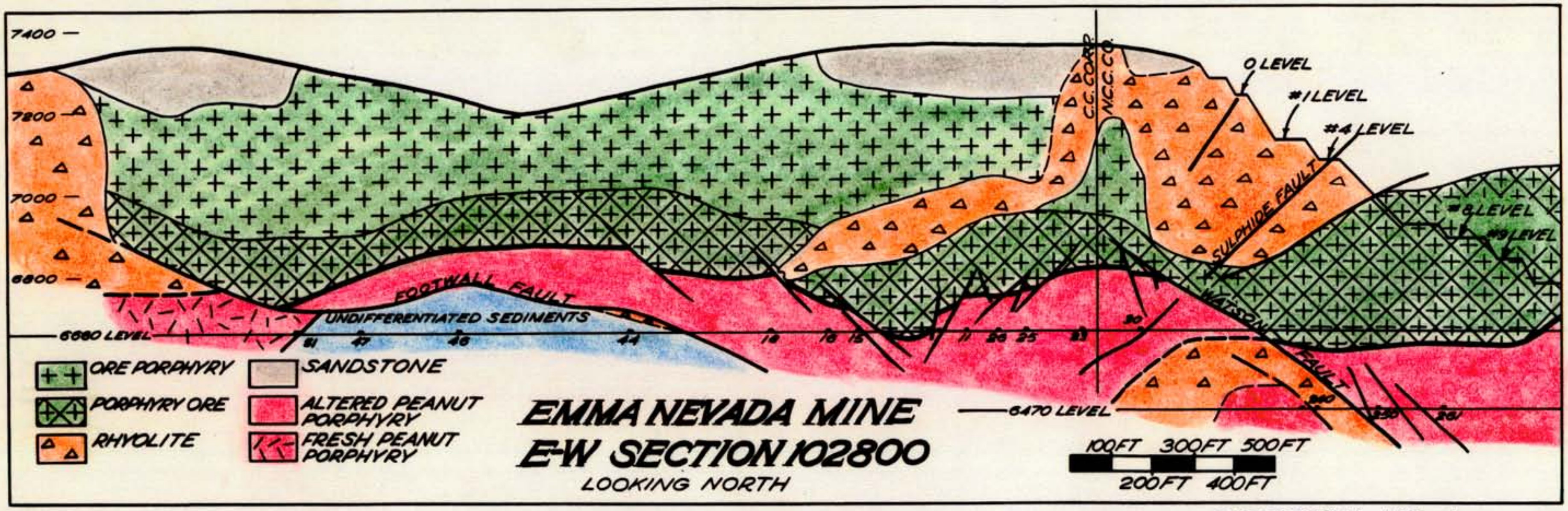

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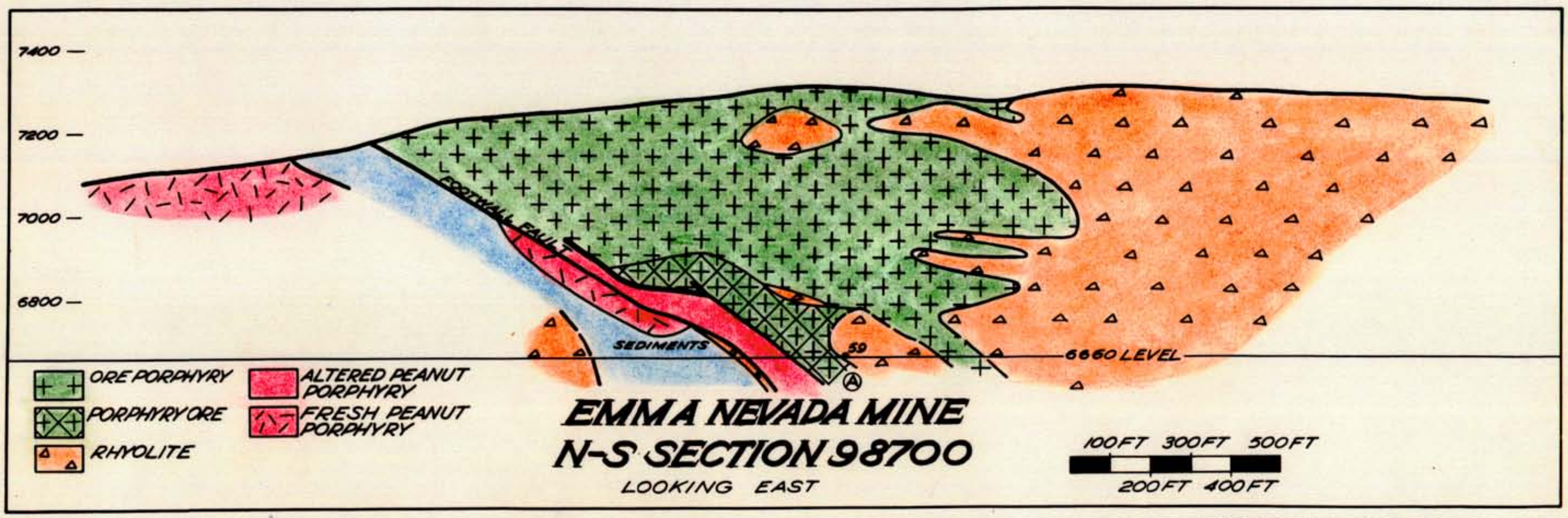

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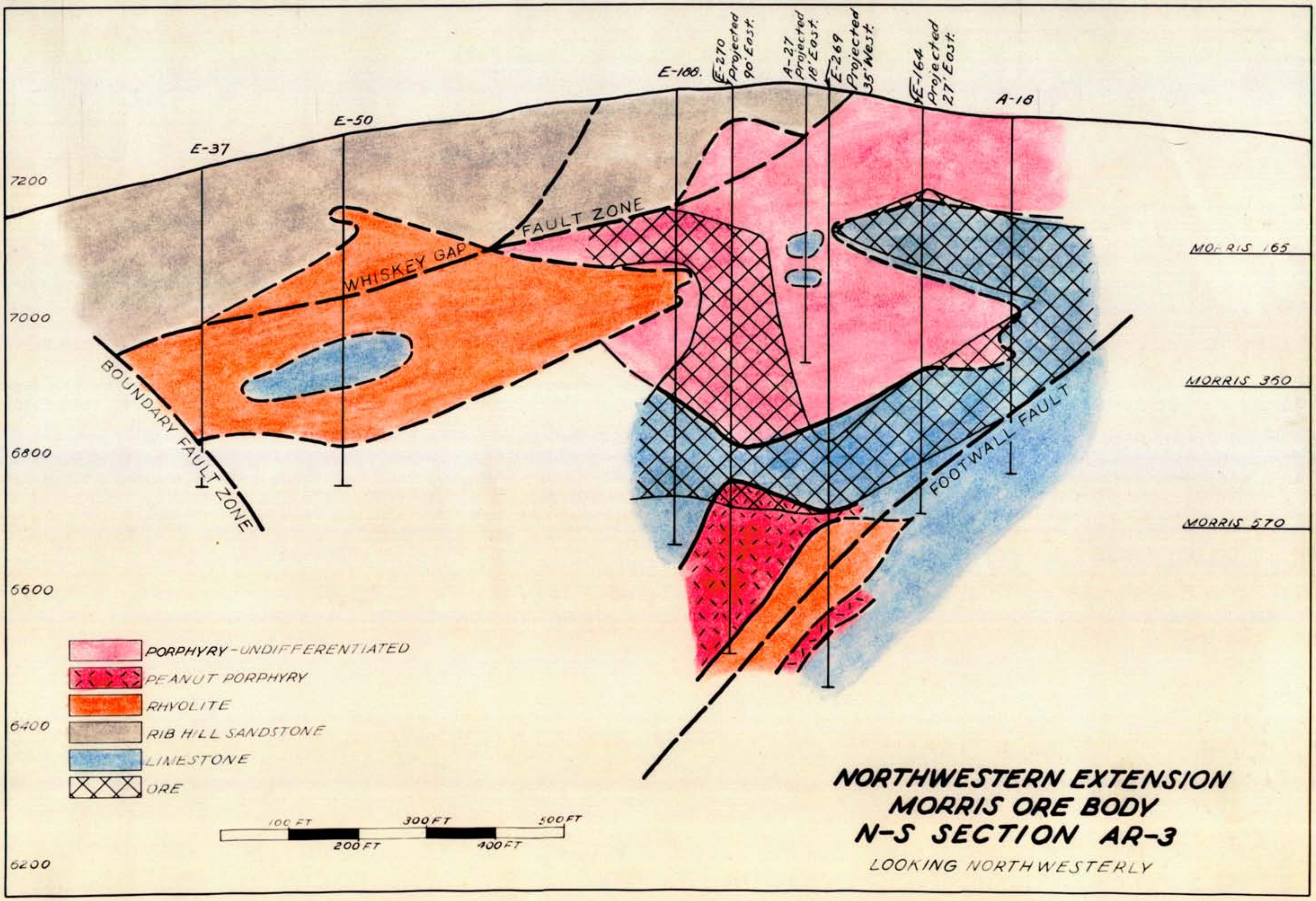


E-37
E-50
E-188.
E-270 Projected 90' East.
A-27 Projected 18' East.
E-269 Projected 35' West.
E-164 Projected 27' East.
A-18
7200
7000
6800
6600
6400
6200
MORRIS 165
MORRIS 360
MORRIS 570
WHISKEY GAP FAULT ZONE
BOUNDARY FAULT ZONE
FOOTWALL FAULT
PORPHYRY-UNDIFFERENTIATED
PEANUT PORPHYRY
RHYOLITE
RIB HILL SANDSTONE
LIMESTONE
ORE
100 FT
200 FT
300 FT
400 FT
500 FT
NORTHWESTERN EXTENSION
MORRIS ORE BODY
N-S SECTION AR-3
LOOKING NORTHWESTERLY

Figure 9

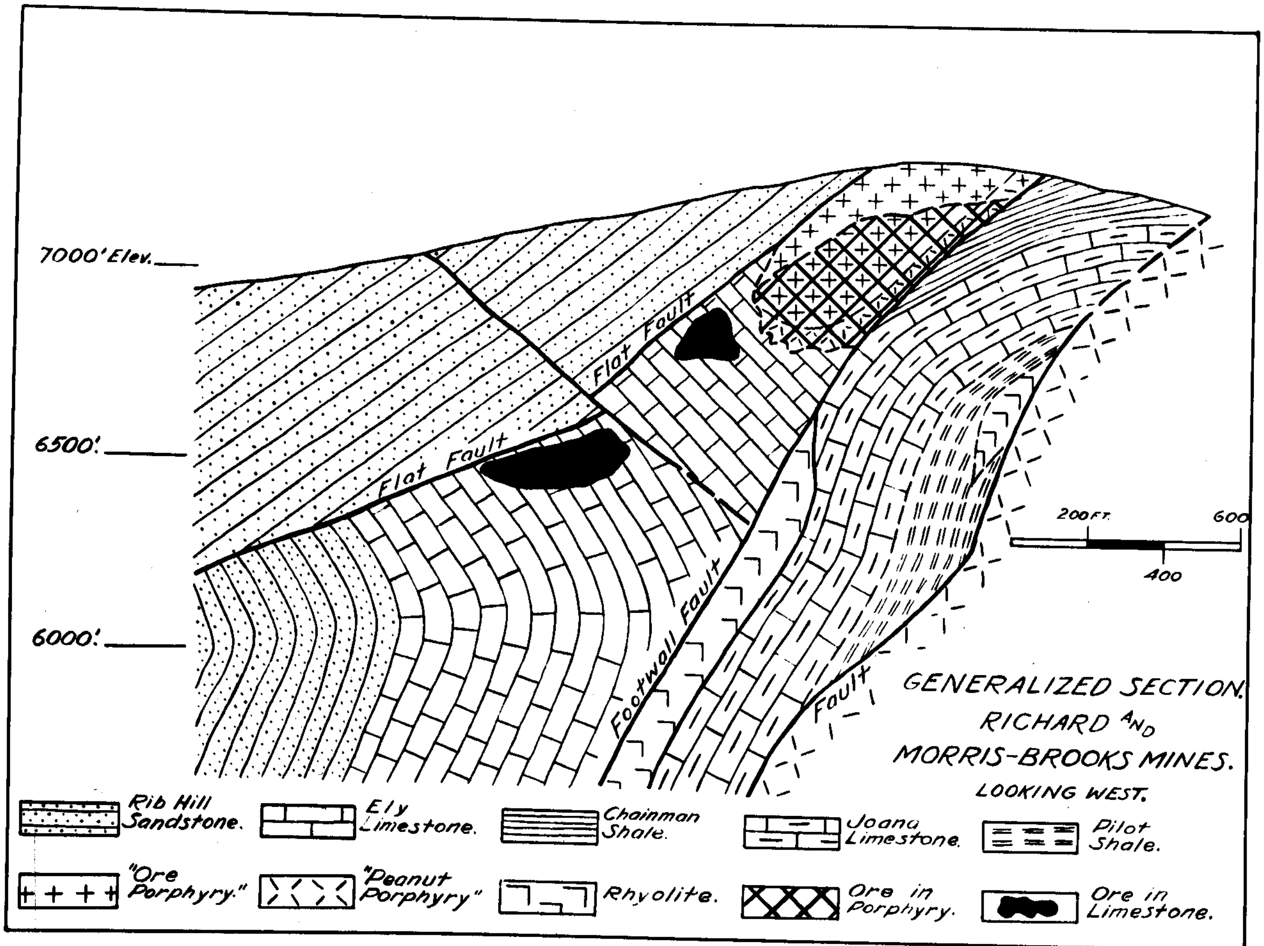


Figure 5.

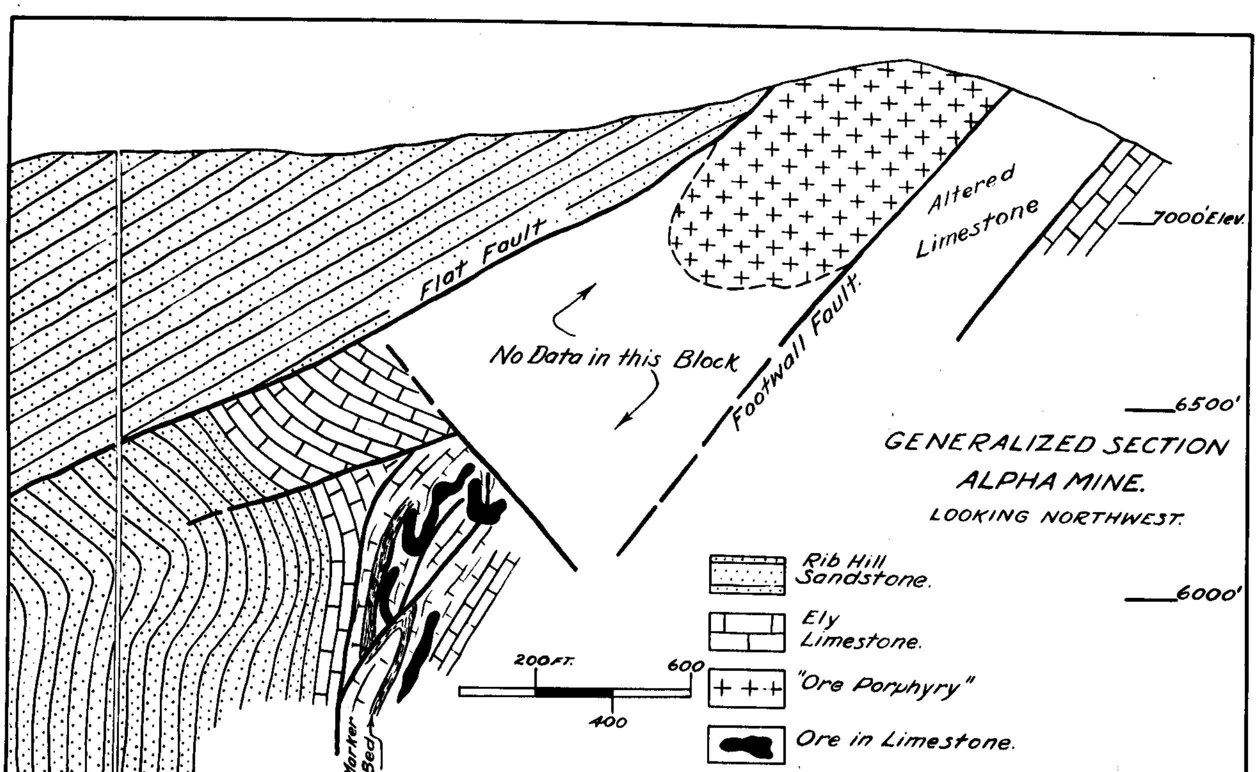


Figure 6.

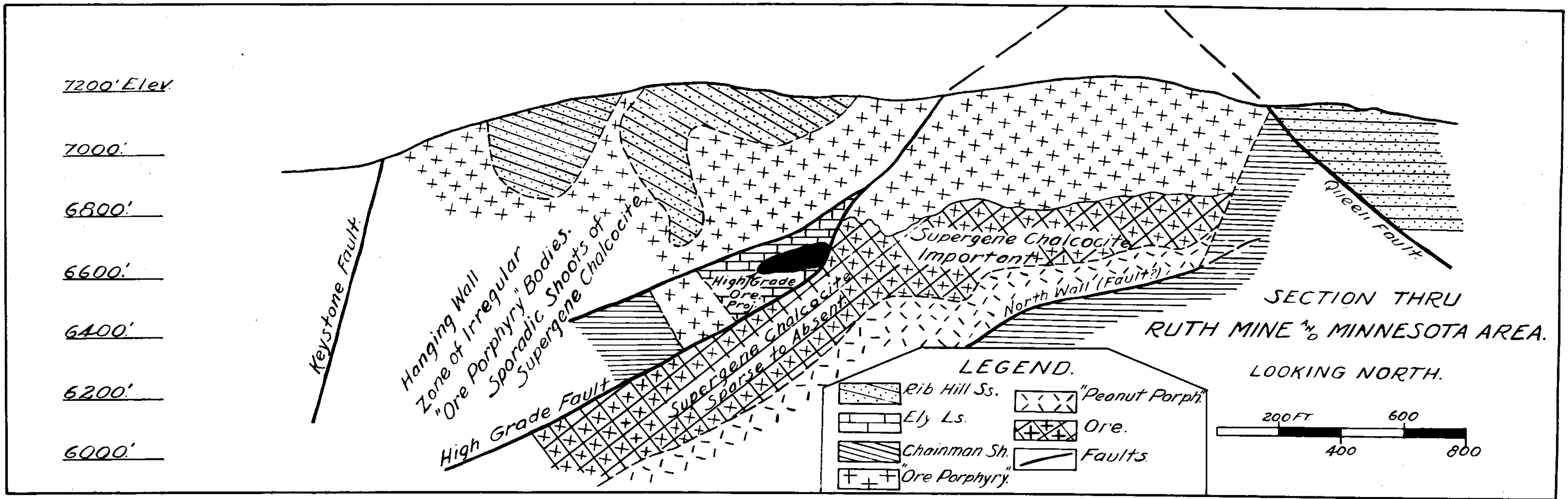


Figure 3.

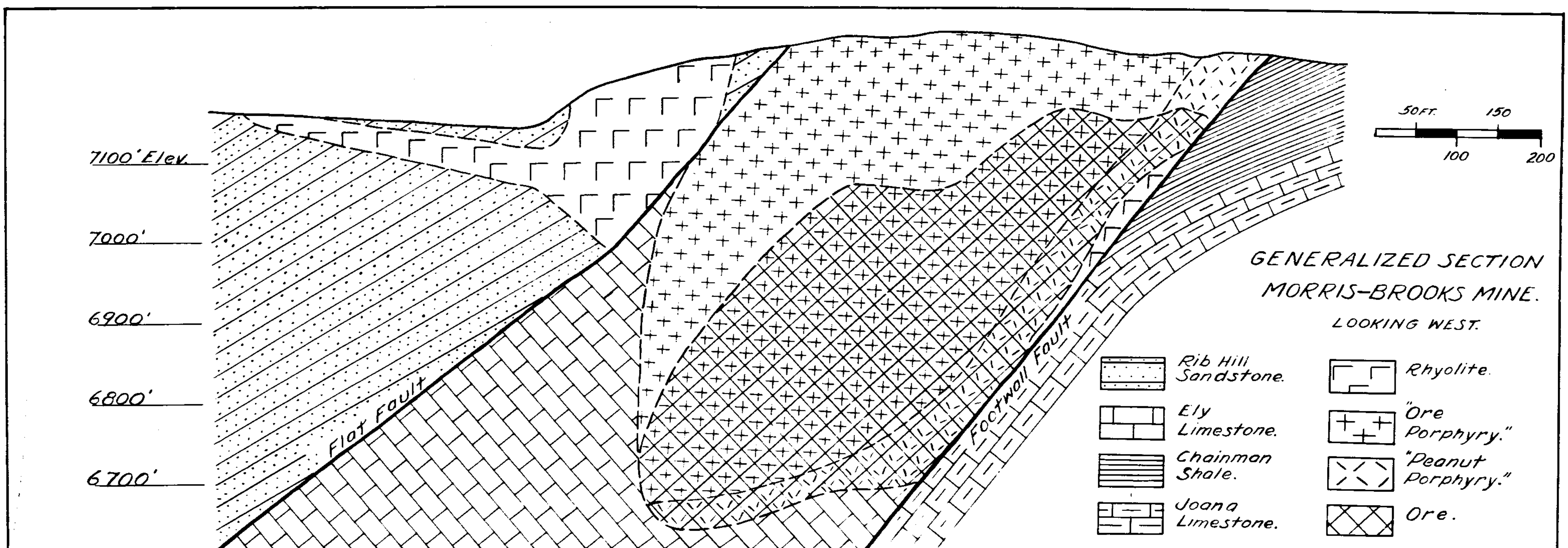


Figure 4.

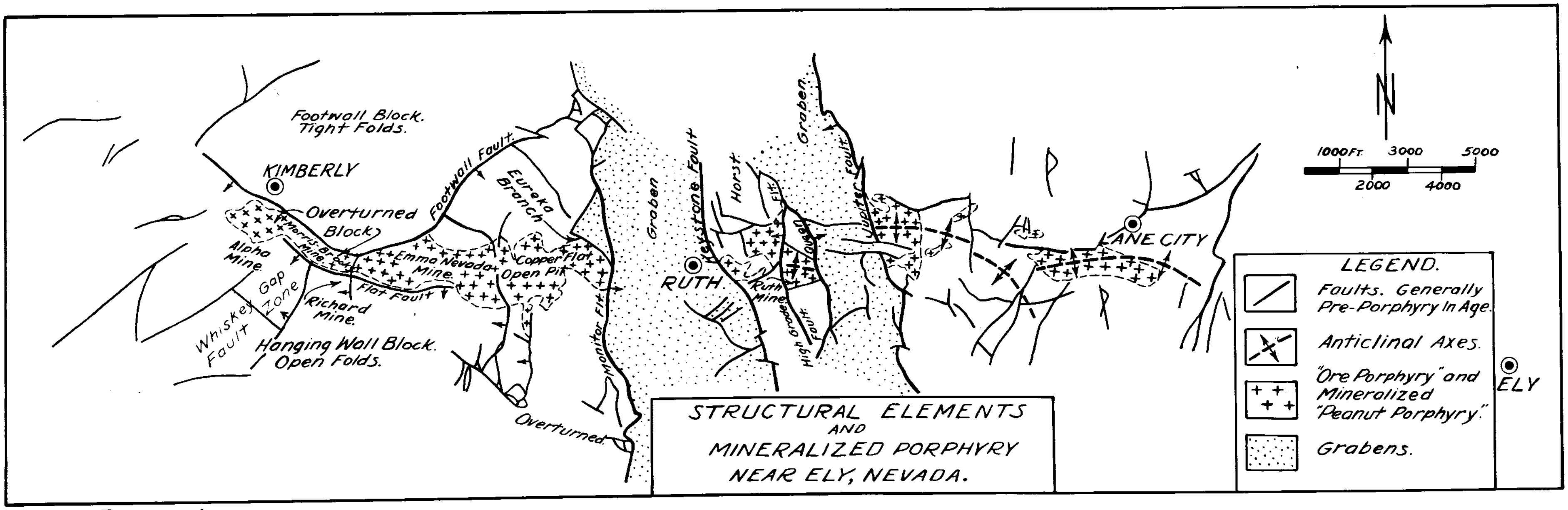


Figure 1

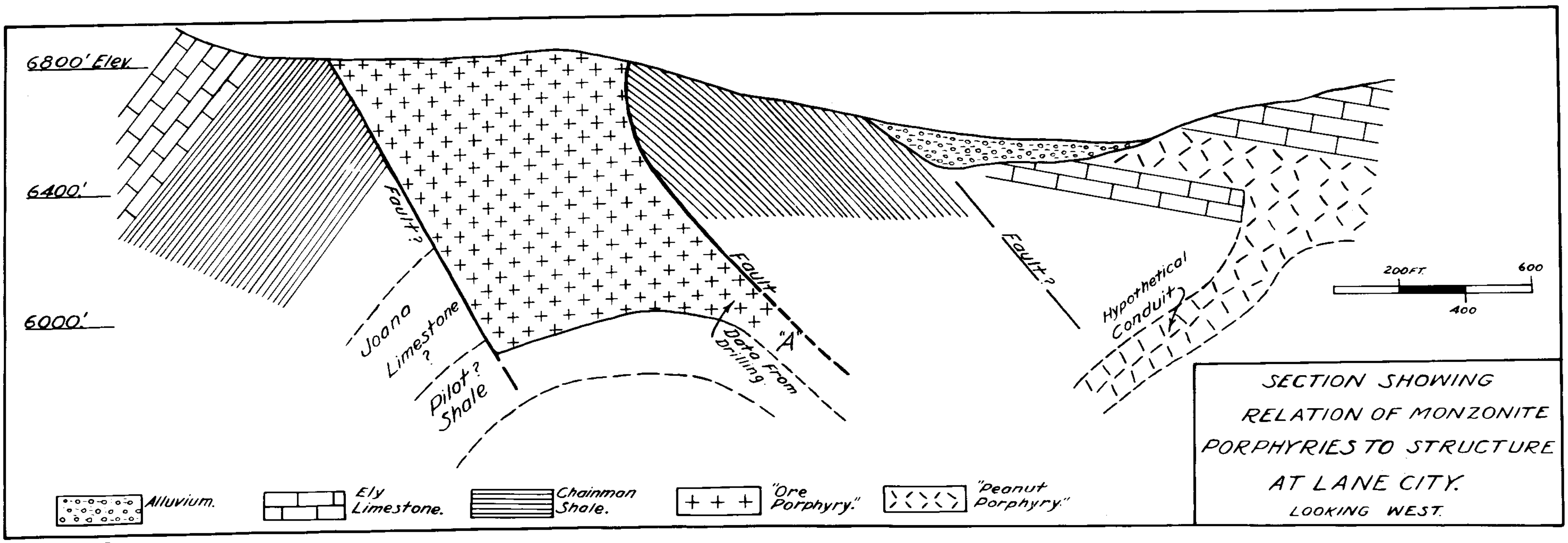
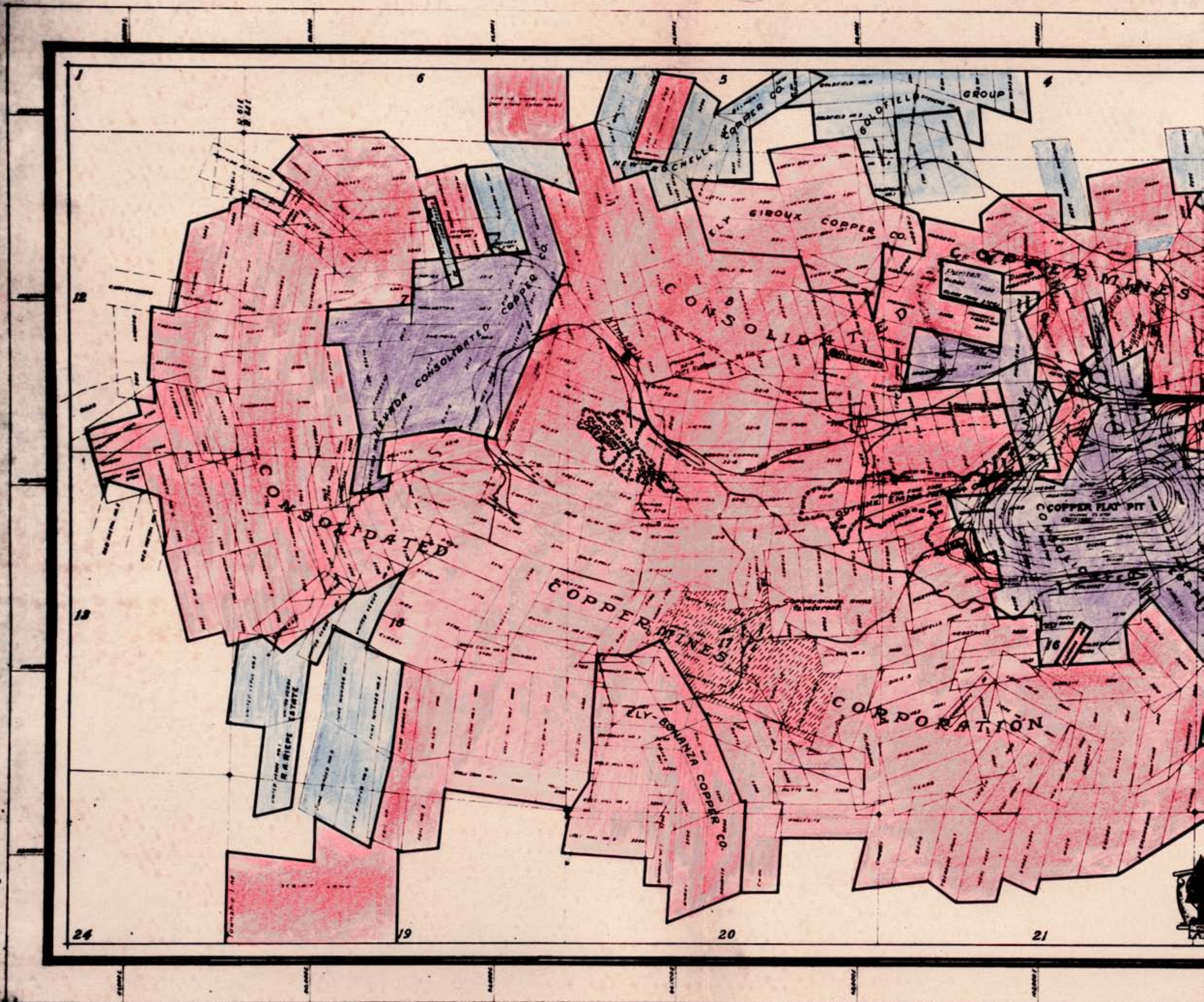
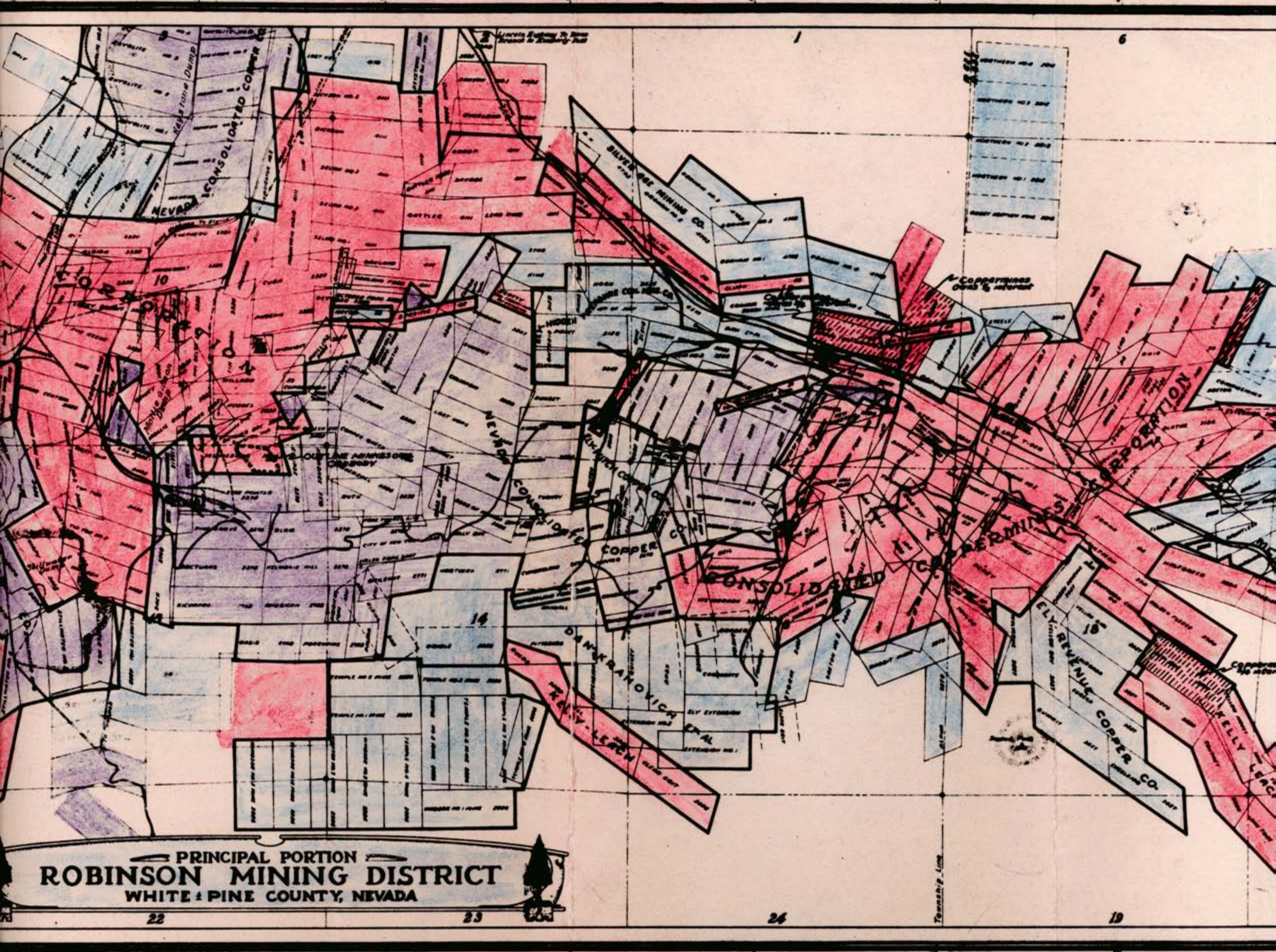


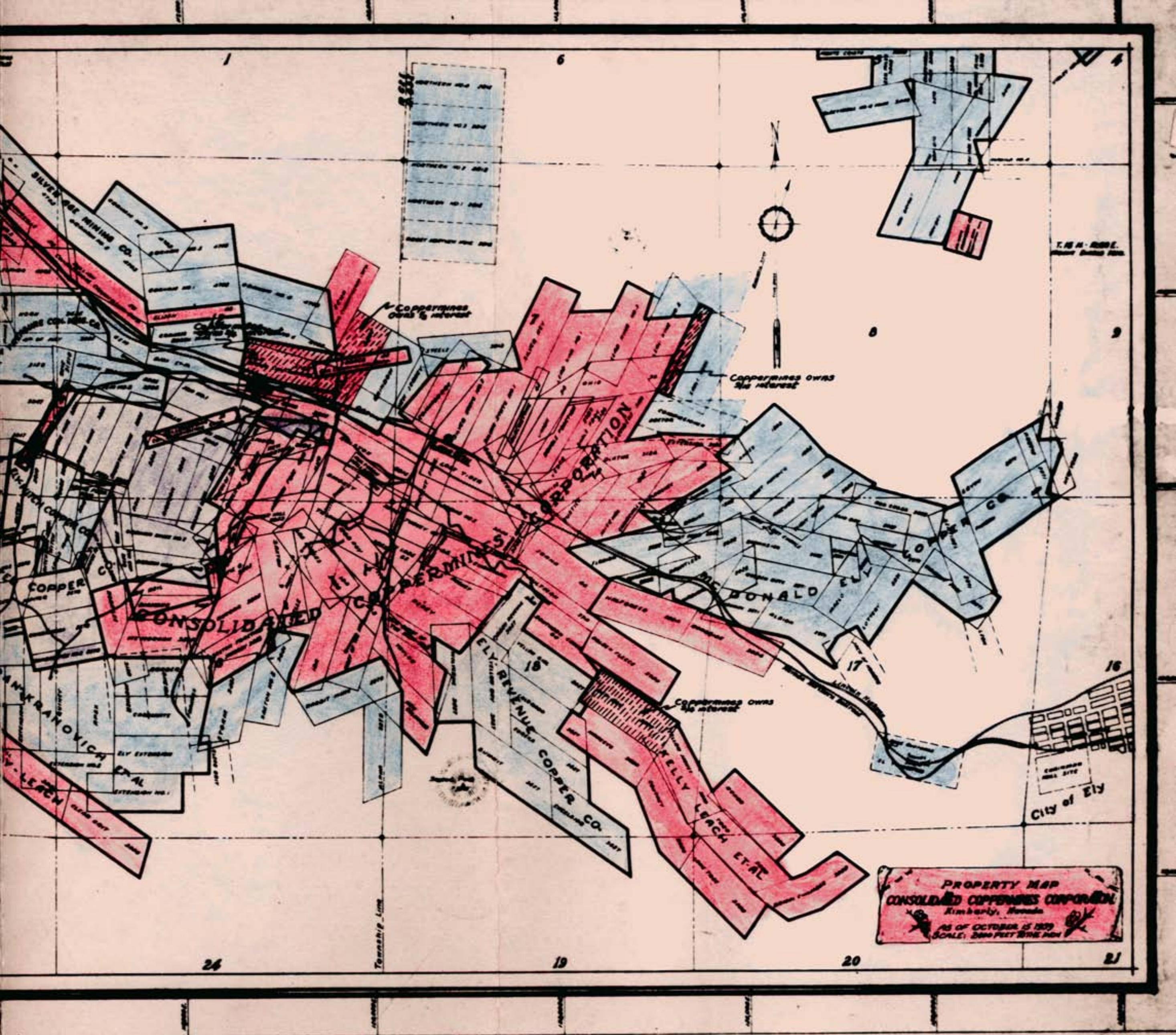
Figure 2.

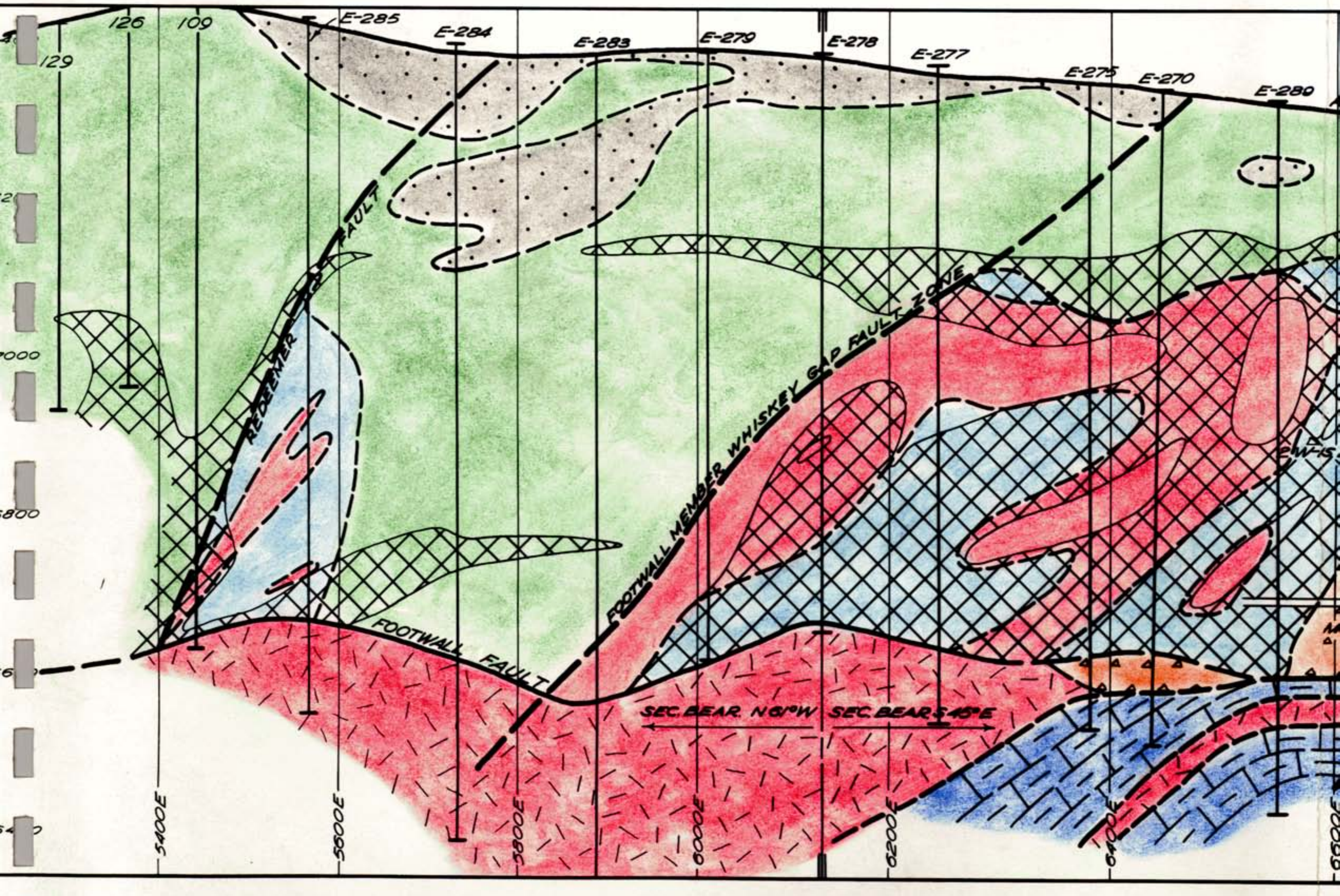


NEW ROCHELLE COPPER CO.
GOLDFIELD
GROUP
ELY GIROUX COPPER CO.
CONSOLIDATED
NEVADA CONSOLIDATED COPPER CO.
CONSOLIDATED
COPPER MINES
CORPORATION
ELY-BONANZA COPPER CO.
COPPER FLAT PIT
R.R. RIEPE ESTATE
1
6
5
4
12
7
8
13
18
17
16
24
19
20
21



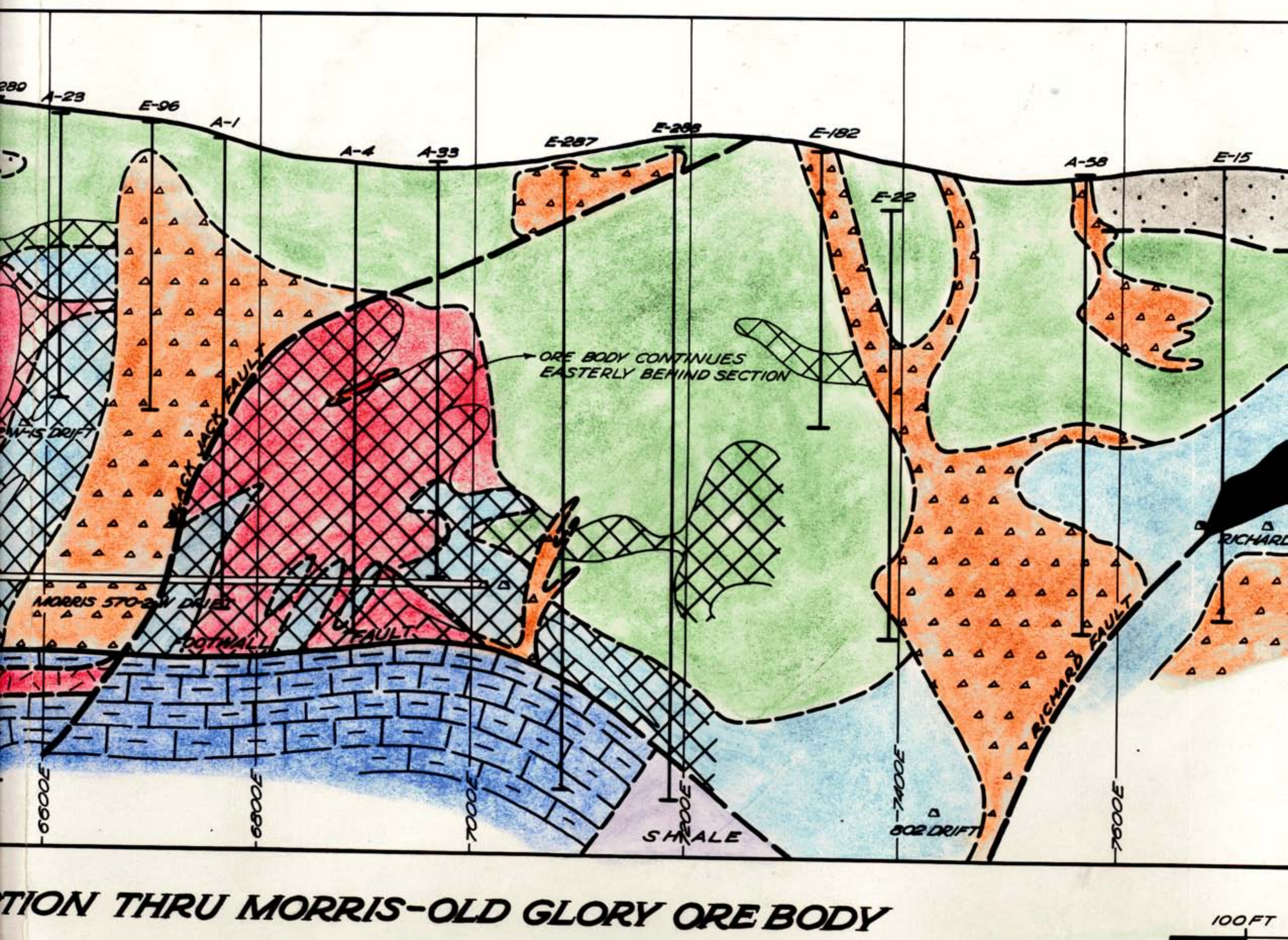
PRINCIPAL PORTION
ROBINSON MINING DISTRICT
WHITE PINE COUNTY, NEVADA
NEVADA CONSOLIDATED COPPER CO.
CONSOLIDATED COPPERMINES CORPORATION
ELY REVENUE COPPER CO.
DAN KRANOVICH ET AL
KELLY-LEACH
Keystone Dump
Township Line
1
6
10
14
18
22
23
24
19


PROPERTY MAP
CONSOLIDATED COPPERMINES CORPORATION
Kimberly, Nevada
AS OF OCTOBER 15
CONSOLIDATED COPPERMINES CORPORATION
SILVER AGE MINING CO.
ELY REVENUE COPPER CO.
McDONALD ELY COPPER CO.
KELLY LEACH ET AL
Coppermines owns ½ interest
Coppermines owns ½ interest
Coppermines owns ½ interest
Township Line
City of Ely
1
6
4
8
9
17
16
18
24
19
20
21



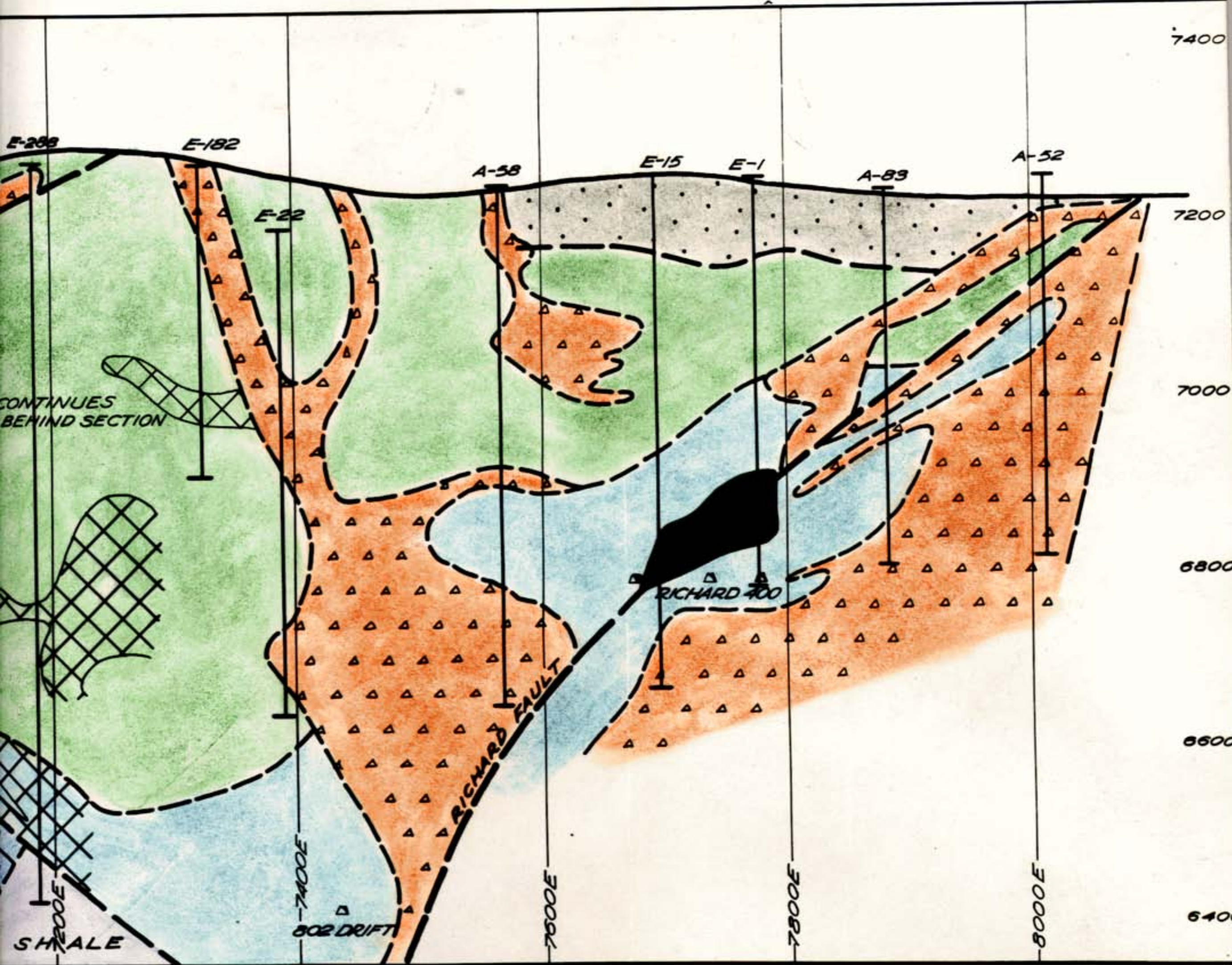
LONGITUDINAL SECTIO

SECTION NO. 3



TION THRU MORRIS-OLD GLORY ORE BODY

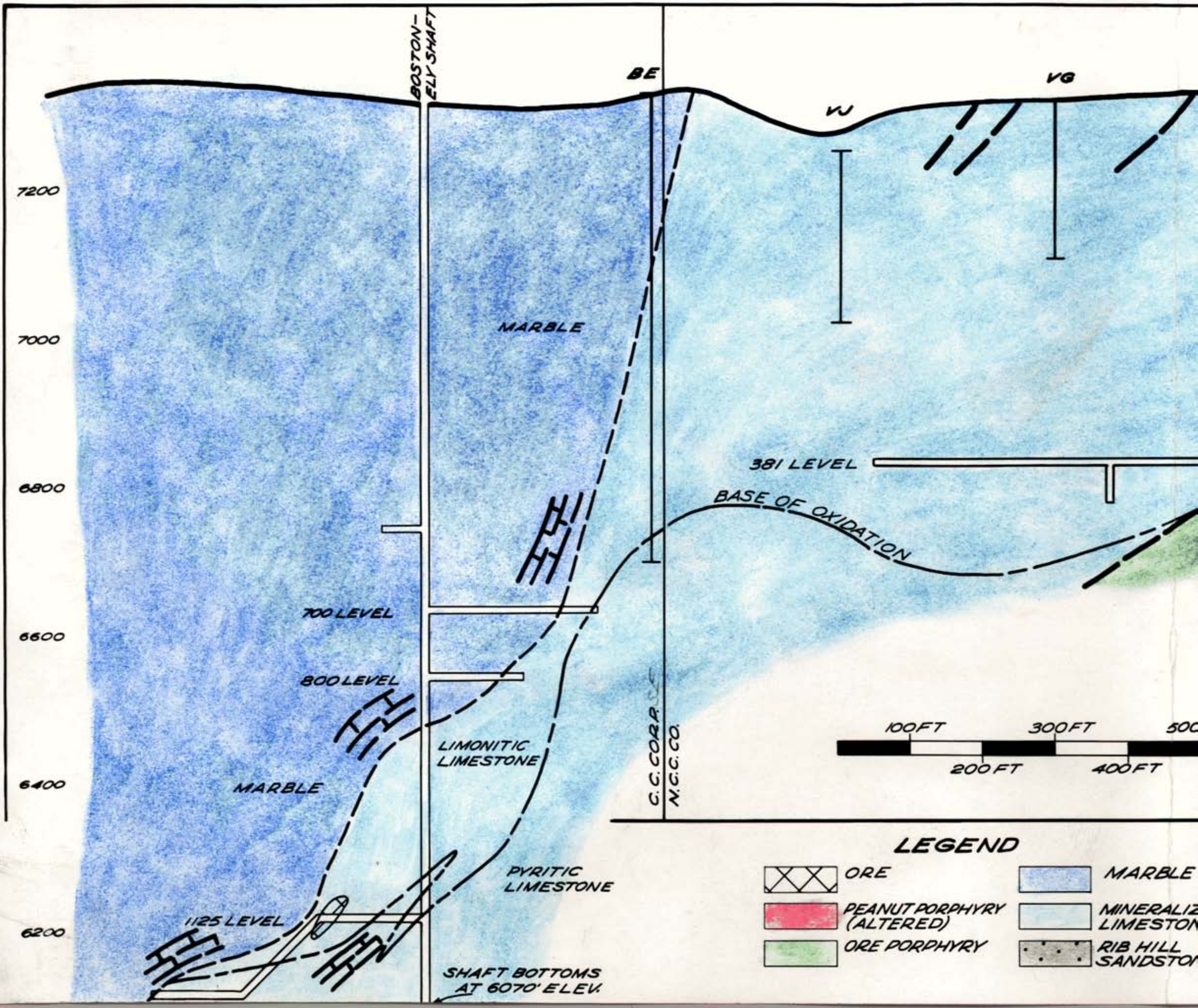
LOOKING NORTHERLY



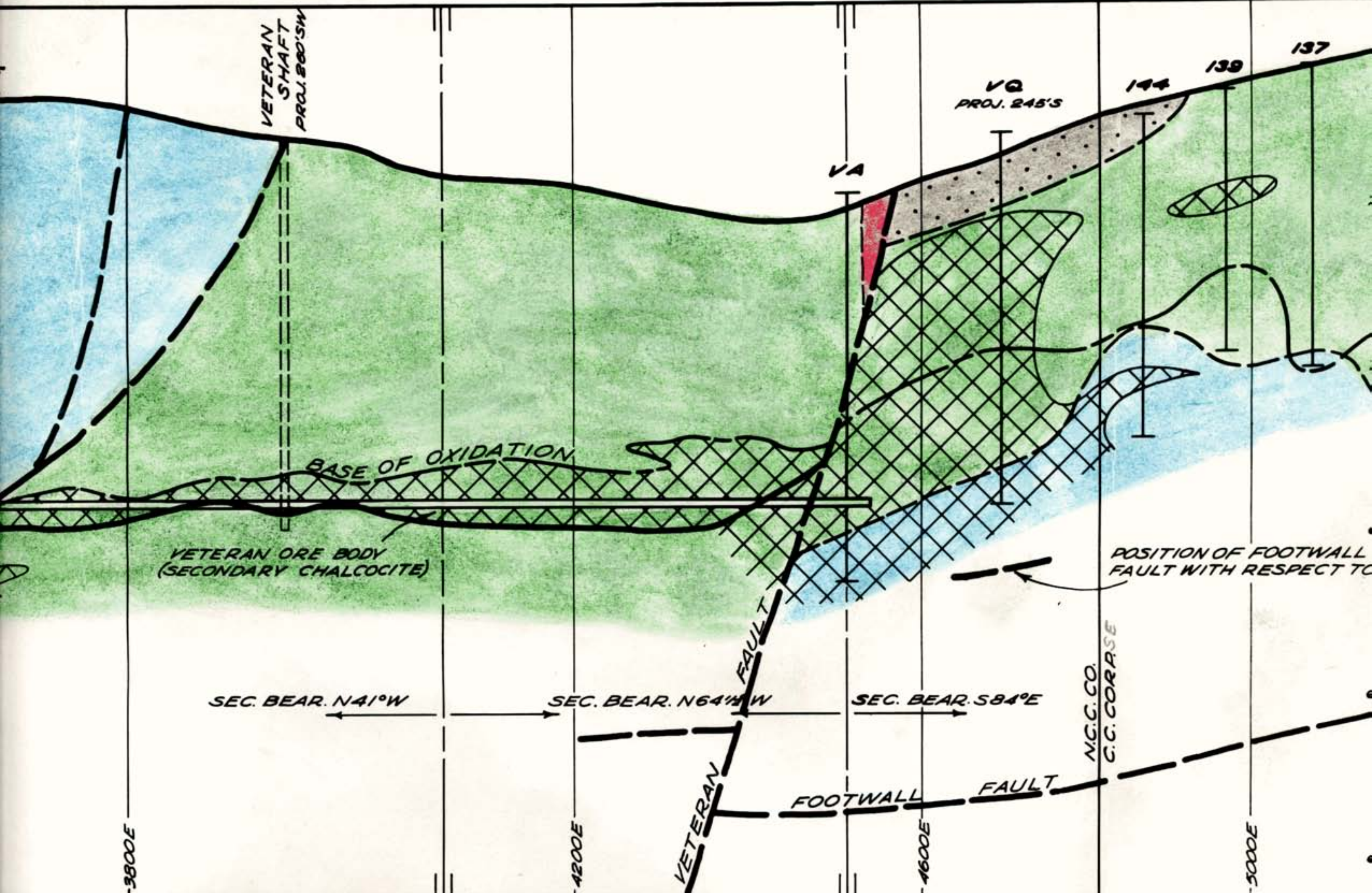
RY ORE BODY

100 FT 300 FT 500 FT
200 FT 400 FT

Z-398
S.C. #9
3950 0002



BOSTON-ELY SHAFT
BE
VG
VJ
7200
7000
6800
6600
6400
6200
MARBLE
381 LEVEL
BASE OF OXIDATION
700 LEVEL
800 LEVEL
LIMONITIC LIMESTONE
MARBLE
PYRITIC LIMESTONE
1125 LEVEL
SHAFT BOTTOMS AT 6070' ELEV.
C.C.CORR.
N.C.C.CO.
100FT
300FT
200FT
400FT
LEGEND
ORE
PEANUT PORPHYRY (ALTERED)
ORE PORPHYRY
MARBLE
RIB HILL



SECTION THRU
VETERAN ORE BODY AND BOSTON-ELY SHAFT
(EXTENSION OF MORRIS-OLD GLORY LONGITUDINAL SECTION)
LOOKING NORTHEASTERLY

3950 0026 SC#