CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
3550 N. Central Ave, 2nd floor
Phoenix, AZ, 85012
602-771-1601
http://www.azgs.az.gov
inquiries@azgs.az.gov

THE INTRUSIVE DIABASE BODY IN THE NO. 1 MINE OF THE RAY CONSOLIDATED COPPER CO., RAY.ARIZONA.

Introduction.

The mass of altered diabase described by Ransome in U.S.G.S. Professional Paper 115, " The Copper Deposits of Ray and Miami,Arizona",1919, forms the most significant geological feature in the No.1 and No.3 Mines at Ray. Ransome describes it as a sill,the exact shape of which is unknown, but which is roughly tabular and dips in a general way to the E or NE . Investigation done by the geologists on the company's staff,including the writer,since Mr. Ransome's work at the mine,seems to point to the probability that the mass is of the nature of a stock, rather than a sill. Whether it be a stock or a sill is not relevant to the purpose of this paper; the point of interest to the economic geologist connected with the mass is the blanket of high grade copper ore which rests upon it.

Brief Review of the Geology of the Mine. (Petrographic details partly from Ransome)

The No.1 and No.3 Mines of the Ray Consolidated Copper Co. have partially developed the Eastern area of the Ray disseminated ore body; this Eastern area (see Fig.1) is about 2000' in a N-S direction and about 3000' in an E-W direction, and is separated from the Western area (of somewhat smaller dimensions) by a narrow neck only 300' wide. The types of rock represented are as follows:

1. Pinal Schist. This is the principal formation of the district. It is of Pre-Cambrian age, and consists essentially of dynamically metamorphosed arkosic sandstones and shales. Bedding is rarely visible, but, where seen, coincides in a general way with the planes of schistosity. The rock is an aggregation of quartz and sericite; the beds of original shales give bands of fissile sericite,while the arkosic beds give a fine-granular rock consisting of quartz grains surrounded by shreds of sericite.

2. Diabase. Intrusive into the schist is a body of diabase. This rock is by no means limited to the No.1 and 3 Mines. It is correlated by Ransome with the diabasic intrusions in the Globe area; with diabase near Roosevelt; in the Sierra Ancha; and in the Santa Catalina Range, NE of Tucson. In the Ray area, beside the occurrence which is the subject of this paper, it is extensively exposed on the surface in the " fault mosaic " area East of the Mineral Creek or Ray Fault, where it is cut off by some faults and cuts across others.

It is, where fresh, a medium fine-grained, dark gray holocrystalline rock made up essentially of basic plagioclase and augite; it contains as accessory minerals olivine and magnetite. Where exposed in the Ray district, in the vicinity of the No.1 Mine, it is fine-grained to aphanitic, with few visible phenocrysts, approaching the texture of a basalt, and is besides intensely altered to a mass of secondary biotite, secondary green amphibole and altered plagioclase. This alteration has been ascribed by Ransome to the effect of contact metamorphism produced by the intrusion of the quartz-monzonite porphyry described below. The contact metamorphism of the diabase on the Pinal schist which it intrudes is not readily perceptible, doubtless due to the stability of the minerals (quartz and sericite) of which the schist is chiefly composed.

3. Quartz-Monzonite Porphyry. This rock contains phenocrysts of quartz, plagioclase and orthoclase up to 2 cm. in length, in a fine, equi-granular groundmass consisting of quartz and orthoclase. It is intensely kaolinized where exposed outside of the mineralized area, but in the latter the feldspar has largely gone over to sericite under the influence presumably of hydrothermal alteration, so that the rock, like the Pinal schist, is largely made up of quartz and sericite ; but it can be easily recognized by the general lack of schistosity, the rather frequent kaolinized feldspar phenocrysts and the relict texture of the rock.

This porphyry occurs in the No.1 Mine as a rudely cylindrical stock intrusive into the schist and presumably into the diabase as well. This stock reaches the surface.

Nature of the Ore.

1. Protore. All three of the rock masses described above were subjected to the primary hypogene mineralization, which is represented by numberless tiny veinlets filled with quartz and pyrite, accompanied by a little chalcopyrite; the veinlets traverse the rock in every conceivable direction and are generally closely spaced. Pyrite also occurs disseminated more or less generally thruout the rock; I noted that the disseminated pyrite, in the true meaning of the word disseminated, was more characteristic of the protore in the porphyry than that in the schist, the small veinlets being more common in the latter. This holds also of course for the enriched ore. The diabase protore, as noted by Ransome, is somewhat richer in chalcopyrite than the porphyry or schist protores.

2. Ore. Formed by the partial to complete replacement of the primary pyrite and chalcopyrite of the protore by supergene chalcocite; the resulting rock is speckled over with the grains of sooty chalcocite ~~grains~~ or traversed by innumerable veinlets of chalcocite. As noted above, the speckled type is more typically developed in the porphyry, while the veinlet type is dominant in the schist. There is practically no enriched ore in the diabase itself in the No.1 Mine, for reasons given below.

3. Capping. This consists, above the orebodies of the No.1 and No.3 Mines, of leached schist or porphyry, having when crushed, as in the stope-chutes, a very rusty appearance. Where undisturbed by mining however, it is apparent that the limonite is confined to veinlets, which it fills together with quartz, and to tiny specks scattered thruout the rock, which are seen to be residual spongy limonite partially filling pyrite and chalcopyrite casts.

A point of interest in this connection is the fact that in the schist at least,mineralization has affected the schist itself hardly at all,so that protore,ore and capping look exactly alike except for the presence of primary sulfides in the first,enriched sulfides in the second,and limonite residuals in the last. General painting or flooding of the capping by limonitic pigment is the exception in the capping,but a view of the crushed capping coming thru the chutes in a drawing section would not suggest this.

Another fact worthy of mention is the remarkable difference in the behavior of the capping and the ore in the stopes. The ore breaks down into discrete blocks,often of considerable size; fines are not a large percentage of the broken rock in the chutes; frequently or perhaps generally the shape of the fragments bears no relation to the veinlets of chalcocite,or in other words these veinlets are not planes of weakness in the rock. The ore is tough,especially in the schist,and due to the size of many of the blocks,drawing thru the chutes is often troublesome,necessitating frequent bulldozing above the chute gates. This condition prevails as long as ore is being drawn thru the chutes,but as soon as an appreciable admixture of waste (capping) occurs,the material flows like water, and fines are in the majority. This weakening of the rock thru leaching and oxidation I hope to touch upon again in more detail at a later date.

The thickness of the capping is very variable,ranging from 50' to 500'. In some places along Copper Canyon and elsewhere much of the copper was fixed in the capping in the form of carbonates and silicates,and was mined by leasers, but in the vicinity under discussion most of the copper was leached out of the capping,so that its average copper content is around 0.2 to 0.3%.

The upper surface of the enriched ore is exceedingly irregular in the No. 1 Mine,and is not referable to any regular surface,but in a very rough way it follows the present configuration of the surface. The lower surface likewise is irregular.

Structure of the Diabase Mass. (Note- Elevations are above Sea-Level)

Complete data are lacking regarding this. Fig.3 is a contour map of the surface of the highest portions of this diabase mass, as far as development up to 1921 has revealed it. (I am informed by letter from Mr.R.W.Thomas that little or nothing has been done since). Fig.4 is a generalized cross-section thru the best known portion of the mass. While the contours show marked local irregularities, the general structure is fairly well shown, notably the roughly vertical west face of the underground "hill" and the gentle eastward or northeastward slope. In the southern portion of the region shown in this map (Fig.3) the position of the 1985 and 1945 contours shows a very decided overhang to the "cliff", suggesting an approach to the thick sill described by Ransome, but from studies conducted in the mine as a whole, the general structure of the mass appears to be, not tabular but stock-like, the body increasing in size with depth. The greater part of the eastern section of the 1775 level is in diabase. It may be a sill, but if so it is several hundred feet in thickness in at least one place. As shown in Fig.4, the surface of the mass dips gently down to the east in the direction of the No.3 Mine, but west of this mine it is seen dipping westerly back toward the mine, indicating a syncline if the mass is a sill. There seems to be nothing in the way of structure in the surrounding schist to suggest a syncline, so that it appears to me more probable that this depression is a hollow in the top surface of the diabase mass. However, it is not essential to the theme of this paper whether the mass is a stock or a sill.

Insert yellow sheet attached

An important feature connected with this body of diabase in the area considered, is the "blanket fault" shown in section in Fig.4, and by contours in figure 3. It is, in fact, a blanket of gouge, in places resting directly on the diabase mass, in

Insert

High Grade Ore Connected with the Diabase

Resting as a coating, of variable thickness, on the higher portion of this ~~this~~ diabase mass, is a ~~remarkable~~ body of chalcocite ore, of varying richness but ~~of~~ remarkably continuous. The average % tenor is perhaps 4% Cu. As stated below, this body of ore is seldom over 25' thick, & ranges thence down to nearly nothing locally; the ~~average~~ thickness of the ore is related to the attitude of the diabase surface — on the fairly flat top of the diabase mass, the ore may reach 3-4 sets (21-28') in thickness or even more; while down the gentle Eastern slope of the "hill" the average thickness is about 8-10'. Details of occurrence, & the significance of this relation of the thickness of ore to the attitude of the diabase surface are discussed below.

a good rule: never speculate unless you have to.

others being 10 or more feet above it in the ~~leached~~ schist. This fault is limited to the gentle north-east slope of the diabase, and dips therefore gently E or NE. It was doubtless caused by stresses in the crust selecting the contact between the relatively hard, brittle quartz-sericite schist and the soft, plastic diabase as a surface of least resistance. It is not known whether the first faulting along this surface preceded the primary mineralization; certainly movement has occurred subsequent to the primary mineralization, and probably a certain amount after the secondary enrichment. The fault is accompanied by as much as five feet of gouge, white, where the fault lies wholly in the schist, green to black where it is on the contact (schist-diabase). The great mass of this gouge is believed to have been formed after the primary mineralization and before the secondary enrichment. Very possibly the fault itself first occurred after the alteration of the diabase to "greenstone", and as this alteration is presumably XXXXXXXXX referable to the intrusion of the monzonite, which in turn is connected in all probability with the primary mineralization, it seems quite possible that the faulting occurred entirely subsequent to the primary mineralization. XX I offer the suggestion that the alteration of the diabase is in part a type of hydrothermal alteration connected directly with the primary mineralization and not connected in any way with the intrusion of the monzonite; in part dynamic metamorphism. This alternative would also make the alteration ~~also~~ subsequent to or accompanying the primary mineralization, so that it is not pertinent to the present subject.

why speculate

The blanket of gouge accompanying the fault (the latter has no measurable displacement) greatly assisted the ~~latter~~ diabase in arresting the downward flow of the copper bearing solutions. Where the blanket of gouge is impervious, ~~i.e.~~ and persistent, and well above the diabase, in the schist, if secondary chalcocitic ore is present, it is above the gouge, as a layer from a few inches to 15 feet or more in thickness; below the gouge is perhaps as much as 10-20 feet of unleached schist containing primary pyrite, while below the schist is the diabase, also showing primary mineralization. Above the layer of ore next the gouge is typical leached, oxidized capping. The more than usually intense fracturing of the schist just above the gouge, probably connected with the faulting, seems to have been exceptionally favorable to the deposition of the chalcocite (in places)

Where the fault zone coincides with the schist-diabase contact (and this is perhaps the general rule) the slickensiding, crushing etc. of the diabase has produced a selvage even more impervious than the gouge formed in the schist. Where, as locally, gouge is entirely absent, either in the schist or along the contact, the layer of ore nevertheless frequently occurs; the undisturbed diabase alone was sufficiently impervious to halt the downward flow of the solutions. In this case however, the ore penetrates the diabase for a few feet, in veinlets. Where selvage is present, the diabase is uniformly barren of enriched sulfides. Where ore does penetrate the diabase, native copper is rather common, with less amounts of native silver. Cuprite also occurs.

The average thickness of the coating of ore resting on the surface of the higher portions of the diabase mass is perhaps 2 sets (14ft). This thickness persists down the east slope of the diabase "hill" to about the 1890 level (the highest known portion of the diabase is about 2000 ft) Below this contour of the diabase mass, the ore, while locally concentrated just above the diabase contact or above the gouge, is no longer limited to the first 10 or 15 ft. above this surface, but extends on up as normal disseminated ore for varying heights above the contact, the heights increasing as we go down the diabase slope. Above this disseminated ore is ordinary leached capping.

This condition is illustrated in the 1890 Ray Central Level, shown on the map, which was stoped under the supervision of the writer. The diabase contact was exposed in the drifts on this level, below the stopes, but about 50 ft.

of ore averaging 2% in copper was stoped above this contact. Likewise down the dip of the contact, on the 1850 Ray Central, the diabase is found in the drifts; the stoping height was greater than 50 ft.; exact height unknown.

The explanation offered for this transition down the E dip of the diabase contact from a concentrated, thin blanket of high grade ore to disseminated ore of normal character is as follows:

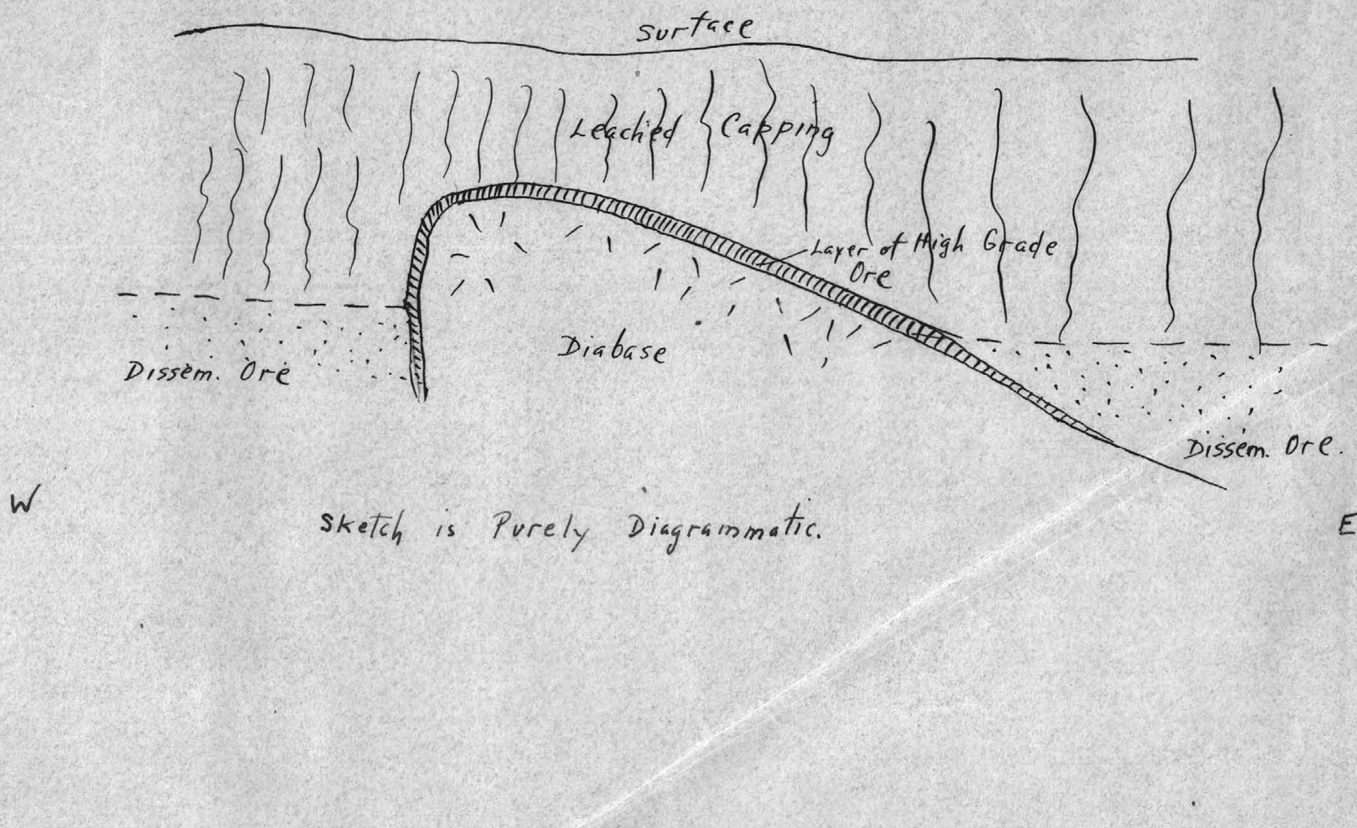
The upper portions of the diabase mass lay above the general level of the ground water while the present enriched orebody was being formed; the precipitation of supergene chalcocite upon the surface of the diabase mass and above the general level of the groundwater was caused by the stopping or deflection and slowing down of the solutions by the diabase, which was protected from oxidation, altho above the general level of the groundwater, by its impervious character, and also possibly by the blanket of gouge which covered it in many places. The diabase contains numerous precipitating agents besides its primary pyrite and chalcopyrite, as for example magnetite and the ferromagnesian minerals. The local trapping of stagnant groundwater in numerous basins on the surface of the diabase mass, several of which basins are suggested on the contour map (Fig.3) doubtless also assisted precipitation, but the main mode of precipitation is believed to have been as follows: The descending waters, travelling sluggishly thru the shattered schist just above the diabase contact, probably formed a large, continuous sheet of water flowing down the east slope of the diabase mass, and thus had every opportunity to come in contact with the reducing agents contained in the diabase. It is worthy of note that in several places where the gouge of the blanket fault is separated from the diabase by schist, none or very little ore is found ~~along~~ above the gouge, but that practically in every locality where the fault coincides with the diabase surface, or where no faulting is visible, ore is found as a layer resting on the diabase. The most extraordinary example of

??
mag → cc

what is def of W.T.?

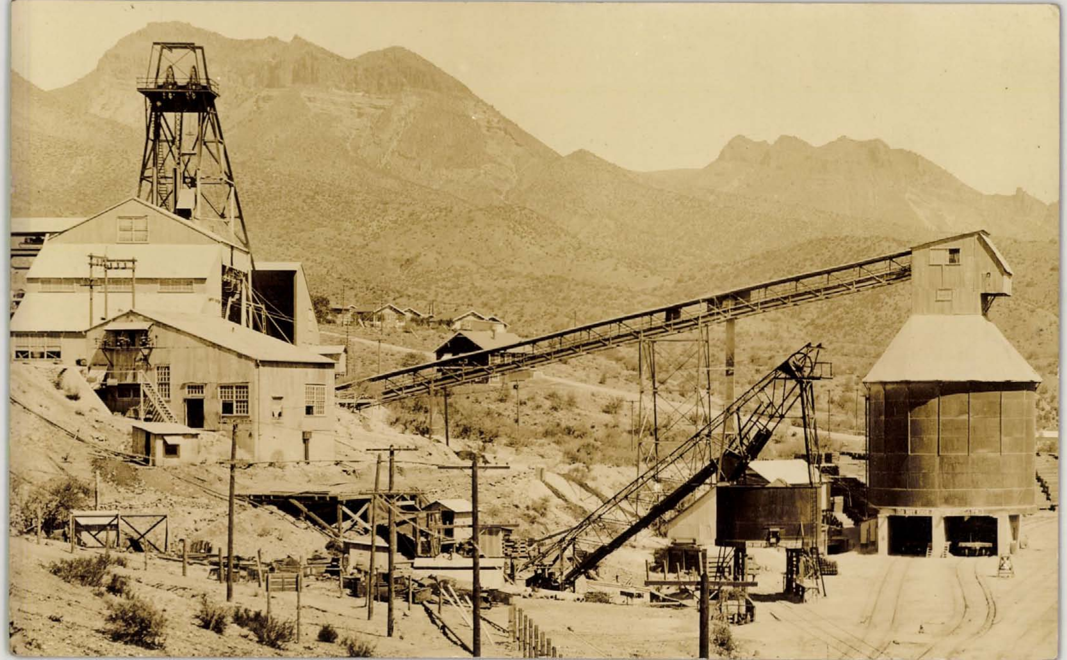
this occurs on the vertical western side of the diabase "hill" where a layer of ore several sets thick ~~rests on~~ is plastered against the diabase contact from the top of the diabase mass to about the 1945 level or slightly below. (See Fig.4) No faulting at all is visible here, and the vertical side of the diabase offered no obstruction to the descent of the solutions. This is almost positive proof that the principal cause for ore deposition lay in the reducing power of the unoxidized diabase.

The groundwater apparently surrounded the diabase "hill" much as an ocean surrounds an island of abrupt relief, and it is below this "shoreline" that the ore is found to change by degrees to the normal disseminated type, increasing in vertical extent as the diabase contact, which delimited the lower surface of the orebody, got further and further below the water table.



Sketch is Purely Diagrammatic.

Fig. 1 Sketch Map of Ray Orebody (Not included)
" 2. General Map of the W Section No. 1 Mine
" 3 Contour Map of the Diabase Surface in vicinity of the Pearl Handle Slice
" 4. Cross-Section of the Diabase Mass.

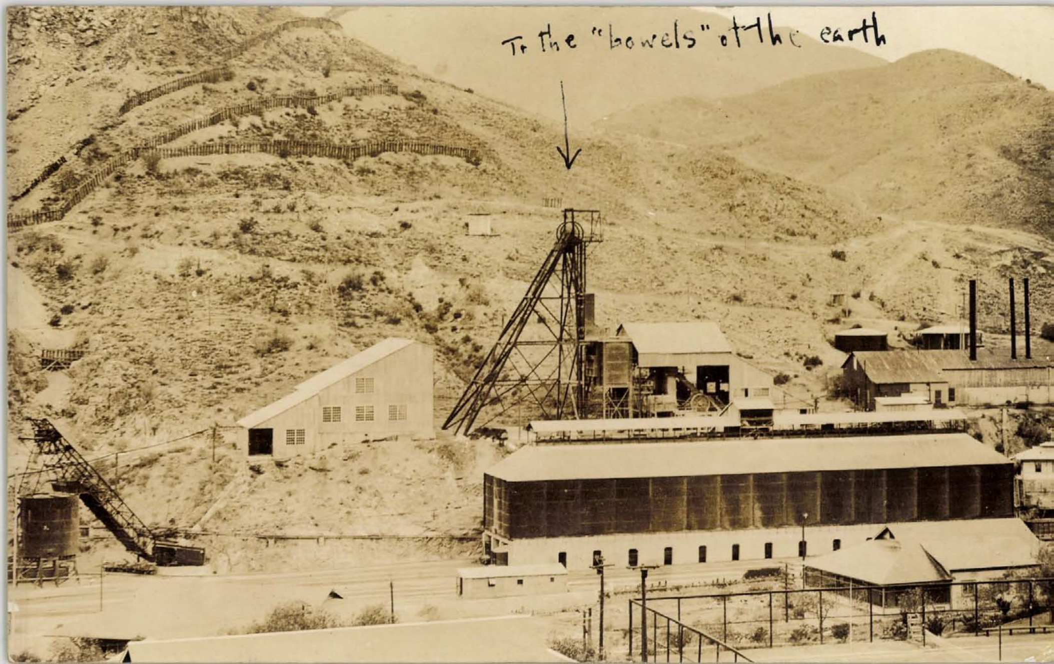


POST CARD

▲ A Z O ▲
A PLACE A
Z STAMP Z
O HERE O
▼ A Z O ▼

CORRESPONDENCE

ADDRESS


To the "bowels" of the earth

POST CARD

CORRESPONDENCE

Jan. 27

Dear Mother:

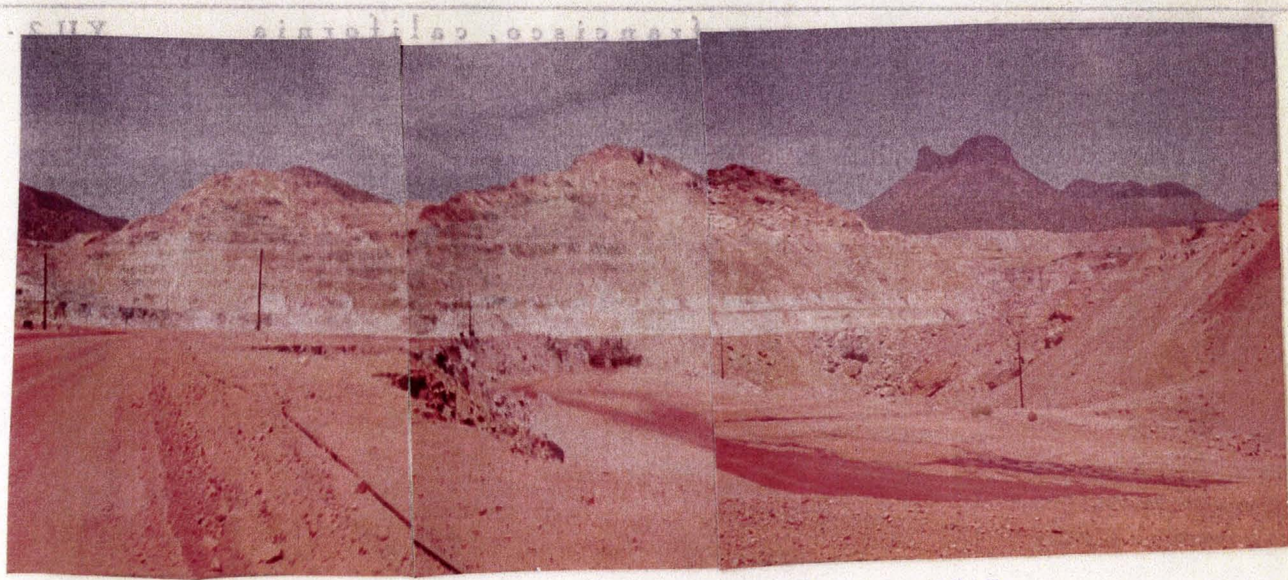
This is the day you and ?X! celebrate. May your birthday have been happier than his.

Ed.

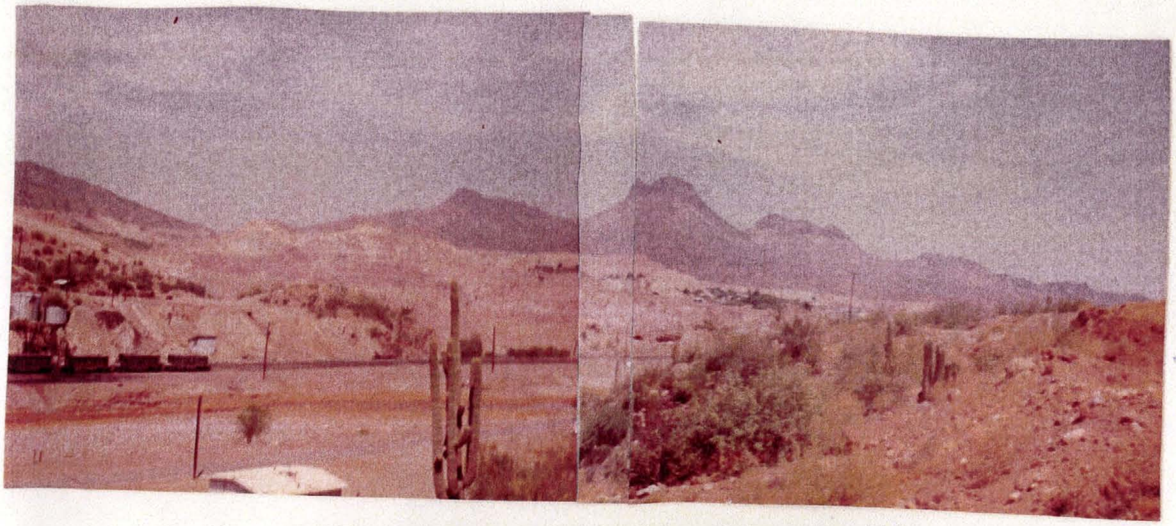
ADDRESS

Mrs. J. P. Wisser
1018 Oxford St.
Berkeley
California

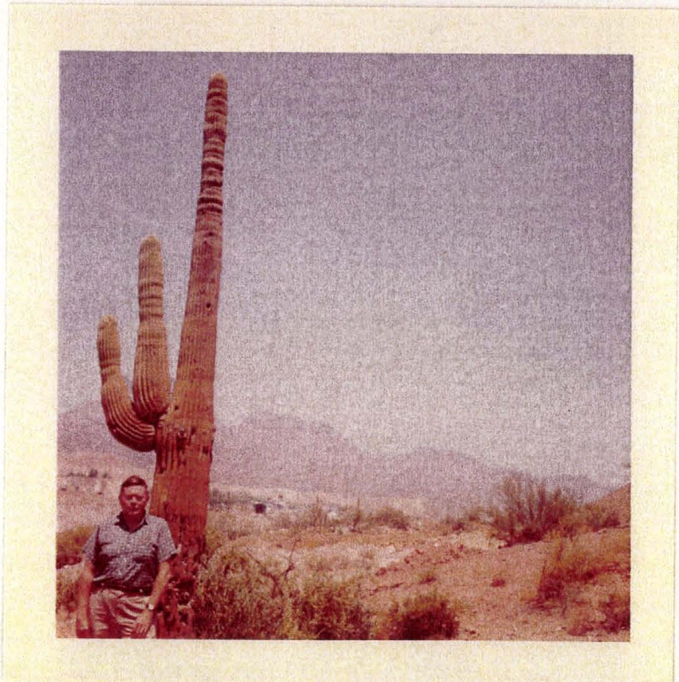
~~[illegible]~~
~~[illegible]~~



WEST PIT, SHOWING CAPPING ABOVE ORE



GENERAL PANORAMA
Taken from near Ray Co. Club



RAY -
JULY 1960