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ECONOMIC GEOLOGICAL RECONNAISSANCE OF CASA GRANDE MINING DISTRICT

PINAL COUNTY - ARIZONA

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J. B. TENNEY

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CASA GRANDE CHAMBER OF COMMERCE

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INTRODUCTION

In response to a demand for general information on the geology and ore deposits of the Casa Grande mining district, this reconnaissance survey was made to serve as a basis for more detailed work at a later date. No attempt at mapping was made during the eleven days spent in the field from January 11 to January 24,1933. All the important mines and prospects were visited, and observations were made of the broad geologic features of the different desert ranges of the district, and, more especially, of those features important from an economic standpoint.

The mining district had its major development in the 'eighties and early 'nineties during which time it was important as a silver district. Since the drop in the price of silver in 1894 there has been some development of copper and gold deposits, but the reputation of the district as an old "ghost" silver district has militated against its development.

The work was done by the author, then a member of the staff of the Arizona bureau of Mines, under a cooperative agreement between the Bureau and the Casa Grande Chamber of Commerce. During the summer of 1934, additional studies were made of the Vekol Mountains deposits.

GEOGRAPHY AND TOPOGRAPHY

The Casa Grande Mining District is of indeterminite extent,and in general, covers that part of Pinal and northern Pima counties south and southwest of the town of Casa Grande. The southern boundary of the area included in this survey has been arbitrarily taken at the common boundary line of Pima and Pinal counties. The district is almost entirely within the Papago Indian Reservation.

Arizona has been divided by Ransome[1] into three physiographic provinces:

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[1] Ransome, F.L.,Geology of the Globe copper district, Arizona. U.S.Geol. Surv. Professional Paper No. 12,1903, p. 10.

The Plateau Province which covers the greater part of the northern and northwestern part of the state; the Mountain Province which covers the higher mountainous part of the state and which cuts a swathe several hundred miles wide from the southeast corner of the state in a northwesterly direction to the site of Hoover Dam near the northwest corner; and the Desert Region to the southwest of the mountains. The Casa Grande district is near the eastern boundary of the desert region. The characteristics of the desert region are marked in general by low-lying north-south to northwesterly striking narrow ridges separated by broad alluvium-filled desert plains with little or no outward drainage. Dry lakes or playas are common and the hill ridges are barren of all but desert vegetation. Rainfall is slight and is confined to a summer season of torrential erratic short thunder storms from July to September, and a winter season of more gentle rains during the months of January and February. The winter rains are uncertain, and dry winter seasons are frequent..

The average elevation of the plains in the Casa Grande district is about 1600 feet above sea level and the highest points of the mountain ridges attain an elevation of from 2000 to 3500 feet. At such elevations in Arizona the winter climate is an ideal one of balmy days and invigorating cool nights. During the summer months, the days are hot, but the nights are cool.

The principal mountain ridges in the district are the Silver Reef, Vekol, Slate, and Cimarron.

Silver Reef Mountains

The Silver Reef Mountains, eleven miles southwest of Casa Grande form a much eroded ridge ten miles in length and about three miles in width with a generally east-west strike. They are separated from the Slate Mountains to the south by a

somewhat rolling detritus-covered plain three miles wide through which protrude several isolated low hills which are erosion remnants of a connecting ridge between the Slate and Silver Reef mountains.

Slate Mountain

Slate mountain, one of the highest ridges of the district, strikes about North 10 degrees west for a distance of nine miles and is about three miles wide. It rises to a maximum elevation of about three thousand feet above the surrounding plains.

Vekol Mountains.

The largest range in the district is the Vekol, separated from the Slate-Silver Reef ridge by seven miles of plain. These mountains are formed of two principal northwest trending ridges about four miles apart joined at their southern ends by an eastern trending ridge. The three together form a U-shaped mass with several minor ridges and isolated buttes within the northward opening amphitheater. The length of the range from south to north is about six miles and the width between the two northwesterly trending main ridges is about five miles. The highest point of the range is at the southeastern end of the western-most ridge where an elevation of about 3500 feet above sea level is attained.

Cimarron Hills

The Cimarron Hills form a northwestward chain of low-lying highly eroded buttes which together attain a length of about three miles and have a width of about two miles. They lie to the south of the Vekol mountains from which they are separated by a broad plain three miles wide at the northwestern end and widening to over six miles at the southeastern end.

GEOLOGY

Silver Reef Mountains

This low-lying ridge is composed essentially of gently-tilted beds of amygdaloidal lavas of composition varying from rhyolite to basalt, resting on an old surface of coarse biotite granite. Erosion has stripped the lava covering from the northern side of the hills leaving a narrow piedmont a few hundred to a thousand feet wide of granite between the valley fill to the north and the lava cliffs to the south. This old granite is much crushed and faulted and the faults have been invaded by siliceous solutions carrying variable amounts of iron and other metals. The faulting was in part at least later than the lava, but mineralization is almost entirely confined to the granite.

Slate Mountain.

The core of Slate Mountain is made up of a mass of pre-Cambrain schist, probably to be correlated with the pre-Cambrain Pinal schist of Bisbee[1] and the Globe-Ray[2]

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1 Ransome, F.L., The geology and ore deposits of the Bisbee quadrangle, Arizona. Professional Paper No. 21, 1904, pp. 24-25.

2 Ransome, F.L. The Copper deposits of Ray and Miami, Arizona. U.S. Geol. Surv. Professional Paper No. 115,1919,pp. 32-34.

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region as described by Ransome. The schist is here made up of thinly-laminated sandy slates with abundant sericite. The schistosity strikes north 10 to 20

degrees west and dips steeply to the east. The outcrops resemble those of the Yavapai schist of the Bradshaw quadrangle. Cutting this old formation are many siliceous iron-stained quartz veins in part cutting across the schistosity and in part occurring as lenses in the schist.

At the northwest end of the mountain, the schist is overlain by a thick succession of Paleozoic and possibly older sediments. The bottom of the section is composed of much indurated quartzite about 1000 feet thick within which occurs a 100-foot bed of very cherty platy dolomite interbedded with a 50-foot sill of coarsely crystalline highly weathered diabase. Overlying the quartzite is about 150 feet of Upper Cambrain cherty limestone probably the equivalent of the Abrigo[1] formation of the Bisbee district which in turn is overlain by about

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1 Op. cit. pp. 30-33.

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150 feet of coral-bearing limestone of Devonian age corresponding to the Martin limestone of Bisbee.[2] Within both of these formations are beds of sandstone 25

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2 Op. cit. pp. 33-42

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to 50 feet thick. Overlying the Martin limestone is a thick bed of pure dark-grey crinoidal limestone probably of Mississippian age the equivalent of the Escabrosa limestone of Bisbee.[3] It is not over 100 feet in thickness and is

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3 Op. cit. pp. 42-44

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overlain by cherty limestone resembling the Naco limestone of Bisbee.[4] Over 1000 feet of this formation outcrops at the north end of Slate Mountain. The

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4 Op. cit. pp. 44-46

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basal members of this section of sediments may be the equivalent of the upper members of the Apache series of Globe with the cherty dolomite corresponding to the Mescal limestone of central Arizona.[5] The dip of the beds is north 20 to 30

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5 Ransome, F.L. The copper deposits of Ray and Miami, Arizona. U.S.Geol. Survey. Professional Paper No. 115, 1919, pp. 42-43.

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degrees west at angles varying from 10 to 20 degrees. The section is much broken by northeast faults with throws of several hundred feet down to the southwest. This series of faults has been responsible for the detached hills between the Slate and the Silver Reef mountains which have been carved from fault blocks of the same series of sediments. There occur also a series of northwest faults through the sediments some of which have large throws.

The mountain has been subjected to considerable intrusion. At the northwest end are several large dikes classified in the field as diorite. The contacts with the limestone are in places formed of garnetized limestone and in other places of iron-stained quartz and calcite. The dikes followed both series of faults. In the southwest end of the range, the schist has been

invaded by a large igneous mass classified in the field as biotite quartz monzonite, near one contact of which the schist has been invaded by solutions carrying calcite, quartz, iron, and copper. The outcrop is about a mile by half a mile in extent.

Near the western flank of Slate Mountain are several isolated low erosion remnants of Paleozoic limestone with the beds dipping to the west.

Vekol Mountains. This range of mountains has been carved almost entirely from Paleozoic sediments mostly limestones. The prevailing dip of the sediments is about north 60 degrees west at angles varying from 10 to 30 degrees. At the southeastern end of the range the basement schist similar to that of Slate mountain is exposed. The range has been subjected to much faulting, the prevailing system being North 10 to 30 degrees West with the down throw to the north-east. The effect of the faults has been to leave a series of northwesterly trending hog-back ridges separated by detritus-filled troughs. The stratigraphic sequence is similar to that in Slate mountain except that the Mescal (?) limestone is missing and is apparently replaced by a thick sill of diabase. In this range, the upper Carboniferous limestone contains numerous beds of sandstone and at least one thick conglomerate member, exposed in the ridge west of the Reward mine. Capping the most easterly ridge formed of Pennsylvania limestone is a thick bed of conglomerate composed of partly rounded quartzite and some limestone fragments, overlain by little indurated red shales. The same conglomerate and shales again outcrop at the southwest end of the range near the Copperosity mine.

The limestone ridge at the northwest end of the range is capped by lava of intermediate to basic composition. On the western flanks of the range the limestone is intruded by two large masses of andesite porphyry capped by andesitic lava flows, breccias and tuffs.

The range has been extensively intruded by dikes classified in the field as diorite and quartz diorite varying in thickness from a few feet up to several thousand feet. Most of the contacts show some alteration. Lime garnet zones are commonly developed and close to many contacts, the limestone has been much shattered and mineralized with iron, calcite, quartz, and copper. This second type of mineralization has been left as copper stained gossan cut by numerous gypsum veinlets.

Cimarron Hills. This low-lying much dissected ridge has been largely carved from amygdaloidal lava the beds of which have been slightly tilted at various angles. The composition of most of them is basic approaching basalt. The piedmont slopes of the hills, from which the lava has been eroded, is composed, in the greater part, of intrusive masses of granite rocks varying in composition from diorite to quartz monzonite. At the southeastern end of the range, remnants of schist remain.

This pre-lava complex has been intensely broken by faults, the predominant strike of which is easterly and which varies from north 60 degrees east to north 70 degrees west. Many of these faults have been highly mineralized by two types of solutions. In one, the prevailing mineral was quartz and in the other, sericite and salts of iron and copper.

MINERAL DEPOSITS

VEKOL MOUNTAINS

This range has been the most extensively mineralized of any in the district and has furnished the greatest bulk of the ore produced in the past. The principal mines are the Vekol, Reward, Copperosity, Great Eastern, Christmas Gift, Republic and Spondulix.

VEKOL MINE

History and Production

The outcrop is said to have been shown to the original locator by a Papago Indian about 1879 three years after the completion of the Southern Pacific Railroad from Yuma to Casa Grande which, until 1880, was the eastern terminus of the road. The locations were acquired in 1880 by Judge John D. Walker who started developing the mine by a series of open cuts and tunnels. The ore extracted was carefully sorted to a grade of from 200 ounces up to several thousand ounces in silver and was shipped to the Selby smelter in San Francisco, to the El Paso smelter, and to smelters in Colorado. Operations were gradually expanded as the development proceeded, and in 1884, Judge Walker enlisted the financial aid of his brother Lucian to further expand the scale of operations by building a mill to obviate the expense of sorting, and to beneficiate the accumulation of rejects from past sorting. The mill was completed in 1885 and consisted of ten stamps followed by pan-amalgamation. It was moved from a former site in Queen Creek near the Silver King mine in 1884, but litigation with the former owners prevented its use until 1885. Water for milling was developed at the mine by the drilling of a 350-foot well. The stamps commenced dropping July 8th, 1885, and the mill was run until about April, 1889 at an average rate of about 470 tons a month. It was finally closed due to the lowering of the mill heads below the economic limit. Shipments of sorted high grade ore were resumed, which were made to the El Paso smelter until the death of John D. Walker in 1894 followed shortly by the death of his brother. Litigation then ensued between the heirs of the brothers, and the mine was closed except at intermittent periods. It was not reopened until 1908 when it was bonded to a New Orleans and Texas company. This company confined itself almost entirely to prospecting. A four-hundred foot shaft was sunk and several hundred feet of deep-level prospecting was done with negative results. The mine was closed after four years of work during which time but little production was made. It was reopened in 1918 by a group of Phoenix men. The mill was reconditioned and concentrating tables were added to treat the large accumulation of mine dump as a low grade ore, but the attempt was a failure. A few shipments of concentrate were made. The property is now owned by Paul R. Daggs of Upland, California. The production figures for the mine have been derived from U.S. Mint Reports, partly from the yearly production figures published each year by the Tucson Star, in large part from smelter settlement sheets in the possession of the owners of ore shipped and a partial milling record, and in part from the yearly reports of the United States Geological Survey on mine production. After allowing for ore stolen and unrecorded production a figure very close to $1,000,000 was arrived at, almost entirely in silver. A summary is shown in the following table:

VEKOL MINE PRODUCTION

Period	Price of Silver	How treated	Ounces Silver produced	Value in dollars	Source of Information
1882	$1.14	Sorted & Shipped	19745	$22,509	Ariz. Star
1883	$1.11	" " "	75676	84,000	" "
1884	1.11	" " "	79279	88,000	" "
1885	1.07	" " "	47121	51,171	Company Records
1885 to 1889	0.98	Milled and bullion shipped	525030	523,752	Company Rec. to March, 1888 Estimated to Apr. 1889
1889 to 1893	0.93	Sorted & shipped	209345	207,664	Company Records plus estimated urecorded shipments.

Period	Price of silver	How Treated	Ounces silver produced	Value in dollars	Source of Information
1908	0.53	Sorted & Shipped	3961	2,256	U.S.G.S.Min Res. A little lead credited
1909	0.52	" "	5329	3,000	(Same as above)
1915	0.51	Ore concentrated & concentrates shipped	30000	16,620	(Same as above)
1916	0.66	Ore concentrated & concentrates shipped	8000	5,816	(Same as above)
GRAND TOTAL			1,003,486	$1,004,788	

Location and Mining Property

The mine is situated on the western side of the Vekol mountains about midway of the length of the range, There are twenty-two mining claims owned of which six are patented. They lie in T 9 S R 2 E Section 33 and in T 10 S R 2 E Section 4 (Gila and Salt River Meridian). The mine is twenty-nine miles southwest of Casa Grande to which it is connected by a forty-three mile fair road, twenty-nine miles of which is partly graded and the ramaining twelve miles of which is a fair desert road passable except in wet weather. The camp, consisting of frame and adobe buildings, four of which are in good repair, has been built in a west-flowing arroya heading in a low pass in the westermost ridge the mountains.

Mine Development.

The major workings of the mine have been driven from a series of tunnels starting from the southern side of the arroya. Most of these tunnels were driven at a down grade of from one to ten degrees in a south ten to thirty degree east direction. They are inter-connected by irregular stopes, raises, and inclines, the whole forming an extremely intricate network of workings which extend a total distance of about 1070 feet to the southeast of the outcrop with a width of about 320 feet. At the south-east end, the workings are connected to the Argosy shaft, an untimbered nearly vertical shaft 300 feet deep. In the arroya northwest of the tunnel entrances the main shaft, a vertical two-compartment timbered shaft, has been sunk to a depth of 400 feet, the bottom 100 feet of which is now under water. At the 250-foot level two drifts have been driven under the upper workings to which they are connected by raises. Very little timbering was necessary and little of the work has been filled. About eight miles was done, the greater part of which is accessible.

GEOLOGY AND ORE OCCURRENCE

The ore occurs as irregular replacements of Pennsylvania Limestone within a horizon varying in thickness from a few feet up to ten feet, locally known as the "shale" horizon. It is capped by hard fractured limestone, and underlain by compact dolomitized limestone. All of the ore was either highly oxidized or enriched. The only primary ore or "protore" (as the primary ore is not commercial) was found at the southeastern end of the occurence in the underlying dolomitized beds near the Argosy shaft. The ore bodies were controlled by a series of closely parallel faults of small throw, striking from north-south to north 30 degrees west, with dips varying from 50 degrees to the east to an equal inclination to the west. The width of this zone of faulting is about 400 feet. The dip of the limestone beds varies from ten to thirty degrees about south seventy degrees west, nearly at right angles to the strike of the fault system. The ore horizon in this zone also dips with the limestone beds so that the high part is at the eastern edge and the lower part

at the western edge. The surface expression of the fault zone is a partial replacement of limestone beds, especially those with abundant chert, by limonite. No lateral work was done outside of the fault zone in the search for other possible zones. A second equally strong, or stronger belt of limonite stained limestone occurs about 400 feet to the west of the prospected zone, under which no work has been done.

At the northwest end of the ore zone, outcropping in the arroya, is a steeply-dipping dike classified in the field as diorite porphyry, 20 to 40 feet thick, striking northeast. It is little altered and contacts with the limestone are generally barren except at the intersection with the north west faults. About 3000 feet west of the outcropping ore is an outcrop about 3000 feet in diameter of andesite lava, tuffs and breccias, dipping to the southwest at about the same inclination as the limestone. It is separated from the limestone by about 2500 feet of recent detritus.

At the southeast end of the workings occur a series of north 60 to 75 degrees east faults, apparently limiting the northwest series or forming fault blocks with them. The limonite stained outcrops of the known ore zone also end at this northeast series of faults.

The ore, judging by the very sparce remaining seams on the edges of the stopes, was almost entirely oxidized. It consisted of small nodules, locally termed nuggets, of horn silver, argentite, and silver-bearing tetrahedrite (freibergite?) in a gangue of iron-stained slightly copper stained kaolinized limestone with abundant secondary calcite veins. Very little silicification exists except at the southeast end of the mine where mineralization was stronger.

There were two ore bodies found and mined: The Corkscrew, which out pped in the arroya, and was followed into the hill to the southeast, and e Argosy to the southeast of the Corkscrew, associated with a continuation of the same series of faults and separated from it by about 170 feet of kaolinized limonite-stained limestone with lean silver values. The Argosy ore body at its southeast end is capped by over 300 feet of limestone. The ore here is said to have been less oxidized. Extraction drifts in the underlying dolomite cut a few beds replaced with galena, zinc blend and pyrite with a little attendant silver.

The occurence of a bedded deposit nearly horizontal on the strike and inclined at a small angle across the strike, consisting of highly enriched silver ore well above the present water table, cannot be explained by the usual processes of vein enrichment. The only satisfactory explanation is that the enrichment was effected by the leaching of values out of a series of closely spaced nearly vertical veinlets and their redeposition at an old watertable. The fact that the ore horizon is now inclined with the dip of the limestone and overlying lavas shows that this old water table was established before the tilting of the beds to their present attitude. The limestone below the old table was altered to dolomite, and all that remained fixed in the old leached area above the water table was the iron, oxidized to the stable form of limonite. The occurence in this respect, closely paralells those of Magma[1] and Miami[2] where mineralization and enrichment took place before the development of the Basin Range structure, of tilted faults blocks.

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1 Short, N.M. and Ettlinger, I.A. Ore Deposition and Enrichment at the Magma Mine, Superior, Arizona. Trans. Am. Inst. Min. and Met. Eng. Vol LXXIV, 1926, pp 194,195.

2. Ransome, F.L. The Copper deposits of Ray and Miami, Arizona. U.S.Geol Surv. Prof. Paper No. 115, 1919,pp 148-149.

FUTURE POSSIBILITIES

The ore bodies already exploited have been almost completely denuded of commercial ore. The favorable horizon at the ancient water table has been so

well prospected in the or[illegible]ault zone prospected that the [illegible]ssibility of the existence of sizeable, hi[illegible]n ore bodies in this zone is [illegible]te.

As previously mentioned, there exists on the property a second parallel strongly mineralized north west belt of limonite-stained limestone to the southwest of the prospected zone. No work has been done at the old water table horizon under this belt. It is quite possible that high grade enriched silver ore underlies this belt at the same horizon as that of the known ore bodies.

There is also a possibility of an ore zone at the old water table horizon at the zone of north east faults to the south of the Argosy ore body. Evidence to strengthen this possibility is that at the Great Eastern property about 2000 feet to the south of the Argosy shaft, the ore is associated with an east-west system of faults at the old water table horizon. Additional evidence strengthening this hypothesis is the occurence of a small outcrop at the same horizon on the eastern slope of the ridge, known as the Mount Vernon, 900 feet distant, closely associated with the same series of northeast faults that limits the Argosy ore. A zone such as this one, would be an inclined one and therefore more difficult to prospect and mine.

GREAT EASTERN MINE

History

This silver deposit, similar in many respects to the Vekol was found shortly after the discovery of the Vekol. The outcrop was not as large and the production was much less. The mine was most actively worked from 1885 to 1894, and some of the ore is reported by the present owners to have been treated at the Vekol mill. An attempt to revive the mine was made in 1931 and 1932 when an extension of the ore zone was prospected by lessees and a little lowgrade lead silver ore was shipped. The mine is owned by the Elliott Brothers of Casa Grande.

Location and Mining Property.

The mine adjoins the Vekol to the southeast, and the principal workings are about 2000 feet from the Argosy shaft. There are several claims in the group all unpatented. The road to the mine from Casa Grande is the same as that to the Vekol up to that property with the addition of two miles of desert road between the Vekol and the Great Eastern. The principal workings are on the north side of a westward-flowing arroya which cuts the westermost ridge of the Vekol range and heads in a high pass in the ridge.

Mine Development.

The principal work done at this property was in open cuts, drifts, and small stopes, aggregating over a thousand feet of work. The general strike of the workings is east-west, and the maximum width about 100 feet. The greatest depth attained in the upper workings was about 75 feet. In addition to this work there was sunk near the eastern end of the workings a vertical shaft, now inaccessible, said to be 200 feet deep.

About 100 feet east of the main workings, two tunnels 50 feet apart vertically, were driven, and a little stoping was done from the upper tunnel.

Geology and Ore Occurrence

The ore at the Great Eastern occurs as replacement deposits very similar to those of the Vekol. The dominating structure is here a system of two or more faults striking east with nearly vertical dips. The ore occurs as bedded deposits in Pennsylvania limestone, one of the important horizons being a kaolinized limestone bed, probably identical to that at the Vekol. Other beds are also replaced, and some ore occurs as a replacement of the fault gouges. The limestone dips in a westerly direction as at the Vekol.

Closely associated with the fault zone, outcropping 10 to 20 feet south of the workings, is a dike classified in the field as diorite porphyry.

The dike is fresh and the contacts with the limestone are generally barren. The ore is all oxidized and remaining streaks much resemble the ore at the Vekol. Residual galena nodules occur surrounded by copper-stained kaolin. The thickness of the replaced beds, judged by the stoping done, varied from a foot to five feet. The alteration of the wall rock is slight as at the Vekol. The total length of the zone as developed is about 500 feet.

Future Possibilities.

The upper and accessible workings have been virtually mined out. There is said to be ore left in the shaft. The close association of the ore with a dike of diorite, and with the east-west fault zone, and the finding of ore in several horizons, makes prospecting for future ore bodies easier than at the neighboring Vekol. The zone is small however, and general prospecting for possible extensions east and west of prospected ground, considering the weakness of the solutions, may not be justified. In the 500 foot length of mineralized fault zone, there is a possibility for the existence in depth of enriched silver ore, and the search for such possible deep favorable horizons is justified.

REWARD MINE

History and Production

The Reward Copper Mine was discovered at about the same time as the Vekol in 1879 or 1880. The price of copper at that time varied between eighteen and twenty six cents. Copper mines were then at a premium and by 1883, the mine had been acquired by a strong company known as the Reward Mining Company, a 110-foot incline had been sunk in ore and the U.S. Mint Report for that year reported 700 to 1000 tons of 26 percent ore on the dump ready for treatment. In the following year, after the development of water in an 800 foot well at the mine a small water-jacket blast furnace was erected. This was put in blast in 1885 and produced, according to the Tucson Star, 37,660 pounds of black copper. The price of copper had started to drop in 1883, and the average for 1884 was 13 cents and for 1885 was 11 cents.

The mine and smelter were closed late in 1885 and remained down until 1902 when the mine was acquired by a British company organized as the United Arizona Copper Company. The smelter was rebuilt and enlarged to a capacity of 30 tons a day and a small production was made in 1903.

In 1905, during the boom copper market of that year, the mine was bonded to a Bisbee and Duluth organization known as the Casa Grande Development Company, promoted by H.B.Hovland and Hoval A. Smith. A small tonnage of high grade ore was mined and shipped to the El Paso smelter in 1907 and 1908 after which the mine was closed. The option was surrendered in 1910. The mine was reopened during the World War years and a little ore was shipped and considerable development work was done by the present owners. The mine was again closed in 1920 and remained closed until 1929 when a lessee shipped 1000 tons of neutral slag from former smelting operations.

The total production of the mine has been about 450,000 pounds of copper with a gross value of about $75,000.

The mine is owned by Kimball Pomeroy and Dr. Schorneck of Mesa, Arizona.

Location and Mining Property

The mine is situated on the eastern slope of the easternmost ridge of the Vekol mountains, about mid-way of the length of the range. It is about five miles due east of the Vekol mine. The property is reached from Casa Grande by a 36-mile desert road, 29 miles of which is maintained as a county road, and seven miles of which is a fair desert road passable except under severe weather conditions.

The property consists of two patented claims and 27 claims held by location. Most of the work has been done on patented ground.

Mine Development.

The principal work has been done from an inclined shaft sunk to a depth of about 600 feet on an inclination of about 27 degrees. The shaft was sunk from the end of a cross-cut tunnel 100 feet long which cut the ore bed on which the shaft was sunk 50 feet below the outcrop. Levels are spaced at approximately 100 foot intervals, and several thousand feet of lateral work has been done on each side of the shaft. At the bottom of the incline a 225-foot winze was sunk at an inclination of 50 degrees for a distance of 25 feet followed by 200 feet of vertical winze. In addition to the lateral work, considerable stoping was done close to the shaft, and several prospect inclined raises and winzes were driven.

A thousand feet east of the inclined shaft a vertical shaft was sunk from which, judging by the size of the dump, considerable work was done. The shaft is badly caved and inaccessible.

Starting 1000 feet south of the shaft, on the eastern slopes of the ridge, are a series of open cuts, cross-cut tunnels and inclined shafts, aggregating several thousand feet of work, for a distance of about 4000 feet south of the main incline shaft. At the south end of this zone a 350-foot shaft was sunk, known as the Phonodorea shaft.

Geology and Ore Occurrence.

The ore occurs entirely as bedded replacements of Pennsylvania limestone in close association although not generally in direct contact with porphyry dikes classified in the field as diorite porphyry. The dip of the limestone is west 15 to 20 degrees. The principal ore bed developed lies below 15 feet of calcareous, thin-bedded shale, which is overlain by ten feet of thin bedded brown quartzite, in turn overlain by a massive medium-grained limestone. The principal ore bed outcrops as copper-stained gossan about three feet thick for about 100 feet on the strike followed to the south by over 100 feet of massive garnet two to three feet thick. The main shaft was sunk near the center of the gossan outcrop and continued in oxidized ore to a depth on the incline of over 600 feet. The lateral work at each level developed a length and thickness of ore on each level of about the same as the length and thickness as that of gossan outcrop. South of the ore garnetized limestone was encountered on each level. An inclined winze 100 feet deep was sunk at right angles to the bedding on the 300-foot level was driven in fresh limestone throughout. The ore bed terminated at the bottom of the inclined shaft against a strong fault striking north-south with vertical dip. The winze from the bottom of the shaft was started in the fault and was continued to the bottom in unaltered limestone.

East of the outcropping ore bed, covered by the mine dump and surface detrius, a north striking fault of several hundred feet occurs which has dropped the beds to the east several hundred feet as evidenced by the outcrops occurring in a low hill 500 feet east of the main workings on the eastern flanks of which a vertical shaft was sunk in an attempt to find the faulted segment of the ore. This shaft, now inaccessible, was sunk on an east-west nearly vertical fault associated with a strong copper-stained gossan. Judging from the dump at the shaft, the work was done in limestone and quartzite.

About 1000 feet south of the main ore outcrop, on the eastern side of the ridge, a dike or mass of porphyry outcrops, classified in the field as diorite porphyry. This dike with a generally north-south strike can be traced for over 3000 feet to the south. Its width is uncertain as the eastern side and a considerable part of the outcrop itself is covered by recent conglomerate or "caliche". Considerable mineralization accompanies the dike. At many points, certain favorable beds are strongly garnetized, and in several occurences garnetization extends for several hundred feet down dip from the contacts. The garnet formed in the yellow lime garnet grossularite. Other beds have been

intensely replaced with iron and copper sulphides which have been left as strong copper-stained gossans associated with veinlets of gypsum. Several thousand feet of work has been done on these various outcrops and in the Phonodoree shaft sunk on a massive limonite outcrop about 4000 feet south of the main Reward workings the only sulphide ore on the property was encountered as three beds replaced by zinc-blende associated with pyrite specularite, magnetite, and chalcopyrite. The thickness of mineralized beds in the southern contact deposits varies from a foot to ten feet and over. The copper occurs as veinlets and stain of chrysocolla in the gossans. The gossan material consists of limonite and much silky yellow jarosite. The grade is generally low in copper, although some small lenses of better grade ore were encountered.

Future Possibilities.

The oxidized ore remaining in the main workings at the north end of the property is of medium grade, and requires considerable sorting to allow for shipment to a smelter at a profit. Oxidation is probably deep in this extremely arid part of the state. The present ground water level was encountered in the bottom of the winze off the bottom of the 600-foot inclined shaft, about 400 feet vertically below the level of the surrounding plain. It is, however, probable that oxidation extends considerably deeper than the present ground water table due to gradual rise of the table in the past as the valleys or plains were filled with detrital material washed in from the mountains. In the well sunk at the mine, permanent water was encountered at a depth of about 800 feet. The strong persistance of mineralization following favorable beds, demonstrated in those beds followed, makes the search for deep-level, sulphide ore attractive, as the possibilities are good for large bodies amenable to treatment by selective flotation. In this deep prospecting the search for ore in other beds than those now developed would be necessary.

In the southern end of the property the same conditions exist except that deep prospecting may encounter primary material richer in zinc than in copper.

CHRISTMAS GIFT MINE

History and Production

The Christmas Gift Mine adjoining the Reward to the north was discovered about 1883 by Burnham and Chilson. A rich pocket of high grade gold ore associated with a little galena and lead carbonate was found outcropping. After shipping about $5000 worth of ore, the mine was sold to Eals and Chamberlain of Ohio who continued to develop the pocket and are said to have shipped a total of $45000 of gold ore from the one pocket, which was exhausted at a depth of about fifteen feet below the outcrop.

Very little further work was done. A vertical shaft was sunk about 100 feet north of the outcrop to a depth of 200 feet and drifts were run under the outcrop with negative results. North of the shaft a second small outcrop of oxidized lead ore was later followed and stoped but no further high grade ore was found. The mine is now owned by Mrs. Drew of Casa Grande.

Location and Mining Property.

The mine workings are located on the eastern slope of the north extension of the same ridge on which the Reward is situated from which it is separated by a low pass through which the road from the Reward to the Vekol is laid. The workings are about 2000 feet north 12 degrees west of the Reward. The mine is held by location and consists of several claims.

Geology and Ore Occurrence.

The country rock consists of Pennsylvania cherty dark grey limestone

dipping 15 to 20 degrees west. Cutting the limestone are three or more dikes of porphyry classified in the field as diorite porphyry. The dikes form a series striking North 70 to 80 degrees West and dip steeply to the south. They vary in thickness from three to ten feet. The ore bodies are found at and close to the dike contacts. For the greater length of the contacts there is very slight addition of iron and a little copper to the limestone with many calcite veinlets extending for several feet from the contacts. At certain limited parts of the contacts, oxidized lead ore occurs with occasional kernels of galena, associated with limonite and calcite. The ore streaks are small. In the gold stope, the mineralization extended a maximum distance of 30 feet away from the contact along a favorable bed for a distance of about 60 feet along the strike of the porphyry. The thickness of the bed varied from a few inches up to a maximum of six feet. In the small lead stope north of the shaft an ore body of about equal dimemsions was mined in association with a second parallel dike. Another dike has been superficially prospected with pits and trenches about 100 feet south of the gold stope, but little or no commercial ore was found.

Future Possibilities.

The occurrence of the one small rich gold pocket makes the search for other similar pockets attractive. Considerable trenching of the numerous porphyry dikes is warranted. The weakness of mineralization and the small size of the ore bodies makes more expensive prospecting very hazardous.

REPUBLIC MINE

Location and Mining Property

The Republic copper mine covers a large group of claims about three miles southwest of the Reward Mine in the Vekol mountain ampitheater. A considerable amount of work has been done at various parts of the group chiefly in open cuts, shallow pits and inclined shafts. The most extensive workings are at the southwestern end of the group where a large open cut was made and a vertical shaft over 100 feet deep was sunk.

The principal production was made in 1917 when a little ore was sorted and shipped. The property is owned by The Elliott Brothers of Casa Grande.

Geology and Ore Occurrence.

The ore occurs as contact replacement deposits of Pennsylvanian limestone in close association with dikes of porphyry classified in the field as quartz monzonite. The dip of the limestone is about 20 degrees west. Several irregular dikes of porphyry outcrop, and the ore, consisting of chrysocolla and carbonate veinlets in gossans of limonite and jarosite with abundant gypsum, replaces favorable beds close to the contacts. Considerable lime garnet occurs on the contacts. The strongest mineralization is at the southwest end of the property on a low ridge of Pennsylvanian limestone. The limestone is cut by a large northeasterly striking fault bringing basal Cambrian or pre-Cambrian quartzite up on the western side. The fault has been invaded by a dike of porphyry classified in the field as quartz monzonite about 200 feet wide, which increases, 1000 feet to the south, to an outcropping mass about 1000 feet in diameter. A gossan outcrop with veinlets of chrysocolla and malachite was here trenched to a depth of about ten feet for a length on the strike of about 200 feet and with a width of over 50 feet. Abundant lime garnet occurs on the eastern side of the gossan. The porphyry is itself mineralized for a few feet away from the contact by limonite pits and a few small veinlets of chrysocolla.

Future Possibilities.

The ore occurrence is similar to that at the Reward. The ore is low to medium grade and thoroughly oxidized, and necessitates careful sorting to stand transportation charges. The mineralization is strong and the association with a large mass of porphyry makes a condition favorable for the existence of replacement along favorable beds at greater depth. Deep prospecting is justified for possible sulphide ore amenable to concentration by selective flotation into a high grade shipping product.

COPPEROSITY MINE

History and Production.

The Copperosity copper deposit was first discovered and located in the early eighties about the same time as the Reward and Vekol. Very little work was done, however, until 1890 when it was developed under the superintedency of E.J. Bonsall. The outcropping ore was followed down in several inclined shafts but few shipments were made. Development of the mine continued under Bonsall until 1906 when the mine was sold to the Copperosity Mining Company, financed in Texas. Ore was stoped and shipped during the high market of 1907, but the mine was closed at the end of the year.

No further work was done until the World War years of 1915,1916 and 1917 when the company was reorganized and refinanced. A two compartment vertical shaft was sunk to a depth of 300 feet, connections with the earlier developed ore body were made on the 200-foot level and considerable high grade ore was stoped, hauled to Casa Grande and shipped. The mine was again closed at the end of 1917 and has not been worked since. The company was reorganized in 1922 as the Houston-Arizona Copper Company which is the present owner.

The total recorded production of the mine has been about 360,000 pounds of copper with a gross value of about $80,000. In the Copper Handbook, Vol. X, page 679, the mine was reported by the owners to have had a production previous to 1906 of $200,000, but no records exist, and it is doubtful if it was made unless by the Spaniards prior to the Gadsen Purchase.

Location and Mining Property.

The Copperosity Mine is situated at the western end of the east-west trending ridge at the south end of the mountains. The mine is reached from Casa Grande by the 29 mile partly graded county road to the Jack Rabbit followed by about ten miles of fair desert road, passable except in wet weather.

The property is composed of ten patented claims three claims long and three wide together with a claim covering the camp site. At the camp, south of the workings, there are several substantial adobe and frame buildings including a store and general office all in good repair. The shaft and compressor house at the mine is in bad repair.

Mine Development.

The principal work at the mine is a vertical two-compartment shaft sunk to a depth of 300 feet (water level) with levels at 200 and 300 feet below the collar. Several hundred feet of lateral work were driven, and connections were made on the 200-foot level with the irregular workings sunk in ore from the outcrop northeast of the shaft. Off of the inclined workings considerable drifting and stoping have been done, aggregating about 1000 feet. In addition to this, several shallow pits and open cuts were made on ore and gossan outcrops north of the main shaft.

Geology and Ore Occurrence

The claims of the Copperosity mine cover Paleozoic limestones, pre-Cambrian schist, a small area of post-Paleozoic shales and conglomerate, and small outcrops of quartz porphyry. The ore consists of replacement deposits in limestone of carbonates, silicates and oxides of copper in a gangue of limonite, gypsum and calcite. The principal work has been done in Devonian and Cambrian limestones. The property covers a part of an extensive section of sediments and basement schist already described under the general geology of the Vekol Mountains. The dip of the sediments at the mine varies from 30 to 50 degrees North 20 to 30 degrees West. The main vertical shaft starts and was sunk in a pink limestone bed near the top of the Devonian limestone. The dips at the shaft are steep averaging about 50 degrees. A few feet west of the shaft the Devonian limestone is covered by several hundred feet of reddish thin-bedded shales in which there is a thick bed of coarse little indurated conglomerate made up of partly rounded boulders of quartzite and Paleozoic limestone. About 300 feet west of the shaft a large fault occurs which brings up pre-Cambrian schist to the west. The greater part of the camp site is located on schist.

The ore so far discovered, occurs as a single body of oxidized ore replacing Devonian limestone on either side of a series of closely-spaced parallel faults striking North 60 degrees West dipping 45 degrees to the southwest. Mineralization extends about 50 feet on each side of the faults and extends down the dip of individual beds for a distance of 25 feet and over. The ore outcropped and was followed down to a depth of over 200 feet on the incline following the dip of the fault zone. Connections were made with the inclined workings eight feet above the 200-foot level of the main shaft, 100 feet west of the shaft. The inclined workings are irregular and consist of drifts, inclined raises and winzes almost all in ore. The thickness of ore varies from a few inches up to five feet with an average width of about three feet. Considerable gypsum and calcite is associated with the limonite but sparse silica. Considerable ore has been removed by stoping.

Between the ore outcrop and the vertical shaft, there is an irregular outcrop of quartz porphyry showing no alteration but with a little garnet developed on the contact.

The mineralized fault to the northwest of the ore outcrops strongly for a thousand feet or more as veins of manganese oxide and limonite a few inches to a foot in thickness associated with calcite and chrysocolla stain.

Future Possibilities.

The oxidized ore is not high grade as a whole and requires careful sorting to allow for shipment at a profit. Little lateral work has been done out of ore. Due to the dip of the sediments to the west, and to the fact that the ore occurs close to the base of the limestone section, prospecting of the fault zone to the east would penetrate unfavorable quartzites. Prospecting to the west on the other hand is promising as higher horizons of limestones favorable for replacement would be prospected, and the fault zone outcrop is strongly mineralized.

Profitable operations except under an abnormally high copper market are difficult with medium grade oxidized ore amenable only to direct smelting. Oxidation is probably deep as at the Reward. For this reason also, prospecting of the northwest fault zone to the northwest is desirable, as if ore is found, deep prospecting for limestone replaced by sulphide ore would be possible. Deep level prospecting of the zone under the developed ore body would lead shortly into unfavorable quartzite beds. Sulphide ore, if found would be amenable to selective flotation whereby high grade concentrates could be shipped profitably.

CIMARRON HILLS

PAPAGO MINE

History

The first discovery of gold was made prior to 1902 but no records exist as to the locators. The present locations were made in 1902 by W.T.Davis and his wife who found the ground abandoned. A small amount of work had been done on the prominent quartz ledge in the past.

Mr. and Mrs. Davis built a cabin on the ground and lived together there until Mrs. Davis' death in 1932, after which Mr. Davis continued to make it his home.

In 1926 the Papago Gold Mining Company of Casa Grande was organized to thoroughly test the ground. Considerable surface trenching and shaft work was done to determine the extent and value of the ledge. This work is now being continued.

Location and Mining Property.

The mine is situated in the piedmont slopes of the Cimarron Hills at the northwest end of the range. It is about three miles South 45 degrees West of the Vekol, from which it is separated by a somewhat rolling plain. The property is reached by fair desert road from either the Vekol or the Copperosity, and is about 46 miles from Casa Grande.

The property consists of a compact group of forty-one claims six claims long. All are held by location.

Mine Development.

The mine has been developed by a series of cross-cut trenches over a vein exposure of about 3000 feet long. In addition to this, three shafts have been sunk to a maximum depth of 100 feet, and crosscut drifts have been driven from two of them. At the eastern end of the property a short tunnel was driven in the vein off which a shallow winze was sunk.

The trenches, as fast as they were completed to permanent bed rock, were accurately channel-sampled under the supervision of a competent engineer, the large samples obtained were carefully quartered and were assayed and check-assayed. In many cases re-sampling was undertaken. The existing shafts were also carefully sampled and an additional shaft was sunk to a depth of 100 feet.

GEOLOGY AND ORE OCCURENCE

The basement complex in the piedmont slopes of the Cimarron Hills at the mine consists of coarse granitic rocks classified in the field as diorite and quartz diorite grading into granite. The basal rocks are capped to the south of the mine by basic lava flows. Cutting the granitic rocks is a large prominent ledge, 40 to 150 feet in width, striking East and dipping 40 to 60 degrees to the South. The ledge consists essentially of highly brecciated silicified "granite" with numerous later veinlets of manganese and iron-stained calcite, varying in thickness from a knife blade to three inches. The quartz is much iron-stained and all samples indicate the general dissemination of finely divided gold, and some silver mineral. The vein outcrops over a length of about a mile. Over 657 feet of exposure, surface trenching and sampling has been completed, and incompleted trenches have demonstrated the continuity of values to an additional 1242 feet to the west and at least 1000 feet to the east of the proved ground. In the 657 feet of completed work, a geometrical average value for an average width of about 48 feet of the footwall portion of the vein showed$1.73 in gold and$1.05 in silver, a total of$2.78. For the 1242 feet to the west, the average of scattered samples yielded about 1.81 in gold and silver. In the vein to the East scattered samples yielded returns varying from $1.28 to $3.86. One shoot or pocket of higher grade material was found in one of the trenches, where an average of $5.42

over a width of 40 feet was obtained. A 40 foot inclined shaft was sunk at the hanging wall end of this trench and the samples yielded an average of $6.74. A second rich spot was found in another trench where the average over 50 feet of width was $4.08. All the above values are figured on the basis of gold at $35 an ounce and silver at 64½ cents an ounce.

Possibilities.

The strength and size of the vein and the uniformity of values makes the property an interesting one, as very low mining and milling costs could be achieved on the large-scale operations possible. It is unlikely that either impoverishment or enrichment of gold would take place in depth as the vein is compact, and little ground water circulation has been possible. The presence of manganese oxides alone might allow for some enrichment of gold but this would have been counteracted by the calcite present. There is no reason why the vein should not continue to a very considerable depth with the strength, size and gold tenor exposed on the surface.

GREENBACK MINE

History.

The original discovery in the camp was made in the nineties when the brightly-stained oxidized copper veinlets at the site of the camp were discovered. Little work was done until 1916 when ten claims were located by Humphrey, which were purchased in the following year by Paul Hinshaw of Casa Grande. Seventeen more claims were added to the group by location. In 1918, 30 claims known as the Greenback group, covering the greater part of a system of prominent quartz veins were located by Howard Snyder, and these were also purchased by Hinshaw. The Pinal Grande Mining Company was then organized to exploit the copper claims, and, in 1919, a 289-foot churn drill hole was sunk to water level, which was sunk throughout in low grade copper-bearing material, the copper being in the form of veinlets of chrysocolla and carbonates. All work ceased after the break in the market in 1920.

Early in 1921, John Anneshfky, who had been left as caretaker, located three claims known as the Silver Queen group, covering a part of the quartz vein system, and discovered an outcrop of gold ore said to have assayed $20 a ton. This group was then optioned to the Vindicator Gold Mining Company of Cripple Creek, which company sank a 96-foot shaft on the showing. The values ceased at a depth of about 50 feet and the option was surrendered. The claims were then bought by the Pinal Grande Mining Company. After driving a short drift at the bottom of the pocket, work again ceased. A second high-grade shoot of gold ore was found in 1922 at the Greenback shaft, about 2000 feet to the east of the original discovery. Considerable interest in the district resulted and in 1924, Hinshaw and Frank Royer of Los Angeles organized the Greenback Gold Mining Company to take over all the assets of the Pinal Grande Mining Company. The Greenback shaft was sunk to a depth of 100 feet, but as values ceased at 50 feet, and the vein itself proved hard to follow, work was again transferred to the original discovery. The 96-foot shaft known as the Pinal shaft was sunk to a depth of 475 feet, and drifts were run on the 150 and 300-foot levels. Occasional small pockets of low grade ore were found but no ore bodies of commercial grade. Work was also done at the Greenback shaft where several hundred feet of drifting was done on the 100-foot level with negative results. The Pinal shaft was then sunk to a depth of 688 feet. Water was encountered a few feet below the 500-foot level and a small pump installation became necessary. A little work was done on the 600-foot level, and the last work was done on the 500-foot level. On the depletion of the company funds in December, 1926, the mine was closed and left in the hands of

James Megson as caretaker. Assessment work for 1927 was done by sinking a winze on the 500 foot level. In 1932, the group was relocated by Wesley Oates of Casa Grande, on the grounds that no assessment work had been done for 1929 and 1930. His rights were acquired shortly afterwards by Frank M. Leonard of Casa Grande.

Location and Mining Property.

The Greenback Mine is on the northwest slopes of the Cimarron Hills, about two miles southeast of the Papago Mine. It is reached by a fair desert road from the Jack Rabbit Mine, which is connected to Casa Grande by 29 miles of partially-graded county road. The total distance from Casa Grande is about 41 miles.

The group consists of 60 claims covering an area of 1190 acres, all unpatented and held by location.

Mine Development.

The principal work is at the Pinal shaft, about half a mile southeast of the camp site. This shaft was sunk to a depth of 688 feet on an inclination of about 50 degrees, the bottom 160 feet being now under water. Levels were driven east and west on the 50,150,300, and 500-foot levels, aggragating about 700 feet The most extensively developed level is the 500 foot level where 370 feet of drifting was done together with a 40-foot winze.

About 2000 feet east of the Pinal shaft, the Greenback shaft was sunk to a depth of 100 feet on a 40 degree incline. A short level was run at 50 feet, and about 380 feet of drifting to the east and west was done on the 100-foot level.

In addition to this work, a number of open cuts and shallow shafts were driven between the two main shafts.

At the camp site, a 289-foot churn drill hole was sunk, which supplies the camp with water. The camp is supplied with half a dozen small frame buildings, and a large boarding house and store.

Geology and Occurrence.

The basal complex on which the lava rests at the Greenback mine consists of a series of large intrusive masses of porphyry varying in composition from diorite to quartz monzonite. These igneous rocks have been intruded into Pre-Cambrian schist, small remnant outcrops of which are found west of the Pinal shaft. Resting on a partially planed surface of these basal rocks is a thick series of basic lava flows and volcanic breccias, which have been tilted at slight angles to the northeast. The range is a typical basin-range ridge, much modified by erosion into a series of low rugged hills. The basal complex underlying the lava has been exposed by erosion in the piedmont slopes of the hills.

The mineralization is all pre-lava and was probably closely related to the porphyritic intrusives. Two types of mineralization are found. In the first type the magma after solidification and partial shattering, was invaded by solutions containing potash, alumina and sparse silica, together with salts of copper. The fractures were filled with veinlets of sericite and metallic sulphides and the fragments between fractures were partly impregnated. Subsequent oxidation has left a limonite-stained, kaolinized slightly copper-stained mass containing veinlets of chrysocolla. It was an outcrop of this type at the camp site that first attracted prospectors and on which the first locations were made.

In the second type of mineralization, which probably followed the first type, the porphyry was invaded along a major north 70 degree west fault zone, by intensely siliceous solutions carrying a little iron and copper sulphides and a small amount of erratically distributed gold. This type of mineralization has been left as a network of quartz veins which strike northwest in a zone of intensely brecciated porphyry. Parts of the veins are somewhat stained

with limonite, a little green copper carbonate and silicate, and sporadic pockets rich in free gold occur. The total length of the zone is about 3000 feet and the width varies between 50 and 200 feet. The general dip of the zone is about 60 degrees to the south and the thickness of individual veins varies from a foot to over 50 feet. A last phase in this type of mineralization was the filling of post quartz fracture with calcite associated with minor amounts of iron and manganese salts. It is on the veins of the second type of mineralization that the Greenback and Pinal shafts were sunk on outcrops rich in gold. In the work done on both outcrops, the gold-rich pockets in the veins proved small. There is a possibility that they may be the tops of definite shoots, but insufficient work has been done to demonstrate this. The bottom of the ore in the Pinal shaft was reached at 50 feet and no further pockets or shoots were encountered. At the Greenback shaft the bottom of the ore was at about 35 feet. At 50 feet the character of vein filling changed, and the vein was probably cut off by a fault. The 100-foot level drifting was driven entirely in country rock cut by numerous calcite veins dipping at various angles.

At the Pinal shaft the vein dips about 50 degrees to the south and was continuous to the bottom of the shaft with an average thickness of about six feet. At the water-level about 520 feet below the outcrop, occasional grains of rusty pyrite occur in the quartz and on the walls of the vein, and assays have shown the pyrite to be frequently gold bearing. Equally high samples have been obtained from limonite-stained portions of the vein on the 150 and 300-foot levels. The outcrop at the surface on which the shaft was started was more heavily stained with limonite than elsewhere. This condition was also true at the rich outcrop at the Greenback shaft. The vein filling is very dense quarts almost devoid of vugs or fractures. It is highly improbable that sufficient ground water movement has existed in the past to have allowed for transportation and subsequent enrichment of the gold.

At the surface outcrops the quartz has been much reworked by surface waters, with the development in the few feet of surface skin of much chalcedonic quartz containing vugs lined with quartz crystals. Sampling of surface outcrops is said to be an unreliable index of values below. It is possible that any gold present may have been removed in the weathering process.

Between the Pinal and Greenback shafts are many vein outcrops, in the network of veins, more heavily limonite-stained than the two portions of the vein system prospected at depth.

In the work done at the Pinal shaft the greater part of the vein consisting of massive white quartz, was virtually barren of gold.

Possibilities.

The scattered sampling done on the property suggests the association of much of the gold with iron. Work concentrated on the more heavily limonite-stained parts of the vein may develop high grade shoots, or the values may be sufficiently disseminated to constitute a profitable low grade ore. Conditions at that part of the Papago vein, which is much stained with limonite, suggests that similar conditions may exist at the Greenback vein network in those parts more highly impregnated with iron.

S L A T E MOUNTAIN

LAKE SHORE MINE

History and Production.

The small oxidized copper outcrop of this mine, exposed in the bottom of an arroya on the piedmont slope at the southwest end of the mountain, was

first located in the early eighties by Trout and Atchinson. By the end of 1884 a shaft 112 feet deep had been sunk, and drifting had proved an ore body 700 feet long and 100 feet wide under the surface detritus south of the outcrop. The severe drop in the price of copper at the end of 1884, discouraged further work and the property was abandoned for many years.

About 1905 the mine was relocated by B.S.Wilson who shipped a little carefully sorted ore during the high copper market ending with the panic of 1907. The mine was acquired from Wilson in 1914 by the present owner. Frank M. Leonard. A new vertical shaft was sunk, about 200 feet south of the outcrop, to a depth of 285 feet and the ore body was systematically blocked on three levels. It was bonded early in 1917 to the Atlas Development Company and ore was stoped from the richer northern part of the ore body and hauled to the Sasco smelter until July of that year when the option was surrendered. In 1919 Leonard sank five churn drill holes south of the underground workings to further prospect the ground and reported a blocked tonnage of over a million tons of three percent oxidized copper ore. Two winzes were also sunk from the 285 foot level to prospect the ore zone below water-level and some enriched sulphide ore was reported.

During the high copper market of 1929, a small tonnage of ore was sorted from the mine dumps, was hauled to Casa Grande and shipped.

The mine is owned by Frank M. Leonard of Casa Grande, and the production has been approximately 280,000 pounds of copper with a gross value of about $64,000.

Location and Mining Property.

The mine is located at the southwest end of Slate Mountain on the piedmont slope of the range. It is connected to the Casa Grande-Covered Wells road by about three miles of fair desert road. The total distance to Casa Grande is about 35 miles.

The mining property consists of a group of 35 claims, three of which are patented. The camp is situated on the mesa east of the workings and consists of frame dwelling houses, boarding house, and power plant.

Mine Development.

The principal development on the property has been from a two-compartment vertical shaft sunk at a point about 200 feet south of the outcrop to a depth of 285 feet.

From this shaft several thousand feet of drifts, cross cuts, raises and winzes have been driven, from levels 115 feet, 170 feet, and 285 feet below the collar, and considerable stoping has been done above the 170-foot level, most of which was between the 115 foot level and the outcrop north of the shaft. From the bottom level two winzes were sunk which are now filled with water. The level work was done in a systematic manner and was pushed to a total distance of about 550 feet south and 150 feet north of the shaft and cross cuts developed the ground to a distance of about 300 feet east and 200 feet west of the shaft.

In addition to the work from the shaft, considerable work in the form of open cuts, small stopes and shallow shafts was done on the outcrop 200 feet north of the shaft, and other shallow prospect pits were sunk at scattered points on the property. Five churn drill holes south of the shaft were sunk several hundred feet deep.

Geology and Ore Occurrence.

The greater part of the surface is covered by surface outwash. The only outcrop of ore or mineralized ground is in the bottom of a broad shallow southwestward-flowing arroya. This arroya heads in the mountains 1500 feet east where there outcrops a large granite mass classified in the field as biotite granodiorite about a mile long by 2000 feet wide which intrudes the pre-Cambrian

schist which forms the core of the range. The ore outcrop consists of chrysocolla and calcite veinlets cutting a limonitized kaolinized schist. The schistosity strikes north 20 degrees west and dips 50 to 60 degrees to the east. The ore is closely associated with a strong fault zone parralel with the schistosity.

Underground development has proved this outcropping ore to be the northwest end of an ore body of similar material extending about 700 feet to the south with a width varying from 75 to 100 feet, all replacing schist.

On the bottom level, at a depth of 250 feet, the ore body is limited to the east by granodiorite. The contact is approximately north and south and dips 50 to 60 degrees to the west. The contact is about 50 feet east of the shaft. Winzes sunk on the ore close to the contact are said to have penetrated some sulphides of copper, both chalcopyrite and chalcocite. This work is now under water.

The mine has been thoroughly sampled and the results have been posted. The assays posted vary from one per cent to 4 per cent copper with a general average of about 2 percent. The values gradually fade on the upper level both east and west of the ore body through a distance of ten to twenty feet into slightly limonite stained schist and finally into fresh schist. The contact with the granodiorite and the ore on the bottom level is sharp and the alteration of the granodiorite is very slight. Well over a million tons is blocked out, the total amount depending on the minimum grade assumed as ore. All is thoroughly oxidized.

Possibilities.

There exists at the property a large tonnage of oxidized low grade ore in a compact ore body amenable to cheap mining costs. The ore presents a difficult metallurgical problem, as it is too low grade to smelt direct, is not readily amenable to concentration by gravity or flotation, and would be an expensive ore to leach by sulphuric acid due to the calcite present. It is possible that it would yield to ammonia leaching, or possibly a combination of flotation and leaching. The comparatively high grade and size of the ore body warrant careful metallurgical testing.

The limiting of th ore on the bottom level by the granodiorite suggests the limiting of the ore in depth, and that the ore body occurs in the schist overlying a saucer-like depression at the top of the intrusive mass. However, the steep dip of the contact on the 250-foot level and the absence of granodiorite in the cross-cuts driven several hundred feet east in the upper levels are strong arguments against this. There is warranted a very considerable amount of work in prospecting below water level for possible extensions of the ore body depth into enriched or primary sulphide ore, more readily amenable to cheap concentration.

There is also a possibility that the granodiorite cut on the 285-foot level does not represent the main mass, but a narrow dike apophysis, and that ore will be encountered on the eastern side.

OLD MAMMON MINE

History and Production.

This old gold property is the only property now producing in the district. It was discovered by John Morand and Peterson in 1892 and a company was shortly organized to exploit the find. By 1893, a well had been sunk to water, a pipe line had been laid to the mine, and a twenty stamp amalgamation mill had been built. The vein was opened up and the mill was

operated intermittently until the middle of 1897. A total of about 2500 tons was treated of ore netting about $14 in gold which yielded about $35,000 from an ore shoot 80 feet long and two feet thick stoped to a depth of 250 feet, at which depth the shoot was bottomed.

Little work was done after 1897 until late in 1932 when the property was bonded by Mrs. Elizabeth Elliot of Casa Grande, the present owner, to Mr. Minor. Surface trenching near the old workings uncovered a parallel vein from which a test shipment of two tons made in January,1933, returned over $30 a ton in gold.

Location and Mining Property.

The mine is on the western slope of the ridge about midway of its length in a shallow basin cut by a northwestward flowing arroya. It is reached from the county highway between Casa Grande and Covered Wells by about a mile of fair desert road. The total distance from Casa Grande is about 33 miles.

The property is composed of five claims none of which are patented. The camp consists of one large adobe cabin and several smaller frame cabins.

Mine Development.

The principal work on the property has been done from an inclined stull-timbered shaft sunk to a depth of 270 feet, off of which are several hundred feet of drifts and raises, all connected with partly filled stopes in an ore shoot in a vein striking north 60 degrees east dipping 70 degrees to the northwest. The stoping extends on both sides of the shaft and has an average length of about 80 feet and a thickness of ore varying from a foot to three feet. The stopes were broken to a width of about three feet and the waste was used as back fill. In addition to the main workings the property has been prospected by numerous trenches,open cuts and shallow pits. The present work consists of trenching on a second parallel vein about twenty feet southeast of the older worked vein.

Geology and Ore Occurrence.

The property is located on pre-Cambrian schist composed essentially of sandy slates. The schistosity has been developed parallel to the bedding and strikes north 20 degrees West and dips 50 degrees to the Northeast. Cutting the schist are many white quartz veins, some of which cut across the schistosity and others of which occur as lenses in the schist. These veins are slightly stained with limonite and occasional chrysocolla and malachite. Free gold is erratically distributed in them.

The principal vein worked in the past strikes North 60 degrees East and dips 70 degrees to the Northwest throughout most of its course and where stoped. About 200 feet northeast of the shaft, it makes a sharp bend to the right and at about 50 feet from the bend changes its strike to conform with the schistosity, south 20 degrees east. The thickness of the vein varies from a few inches to a maximum of three feet with an average of about 20 inches.

A parallel vein now being exposed by trenching, the outcrop of which was masked by detritus, occurs about 20 feet southeast of the older vein. Its thickness, exposed over a length of about 50 feet of trench, averages about 20 inches. Two tons shipped in January,1933, returned over $30 a ton. Development work on this vein is now in progress.

Possibilities.

The existence of high grade gold ore shoots in the veins cutting the schist in this area, of sufficient size to warrant limited mine equipment has been demonstrated by past operations. The shoots are small but rich enough to warrant considerable expenditure in trenching and sampling, and the ore is rich enough to stand haulage and freight charges to custom smelters.

JACK RABBIT, TURNING POINT, DESERT QUEEN, AND ORIZABA MINES

History and Production.

These four silver-gold deposits in the Paleozoic sediments at the north end of the mountain were discovered in the early eighties. The first to be exploited was the Jack Rabbit where a little carefully sorted 300-ounce silver ore was shipped in 1883 and the mine had by then been developed to a depth of 90 feet. The following year the orizaba reported to the Director of the Mint the shipment of 5 tons netting $2000 in silver and that about 600 tons of $5 to $100 ore lay on the dump. After the exhaustion of the richer outcropping ore little further work was done until about 1892 when the Jack Rabbit mine was acquired by the Casa Grande Copper and Gold Mining Company financed from Denver. The mine was developed intermittently in the succeeding ten years during which time the demonitization of silver and the consequent drop in the price to a level of less than 60 cents and ounce were discouraging factors. The ore shoot was developed to a depth of 200 feet at which depth a large flow of water was encountered. A cyanide plant was built in 1901 which was not a financial success.

In 1908 the Jack Rabbit mine passed into the hands of the Tube City Mining and Milling Company of McKeesport, Pennsylvania. The main shaft was sunk by this company to a depth of about 400 feet against a very heavy flow of water, and a little rich sorted ore was sacked and shipped until the abandonment of the mine in 1910.

The Turning Point mine adjoining the Jack Rabbit on the west, located on a probable continuation of the Jack Rabbit lode was probably found at the same time as the Jack Rabbit. The first development work was done in 1898 when it was reported that a mill to treat the ore blocked was to be erected. Work was suspended until 1902 when a 10-stamp mill was built which treated a small tonnage, after which the mine was closed. A little high grade ore was stoped in 1911 and shipped.

The Desert Queen, adjoining the Jack Rabbit to the south was first worked from 1905 to 1907 by the Desert Queen Gold Mining Company. Considerable shallow development work was done and a Tremain steam stamp mill of 4 stamps was erected. Amalgamation and concentration methods were employed. After a short run the mine was abandoned.

The Orizaba Mine, about two miles North 50 degrees West from the Jack Rabbit is located in one of several low hills in the much dissected ridge between the Silver Reef and Slate Mountains. After the first work in the early eighties, little was done until about 1915 when the property was developed by a deep vertical shaft, and was equipped with a small mill. Since that time, lessees have stoped a little rich lead-silver ore from shallow depths, chiefly in 1923 and 1925.

The total production of the four mines has been small. Accurate figures are not available. It is probable that at least $20,000 in silver and silver-lead ore was produced in the eighties, chiefly from the Jack Rabbit and Orizaba. The production since then has not been over an equal amount.

Geology and Ore Occurrence.

The ore bodies of the Jack Rabbit, Turning Point, and Desert Queen mines at the northern end of Slate Mountain are replacements of Pennsylvanian limestone in strong fault zones, at or near the contact with dikes of porphyry classified in the field as diorite porphyry. At the Jack Rabbit and Turning Point, the ore is found in a strong fracture striking North 20

to 30 degrees East dipping 60 degrees to the East, at the contact of a 100-foot wide dike of porphyry and Pennsylvanian limestone, the porphyry forming the footwall of the fault. The ore consists of heavily limonite-stained sheared limestone with a little copper silicate and carbonate stain. The better ore is said to have averaged about $18 in silver and gold. The shafts of both the Jack Rabbit and Turning Point are caved and inaccessible. The total length exposed by surface trenching between the two shafts is about 2000 feet.

A heavy flow of water was encountered in the Jack Rabbit shaft at a depth of 200 feet.

At the Desert Queen, the ore occurs in a strong fault striking North 60 degrees East dipping 50 to 80 degrees to the south, cutting Pennsylvanian limestone. Southeast of the fault and parralleling it is a dike of diorite porphyry ten to 20 feet thick. The ore consists of limonite-stained quartz and calcite with some chrysocolla stain. Most of the stoping was done in a single outcropping ore shoot 50 feet long and 80 feet deep. The fault vein has been opened at intervals by pits and cuts for a distance of about 1500 feet along the strike. The porphyry contacts are usually barren. A little lime garnet has been developed sporadically. The ore is said to have contained values in silver.

At the Orizaba Mine, two miles North 50 degrees West from the Jack Rabbit, the ore is associated with a fracture zone 50 feet wide striking north and dipping 60 to 75 degrees to the west, at the contact of Cambrian quartzite to the east and Pennsylvanian limestone to the west. The Pennsylvanian limestone is highly crushed and occurs as a block thrust over the quartzite. The eastern boundary of the block is the north-south fault zone in which the ore occurs. The contact extends to the north a distance of about 500 feet from the valley fill, and then swings to the west. The quartzite beds dip north 50 degrees East 30 degrees. The ore consists of limonite and chrysocolla-stained quartzite with seams of silver-bearing lead carbonate partly replacing the bedding and partly replacing fault gouge. The zone has been opened by shallow pits, stopes and open cuts for a total length of 300 feet on the strike of the fault zone. A vertical shaft was sunk 200 feet southeast of the zone, from which considerable work was done, judging from the size of the dump. The shaft is caved and water stands 75 feet below the surface. A second zone of fracturing within the quartzite occurs 300 feet north of the shaft. This zone strikes North 72 degrees East and dips 70 degrees to the south. It also has been extensively prospected by shallow pits and open cuts. The mineralization in this zone is similar to that in the main workings and it has been followed for a distance of about 200 feet to the northeast from its junction with the north-south zone. Altogether several thousand feet of work has been done on the property.

SILVER REEF MOUNTAINS

SILVER REEF MINE

History and Production

This old silver mine was probably discovered in the early eighties, although it was not mentioned in the early U.S. mint reports.

The first extensive work was done about 1905 when a deep shaft was sunk on the vein and a 20-stamp mill and 50-ton cyanide plant were erected. The company operating the mine was the Arizona Mercantile Transportation and Smelting Company. After a short mill run, the mine was closed. It remained idle until 1914 when it was relocated by B.S.Wilson and about 1000 tons of silver ore were mined from a vein about 2000 feet east of the old workings, after which the mine was again closed. In 1919 it was purchased by Frank M. Leonard and associates. A two-compartment shaft was sunk 125 feet on the vein mined by Wilson

after which the mine w again closed.

In 1925 Frank M. Leonard, Jr obtained a lease on that part of the ground worked by Wilson and shipped 1000 tons of 22 ounce siliceous ore left by Wilson in the footwall of the vein. This ore was shipped to the Hayden Smelter as flux. Shipments continued through 1928 at about the same rate and in 1929 the mine was bonded to the Silver Reef Mining and Milling Company promoted by Percy Williams. The company drove a deep extraction tunnel, and shipped 250 tons of 15 ounce siliceous silver ore, after which the option was surrendered.

The presnt owners are: Frank M. Leonard, Charles R. Leonard, Frank Royer, James W. Gerard, and John Hays Hammond. Twelve claims surveyed for patent are held in the group. The total recorded production has been about $60,000 almost entirely in silver.

Geology and Ore Occurrence.

The claims of the mine are located on the northern piedmont slopes of the Silver Reef Hills, about 13 miles south of Casa Grande. The Casa Grande-Covered Wells partly graded highway passes within a quarter of a mile of the workings and is connected with them by a fair road.

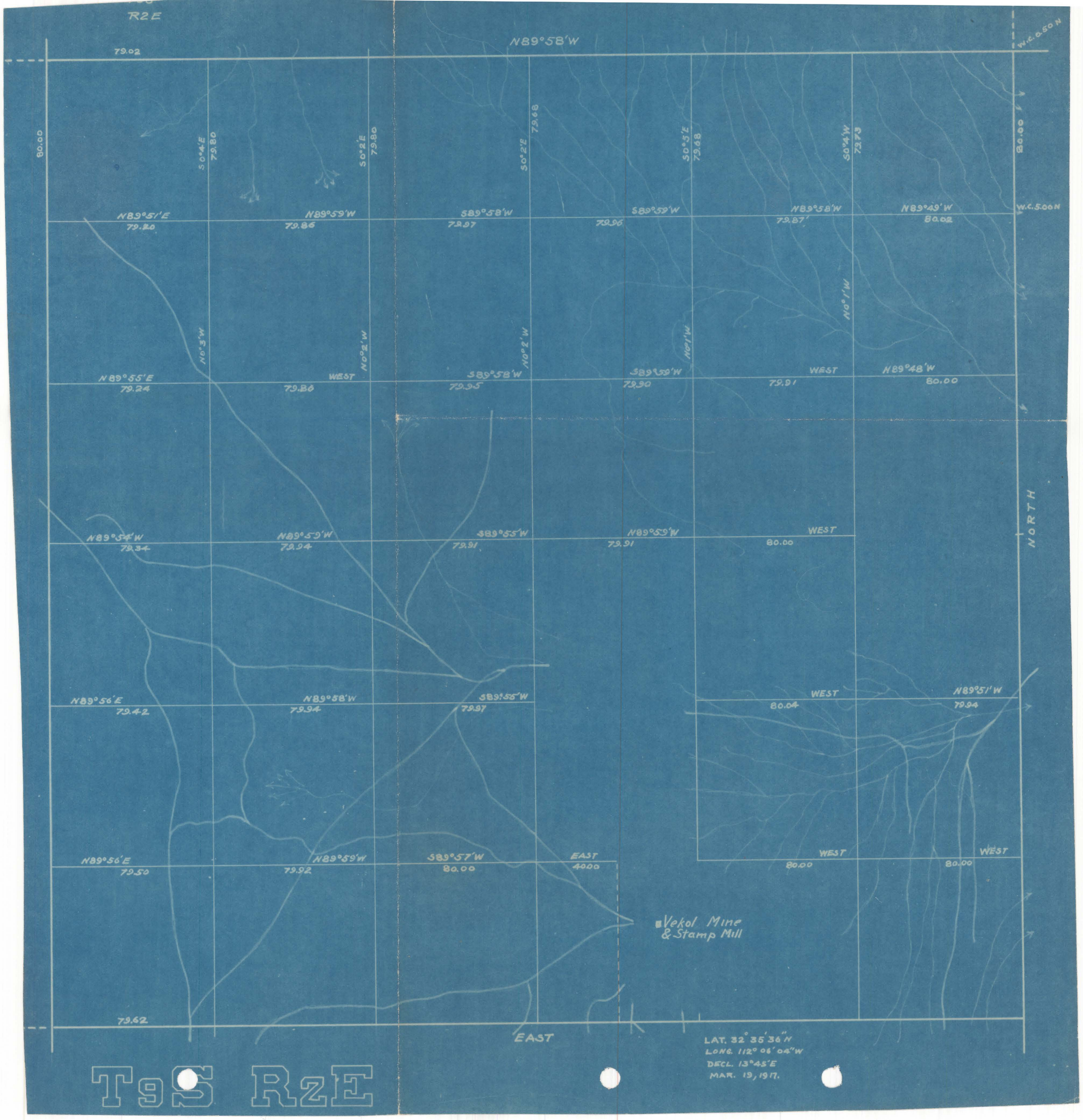
The northern piedmont slopes of the mountains consist of coarse grained granite. A few hundred feet south of the mine workings a partly planed surface of this older granite is capped by essentially flat-lying amygdaloidal flows of lava , the exact composition of which was not determined. The granite has been much broken by steeply inclined faults and sheer zones striking east and west, and some of these faults have involved the lava as well as the underlying granite. The faults have been strongly mineralized by siliceous solutions carrying iron, a little copper, lead, and a small amount of erratically distributed silver salts. Subsequent oxidation has left them as closely spaced limonite and copper-stained quartz veins, varying in thickness from a few inches up to five feet. Many of the veins show crustification and sharp walls, but in most of them the quartz grades through partly silicified granite into fresh granite with no distinct walls. The higher silver values occur as shoots in the vein in association with lead carbonate and copper carbonate and silicate stain. The exact form of the silver was not determined but is probably chloride. A little free silver and black sulphide(argentite?) have been reported. Most of the work on the property has been done at the western end, where several thousand feet of shafts and drifts were driven on a single vein varying from a foot to five feet in thickness. The total depth prospected was about 350 feet, but the workings are in bad condition and were not visited. The production from this end of the property was small and the values are said to be low. The principal production has come from a parallel vein about 2000 feet east of the main workings where a shoot of better grade ore was mined. The vein in the shoot is ten feet thick and the shoot is several hundred feet long. In this vein the fault in which it occurs cut the lava which at the outcrop formed the hanging wall. The mineralization is confined however to the granite. It is probable that the movement on the fault was revived after the deposition of the lava and that the mineralization took place before the volcanic activity.

G E N E R A L SUMMARY

From the foregoing descriptions of the principal ore deposits of the Casa Grande District, it is seen that possibilities for the future development of profitable mines are far from exhausted. Some of the silver deposits were sufficiently rich to have been profitable worked even during low silver market years. The possibilities at these properties for the development of new ore bodies are good.

The copper mines of the district are of medium grade, but the mineralization is strong, and amply justifies the expenditure of considerable capital in the search at depth for enriched or primary sulphide ore amenable to modern metallurgical treatment.

The gold deposits are large but generally of low grade. Their size and consequent adaptability to cheap mining and exploitation make them attractive.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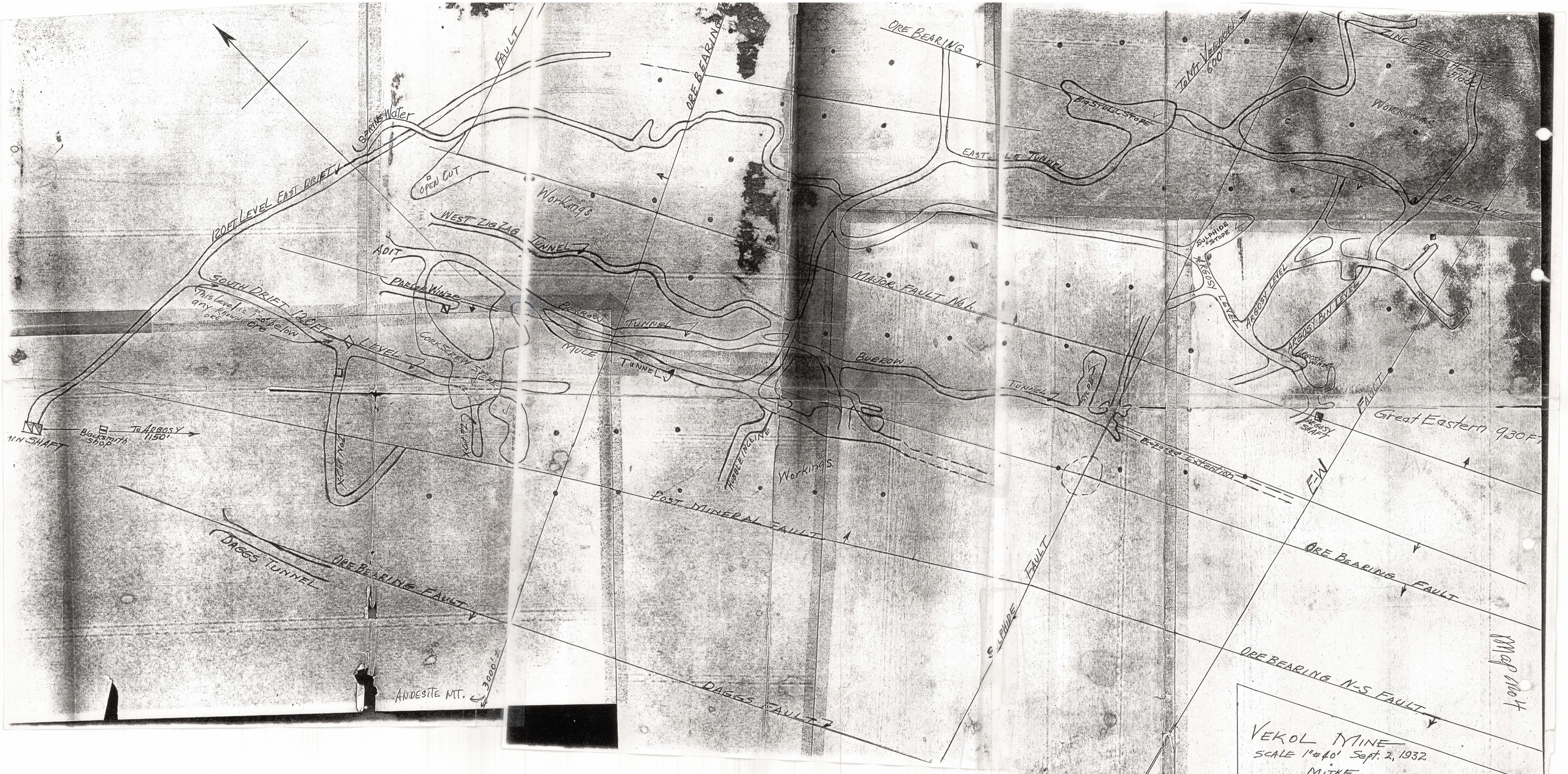
79.50
N89°59'W
79.92
S89°57'W
80.00
EAST
4000
WEST
80.00
WEST
80.00
Vekol Mine
& Stamp Mill
79.62
EAST
LAT. 32° 35' 36" N
LONG. 112° 06' 04" W
DECL. 13° 45' E
MAR. 19, 1917.
T9S R2E

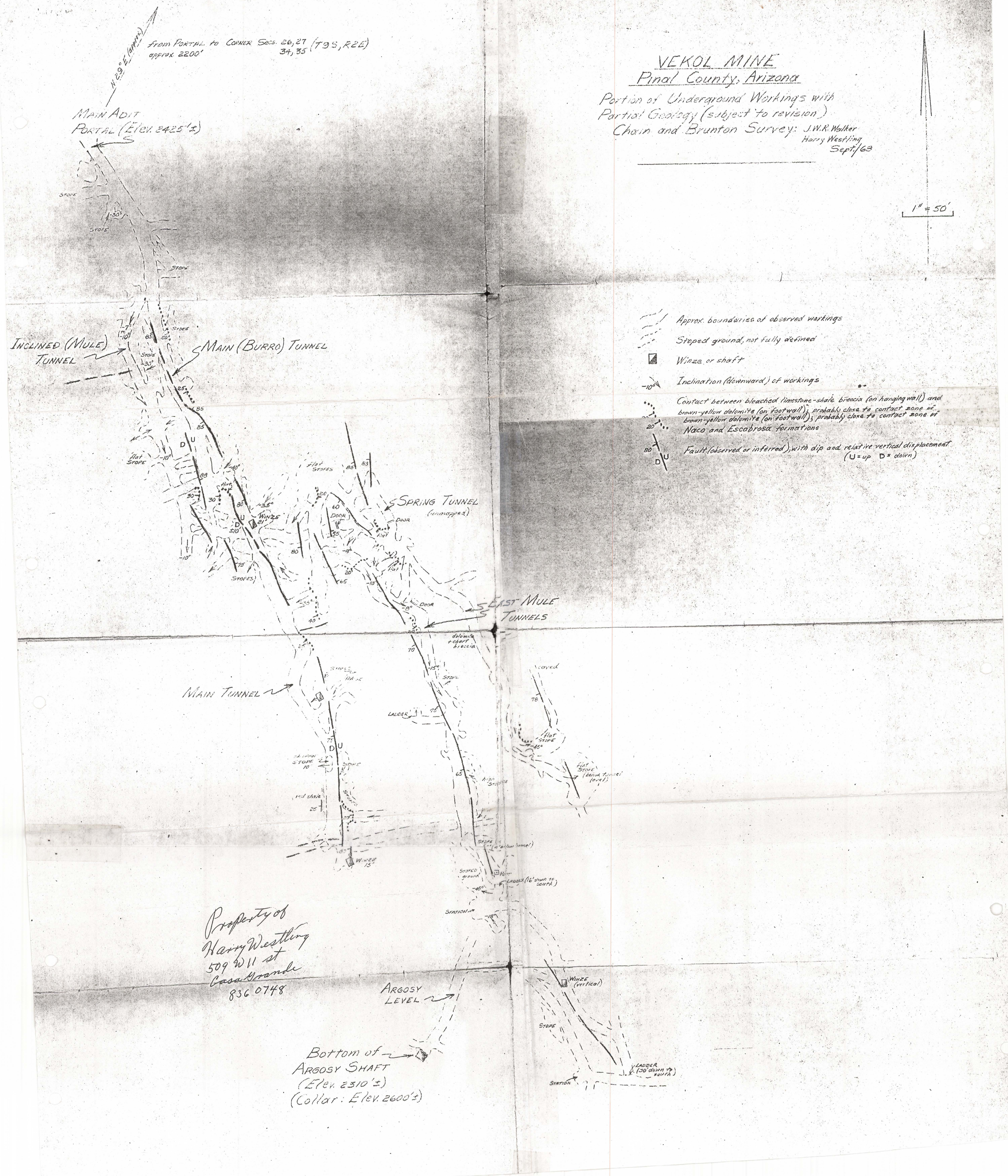

VEKOL MINE
SCALE 1"=40' Sept. 2, 1932
MITKE
Map No 4
ORE BEARING FAULT
ORE BEARING N-S FAULT
POST MINERAL FAULT
DAGGS FAULT
DAGGS TUNNEL
ANDESITE MT.
3000'±
MIN SHAFT
Blacksmith Shop
To ARGOSY 1150'
120 FT LEVEL EAST DRIFT
SPRING Water
FAULT
OPEN CUT
WEST ZIGZAG TUNNEL
Workings
ADIT
PARLOR WINZE
SOUTH DRIFT 120 FT
This level is 70' below any known ore
LEVEL
CORKSCREW STOPE
BUBROW TUNNEL
MULE TUNNEL
BUBROW
MAJOR FAULT No 1
ORE BEARING
EAST LE TUNNEL
HOBBLE INCLINE
Workings
TUNNEL
STOPE
Proposed Extension
E-W
FAULT
SLIDE
To Mt. Vernon 600'
BIG STOPE
SULPHIDE STOPE
ARGOSY LEVEL
ARGOSY BIN LEVEL
ARGOSY SHAFT
Great Eastern 930 FT
ZINC FAULT
Workings
LE FAULT

VEKOL MINE
Pinal County, Arizona

Portion of Underground Workings with Partial Geology (subject to revision)
Chain and Brunton Survey: J.W.R. Walker
Harry Westling
Sept/68

1" = 50'

Approx. boundaries of observed workings
Stoped ground, not fully defined
Winze or shaft
Inclination (downward) of workings
Contact between bleached limestone-shale breccia (on hanging wall) and brown-yellow dolomite (on footwall); probably close to contact zone of Naco and Escabrosa formations
Fault (observed or inferred), with dip and relative vertical displacement (U = up D = down)



Property of
Harry Westling
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