REPORT ON THE GEOLOGY OF THE WALKER DISTRICT, YAVAPAI COUNTY, ARIZONA, WITH A DETAILED DESCRIPTION OF THE SHELDON MINE AND ORE

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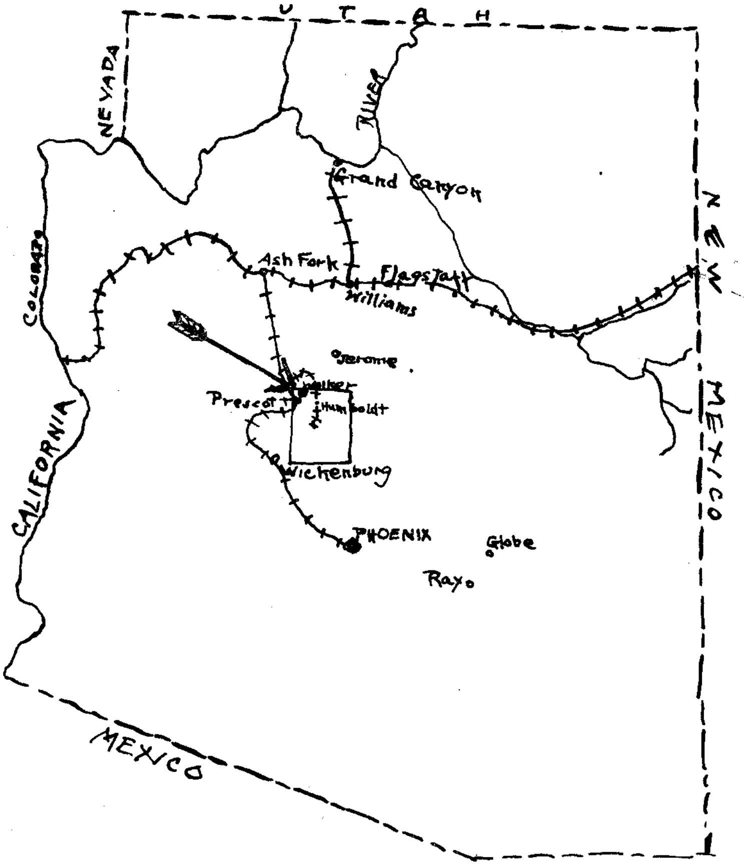

Index Map of Arizona Showing Location of Walker in Northwest Corner of Bradshaw Mountains Quadrangle.

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This thesis is submitted along with eleven thin sections, six polished sections, and three trays of specimens collected in the field.

MAPS AND ILLUSTRATIONS

Maps:--

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PART ONE

GENERAL GEOLOGY OF AREA

INTRODUCTION

The area to be treated in this report is the property of the Sheldon Mining Company, located at Walker, Arizona, about sixteen miles by road from Prescott. Walker will be seen in the extreme northwest corner of the Bradshaw Mountains quadrangle. ~~(See Pl.)~~.

The Sheldon property consists of forty two patented adjoining claims, and extends roughly for about a mile and a half in a southwesterly direction from the town of Walker. The elevation at the Sheldon head-frame is 6500 feet, but the whole district is very hilly, and at places in the area studied, the elevation was roughly estimated at close to 6900 feet. A photographic enlargement of the area made from the U. S. G. S. Topographical map, prepared by Jaggar and Palache in 1902, proved inaccurate for such a small area, and hence of no use for my purposes. As a crude makeshift, I have sketched in the major topographical features on a small claim map, which accompanies this report. (Pl. I). Elevations as well as distances are all estimated only.

In general, the topography consists of many rounded hills, anywhere from two hundred to four hundred feet high in a valley between two higher sets of hills on the northwest and southeast. This valley has been formed by Lynx Creek, a locally famous (in former years), placer stream, which has its headwaters in this region. The evenly rounded shape of the hills is charateristic of the way in which the grano-diorite of this area weathers.

The climate of the Walker district might be termed arid, with a fair amount of rainfall. I have been there both in the summer and winter. A hot summer day may find the thermometer in the nineties, whereas, it will drop to the low forties at night. But the heat is not depressing, due to the dryness of the atmosphere. On the other hand, when I was out there in December, though the temperature was cold, it was not uncomfortable to work wearing only a couple of light sweaters.

Being exclusively a mining district, there is no agricultural development. Walker is, on the other hand, dependent for its existence upon mining activities in the region. The hills are all more or less overgrown and wooded, although practically all the trees of any considerable size have been cut for timbering purposes in the mines. At present, the Sheldon imports Oregon lumber for its timbering.

Walker is reached from the Black Canyon Highway, (Prescott to Phoenix), by about nine miles of dirt road, maintained by the state, and kept in a fairly good condition the year round. This same road, if followed, continues over the mountains to Prescott, but has fallen into disuse past the Victory workings and the Ninety Seven claim, and is impassable for an automobile. About thirty years ago the A. T. & S. F. commenced the Poland tunnel, 8500 feet in length, between Poland and Walker. They abandoned the undertaking, however, and the tunnel was completed about 1904 by private interests. In 1922 Sheldon Mining Company bought the Poland tunnel; so now the ore is taken through the tunnel by means of a narrow-guage train, with gasoline locomotion, to a branch of the Atchison at Poland.

PURPOSE OF THE REPORT

In this report, it will be my purpose to try to put forth:

(1) A description of the geology of the district as seen on a trip there in December Of 1930.

(2) A description of the Sheldon mine proper, the mining methods employed, and the concentration and smelting of the ore, etc.

(3) A description of the country rocks and ores as determined by microscopic study, conducted at the laboratory at Princeton University, of thin and polished sections from specimens taken in the field.

(4) Recommendations for further development on the property as determined from the above study.

In preparation of this report, I have been very considerably dependent on aid from outside sources. George A. Packard, who had been engaged to conduct a similar geologic survey for the company, was just finishing his work when I visited the property, and I am indebted to him and his assistant, Mr. Maury, for valuable assistance in the field. In their work, they had mapped out and marked all the cuts, shafts, tunnels, outcrops, etc., and this convenience was invaluable to me. Furthermore, I am grateful to officials of the company and to the manager, George D. French, for much information regarding the mining methods, mill flow sheet, etc., and to W. J. Casey for information regarding the mining history of the region.

Waiting for the "skip" at the Sheldon head frame. Right to left: Mr. French, mine superintendent; Joe Groves, chief mechanic; Mr. Packard; Mr. Lecklider, mine assayer; Mr. Maury, assistant to Mr. Packard; and the author.

ADVANCE SUMMARY OF GEOLOGY

For the most part, the claims of the Sheldon Mining Company are all situated in grano-diorite of doubtful age. There has been much discussion as to the probable age of the grano-dioritic rocks which occur in several large irregular intrusive masses in this vicinity. The generally accepted opinion, however, seems to be that they are the youngest intrusive masses in the quadrangle. (Cf. Bull. 782). Lindgren states that the pre-Cambrian of Arizona contains few, if any, rocks of this character, "but the rock agrees closely with the intrusives of Jurassic of later age which are so abundant in the western coast region of North America. The probability is strong that these masses were intruded in Cretaceous or early Tertiary time." This quartz diorite is known to be the youngest plutonic in the region, because it shows intrusive contacts with all the known pre-Cambrian rocks.

I was unable, in the limited amount of time I had, to further investigate this question, and I am merely re-stating the views of Jaggar and Palache and Lindgren in the above paragraph.

The quartz diorite above embraces all the southwestern claims which were studied, but to the north, the Yavapai schist is encountered in the vicinity of the drying plant. No definite line of contact was established between the two. It was found instead, that the gradation from the quartz diorite to the schist is a very irregular one. The grano-diorite extends several hundred feet on the road north of the drying plant before the schist is encountered, where tongues and isolated blocks of schist were traced as far south as the middle of the Eureka claim.

The third and last type of rock encountered was a dike of rhyolite porphyry, forming the hanging wall of the vein along which T9 has been cut, and striking about N 60 E. It apparently pinches out somewhere near T9, as it was not observed to continue on the south side of Accidental Gulch. The dike is about 50 feet wide and was followed for at least 200 feet to the Mudhole shaft to the north (S 10).

The entire area is covered by innumerable veins, with many branches and splits. In general, these are ordinarily divided into four major groups, - the Sheldon, the Eureka, the Capital and the Mudhole. They are all so intricately inter-woven that it is often difficult to ascribe a vein to any one system, as it might belong to either one. The veins all have a general, or average strike of about N 50 E.

No important faulting or slippage was observed in the grano-diorite; in truth, the absence of the effects of any strain is characteristic of this rock, and is one of the reasons for believing it to be a younger intrusive.

A more complete description of the various rocks, including data as to their mineral composition, will be included in a later chapter.

MINING HISTORY OF DISTRICT

Lynx Creek is famous for its placer operations, which date back to about 1862. Piles of dirt along the road bear out this fact. The gold placer values are located in the Quaternary gravels and are supposed to be derived from the disintegration and weathering of post-Cambrian veins in this district.

Much gold has been panned along Lynx Creek opposite the Eureka claims, and Mr. Casey states that the largest nugget of which he knows was worth $80. Placer operations have continued intermittently along Lynx Creek up to the present day. The total placer output since 1862 is put at about $1,000,000.

Mining was carried on in very early days on the Fortune claim, and gold ore assaying $300 to the ton was taken from the Sheldon vein. Of course, this mining was carried on long before the days of wagon transportation in Walker. The ore was packed to the mill, which was an arrastra ~~araster~~. There were three of these ~~arasters~~ along the Sheldon vein. The one which was located near the site of the present Sheldon headframe was run by a man by the name of Shelton for a number of years. These ~~arasters~~ consisted of flat rocks on the floor, and standing on end for the sides, with similar rocks for drags for drushing the ore.

In 1893, when the price of silver dropped, men came from Colorado to Arizona, many of them to Walker. They leased the Sheldon holdings, at that time owned by Judge Griffen. The Fortune shaft was sunk at this time to a depth of 100 feet, and another one to a depth of 90 feet. The ore from these shafts ran, probably, about $35., gold and silver, to the ton. The copper was not recovered. The ore was milled at a ten-stamp mill near the shaft and good results were obtained till the water level was reached in the mine.

Work was similarly carried on in the early days on the Eureka claims, and milling was done at a three-stamp mill a little below the site of the Sheldon tailings pond.

The Mudhole shaft was started in 1897, but closed down in 1903, on account of labor trouble. That is the reason the mine was not protected at the time they closed. The pumps were pulled to the surface, and the mine filled up to the tunnel level. It was reopened in 1908, but the ore that had been in the mine at the time of the shutdown was a total loss. Some mining was done, however,—enough to pay for about one-third the cost of reopening. It was abandoned again after two years.

Besides the workings mentioned above, there have been countless other workings in the district, that were carried on previous to 1915. The numerous cuts, shafts, and tunnels to be described below bear out this fact.

The present Sheldon shaft was started by the Sheldon Mining Company in the fall of 1919. The shaft was sunk to the 450 level, and the prospects seemed to warrant further sinking to the 650. In 1924, the mill was built, and the shaft sunk further to the 850 level. Operations were then carried on for two years, mining about 26,000 tons annually. At this time the mine shut down, and, during the rather poor copper market, took the oportunity to enlarge to a three compartment shaft, and to sink another 400 feet, which took about three years. Operations were resumed in 1929 on the basis of about 150 tons per day, till the summer of 1930, when mine was again closed due to the low price of copper.

Geologically, the area has been studied by Jaggar and Palache in 1902 (1); by Waldemar Lindgren in 1922 (2); and by George F. Packard and Mr. Maury in the fall of 1930 (3). Also, several mining engineers, such as W. V. deCamp, of the United Verde mine; Julius Kruttschnitt of the A. S. & R. Co.; and George M. Colvocoresses, have studied the Sheldon Mine and surrounding property.

(1) Bradshaw Mts. Folio (No. 126) U.S.G.S.
(2) Report on Geology of Yavapai Co. (Bull. 782, U.S.G.S.)
(3) Report on Property of Sheldon Mining Co., 1931

DETAILED DESCRIPTION OF THE VEIN SYSTEMS

As stated above, there are four major vein systems. They show up quite plainly if the outcrop map (Pl. II) is consulted. It will be seen from this that the Sheldon vein continues in a good clear-cut line, (with minor splits), for a distance of at least 7000 feet, and the contention is that the vein continues still farther to the south, altho I did not trace it further than the Ninety Seven claim. The surface croppings of the Capital system, however, are only traceable for about 3000 to 3500 feet on the Capital and First No. Extension Capital claims. What I will term as the Mudhole system is a set of two parallel veins on either side of a rhyolite porphyry dike which runs through the Golden Fleece, Snow Flower and Gold Belt claims. The Eureka, on the other hand, is not such a clear-cut vein as the three mentioned above, but rather consists of an intricate maze of veins with many splits, further complicated by small veins formed at the contacts between the grano-diorite and the many included blocks of schist prevalent in this area.

SHELDON SYSTEM

The Sheldon vein is a vein averaging from three to four feet wide, with a general strike of about N 50 E and dipping averagely about 71 to the southeast. The walls are of grano-diorite, and in general are quite strong. A mistake as to the proper calculation of the dip of the vein by the man who started sinking the present Sheldon shaft has cost the company much money in the later deep workings. He commenced the shaft on an 80 degree angle, the dip of the vein at the point where he started, but did not take into account the fact that it soon flattens to about 70 degrees, thus necessitating cross cutting to the south more and more on each succeeding level downward.

A considerable amount of mining has been done on various parts of the Sheldon vein, as is evidenced by numerous shafts, tunnels, cuts and assessment holes all along the croppings of the vein, not to mention the old Fortune shaft, as well as the Victory mine (T4), which has been working up till comparatively recent times. This mine, located on the Independence claim, does not belong to the company.

A cross section of the terrain, showing the location of croppings on the Sheldon vein accompanied this report, (Pl.III). It is taken after the report of Mr. Packard. In conjunction with Mr. Packard's work there, Mr. Lecklider, the company assayer, has assayed samples from practically all the outcrops shown, and I will include them wherever important in the ensuing detailed description:

S2 - This is the original Sheldon shaft, (the No. 1), sunk to a level of 207 feet about the year 1904. It is vertical; mining was carried on essentially for the gold and silver values present near the surface.

R1 - (Short Cut). Vein here two to three feet wide. An old raise to the surface, probably from the No. 1 shoot. Dips 90 SE.

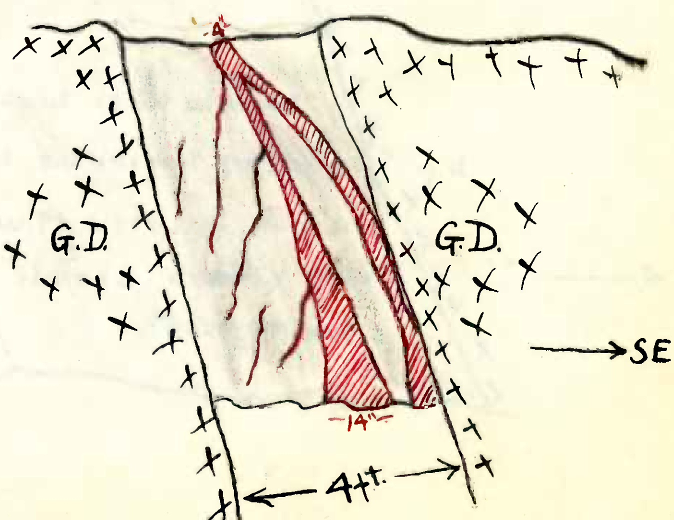
S1 - (Champion). An old vertical shaft, inaccessible, supposed to be 110 feet deep.

T1 - (Shelton). This tunnel was opened up for inspection after I left, so I shall quote Mr. Packard in part: "This tunnel shows four narrow seams of quartz in grano-diorite. There is considerable copper carbonate, oxide, as well as chalcopyrite and chalcocite. The tunnel follows two seams for about 50 feet, beyond which there is only a single seam, but a split going out from the southeast wall is encountered in a crosscut beyond, and drifted on to the face, which is 130 feet in. There was considerable stoping in these narrow seams which must have yielded ore of good grade in order to make it pay."

C3 - (Shelton). The vein here is four to five feet wide and looks pretty good. It seems to be narrow at the top with a good chance of widening lower down, both from the appearance and the fact that there is porphyry on either side. This porphyry is shot with numerous quartz stringers, mainly coming off on the northern side, or footwall. Strike, N 45 E; dip, 75 SE. A sample taken here, 48" wide, a honeycomb quartz, assayed:

Gold	-	.09 oz.
Silver	-	12.18 %
Copper	-	.18 %

C3



C2 - A cut, a few feet to the south, seeming to bear out the idea that the vein appears to widen out here.

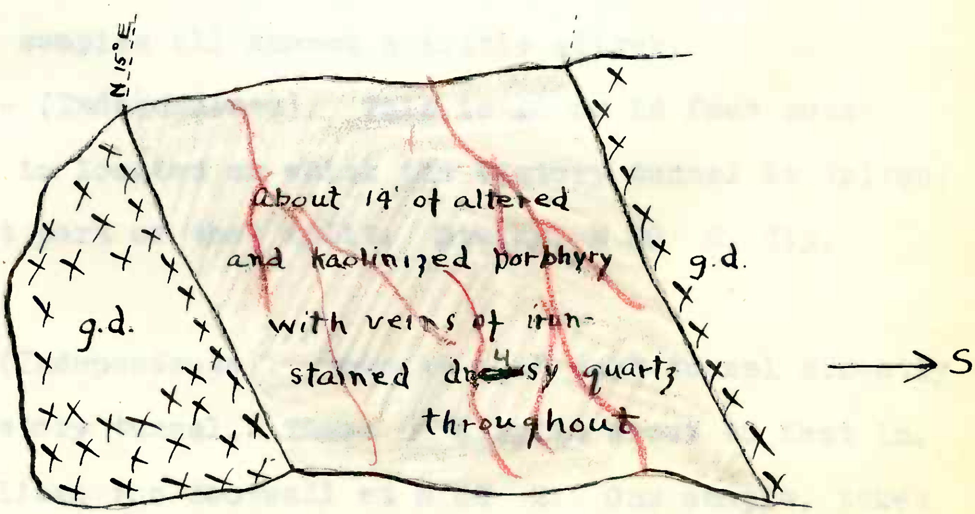
C4 - (Shelton). This is a cut showing a 20x10x5' face, striking N 25 E, dip, 72 SE. A sample assayed, .7 oz. silver, and a trace of gold.

C5 - A face, which does not show up the vein well, hence no data.

C6 - (Shelton). A 20x10x2' face. Strike was doubtful, possibly N 10 E, and dip 80 SE. This seems to be too far removed from the strike of the Sheldon vein to be a part of it. A sample eight inches wide on the southeast side, assayed, gold, .36; silver, silver, 5.36, copper, .20.

C7 - This is a large cut, about 40 feet deep, and 15x15' for the other dimensions. The vein is very wide here, about 14', at least, largely of kaolinized materials with several streaks of better material running through it. Five samples were taken along this face, but none of them showed any appreciable values. Strike, N 15 E, dip, about 70 E.

C7



T2 - This is a tunnel, which goes into the hill about 30 feet southwest of C7. The interior of it was inaccessible, but the strike was computed to be about N 15 E, and the dip, 60 E. The dump showed some rock which seemed to be a very weathered (or acid) phase of the grano-diorite. It was impossible to tell whether this came from the foot or hanging wall of the vein.

C8 - (American Flag). A cut, 8x7x4', striking about N 40 E, dip 75 SE. A 5 inch sample assayed, .72 silver. Mr. Packard thinks this is probably the Independence split of the Sheldon vein.

C8a - Probably an assessment hole in the hanging wall of vein.

C9 - A 7x3x2½' cut, which does not show much of anything.

C10 - A dubious cut from which no definite data could be obtained.

C10a - A cut which should be about directly above the end of the Victory tunnel. The strike seemed to be N 30 E, and dip 80 SE. Four samples all showed a little silver.

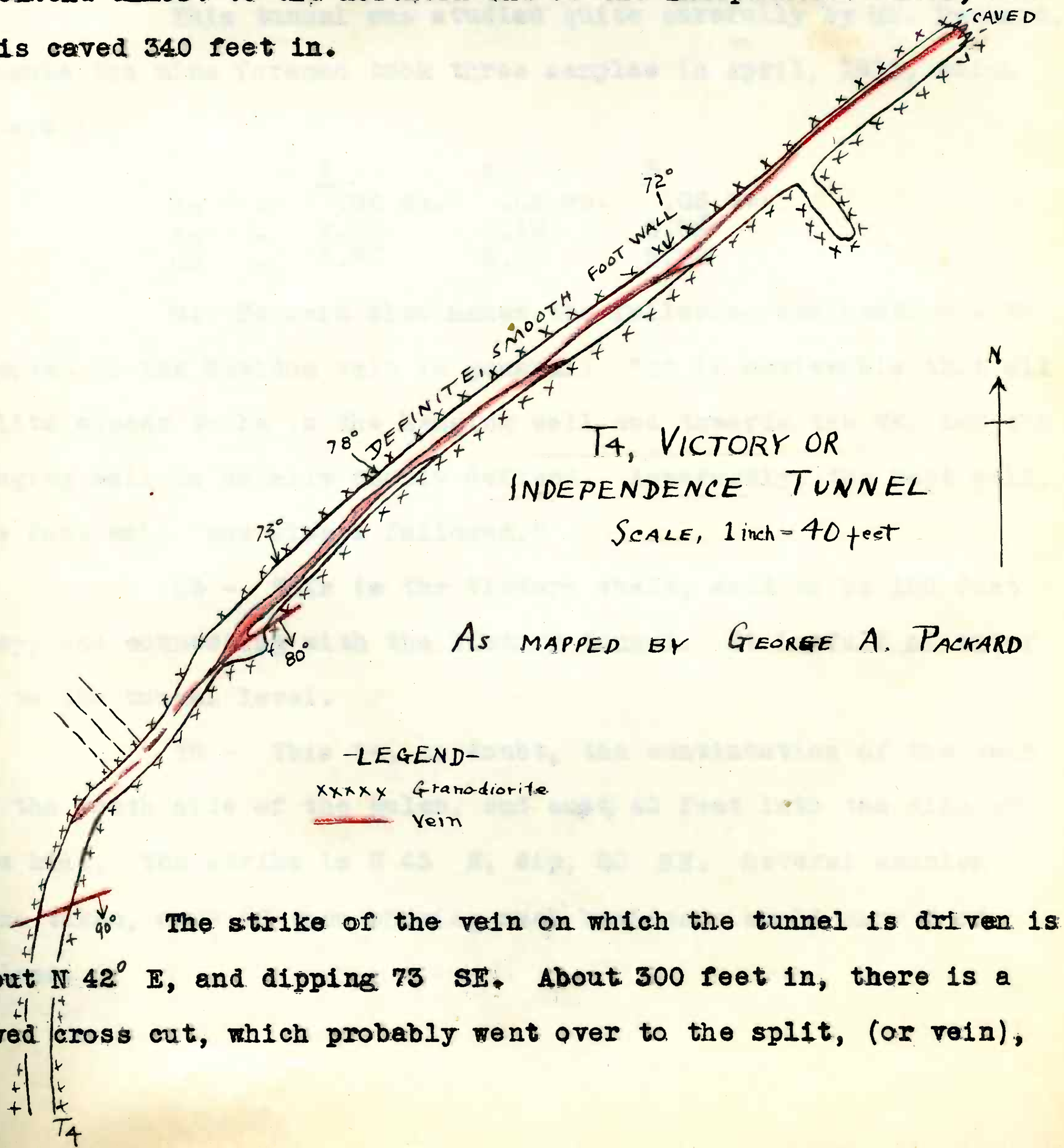
C10b - (Independence). This is 10 or 16 feet south of where the vein is located on which the Victory tunnel is driven; so probably is not part of that split. Strike, N 30 E, dip, 70 S.

T3 - (Independence). This is a 65 foot tunnel directly above the main Victory tunnel. There is a split about 45 feet in, but the tunnel follows the footwall at N 32 E. One sample, taken 45 feet in, assayed:

Au - .66 oz.
Ag - 4.44 %
Cu - .62 %

Mr. Packard believes that the split, occurring 45 feet in, and which goes in to the hanging wall at N 40 E, may show in C9 and C8b.

T4 - (Independence). This is the main Victory tunnel. As will be seen from the vertical projection, this tunnel is said to extend almost to the northern end of the Independence claim, but is is caved 340 feet in.



The strike of the vein on which the tunnel is driven is about N 42° E, and dipping 73 SE. About 300 feet in, there is a caved cross cut, which probably went over to the split, (or vein), which crops at C10b. About 60 feet in, there is a small vein, probably splitting from the main vein somewhere to the south, and striking N 20 E, with a dip of 90 S. See sketch.

Several samples were taken at different points along the tunnel, the best assaying:

Au	-	Tr.
Ag	-	2.14%
Cu	-	3.71 %

This tunnel was studied quite carefully by Mr. Packard, because the mine foreman took three samples in April, 1930, which assayed:

		1	2	3
Au	-	.06 oz.	.02 oz.	.03 oz.
Ag	-	7.2%	2.1%	5.3%
Cu	-	3.9%	3.5%	3.8%

Mr. Packard also makes the following observation with respect to the Sheldon vein in general: "It is noticeable that all splits appear to be in the hanging wall and towards the NE, and the hanging wall is usually poorly defined. Apparently, the best wall, the foot wall, was always followed."

S3 - This is the Victory shaft, said to be 150 feet deep, and connecting with the Victory tunnel. It is full of water up to the tunnel level.

T6 - This is, no doubt, the continuation of the vein on the south side of the gulch, and cust 40 feet into the side of the hill. The strike is N 45 E, dip, 80 SE. Several samples were taken, none of them showing much besides a small amount of silver.

C24 - This was a cut about 50 feet down the slope from the summit of the hill on the Ninety Eight claim. It was from fifteen to twenty feet long, with the vein striking N 50 E, dip 72 SE. The vein is about three feet wide at this point, and judging from the strike, dip, and so on, it is, undoubtedly, a continuation of the main Sheldon vein. Two samples of mixed quartz and altered (porphyritic) grano-diorite assayed:

Au	-	.02 oz.	.14 oz.
Ag	-	.54 %	.26 %
Cu	-	--	--

C23 - (Ninety Eight). Entire vein does not show. Some good white quartz was seen here.

C22 - (Ninety Eight). This is a good clear showing of the Sheldon vein, and is computed to be about 3100 feet south of the Sheldon shaft. The samples taken here did not show up well.

T7 - (Ninety Eight). It is right in this district, (T7, C25 and C26), that it has been considered by the company that there is another good shoot. The Ninety Eight "Discovery Post" is right in this gulch. A sample taken by Mr. French a year or so ago from C26, of good sulphide ore, showed very promising returns, but none of the samples taken in December turned out very well. This all goes to show how inaccurate this method of studying a vein is. Several times, and in several places, when two or more samples were taken from the same cut by the same or different persons, the assayer's analysis produced widely varying results. All the samples taken from T7 show some silver, one a trace of gold, and another, .35% copper. In the tunnel, it was interesting to note several masses of sulphur, which had been leached out of the pyrite, which was very plentiful in this vein. The vein here appeared to be about 10 feet wide, striking N 28 E, and dipping about 80 SE.

C27, 28 and 29 - These are three cuts on the Ninety Seven claim which I did not visit. With respect to C27, a cut 25 feet long, there is said (by Mr. Casey), to be a winze sunk below this cut to a depth of about 40 feet, from which ore, carrying 2.5% copper and $4. in gold, has been taken.

NORTH ON THE VEIN FROM THE SHELDON SHAFT

S4 - A caved shaft, probably over the No. 2 ore shoot. The water stands in this shaft within fifteen feet of the surface. The apparent strike is N 30 E and the dip is 55 SE. Judging from the dump, Mr. Packard estimates that the shaft is not over 25 feet deep, but he states that some of it may have been washed away. Assay from dump:

Au	-	.34 oz.
Ag	-	8.84 %
Cu	-	2.01 %

S5 - The Sheldon vein splits between S4 and S5, one split cutting north in to the Last Chance claim, while the other, probably the main vein), continues on thru the Link and Fortune claims. S5 is on the south split, in the Link claim. This shaft is also estimated to be from twenty five to thirty feet deep. The strike is roughly N 60 E.

C11, 12, 13 and 15 - These are a series of cuts in the vicinity of S5, and on both sides of it. Showing altered grano-diorite enclosing the three to four foot Sheldon vein.

C16 - This cut is located in the southwest end of the Fortune claim, and presents a problem in that it dips 85 degrees to the northwest, but some splits on the vein dip 88 degrees SE. On the southwest face there are two to four inches of quartz, then 12" of silicified vesicular grano-diorite, 4 inches of quartz, and two feet more of altered and silicified grano-diorite, shot with quartz seams. This cut is interesting in that a sample, taken from the north face, assayed, (11"):

Au	-	2.22 oz.
Ag	-	3.62 %
Cu	-	--- %

Another sample, taken three feet northeast by Mr. Maury, about seven inches wide, assayed:

Au	-	3.62 oz.
Ag	-	2.48 %
Cu	-	---

It is underneath this cut that Packard thinks there is possibly a good ore shoot. As a result of Mr. Packard's recommendation for lateral development to the north and south along the vein, four men are at present mining on the north face of the 450' level, with the intention of getting under C16.

C18 - This is a curved cut, about twenty feet deep, on the Fortune claim. It is about eighty five feet long, measuring as follows: (starting at the north end) - thirty five feet, striking N 50 E, and dipping 85 SE; thirty feet, striking N 20 E; dip, 80 SE; and twenty feet, striking N 15 W. The ore follows the south, or hanging wall, in a vein about a foot wide. Rose, the timberman at the mine, states that a man by the name of Dehlin, stoped out of this cut, ore that milled $98. a ton. Assays of several specimens taken showed some gold and silver.

S6 - This shaft is about 200 feet north of C18. It has two compartments, but has been abandoned. There are supposed to be drifts and stoping both ways.

S7 - Another two-compartment shaft on the Fortune claim, also about 200 feet deep, (inaccessible), and about 300 feet north of S6. There is quite a large dump, showing galena and sphalerite, as well as much pyrite. The shaft does not seem to be on the main Sheldon vein. It is more probably on a hanging wall split.

C20 - A cut with quite a considerable dump, well shot with yellow oxide of lead. No strike or dip obtainable.

C19 - A cut adjacent to C20. Shows nothing.

S8 - This is the main Fortune shaft. It is reported to be at least 300 feet deep, and the headframe is still standing. Good gold ore is said to have been taken from here, though no figures were obtainable. Some specimens of the ore were picked up off the dump, and will be treated in a later part of this report.

EUREKA VEIN SYSTEM

This is, as I have stated above, not merely one simple vein. It is, rather, a complex arrangement of at least four veins, with many splits, either in the schist, the grano-diorite, or at a contact of the two. It is in this general region, (embracing the New State, Eureka, Midnight Snap and Whitehouse claims), that we are near the contact between the Tertiary granodioritic intrusion and the pre-Cambrian Yavapai schist. It has not been definitely determined whether the veins that have formed at or near the contact between these two are of contact metamorphic origin or of magmatic origin. A rough guess, from the type of ore that was seen and from the field relations, would seem to indicate that the veins here are of magmatic origin, the same as the other veins in this district, - the ore having been injected from below into fissures and zones of weakness that were already present in the country rock. This matter, however, I shall treat in another part of the report, in connection with the laboratory study. ?

If the map showing the workings on the Sheldon property is consulted, it will be seen that the majority of the veins strike about N 45 E, and practically all of them dip from 80 to 90 degrees to the southeast. This is varied at C84, 85 and 86, however, where a vein dips from 80 to 85 degrees to the northwest.

These claims have been worked a great deal in former years, as is evidenced by fifteen or twenty shafts, some of which are said to be fairly deep, and by the Eureka tunnel, (T12), which cuts into the side of the hill for a distance of over 400 feet.

There is also the remains of an old narrow gauge railroad which skirted the hill, and was used for a short time for the transportation of ore from the various shafts on the hill.

<u>In Detail</u>:

C156 and 155 - These are two small cuts which showed the vein which is no doubt the continuation of S34, strike, N 40 E; dip, 80 N.

S35 - Strike, No 53 E, dip, 85 N.

S34 - The continuation of C155 and 156. This is the so-called Discovery Vein. The vein at this shaft showed red druzy quartz, with a certain amount of pyrite.

S33 - This is the lower Curran shaft. Strike, N 27 E, dip, 85 NW. Ore specimens from the dump showed 5.16 oz. of silver and .04 oz. of gold.

S32 - Upper Curran shaft. This was boarded over and it was impossible to see anything. There are about 20 tons on the dump.

C140, 137 and 135. A series of three cuts at the western end of the Eureka claim. None of the assays showed anything good, except that one sample from C137 showed 3.18 ounces of silver. 137 dips N 30 E, while the vein seems to be either split or to curve around to a strike of N 50 E at C 135.

C130 - Strike, N 55 E, dip, 85 S. Sample showed only a little gold and silver.

C131 - This cut showed no vein, but was interesting in that the granodiorite showed considerable copper stain, (malachite and azurite), disseminated over the surface of it. A specimen of this rock accompanies this report. It furnishes rather interesting problem as to how the stain got there. Either the copper is present in the grano-diorite, or the stain may just be a coating of oxide from some copper further up on the hill, which has been washed down.

C94 - Cutt a few feet east of C95. Strike and dip indefinite.

C95 and 97 - Two adjoining cuts on the Eureka claim. Strike, N 80 E, dip, 85 S.

S26 and C92 - This is a long cut, about 80 feet long, with a small pit S26 sunk about in the center. Strike, N 60 E, dip, 85 N. No values shown in assay.

S25 - A shaft said by Mr. Casey to have been sunk almost to the Eureka tunnel on a well-defined vein, striking N 40 E, dip, 88 SE. Sample showed some lead, probably from the yellow lead carbonate. Gold, silver and copper in small amounts were shown in the assay.

S22 - This shaft is sunk on a contact between the schist and the grano-diorite. It is about fifty feet deep. A sample from the dump showed:

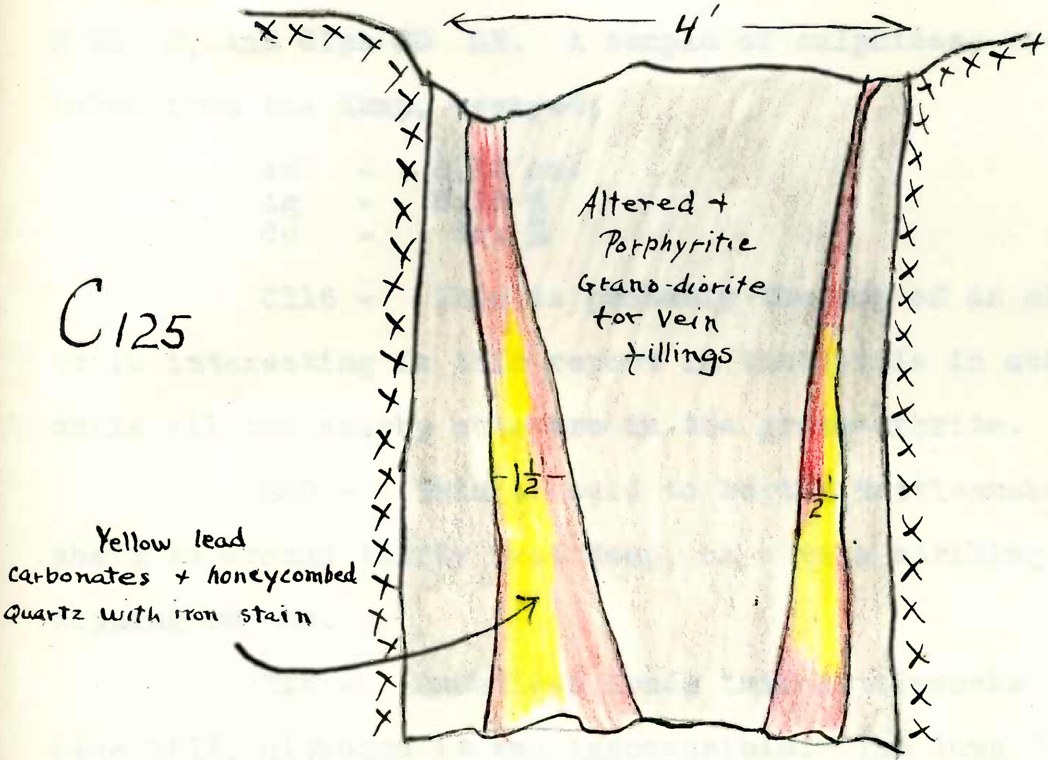
Au	-	.20 oz.
Ag	-	1.64 %
Cu	-	---
Fe	-	20.16 %

The high percentage of iron seems to be characteristic of the contact zones between the schist and the grano-diorite. A specimen was taken from a small schist block which had been included in the intrusive grano-diorite, and from it, a thin section was made. The microscopic examination revealed that there had been a concentration of magnetite at the contact. A photograph of this slide accompanies this report, (Pl.V).

C89 - Eureka claim. Strike, N 62 E, dip, 80 NW.

C85 and S24 - Cropping of what is probably the Eureka vein. Strike about N 40 E, and dip 85 North. S 24 about 90 feet east, is supposed to connect with drift from Eureka tunnel. Specimens from dump at S24 show a little copper. On the dump were found both schist and grano-diorite, showing that there is a schist block present at some point in the shaft. Schist is also encountered at the end of the west drift at the end of the Eureka tunnel, (T12). So doubtless this is where the schist comes from. Some rhombohedral crystals of siderite were found on the dump, as well as some quartz crystals.

C128, 127; and 125 - These three cuts are doubtless a continuation of the vein shown at C130. The strike is N 40 E, and the dip is vertical. "Jersey" MacLeod, an "old-timer" in the district, took me to C125 and said that he had caught and brought about the arrest of a man by the name of MacDonald who was doing some "Hi-grading" in this pit. An assay of a specimen taken by Mr. French, however, showed only a trace of gold and .36 oz. of silver.



C80 and 81 - C80 is a long cut, (about 200 feet), with the vein striking N 60 E at the north end and N 40 E at the south end. C81 is a branch from C80, and strikes at N 60 E. The dip is 80 S.

C76, 77 and 78 - These are a series of three cuts a few feet south of C80 and more or less parallel to it. The average strike was N 45 E, and the dip 75 SE. Assays were uninteresting.

S23 - This is known as the Strom Shaft, sunk in 1895; about 50 feet deep. The vein is nearly two feet wide, strikes N 35 E, and dips 80 SE. A sample of sulphides, rich in pyrite, taken from the dump, assayed:

Au	-	4.10 oz.
Ag	-	3.18 %
Cu	-	tr. %

C116 - This is probably the top of an old tunnel. It is interesting in this report in that it is in schist again, while all the nearby cuts are in the grano-diorite.

S30 - This is said to be the Rattlesnake vein. The shaft is around thirty feet deep, on a vein striking N 60 E, and dipping 88 Se.

T13 - Doubtless leads into Rattlesnake vein from side hill, although it was inaccessible. The dump from this tunnel was practically all crystalline schist.

S31, C119 and 120 - S31 is probably the top of a stope on the Eberhart vein. The vein strikes N 44 E and dips, 75 SE. The wall rock here is a very black coarsely crystalline basic rock. Mr. Packard says, "Looks like a basic dike, but is probably a metamorphosed schist." Dr. Buddington, on the other hand, thinks it very possible that it is a basic form of the grano-diorite if the field relationships support such a contention, (which they do).

C119 and 120 are either cuts or caved stopes on the Eberhart vein.

C120 has a pipe connecting with the Eureka tunnel, (T12).

C75 and S20 - C75 is a long cut on the border line between the Eureka and Midnight Snap claims. It dips 80 SE with a strike of N 30 E. The cut is 150 feet long, and due to the fact that one sample of coarse quartz taken from the dump showed 1.58 oz. of gold, 3.38 oz. of silver, the cut was dug out in connection with Mr. Packard's work, but no specimens were found that measured up to the first sample taken. S20 is merely a pit at the east end of the cut.

C99 - A wide vein showing lead carbonates, iron oxides and pyrite. Strike, N 55 E; dip, 80 SE.

C184 - About 75 feet from S20. Strike, N 60 E; dip, vertical.

C109 - Vein striking N 40 E, dip, nearly vertical. This cut was opened up to be studies and it showed schist on the SE wall and grano-diorite on the NW wall.

C110, 183 and 98 - These are continuations of the same vein as C109, but have schist for both the hanging and foot wall. The vein seems to have lost all the values when it entered the schist, which may or may not be significant.

S27 - The vein here strikes N 55 E and dips 75 SE at the surface, but a few feet down the shaft, the vein changes its dip to 87 NW. There is schist on both the foot and hanging wall, but only a few feet northwest is found grano-diorite, so the vein is near the contact.

C185 and 185a - (Whitehouse). Strike, N 50 E; dip, 84 E, in Yavapai schist. Rose quartz in vein. Gold, .44; Ag., 1.06.

S18 - (No. Capitol Ext.) Vein, striking N 28 E, and dipping nearly vertical. Yavapai "greenstones" seem to show in this dump.

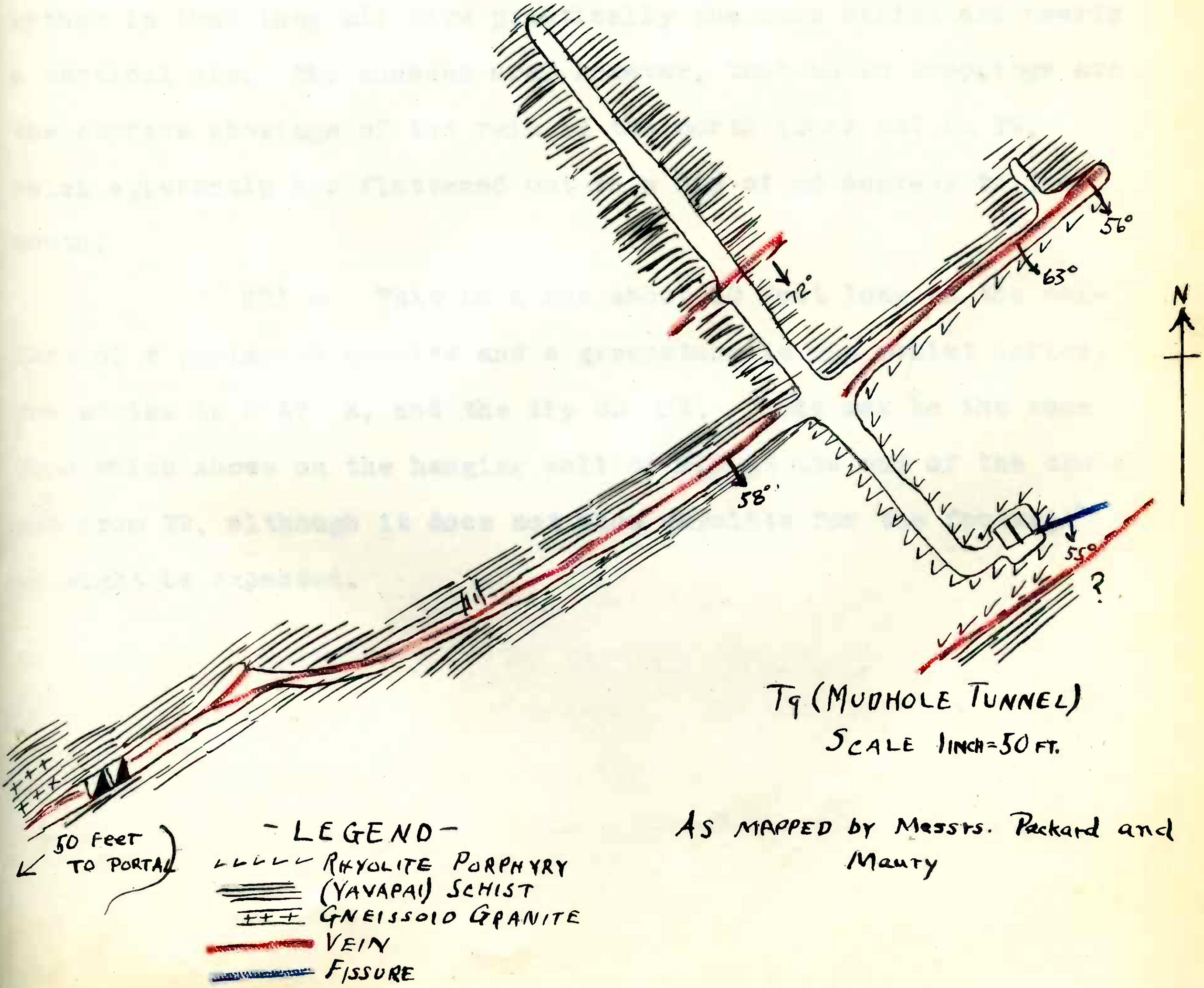
CAPITOL VEIN SYSTEM

This vein crops in cuts 48 to 53 on the Capitol claim and cuts 54 and 57 on the North Capitol Extension claim, as well as at S17. Due to the fact that none of these cuts show anything of interest, I did not study any of them, being hard-pressed for time, as it was. The Capitol vein is more or less parallel to the Sheldon vein, and dips nearly vertical, and it is commonly agreed that it is this vein that is met on the 200 foot cross cut on the 650 level of the Sheldon vein.

MUDHOLE VEIN SYSTEM

This system is, perhaps, the simplest of any of the vein systems on the property, in that it consists mainly of two parallel veins on either side of a dike of rhyolite porphyry, which cuts through the Golden Fleece No. 3 and Snow Flower claims. It is not so much complicated by splits and contacts with granodiorite, etc. Furthermore, the Mudhole tunnel, with a cross cut thru the schist and the rhyolite porphyry afford an excellent opportunity to study both the structure and the veins. There are, furthermore, two parallel sets of cuts from the vicinity of S13 to the New Mudhole shaft, (S10). The accompanying sketch of the Mudhole tunnel (T9) shows the lay-out of the veins.

T9 - This tunnel enters the side of the hill from Accidental Gulch and proceeds along the vein at a strike of N 60 E, and with schist, (gneissoid granite) for the walls. The hanging wall, however, soon becomes rhyolite porphyry, and the vein follows along this contact. About 340 feet in there is a cross cut, which goes both ways, intersecting two small veins in the schist to the north, and cutting through about 50 feet of rhyolite southward to the vein on the other side of the dike. S13 connects with the south end of this cross cut. A very interesting feature is observed at the juncture of the cross cut and the main drift, where the vein is offset by about four feet. This occurs, as will be seen from the



T9 (Mudhole Tunnel)
Scale 1 inch = 50 ft.

As mapped by Messrs. Packard and Mauty

sketch, at the point where the rhyolite displaces the schist for the hanging wall. There is no evidence of a lateral fault at this point, so the only explanation is either an "S" shaped twist in the vein, or else the vein here has a "horse-tail", or echelon structure.

The ore in this vein runs high in lead, galena being seen in quite large amounts. Sphalerite is also seen in the ore. The sketch will show the details of the tunnel.

C33, 31b and 30b - These three cuts are grouped together in that they all have practically the same strike and nearly a vertical dip. The chances are, however, that these croppings are the surface showings of the vein in the north cross cut in T9, which apparently has flattened out to a dip of 66 degrees to the south.

C31 - This is a cut about 30 feet long on the contact of a gneissoid granite and a greenstone in the schist series. The strike is N 47 E, and the dip 80 SE. This may be the same vein which shows on the hanging wall of S13 at the end of the cross cut from T9, although it does not show rhyolite for the footwall as might be expected.

PETROGRAPHIC DESCRIPTION OF COUNTRY ROCKS

Yavapai Schist

The Yavapai Schist is another facies of the Pinal Schist of the Globe and Bisbee district. This series is known as the Vishnu Schist in the Grand Canyon, where it unconformably underlies the Grand Canyon series.

These schists have been studied by many geologists such as Jappar and Palache in the Bradshaw Mountains; by Ransome at Ray, Miami, and Bisbee in the Mazatzol Mountains; by Lindgren at Clifton; by Schrader and Bancroft in the western part of the state; and by Bryan and Ross in the southwestern part of Arizona.

Jaggar and Palache describe these rocks as "chiefly phyllite, mica schist, and hornblende schist, with limestone lenses, quartzite, and siliceous schist lenses. **** Within the schist areas are conglomerate and sandstone bands and lenses, and zones of intense metamorphism where the rocks are amphobilitic and contain epidote and garnet, zoisite, tourmaline, andalusite, and mica in various amounts. The typical phyllite as developed in the great body of Yavapai Schist which occupies the northern half of the center of the quadrangle is a finely foliated blue or silvery schist consisting chiefly of quartz and the form of muscovite mica known as sericite. The foliation is pronounced, but the surface of the partings are not plain, so that nowhere are truly cleavable slates found. The rock consists largely of interlocking quartz grains, producing a mosaic, the sericite being interwoven with the grains, or forming layers wrapped about individual grains. Occasionally single large rounded grains of quartz are seen, their edges granulated. Plagio clase, calcite, epidote, zoisite, pyrite and magnetite are often found in scattered grains."

The rocks are the oldest known of the Pre-Cambrian series, and are interpreted as being a recrystallized and metamorphosed sedimentary series, as is backed up by the fact that lenses of quartzite, conglomerate and more rarely, limestone, are found.

Several distinct phases or types of schist were encountered in the Walker district.

In the north crosscut of the Mudhole tunnel, (T9), the finely foliated blue schist described by Palache was found. The lines of schistosity had a strike of roughly about N 60 E, and the dip ranged from nearly vertical to about 80 S. The photomicrograph taken from Lindgren, ~~(Pl.)~~, with this report, is an illustration of this phase of the series. The prisms of tourmaline are indicative of high temperature metamorphism. In the slide I had made of a specimen of this rock, no tourmaline was found, neither was any magnetite, but it did show considerable pyrite disseminated thruout. It was found in one place that pyrite had replaced partially a phenocryst of quartz. Distinct bands or lenses of sericite as well as epidote were found thruout the slide.

Another phase of the schist found was a green amphibolite which showed up in the north wall of the vein at C185. There is the possibility that this rock may be one that has been altered by contact metamorphism with the grano-diorite, which is found about fifty feet to the north. It is a medium to fine-grained amphibolite of a deep green color, (specimen C29). Under the microscope it shows considerable magnetite, some pyrite, as well as quartz phenocrysts in a matrix of amphibole, which has been altered to a large extent to a mixture of chlorite, serpentine, and some sericite. There seem to be two kinds of amphibole present in this slide, - one, which has partially altered to cloudy magnetite, and the other a brown hornblende altering to chlorite. No tourmaline was found in this particular slide, which might be found if this is a contact metamorphism phase.

A third important phase of the schist was what was termed in the field as gneissoid granite. This was found at various points along the road up Accidental Gulch from the drier plant to T9. It was found at the portal to T9 on the east, or hanging wall. It consists of a matrix of quartz and sericite, fine-grained, with wavy bands of chlorite and quartz, giving it the gneissic structure. Crystals of apatite are interstitial with the quartz. Some hematite is present in small particles. There is possibly a little pyrite, and magnetite is again found replacing the chlorite.

An interesting block of this gneissoid granite was found included in an outcrop of the grano-diorite along the old railroad track parallel with the southern slope of the Eureka hill. The block was only a foot long and about half as wide. There was copper stain on the surface of the contact, and this seemed to bear out the hypothesis that mineralization and copper values found in fissures along zones of contact are a product of contact metamorphism.

BLOCK OF GNEISSOID GRANITE INCLUDED IN GRANODIORITE

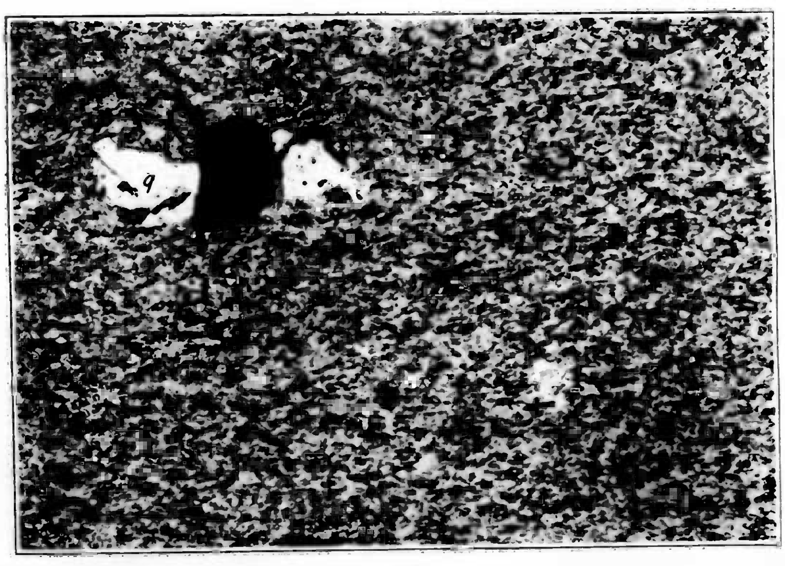
See slide #C23

In opposition to this, is the fact that the veins do not by any means seem to follow only the lines of contact. They may follow along a contact for a while, but continue more or less undaunted out into the grano-diorite, where no schist is anywhere near. The one thing that a slide made from a chip taken at the edge of this small schist block did show, was a concentration of magnetite at and near contact with the grano-diorite. It will be remembered that a sample taken from S22 which was on a contact between shcist and grano-diorite, showed 20% iron. These two observations seem to back each other up.

All things considered, my conclusion as to the origin of the pay streaks in the veins is that they are of magmatic origin, and have nothing directly to do with the contact metamorphic effects of the grano-diorite intruding into the schist. Rather, it is probable that zones of weakness and fracture were developed both in the rocks and, of course, at the contacts between the rocks, subsequent to the intrusion of the stock or batholith of grano-diorite.

PLATE IV

Photomicrograph of thin section showing granodiorite of Walker district. Andesine-oligoclase, quartz(q), biotite, hornblende(h), titanite(t), magnetite(black), and pyrite(stippled). Enlaged 32 diameters. Ordinary light. (after Lindgren).



Photomicrograph of thin section showing Yavapai schist. Matrix of chlorite(c), sericite and quartz, with metacrysts of magnetite (black), quartz tails(q), and prisms of tourmaline(t). Enlarged 32 diameters. Ordinary light. (after Lindgren).

GRANO-DIORITE

General Features: This rock is by far the most extensive one on the Sheldon property, comprising at least 70% of the total area, as will be seen from the areal map, (Pl. I).

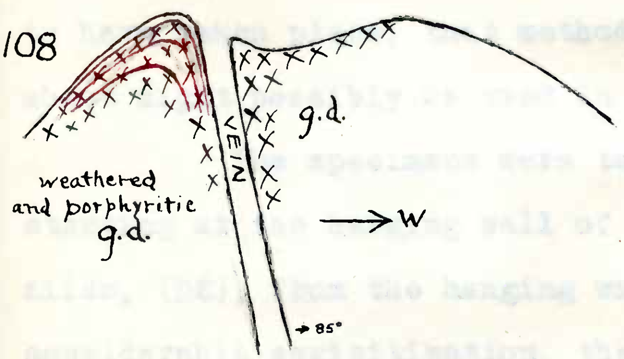
The rock is for the most part a light grey one of granitic appearance, and composed mostly of white orthoclase and plagioclase, with more or less interstitial quartz, with a good deal of biotite and magnetite in crystals large enough to be seen with the naked eye. The rock has no banded or gneissic structure as is seen in the gneissoid granite of the schist series. Indeed, as Jaggar and Palache say:" - - - - - - as shown by microscopic study, its constituents are free from evidence of unusual strain."

In the field, the grano-diorite is seen in large outcrops to be extremely subject to exfoliation, and hence practically all the loose boulders that have been exposed for any length of time to the elements are well-rounded into spheroidal forms. As a matter of fact, the hills themselves are smoothly rounded as a result of this property of the grano-diorite. I have tried to bring this out on the topographic map. Jointing is very irregular in this rock, and in a large exposure near S24, it seemed as if the term polygonal cracking were more descriptive than "joining". In this same exposure, several quartz seams or "stringers" were seen across the face of the rock. They were not more than ½" to 1" wide and did not seem to strike definitely in any one direction, although the most consistent one did strike about parallel to the vein systems, (N 40 E), with a dip of 40 NE.

On the New State claim there was observed a two inch seam of aplite running across the face of an exposure. In small vugs within the aplite were found several crystals of actinolite.

The character of the granodiorite varies considerably. It ranges from a rather coarsely crystalline mass in some places, to a very fine-grained, almost porphyritic structure, which was seen on the summit of the hill above the drier plant, as well as at C108, on the Eureka claim. In these two places was observed a rather curious phenomenon, in that a series of concentric bands of iron oxide were seen staining the rock. The bands were parallel to the contour of the ground. These were caused by the chemical action of the meteoric waters leaching out the iron from the rock and re-depositing it in the form of bands of iron oxides. A specimen of this is included in the collection.

C108



At the portal to the Eureka tunnel was found a very black coarse rock which is probably a basal ic phase form of the grano-diorite. It is definitely near the contact with the Yavapai schist which is found only a few feet to the south, across Lynx Creek. A ~~photomicrograph~~ slide (#C25) ~~is included in~~ accompanies the report, ([redacted]). The more acid feldspars are not present in any great numbers, having been replaced to a large extent by chlorite. The quartz has remained essentially unchanged, but only here and there is found a crystal of plagioclase that has not been completely altered to chlorite. The biotite, as well, has gone into chlorite. Magnetite and pyrite remain unaltered. Much hornblende is present.

Under the microscope, the more typical grano-diorite is found to contain, - besides the minerals mentioned above, - apatite and pyrite, always; titanite and calcite in occasional crystals.

A series of specimens were taken from the 650 level of the Sheldon mine, in an effort to determine the amount of sericitization in the wall rocks.* If a good amount was found to have taken place, that method of tracing a suspected ore shoot might possibly be used in the future by the company.

The specimens were taken at five foot intervals, starting at the hanging wall of the No. 1 ore shoot. The first slide, (D2), from the hanging wall face, shows, as expected, considerable sericitization, the mica having filled extensively the interstices between the quartz, and having almost completely obliterated the phenocrysts of plagioclase. Likewise, chlorite and epidote have replaced the biotite. A slide of the specimen taken only five feet to the southeast on the crosscut showed, however, hardly any alteration from the usual form of the grano-diorite, and D4, taken about ten feet from the hanging wall face, showed that the plagioclase had hardly been touched.

* Slides # D2 - D5

Slide #C34 C.+. Specimen # C37

A. <u>Photomicrograph of thin section showing rhyolite porphyry.</u>

Matrix of micropoikilitic quartz, with metacrysts of quartz(q), and feldspar(p), with small crystals of pyrite(black), and chlorite(c). Ordinary light. Enlarged 19 diameters.

Slide #C11 Whole spec. used for slide

B. <u>Photomicrograph of thin section showing contact between schist and rhyolite porphyry.</u> Quartz lenses(q), sericite(s), plagioclase, altered to chlorite and sericite(p). Rhyolite to right of contact. Ordinary light. Enlarged 19 diameters.

Slide #C29 Specimen # C#29

C. <u>Photomicrograph of thin section showing amphibolite schist.</u>

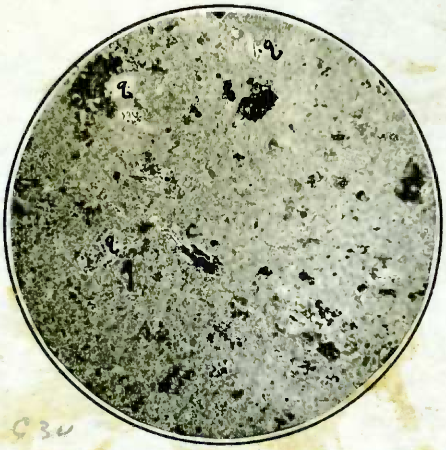
Amphibole altered to chlorite and epidote(c), Quartz(q). Ordinary light. Enlarged 18 diameters.

Slide #C23 Specimen # C23

D. <u>Photomicrograph of thin section showing contact between granodiorite and gneissoid granite(right)</u>

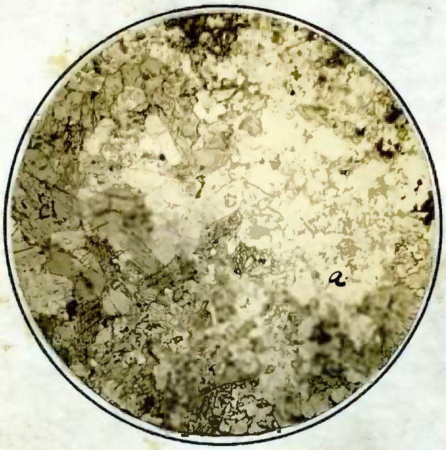
Biotite altering to chlorite(b), quartz(q), apatite(a), and Magnetite(black), plagioclase(p). Ordinary light. Enlarged 18 diameters.

PLATE V

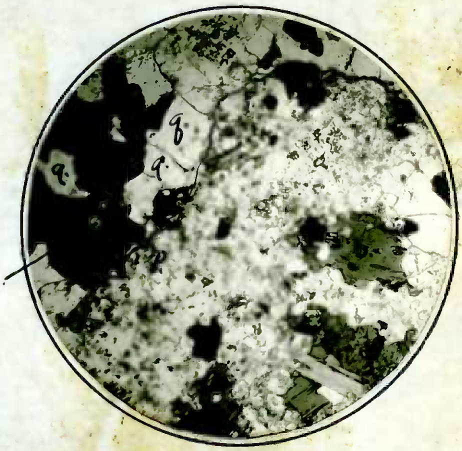


A.

B.



C.



D.

The following is a partial analysis of a typical grano-diorite specimen from the Walker district, made for Lindgren in 1922:

SiO	-	65.74%
Al_2O_3	-	16.76%
Fe O	-	3.99%
MgO	-	1.70%
CaO	-	3.78%
Na_2O	-	3.37%
K_2O		3.55%
Loss on ignition		.99%
		99.88%

RHYOLITE PORPHYRY DIKE

This is an acidic dike intrusion into the Yavapai schist, about fifty feet wide, extending 2000 feet from the vicinity of Accidental Gulch, almost to the Poland tunnel. It strikes about No. 60 E, which is roughly the strike of the schist adjoining it, and dips 54 SE. The rock is a dull, yellowish white, locally porous and usually more or less decomposed. Under the microscope, it shows quartz and felspar phenocrysts in a micropoikilitic ground mass of quartz and what is possibly plagioclase. Pyrite, apatite and microcline are seen thruout. The rock is strongly sericitized, muscovite mica and chlorite occurring as pseudomorphs after biotite and plagioclase.

The dikes of this character are common in the Bradshow Mountains Quadrangle, and are found in contact with the Tertiary or Cretaceous grano-diorite, so they are known to have intruded later than that time.

PART TWO

ECONOMIC GEOLOGY

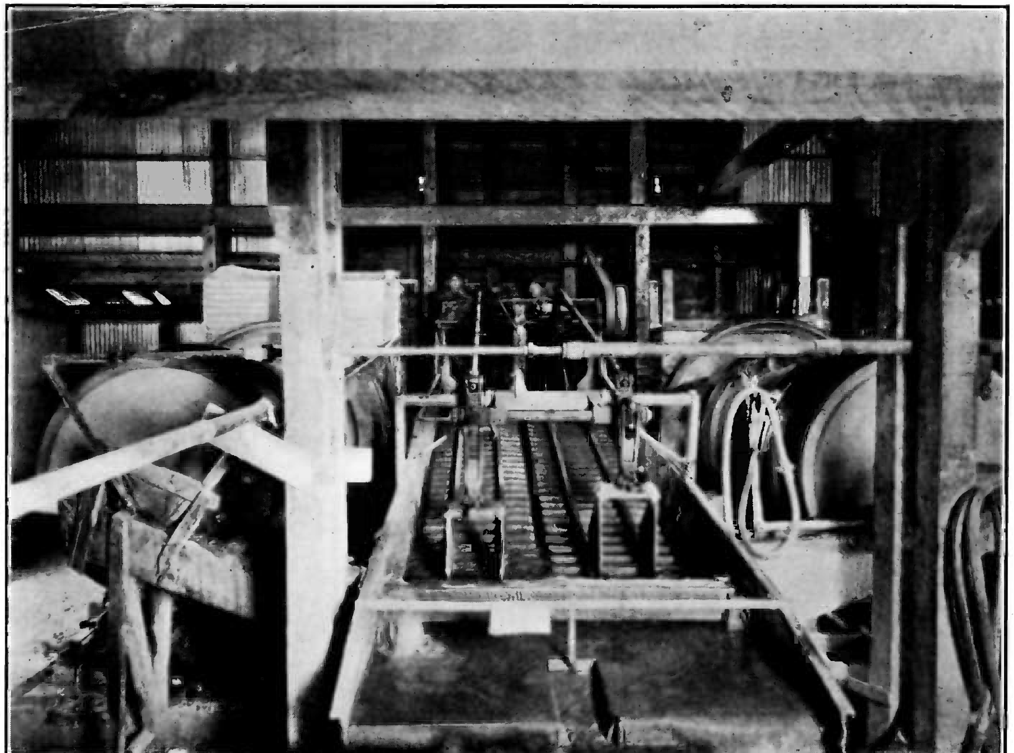
GENERAL DESCRIPTION OF SHELDON MINE AS DEVELOPED TO DATE

The Sheldon Mine consists of a three-compartment shaft, sunk to a level of 1250 feet, with drifts on the 250, 450, 650, 850, 950, 1100 and 1250 levels. The shaft dips 80 degrees to the south, on what was supposed to be the dip of the vein; but it being later found that the vein flattens out to about 71 degrees, work on the deeper levels involves considerable cross-cutting before the vein is reached.

The workings on the 250 level have been abandoned, and the southern end of the drifts on the 450 and 650 levels were inaccessible in December 1930, but are now again being opened for further prospecting.

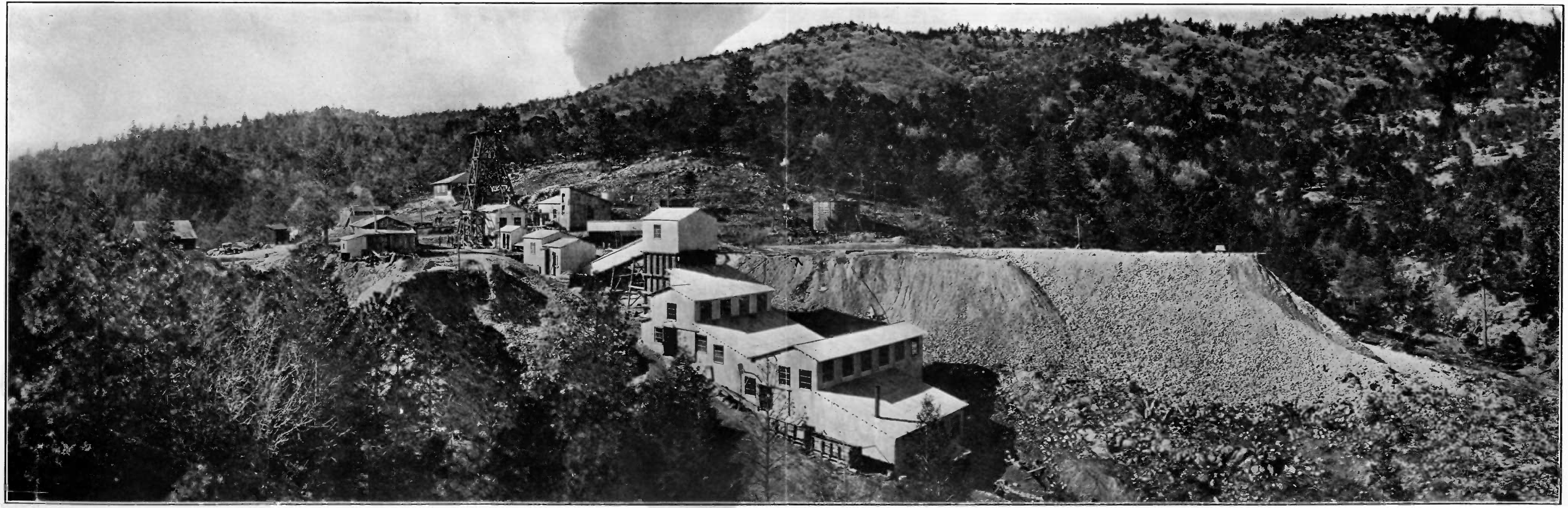
The shaft was originally a two-compartment shaft. It was enlarged to three compartments in 1927. There is a double skip, to speed up ore extraction, and cut down expense lost by wasted time. The third compartment, or "manway", carries the ladder, water and compressed air pipes, electric cables, etc. The hoist is a double drum electric, capable of operating to a depth of 2000 feet, and is located in a hoist room fifty feet from the head-frame. The head-frame stands about eighty feet high.

There are five major ore shoots in the workings, and ore has been taken from all of them. The average value of the ore from the whole mine as computed from the assays on the various levels and shoots, is as follows:



MILL INTERIOR

Showing classifier
with primary and
secondary rod mills



UPPER SECTION OF CAMP—Showing office, head frame, mill, blacksmith shop, hoist house and other buildings

Au	-	.086 oz.
Ag	-	6.030 oz.
Cu	-	2.680 %
Pb	-	.095 %

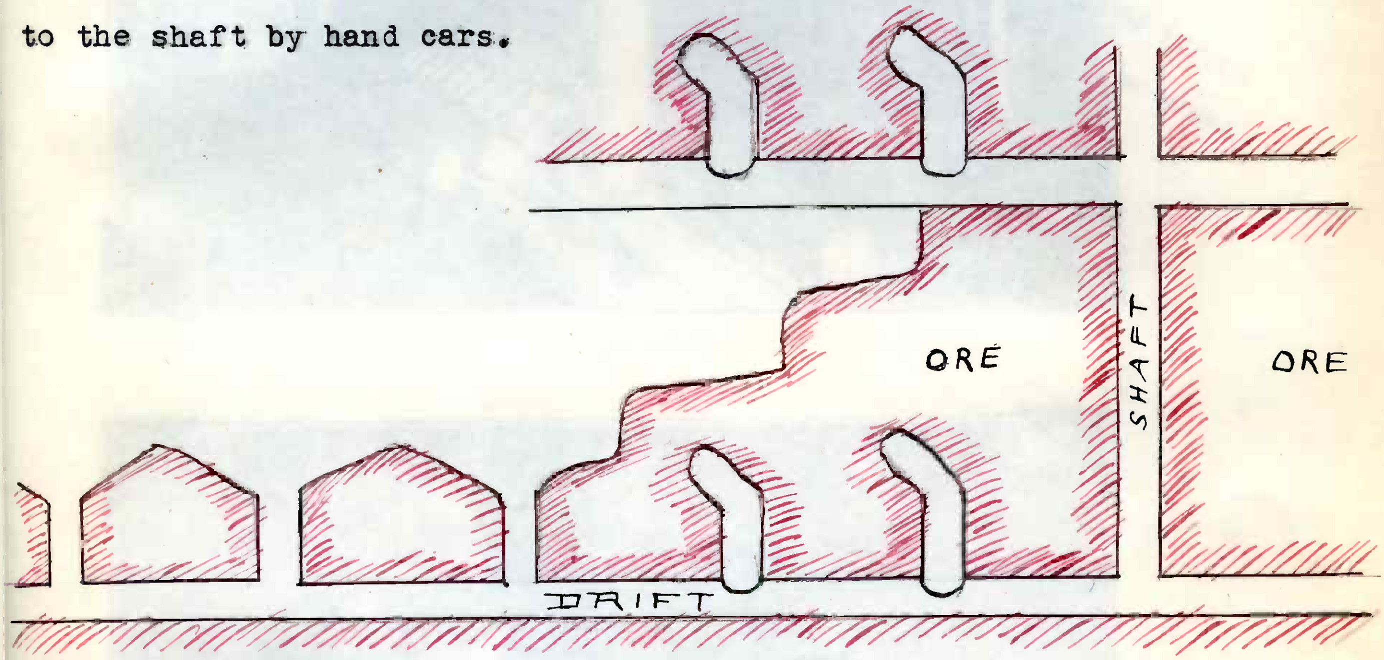
Ore in the mine as follows:

Shoot	Tons	Stoped	Left
No. 1	43,509	18,573	25,230
No. 2	33,914	12,067	19,647
No. 3	20,211	12,701	7,395
No. 4	98,408	12,069	86,339
No. 5	10,958	1,251	9,707

The Vertical Projection of the Sheldon Vein System accompanying this report, (Pl.III), shows the approximate location of the ore shoots in the mine.

METHOD OF MINING

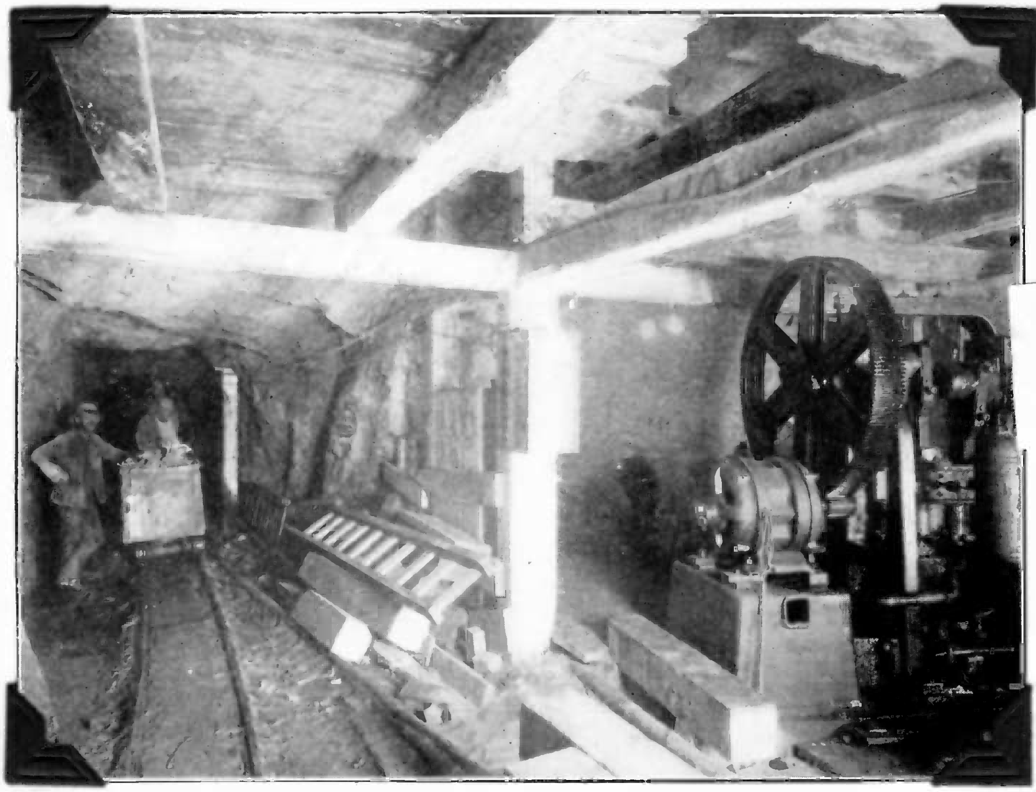
Mining is done by the underhand stoping method in use at the French Creek Mine. Raises are opened at about 50 foot intervals at the base of an ore block on a drift, and ore is mined from the block by proceeding in a series of steps as shown in drawing. Shutes are placed in each raise. Ore is transported from the shutes to the shaft by hand cars.



UNDERGROUND WATER

The water table varies in the mine with changing weather conditions. It averages about 150 feet below the surface. The water is very acid, from the igneous grano-diorite.

The mine is equipped with three pumps, located on the 650, 850 and 1250 levels, which work in series. These pump about 100,000 gallons per day. The accompanying illustration shows the pump at the 850 foot level.



850′ LEVEL
Station at Shaft

850′ LEVEL
Drilling in ore
Face of North Drift

DESCRIPTION OF ORE FROM SHELDON MINE

The ore from the Sheldon mine consists chiefly of chalcopyrite and pyrite in a normal fissure vein from three to four feet wide. Tetrahedrite begins to show in quantity on the 850 level of the No. 1 shoot, and brings up the silver values accordingly. Number 5 shoot runs high in tetrahedrite from the 1100 to the 1250 level, where the assay shows 11.24 ounces of silver, and the copper runs 4.47%. Primary Bornite and primary chalcocite occur in but small quantities. The gold values in the ore are contained in the pyrite. The gangue minerals are chiefly quartz and calcite. The ore contains an appreciable amount of lead values in the form of galena, especially above the 650 level. Number 3 shoot shows the most lead, the assays ranging from 2.08% to 2.59%, and averaging for the whole shoot 2.39%. A certain amount of zinc is present in the form of sphalerite.

MILL OPERATION AND FLOW SHEET

In the milling of the Sheldon ore, in which the copper values are chiefly contained in the pyrite and chalcopyrite, there has to be a special addition to the milling process to recover the lead values, which, it will be remembered, average about .095% per ton. The flow sheet of the mill is as follows:

Mine run ore to gyratory crusher -- 2½" product.

Gyratory to Symons disc crusher -- ¾" product.

Symons crusher to fine ore bin -- 300 tons capacity.

Fine ore bin through feeder to #1 rod mill, where water is added, and about 1000 gallons for each ton of ore.

No. 1 rod mill discharge (35 mesh) through launders to 3 Butchart tables, where lead concentrate is made. Lead concentrate goes through pipe launder to settling sump, from which it is pumped to drying boxes.

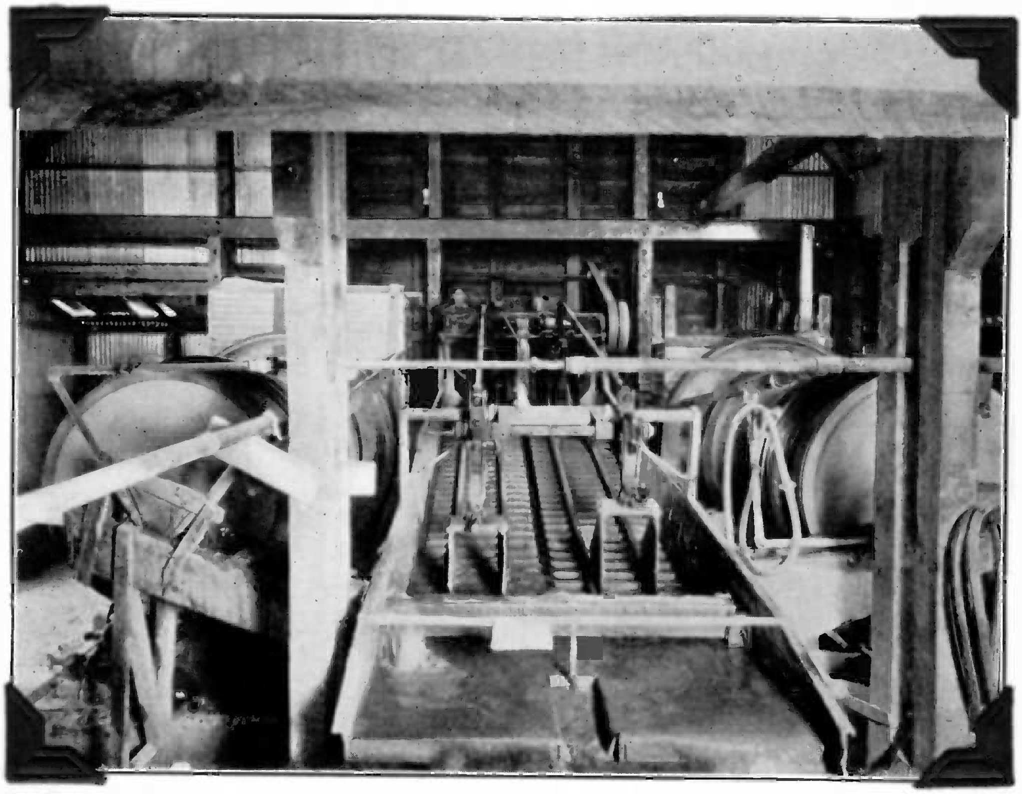
From tables, balance of ore pulp, containing the copper, gold and silver values, goes to a Wilfley sand pump, which pumps it back to a 6x20' Dorr classifier, which operates in a closed circuit with the #2 rod mill.

The pulp is reground in the #2 rod mill.

Overflow of classifier (100 mesh) to M S 16 cell oil flotation machine.

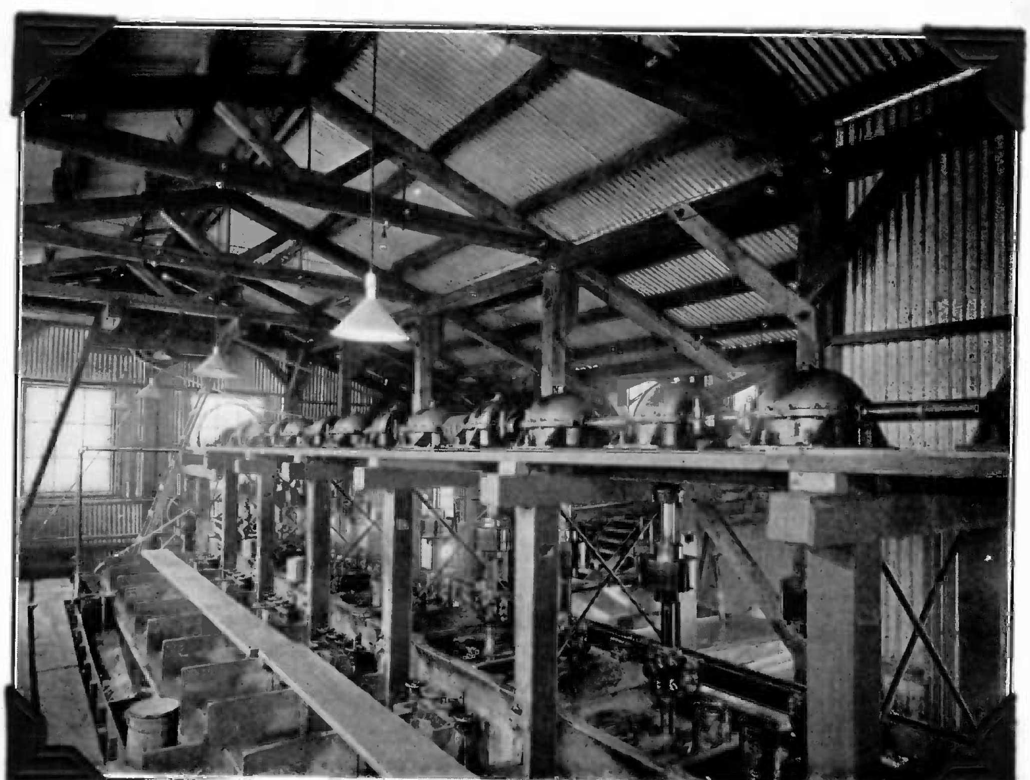
Flotation of copper concentrate through wooden pipe line to filter plant.

Flotation tailings through Wilfley sand pump to tailings pond.



MILL INTERIOR

Showing classifier with primary and secondary rod mills



MILL INTERIOR

Showing 16-cell flotation battery

The flotation process is as follows:
When the pulp enters the flotation machine, the reagents are added as follows:

Yarmor Pine Oil (frothing agent) - ½ lb. per ton of ore
Ethyl Xanthate (collecting agent)- 1/10 lb. per ton of ore.

More water is also added, and the solution, (ore pulp, reagents, etc.), is violently agitated. Oil bubbles form around the particles of mineral and float them to the surface. A thick froth of these bubbles is continually skimmed from the surface of the cells. The copper concentrate is contained on the surface of these bubbles. The tailings are drawn from the bottom of the end, or tail cell.

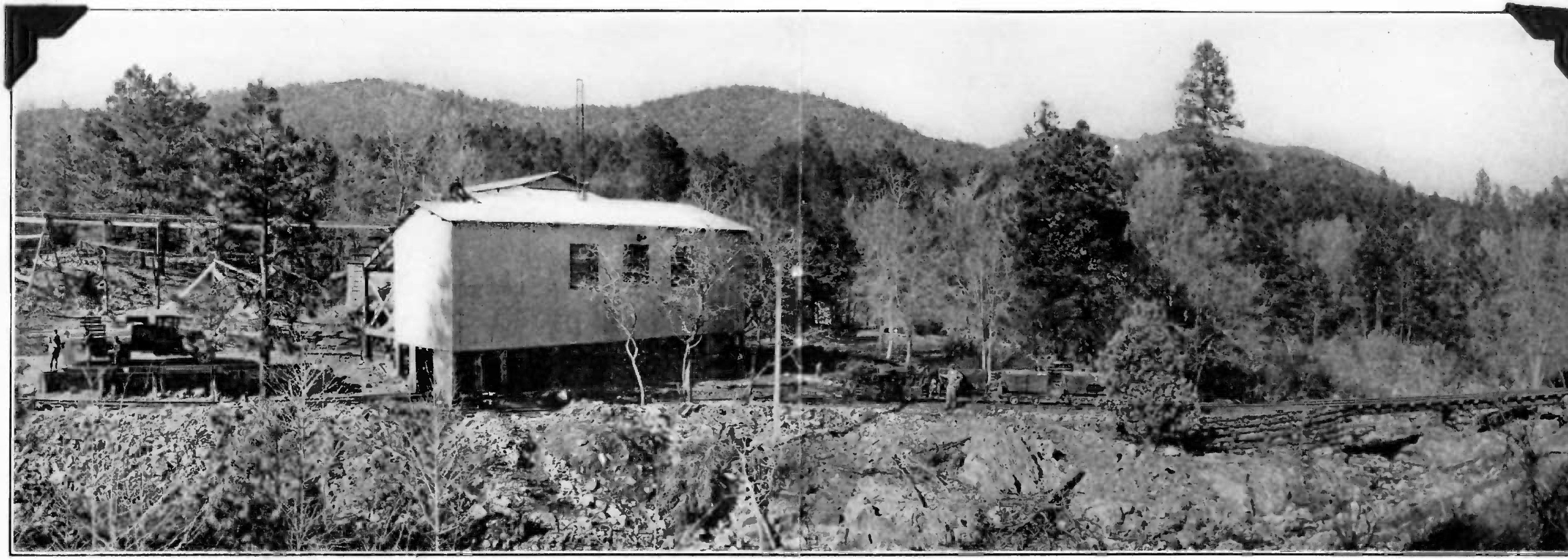
OPERATION OF THE FILTER PLANT

The wet concentrates, as they come down by the pipe line from the mill to the drier plant, are first put into a 40' Dorr thickener, which acts as a settler. This partially dried concentrate is then taken to six and eight foot diameter Oliver filters, where it is further dried by vacuum pipes.

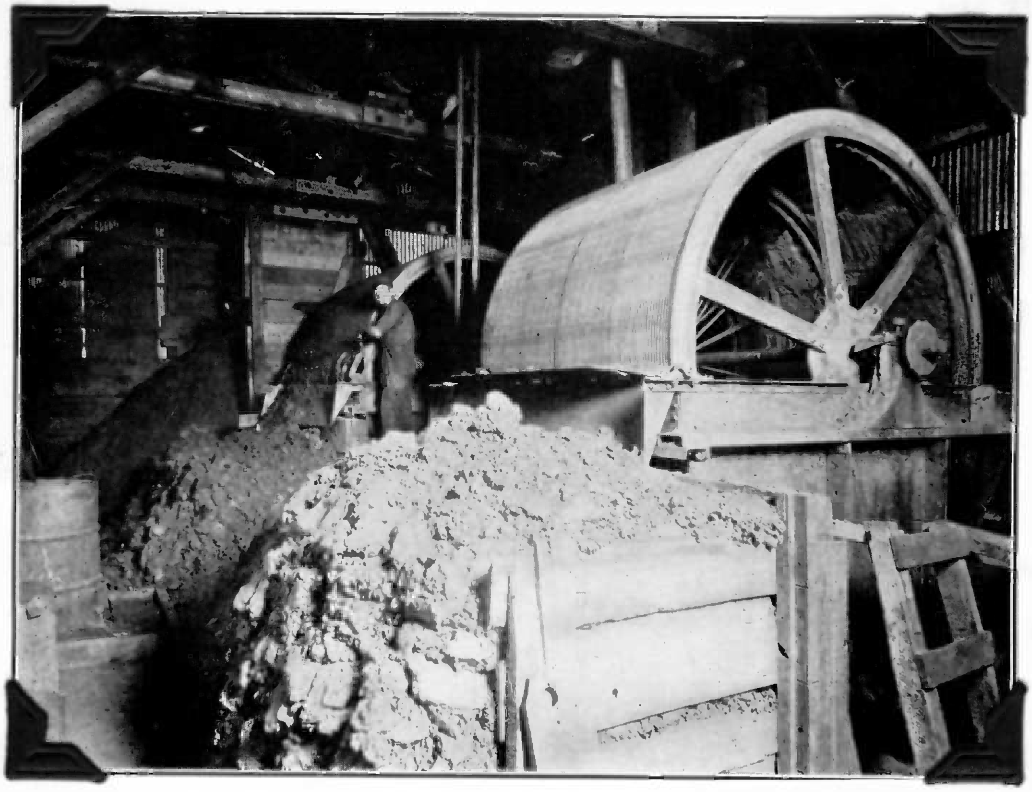
This concentrate is now ready for smelting. It has been concentrated from 2½ to 3% copper to 7½ to 8% concentrates, and it has been dried.

FACILITIES FOR TRANSPORTATION OF THE CONCENTRATES

The company owns the Poland tunnel, part of which was driven by the Atchison Railroad Company, and then abandoned by them. The completion of the tunnel was effected about 1904 by



FILTER AND DRYING PLANT, NEAR WALKER—One mile down the hill north of the shaft



INTERIOR
DRYING PLANT

Showing 8′ and
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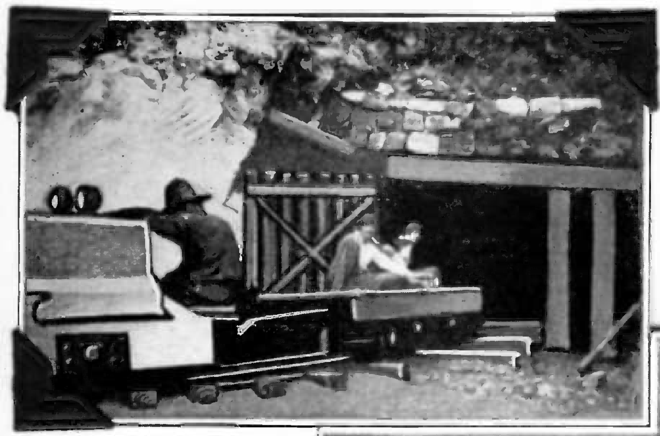


SHELDON
TRANSPORTATION TUNNEL

Portal at Poland

LOADING BINS
AT POLAND

Showing Sheldon ore
train above and
Santa Fé train
receiving shipment

private interests. A narrow-gauge train with gasoline locomotion runs through to Poland, where ore is dumped into Atchison cars, which railroad runs a branch to Poland. The ore is shipped thence to the smelter.

SMELTING OF THE ORE

Under ordinary conditions, the ore is smelted at Humboldt, Arizona. This smelter originally went under the name of the Val Verde smelter; it changed hands and became the property of the Arizona Consolidated Smelting Company in 1906. Later, it was sold again to the Southwest Metals Company, which operated it on a custom basis until 1927. Since the continued operation of this smelter

HUMBOLDT SMELTER

Roasting Plant in foreground

was very desirable to the Sheldon Mining Company, it bought out the Southwest Metals Company, which included, as well as the smelter, two mines nearby; the DeSoto and the Blue Bell. The furnace was rebuilt to about half its original size, and was blown in again in February, 1929.

The smelter operated on a custom basis, deriving its chief ore supply from the Sheldon, United Verde Extension, Blue Bell and DeSoto mines, and others in the vicinity. The Sheldon ore, which is heavy in iron, is very desirable as a smelter charge, as most of the other ore available for treatment at Humboldt runs high in silica, and the iron is needed as a flux to balance the silica. Briefly, the smelter operation is as follows:

The ore is first "roasted". The purpose of this is to drive off some of the excess sulphur in the form of sulphur dioxide. Care is taken in this process not to have the temperature too high, for fear the values will melt, which is not desirable.

The roasted material is taken, while still hot, to the reverberatory furnace, where it is separated into matte and slag, under a temperature of about 3000 F. The charge must be properly balanced, with iron and silica to make the flux. Otherwise the quality of the matte will be adversely affected. The slag is drawn off in the usual manner, and the matte is removed through tap holes at the base of the furnace.

The matte, containing about 35% copper, as well as some iron, is carried to the convertors in a molten mass. The iron must be separated out, and this is done by the adding of more siliceous ore to the convertor charge, and the resulting slag, a complicated iron silicate, is drawn off from time to time during the converting operation.

The convertors reduce the matte to blister copper, or bullion, by driving off the sulphur in the form of sulphur dioxide. The bullion is 99-99.5% pure copper. It is then loaded into cars ready to be shipped to electrolytic refineries.

P A R T T H R E E

C O N C L U S I O N S

POSSIBILITIES OF FINDING COMMERCIAL ORE AT DEPTH

The company is somewhat disappointed with the evident dwindling or fading of the ore shoots below the 950 level. Numbers 2 and 3 ore shoots are not encountered on the 950 level, although, as the mine map indicates? ~~states~~, there is the possibility that the drift was run on the wrong split. The south drift on the 950 seems also to be on the wrong split, as the No. 4 shoot is not found, although it shows up both above, on the 850 level, and below, on the 1250.

There are several factors which must be considered in studying this question. First, the age of the grano-diorite has a certain bearing, as it is more common to find deep-seated, high temperature deposits in the pre-Cambrian rocks.' I do not believe that there is any geologic explanation for this, except for the fact that the oldest rocks have had a much longer period of time in which to be eroded away, thus exposing the deep-seated high temperature deposits.

A second factor which is more or less important is the question of enrichment. It will be noted from the accompanying graph, (Pl.VI), which is admittedly rather crude, the figures being taken from the mine assay map, that the copper curve goes up between the 650 and 950 levels. If this fact is due to a primary variation in the deposition, there is nothing to worry about, but if this slight increase in the values is due to supergene enrichment from the leaching effect of waters percolating down from above, and re-depositing copper in this zone, it would be safe to say that there will not be found much primary ore in quantities enough to make it profitable to mine below the zone of enrichment.

The third factor is the type of deposit at Sheldon. A high temperature deposit is usually found to persist quite uniformly over a long vertical range, whereas, a low temperature deposit is very erratic in that a hundred feet vertically may make a great difference in the character and value of the ore.

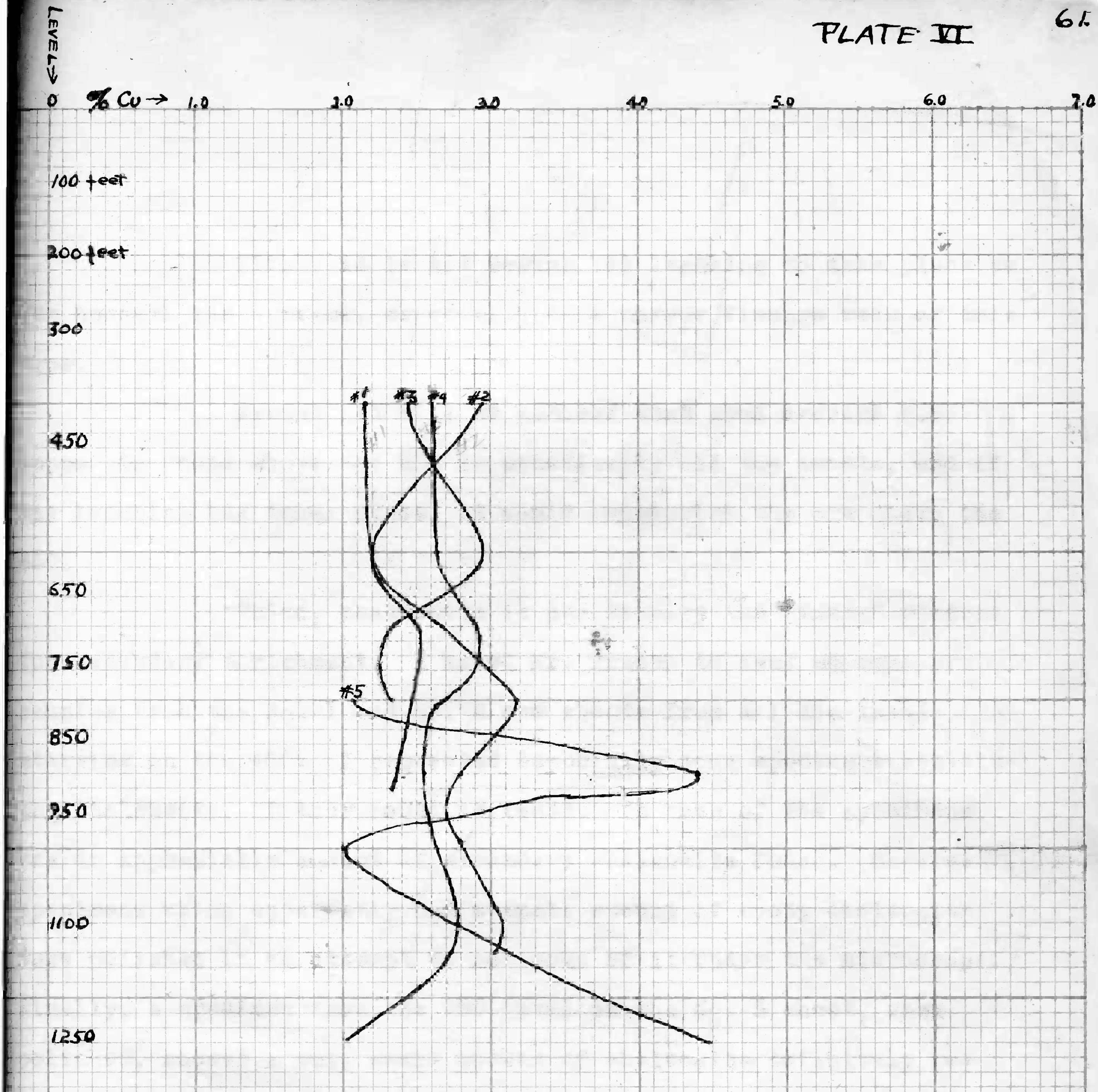
With respect to the age of the grano-diorite. I have spoken of this above and stated the views of Lindgren and Jaggar and Palache on the subject. Jaggar and Palache, it will be remembered, placed these grano-diorite intrusions as late pre-Cambrian, probably Algonkian; whereas, Lindgren is more of the opinion that they are of late Cretaceous, or early Tertiary age. There are no Paleozoics in the area intruded by this grano-diorite, so structural relationships do not solve the problem. Lindgren calls attention to the fact that the "rock agrees closely with the intrusives of Jurassic or later age, which are so abundant in the western coast region of North America." There is also the fact that the rock is relatively fresh and shows little evidence of unusual strain, and is free from banded or gneissic structures, which would lead one to believe that it is a comparatively young intrusive.

Over against this argument is the fact that Jaggar and Palache made a much more careful study of the Bradshaw Mountains than did Lindgren, who, as a matter of fact, made only a hurried study of the Walker district. Mr. Colvocoresses, a man well acquainted with a number of the mines in Yavapai County, is inclined to accept Jaggar and Palache's estimate of the age of the granodiorite, apparently basing his opinion on the character of the minerals found in the vein fillings.

To the best of my knowledge, this is no criterion for judging the age of a wall rock unless the material in the veins can definitely be traced to the same source as the ore in a similar mine nearby. Mr. Colvocoresses, I believe, is suggesting that the vein fillings in the Walker district have possibly the same source as the Blue Bell ore, which is a replacement deposit of the schist, and located about 25 miles from Walker. This mine has been developed to a depth of 1600 feet. Even if the veins in these two mines are contemporaneous and are from the same source, they are probably a late Tertiary stage of mineralization, due to the low temperature character of the ore.

SUPERGENE ENRICHMENT

An increase of the copper curves between the 650 and 950 levels of the Sheldon mine is clearly shown. This might be due to either secondary enrichment or to a primary variation in the deposition of the ore. My conclusions are that it is due to the latter cause for the following reasons:



SHELDON MINE

GRAPH SHOWING COPPER CURVES ALONG THE PITCH LENGTHS OF THE FIVE ORE SHOOTS

(Figures taken from Mine Assay Map)

First, it is not common for leaching to take place so far beneath the surface, especially in a narrow fissure vein of this type.

Second, it will be noticed that good average 2.5% copper is found above the 650 in practically all the shoots, and if any leaching has taken place, it would impoverish the ore above the 650.

Third, chalcocite is practically the "index" mineral for secondary enrichment. I asked Mr. French to send me some ore samples from the No. 1 and No. 2 ore shoots from all the levels, starting on the 450. I requested especially some specimens containing chalcocite, if they could be found. In none of the specimens was an appreciable amount of secondary chalcocite found. Several specimens which apparently had a small amount of sooty chalcocite were polished in an attempt to see some of it under the microscope. Finally, a specimen from the 950 level on the No. 5 shoot, when polished, showed a very small amount of chalcocite definitely replacing the chalcopyrite. It had also crept in between vugs in the quartz crystals. This much secondary chalcocite is to be expected, however, in any ore, and does not seem to occur in sufficient quantity to enrich the ore at all. Therefore, my explanation of a rise in the copper curves in the 650-950 zone is simply that it is due to a primary variation in the deposition of the ore. Another zone of similar enrichment from a primary cause could be quite possible below the present workings, altho there is no way of being sure.

The deposit, I repeat, is generally admitted to be of a low-temperature character. None of the high temperature minerals, such as augite, amphibole, olivine, biotite, tourmaline, topaz, garnet and magnetite are found. For this reason, vertical variation of the character of the ore is to be expected, and unless, (which is almost too much to hope for), the vein will tend to gradually grade into intermediate temperature character, the primary low temperature values cannot be expected to continue much deeper.

One item which may prove interesting if the company decides to sink another 200 feet, is that an intersection of the Sheldon vein with the vertical Capital vein is to be expected at about the 1450 level. The veins are 200 feet apart on the 650 level, 50 feet apart on the 1250 level, and hence, if we apply geometry, the intersection should occur 200 feet below the present workings.

Lindgren makes the following statement concerning intersections in veins:

> "Enrichment and ore shoots along intersections of two veins or of a vein and a fissure are very common phenomena, well exemplified at Friedberg, Saxony, and at Cripple Creek, Colorado. Van Hise attributes the shoots at such intersections to the mingling of two solutions and the consequent precipitation of some constituents. In part they may be due to the shattering of the rocks at the intersection, and Penrose noted that shoots are more likely to occur where the intersection takes place at acute angles, forming wedge-shaped blocks that are easily broken along their edges.
>
> Though enrichment at intersections is common, it is by no means a universal rule, and indeed sometimes a vein is impoverished at the intersection with a barren fissure. The occurrence

of the large shoots such as those in the gold-quartz veins of California, at Cripple Creek and in the Coeur d'Alene lead mines cannot be fully explained by intersections or by the influence of the wall rock. Such shoots are generally considered as the result of decrease in temperature of ascending solutions in channels of circulation."

It might be advisable for the company at some future date to sink a winze from the 1250 level with the small 25 H.P. hoist to see what could be found at the intersection of the Sheldon and the Capitol.

APPLICATION OF THE ZONAL THEORY TO SHELDON ORE

Altho decrease of pressure, temperature and concentration are the fundamental causes for deposition of ore shoots, this does not necessarily mean that deposits should gradually become poorer or barren with depth. Copper is known to have a long vertical range of deposition, and unlike gold and silver, it seems to be deposited in greatest quantity at lower levels and high temperatures. Lead is precipitated generally nearer the surface, and zinc is intermediate between the two.

W. H. Emmons* has studied the primary changes in ore deposits related to depth, and has reconstructed an "ideal" vein system, based on the elements of several veins. It would hardly be expected to ever find a vein that conformed in characteristics to the one described by Mr. Emmons, as he himself admits, but it is interesting as a reasonable argument for the zonal theory. The following is the probable succession of deposition of minerals:

SURFACE

Barren	1.	Barren zone, chalcedony, quartz, barite, fluorite, etc. Some veins carry a little mercury, antimony, or arsenic.
Mercury	2.	Quicksilver veins, commonly with chalcedony, marcasite, etc. Barite-fluorite veins.
Antimony	3.	Antimony ores- stibnite often passing downward into lead, with antimonates. Many carry gold.
Gold	4.	Bonanza ores of precious metals. Argentite, antimony and arsenic minerals common.
Silver		Silver minerals, some copper, lead and zinc sulfides, quartz, calcite, rhodochrosite, adularia, alunite, etc.
Barren	5.	Most nearly consistent barren zone, represents the bottoms of many Tertiary precious metals veins. Quartz, carbonates, etc., with pyrite and small amounts of other sulfides.
Silver	6.	Argentite veins, complex antimony silver sulfides, stibnite, etc. Galena veins with silver. Commonly silver decreases with depth. Quartz gangue, siderite common, often increasing with depth.
Lead	7.	Galena veins, commonly with some silver. Sphalerite generally present, increasing with depth. Chalcopyrite common. Gangue is quartz and often carbonates (Fe, Mn, Ca).
Zinc	8.	Sphalerite veins with some lead and chalcopyrite, quartz, gangue.
Copper	9.	Tetrahedrite veins, commonly argentiferous, chalcopyrite present. Some pass downward into chalcopyrite. Enargite veins generally with tetrahedrite and tennantite.
Copper	10.	Chalcopyrite veins, generally with pyrite, often with pyrrhotite. The gangue is quartz and in some places carbonates. Some pass downward into pyrite and pyrrhotite with a little chalcopyrite. Generally carry silver or gold.
Gold	11.	Gold veins with quartz, pyrite, and commonly arsenopyrite and chalcopyrite. At places zones 10 and 11 are reversed.
Bismuth	12.	Bismuthinite and native bismuth with quartz and pyrite, etc.
Arsenic	13.	Arsenopyrite with chalcopyrite and often tungsten ores.
Tungsten	14.	Tungsten veins with quartz, pyrite, chalcopyrite, pyrrhotite, etc.
Tin	15.	Cassiterite veins with quartz, tourmaline, topaz, etc.
Barren	16.	Quartz with small amounts of other minerals.

Experience teaches that Tertiary metallization is quite apt to become barren with depth. True, it is not established that the Sheldon vein was formed in Tertiary times, but it is my personal opinion that this is the case. It is just possible that the Sheldon mine has reached zone 5, although it cannot definitely be proved, except by actual exploration.

CONCLUSION

The immediate problem facing the company is the future policy as regards development and working of the mine. The mine was shut down in September, 1930, subsequent to the fall in the price of copper in the spring of that year. At present development work is being carried on in the north face of the 450 level in an effort to get under a possible shoot located about 900 feet from the present face. Similar prospecting is planned for the south face of the same drift where it is expected more ore will be found. Due to the disappointing showings on the lower levels, work has been abandoned there for the time being, although it is being kept pumped out. This is doubtless the most logical course to pursue pending the improvement of conditions in the market.

With respect to the deeper workings, my conclusion as to the continuation of commercial ore below the 1250 level is that it is not at all outside the limits of probability. It is possible and to be hoped for that an ore body may be found at the intersection of the Capitol and Sheldon veins at about the 1450 level.

The age of the veins and the grano-diorite in which they are included still remains an open question, although appearances seem to me rather convincing that the grano-diorite was not intruded until late Cretaceous or early Tertiary times. This means that the veins and the included ore shoots were not developed till still later times. It is generally admitted that the ore came from some deep seated magma , and is not a concentration formed by lateral secretion.

Slides to determine the amount of sericitization in the wall rocks adjoining a pay shoot, showed very little alteration of the wall rocks. Hence, the method of locating possible ore shoots in the future by this means cannot be used. The method used by Mr. Packard in searching for ore was to sample all faces in cuts, shafts and tunnels on the property and to determine their assays. This method, although it is far from perfect, is the most satisfactory that has been tried to date.

Slides, furthermore, revealed the fact that deposits of workable ore found at contacts between the schist and the grano-diorite, and the schist and the porphyry, are not the products of contact metamorphism. A concentration of iron in the form of magnetite seems to be the chief product of any contact metamorphic action in this district. Veins and perhaps ore may be expected and are found at such zones of contact on the property, but they are caused by the intrusion of the magma along zones of structural weakness.

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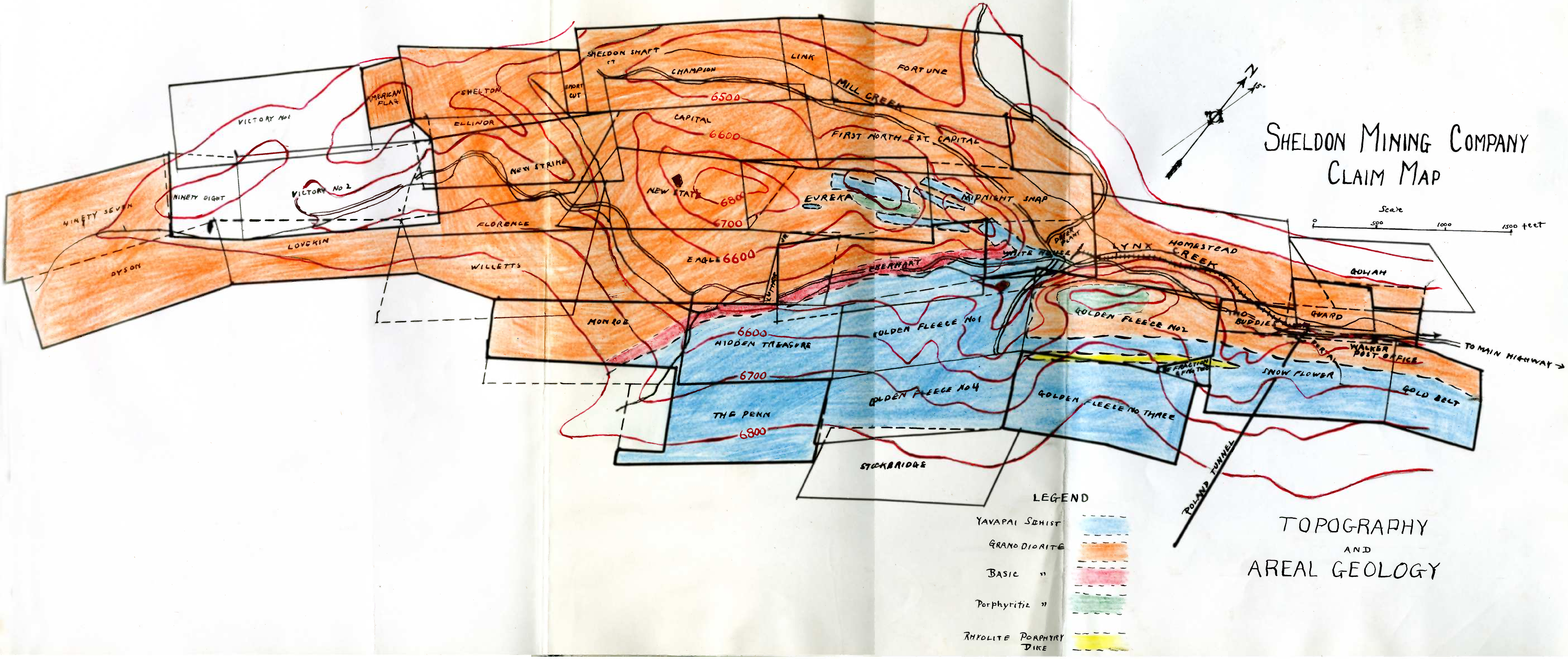
SHELDON MINING COMPANY
CLAIM MAP
N
15°
Scale
0 500 1000 1500 feet
TOPOGRAPHY
AND
AREAL GEOLOGY
LEGEND
YAVAPAI SCHIST
GRANO DIORITE
BASIC "
Porphyritic "
RHYOLITE PORPHYRY DIKE
NINETY SEVEN
DYSON
NINETY EIGHT
VICTORY No1
VICTORY No 2
LOVEKIN
AMERICAN FLAG
SHELTON
ELLINOR
SHORT CUT
SHELDON SHAFT
CHAMPION
LINK
FORTUNE
MILL CREEK
6500
CAPITAL
6600
FIRST NORTH EXT. CAPITAL
NEW STRIKE
FLORENCE
NEW STATE
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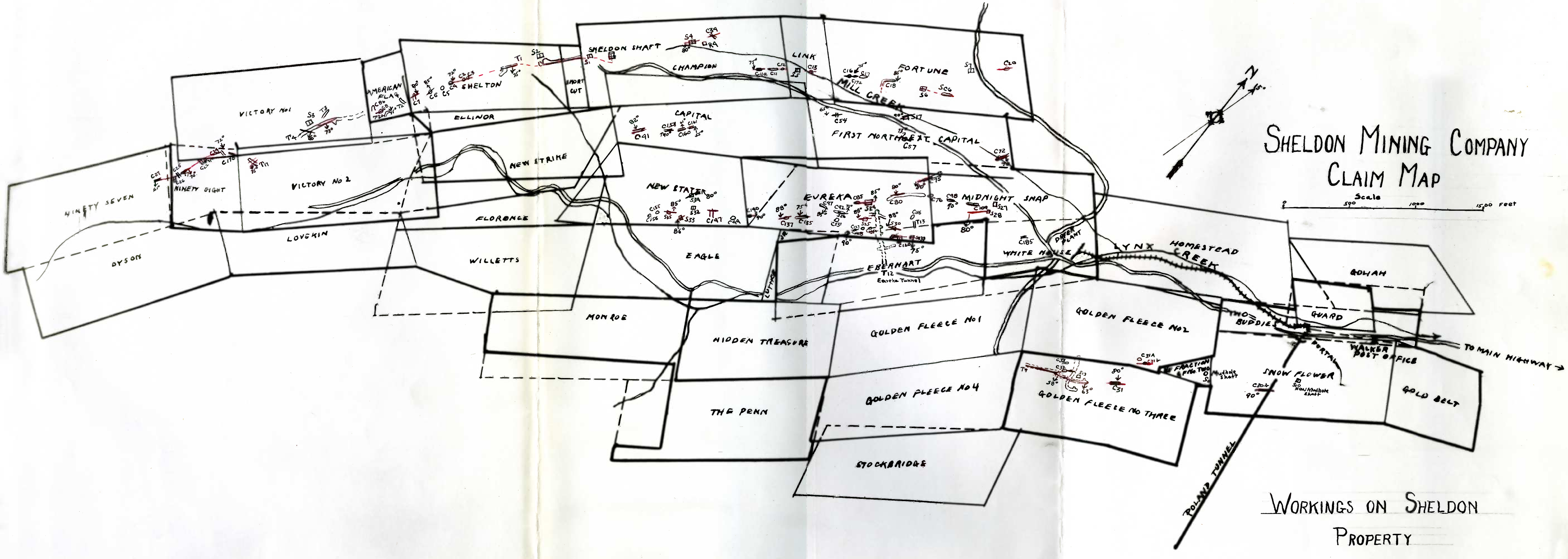
EUREKA
MIDNIGHT SNAP
WILLETTS
EAGLE 6600
LUTHER
EBERHART
WHITE HOUSE
LYNX
HOMESTEAD
CREEK
GOLIAH
GUARD
MONROE
6600
HIDDEN TREASURE
GOLDEN FLEECE No1
GOLDEN FLEECE No2
TWO BUDDIES
WALKER POST OFFICE
TO MAIN HIGHWAY →
6700
THE PENN
6800
GOLDEN FLEECE No 4
GOLDEN FLEECE No THREE
FRACTION
SNOW FLOWER
GOLD BELT
STOCKBRIDGE
POLAND TUNNEL



Sheldon Mining Company Claim Map

Workings on Sheldon Property

VERTICAL PROJECTION SHELDON VEIN SYSTEM
LOOKING NORTHWEST
UNDERGROUND WORKINGS TAKEN FROM MINE MAPS

After Report of George A. Packard – February 1931.

SHELDON MINING Co

Copy PJL's letter ——
to French Mch 11/31

"Have just read Mr. Colvocoresses' letter, and while naturally I don't know much what I'm talking about, there is one point which seems to me rather important, and which Mr. Colvo does not mention, and which Packard passes over with a few words in his report, and those few words may not necessarily be true. In speaking of the silver and copper curves on page 20, Packard states that they "both tend to show a peak between the 650 and 950 levels, doubtless due to leaching from above and secondary enrichment."

I have been talking to Dr. Sampson down here, who is, incidentally, a good authority on this sort of work, and he for a number of reasons doubts seriously that contention. He does not believe it true, first, because the so-called enriched zone is too far below the surface and, at least the present, water table. You don't happen to know, off-hand, what the water table was back in 1900 when they were mining at Sheldon ? It may have risen since then. His second objection to the enrichment theory is that there is little chalcocite to be found in this zone that would be visible to the naked eye, and chalcocite, in large quantities, is supposed to be present in all zones of enrichment. Perhaps I was mistaken in telling him it was not present, but on the other hand, Packard does not exactly make sense when he states, at the top of page 18, "Chalcocite occurs .... both as the sooty secondary variety and as the primary steel grey mineral. The latter occurs more generally <u>below</u> the 650 level." Obviously, this does not jibe with his statement quoted above relative to enrichment between the 650 and 950 levels. It seems to me that the secondary form of chalcocite should be found here, if anywhere.

The importance of determining whether or not Packard is right about this is obvious. If the zone is an enriched zone, there is no possibility of coming upon any commercial ore after you have passed down below it. If, however, the apparent higher values of the 650-950 levels is due to a primary variation in the magma when the vein was formed, there is a possibility that more good ore may be found with depth.

In view of the above, Dr. Sampson believes it would be useful, if not important, to try to throw some light on this subject. It would not be at all difficult to establish an answer here in the laboratory by having some sections made of the ores in question. If the ores are secondary, there is no use going further downward. If they are not, there is still some chance of finding more at depth.

I hate to be a second Maury and ask you to get my milk for me and have my laundry done up and a thousand other things, but would it be too much trouble for someone to get me a few ore specimens from the different levels so I can see what can be dome with them ? Of course, I should have done that when I was there in December, but I was in such a fog I did not know just what I did want. What I would like, would be a hand specimen from, (wherever possible), each level, starting at about the 450 and going down to the 1100 on, for instance, No. 1 ore shoot. And similarly, specimens of ore from the No. 5 shoot starting at about the 850, and on down to the 1250. That totals up to about 10 specimens as I figure it. If you figure that some of those places are inaccessible, it wouldn't make much difference if the same thing were done on another shoot which, in your opinion, would be better for the purpose. The better looking the specimens are as to amount of different minerals, the better they will look under the microscope; so for that reason an exceptional ore specimen might show up more interesting things than a typical one. I sure would appreciate it if you could send me those. I'm sorry I didn't have enough sense to do it myself. I can use them as soon as you can get an opportunity to send them to me, as it takes a little time to have the sections made, and the report is due much too soon."

W J Casey's letter of April 9, 1931

The first gold taken from in and around Walker was placer, started in or about 1862 on Lynx Creek; also from Rich Gulch and Knapp's Gulch. Rich Gulch cuts thru part of the Sheldon claims, then turns south and parallels the Sheldon vein for about 2000 feet. At this point there was some very rich placer dirt washed. Then it cut thru the Sheldon vein and lost the pay dirt.

Lynx Creek parallels the Eureka claims. Along here was the richest placer found on Lynx Creek. Knapp's Gulch also parallels the east holdings of the Sheldon property. The gold taken from that gulch was mostly nuggets, the largest of which I know being worth $80. Placering on Lynx Creek has continued intermitently ever since.

On Fortune claim in the early days there was gold ore taken from the Sheldon vein that assayed as high as $300. to the ton.

The rich ore mentioned was taken from the various veins long before wagon transportation. The ore was packed to the mill which was an araster, built with flat rocks on the floor and standing on end for the sides, with similar rocks for drags for crushing the ore. There were three of these arasters along the Sheldon vein. The one up close to the present Sheldon shaft was worked by a man by the name of Shelton, who arastered ore for many years.

In 1893 when the price of silver dropped, men came from Colorado to Arizona, many of them to Walker. They leased the Sheldon holdings at that time owned by Judge Griffen. They put the Fortune shaft down 100 feet and another one 90 feet. They milled their ore at a ten-stamp mill and got some very good returns until they reached water level. I was in the Fortune shaft in July 1893, when the leasers were working it. At that time there was three feet of ore that assayed $35. gold and silver. They paid no attention to copper in those days. There was an araster on the Eureka claim also where the old timers worked out some very high grade ore, and later had a three-stamp mill a little below the present Sheldon tailings pond.

The Gold Penn was the original name of the mine now known as the Mudhole. The miners gave it that name on account of the talc, which, when wet, stuck to their clothes and when they came off shift they had to scrape it off with some sharp edged instrument. The Gold Penn was owned by the same man as the Sheldon, Judge Griffen. In the early days he and a man named Fred Gobel worked on the Mudhole property east of the Walker store, and they called the shaft their "bank". The Mudhole ore consisted of a granular mixture of galena, zinc blende and small amounts of other sulphides. The gold and silver ran about $75. a ton.

About the year 1904, George Middleton and T. G. Norris, of Prescott, secured a lease from the then owner, a Mr. Ingraham of Minnesota, of the ground which at present composes most of the Sheldon property, near Walker. A company was formed to develop the claims, but due to insufficient capital, coupled with poor management, it was not successful. However, Middleton did succeed in sinking a shaft, the No. 1, about 200 feet, and also doing some drifting and stoping, north and south, on the 100 and 200 foot levels. This was in 1905 and 1906.

Some excellent gold, silver and copper ore was produced, but not in sufficient quantities to make it pay. There was no electric power at Walker at that time and timber on the claims furnished fuel for the boilers.

The property stood idle from 1906 to about 1916, about which time the present company was formed. The following claims were purchased outright from Ingraham and became the nucleus of the Sheldon Mining Company property:

American Flag	Fortune
Shelton	Capital
Short Cut	Midnight Snap
Champion	Whitehouse -
Link	

all patented.

GEORGE M. COLVOCORESSES
MINING AND METALLURGICAL ENGINEER
1108 LUHRS TOWER
PHOENIX, ARIZONA

February 26, 1931.

Mr. H. R. Lathrop,
Room #2501,
111 John Street,
New York, N. Y.

Dear Sir:

This letter is intended as a comment on the report for the Sheldon Mining Company, by George A. Packard, dated February, 1931.

I have very carefully gone over Mr. Packard's excellent report, especially his conclusions and recommendations. It is evident that Mr. Packard has made a very thorough and careful examination of your entire property, including the surface workings and outcrops, other than those on the Sheldon Vein, many of which I understand had never before been critically examined and sampled. Mr. Packard's conclusions are obviously entitled to great respect as representing the opinions of a very experienced and capable engineer, based upon a large amount of data and a careful correlation of all the information obtained. With many of his conclusions I entirely agree, but there are some exceptions to which I wish to call your attention.

Apparently Mr. Packard has divided the showings into three principal vein systems, namely, the Mud

Hole Vein, the Eureka, with its extension to the Midnight Snap, and the Sheldon, including the Capital.

In reference to the Mud Hole, Mr. Packard considers that no information now available seems to justify any further exploration of this portion of the property, and, no doubt, he is correct as far as present conditions are concerned. However, we have substantial evidence that the Mud Hole at one time produced a large quantity of good grade gold-silver ore which concentrated into a product containing $70 value in gold and about 5 ozs. silver. It is reasonable to suppose that some ore is still left in the mine and it is important to determine whether or not its quantity and quality would justify the substantial expense involved in reopening the property.

Mud hole

It appears to me that before you reach any definite conclusion on the Mud Hole, it would be very advisable to make a more thorough search of the records of operation, and, if possible, to obtain from the former owners any assay maps or engineers' reports that may still be in existence. I understand that the local records were all destroyed by a fire but believe that duplicates of these may have been retained at the eastern office of the Arizona-Penn Mining Company, which I am told was located somewhere in Pennsylvania, and it should be possible to obtain the former address of this company and the names of the officers who might be able to uncover important information in their files and submit the same to you for further consideration.

In reference to the Eureka Vein System, I recall visiting the Eureka Tunnel several years ago and noted a little ore in the crosscut at the end, some of which was then being stoped out for shipment to Humboldt. My general opinion was not favorable. As Mr. Packard suggests, these workings could probably be turned over to lessees who might gouge out a small quantity of high grade material and at the same time carry on a little development which might be valuable in future.

Eureka

The most important vein system is, of course, the Sheldon, and the future of your Company will probably depend almost entirely upon the operations which can be carried out on this vein and its extensions. It therefore becomes doubly important to arrive at some definite conclusion concerning the probable condition of the ore deposits indicated by outcrops on the Sheldon Vein or in the workings from your main shaft.

Now, in reference to the geology and ore occurrences at the Sheldon, Mr. Packard expresses opinions with which I cannot agree. On page (11) of his report he states that: "veins formed in the Tertiary Period have not been found to persist to a depth of more than 3000', while those in the Pre-Cambrian often continue to great depths". I am always distrustful of sweeping assertions of this nature but must agree with Mr. Packard in the above statement, at

Sheldon x Capital

least in so far as it applies to most of the veins so far developed in Yavapai County; but I do not believe that the Sheldon Vein belongs to the Tertiary Period.

The Sheldon Vein occurs in the granodiorite which is admittedly of doubtful age but younger than the other intrusives, excepting the rhyolites and porphyrys. Packard quotes Lindgren as believing that this granodiorite was formed in the Cretaceous or early Tertiary Period and this conclusion is apparently based on the fact that it resembles certain intrusives found on the West Coast which have been assigned to the Jurassic and later periods. There is, however, no very definite information on this point.

Jagger and Palache, who studied the Bradshaw District much more carefully than Lindgren, merely state that the age of the granodiorite is uncertain, but older than the Tertiary. On their map they show it as late Algonkian, i.e., just prior to the Cambrian. I think that no definite determination of the age of this rock has yet been made by any geologist, but still I feel that there is much evidence favoring its being considerably more ancient than Packard or Lindgren suppose, and this evidence is found more particularly in the minerals which compose the vein filling, rather than in the composition of the rock itself.

Lindgren's study of this district was (as he himself states) made hurriedly and when he examined the

Sheldon in 1922 the workings had reached a depth of only 650' and most of the development was on the 450' level and above. Lindgren wrote: "Most of the value of the ore is in gold", which statement he certainly would not ~~have~~ make if he had the opportunity to visit the mine as developed at the present time.

It is of course obvious that the granodiorite must be younger than the schists and granites, all of which are definitely and anciently Pre-Cambrian, but the intrusion might have occurred at any time subsequent to the formation of those rocks and the formation and filling of the veins might have occurred shortly after the intrusion or at any later time. As to the method by which the ore has been deposited, there has usually been a fairly substantial agreement that this came from heated solutions originating in a deep-seated magma, and the similarity between the minerals found in the Sheldon and Storm Cloud and the minerals found in the Blue Bell and some of the other mines would seem to indicate that all of these veins might have had their origin from the same or a similar source - possibly the ~~later and~~ comparatively recent rhyolite intrusions, but equally possibly blind magmas which may underlie the schists, granites, granodiorites and other formations found in the Bradshaws. The origin of the ores as above suggested has I think been approved by J. H. Shooley who examined the Sheldon in 1916, Mark Bradley in 1915, W. V. DeCamp in 1918, and Julius Kruttschnitt in 1922.

It is to be noted that both Jagger and Lindgren in describing the various minerals which are found in the district (other than gold and silver) indicate that these are usually noted in the Pre-Cambrian deposits. This applies particularly to Galena, Sphalerite, Tetrahedrite ~~and~~ Chalcopyrite and Pyrite. It is true that nearly all of these minerals are found to a small extent in some of the latter veins but their presence in such quantity as occurs in the Sheldon Mine would seem to indicate a relationship to the older deposits.

The Sheldon Vein is a normal fissure and the quartz filling is unlike the replacements, such as those which occur at Blue Bell, but some pertinent comparisons may be made and, in this connection, I wish to mention that in 1919 a very careful petrographic study of the Blue Bell rocks and ores was made by Prof. Charles P. Berkey of Columbia, who is a recognized authority on this subject. Berkey considered that it was impossible to determine whether the mineralization of the Blue Bell Vein occurred during the original deformation of the schist in Pre-Cambrian times or at a later date, but he was quite positive that the minerals were derived from ascending solutions originating in an intrusive magma and it is to be noted that, although the proportion of the various minerals is different in the Sheldon and Blue Bell, practically the same minerals do occur. In Berkey's opinion all of these minerals were deposited in very ancient times, and he concluded that there was every indication that the vein itself would go down to great depths, and also that the mineralization would continue downwards except as it might be modified by local conditions causing zones of enrichment or of impoverishment, the occurrence of which could not be predicted from geological considerations, but only by actual underground exploration.

I understand that similar petrographic studies of the Sheldon rocks and ore minerals are now being undertaken at Princeton University and these will have a more direct bearing on the question at issue than the similar studies made at the Blue Bell, but, none the less, I think that the latter are worth mentioning.

It is, therefore, my opinion that the Walker granodiorite was probably formed in a period much before the Tertiary. I believe also that the Sheldon Vein may have been formed and filled at a much earlier period and I do not think that there is any geological justification for concluding that either the vein or the ore will peter out at a comparatively shallow depth. It is, of course, impossible to determine how much of the original surface of this country has been worn away by erosion but the fact that the vein can now be traced for over 7,000' on the surface and the vein system (if one includes some of the apparent extensions) for a much longer distance, would in my opinion justify the probability that the vein will extend far below the 1250' level in the Sheldon Mine and that ore will also continue downwards, except as this is influenced by purely local conditions.

As to the decrease in the length of the oreshoots and the value of the ore which is noted by Mr. Packard, especially on his graphs, I can only say that I do not consider that the development which has been done below the 950' level, , or even below the 750' level, is sufficiently thorough to enable one to draw ~~positive~~ conclusions. It is, of course, possible that the ore may be passing through a very poor zone below the 950', and it is equally possible that a greater quantity and better quality of ore might be found below, as was the case at Blue Bell and the United Verde, or, on the other hand, the ore may pinch out entirely. Certainly the present showings on the 1100' and 1250' levels are disappointing and do not justify any optimistic opinion regarding the lower workings of the mine. I understand, however, from Mr. French that the expense involved in keeping the two lower levels open is small and I would, therefore, suggest that at some future time the Sheldon Company should set aside a definite amount of money to be used for further development on these two levels and above - particularly in extending the 1250' level under the #4 oreshoot and in extending the 850' (which really terminates about 100' short of where it is shown on the mine map) and the 950' to the north, which work could be followed by a similar extension of the 1100 and 1250', provided satisfactory results are obtained.

It seems to me quite possible that these extensions of the levels, coupled with crosscuts or long holes into the walls at intervals, might entirely change the present outlook, otherwise, one would simply have to admit that for some reason or other the ore had become impoverished below the 950' level and it would then be in order to adopt Mr. Packard's suggestion that the two lower levels of the mine should be abandoned altogether except for the extraction of such ore as is already developed and can be mined with a profit.

Meantime, I entirely agree that Packard's recommendation to continue the development on the upper levels is the logical policy for the company to pursue and this work should probably be done in advance of any exploration at depth, both because it is likely to develop some ores with substantial gold values which could be profitably mined under present conditions and because there is reason to believe that more important ore bodies will be found north and south of the present workings than in the extension of the developed oreshoots below the 950'. I believe that your surface indications are extremely promising and give you every reason to hope that some good oreshoots exist beyond the limits of your underground development, and there is always a chance that entirely blind lenses or shoots will be found in the vein as has proved to be the case in many other mines of the district. Should any new shoots be found, it would be logical to expect that their long axes would be in the vertical plane and that you might be able to profitably mine them all the way from the surface or apex down to some undetermined point and possibly well below the present lower workings in the mine.

In connection with the ore values, working costs, and profits, I note that Mr. Packard's figures check quite closely with those which I made for you when reporting on your property in April, 1929. The results, of course, are arrived at by the application of simple mathematics, but they emphasize the fact that much of your ore in the lower levels is non-commercial, while present metal prices prevail, and would not allow any substantial margin of profit unless the prices of copper and silver improved to an extent that cannot be reasonably anticipated.

Obviously there is no gain for a company to spend money developing ore which can only be mined and treated at a loss, and, therefore, for economical rather than geological reasons, I feel very strongly that your logical policy will be to concentrate your future developments on the upper levels of the mine, at least until such time as a substantial improvement in the metal prices may permit you to class as commercial the ore which you have developed or are likely to develop on the 1100' and 1250' levels. If no better grade of ore should be found on these levels than has been proved to date, it might seem desirable to abandon them even though substamtial additional tonnage existed.

In any event, I would certainly not advise you to consider at present any exploration to a greater depth. I think that for the time being you should confine your work to the 450 and 650' levels; later consider the further exploration as suggested below 650 and 950', and only plan on further sinking in the event that a very much better grade of material is eventually proved up in the lower workings of the mine.

In addition to the extension of the levels for the purpose of proving up additional oreshoots as recommended, I want to repeat that I believe you should now thoroughly explore the old workings between the 450' and the surface. Your block stope map indicates that about 8,000' tons of ore with excellent gold values is left on the north side of the shaft above the 450'. Some of this may be inaccessible except at prohibitive expense, but, from past experience, under somewhat similar conditions, I believe that you are very likely to find a much larger tonnage of ore in these workings than can now be estimated, and much of this material should be of a sufficiently good grade to work with profit even under present market prices.

If oxidized ore is found, it may be difficult to concentrate with advantage, but, in any event, it would be a very desirable charge to a smelter and you might find it possible to cover the upkeep of your property and to pay for a moderate amount of exploration from such a production as could be made from these old workings.

Very truly yours,

G. M. Colvocoresses

GMC:EBH.

P. J. Lathrop

Saved = ✓

WALKER COLLECTION(Tray #1)

Specimen #	Description and location	Thesis page
C1	Gneissoid granite from included block. T12.	
C2	Typical g. d. with quartz stringer	39
B10	Typical g.d. with aplite dike	40
B10a	Same aplite dike with actinolite and quartz xls.	40
C4	Contact of g.d. and schist block. dump S24	5
C5	" " "	"
C6	Kaolinixed vein material Mudhole vein. Entrance T9.	
C10	Contact schist block with g.d. Near cut 100.	5
C13*	Gneissoid granite. Accidental Gulch.	35
C14	Amphibolite schist. " "	34
C15	Same as C13 Further up Gulch.	
C17	" " " . 150 ft. up gulch.	
C18	Weathered granodiorite. 460 ft. up gulch; 30 ft. above road.	40
C19	" " Possibly float.	40
C20	" "	40
C21	Weathered schist	
C22	Schist	
C23*	Contact gneissoid granite with granodiorite. 400 ft. S. of T13 along abandoned R. R.	35
C25*	Basic form of g. d. Entrance to T12.	40
C29*	Green Amphibolite. Cut 185.	34
C31	Weathered granodiorite. 50 ft. West of Shaft 13	40
C32	Bands of iron oxide in g. d. from weathering. 100 ft. west of shaft 13	40
C34*	Typical rhyolite porphyry. Dump shaft 13.	44
C35	Yavapai schist. Tunnel 9	34
C36	" " "	34
C37	Rhyolite porphyry. Tunnel 9	44
B1	Malachite and azurite staining g.d.	

* Slide was made of this specimen.

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