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TWIN BUTTES MINING DISTRICT  
Pima County, Arizona

Harrison Schmitt  
July, 1950

HARRISON SCHMITT  
MINING GEOLOGIST  
SILVER CITY, NEW MEXICO

July 13, 1950

To: Mr. Allan B. Bowman  
Assistant Gen. Manager  
Banner Mining Co.  
Box 482  
Lordsburg, New Mexico

From: Harrison Schmitt

Subject: Twin Buttes District, Pima County, Arizona

References: Maps and other data supplied by W. F. Foy; Fields, Howard,  
Report of March 1947 (in Appendix); U.S. Bureau of Mines,  
Report of Feb. 1943 (in Appendix); U. S. Bureau of Mines  
map; Surface map by Dr. E. Wilson, Arizona Bureau of Mines.

Geography

The Twin Buttes District is about eight miles southwest of Sahuarita, Arizona. Sahuarita is a station on the branch of the Southern Pacific R. R. which connects Tucson and Nogales, Arizona. The district is about 25 miles S15W from Tucson. The Sierrita mountains lie about 6 miles to the west. There are good road connections with Sahuarita and Tucson. The closest available electric power is at Sahuarita. There is water in some of the local mine shafts such as the Gladstone and Morgan. The Glance shaft is said to make about 50 GPM. The area is one of low hills favorable for mining operations. The climate is very dry with mild agreeable winters and hot summers.

Mines-Production-Grade

The mines of the northern part of the area and presently of chief interest are, listed from west to east, the Minnie, Copper Butte, King, Queen, Glance and Bullion. The depth in feet to their lowest levels is respectively: Minnie 325, Butte 359, King 330, Queen 670, Glance 626 and Bullion 500.

Of these the Minnie, King, Queen and Glance were the chief producers. Production to 1947 is listed below. The data are from Fields and the US Bureau of Mines reports and basically from W. F. Foy. The Senator Morgan and the Contention mines production is included. These mines are about 1 1/2 miles southwest of the area but are properly part of the district.

<u>Mine</u>	<u>Tons</u>	<u>Grade</u>	<u>Pounds Cu</u>	<u>Value</u>
Bullion	Nil	_____	_____	_____
Glance	118,066	6.72% Cu	15,870,493	\$2,786,126.54*
		(Early production included with Morgan)		
Queen	75,186	7.05%	10,608,048	\$1,747,852.56*
King	(Included with Morgan)			\$ 275,000.00*
Buttes	Nil	_____	_____	_____
Minnie	62,477	4.71% Cu	5,865,333	\$1,339,804.15*
Morgan	132,402	5.92% Cu	15,688,237	\$2,035,306.57*
		(Includes King and early Queen)		
Total	388,231	6.17% Cu	48,032,111	\$8,184,089.92* (\$9,225,597.30)**
Contention	8,000	13-14% Zn* 2% Cu* 1.7% oz Ag*		

The above information was obtained from the War Minerals Report #47 (U. S. B. of M.), Foy\*, and Fields' report\*\*.

The grade is good and makes direct shipping possible under certain conditions. The Minnie, Queen and Glance together produced \$5,685,596 gross averaging about 6.0% Cu and 2.0 oz Ag according to Fields.

#### Geology

A good surface geological map on a scale of 200 ft. to the inch made by Dr. Eldred Wilson of the Arizona Bureau of mines was available for this report. The underground data on hand are limited to maps of the workings and which

show here and there locations of the granite sedimentary contact. Nevertheless the general and structural geology is fairly clear in a broad way when studied with Wilson's map and the various available reports as a basis. I have visited the district and viewed the surface geology many times but have done no formal mapping.

The part of the district lying from the Minnie shaft to the Bullion shaft is characterized by an elongated block of sedimentary rocks about 7,500 ft. long and 2,500 ft. wide largely or wholly surrounded by an igneous mass classified <sup>as</sup> granite. The long axis of the block bears about N70W.

Wilson's work shows that the area contains marble, limestones, shales, nevaculite and quartzites. One limestone is indicated as Devonian in age. The beds in most of the block dip from 65 to 90 degrees to the northeast but do not appear to be isoclinally folded since beds are not repeated. In the northwest section of the block dips vary from 45 to 80 degrees to the southwest. One end or the other of the block must have been overturned since the beds seem to be the same continuous series from northwest to southeast. If the beds on the southwest edge are the older then the northwest part of the block is overturned. The sedimentary rocks obviously have undergone strong dynamic action. The steep dips suggest dynamics of a thrusting nature.

The fact that the block is surrounded by granite suggests that it is a roof pendant. In other words it may make contact with the granite in depth. Fields reports that a vertical diamond drill hole in the Glance mine drilled from the 625 level was in limestone down to 500 ft., the bottom of the hole.

The block is cut by prominent northeast high-angle faults. Dips are not shown on these faults on the copy of Wilson's map so whether they are normal or reversed faults cannot be made out from the map. In some cases the northwest walls have moved northeast, in other cases southwest. They

may be tear faults related to thrustin movements. Some bedding faults and fissures are reported associated with the ore deposits.

At the surface a moderate to strong amount of metamorphism is evident. This appears to be the result of both dynamic and thermal metamorphism. The limestones have been marbleized, the shales converted to hornfels or hornstone and there is prominent quartzite and novaculite. Relatively small areas of green and brown garnet and epidote occur particularly along the north contact with the granite. The known ore deposits have been found along this contact only. The garnet is said to be more prominent in depth. The surface exposures of garnet are not as extensive as is the case of most deposits classified as contact metamorphic ( more accurately contact pyrometasomatic).

The many "marker" beds and a fair regularity of the structure will make it possible to develop a much more accurate picture of the structure if sufficient data are collected and integrated.

#### Ore Deposits

The ore bodies are vein-like to lense-like to pod-like in form and usually are found irregularly in masses of garnet and silicates that lie on the contact between granite and marble. The average thickness of the garnet-ore zone is about 50 ft. It is said that in a given mineable ore body about 50 per cent of the garnet mass is ore above 5% Cu. The barren or lower grade garnet is either sorted out, or avoided in mining. The ore is largely massive pyrite, chalcopyrite and bornite and in places contains sphalerite. Oxidized ore was mined near the surface. Gangue minerals include garnet, pyroxene magnetite, calcite and siderite

A number of factors seem to have controlled the localization of the ore. Most of the ore, excepting the King fissure and a few other <sup>ore bearing</sup> fissures, contacts the granite. All of it replaces limestone. All the ore bodies are closely associated with the northeast faults and in cases northwest bedding faults. The northeast faults are the cause of at least some of the "rolls" on the

granite contact discribed by Fields in his report.

The Glance and Queen mineralization replaces a certain bed of marble which lies just northeast of "marker" bed chg of Wilson's map. This bed appears to be about 200 ft. thick. The Copper Butte and Minnie mineralization occurs in a bed or beds that<sup>u</sup> are lower (?) in the section. The Bullion fissure is along bedding of limestone higher (?) in the section. Both the Queen and Glance ore bodies pitch southeast. They appear to be following the intersection of limestone or marble bedding with the granite contact where the area is cut by northeast and bedding plane faults.

It is usually a mistake to assume that any one factor or combination of factors exclusively controls the localization of a given set of ore bodies. As a rule thinking in this matter is too narrow. With many miners it is almost a fetish to explore a "contact" thus neglecting ground which may become later productive. Nevertheless, it would seem that ~~in~~ the stretch of contact between the Queen and Glance ore bodies and extending to the Bullion fissure has enough associated, known influential structural factors to justify first attention in exploration. The known favorable limestone and marble beds are in continous contact with the granite and four or more northeast faults and fissures intersect this contact. Next in importance for exploration attention would be the same northeast contact from the Queen through the King and Copper Butte areas to the Minnie. This section is crossed by a number of northeast faults. Experience has shown that in general if ore bodies are not too deep they usually have some sort of expression at the surface if the surface does not have a post-ore cover or mantlee(Schmitt, "Outcrops of Ore Shoots", Ec. Geol. pp 654-673, 1939). The known deeper ore in the area ocured below small surface workings from which oxidized ore was mined. Apparently most surface showings of consequence have been explored in depth and in most cases resulted in mines. The

lack of other important unexplored surface showings is on the unfavorable side, but is off-set to a large degree by the fact that about one third of the northeast contact is covered by post-ore mantle rock. The exploration to date along this contact by drilling and minor drifting does not seem to have been adequate, judging by reports available. It is true that we do not have detailed maps of this work. Particularly we do not have accurate data on the diamond drill holes.

Considering the good character and grade of the ore and the large amount of ground between the known ore bodies the district seems to be inadequately prospected. Modern methods of mapping and compilation of data and the laying out of headings and diamond drill holes should have good results.

Just why the district was not reopened and explored in an adequate manner since its active stage during World War I is not clear, though it seems to have been due to certain property difficulties and perhaps also because of the general prejudice against contact metamorphic deposits. There appears to be no factual basis for such a prejudice (Schmitt, "The Contact Pyrometamorphic Aureoles", pp 607, AIME Tech. Pub. 2356, 1948).

Reports by the Bureau of Mines and others indicate a moderately large tonnage of ore in depth in the Glance and Queen mines. The Bureau of Mines (WMR 47) estimated in 1943 that the following ore reserves were present:

<u>Mine</u>	<u>Grade</u>		<u>Tons</u>	<u>Remarks</u>
	Cu	Zn		
Minnie	3.15		?	Grade of last ore shipped
Copper King			?	Zinc and opper ore reported
Copper Queen	6.0		?	Ore reported left in lower levels
Copper Glance	6.0		30,000	Below and just above 525 level
Contention Mine	2.0	17	15,000	± 8,000 tons mined in the past several years

The above reserves might be called reserves of reasonable certainty. They would normally be placed in the category of probable in an engineering estimate.

The term geologically prospective is one which I have found useful to designate the category of ore which includes that inferred as geologically probable. Such an inference is normally based on: (1) The concentration of ore or ore bodies known to a given volume of ground, i.e., amount of ore per given block, (2) the geological probability for the existence of blocks of ground of similar character and (3) the total volume of such unexplored favorable ground. One's first attention, of course, turns to the blocks of favorable unexplored ground on the northeast limestone-granite contact. This contact also is known to exist in depth and to the southwest of the limestone block. On the northeast side it appears to be at least 7500 x 2000 ft in area. By estimate about one-half of this area has been moderately well explored. (This amounts to about eight 1000 ft. sq. blocks out of about sixteen 1000 ft. sq. blocks).

The last table gives some indication of the more firmly assured reserves. Since the ore shipped was usually above 5 per cent there is probably milling grade ore remaining in pillars and untouched blocks especially in the Minnie, Glance and Queen mines. Such ore could exceed several hundred thousand tons considering the amount of high-grade previously shipped. Thus the probable ore, plus the lower grade milling ore, plus the geologically prospective ore at the contact on the northeast, on the contact in depth, and on the contact to the southwest justifies an engineering estimate plus a geological guess of tonnage totaling 1,000,000. This is only three times as much as was previously mined on the northeast contact. Most of this tonnage would be in the category of geologically prospective.

Fields has rehabilitated the Glance shaft down to the level. This would

put the 30,000 tons of 6.0% Cu probable ore within fairly easy reach. I think this shaft should be the first to be reopened. The ore is of direct shipping grade and would help support the preliminary exploration work.

Favorable areas for first exploration, in addition to the longer unexplored inter-mine areas along the contact, appear to be: (1) The King fissure in depth and at the contact, (2) The area between the King and Queen ore bodies, (3) The Queen ore shoot in depth, (4) The Glance ore shoot in depth, (5) The Bullion bedding-plane fissure and cross faulting in depth. Detailed mapping and study will doubtless indicate other favorable objectives, including some not on the main contact.

The Twin Buttes district seems to be one of those inadequately explored in the past. For several decades I have been in favor of renewed exploration there and have so expressed myself in several previous written reports and verbal discussions. Of six carefully studied districts in the Southwest selected by me for recommendation for exploration a few years ago I put the Twin Buttes district at the top of the list. Drs. B. S. Butler of the University of Arizona and Eldred Wilson of the Arizona Bureau of Mines have several times stated their liking for the district.

HS:ss  
cc:2 extra  
file

*Harison Schmitt*

APPENDIX

C O P Y

REPORT

TWIN BUTTES GROUP COPPER MINES  
TWIN BUTTES, PIMA COUNTY, ARIZONA

By

Howard H. Fields

March 1947

## TWIN BUTTES

### LOCATION:

The twin Buttes Mining District lies in the Sierrita Mountains, about 6 miles west of Sahuarita, a station on the Southern Pacific Railroad, 25 miles south of Tucson, Arizona, toward Nogales. The Tucson-Nogales oiled highway also passes through Sahuarita. A very good graded gravel road connects the camp with Sahuarita, so transportation is most economical. The following are the principal mines of the district:

Morgan, Minnie, Copper Buttes, Copper King, Copper Queen, Copper Glance, and Copper Bullion.

### CLIMATE:

The climate is typically that of Tucson and southern Arizona - hot days, cool nights, with summer showers. The vegetation is sparse and that of the arid desert section. Water for domestic use and for mine operation is available at the Gladstone Shaft, which is under lease.

### LABOR:

Labor is largely Mexican and seems to be abundant in this particular section. The proximity to the border assures a fair supply. The camp has practically all the buildings necessary to begin operation, though the ore bins, etc., will need repairs before commencement of operation.

### HISTORY:

The known history of Twin Buttes mining district dates from the nineties, when four prospectors gophered various surface outcrops of copper carbonates, hauling same to Tucson by wagon. This continued up to the year 1905, when a group of men headed by David S. Rose, then Mayor of Milwaukee, formed the Twin Buttes Mining and Smelting Co., which acquired all the Favorable property in the district. They built a standard gauge railroad from Tucson to Twin Buttes, 28 miles in length, and began mining operation in 1906, erecting a smelter near the Santa Cruz River, 9 miles from the mines. They operated until the spring of 1913, directing most of their attention on the Morgan Group, as this particular group had the best surface showing.

During these operations the Twin Buttes Mining and Smelting Co. produced a gross of \$3,110,000. Most of this came from the Morgan Mine, the balance from the Copper Glance, Copper Queen and Copper King, the latter group being on a different contact with very little surface showing, and was not worth considering at that time. However, later operations proved this contact to be the richest zone of the district, higher grade ore and larger ore bodies. The gross production from this contact to date is, \$6,115,597.30. This, with the old company's production of \$3,110,000.00 makes a grand total of \$9,225,597.30 for the district.

In 1913, after some of the older officials of the company had died or passed out of the picture, operations ceased. From then on until 1918 the Morgan Mine was worked by leasers. In 1914, Ed. Bush from Butte, Mont., who had been leasing at the Morgan, took a lease and bond on the old Minnie mine, which lay on the Glance-King contact adjoining the Copper Butte on the west. Bush and his partners netted over \$400,000.00 in the years 1914-15 and 16. It was while operating the Minnie and seeing the possibilities of this contact that Bush took a lease and bond on the Copper Glance, which had been previously worked by the old company. This contract was for \$300,000.00 for 3 years on a 10% royalty basis, during 1916-17-18, until the drop of copper after the Armistice. Bush paid \$233,796.16 in royalties to the old company and netted a substantial sum besides.

In 1917, being more convinced than ever of the possibilities of the Copper Queen, Bush took a 3 year lease and bond for \$100,000.00 on this property. He paid this \$100,000.00 in royalties after the second year and netted besides \$180,643.72 for himself and partners.

W. F. Foy became associated with Bush in 1917, when they took over the Copper Queen, and Foy carried on operations after Bush's death in 1920, by reopening the Copper Queen, and during 1923-26 paid dividends totalling \$412,000.00, besides sinking a 500' shaft on the Bullion and a 400' shaft on the Gladstone. This expenses was absorbed in operating costs.

Foy purchased the properties from his associates in 1928, forming the Buttes Copper Company, embracing all the properties in the district, but the panic halted this project and the properties reverted to their original owners.

In 1938 Mr. Foy arranged a new deal and I became associated with him in 1942. A loan of \$9,000.00 was granted by the R.F.C. to start unwatering the mines and show sufficient evidence to warrant additional funds to equip and place them in production. Due to difficult operation conditions, this was not sufficient, and I, personally, advanced some \$15,500.00 to complete it. The Glance and Queen mines were unwatered to the 525 level, where a personal examination showed the ore expected did exist. The shaft was retimbered, the headframe repaired, 2,310 cu. ft. Chicago Pneumatic air compressors were brought and installed, air and water lines installed in the shaft and a Cameron sinking pump obtained. The small amount of water remaining can be easily removed with this equipment and the mine equipped for production.

Mr. Foy eventually relinquished his contract so I could arrange a more favorable one. The mines held under the present lease and option are:

Copper Glance	Pat. No. 2643
Copper Bullion	" " "
Copper King	" " "
Copper Buttes	" " "

The terms of the lease-option from the owners, Twin Buttes Mining and Smelting Co., Room 112, 229 East Wisconsin Ave., Milwaukee 2, Wisconsin are:

Date, Feb. 1, 1945. Term 6 yrs. Royalty 10%  
 Price, \$60,000.00. Minimum payments, \$100.00 monthly

Foy owns the Minnie and Copper Queen mines and will include the Queen in any deal which I make for the balance of the group, in a separate agreement.

The following gives details of shipments from the various mines, These were shipped to the Southern Pacific Railroad at Sahuarita over the Twin Buttes railroad, a company road now abandoned and dismantled.

<u>Mine</u>	<u>Date</u>	<u>Cu Price</u>	<u>R. R. Cars</u>	<u>Dry Tons</u>	<u>%Cu</u>	<u>Gross Cu. &amp; Ag.</u>	<u>Net Profits</u>
Minnie	1914 1918	22.73¢	1370	62,477	4.71	\$1,282,202	\$293,805
Queen	1917 1920	19.145¢	310	15,234	9.14	556,396	180,648
Queen	1923 1926	13.83¢	1078	59,952	6.55	1,060,872	412,218
Glance	1916 1919	18.001¢	2432	118,066	6.72	2,786,126	629,282
TOTAL				255,729		\$5,685,596	\$1,715,953

#### GEOLOGY:

In general, the geology is that common to replacement in a contact zone between bedded limestones and underlying granite. This contact has roughly as east-west strike and dips to the south at about 60 degrees. The contact lies in the form of a shallow arc, whose continuity is broken in several places by rolls, which are usually accompanied by cross fracturing. These rolls probably were occasioned by pressure due to the granite intrusions, which also may have caused the fracturing.

The lime is metamorphosed along the contact to a garnet and these garnet occurrences extend into the limestone for considerable distances at the location of the rolls and fractures. All of the ore found to date in the garnet in the "roll" area.

The lime beds have been tilted by the granite intrusion and faulting but in general the contact crosses the beds, so there is a variation in the garnetization from the surface down, due to variations in the solubilities of the beds traversed.

The persistence of the lime is shown by a diamond drill hole, drilled vertically from the 625 level of the Glance mine, which showed lime to a further depth of 500 feet, with the hole bottom still in lime.

The contact is known for a distance of 9,000 feet and the recognized "rolls" which have been named for the claims on which they occur, are from east to west - Copper Bullion, Copper Glance, Copper Queen, Copper King, Copper Buttes, and Minnie. The Copper Glance, Copper Queen and Minnie have been developed into good producing mines. The Copper King has produced an estimated \$150,000.00 from a small fracture. The Copper Bullion has encountered a strong fracture filled with leached oxidized ore (not commercial). Neither of these developments has reached the contact so their present interesting showings warrant the expectance of ore bodies on the contact similar to those found in the other three mines.

There is an unprospected "roll" between the Glance and Queen, which could be prospected from the drift connecting these two shafts, and which was driven off the contact for permanence. Also, there are several other areas where "rolls" can be expected, as between the King, Buttes and Minnie.

The outcrops of contact garnet, or ore, are so inconspicuous as to have been practically non-existent. The small mineralized fracture on the surface at the King is the best. In the Queen and Glance the surface showed a very small fracture filled with oxidized copper ore but no commercial ore bodies were encountered until a depth of 300 feet was reached. However, from this point the ore has been practically continuous to their present bottoms, which are in ore.

In general, five "rolls" have been found in the 9,000 feet of known contact, leaving a good chance for a similar number to be found by intelligent prospecting.

The ore found to date is almost entirely a massive pyrite containing bornite and chalcopyrite, there being almost no oxidized ore in any of the mines. These ore minerals are found in the garnet in irregular shaped ore bodies typical of replacement deposits. There has been no sign of diminution in intensity of mineralization or grade to the present depth.

#### MINE WORKINGS:

##### Copper Bullion:

This shaft is in solid limestone and is open all the way. It contains little seepage water and has no surface improvements at present.

##### Copper Glance:

The shaft has been retimbered to 525 level, which has been unwatered for inspection. The level is in fair shape permitting access to all the stopes. The drift to connect with the Queen is open. The workings below the 525 level are probably all in good shape since they are relatively new. The headframe has been put in good shape and the shaft is operated by a 15 H. P. gasoline hoist.

On the 400 and 525 levels there exists ore faces which will mine 4% copper, making it possible to begin production at once. When we unwatered

these levels, I had an opportunity to take a few check samples to confirm this.

Copper Queen:

The shaft has caved around the collar for a depth of 3-4 sets, requiring reopening ventilation in the Glance and Queen mines through the 525 drift, which is the 7th level of the Queen. Unwatering the Glance, takes the Queen water to the 7th level, but supplementary equipment is needed in each case to unwater the bottom of the mine. It is confidentially expected the Queen mine will prove similar to the Glance in that fairly recent timbering, which has been under water, will be in such shape it will not have to be replaced. The Queen has a headframe, hoist house and a 50 HP hoist.

Copper King:

The shaft has been re-laddered and the timbering repaired. It has nor surface improvements. The rehabilitation to the 200 level was for the purpose of preparing for diamond drilling to the contact.

ORE RESERVES:

The calculation of ore reserves in lime replacement bodies is a difficult matter, but the following is good practice and details the manner in which the Copper Glance reserves are estimated.

The ore occurs in connected lenses in a large mass of garnet, which occurs along the contact of the granite and overlying limestones. Using the known tonnage mined above the 525 level and below the 300 level from the garnet area there, we find a block 100 feet by 200 feet extending from the 300 to the 525, an incline distance of 270 feet. This block contains 5,400,000 cu. ft. of garnet or 540,000 tons of garnet zone, which actually has produced 118,066 tons of ore averaging 6.72% copper.

From the 525 level to the bottom of the 626 winze, which is still in ore, using the same manner of calculation, we are justified in expecting 400,000 tons of garnet ore zone which could produce 87,400 tons of ore at similar grade. The partial development on these lower levels does not show a any diminution in size or grade.

An average of all the mine samples taken during the last 40 days operation shows:

525 level workings assayed	6.80% copper
625 level workings assayed	7.70% "
AVERAGE	7.45% "

There is no reason to expect the ore bodies to bottom at the present level as diamond drilling shows the limestones, which are essential to ore formation, continue at least 500 feet deeper.

This diamond drill hole was drilled from the 625 level so there is 400 feet of limestone below the 700 level. The 400 feet of limestone from the 300 to the 700 level produced 118,066 tons and is estimated to contain 87,400 tons ore, a total of 205,466 tons. It is possible the succeeding 400 feet will contain a similar amount of similar grade.

Copper Queen:

The Queen has been mined to a greater depth than the Glance, but an estimate using similar reasoning shows approximately 40,000 tons reasonably expected, and a possible additional 50,000 tons averaging 6.50% copper.

Copper Bullion:

Copper King:

These two areas have just as good a chance of developing substantial ore bodies as the Glance and Queen had, and of similar grade. It is remarkable that the three mines on this contact that were developed to the contact in the favorable "roll" area, all proved very profitable, and adds to the possibility of that two known areas may also develop similarly. In addition to these, there are other likely "roll" areas between the Glance and the Queen, and the King and the Minnie.

	<u>Production</u>		<u>Probable Ore</u>		<u>Possible Ore</u>	
	Tons	%Cu	Tons	%Cu	Tons	%Cu
Copper Glance	118,066	6.72	87,400	7.45	205,466	6.00
Copper Queen	75,086	7.08	40,000	7.00	50,000	6.50
Minnie	<u>62,477</u>	<u>4.71</u>	<u>30,000</u>	<u>3.25</u>	<u>30,000</u>	<u>4.00</u>
	255,629	6.35	157,400	6.53	285,466	6.23

In the unprospected "rolls", Copper King and Copper Bullion, it is possible they will each contain a somewhat similar tonnage to the average of the three, which is 232,830 tons, averaging 6.35% copper.

There is a good "roll" between the Glance and Queen mines, which can be prospected from the 525 level of the Glance, and it also could develop a similar tonnage and grade like that estimated in the Copper King and Copper Bullion.

The property has an entirely possible chance of producing four or five times the quantity in the future that it has produced in the past.

**COST OF PRODUCTION:**

Since the Copper Queen mine was unwatered, rehabilitated, and put into production in 1919, under circumstances existing today in a similar way, costs and outcome could be very much alike. Mr. Foy started with a capital of \$21,000.00, copper price averaged 13.83¢, shafts were caved and mine full of water. The net profits for 1923-1926 were \$412,216.00 on 59,952 tons.

The detailed costs at that time were as follows:

<u>Direct</u>	<u>Per Ton</u>	<u>Indirect</u>	<u>Per Ton</u>
Labor	\$1.686	Prospect Outside	
Labor Ins.	.083	Mines	\$ .688
Power	.097	General	.062
Explosives	.179	Repairs Renewals	.112
Smelter Represent.	.058	Taxes - St. & Co.	.218
Pumping	.076	Taxes - Federal	.476
Timber	<u>.022</u>		
<b>Total direct</b>	<b>\$2.372</b>	<b>Total indirect</b>	<b>\$1.556</b>

Total all costs \$3.928

Future costs of mining will not include "prospect outside mines", but labor will be higher, so a cost of \$4.00 per ton is estimated.

Cost of Smelting - Transportation and Outcome:

Assuming the first production would come from the Copper Glance mine, and using an approximation of the average assays of the last 58 railroad cars, 3,154.3 tons, namely, copper 6.0%, silver 2.0 ox, the following figures will show the outcome:

The price of copper is considered basically at 12¢. I have two premiums "A" of 5¢ and "B" of 7¢, but will only consider "A", as the extension of "B" after July 1st is problematical. If the "A" premium is not extended, the ceiling price of copper will be raised, so the net should be about the same.

Pay		
Silver 2.0oz less 0.5 oz at 70¢		\$1.05
Copper 6.0% 120# less 12#		
108% at 12¢ less 216¢		<u>10.15</u>
		\$11.20
Deduct		
Hayden Smelting	\$2.50	
RR Frt. plus 5% H <sub>2</sub> O	<u>1.50</u>	<u>4.00</u>
		\$7.20
Royalty 10%	.72	
Trucking	.80	
Mining	<u>4.00</u>	<u>5.52</u>
		\$1.68
Premium "A" 97% of 120# at 5¢		<u>5.82</u>
		\$7.50
Net Profit per ton		\$7.50

The R.F.C. loan must be paid as it is an obligation of the lease, but the local officers assure me that 5% royalty per ton is about what may be expected, as a basis for reimbursement.

#### FUTURE OPERATIONS:

To reopen this group of mines, several plans may be followed:

1. A diamond drilling campaign from the surface and shallow open workings to prospect the possible ore areas.

Copper King.....3,	200-ft holes
Copper Bullion.....3,	200-ft holes

Deeper drilling to prove vertical extensions of known ore bodies.

Copper Glance.....2,	1,000-ft holes
Copper Queen.....2,	1,000-ft holes

If this program proved successful, then the reopening of the mine would follow and be guided by the information gained from such drilling.

II. Commence reopening the Glance mine, followed by the Queen reopening, with subsequent or simultaneous diamond drilling. With the equipment installed, the shaft practically repaired, headframes repaired, and the small amount of water remaining in mine, the reopening of the Glance seems logical.

Shipments could begin within 90 days after work commences and should furnish the funds for reopening the Queen and do the drilling necessary to develop the new possible shoots.

The estimated cost of getting into production and amount of operating capital needed, is:

Hoist	Move 50Hp Diesel Hoist Queen Mine to Glance	
	Extend building foundations, small repairs.....	\$ 750.00
Shaft	Repair, tighten guids and sets	
	ladders to 625.....	500.00
Levels	Cleanup 525, 625. Repair, install track.....	1,000.00
	Ore Bin Repair.....	250.00
	Unwater 500, 625 levels, 625 winze with	
	Cameron Pump.....	1,000.00
Air Receiver	Install.....	75.00
Equipment:		
	3 Jackhammer type drills, hose, tanks,	
	1 cradle, 1 stoper, hose tank line oilers.....	1,200.00
	4000# drill steel (use Contention sharpener.....	750.00
	2500 ft. 12# rail and spikes (5 ton).....	300.00
	10 mine cars (used).....	1,000.00
	2500 ft. 2" pipe - 21#.....	525.00
	2500 Ft. 1/2" pipe - 15¢.....	375.00
	1000, "1" pipe - 12¢.....	120.00

Estimate cost, etc.....

Equipment (cont'd)

Fittings, valves, etc.....	\$	250.00
Air Hoist - 625 winze.....		500.00
Air Pump - " " .....		250.00
Shovels, picks, wrenches, misc. tools.....		<u>250.00</u>
	\$	9,095.00
Reopening Queen shaft for ventilation.....		1,350.00
Carload miscellaneous timber (repairs and operation).....		1,450.00
30 day payroll - 1,000 tons.....		4,000.00
Pickup truck.....		1,000.00
	TOTAL	\$16,895.00

In order to meet any unforeseen contingencies, a fund of \$25,000.00 should be available.

All the maps and records were furnished by Mr. W. F. Foy, who was the manager under the last operations. When I was ore purchasing agent for the American Smelting and Refining Company, I bought the Copper Queen production from Mr. Foy during 1923-26. I saw his operations and was so very favorably impressed that I have confidence in all this data. The evidence disclosed in unwatering to date has confirmed his statements.

Considering the history of production and profits from these mines, and reviewing the maps and considering Mr. Foy's statements concerning the ore in the Glance mine available for immediate production, it is entirely probable that more than enough ore can be easily and quickly produced to repay the capital investment, a drilling and development campaign, and furnish profits soon after production begins.

With intelligent management, the purchase price of the mines can be accomplished through royalty payments, ore can be developed for the future, and along time mining operation of fair size can be developed.

(Signed) Howard H. Fields  
Howard H. Fields.  
March 21, 1947.

C O P Y

WAR MINERAL REPORT  
United States Department of the Interior - Bureau of Mines

W.M.R. 47 - Copper, Zinc

February 1943

TWIN BUTTES CAMP  
Pima County, Arizona

SUMMARY

The mines of the Twin Buttes Camp are at contacts of intrusive granite with older sediments, largely limestone. The ores are principally the contact metamorphic type and are localized in the hanging wall sediments at the junction of small fissure veins with the granite contact. No important ore bodies were exposed at the surface, but were discovered by sinking on the fissure veins to the contact zone. Masses of garnetized rock in the contact zone also serve as possible indicators of underlying ore bodies.

Five mines in the area - Minnie, Copper King, Copper Queen, Copper Glance, and Senator Morgan - have yielded 388,000 tons of ore averaging 6.17 percent copper and a small tonnage of high-grade oxidized zinc ore. Developed reserves in two of these mines amount to 30,000 tons of 6 percent copper ore. The Contention mine, on another segment of the granite contact, has 15,000 tons of developed zinc-copper ore averaging 17 percent zinc and 2 percent copper. Ore development is in progress at this mine, financed by a \$20,00 Reconstruction Finance Corporation loan.

All of the copper mines except the Senator Morgan lie along an 8,000 foot east-west segment of the granite-sedimentary contact. Two other shafts, which yielded no production, were sunk on this contact, so that some 6,300 feet of the contact zone is accessible for underground exploration. Geologic conditions favorable to ore deposition are found along some 2,500 linear feet of unexplored portions of this contact zone.

All of these mines are controlled by the owner and operator of the Copper Queen and Contention mines, who holds the other mines under lease. Financing has been arranged for extracting shipping ore now exposed on the lower levels of the Copper Queen and Copper Glance mines and for continued development and mining. Preliminary rehabilitation is under way. Four of the shafts have been made accessible, and the lower levels of the Copper Queen and Copper Glance, now under water, will be unwatered soon.

Mining cost of shipping ore is estimated at \$5.00 a ton. Ore of lower grade than 5 percent copper will yield little profit when shipped to the smelter.

The Bureau of Mines has begun an exploration program in which it is planning to include (1) mapping and geologic study, both at outcrop and underground; (2) sampling of underground workings and diamond drill testing of parts of the Twin Buttes contact zone for extensions of known ore bodies and search for new ones; and (3) sampling the Contention mine and diamond

drilling to prove extensions of that ore body. About 4,000 feet of diamond drilling and 500 feet of underground drifting will be needed. The total cost of the project is estimated at \$45,000.00. This program has a dual purpose--first, to disclose additional reserves of shipping ore, and second, to estimate the tonnage of milling grade ore and if the available tonnage of the latter is sufficient to justify the erection of a mill, to make metallurgical tests and proposals for a custom mill in this camp.

This program offers an opportunity to disclose ore bodies that should yield copper ore and zinc-copper ore of shipping grade. The expectation is 25,000,000 pounds of copper to be produced from 1943 to 1947, inclusive.

#### INTRODUCTION

The Twin Buttes Camp embraces eight mines that lie along a contact of granite with Paleozoic limestones and quartzite. Five of these have been producers; another is in active development and has some zinc-copper ore blocked out. There is known reserve of some copper ore in two of the old producers.

In June, 1942, when a Bureau of Mines engineer investigated these mines, only one of them was accessible. Maps of the others are available, as well as records and smelter settlements covering the greater part of the copper produced from the camp, and a geological report on the Twin Buttes district by Ronald L. Brown in the Univ. of Ariz. library. The present operator, who has been connected with these mines since 1916, supplied much information.

The Senator Morgan group, under lease to Charles Taylor of Tucson, Arizona, is owned by the Twin Buttes Mining and Smelting Co. of Milwaukee, Wisconsin, which also owns the Copper Gance, Copper Buttes, Copper Bullion, and Copper King mines. These are leased to William Foy, of Twin Buttes, until 1948.

The Midland Copper Co., now defunct, owned the Copper Queen mine. William Foy, a former shareholder in that company, has been paying taxes on the mine for several years.

The Ariz. Buttes (Minnie) group of claims and the Contention group, all unpatented, are held by William Foy.

The Taurus claim (unpatented) is held by G. Gavin, Box 13, Ruby Star Route, Tucson, Arizona.

Work has been started at the Copper Gance to rehabilitate the shaft and unwater the mine and the Copper Queen, which is connected the Copper Gance in the seventh level. William Foy has unwatered the Contention mine and is doing development work there.

#### HISTORY

The first locations are said to have been made in 1876. Little mining was done before 1905, when D. S. Rose, of Milwaukee, organized the Twin Buttes Mining and Smelting Co., and acquired the more promising claims in the area,

except the Minnie Group. This company built 28 miles of standard gage railroad from Twin Buttes to Tucson and erected a smelter on the Santa Cruz River. It operated from 1906 to 1913, but was not highly successful. It produced 132,500 tons of ore averaging 5.92 percent copper, mainly from the Morgan mine, but some of it from the Copper Glance and Copper King mines.

Ed Bush leased the Morgan mine in 1913 and produced a few carloads of low grade ore. He relinquished that lease in 1914 and took a lease and purchase option on the Minnie mine, which he developed and operated from 1914 to 1917.

Ed Bush and associates organized the Midland Copper Co. in 1917 and took the Copper Glance and Copper Queen mines under lease and purchase option. The Copper Queen was paid for out of royalties. The lease on the Copper Glance was surrendered in 1918, and the mine has since lain idle. It has produced 118,066 tons of ore, averaging 6.72 percent copper. Bush died in 1920. The company reopened the Copper Queen mine in 1922 under the management of William Foy, and shipped ore from 1923 to 1926. The Copper Queen produced 75,186 tons of 7.05 percent copper ore from 1917 to 1926. William Foy produced a little ore from the Minnie mine in 1928.

Total production from the camp has amounted to 388,231 tons averaging 6.17 percent copper, contributed as follows:

<u>Mine</u>	<u>Dry Tons</u>	<u>Copper, percent</u>	<u>Copper Content, pounds</u>
Senator Morgan <sup>1</sup>	132,502	5.92	15,688,237
Copper Glance	118,066	6.72	15,870,493
Copper Queen	75,186	7.05	10,608,048
Minnie	<u>62,477</u>	<u>4.71</u>	<u>5,865,333</u>
	388,231	6.17	48,032,111

<sup>1</sup>Production credited to the Senator Morgan mine includes all of the ore produced from the Copper King and the early production from the Copper Glance.

#### PHYSICAL FEATURES

The Twin Buttes Camp, in the Pima Mining District, is 28 miles south of Tucson on the Tucson-Continental County road. It is 6 miles south of Mineral Hill. Almost half of the road is paved and the remainder is will graded. A graded road 9 miles long connects the camp with Sahuarita, on the Nogales branch of the Southern Pacific Railroad and on paved U.S. Highway 89.

Topographic relief is not great. The altitude is about 3,400 feet, wherefore temperatures are somewhat lower than at Tucson.

Potable water is obtainable from three old prospect shafts in the area, but the nearest supply is rather scant in dry weather. Mine water is used for other than camp purposes.

Although labor is not abundant, a few experienced men are available, and some ordinary laborers can be obtained.

#### GEOLOGY

The ore deposits of the camp, as indicated by past development, are mainly the contact-metamorphic type and are at or near the contacts of intrusive granite with Paleozoic limestones and quartzites. The ore shoots lie in metamorphosed sediments adjacent to a zone of garnet rock that separates the ore from the footwall granite.

The principal group of copper mines lies along the north side of a sedimentary ridge that may be completely surrounded by granite. The greater part of the contact is masked by alluvium. The claims lie end to end, with their side lines roughly parallel to a nearly east-west segment of the granite-sedimentary contact, which is about 8,000 feet long (fig. 1). From west to east the mines are Minnie (Arizona Buttes), Copper Buttes, Copper King, Copper Queen, Copper Gance, and Copper Bullion. The contact is approximately defined by outcrops toward the west but is masked by a thick mantle of alluvium toward the east. The dip of the contact is south. Some transverse faulting has been noted along this segment of the contact.

The Contention zinc-copper ore body on the North Star claim about 3,500 feet south of the Minnie mine, is on the granite sedimentary contact at the northeast side of another block of sediments. The intervening contact line between the mine and the Twin Buttes group is several miles long, within which interval the granite presents many phases, grading from true granite to diorite. Quartz segregations and lamprophyric dikes also occur.

The old Senator Morgan mine, adjoining the Contention at the southeast, is near a faulted segment of the same granite-limestone contact that trends northwesterly. Several faults are noted in this general area.

#### ORE DEPOSITS

The Copper Bullion, Copper Gance, Copper Queen, Copper King, and Minnie form a geologic unit. Mining on the Gance, Queen, and Minnie has shown that these are contact-metamorphic deposits. Chalcopyrite, together with a little bornite, is the principal copper mineral, although copper carbonates and native copper are found. The gangue consists of garnet, epidotized limestone, and some specular hematite. The three mines have the following characteristics:

1. Initial work was on small fissure veins containing copper carbonate ore.
2. The veins led to contact metamorphic deposits of economic importance.
3. The contact metamorphic ore bodies did not outcrop.

4. The ore shoot developed, in each instance, has an easterly rake and consists of connected, irregularly shaped ore bodies within the contact zone. The shoots are lenticular in general outline, have an average thickness of 30-80 feet, and are about half replaced by copper ore above 5 percent grade.

5. At the surface and in the vicinity of the upward projection of the ore bodies, is a zone of garnetization, containing minor amounts of copper carbonates.

6. Progressively from west to east, the contact metamorphic bodies occur at greater depth below the surface.

7. The depth of these bodies is a function of the horizontal distance between the granite contact and the fissure vein appearing over each body.

8. The importance of the underlying ore body appears to be reflected in the strength of garnetization, where the limestones are of equal amenability to contact metamorphism.

The water table is about 425 feet below the collar of the Copper Glance shaft. That mine makes 50 gallons of water a minute at the 625 foot horizon.

#### DESCRIPTION OF MINES

Minnie (Arizona Buttes) - This was the first of the group to be explored. Most of the fissure vein over the ore shoot has been eroded, so that strong mineralization was evident at the surface. The ore shoot lies between limestone and a footwall wedge of quartzite, the thin edge of the wedge being towards the east. This was passed in drifting east on the 325 foot level where granite was encountered on the footwall of the mineralized zone. The copper content there fell below 3 percent. Mineralization appears to have been localized by transverse fractures that pass from the granite through the quartzite into the limestone hanging wall. The quartzite is partly mineralized adjacent to these fractures and yielded some ore.

The ore shoot, as developed, is about 500' along its pitching axis, roughly oval in cross section and about 70' wide. Total production has amounted to 62,477 tons with average grade of 4.71% copper. The ore diminished in grade on the lowest level; 5,100 tons mined there in 1929 averaged 3.15 percent copper. Ore of similar grade remains in the mine, according downward. Future exploration in this mine had best be directed eastward along the granite limestone contact toward the Copper Buttes shaft about 1,400 feet away. The 325' level was driven 375' east on this contact without encountering shipping ore. This exploration is not recommended at present.

Copper Buttes - There is a moderate development of banded garnetization between the Minnie and the Buttes shaft. A small mineralized fissure vein outcrops at the Buttes shaft, which was sunk on this vein at an inclination of about 60 degrees southerly. The shaft entered the footwall granite at 100' and was continued in granite to 300' on the slope. Crosscuts were driven to the hanging wall limestone at the 200 and 300' levels. Drifting along the contact on these levels aggregates about 225'. The contact, where exposed underground, has a leached zone with some mineralization that averages

about 5' in width. This zone contains some chalcopryite in garnet rock, but the material is below commercial grade. Exploration, if undertaken, should be directed westward along the contact toward the Minnie; that is, not contemplated as part of the Bureau's present work.

Copper King - The King shaft was started early in the century on a fissure vein containing copper carbonate. The shaft was last used in 1913 and is reported to be 300 feet deep. The vein is in limestone and dips steeply toward the south. It is exposed for a length of 250 feet at the surface, where it pinches and swills along the strike; underground openings show the same variation in width down the dip. Average width is about 5 feet. Leasers are now mining at the surface working westward toward the granite contact which is masked by alluvium.

Mine records show that oxidized zinc ore was found in the foot wall limestone a short distance north of the vein. Smelter settlements indicate that 2,183 tons of ore carrying 27 to 34 percent zinc was shipped to Kansas and Colorado smelters.

There is a moderate development of garnet in the hanging wall limestone over the King fracture. Eastwardly the surface trace of the fracture fades out into a heavy body of garnet rock overlying the Queen stopes. Although the King fissure is well within the hanging wall (perhaps 300 feet), relative to the Queen shaft, it is not unlikely that it connects with the Queen ore body. The intervening block of ground, about 400 feet measured along the rake of the Queen ore shoot, will be explored through stoping in the two mines.

The block of ground below the King workings is considered a promising potential source of copper ore and possibly of zinc ore, also. An ore shoot should be found at the junction of the King fissure with the granite contact, assuming that ore deposition here followed the pattern exposed by development at the Minnie mine to the west and at the Queen and Glance mines immediately to the east. The strike and the attitude of the granite foot wall are unknown between the queen mine and the Copper Butte shaft, so that the distance from the lowest level of the King workings to the granite foot wall is unpredictable.

Copper Queen - The first work at the Queen mine was on a small fracture filling of copper carbonate ore, as at the Minnie, King, and Glance mines. A shaft was sunk on the fracture about 100 feet, almost vertically. In view of geologic conditions already proved at the Minnie and Glance mines, this shaft was abandoned and another one was started, inclined 72 degrees south. This second shaft intersected the hanging wall limestone and encountered the metamorphic ore body at 440 feet inclined depth, and has been sunk to 740 feet. Ore was stoped from above the 440 down to the 700 foot level. The ore body is said to diminish in thickness and grade in the backs of the stopes above the 440 foot level. Complete assay records of this last work indicate that the grade of ore is about the same as that of the ore mined above. Selective mining is necessary, as at the Glance and Minnie mines. About half the material in the ore shoot is shipping ore of 6 percent grade.

The shaft cut the granite contact at an inclined depth of 570 feet; on the 700 foot level it is 70 feet in the foot wall granite. A wall of granite was encountered 175 feet west of the shaft on the 700 foot level. The calculated dip of the contact between these points is 45 degrees south. Ore was mined from the reentrant angle, and the granite was followed 60 feet toward the hanging wall without finding its contact with the limestone. There is low grade mineralization along this crosscut. A similar granite projection was found east of the Queen stopes on the 650 foot level about 300 feet east of the shaft. Here it is clearly the result of transverse shearing. The ore continued well back into the foot wall granite. Neither of these projections was found on the higher levels. If they continue downward, they may form the western and eastern limits of the Queen ore body. They are 500 feet apart where observed, but it is reported that they incline slightly toward each other downward. The major ore shoot has a width of about 200 feet, although some ore has been mined along the entire strike length of 500 feet.

The Copper Queen could be explored at both upper and lower ends of the developed part of the ore zone. The upper and westerly projection would be difficult and costly to reach by diamond drilling. Continuation to depth could be proved only by sinking on the ore body or crosscutting into the hanging wall and diamond drilling.

The Copper Queen has produced 75,186 tons of ore containing 7.05 per cent copper and about 2 oz silver per ton.

Copper Gance - The first work at the Copper Gance was an inclined shaft on a small fissure in limestone that strikes N. 60 degrees W. and dips steeply south. Two ore shoots were found on opposite sides of the shaft, about 100 feet apart, on the 150 foot level. The first shaft was abandoned, and a vertical shaft was sunk, directed at the western ore shoot. This shaft entered the contact zone between granite and limestone at 330 feet. Two lobes of ore were developed, which join on the 400 level and connect with the eastern ore body found on the 150 foot level in the fissure vein. The ore in the contact zone was developed easterly and downward to a vertical depth of 550 feet.

The shaft intersected the granite contact at 380 feet and was sunk in the foot wall granite to 625 feet, where the crosscut to the ore zone is 150 feet long. Two winzes were sunk in ore on the 625 foot level. The ore is similar in grade to that mined at higher levels. The ore shoot rakes to the east. It has been developed for a length of 400 feet; it is about 200 feet wide and 60 feet thick. About half of the shoot is ore.

A west drift on the 525 foot level connects with workings of the Queen mine. This drift was carried along the granite foot wall for 365 feet from the Gance workings, and thence, due to the undulating contact surface, in the limestone hanging wall for the final 1,000 feet.

Above the 450 foot level, the Gance stopes are almost entirely west of the shaft, but the ore body lies directly in front of the shaft on the 625 foot level.

Drifts were carried about 275 feet east of the shaft in the contact zone on the 450 foot and 525 foot levels. No profitable ore was found in these drifts nor in short crosscuts driven north and south from them.

Considerable diamond drilling has been done from underground stations in both the Glance and the Queen mines. These holes were all directed into the hanging wall at various angles, but, so far as known, none was directed toward the granite contact.

Copper Bullion - A vertical shaft on the Copper Bullion claim was sunk 500 feet to explore a strong vein in the cherty Cambrian limestone known as the Abrigo formation. The vein has an average width of 18 feet, dips steeply northward, and strikes N 60 degrees W in conformity with the bedding of the formation. The cherty country rock suffered little alteration, but there is some garnetization in the fissure filling. The shaft is in the vein to a depth of 50 feet and in the hard, cherty limestone footwall below the depth. Crosscuts were driven to the vein at the 100, 200 and 300 foot levels, and raises were carried up in the vein from these crosscuts. A 100 foot winze was sunk in the vein on the 300 foot level. A crosscut was started toward the vein on the 500 foot level but was not finished. A diamond drill hole 380 feet deep and almost horizontal was directed northeasterly and did not reach the granite contact.

The Copper Bullion vein filling is largely iron oxide, garnet, and partly garnetized limestone, with streaks of copper sulfide and oxide. A little shipping ore was mined from the upper part of the vein. The Copper Bullion fissure appears to be on the projected strike of the Copper Glance fissure but in a different type of limestone. The horizontal distance between the shafts is about 1,300 feet. No ore exposures were observed except minor occurrences of copper carbonates in garnet near the Glance shaft.

The granite contact north of the Copper Bullion shaft is marked by a heavy mantle of alluvium. The probable line of junction between the vein and the contact is indeterminate but is certainly at considerable depth. There appears to be ample room here for a deep deposit of copper ore.

Contention Mine - An exceptionally strong development of dark garnet rock occurs at the Contention mine. Thin beds of unreplaced limestone remain in the garnet zone, which is nearly 100 feet wide. The zone is separated from the granite here and there by unreplaced limestone and at some places by a thin bed of quartzite. The contact zone is irregular and is interrupted by faulting.

There is one vertical shaft 221 feet deep. A crosscut on the 150 foot level was driven southwesterly and encountered a thin vein at 100 feet from the shaft. This was drifted upon to the south from a distance of 157 feet and was crosscut at two places. Three raises were connected by a sublevel 80 feet above the drift. All of this work is in ore. One raise was continued to 60 feet above the subdrift, where its face is partly in ore. Two winzes were sunk in ore from the 150 foot level. It is reported that a crosscut was driven to the ore on the 210 foot level (under water at date of examination) and that the vein was drifted on, in ore, for 150 feet, southward.

Development is insufficient to determine the structural relationship. The pitching of the ore to the north is probably related to a fault that

outcrops a little north of the shaft. An east-west arroyo probably marks the trace of this fault. Beds on the two sides of the arroyo show almost no horizontal displacement but differ by 35 degrees in strike.

The ore shoot contains masses of irregularly distributed garnet. It has a foot wall slip, below which the beds have not been prospected. A zone of radially bladed actinolite may mark the hanging wall, but this has not been crosscut outward from the ore body. Widths across the ore range from 4 to 22 feet, but the average thickness is not less than 12 feet.

A class B development loan of \$20,000.00 has been granted by the R.F.C. to be used to develop ore reserves to the south at a depth of 300 feet.

It is worthwhile nothing that his ore body did not outcrop and that there were no proven ore bodies in the immediate vicinity. Ed Bush, following his experience at other mines in the district, sank 150 feet on the garnet zone and the crosscut toward the hanging wall limestone to discover the ore. A similar exploration program on the Gladstone claim, undertaken later, was unsuccessful.

Taurus - This is an unpatented claim of irregular shape adjoining the North Star (Contention) claim on the southeast. The heavily garnetized contact zone on the North Star claim continues southeasterly across the Taurus claim but pinches out near the southeast end line of that claim. On the Taurus, about 800 feet southeast of the Contention shaft, measured along the contact (500 feet southeast of the nearest proposed diamond drill hole) is an outcrop containing copper carbonates enclosed in the garnetized and epidotized limestone. This copper streak is about one foot wide. There is no development except a few test pits.

#### ORE RESERVES

Minnie Mine - Records and assay maps indicate that the developed ore shoot in the Minnie mine may be nearly exhausted. Both grade and thickness of the ore are diminishing at the edges of the stoped areas. The last ore shipped averaged 3.15 percent copper, which is not shipping grade at this time. No reserves are credited to this mine.

Copper King Mine - Ore probably remains in the King fractures. Both zinc and copper ores were being shipped from the mine when the Twin Buttes Mining & Smelting Co. suspended operation in 1913. No assay maps are available. The shaft has been cleaned out and retimbered.

Copper Queen Mine - Assay records indicate that ore of the same grade as that mined above (about 6 percent copper) can be mined from the lowest levels. The thickness of the oreshoot diminished within the lowest 100 feet of its depth.

Copper Glance Mine - The Copper Glance ore shoot has been proved on the 525 and 625 foot levels but only partly extracted there. Reserve is estimated at 30,000 tons of 6 percent copper ore, based on past production from higher levels.

Contention Mine - Proved reserve is about 15,000 tons of ore that will average about 17 percent zinc and 2 percent copper.

Total Reserves are thus 30,000 tons of 6 percent copper ore and 15,000 tons of zinc-copper ore at 17 percent zinc and 2 percent copper.

MINING COSTS

Mining cost per ton of shipping ore at the Copper Queen mine from 1923 to 1926 were as follows:

Labor.....	\$1.668	
Insurance.....	.083	
Power and Air.....	.097	
Explosives.....	.197	
Smelter representation.....	.058	
Pumping.....	.076	
Miscellaneous supplies.....	.171	
Timber.....	<u>.022</u>	\$2.372
Prospecting and Development.....		.688
Overhead:		
General office expense.....	.062	
Repairs and renewals.....	.112	
Taxes, State and Co. ....	.218	
Taxes, Federal, Inc. ....	<u>.477</u>	.869
Total cost per ton of shipping ore.....		3.929
Estimated present cost.....		5.00

Smelter returns at the mine, according to American Smelting and Refining Co. schedule, on copper ore delivered at Hayden, are as follows:

Cu. 13.85¢	Ag. 70¢
On 4.5 percent copper, 2 oz. per ton silver.....	\$5.87
Less royalty 10% of net smelter returns.....	.59
Net per ton at the mine.....	<u>\$5.28</u>
On 5 percent copper ore, 2 oz per ton silver.....	7.48
Less royalty 10 percent of net smelter returns	
Net per ton at the mine.....	<u>\$6.73</u>
On 6 percent copper ore, 2 oz per ton Ag.....	11.10
Less royalty 10% of net smelter returns.....	1.10
Net per ton at the mine.....	\$9.99

The lease terms under which the mines will be operated are not known, but a royalty of 10 percent of net smelter returns is a general standard on this grade of ore. According to the above calculations there will be no profit in shipping 4.5 per cent ore, and 5 percent copper will be probably cutoff for shipping ore.

PROPOSED EXPLORATION BY BUREAU OF MINES

The complete program includes the following items, at their estimated costs:

1. Surveying and mapping surface and underground workings and preliminary character sampling.....\$4,000.00
  2. Rehabilitation of mine to give access for drilling, mapping, and cutting of underground drill stations..... 3,000.00
  3. Surface trenching..... 2,000.00
  4. Diamond drilling, including supervision, sampling, and analyses, 4,000 feet at \$6.00 per ft.....24,000.00
  5. Driving exploratory headings to favorable areas, 500 ft. at 14 dollars a ft..... 7,000.00
  6. Mine sampling..... 3,000.00
  7. Contingencies..... 2,000.00
- \$45,000.00

For the immediate future, work will be limited to item 3, the results of which will largely determine the advisability of further procedure.

Copper King Mine: Objectives are to extend the known ore reserve and determine its grade. Diamond drilling is proposed to test the Copper King fracture down to the granite contact and also the contact zone. It is proposed to drive a crosscut 100 ft into the hanging wall on the 300 ft level and to cut a diamond drill station at its end. Drill holes totalling 1,310 feet will be directed at different angles to crosscut the vein at intervals down to its junction with the contact and also to crosscut the contact zone. Some holes will be continued into the footwall of the vein to test the continuity downward of the footwall zinc ore body, from which it is estimated that 1,100,000 lbs of zinc has been shipped in ore.

Copper Queen and Copper Glance: It is proposed to test a 1,000 ft gap of unexplored contact zone between Copper Queen and Copper Glance workings by diamond drilling from stations in the long drift on the 525 ft level of the Glance. The drill holes will be spaced at 100 ft intervals and will be directed northeasterly with 45° downward inclination. The total footage to be drilled is estimated at 1,375 ft.

Copper Glance: The Operator proposes to extend the east drift on the 525 ft level 250 feet eastward, and to drive along the limestone hanging wall, thus leaving most of the contact zone unexplored. The contact zone contiguous to the proposed drift seems particularly promising because of its proximity to known ore and because it is under a very heavy mass of garnet rock at the surface. The Bureau of Mines proposes to drill five holes from this drift northerly to the granite footwall. The holes will be inclined about 45° downward and will be about 100 feet deep. The total drilling is estimated at 400 feet. This may disclose an ore shoot similar to the Glance ore body.

Copper Bullion: The drilling proposed on this claim is to determine the copper content of an 18-ft vein at and below the 500 ft level. The vein has been exposed near the shaft to the 400 ft level. It is leached and oxidized and has spots of copper mineralization to that depth. The drill will be stationed at the bottom of the shaft. If the test holes find profitable ore, divergent holes will be drilled to explore the ore body along the strike as far as is practicable from one station. The proposal calls for 840 ft of initial and 845 feet of supplementary drilling. This work may disclose an ore body extending to considerable depth.

Contention: The proposed drilling is directed toward proving the continuation of this ore body in depth and along the strike. It will also test the zone between the footwall of the proved ore body and the granite contact. About 1,300 feet of drilling is required. This is expected to increase the present reserve of zinc-copper ore. It will also test the type of mineralization that prevails at greater depth. It is suspected that the copper content of the ore will increase and the zinc content decrease as depth is attained. If a fairly large tonnage of the zinc-copper ore should be developed, a mill will be required to beneficiate this ore.

Taurus: It is proposed to drill two holes on the Taurus claim unless the results of drilling on the Contention are discouraging. The holes are designed to cut the contact at vertical depths of 150 and 250 feet under the surface showing of copper ore. This drilling may discover an ore shoot similar to those already proved along this contact.

#### CONCLUSIONS

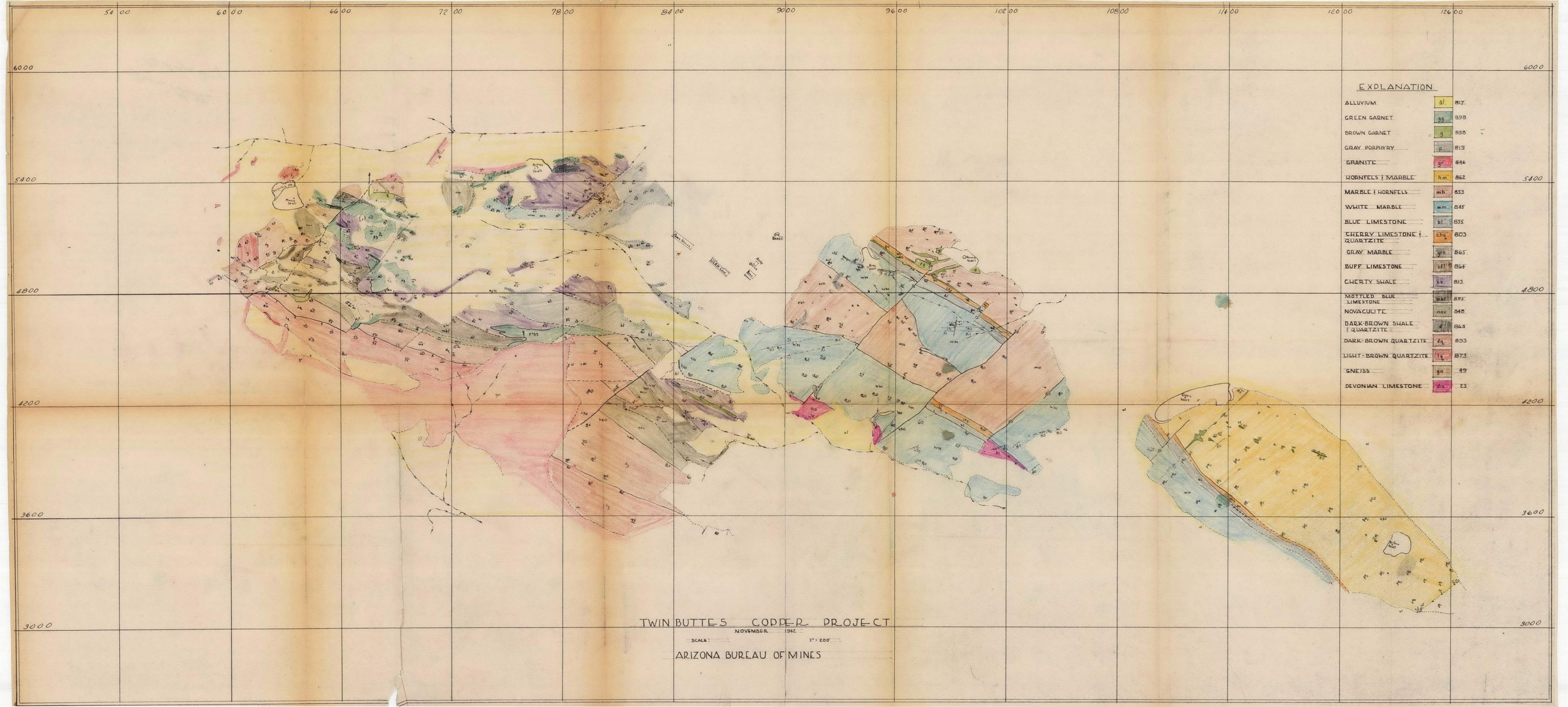
It is believed that the above program should disclose additional ore bodies. The work will decide whether a custom mill should be built in the district. There are two possible sources of mill ore-copper ore at the Twin Buttes group of mines too low in grade to ship directly to a smelter and zinc-copper ore at the Contention mine that will need both concentration and separation.

The Bureau's sampling will determine the available tonnage of such ores. If the tonnage is high enough to justify a mill, then ore dressing tests will be made by the Bureau of Mines Metallurgical Laboratory followed by proposals for a custom mill. It is probable, however, that enough mill ore will be indicated to recommend a 100 ton milling unit that can begin operation by the end of 1943.

EXPECTED PRODUCTION

	<u>Copper, pounds</u>	
	<u>From smelting ore</u>	<u>From milling ore</u>
1943.....	2,192,000	2,386,000
1944.....	3,288,000	2,386,000
1945.....	3,288,000	2,386,000
1946.....	3,288,000	2,386,000
1947.....	<u>3,288,000</u>	<u>2,386,000</u>
	15,344,000	9,544,000

Production of zinc probably will not be high, its amount cannot be estimated at this time because it is likely that the zinc content of the Contention ore will decline as depth is attained.



EXPLANATION

ALLUVIUM	al.	817
GREEN GARNET	gg	898
BROWN GARNET	g	858
GRAY PORPHYRY	p	819
GRANITE	gr	846
HORNFELS & MARBLE	hm	862
MARBLE & HORNFELS	mh	853
WHITE MARBLE	wm	845
BLUE LIMESTONE	bl	835
CHERRY LIMESTONE & QUARTZITE	chq	803
GRAY MARBLE	grn	865
BUFF LIMESTONE	blf	864
CHERTY SHALE	cs	813
MOTTLED BLUE LIMESTONE	mb	895
NOVACULITE	nov	848
DARK-BROWN SHALE & QUARTZITE	d	863
DARK-BROWN QUARTZITE	dq	893
LIGHT-BROWN QUARTZITE	lq	873
GNEISS	gn	49
DEVONIAN LIMESTONE	dis	23

TWIN BUTTES COPPER PROJECT  
 NOVEMBER 1942  
 SCALE: 1" = 200'  
 ARIZONA BUREAU OF MINES

U. S. Bureau of Mines

John Butts  
Geologic Map

# Geologic Maps

		0009
00 09	54 00	

future" for clean fuel from coal. (Story on Page 2)

~~The Mining Record, Vol. 83, No. 32, p. 1.~~



# ING RECORD

OF THE MINING INDUSTRY

*The Mining Record*

FOR  
EIGHTY-THREE  
YEARS

-CM  
ELL  
LINKS  
ROF  
OLF  
I

# Conveyor Belt Servicing Is Big Business

10K 1977

JHC

of capacity because of depressed levels of copper demand and prices. During 1977 the concentrator continued to operate at 60% of capacity until October 1, when the processing rate was further reduced to approximately 40% of capacity.

The oxide ore processing plant, which has a rated capacity of 10,000 tons per day, is currently operating at full capacity.

Ore reserves at Twin Buttes are currently estimated to be approximately 329 million tons of sulfide ore with an average grade of 0.67% copper and 0.03% molybdenum at a cutoff grade of 0.2% copper, and approximately 57 million tons of oxide ore with an average grade of 1.1% copper at a cutoff grade of 0.6% copper.

There is set forth below certain information concerning sulfide concentrating and oxide plant activities at Twin Buttes for the five years ended December 31, 1977. Information as to average price received for and cost per pound of refined copper relates only to Amax's share of production.

	Years Ended December 31,					
	1973	1974	1975	1976	1977	
Ore processed (thousands of tons)						
Sulfide .....	10,892	10,484	2,307(1)	8,851	8,388	
Oxide .....	—	—	1,009(2)	2,926	3,488	
Average total copper assay content of ore processed						
Sulfide(3) .....	0.824%	0.628%	0.596%	1.119% (1)	1.107% (1)	
Oxide .....	—	—	1.271%	1.309%	1.295%	
Recovery of total copper						
Sulfide concentrator .....	128,360,564 <sup>#</sup> 71.51%	2,978,570 <sup>ca</sup> 70.61%	17,275,148 <sup>ca</sup> 62.82% (1)	12,577,196 68.04% (1)	141,939,399 87.20% (1)	ave 72.04%
Oxide plant .....	—	—	64.60% (2)	75.25%	76.20%	72.02
Production (net tons)						
Sulfide concentrator						
Copper concentrates ...	233,700	158,411(1)	29,921(1)	247,825	335,975	
Copper contained in concentrates .....	64,152	45,458(1)	8,495(1)	66,665	84,922	
Oxide plant: copper produced	—	—	6,731	28,962	34,387	
Amax average price received per pound of refined copper sold ..	\$ .7272(4)	\$ .8662(4)	\$ .7693(5)	\$ .7079(6)	\$ .6297(6)	
Amax average cost per pound of refined copper						
Sold(7) .....	\$ .5127(4)	\$ .7026(4)	(5)	\$ .9264	\$ .6585	
Produced(8) .....	\$ .5070	\$ .7230	(5)	\$ .7361	\$ .6480	

(1) As explained above, the sulfide ore concentrating facility was shut down from March 1975 to January 1976. The decline in the rate of copper produced in concentrates in 1974 and the first two months of 1975, as well as the low average recovery in the latter period, was due primarily to the temporary mining of lower grades of ore in the exposed portion of the orebody pending development for mining of the northeast orebody which contains substantially higher grade ore. Milling of ore from the northeast orebody was initiated during the first quarter of 1976. Sulfide concentrator recoveries were relatively low in the period immediately following the renewal of operations in January 1976 due to start-up problems with metallurgical control; however, during the last nine months of 1976 and during 1977 average recoveries were higher than in prior years, and the grade of ore mined

DH 1183 1972-73 Assessment C.F.B.  
 Rotary cuttings at 10' intervals 0'-1499'  
 0'-79' Alluvium, much caliche 70'-79'  
 79'-±215' Turkey track Andesite.  
 ±215'-~~1300~~'1499' Fan conglomerate, often  
 with reddish brown mud, frags of  
 Mesozoic clastics<sup>+</sup>, intrusive,  
 loc grey to blk ls and tuff,  
 530'-540' numerous chips grey  
 ls  
 1300'-~~1300~~<sup>1499</sup>' few to numer  
 chips bio rhyolite tuff or  
 possible inter-fan. tuff  
 bands.

1499' start NX core.

1499'-1706' EOH Red to reddish brown  
 Fan conglomerate with predominately  
 Mesozoic clastic fragments, occ  
 frag limestone, occ siltst.

1559' slip 45°





**THE ANACONDA COMPANY**  
**ARIZONA OPERATIONS**  
**DRILL HOLE RECORD**  
 SCALE \_\_\_\_\_

DIRECTION \_\_\_\_\_ HOLE NO. 1183  
 INCLINATION \_\_\_\_\_ PROPERTY \_\_\_\_\_  
 STARTED \_\_\_\_\_ LOCATION \_\_\_\_\_  
 COMPLETED \_\_\_\_\_ COLLAR COORD. N. \_\_\_\_\_ E. \_\_\_\_\_  
 DEPTH \_\_\_\_\_ COLLAR ELEV. \_\_\_\_\_  
 NOTES BY \_\_\_\_\_ SHEET 2 OF \_\_\_\_\_

ROCK AND ALTERATION	COL	STRUCTURE AND MINERAL	% REC.	CORE ASSAYS				SLUDGE ASSAYS					
				SECT.				SECT.					
				9.2									
				1673									
				9.5									
				1683									
				9.2									
				1693									
				9.1									
				1703									
				2.4									
				1706									
				1715									
				1715									
				106									
				8.5									
				1723									
				115									
				10.4									
				1732									
				99									
				9.9									
				1742									
				100									
				10.0									
				1752									
				104									
				8.3									
				1760									
				105									
				10.5									
				1770									
				101									
				10.1									
				1780									
				107									
				9.6									
				1789									
				97									
				9.7									
				1799									
				99									
				9.9									
				1809									
				106									
				7.7									
				1817									
				101									
				10.1									
				1828									
				104									
				9.5									
				1836									

1715'-1835' Fanglomerate

Generally reddish brown; fn to coarse clastic frags of variable lithology that are sub-angular in a fn to med gn, reddish brown silty matrix. Poorly sorted.

1715'-1835' Rock is poorly sorted and poorly bedded. Few gypsum veinlets 1/8-1/4 in thick. Abn FeOx in matrix.

50H. logged by MNG 1/23/74

1808'-1835' Generally med well sorted pebble-size frags of variable lithology. Bio-rhyolite tuff(?) frags common.

30 40 Fracs w/ FeOx

very weak bedding(?)

1837'-1839' Fanglomerate as above.





**THE ANACONDA COMPANY**  
**ARIZONA OPERATIONS**  
**DRILL HOLE RECORD**  
 SCALE 1 in = 20 ft

DIRECTION \_\_\_\_\_ HOLE NO. 1183  
 INCLINATION \_\_\_\_\_ PROPERTY \_\_\_\_\_  
 STARTED \_\_\_\_\_ LOCATION \_\_\_\_\_  
 COMPLETED \_\_\_\_\_ COLLAR COORD. N. \_\_\_\_\_ E. \_\_\_\_\_  
 DEPTH \_\_\_\_\_ COLLAR ELEV. \_\_\_\_\_  
 NOTES BY \_\_\_\_\_ SHEET 5 OF \_\_\_\_\_

ROCK AND ALTERATION	COL	STRUCTURE AND MINERAL	% REC.	CORE ASSAYS			SLUDGE ASSAY		
				SECT.			SECT.		
		80 170 Minor slip w/ FeOx	95	2191					
				9.5					
				2201					
		55 Minor slip(?) w/ FeOx	107						
		40 Minor slip w/ FeOx		9.7					
		45		2210					
				9.6					
		60 Minor slip w/ FeOx	96						
				2220					
				9.6					
		5		2230					
		35		9.5					
				106					
		65		2239					
		25		9.4					
				2249					
		80		10.1					
		70		2259					
		40 Minor slip(?) w/ FeOx	95						
		30 Minor slip(?) w/ FeOx (hem)		9.5					
		40		2269					
		50		110					
		50 Minor slip w/ FeOx		9.7					
				2275					
				9.4					
				2285					
		Vague layering (bdg?) of elongated tuff frags	95						
				9.5					
				2295					
		60		9.5					
		50 Minor slips w/ FeOx	95						
		70		9.5					
		80		2305					
				140		1.4			
		80		10.0					
		50 Minor slips w/ FeOx	100						
				2316					
		55		9.3					
		35 Frac w/ 1/4 in vn of gyp & FeOx selvages	103						
				2325					
		35		9.5					
				2335					
		50		9.2					
				103					
		35		2345					
		45 Minor slips w/ FeOx		9.7					
		60		2354					
		75		9.4					
		Minor slips w/ FeOx	104						
				2368					

Minor vn of gyp →

2316'-2350' TuFF appears generally cr gn with abx FeOx & strongly kaolinized talc spars.

Vague layering of elongated tuFF frags

2364'-2365' Abx white, cr gn, recrystallized ls frags & bands



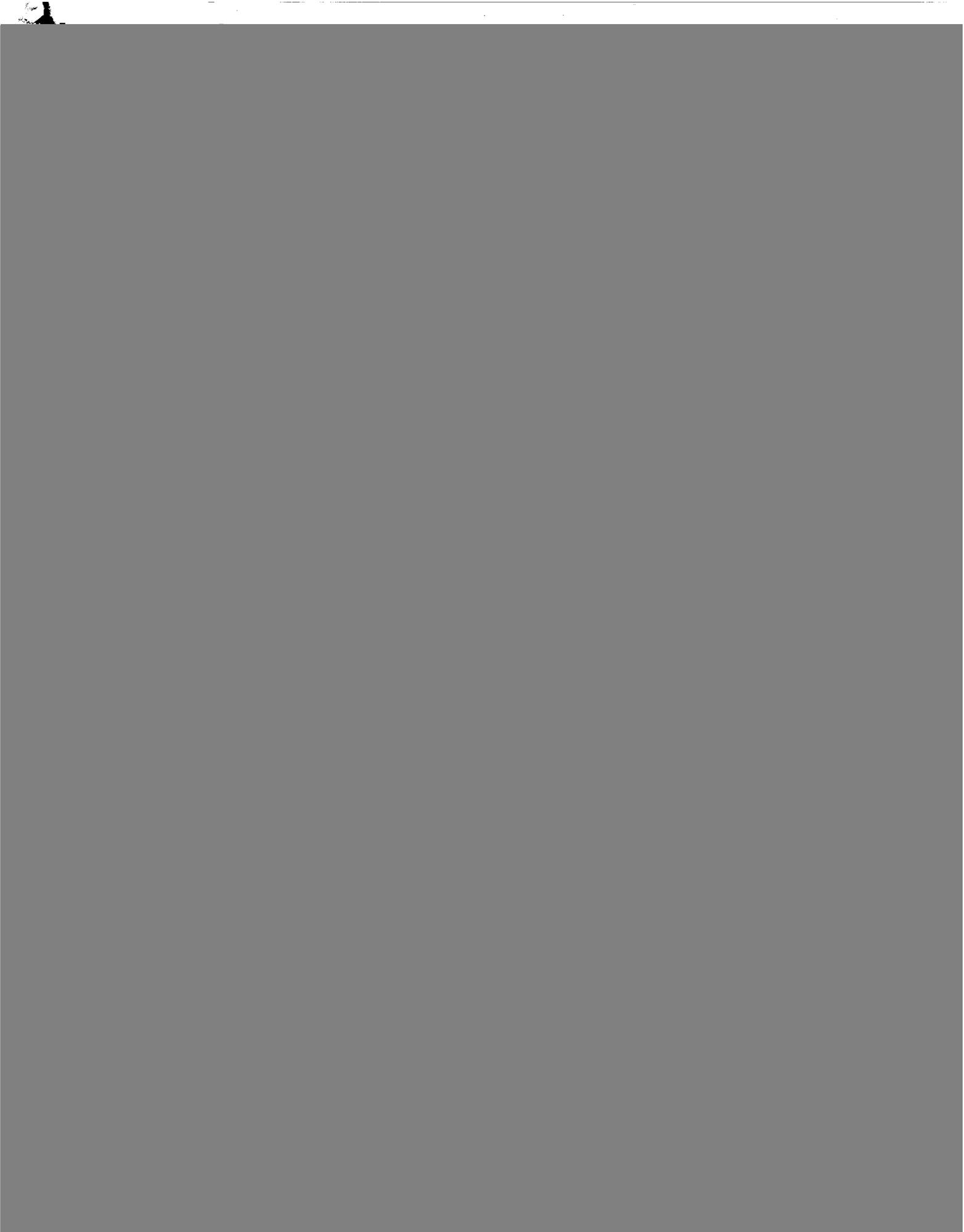


THE ANACONDA COMPANY  
ARIZONA OPERATIONS LABORATORY  
CORE ASSAYS

Date 6-12-73

*Chg # 201*

Sample No.	Hole Numbers		% Total Cu		% Oxide Cu	% Mo	
			X-Ray	Wet		X-Ray	Wet
B-78587	DDH 1183	1449-1504	0.05	Nil		.012	
88		1553-1558	0.05	Nil		.015	
89		1606-1611	0.05	Nil		.015	
90		1663-1668	0.04	Nil		.011	
91	F.O.H	1701-1706	0.05	Nil		.012	
B-78094		1715-1720	.09	Nil		.014	
95		1770-1775	.08	Nil		.012	
96		1825-1830	.11	Nil		.006	
97		1880-1885	.08	Nil		.003	
98		1935-1940	.08	Nil		.003	
99		1990-1995	.11	.02		.009	
B-79100		2045-2050	.11	.01		.013	
01		2100-2105		.05		.003	
02		2155-2160	.08	.01		.010	
03		2210-2215	.11	Nil		.015	
04		2265-2270	.09	Nil		.019	
05		2320-2325	.08	.01		.012	
06		2475-2480	.12	.03		.015	
07		2430-2435	.08	.01		.012	
08		2485-2490	.10	.01		.013	
09		2509-2514	.10	.04		.011	













thologies (Gale, 1965); both hydrous and anhydrous assemblages are present, with the hydrous assemblages commonly occurring as veinlet alteration selvages and fractures cutting older anhydrous skarn. A secondary stage of alteration and of copper grade may have been controlled by primary sedimentary structures; this point will be fully developed in sections of the chapter that follow. Viewed from the perspective of district geology (Figure 22.1), the Mission, Pima, Palo Verde Extension (of Mission), and San Xavier North orebodies lie some 6 miles (10 km) west of the Twin Buttes porphyry copper deposit. The orebodies were discovered beneath some 200 ft. (60 m) of cover that covered them and remains as cover above

much Mesozoic and Paleozoic strata of this part of the district. They are further separated from the Twin Buttes orebody by exposures of the mid-to-late-Tertiary Helmet Fanglomerate (Cooper, 1960), which are about 28.5 m.y. old (Shafiqullah and Langlois, 1978).

The Paleozoic, Mesozoic, and Cenozoic strata of this interval, together with the orebodies within them, are interpreted as lying within a large (ca. 60 mi<sup>2</sup>) (155 km<sup>2</sup>) allochthonous plate which had its origin to the south; the Twin Buttes orebody is interpreted as the "root" of the Mission and contiguous ore systems (Cooper, 1960, 1971, 1973). Interpreted geology of this interval is shown on the cross sections of Figure 22.1. The allochthonous block, the upper

plate of the San Xavier gravity fault, is interpreted from many drill hole samples; interpreted contours of its lower surface are shown in Figure 22.1. This surface is a major, low angle, undulating feature on the northeastern pediment of the Sierrita Mountains. It separates mineralized rock of the upper plate from unmineralized rock in the subjacent rocks. As presently exposed and interpreted, the upper plate of the fault ranges in thickness from a few tens of feet up to 2,000 ft. (ca. 600 m) and is composed of rocks ranging in age from Precambrian to the late Tertiary. Interpretations drawn from certain features of the stratigraphy and structural geology in this upper plate (further considered below) lend credence to the interpretation of the northward direction of movement and the displacement of 6.2 miles (10 km) suggested by Cooper (1960).

characterized by the presence of the 3 Permian formations (from oldest to youngest: the Epitaph Dolomite, the Scherrer Formation, and the Concha Limestone).

### Epitaph Dolomite

Gilluly and others (1954) described and defined the Epitaph Dolomite from exposures in central Cochise County, Arizona. The 750 ft.-section (ca. 250 m) present in the type locality is thinned to about 250 ft. (ca. 80 m) in the mine sequence. Five mappable units are recognizable in the Mission deposit, but they bear only scant resemblance to the units in the type section, owing to pronounced lateral variations in the composition of the formation in this part of Arizona (Butler, 1971). The principal basis of correlation is the presence, within the unit at Mission, of beds of anhydrite, which are unique in this part of the section to the Epitaph Dolomite.

At Mission the oldest (topographically highest) unit is limestone, varying from 35 to 70 ft. (ca. 10-22 m) thick, which is commonly altered to brown garnet tactite. The basal unit is overlain by about 70 ft. (22 m) of light to dark green siltstone and marl. Limestone beds within this unit are locally altered to a distinctive light brown garnet tactite. The middle unit consists of 15 to 35 ft. (5-12 m) of limestone, altered to light brown garnet tactite. The next higher unit, probably originally a mixed clastic and carbonate unit, consists of 20 to 30 ft. (6-10 m) of a green-brown colored, epidote-garnet tactite, and the uppermost unit consists of 40 to 60 ft. (13-20 m) of anhydrite. These characteristics, of both the altered

### MISSION MINE STRATIGRAPHY

The Mission deposit occurs in a sequence of Permian sedimentary rocks overlain by Mesozoic clastic rocks (Figure 22.2). In the central and western parts of the deposit, 3 Permian formations are present but the Paleozoic-Mesozoic unconformity has cut away all but 1 in the eastern part of the orebody. Mesozoic clastic rocks are present as sub-horizontal strata in depositional contact with the overturned Paleozoic sequence and compose the upper stratigraphic unit in the mine sequence. All of the units show the effects of hydrothermal activity and mineralization. The central part of the Mission orebody occupies a structural trough which is

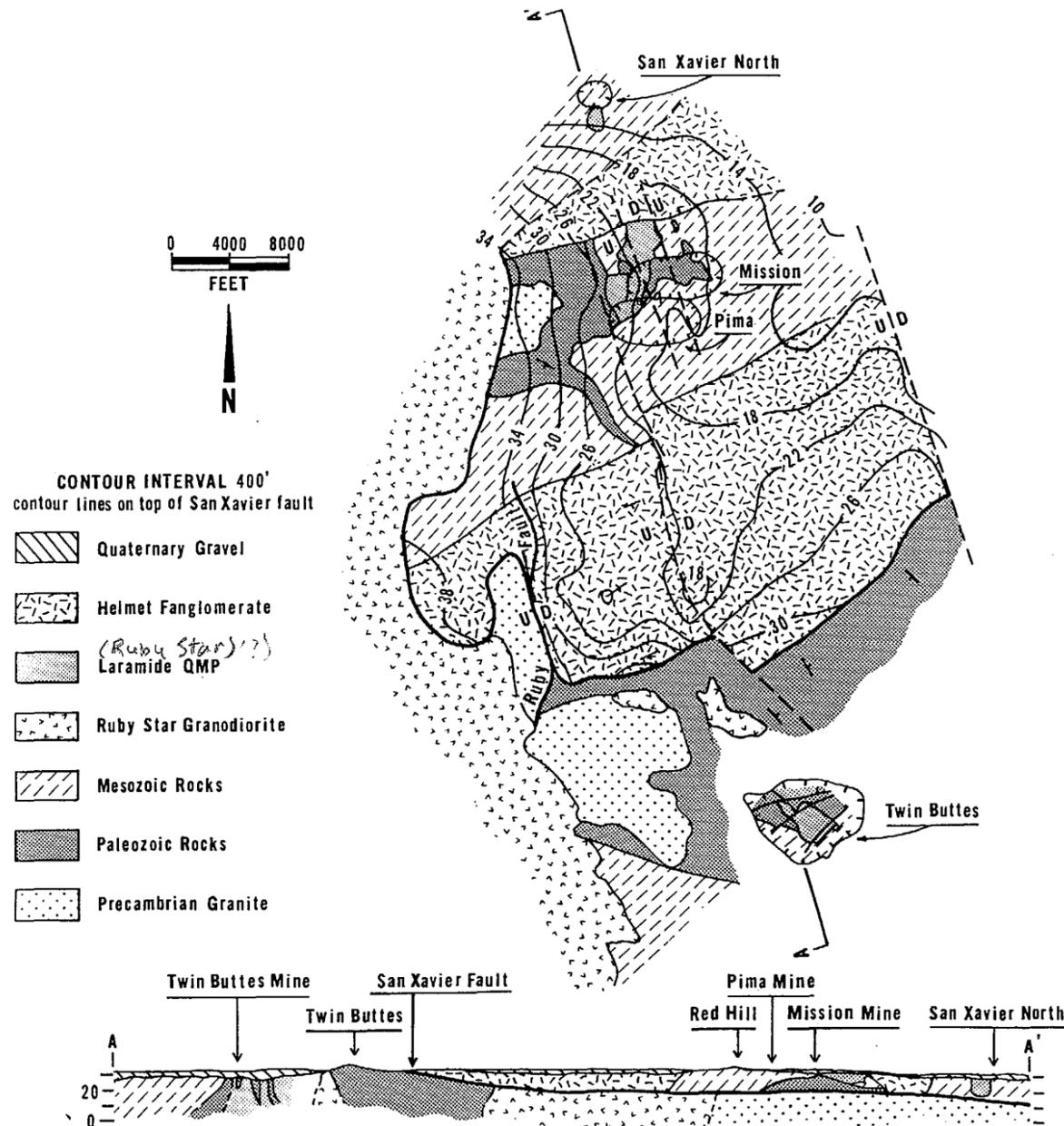


Figure 22.1. General geology of the Pima mining district. Contour lines represent elevation of the San Xavier fault, as interpreted from diamond drill hole samples and scattered surface exposures.

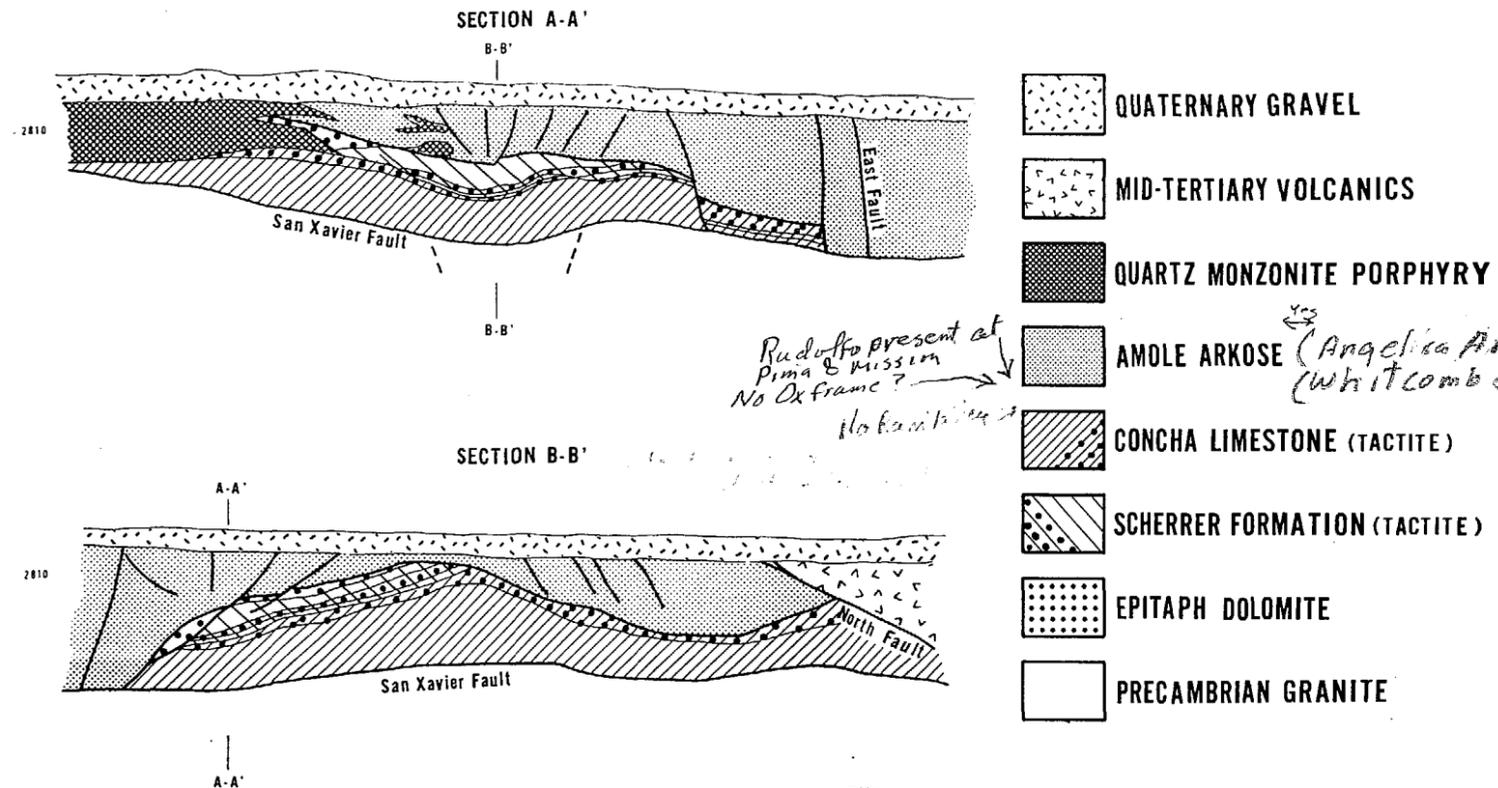


Figure 22.2. Geologic cross sections through the Mission mine and vicinity.

TABLE 21.1  
Description of Mesozoic and Tertiary Rocks in the Sierrita-Esperanza Area

	Name	Age	Description and Occurrence
Tertiary	Tinaja Peak Volcanics	23.7 m.y. (lower member)	Breccia tuffs and flows of intermediate composition; part of the Basin and Range epoch
	Quartz latite (porphyry)	Eocene (?)	Pods and high angle dikes (weakly mineralized)
	Breccia	Eocene 57.0 m.y.	Irregular, pipe-like bodies; large discontinuous masses; dikes
	Ruby Star Quartz Monzonite Porphyry	Eocene 53.5 m.y. (Damon, 1966) 56.0 m.y. (Creasey and Kistler, 1962) 56.9 m.y. (Cooper, 1973)	Stocks and plugs (probable source of metal-bearing hydrothermal solutions)
	Dacite porphyry	Eocene-Paleocene	Dikes and irregularly shaped bodies, probably genetically related to quartz monzonite porphyry
	Ruby Star Granodiorite	Paleocene 58.7 m.y. (Damon, 1966) 59.0 m.y. (Damon, 1965) 61.6 m.y. (Cooper, 1973)	North-northwest-trending batholith considered to be source magma for quartz monzonite porphyry and mineralization
	Biotite quartz diorite	Paleocene(?) to Late Cretaceous 67.0 m.y.* (Cooper, 1973)	North-northwest-trending, rectangular stock and smaller bodies (excellent host for mineralization)
?	Quartz latite porphyry	Uncertain	Principally plugs at Esperanza with associated hybridized zones and thin flows(?) or sills, extending from the vicinity of Esperanza to central Sierrita; occurrence in the central Sierrita pit may represent a chilled fringe or strongly supergene-altered phase of quartz monzonite porphyry.
Mesozoic	Demetrie Volcanics	upper Upper Cretaceous Older than 75 m.y.; (Drewes, 1973)	Sequence of andesitic and dacitic breccias and flows located south and east of Esperanza mine
	Sierrita Granite	Jurassic 140 m.y. (Damon, 1966) 150 m.y. (Cooper, 1973)	Located west and north of Sierrita-Esperanza
	Harris Ranch Quartz Monzonite	Jurassic to Triassic 190 m.y. 210 m.y. (Cooper, 1973)	Northwest-trending stock (excellent host for mineralization); found in Sierrita pit and west of mine area
	Ox Frame Volcanics	Triassic	Rhyolite flows, tuffs, and tuff breccias with intercalated lenticular beds of sandstone/quartzite, and andesite/dacite flows, with a few flow breccias

\* Additional radiometric dates of 47.0 m.y., 56.0 m.y., and 60.0 m.y. (Cooper, 1973) have been obtained from minerals in quartz veinlets in diorite; vein emplacement may be related to Ruby Star Granodiorite intrusion.

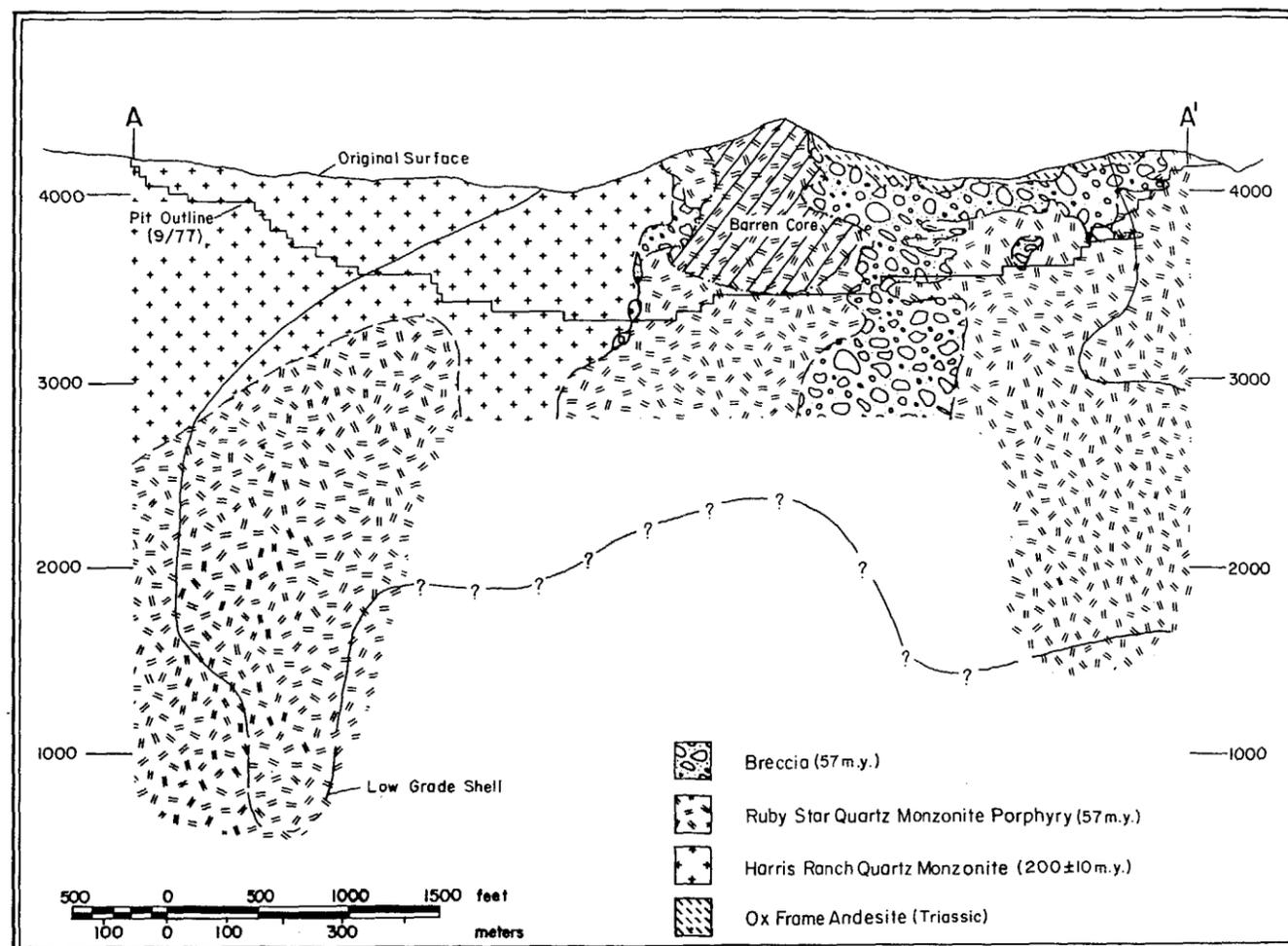


Figure 21.2. Geologic section A-A', trending N55°E through Sierrita

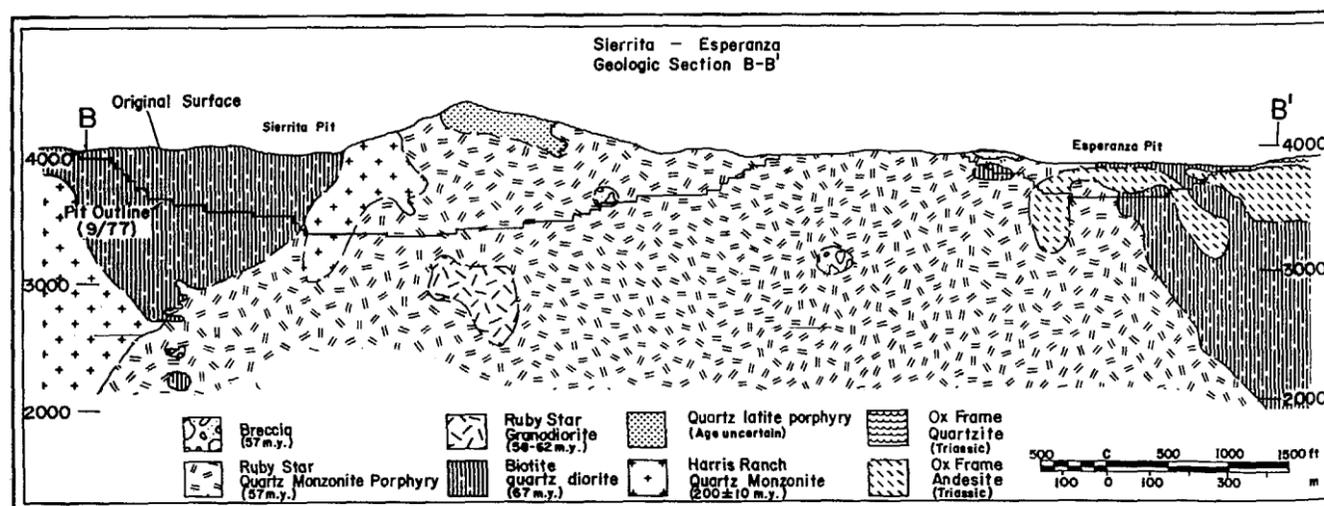


Figure 21.3. Geologic section B-B', trending east-west through Sierrita and Esperanza

of the Ox Frame Volcanics, the reader is referred to Lynch (1967), Cooper (1971) and Smith (1975).

**Andesite.** Ox Frame Andesite is the middle member of the extrusive sequence. It occurs as a mass bordering the Sierrita pit on the south and as pods within rhyolite welded tuff at Esperanza. It is also prominent as xenoliths of variable size in the younger intrusive rocks at Sierrita.

The andesite is dark gray to greenish black, with 15 to 36 percent albite microphenocrysts, 1 to 5 mm long. Albite, an alteration product, occurs locally with epidote, sericite, and clay minerals. Sparse actinolite and epidote are pseudomorphic after augite(?). The groundmass is composed of albite, actinolite, and magnetite microphenocrysts, with interstitial cryptocrystalline "felsite." Epidote, sericite, chlorite, calcite, and minor tourmaline are scattered throughout the andesite.

Andesite was a good host for hypogene and supergene copper metallization. Groundmass biotite and hornblende grains were often a good site for sulfide deposition.

**Rhyolite Welded Tuff.** Rhyolite welded tuff is the upper member of the Ox Frame Volcanics. The unit is exposed across many benches in the southern part of the Esperanza mine, and originally it extended into the Sierrita mine, where xenoliths are present at depth in younger intrusions.

The welded tuff commonly has a flinty groundmass, with a little trace of bedding, and is variable in color, ranging from pink or white to dark gray. Several workers have subdivided the unit based on textural contrasts, degree of welding, and compositional differences. Some important sub-facies include Lynch's (1967) vitric tuff, fragmental tuff, siliceous-aphanitic tuff and Smith's (1975) rhyolite tuff breccia, rhyolite crystal tuff and quartz latite crystal tuff. Zebra quartz (Lynch, 1967) is a related textural variation, which was formed when rhyolite welded tuff was shattered in place (possibly by emplacement of quartz monzonite porphyry) and then injected with magmatic(?) quartz along sub-parallel fractures.

A eutaxitic texture is prominent in welded facies of the tuff.

TABLE 20.1  
Stratigraphic Summary of the Twin Buttes Area

Age	Formation, Members		Description	Thickness		Age Dates (m.y.)	
				Feet	Meters		
Cenozoic	Holocene through Pliocene	"Alluvium"	Sands, gravels, caliche conglomerate at base	0-1000**	(0-305)		
	Miocene	Formation of Tinaja Peak	Volcanics, gravel, and sands	?			
			Andesite dike			23.6 (K-Ar, B)	
	Oligocene	Helmet Fanglomerate	Fanglomerate, andesite flow, tuffs, and monolithic breccias	10,500	(3200)	27.9 (K-Ar, B) tuff 20.7 (K-Ar) andesite	
	Paleocene	Quartz monzonite porphyry	Variable texture, Twin Buttes mine intrusives			56.9 (K-Ar, B) 58.6 (K-Ar, B)	
			Biotite rhyolite	Quartz latite tuff with lithic fragments	?	57 and 58 (K-Ar, B)	
Ruby Star Granodiorite			Granodiorite, quartz monzonite and aplite		57.1, 58.7, 59, 61.4 (K-Ar, B)		
Mesozoic	Late Cretaceous	Red Boy Rhyolite		Rhyolite flows and tuffs	700-1000	(214-305)	
		Demetrie Volcanics		Basal conglomerate, andesite flows and breccia, local rhyolitic tuff	8000	(2440)	
	Early Cretaceous	Angelica Arkose	Ma <sub>3</sub> *	Arkose and siltstone with beds conglomerate	to 1300**	(to 397)	
			Mac*	Conglomerate, volcanic clasts	50-300**	(15-92)	
	Jurassic (?)	Whitcomb Quartzite	Ma <sub>2</sub> *	Quartzite and arkose	10-270**	(3-82)	
			Mav*	Quartzite and acidic volcanics	0-190**	(0-58)	
			Mv*	Rhyodacite tuff, partly welded	0-280**	(0-67)	
			Ma <sub>1</sub> *	Quartzite and acidic volcanics	0-220**	(0-67)	
	Jurassic	Sierrita Granite		Granite, aplite, and gneiss			140 (Rb-Sr, WR) 150 (Pb-a, Z)
	Triassic	Harris Ranch Monzonite		Monzonite, granite, and quartz monzonite			190 and 210 (Pb-a, Z)
		Rodolfo Formation	M <sub>sv</sub> *	Siltstone and volcanics	0-1000**	(0-305)	
			M <sub>L</sub> *	Conglomerate, carbonate-rich	0-250**	(0-76)	
Ox Frame Volcanics		Rhyolitic to dacitic volcanics and quartzite	4000+	(1200+)			

Paleozoic	Permian	Rain Valley Formation		Limestone, minor sandstone beds	+400**	(122)	
		Concha Limestone		Cherty limestone	+480**	(146)	
		Scherrer Formation	Ps <sub>4</sub> *	Quartzite, local carbonate beds	50-120**	(15-37)	
			Ps <sub>3</sub> *	Dolomite, local beds sandstone	80-140**	(15-37)	
			Ps <sub>1</sub> *	Quartzite, partly bimodal; minor carbonate beds	150-320**	(46-98)	
		Epitaph Formation	Pe <sub>4</sub> *	Interbedded siltstone and limestone, local anhydrite and quartzite	90-150**	(27-46)	
			Pe <sub>3</sub> *	Limestone, minor siltstone and anhydrite	100-270**	(31-82)	
			Pe <sub>2</sub> *	Interbedded siltstone, dolomite, limestone, and anhydrite	100-350**	(31-107)	
			Pe <sub>1</sub> *	Siltstone, minor anhydrite	150-380**	(46-116)	
		Colina Limestone		Limestone, thin beds siltstone, anhydrite, and local quartzite	230-370**	(70-113)	
	Earp Formation		Siltstone and sandstone, partly limy and dolomitic; beds limestone and shale	300(?) - 500**	(92(?) - 153)		
	Pennsylvanian	Horquilla Limestone		Limestone, beds siltstone, quartzite near base	550(?) - 980	(168(?) - 299)	
		Black Prince Limestone		Chert and limestone pebble to cobble conglomerate, local ferruginous shale	0-32	(0-10)	
	Mississippian	Escabrosa Limestone		Limestone, partly cherty	200-450	(61-137)	
	Devonian	Martin Formation		Dolomite, limestone and local siltstone	± 240**	(± 73)	
Cambrian	Abrigo Formation	Cal*	Interbedded limestone and siltstone	290-350**	(+85)		
		Caq*	Interbedded quartzite, shale, and siltstone	+280**	(+85)		
	Bolsa Quartzite		Quartzite, local basal conglomerate	170-290**	(52-88)		
Precambrian	Granite		Granite, locally gneissic; local Pinal Schist inclusions			850 (Pb-a, Z)	

\* Member nomenclature, as on Twin Buttes maps.

\*\* Thickness in Twin Buttes mine.

has been altered by silicification and common chlorite-epidote-pyrite alteration. The copper mineralization in the breccia porphyry is also associated with the chlorite-epidote alteration which is controlled by the northwest-southeast trend structure. **Dacite porphyry** dikes cut almost in the whole rock types in the El Pilar except breccia porphyry rock unit. The dacite porphyry is composed of common feldspar phenocrysts with fine-grained siliceous groundmass. In some places the rock has been altered to strong quartz-sericite-pyrite and associated with copper (bornite-chalcopyrite-covelite)-molybdenite mineralization.

## **CONCLUSIONS AND RECOMMENDATIONS**

At the **South El Arco** area, the major trend of the El Arco shear zone is probably overlain by alluvium, colluvium and the Tertiary volcanic rock. The rock-bearing mineralization of Alisitos volcanic andesite is intruded by diorite, shows weak to moderately chlorite-epidote alteration, and seems to be distal of alteration product relative to the El Pilar porphyry deposit. No follow-up detail geologic mapping is recommended within the area except geophysical work such as induced polarization (IP) and ground magnetics.

The **East El Arco** area consists of the Alisitos andesite intruded by diorite which is strongly prophylic altered; there is good evidence that probably a stock-bearing porphyry related mineralization is covered at depth. Follow up geophysical exploration such as Induced Polarization and a Ground Magnetism survey is recommended before testing the target by a drilling program.

At the west **Miraflores** area, the rock-bearing mineralization is commonly exposed in the northern part of west Miraflores related to the Alisitos formation with some dikes of diorite and hornblende porphyry. The mineralization of the area is related with quartz-calcite veins (5 - 10 cm thick) and associated with shearing zones. An additional mapping program of 1:10,000 scale is recommended to the east of the Miraflores area.

The **Bonet** prospect area located in the further west-northwest outside of the Pegaro block is a former claim area property of the Grupo Mexico. The mineralization is probably distal of the porphyry copper system related to the granitoid host rock. Extension of a semi-detailed map is suggested to the south and southeast area perpendicular to the major trend breccia dikes direction of 210°-220°.

The **El Pilar** prospect seems to be a good target for exploration related to porphyry copper type deposit. Based on the first phase semi-detailed mapping

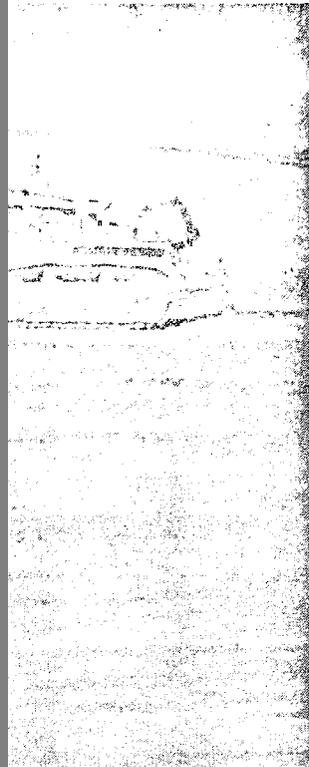
Oliver 7-7 to 7-11-97

CAP II Recon Project							
Dexter Oliver GPS Data							
July 7 to 11, 1997							
Waypoint	Sample No	Easting	Northing	Samp Dep	Local Date & Time		Dist. Cove Zone
W 001		535455	3623783		7-Jul-97	14:41	12S
W 002		539707	3624300		7-Jul-97	16:18	12S
W 003		536455	3623842		7-Jul-97	18:04	12S
W 004		537310	3624543		8-Jul-97	13:29	12S
W 005		535925	3624670		8-Jul-97	15:10	12S
W 006		536747	3625250		8-Jul-97	15:38	12S
W 007		537745	3625303		8-Jul-97	17:32	12S
W 008		538560	3625433		8-Jul-97	17:54	12S
W 009		541551	3611175		9-Jul-97	17:01	12S
W 010		538690	3614177		9-Jul-97	17:38	12S
W 011		540350	3615594		9-Jul-97	19:14	12S
W 012		545260	3612071		10-Jul-97	13:59	12S
W 013		545400	3612984		10-Jul-97	14:34	12S
W 014		546145	3612594		10-Jul-97	15:11	12S
W 015		540995	3612966		10-Jul-97	17:10	12S

in the area, the mineralization generally occurs in almost all types intrusive rock in the El Pilar area. Commonly the copper mineralization is related with the fault structure trending northwest-southeast and northeast-southwest. Petrographic analyses and rock age dating if possible are recommended to better understand the lithology and stratigraphic sequences within the complex intrusive rocks related to the mineralization system of the area. Additional mapping is recommended to follow the major structure surrounding the El Pilar area. It's very possible that the copper mineralization bearing structure still extends along the major northwest-southeast trend of the El Pilar mineralization zone.

baldwin 7-7 to 7-11-97

CAP II Recon Project							
Robert Baldwin GPS Data							
July 7 to 11, 1997							
Waypoint	Sample No.	Easting	Northing	Samp Depth	Local Date & Time		Dist. Cove Zone
W 01		535482	3626608		7-Jul-97	15:24	12S
W 02		536433	3626802		7-Jul-97	16:25	12S
W 03		535572	3629006		7-Jul-97	18:21	12S
W 04		537128	3630012		8-Jul-97	14:14	12S
W 05		536456	3629442		8-Jul-97	15:46	12S
W 06		540609	3613603		9-Jul-97	15:46	12S
W 07		539712	3612993		9-Jul-97	17:16	12S
W 08		539351	3615723		9-Jul-97	19:19	12S
W 09		541937	3612954		10-Jul-97	13:56	12S
W 10		542605	3613679		10-Jul-97	15:40	12S
W 11		543220	3614352		10-Jul-97	16:57	12S
W 12		543902	3615088		10-Jul-97	17:42	12S



Arctic map found  
1973

file: Twin Buttes Amamays

RECEIVED

JAN 9 1975

EXPLORATION DEPT.

Port Nickel refinery during the nine months ended September 30, 1974 were approximately \$4.1 million. This facility has an annual designed capacity of 80 million pounds of nickel and 47 million pounds of copper plus associated by-products and it is estimated that the cost of this project, including amounts spent to date, will be approximately \$53 million. Amax has agreed with Bamangwato Concessions Limited ("BCL") to toll refine approximately 46,000 tonnes per year of nickel-copper matte for a period of 15 years from the time that company's nickel-copper mining project in Botswana is brought into production, resulting in an estimated annual production of approximately 40 million pounds of nickel and 37 million pounds of copper from the Port Nickel refinery. Start-up problems in BCL's operation have, however, delayed receipt at Port Nickel of deliveries of matte from BCL, and it is not anticipated that such deliveries will begin on a regular basis in substantial quantities until the latter half of 1975. Amax has also concluded supply agreements for supplemental quantities of raw materials for the Port Nickel refinery with various other sources. The refinery is not expected to be operated profitably in 1975 and its operations will not become profitable until regular deliveries in substantial quantities commence from BCL or are obtained from other sources. See "Business — Investments in Other Companies — Botswana RST Limited" concerning BCL's start-up problems and for information on Amax's interest in BCL through its holdings in Botswana RST Limited.

Amax has secured a temporary order from the Federal Power Commission enabling Amax to obtain its requirements of natural gas on an interruptible basis for use in the refinery, primarily for process feedstock and for other non-fuel purposes. Amax has petitioned the Commission for permanent relief, and hearings are pending in this matter. Since it is anticipated that natural gas will be curtailed up to about 50% of the time during the 1974-1975 winter months, Amax has installed a propane back-up system and has obtained the necessary allocation from the Federal Government for the use of propane and a propane supply contract in order to obviate the effect of such a curtailment. Amax has converted to fuel oil for its basic fuel for the refinery, and the Louisiana Air Control Commission has issued a temporary variance permitting the use of high sulphur fuel oil. Adequate supplies of fuel oil have been contracted for.

In 1969 Amax entered into a joint venture for the possible development of lateritic nickel deposits in New Caledonia with Société Minière et Métallurgique de Peñarroya S.A., an affiliate of Imetal S.A., formerly Le Nickel S.A. (see "Business — Investments in Other Companies — Imetal S.A."). Drilling to date has indicated that these deposits contain approximately 400 million tonnes of mineralized material having an average grade of 1.37% nickel. Plans for the development of these deposits have not as yet been formulated.

**Base Metals**

**Copper.** In the years 1969 through 1973, and in the nine months ended September 30, 1974, sales of copper, including sales of Amax's share of copper produced from the Twin Buttes mines (in 1973 and 1974) and of copper refined by Amax from materials purchased from others, but exclusive of trading transactions on commodity exchanges and charges for toll refining copper for others, accounted for 30%, 21%, 16%, 19%, 17% and 19%, respectively, of Amax's consolidated sales revenues.

**Copper Mining.** Since 1973 Amax and The Anaconda Company have been equal partners in the operation and development of the Twin Buttes mines, an open pit copper mine located near Tucson, Arizona, and the holding for possible development of certain other nearby mineral properties. The partnership covers only the mining and milling of ore; each partner purchases its share of the production of copper concentrates and is responsible for its own smelting, refining and sales. Amax's share of Twin Buttes concentrates are toll smelted for Amax by others and are refined in part on toll by others and in part at Amax's refinery at Carteret, New Jersey.

Ore reserves at Twin Buttes are estimated at approximately 436 million tons of sulphide ore with an average grade of 0.63% copper and 0.03% molybdenum at a cutoff grade of 0.2% copper, and approximately 55 million tons of oxide ore with an average grade of 1.2% copper at a cutoff grade of 0.6% copper.

AMAX PROSPECTS  
1/75

There is set forth below certain information concerning concentrating activities at Twin Buttes for the four years and nine months ended September 30, 1974. Information for the years prior to 1973 was obtained from Anaconda, during which time Amax had no interest in the operations. Commencing in 1973, Amax's share of the operation is 50%.

	Years Ended December 31,				Nine Months Ended September 30, 1974
	1970	1971	1972	1973	
Tons of ore processed .....	8,975,192	7,666,009	10,738,748	10,891,871	7,366,000
Average total copper assay content of ore processed(1) .....	1.236%	0.988%	0.975%	0.824%	0.639%
Average concentrator recovery(1)	80.01%	71.72%	75.50%	71.51%	75.25%
Net tons of copper concentrates produced at mill .....	285,023	175,280	276,903	233,700	119,522
Net tons copper contained in concentrates produced at mill	87,876	53,331	77,860	64,152	34,652(2)

350  
25  
1750  
700  
5750

(1) Ore processed also contained an average of 0.02% to 0.04% molybdenum. The silver content of the ore is contained in the copper concentrate and is recovered in the refining process. The existing concentrating facility is designed to produce copper concentrates from sulphide ore and not oxide ore. Ore processed by the facility includes some mixed oxide and sulphide ore, most of the oxide copper assay content of which is not recovered.

(2) The decline in the rate of copper produced in concentrates in 1974 is due primarily to the temporary mining of lower grades of ore in the exposed portion of the orebody pending development for mining of the northeast orebody which contains substantially higher grade ore. This development has proceeded more slowly than anticipated. The rate of copper production at Twin Buttes is also expected to increase when a planned oxide copper recovery plant is completed. This expansion program is described below.

Pursuant to its agreement with Anaconda, in July 1973 Amax began contributing to the partnership at the rate of a minimum of \$2.6 million per month toward a total of \$93 million to be invested by Amax for mine development work over a three year period. The financing of up to approximately \$54 million of this amount was arranged through the sale of a production payment from Amax's share of the sulphide copper ore. Through December, 1974, approximately \$45 million has been received on account of this sale and not discharged. Based on Amax's current assumptions as to price, production and other conditions and further assuming that the full \$54 million sale is made, it is estimated that the production payment will be discharged by 1983 out of the proceeds from approximately 14% to 19% of Amax's share of the copper produced during that period from Twin Buttes. With certain limited exceptions, Amax and Anaconda are to share equally all other capital and operating costs of the partnership operations.

Amax and Anaconda have agreed to develop and expand the Twin Buttes mining operations by development of the unmined northeast orebody, expansion of the copper concentrator and ancillary facilities at the mine site, improvement of the ore and waste rock conveyor systems, and construction of an oxide plant (using an electrowinning process) to recover copper from oxide ores, all resulting in an increase of overall production capacity to permit the treatment of approximately 40,000 tons of sulphide ores and of approximately 10,000 tons of oxide ores per day. During the three years ending July 1, 1976, this program is expected to cost over \$275 million for property, plant and equipment, removal of alluvium and waste rock, and other expenditures. Upon completion of this program, average annual production from Twin Buttes is currently estimated to be approximately 90,000 tons of contained copper in concentrates from sulphide ores and approximately 35,000 tons of cathode copper from oxide ores.

Because the foregoing expansion and improvement program has not proceeded as rapidly as anticipated, due mainly to more difficult ground conditions than foreseen, Amax and Anaconda are

# WHAT'S GOING ON in world mining

Arizona . . .

## Anaconda Checks Twin Buttes; Houston Gas to Buy Banner

The Anaconda Company is now producing 8,000 tons of copper, in concentrate, per month at its Twin Buttes open pit mine and mill. This is greater than designed capacity because higher than average mine grade ore is being mined in the open pit.

The company estimates that, based on 0.4 percent copper cut-off, the planned pit areas at Twin Buttes and Palo Verde (Eisenhower) contain an estimated 292,000,000 tons of sulphide ore averaging 0.88 percent copper and 0.03 percent molybdenum. These planned pit areas also contain very large tonnages of materials too low in grade to be mined separately at this time, but containing copper and molybdenum which will necessarily be mined in conjunction with the mining of the ore bodies.

Under presently planned concentrating plant capacity at Twin Buttes, an optimum grade will be maintained in the light of then-existing economic conditions, by blending the ore with various types and grades of these materials.

At Helvetia, about 20 miles east from Twin Buttes, extensive drilling indicates the existence of deposits of copper and molybdenum which appear to be comparable in size, mineralogy, and geologic peculiarities of this deposit; however, additional exploratory and development work remains to be done to complete the determination of its thickness, lateral extent, average mineral content, and feasibility for mining.

The mine at Twin Buttes has been developed and equipped in a manner that would make possible a mining operation substantially greater than the present concentrating plant capacity of 30,000 tons per day. Any increase in plant capacity will, however, depend upon the economic feasibility of such expansion which remains to be determined by Anaconda's experience in processing the ores currently being mined. Widely spaced deep drill holes at Twin Buttes, some to a depth in excess of 3,000 feet, have shown that copper-molybdenum mineralization continues below any planned open pit and into adjacent areas. The extent and grade of this material and the feasibility of mining it can be determined only after further drilling and underground work.

The Twin Buttes, Palo Verde, and Helvetia ore bodies are all on claims owned by the Banner Mining Company and leased by Anaconda. The Houston Natural Gas Company is planning to buy Banner Mining for about \$148,300,000 and merge Banner into Houston Gas. A letter of intent has been signed by the board of directors of each com-

pany and merger plans are underway. Banner rejected a purchase offer some time ago from Newmont Mining Corporation.

France . . .

## Peñarroya's Lead/Zinc Mines and Mills in Six Countries

French-based Peñarroya S.A. is currently mining and concentrating lead and zinc ores in six countries around the world. The company reports that in 1969, despite reduction in the number of operating mines, the Group's lead concentrate production fell by only two percent in comparison with 1968 figures. Zinc concentrate production rose by more than two percent.

In France, several mines increased production appreciably with the exception of Pierrefitte, which shut down in May 1969.

In Spain, lead concentrate production at the Cartagena mine dropped slightly due to the nature of the ore treated, while that of zinc concentrates rose by over 3,000 tons.

In Italy, the four Sardinian mines came under local authority control. Excellent results were obtained at the Salafossa mine.

In Morocco, a strike involving most of the workers affected activity at Aouli and Mibladen mines. It lasted three and

a half months and caused a 15 percent drop in production.

In Greece, production at the Laurium mine rose by 12 percent, as a result of mechanical improvements.

In Brazil, lead concentrate production went up by 3,500 tons; northern groups were more active than those of the south, where reserves are fairly limited.

The Group as a whole recorded a rise in raw metal production of over 12 percent for lead and 30 percent for zinc. Lead tonnages totalled 334,000 tons and zinc tonnages 124,000 tons.

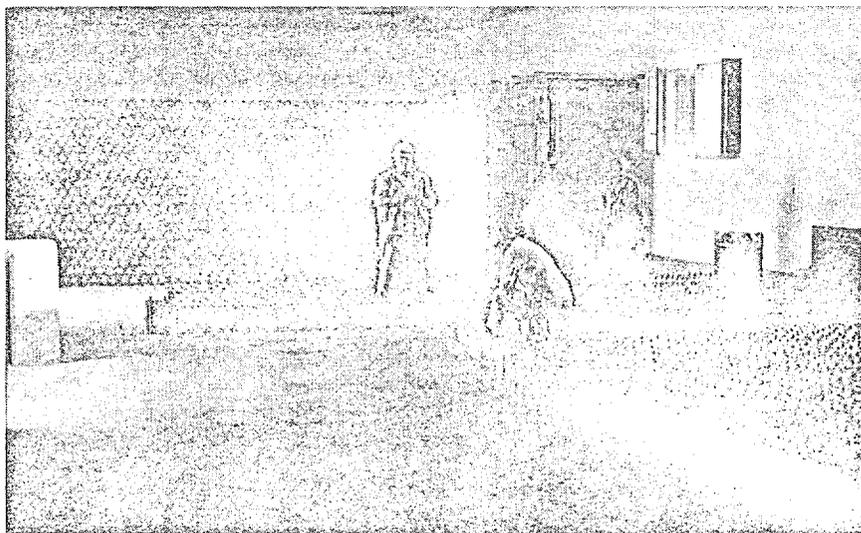
Following a similar upward trend, sulphuric acid production rose by 23 percent, reaching 223,000 tons as against

Production of Lead and Zinc Concentrates by Peñarroya Company during 1969 in metric tons

Country	Lead Conc.	Zinc Conc.
France	39,013	27,759
Spain	30,514	31,370
Italy	14,077	63,748
Greece	3,121	4,236
Morocco	45,288	2,033
Brazil	40,850	—

182,000 tons in 1968. Cadmium production went up from 231 to 291 tons.

In France, progress at the Noyelles-Godault metallurgical plant was satisfactory. Difficulties encountered last year when the zinc smelter was put into operation have been practically surmounted, and production, up by 22,000



## Quicksilver Stockroom at Almadén, World's No. 1 Mine

Part of the mercury store at the Almadén mine in Spain. About 15,000 flasks of mercury are stacked up in the warehouses at the mine. That is about \$5,750,000 worth at today's depressed price level of about \$385.00 per flask. The poor prices reflect the increased supplies now on the market due to new mines, such as Canada's Pinchi Lake, being tempted into the production by the high prices of a few years back. Some of the would-be new or expanded producers have not even reached the market yet with further supplies. Turkey, long a producer, is combining, modernising, and rationalising its mines and boosting production, but the effects of its new activities have not yet been felt. Some of mercury's glamor too has been tarnished by its identification as an environmental pollution hazard. Particularly in lakes where uncontrolled discharge of mercury containing wastes can lead to build up of dangerous concentrations of the element in tissues of fish. In the present situation, some of the leading producing countries are said to be holding supplies off the market to avoid pushing the price down further.

JHC file

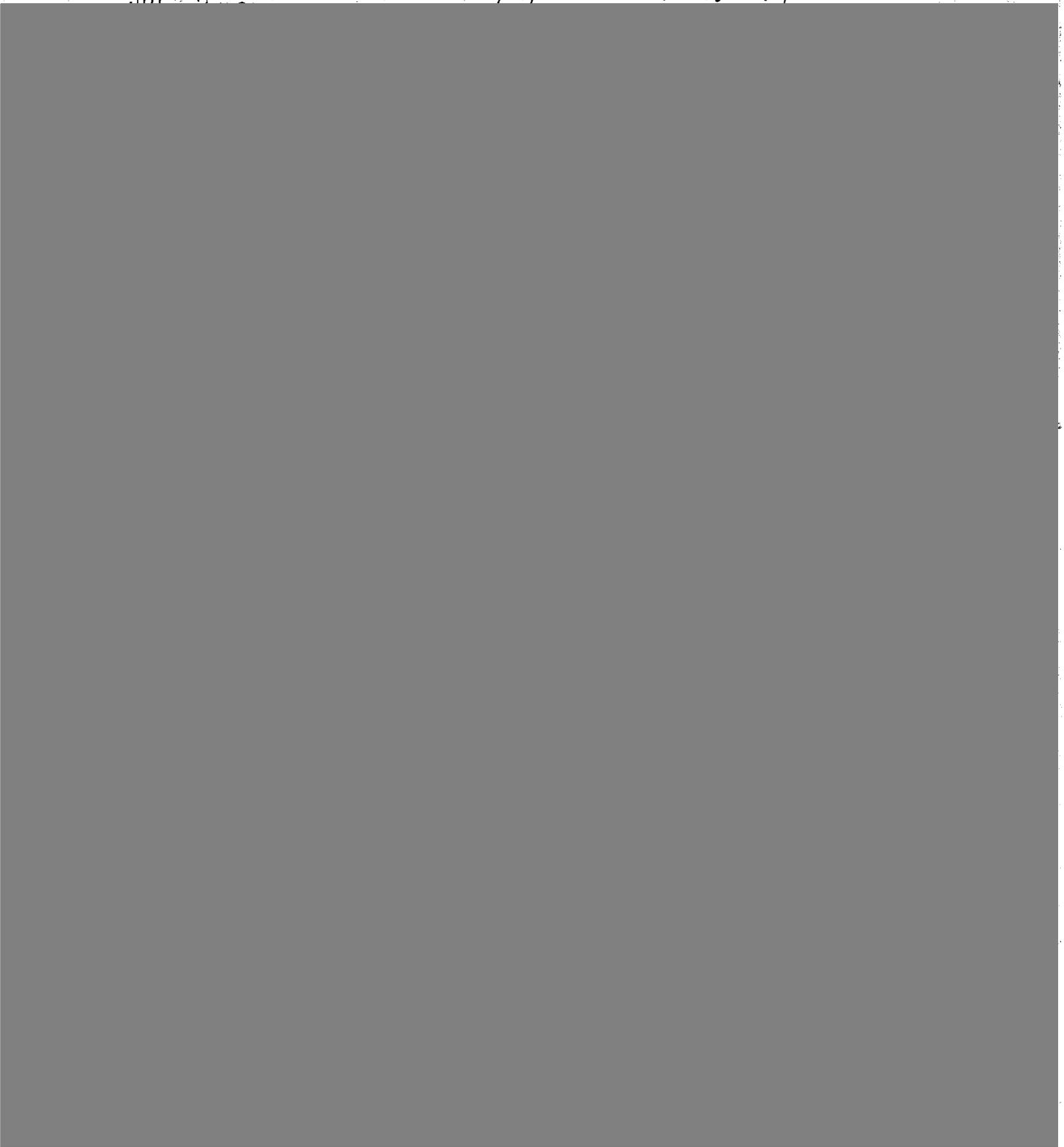
Mr. J. H. Courtright

# Bright Prospects Outlined

## For Tintic Standard Firm

*Mining Record 6-25-69*

W.E.S.



JAN 30 1969

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 PROSPECTUS
 

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 CFB

\$150,000,000

## The Anaconda Company

6<sup>5</sup>/<sub>8</sub>% Debentures Due 1993

Interest payable May 15 and November 15

Annual sinking fund payments of \$9,250,000 commencing in 1978 will retire 92.5% of the issue prior to maturity. The Company may increase the sinking fund payment in any year by an amount not exceeding the required sinking fund payment for that year. The Debentures are redeemable at prices set forth herein at the option of the Company, except that prior to November 15, 1978 no redemption may be made from or in anticipation of moneys borrowed at an interest cost to the Company of less than 6.67% per annum.

THESE SECURITIES HAVE NOT BEEN APPROVED OR DISAPPROVED BY THE SECURITIES AND EXCHANGE COMMISSION NOR HAS THE COMMISSION PASSED UPON THE ACCURACY OR ADEQUACY OF THIS PROSPECTUS. ANY REPRESENTATION TO THE CONTRARY IS A CRIMINAL OFFENSE

	Price to Public(1)	Underwriting Discounts and Commissions	Proceeds to Company(1)(2)
Per Debenture	99.500%	.875%	98.625%
Total	\$149,250,000	\$1,312,500	\$147,937,500

(1) Plus accrued interest, if any.

(2) Before deduction of expenses payable by the Company estimated at \$230,000.

The Debentures are offered by the several Underwriters for delivery on or about December 3, 1968. Such Debentures are offered when, as and if issued by the Company and accepted by the Underwriters and subject to their right to reject orders in whole or in part. In addition, the Debentures are being offered to certain institutions by the Company through the several Underwriters for delivery on April 2, 1969 and July 2, 1969 pursuant to Delayed Delivery Contracts with the Company. See DELAYED DELIVERY ARRANGEMENTS herein. The Debentures will be issued in fully registered form only.

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 The First Boston Corporation
 

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The date of this Prospectus is November 19, 1968.

## Primary Metals

### Copper Ore Reserves

The following table sets forth the Company's copper ore reserves in 1957 and in 1968 as well as the ores mined therefrom during the intervening period:

(thousands of short tons of ore)

Property	Reserves as of January 1, 1957		Ores Mined 1957- September 1, 1968		Reserves as of September 1, 1968	
	Tons(2)	Grade(3)	Tons(2)	Grade(3)	Tons(2)	Grade(3)
<b>Domestic:</b>						
Butte, Montana						
Underground vein mines.....	10,227	4.24	10,713	3.60	12,500	4.27
Underground block caving mine.	180,000	1.00	16,137	0.98	(4)	—
Berkeley open pit mine.....	100,000	0.80	102,916	0.79	414,000	0.74
Yerington, Nevada.....	25,000	0.90	14,906	0.93	67,000	0.54
	40,000(oxide)	0.80	48,933(oxide)	0.73	28,000(oxide)	0.57
Pima County, Arizona.....	—	—	—	—	292,000(5)	0.88(5)
<b>Foreign:</b>						
Chuquicamata, Chile.....						
	450,000	1.63	167,603	1.45	500,000	1.87
	120,000(oxide)	1.32	133,563(oxide)	1.26	46,000(oxide)	1.29
	25,000(mixed)	2.25	12,333(mixed)	1.91	3,500(mixed)(6)	2.85(6)
Exotica, Chile.....	—	—	—	—	153,000(oxide)	1.93(7)
El Salvador, Chile.....	300,000	1.60	66,161	1.53	341,000	1.41
Other Chile.....	3,300	2.25	2,608	2.71	940	2.04
Cerro Verde, Peru.....	—	—	—	—	130,000	1.09
	—	—	—	—	42,200(oxide)	0.89
	—	—	—	—	6,500(mixed)	1.50
Cananea, Mexico.....	77,000	0.80	55,013	0.83	177,000	0.81
Britannia Beach, Canada.....	—	—	3,123	1.19	4,000	1.93
<b>Totals and average grades.....</b>	<u>1,330,527</u>	<u>1.39</u>	<u>634,009</u>	<u>1.23</u>	<u>2,217,640</u>	<u>1.26</u>

← { Twin Buttes  
Eisenhower  
Rosemont? }

#### NOTES:

1. The term "ore reserves" as used herein means those estimated quantities of reasonably assured ore that under present conditions may be profitably mined and treated for the extraction of their metallic constituent or constituents.
2. All tonnage figures are in thousands of short tons of ore. Unless otherwise indicated, the ores are sulphide ores. The metal content of sulphide ore is in physically concentratable form, while the metal content of oxide ore is leachable; the Company's recoveries of copper from the two types of ore have been comparable. Mixed ore contains both oxide and sulphide constituents.
3. Grade means percentage of contained copper.
4. Approximately 72 million tons have been transferred to the Berkeley open pit reserves. The balance is currently unavailable because its location below the bottom of the Berkeley pit prevents extraction by underground block cave mining methods until overlying open pit ore has been removed.
5. To be mined with lower grade materials (see page 10).
6. Part of mixed ore reserve has been mined as sulphide or oxide ore.
7. Overall recovery of approximately 70% of the contained copper is conservatively estimated on the basis of metallurgical test work.

With the exception of the Butte operation hereinafter described, there has been no material variance in the average grades of ore that have been mined from year to year in the period indicated, and no such variance is anticipated. Again except for the Butte operation, there have been no changes in the physical mining conditions at the Company's major mining properties that have materially affected production costs, and no such changes are foreseen.

The increase in total ore reserves from 1,330,527,000 tons in 1957 to 2,217,640,000 tons in 1968 set forth above has resulted primarily from acquisition of new properties and from further exploration

and development work at the Company's existing properties. There is no assurance that such acquisitions, exploration and development will add to the Company's reserves at the same rate as in the past or will maintain the Company's reserves at levels comparable to those of 1968.

### Copper Production

The following table summarizes Anaconda's production of copper metal over the five and one-half years beginning 1963:

	(short tons of copper)							
	1963	1964	1965	1966	1967	1967		1968
						1st 6 Months	2nd 6 Months	1st 6 Months
Domestic mines:								
Butte, Montana .....	79,780	101,230	117,027	121,790	63,375	58,910	4,465	20,284
Yerington, Nevada.....	43,189	37,938	38,508	38,789	23,011	18,921	4,090	11,995
Total domestic mines.....	122,969	139,168	155,535	160,579	86,386	77,831	8,555	32,279
Foreign mines:								
Chuquicamata, Chile .....	302,957	317,517	278,578	334,578	305,169	146,052	159,117	142,631
El Salvador, Chile.....	97,242	84,277	81,725	85,964	85,987	48,194	37,793	47,168
Other Chile .....	6,771	4,722	8,433	5,534	6,034	3,713	2,321	2,570
Cananea, Mexico .....	31,967	30,944	29,033	33,021	35,496	18,552	16,944	16,973
Britannia Beach, Canada .....	3,981	7,370	1,581	4,172	2,893	2,541	352	682
Total foreign mines.....	442,918	444,830	399,350	463,269	435,579	219,052	216,527	210,024
Total Company mines.....	565,887	583,998	554,885	623,848	521,965	296,883	225,082	242,303
Purchased material and toll.....	75,659	91,452	133,831	148,677	101,811	69,457	32,354	38,000
Grand total .....	641,546	675,450	688,716	772,525	623,776	366,340	257,436	280,303

### Domestic Copper Properties

Anaconda's principal domestic copper mines are located in the Butte District, Montana. The Berkeley open pit mine and the Steward and Mountain Con underground mines are Anaconda's principal operating mines in the Butte District. Copper in minor amounts is also produced from surface and underground leaching operations. Sulphide copper ores mined in the Butte District are concentrated in a plant adjacent to the Berkeley pit and the resulting concentrates are shipped to Anaconda, Montana where they are smelted into blister copper at the Company's plant.

In 1966, the most recent full year of uninterrupted operation, the Butte mines produced 121,790 tons of copper. The proportion of copper produced from open pit operations in the Butte District has steadily increased since the Berkeley pit was opened in 1954, and in 1966 such proportion was approximately 60%. This increase, together with a curtailment of underground mining operations, has resulted in a reduction of the average grade of ore mined in the Butte District. The Company's estimated ore reserves in the Butte District are 12,500,000 tons averaging approximately 4.27% copper and 1.59 ounces of silver per ton in the underground vein mines and 414,000,000 tons averaging approximately 0.74% copper at the Berkeley pit.

Anaconda also mines oxide and sulphide copper ores at the Yerington open pit mine located at Weed Heights, Nevada. The oxide ores are processed at an integrated leaching and precipitating plant, and the sulphide ores are processed at a concentrator. Both plants are located near the mine.

The resulting precipitates and concentrates are shipped to Anaconda, Montana for smelting. In 1966, the most recent full year of uninterrupted operation, the Yerington mine yielded approximately 38,800 tons of copper. Oxide ore reserves at the Yerington mine are estimated at 28,000,000 tons averaging approximately 0.57% copper, and sulphide ore reserves are estimated at 67,000,000 tons averaging approximately 0.54% copper. An intensive exploration program is being conducted in an effort to locate additional ore bodies in the Yerington District.

Blister copper produced at the smelter at Anaconda, Montana is shipped to the Company's electrolytic refinery at Great Falls, Montana for refining and casting into commercially marketable forms of refined copper. Nearly all such copper is consumed by the Company's fabricating subsidiaries.

To expand its domestic copper production, Anaconda in 1964 leased all the properties of Banner Mining Company located in Pima County, Arizona. The lease agreement gives Anaconda a leasehold interest in such properties for so long as necessary to exhaust the mineral deposits located thereon. Anaconda, as the operator, will account for the lease operations under contract terms whereby Anaconda will recover its investment in approximately 12 years and Anaconda and Banner are expected to share approximately equally in the after-tax profits from mining operations on such properties. Anaconda began development in 1965 of a major new mine on these properties called the Twin Buttes mine, which, together with modern ore concentrating facilities now under construction, is scheduled to commence production in 1969 at an annual rate of about 60,000 tons of copper. Estimated ore reserves on the leased properties in Pima County, including Twin Buttes, are approximately 292,000,000 tons of sulphide ore, averaging 0.88% copper and 0.03% molybdenum. The planned pit areas also contain very large tonnages of materials too low in grade to be mined separately but containing sufficient copper to be mined as part of the ore bodies. Under presently planned concentrating plant capacity, an optimum mining grade will be maintained, in the light of then existing economic conditions, by blending the ore with various types and grades of these materials.

#### *Foreign Copper Properties*

Anaconda's largest foreign copper mine is the Chuquicamata open pit mine located in the Province of Antofagasta, Chile and believed to be the largest known copper ore body in the world. Chile Exploration Company, a wholly-owned subsidiary of Chile Copper Company, a 99.81% owned subsidiary of the Company, operates the Chuquicamata mine. Facilities are located near the Chuquicamata mine to leach and electrolytically precipitate oxide copper ores and to concentrate and smelt sulphide ores. In the first nine months of 1968 approximately 49% of the mine's sulphide ore production was refined in an electrolytic copper refinery located at Chuquicamata, and the balance was shipped as blister copper for refining in the United States or Europe. It is expected that nearly 80% of the mine's sulphide ore production in 1969 will be electrolytically refined at Chuquicamata. Approximately 305,000 tons of copper were produced from the Chuquicamata mine during 1967. Mine and plant expansion at Chuquicamata scheduled to be completed in 1971 is designed to increase estimated productive capacity from about 300,000 tons to 390,000 tons of copper a year. Included in this expansion is an increase in the capacity of the sulphide ore concentrator and smelter to receive the increased sulphide ore output of the Chuquicamata mine.

At Chuquicamata the reserves of ore mineable in open pit operations are estimated as follows: 46,000,000 tons of oxide ore averaging 1.29% copper; 3,500,000 tons of mixed oxide-sulphide ores averaging 2.85% copper, and 500,000,000 tons of sulphide ore averaging 1.87% copper, or total esti-

mated open pit reserves of 549,500,000 tons containing an average 1.83% copper. Deep drill holes have indicated the existence of large additional tonnages of copper sulphide mineralization beneath the lowest pit level now planned, which at the present time have not been sufficiently tested to ascertain to what extent the material is mineable and the valuable metallic contents are recoverable.

Stripping operations are proceeding at Exotica, a new open pit mine of Compañía Minera Exótica S. A. adjacent to the Chuquicamata mine. The Company has a 75% interest in such company, the balance being owned by an agency of the Chilean Government. To date there has been stripped nearly half of the 90,000,000 tons of overburden to be removed before the initial delivery of ore, now estimated for the middle of 1970. Ore from Exotica will be treated on a fee basis at the Chuquicamata oxide plant. The productive capacity of Exotica is planned for 112,500 tons of copper annually. Ore reserves at Exotica are estimated to be approximately 153,000,000 tons of oxide ore averaging 1.98% copper, of which, on the basis of metallurgical testing, approximately 70% is expected to be recovered.

Andes Copper Mining Company, a 99.63% owned subsidiary of the Company, owns the El Salvador mine located in the Province of Atacama, Chile. The ores from this block cave mine are concentrated at a nearby plant and then transported by pipeline and Company-owned railroad approximately 54 miles to its smelter at Potrerillos, Chile, where the concentrates are reduced to blister copper. In 1968 80% of the resulting blister copper will be electrolytically refined at the recently completed Potrerillos refinery. Copper production from El Salvador in 1967 amounted to approximately 86,000 tons. Improvement and expansion of the El Salvador mine and concentrating facilities are in progress and expected to be completed in 1970. Rated annual productive capacity is planned for 110,000 tons of copper. El Salvador ore reserves are estimated at 341,000,000 tons of sulphide ore averaging approximately 1.41% copper.

Anaconda is expanding the Chuquicamata and El Salvador mines and ore treatment facilities and is bringing the Exotica mine into production, as outlined above, under investment agreements recently entered into between its subsidiaries controlling these properties and the Government of Chile pursuant to enabling legislation now consolidated in Law 16,624 ("the Copper Law"). These agreements, which are for a term of 20 years for Chuquicamata and El Salvador and 25 years for Exotica, provide certain guarantees, including the following fixed schedule of income tax rates: (1) for Chuquicamata 52½%, plus a surtax related directly to production beginning at 33% and reducing to zero when production equals or exceeds approximately 340,000 tons (the effective surtax was 5.594% in 1967 and at scheduled production rates this surtax will be eliminated beginning in 1971); (2) for El Salvador 50%; and (3) for Exotica 15%, plus 30% on dividends or profit distributions. All three subsidiaries are subject to certain charges on taxable income for investment in personnel housing, the maximum charge being 5%.

In addition, the agreements contain provisions to protect the above-mentioned subsidiaries against discriminatory application of other taxes, obligations, charges, burdens and norms for determining taxable income. The agreements guarantee that there will be no adverse change in the application of certain provisions of the Copper Law and regulations, among which are provisions permitting copper companies to sell their products for U. S. dollars or other freely convertible currencies with the obligation to return to Chile in such currencies only amounts necessary for payment of their costs, taxes and other

local currency obligations, provisions controlling temporary state monopolization of copper sales during war or certain other extraordinary circumstances, and provisions concerning copper for domestic consumption. The agreements also contain provisions to protect against discriminatory currency exchange rates, and exempt from all duties and customs taxes assets brought into Chile as part of the investments made pursuant to the agreements. Each of the subsidiaries is obligated to invest in Chile annually the amount, if any, by which 4% of its annual net after-tax profits exceeds 8% of its net worth, beginning the calendar year following completion of the investments covered by the agreements. This obligation may not be increased during the terms of the agreements.

The Copper Law created a government agency known as the Copper Corporation to promote the copper industry of Chile. The Copper Corporation may intervene in the international commerce of copper to regulate prices and to maintain or expand markets for Chilean copper and to avoid or counteract actions by others tending to control or restrict such markets. It is also the function of the Copper Corporation to promote purchases in Chile by the copper companies, to collect reports from the copper industry, to render reports to the Government on all matters relating to the production and sale of copper and to inspect and ascertain economic, physical and labor conditions of such production and sales. The Copper Corporation may pass on the terms and conditions of sale of copper to insure that they are at the prevailing market prices and on the best possible terms and conditions, and it may authorize exports of copper and imports necessary for the operation of the producing companies.

The foregoing is only a brief summary of the terms of the investment agreements between the Company and the Government of Chile and of certain pertinent provisions of the Copper Law. For a complete statement of the provisions of such agreements and of such law, reference is made to a full copy of each (with unofficial English translation), which is filed as an exhibit to the Registration Statement.

The Company is considering the development of its Cerro Verde copper properties located near Arequipa in southern Peru and plans to proceed if negotiations with the Peruvian Government can be successfully concluded. The Cerro Verde properties are estimated to contain 42,200,000 tons of oxide ore averaging 0.89% copper, 6,500,000 tons of mixed oxide-sulphide ore averaging 1.50% copper and 130,000,000 tons of sulphide ore averaging 1.09% copper. Prior to production of copper from sulphide ore, which is the major part of the ore body, approximately 126,000,000 tons of oxide ore and waste material will be mined. Of this tonnage approximately 25,000,000 tons of oxide ore averaging 1.04% copper will be placed in a series of prepared leach piles and treated by acid leaching. The rate of recovery of copper from the material cannot be predicted at this time, but tests to date indicate approximately 60% of the contained copper will be recovered. The Company plans to build the necessary sulphide treatment facilities at the appropriate time.

The Company owns through a 99.51% owned subsidiary an open pit copper mine located in Cananea, State of Sonora, Mexico. The ores are both concentrated and smelted at its nearby facilities, and the resulting blister copper is shipped for electrolytic refining to Cobre de Mexico, S. A., in which Anaconda has a 25% interest. Small quantities of copper are also produced by surface and underground leaching. During 1967 blister copper produced from the Cananea operations amounted to 35,496 tons,

and construction is under way to increase the productive capacity at this property by early 1972 to 45,000 tons annually. Ore reserves are estimated at 177,000,000 tons of sulphide ore averaging 0.81% copper.

Anaconda also owns an underground mine at Britannia Beach, British Columbia, Canada. A new copper ore body was recently outlined at the Britannia Beach property, which the Company plans to bring into production by 1971. Ore reserves at Britannia Beach are estimated at 4,000,000 tons of sulphide ore averaging 1.93% copper. The Britannia Beach mill processed 627,868 tons of ore in 1967, and its planned rate of operation following introduction of the new ore body will be 720,000 tons annually.

Insofar as Anaconda's properties include assets in foreign countries and these assets contribute to its earnings, such assets and earnings may be adversely affected by the outcome of future elections and other political developments in those foreign countries, including such possibilities as production or price controls, tax changes and nationalization. The risks of such occurrences and their overall effect upon Anaconda vary from country to country and are not predictable. Although still subject to such risks, the Company believes that its investment agreements with the Government of Chile and the Copper Law in that country, referred to above, provide it with important assurances as to the status of its activities in Chile.

### *Aluminum*

A wholly-owned subsidiary of the Company, Anaconda Aluminum Company, produces refined aluminum in primary forms from purchased alumina at an aluminum reduction plant located at Columbia Falls, Montana. During 1967 approximately 106,000 tons of aluminum were produced there. This plant has recently been expanded from three potlines to five potlines. The two new potlines raise the plant's annual capacity to approximately 175,000 tons of aluminum.

Contractual arrangements made in 1966 give Anaconda an interest in bauxite deposits in Jamaica, West Indies aggregating in excess of 120,000,000 tons and in an alumina processing plant now under construction there. This plant, which is scheduled for completion in mid-1969, will have an annual capacity of 950,000 tons of alumina. Between two and three tons of bauxite are required to produce a ton of alumina and two tons of alumina to produce one ton of aluminum metal. The alumina requirements of the Columbia Falls plant are approximately 350,000 tons per annum, the same as Anaconda's initial share of the Jamaica plant's production. Anaconda's share is subject to reduction to 300,000 tons annually after 1973 if certain options are exercised by Anaconda's partners in the venture. Anaconda's interest in the venture, initially 36.8%, will at all times be directly proportional to its share of the alumina produced by the plant.

### *Uranium*

Anaconda's uranium mines are located in Valencia County, New Mexico, the two major mines being the Jackpile mine and the Paguate mine. The uranium ores produced from such mines are processed into uranium concentrate by Anaconda at its Bluewater plant located near Grants, New Mexico.

Approximately 50% of the uranium concentrate production of the Bluewater plant in 1968 will be sold to the Atomic Energy Commission pursuant to a contract providing for deliveries through 1970. Anaconda has also entered into five long-term contracts for the supply of uranium concentrate to an electrical equipment manufacturer and electric utilities for nuclear power plants. After completion of deliveries under the AEC contract Anaconda's uranium production is expected to be sold to private customers.

Anaconda's uranium mines are estimated to contain a total of 6,987,000 tons of ore averaging 0.323% uranium oxide ( $U_3O_8$ ), or an equivalent of approximately 45,000,000 pounds of uranium oxide. The above-mentioned contracts assure a market for approximately 30,000,000 pounds of such uranium oxide. Exploration work in progress on Anaconda's properties indicates the presence of additional uranium-bearing materials, the amounts and grade of which have not yet been determined.

Anaconda's production of uranium concentrate during the last five years was as follows:

<u>Year</u>	<u>Pounds of <math>U_3O_8</math></u>
1963.....	1,470,000
1964.....	1,510,000
1965.....	1,546,000
1966.....	1,520,000
1967.....	1,532,000

#### *Zinc*

The Company has two large electrolytic zinc refineries in Montana, one located at Anaconda and the other at Great Falls, which together have an annual capacity of 252,000 tons and make Anaconda one of the world's largest producers of zinc. In 1966, the last full year of operation, these refineries produced a total of 180,652 tons of zinc, of which 157,475 tons were from zinc concentrates that were purchased or treated on toll and 23,177 tons were from zinc concentrates from the Company's mines. Operations at such mines, which are located in the Butte District of Montana, were suspended in July 1967; resumption of operations at these mines will depend on future economic conditions and cannot be predicted. Reserves of zinc ores at the Company's mines are estimated to be approximately 6,640,000 tons averaging 8.37% zinc and 3.40 ounces of silver per ton.

#### *Other Metals*

Copper ores at Chuquicamata, El Salvador and Twin Buttes contain significant amounts of molybdenum. Facilities exist at Chuquicamata and El Salvador to extract this by-product, and those at Chuquicamata are being expanded. Provision is being made to recover molybdenum at the Twin Buttes mine when it begins operation in 1969. The Company expects that by 1971 it will be producing annually concentrates containing at least 9,000 tons of molybdenum.

From its mines and other metal production facilities Anaconda also produces lead, cadmium, silver, gold, indium, selenium, bismuth, tellurium, palladium and platinum.

WES

J.H.C.

MAR 8 1968



AMERICAN SMELTING AND REFINING COMPANY  
EXPLORATION DEPARTMENT  
120 BROADWAY, NEW YORK, N.Y. 10005

JOHN J. COLLINS  
CHIEF GEOLOGIST  
Air Mail

W.E.S.

MAR 12 1968

March 6, 1968

Mr. J. H. Courtright  
Tucson Office

Twin Buttes, Arizona

Dear Mr. Courtright:

At Mr. Lacy's request, I am sending to you, separately, one of our two sets of maps showing geology of the Twin Buttes area colored on a print of the Sahuarita Quadrangle, Scale 1:62500 and a transparent overlay of the aeromagnetic contour map prepared by Hycon Aerial Surveys, Inc. which has been reduced to the same scale.

Mr. Lacy said that a report by Bert Morrisson should accompany these maps but I am sorry to say we do not find it in our files here in New York. This will serve to ask Mr. Lacy to make extra copies and send them to you and us.

Very truly yours,

John J. Collins

CC:RJLacy

*Faint, illegible handwritten notes or stamps at the bottom of the page.*

J. H. C.  
JAN 29 1964

AMERICAN SMELTING AND REFINING COMPANY  
United States Mining Department  
Tucson Arizona

January 29, 1964

*JHC*  
1/30/64 *JRW*  
*JHK* *JRW*  
MR. ~~JHK~~, ~~JRW~~  
READ AND RETURN \_\_\_\_\_  
PREPARE ANSWERS \_\_\_\_\_ HANDLE \_\_\_\_\_  
FILE  INITIALS \_\_\_\_\_

FILE MEMORANDUM

We have been advised that in the Twin Buttes area Anaconda has had a contractor survey three of their deep holes drilled to approximately 2,000 feet and have found that two of these holes drifted in the same direction and the third hole drifted at about a right angle to the other two.

The maximum drift of any one hole was 187 feet with an average drift for the three holes of 7 feet with 100 feet of depth.

*TAS*  
T. A. Snedden  
General Manager

TAS:lc

cc: RBMeen  
JHCourtright  
KERichard 

Twin Buttes  
Anaconda