CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
416 W. Congress St., Suite 100
Tucson, Arizona 85701
602-771-1601
http://www.azgs.az.gov
inquiries@azgs.az.gov

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8/13/65

65

828 - 4641'

= 3813

Twin Buttes area

	Cu		Mo.	
555	.80	444.0	.054	29.970
715	.39	278.85	.060	42.90
353	1.07	377.71	.058	20.474
909	2.38	2163.42	.055	49.995
639	1.09	696.51	.013	8.307
642	1.74	1117.08	.028	17.976
3813		5077.57		169.622
		= 1.331% Cu		= .0444% Mo.

Pima P.T. 5/31/61

Three holes being drilled in a line near E. end of Pima pit (about same locations as those seen on previous visit, Labor day, 1960. Have not enlarged plant, though treating greater tonnage by increased regrind. Journay suggests 2 pit may be developed (did not suggest location of 2nd pit — adjoining A S & R ground?) Have started pit enlargement westward in alluvium toward Dairy shaft. - expanding N-S start on Banner E. line.

A S & R pit has stockpiled up to 500,000 T. of "ore" at mill head - according to V. "was surprising" — evidently, good ore was not expected to reach up to gravels, & ready to gravels. Cement indicate there may be considerable oxidation of this material.

One of the oldest rules of my profession states that an exploration geologist should be seldom seen and never heard — if some of you think that I am suffering from over exposure recently, you are correct and I promise to retire into quiet obscurity after this evening —

For many years a geologist was apparently

created to be the
straight man for
humorous mine supers
and pesky informed
metallurgists. We have
had some measure of
relief since geophysicist
and geochemists appeared—
I might say we have
gained some measure of
revenge in recent years
by finding tough
problems in little known
mineral fields for the miners.

and have spent our
afternoons finding
difficult problems for
the metallurgists to solve.

AIME TALK
~~OF~~ THURS. EVE. 11/17/60

This exploration discussion will be on the light side, and we will not attempt to ~~bore~~ confuse you with ideas of ore genesis or mineral succession. It may be of some interest to many of you to know where exploration efforts are being made, and to know the general relationship of ~~the~~ various ~~discussions~~ districts which are ~~currently~~ being explored, or have development projects in progress which are just past the exploration stage. We will not attempt to be all inclusive, and ~~in~~ no ~~case will any~~ information be discussed which is not already public.

Three other members of our panel are Douglas Cook, John Osmond, and Dick Durfey. Dr. Cook, ~~who~~ will start the discussions with a description of interesting mining developments in Sweden and Finland, after collegiate work in England and Canada, he obtained his doctorate from Colorado School of Mines. He has had wide experience, and is currently chief coordinating geologist for Kennecott's Bear Creek Mining Company with headquarters in Salt Lake City. Many of you will know that he has been closely associated with the very successful exploration by Bear Creek in the Tintic District.

Dr. John Osmond, now a consulting geologist in Salt Lake City, obtained his doctorate from Columbia University after work at the University of Texas and University of Wyoming. He was geologist for Gulf Oil Corporation in this district for seven years, ~~following work~~ he previously worked for Humble Oil and Refining Company, and spent two years at the University of Arizona, where he was a member of the geological department staff. Dr. Osmond will discuss current oil exploration in Utah, ~~and~~ Wyoming, and neighboring states, and will mention some of the important developments in non-metallic minerals ~~in this area~~.

Currently one of the most active exploration regions is ~~in~~ Central and Eastern Missouri, where a large number of mining companies are searching for a variety of minerals. Dick Durfey, assistant manager of the drilling division of Boyles Brothers, has recently come to Salt Lake, and is ~~very~~ familiar with the work being done in Missouri. He will give us a brief review of the various projects ~~active~~ in that field.

To close the discussion, I will attempt to describe some of the areas of active exploration in the Western States, (depending on the time that may remain to us after the three other speakers have completed their discussions.) We hope you will hold any questions you may have until all the talks have been presented, ~~and we will have~~ a question and answer period ~~following the efforts by the speakers~~.

We will begin the discussion of western exploration and development activity in Arizona, where the Pima District, located approximately twenty miles southwest of Tucson, continues to be one of the most actively explored areas in the country. No fewer than seventeen large and small mining organizations have exploration offices in Tucson, and most of them at one time or another during the past few years have been active in the Pima District. The area around the old San Javier mine worked by Eagle Picher, has long been known to contain some small ore deposits. At the beginning of the present boom in the Pima District, the Mineral Hill mine, immediately north of the San Javier, was known to contain some 300,000 tons, more or less, of 2 to 3% copper ore, which had been developed near the end of the first world war. This property was taken over by Banner Mining Company at about the same time that the Pima Mine was discovered by United Geophysical. The properties are adjoining, and stripping from the present Pima open cut on the east will extend into Banner property. The Pima pit has been actively worked for several years, and it is rumored that it will be extended to the east in low grade ore. This deposit occurs in metamorphosed sediments cut by irregular intrusives. Adjoining the Pima Mine to the north, A. S. & R. has discovered in their Mission property a reputed large tonnage of low grade ore which can be mined by open pit methods, and stripping is actively underway through unconsolidated lake bed material. Construction of a concentrator is also progressing rapidly and active exploitation will not be long delayed. The Mission ore deposit extends westerly into Banner ground, and Banner Mining Company has sunk a 1000 foot shaft to exploit higher grade lenses in extensions of the Mission ore zone. Geological features with the addition of the so-called "thrust fault" are somewhat similar The Mission ore deposit will also extend into Banner ground. The large sum paid by A.S.& R. Co. to the Indians on the San Javier reservation, immediately north of their property, for prospecting rights really upset the price structure of that region. It has been even more expensive to obtain options in this area than it was previously. The intrusive rocks are similar to those in the Pima deposit. is now the district

The Duval property is some five miles southeast of Pima, and has also west of the

been in operation as an open pit for some time. Bear Creek ~~Mining~~ is reported to have optioned ground to the west and north of the Duval property and to have done some drilling immediately to the north.

American Metal Climax has recently dropped options in the Santa Cruz valley well to the ~~west~~ east of the Duval property after drilling at least three holes through deep alluvium.

Bear Creek, as we all know, is ~~the most~~ a very active exploration group ~~in many areas and~~ in Arizona ~~this is no exception~~ they are especially active. They are reported to hold considerable acreage immediately south of Tucson Mountain Park, west of the Tucson Mountains, where Kern County Land Company has done some drilling. They are reported to be drilling ~~at~~ in the Copper Creek breccia pipe area ~~west~~ east of Mammoth; ~~and~~ at Safford a test shaft is being driven in Bear Creek holdings to obtain additional information after extensive drilling in that area. Additional ground is held near Bowie.

At the Christmas deposit of Inspiration Cons. Copper Company, a 1700 foot shaft is being driven for development of the Christmas ore deposit west of the Christmas fault, and underground work to complete development is being driven. There are important prospective areas east of the Christmas fault which have been little tested, but can be expected to be explored in the future.

In northwestern ~~areas~~ Arizona, north of Kingman and Chloride, Duval Potash and Sulphur is reported to have done sufficient drilling to indicate an interesting ore showing in the Mineral Park area east of the old Emerald Isle property. Other interests are reported to have done some drilling in this general area.

in the Yerington district

In Nevada, there has been much excitement in the past eighteen months but at least to date little new ore has been found. Bear Creek ~~Mining~~ has staked many claims and obtained options on ground immediately south of the Anaconda holdings at Yerington, and ~~have~~ have done limited drilling. Anaconda has done additional geophysical work in the area, and has also acquired additional claims. U. S. Steel Corp. has recently started an exploration project about six miles southeast of Yerington on a geophysical discovery reported to have been found by aerial magnetic work. They ~~also~~ are reported to be using helicopters to ~~obtain~~ ~~to~~ obtain close drape ~~flying~~ ~~aerial results~~ flight patterns. This company has also been active for some time in exploration of iron deposits developed near Lovelock on ground held by Southern Pacific and independent owners. ~~The~~ At Eureka, Nevada, exploration has recently been restarted by a group in which Newmont, U.S. Smelting, Hecla and Ventures interest are associated. Results of drilling of extensions of known ore are reported to be encouraging.

About twenty miles north of Tonopah, Anaconda continues to drill at the Hall prospect in a search for molybdenum ore. The grade is such that it is difficult to know whether or not ore has been encountered, but at least ~~a considerable tonnage of~~ a number of drill holes have continued to cut low grade material ~~is being encountered.~~

At Ely, Kennecott is engaged in drilling to determine possible extensions of the various pit operations, and as this is a most interesting district geologically, we all hope that future enlarged pits will expose some solutions to the complicated problems presented by breccias, replacements, and the disseminated ores now exposed.

One of the most interesting discoveries in Nevada has been the beryllium occurrence at Wheeler Mountain southeast of Ely some forty-five miles, where phenacite ores have been ~~discovered~~ formed. This deposit will be discussed with the beryllium search which has recently been concentrated around Topaz Mountain in Utah.

In Utah most of the exploration projects are well known to all of us. In the Park City District, UPC is exploring in the upper levels of the Keystone area west of the Silver King mine, and some interesting showings are being found, although no large ore bodies are indicated to date. UPC is also extending a long crosscut from the Daly West shaft into the Judge area ~~and are prospecting~~ which will intersect the Middle vein and the Back vein ~~with this work.~~

New Park Mining Company is driving a long crosscut west on the 2000 level to explore in lower Paleozoic beds along the general course of the Mayflower fissure and its various splits. Interesting stratigraphic sections will be explored, and it is hoped that this work will indicate new favorable replacement horizons for the entire Park City District.

In the East Tintic District the Burgin shaft development of Bear Creek continues, and an inclined winze is being sunk ~~from~~ below the 1050 level. This winze is being driven in the footwall of the ~~No Ore locus~~ known ore horizon and will explore ~~fine~~ ore sections previously cut by drill holes. Exploration drilling in the immediate area is being continued from surface.

In the North Tintic District, Anaconda has an option on the old Scranton property, where interesting oxide ore zones in limestone have been followed for about 400 feet below surface. Some exploratory drilling is planned in the immediate future to test shallow ~~extent~~ extensions of these ore zones.

At Milford, there is considerable exploration activity, and Anaconda will attempt some drilling in the area south of the O.K. mine and east of the Old Hickory mine to test below areas covered by overburden. Scattered small copper mines and mineralized outcrops make the hidden areas of some interest, and it is hoped that ~~the~~ various geophysical investigations will help to delimit drilling targets. West of Milford, Shenon & Full are directing exploration work north of the Beaver Carbonate mine. Some drilling has been done recently near

the Beaver Carbonate mine. Pinnacle Exploration Company of (Callahan Zinc) is reported to be interested in the area between the old Horn Silver mine and the Beaver Carbonate, and Anaconda will attempt some drilling in the Cactus mine breccia pipes, and geological investigations at the Horn Silver and nearby areas.

Beryllium, in which interest has recently soared (it is said to be useful in rocket fuel), has been discovered in the area northwest of Delta, Utah around Spor Mountain directly west of Topaz Mountain. Numerous showings of beryllium bearing altered tuff have been discovered below unaltered latite and above basal rhyolite volcanic rocks, the entire series of volcanics lapping onto the limestones which make up Spor Mountain. The volcanic rocks are in turn covered at a distance from the mountain by recent lake beds. As you have noted in the press releases, national interest in the area has been developed, and for a time the various companies competing for claims in the Spor Mountain district appeared to border on a wild west TV western sort of mix-up. Beryllium Resources, Vitro Chemical, Food Machinery, Combined Metals, Dupont, and many individuals have been active in the district, and overlapping claim locations are almost the rule rather than the exception. The mineral sought has not been properly acknowledged, but it is known that the material can be dissolved easily and that high grade precipitates or concentrates can be expected to be recovered from the solvent. It can be predicted that the general geology of the area, and possibly ore controls will be developed in the near future through the very great interest and activity of the many companies engaged in exploration. The other interesting beryllium occurrence, which has also had widespread publicity, is just over the line in Nevada southwest of Delta and Baker at the Wheeler Mountain deposit. Here, phenacite ores have been found in replacements in the lower limestone horizon of the Pioche shale in a series of beds which correspond stratigraphically with the general locus of the Combined Metals bed at Pioche. The Pole Canyon adit, originally driven some 8000 feet to explore the downward extension of lode mineraliza-

tion found high above in the St. Lawrence mine, was later found to have interesting tungsten minerals near its portal. After the tungsten operation had been abandoned, spectrographic examination disclosed some beryllium minerals and, since that discovery, drilling and other underground openings have ~~disclosed considerable amounts~~ have shown of phenacite ore.

Very briefly some comments on projects in other states:

In New Mexico near Magdalena, the Barrett prospect has been ~~discovered~~ opened up then dropped just north of the highway and east of the town. The ~~pro~~spect was optioned by Bunker Hill; it is now being drilled by Denver interests. In Colorado it is reported that American Metal Climax ~~has intensified~~ have stepped up their work in the Front Range in ~~the~~ search for additional molybdenum and other minerals. In Wyoming, U.S. Steel, after extensive drilling, is now committed to the development of the Atlantic iron deposit. ~~At~~ North of ~~an~~ Laramie iron-titanium deposit, ~~to the north is~~ and still being investigated by Union Pacific, and extensive Krupp-Renn tests were made at Pioche, Nevada to determine amenability of the iron-titanium ores to this nitriding case process. In Montana, New Park is reported to be doing some prospecting work ~~to the~~ west of Butte, and Bear Creek is reported still interested in ground at Philipsburg. Anaconda, with other associates, drilled a gas ~~proposal~~ property near Harlowtown during the summer, without success. In Idaho, Exploration activity in the Coeur d'Alene district has been retarded by labor difficulties which have extended over several months. At the Conjecture mine, Federal Uranium is exploring the downward extension of the Conjecture vein. In Washington, Bear Creek has continued work in the Glacier Peak area, and northeast of Moses Lake near Odessa, an exploratory well was drilled through 4200 feet of basalt before going into Tertiary sediments. A similar type prospect is reported to be ~~in progress~~ being drilled in Central Oregon by Humble Oil.

In Western Canada there ~~does not appear to be~~ is any series of projects which are drawing interest similar to that which was current in the Highland Valley area two years ago. In Highland Valley at the Bethlehem prospect underground work has been driven to check ore grades developed by drilling, and it is rumored that a 4000 ton mill will be installed to treat Bethlehem ores. It is also rumored that Japanese capital will finance this installation and that concentrates will be shipped to Japan. South of Bethlehem, Craigmont is engaged in work to delimit ore shown by drilling, and to the north of Bethleham, Rio Tinto is investigating the Trojan structures by various means, including geochemistry. American Metal Climax is reported to have continued exploration of the Boss Mountain molybdenum deposit. Consolidated Mining and Smelting are reported to have continued development on the Lardeau deposit at the north end of Kootenay Lake where limestone replacements have been developed for long strike distances. During the past summer, 32 companies are reported to have used helicopters as aids to exploration in British Columbia and the Yukon.

In Alaska, Bear Creek Mining has continued their exploration in the Kobuk River area. Some exploration is being done northwest of Juneau in areas uncovered by glacier retreat, but no important results have been reported. Oil company magnetic reconnaissance is reported to have outlined an iron discovery in Alaska.

ARIZONA INN
TUCSON, ARIZONA

Crush + Milling 80¢ + 5 = 16¢

Smelt 34

Ref 34

Frt, Ins 1

234

Dep 24

Cost of Ag 254

@ 20 oz
250 000 000 oz
bullion / 5 bullion

166 000 000 ÷ 54 = 24

CHB TUCSON
3/19/64

4/,000,000 0.7% Cu.
0.75% Cu

Duval

from Hepburn.

Call from Kelly

Nov 11/20/58

claim

47,000,000 @ 0.65% Cu

7/22/57

J. P. says ASARCO Pima deposit

35 million Tons 1.0% Cu +.

Probably 100,000,000 if lower grade material included

10/2/58 RBM

Hart - Same zone as Pima - one lense + 1 million tons 7% Cu. - low grade ahead between lences will just carry itself in open pit. Entire

Zone plunges to depth (N?) but may not be economic for underground operations.

Discovered by EM geophysical methods after one anomaly E. of Pine showed nothing. Gravity survey outlined one which can be mined by pit. Did not get downward extension. Gravity work probably possible because of development of tactites in hornfels zones - little one in dolomite.

~~Jack Nelson~~

~~Personnel Forms~~

DUVAL PROSPECT
PIMA CO. ARIZ.
41,000,000 0.7%.

FROM HEPBURN —

VIA KELLY

A S & R

Mission

10/14/63

20,000 T/day - slightly coarser grind.

Will put in by-products plant

MoS_2 to be recovered from conc. and scavenged from tailings.

In high CaO suspension MoS_2 does not come up well with Cu conc.

Will also recover ZnS, PbS?

possibly $CaWO_3$ (runs about same as moly.), tin. Neither $CaWO_3$ or tin may be economic.

$CuFeS_2$ very easy to recover at Mission

S.D.V. Automation and instrumentation have worked well.

M.W.

Expects decision on Northern Peru property by next April - could be to go ahead rapidly. Will use complete automation. Considering two stage autogenous grinding. Bolicdes metallurgy more difficult than Mission - in porphyry, but some Cu_2S on pyrite

5/4/62

MISSION PIT.

12,000 - 18,000 T/day ore; 105,000 T. waste - rapidly expanding on W. side. in gravel.

2850 Bench - looks very low grade with high grade spotty replacement in "argillite" in NW corner. Andesite dikes (2) in NE corner N 15-20 E. Also broken zone. Small normal? faults on W. side strike N. 50° E dip steep or to S.

No def. tactite zones - probably all "argillite" with lensy tactite replaced zones. Bedding not easily apparent. High in old surface N 20° E from pine N. line.

$CuFeS_2$ FeS_2 qtz - many qtz. stringers - argillit slightly chloritized and generally dark to light green color - some areas are bleached or more siliceous and then resemble Pima HW arkose.

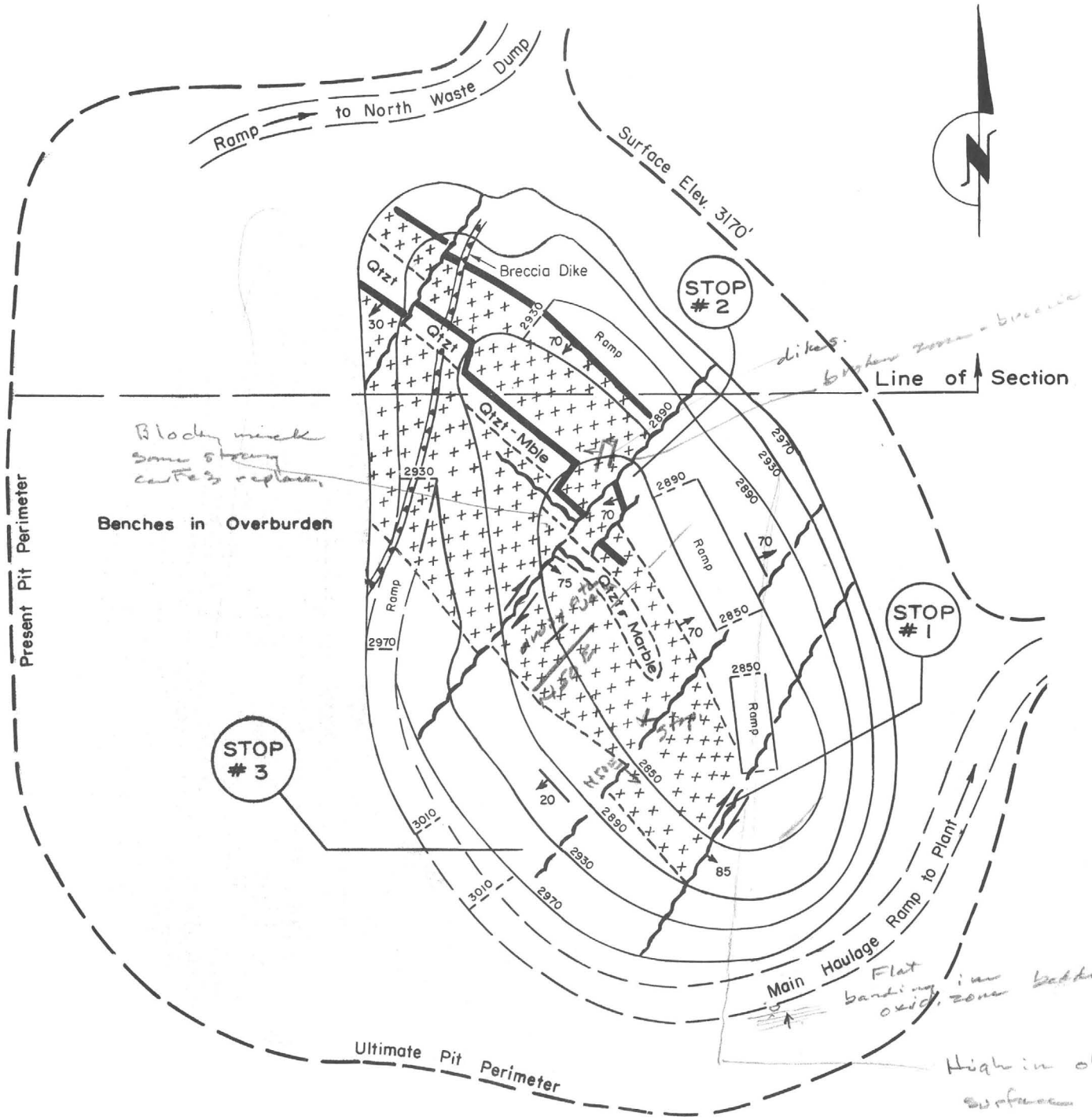
No good strong ground zone seen.

Fidelands MOTOR INN
919 N. STONE AVENUE
TUCSON, ARIZONA

MORIN M. SCOTT
President
CHARLES M. (Chuck) REAVES
General Manager

MAin 2-3541
TELETYPE TS-2831

"Business or Pleasure . . . It's Fabulous"



Sketch Map

MISSION OPEN PIT MINE

SCALE 1" = 400'

Tactite - Hornfels

Argillite

Pre-mineral Fault

Post-mineral Fault

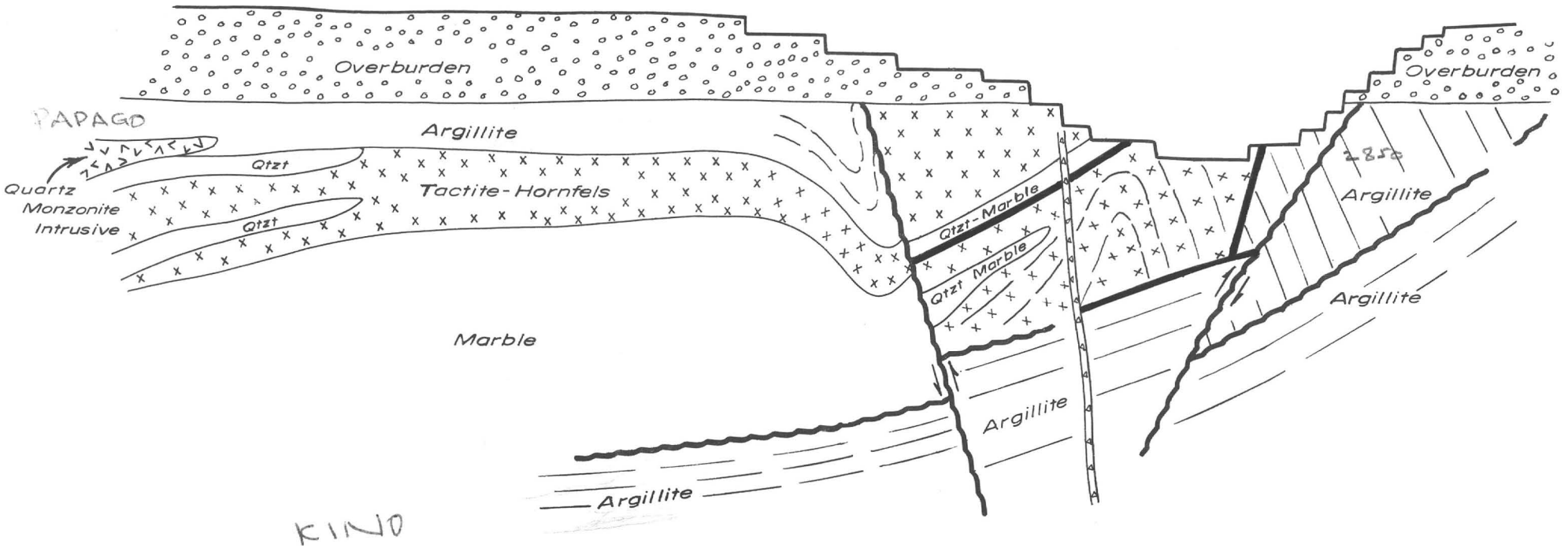
Bedding

Gradational Contact

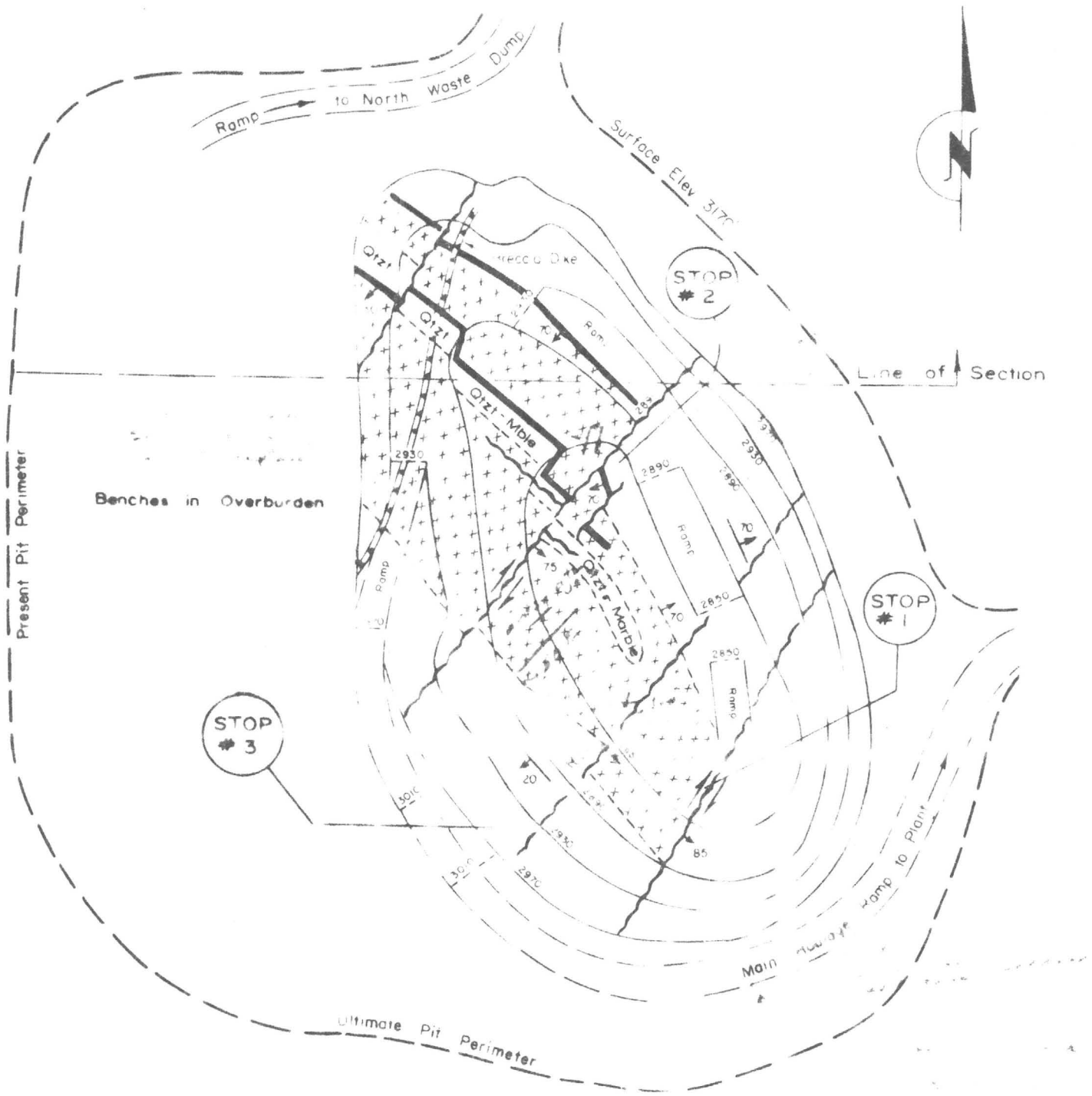
SKETCH
EAST – WEST SECTION

Horizontal and Vertical Scale 1" = 400'

40' benches in ore + waste
originally 50' in waste.



KINO



Sketch Map

MISSION OPEN PIT MINE

SCALE 1" = 400'

Tactite - Hornfels

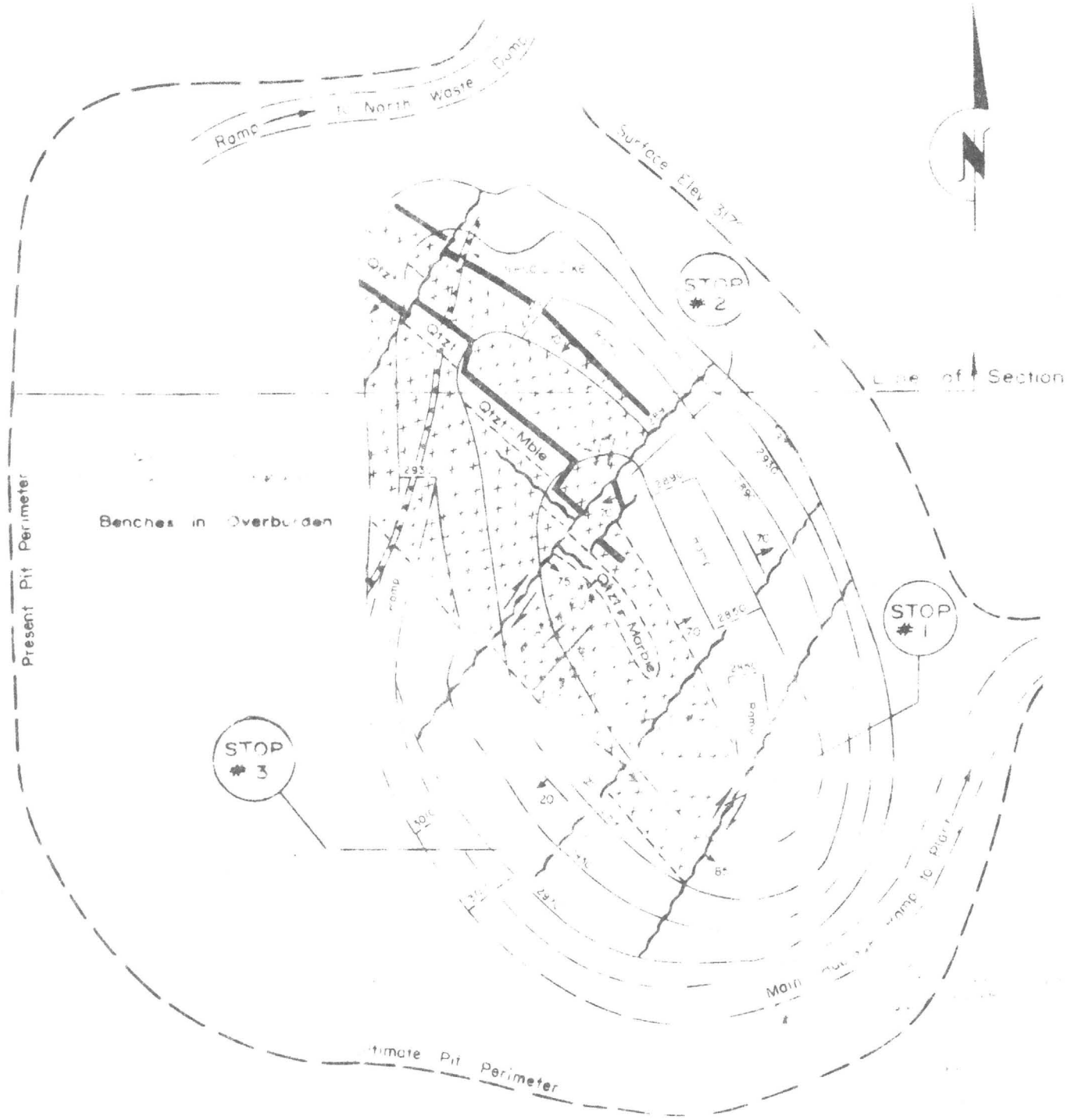
Argillite

Pre-mineral Fault

Post-mineral Fault

Bedding

Gradational Contact



Sketch Map

MISSION OPEN PIT MINE

SCALE 1" = 400'

Tactite - Hornfels

Argillite

Pre-mineral Fault

Post-mineral Fault

Bedding

Gradational Contact

H. Weiss. 12/10/64

Costs at Mission conc. $.50 per ton – Total Reagent cost $0.03 – 0.04/ton. – Steel ball costs 11–13 ¢/ton.

Factor on possible autogenous grinding savings roughly 70% of ball mill steel costs.

Weiss believes 0.12% Cu can be put thru Mission plant at break even costs. This assumes excess mill capacity for 0.12% tonnage, and no overhead charge as this would continue whether or not mill operates. Vincent would raise 0.12 figure to possibly 0.18%

Mission will average 22,000 T/day for 1964; now at 18,000, but have reached 28,000 T/day. (Previously on 22,000 T/day basis, cost per ton installed capacity $750–800/T)
To expand to 48 000 T/day – plant designed for expansion to 65,000 – large gyratory was only expected to run 50% of time on initial tonnage; space left in sec. crushing plant for 4th line of sec. crushers, etc.
Cuajones to be brought in by 1970. (Perry) Michiquillay decision due in next 4 months (Weiss); he obviously expects ASIR to proceed with M., although Perry believes decision will be made on basis of Cuajones plans. Govt pressure?

Mission No plant in operation ("little monster") – no attempt at WO_3 recovery – will get some PbS? ZnS. Circuit will work on Cu concentrate, and also scavenger concentrate at head end of mill which will contain PbS; ZnS with some Cu + Mo.

11/14/59

4000 T/day
to expand to 8000? if pit extended to E. to take in 0.79 ore
Pit to connect with ASAR to N. Deal with Banner imminent?
Pit at 2850 ft. between 4 & 5 bench. - from old shaft - 400' ± to E. good ore FeO_2 in qtz + chlor. L's. - on top bench (GSA strip bench) small faint E-W dip 45-50° to S. between arkose and quartz. No other ore-bearing zones in benches examined. Small N-W fault with E. dip ± 40° E of shaft on bottom bench.

2½ yd shovel -
22 T. trucks.

PIMA MINING COMPANY

History

The Pima orebody was discovered in 1950; extensive underground development was begun in 1952. In August 1954 the parent company, Union Oil Company of California, granted Cyprus Mines Corporation an option to examine the property, and Utah Construction Company was engaged to study the economic possibilities of mining by open pit.

After sampling and drilling to check the work completed under the original Pima management, Cyprus purchased a three-quarter interest in the property, Union Oil retaining one quarter. Cyprus later sold a one-quarter interest to Utah Construction Company, retaining half interest and management responsibility.

The first ore was reached by stripping October 1956, and the first concentrate was produced in December.

The mine lies about 20 miles southwest of Tucson, Arizona. Some 250 people are now employed, all of whom live in Tucson and commute daily.

The Pit

The Pima pit is a 1700 x 1,100-foot oval, the long axis parallel to the strike of the orebody. The north side of the pit is carried as a final pit slope that coincides with the footwall of the orebody. The south side and east and west ends of the pit are working slopes continually being stripped back toward the final slopes.

An inclined roadway extending from the natural ground surface on a 5 percent grade down to the northeast corner provides access to the pit. This road enters the pit 130 feet below the natural surface and continues as a pit ramp on a 5 percent grade to the 3150-foot bench (roughly the base of the alluvial cover). At this point the ramp system is steepened to a 10 percent grade and continues to the pit bottom. The 5 percent grade is maintained in the alluvial section to facilitate perpetual haulage out of the pit. In addition to this main access ramp, temporary working ramps in the alluvial areas allow shorter routes to dumps. These are left on top of working benches and do not change the overall working slopes.

Below the base of the alluvium, haulage is by truck down to the skip loading point or up from the bottom to the skip loading point.

The final pit slopes in the alluvium are laid out at 1.2:1 overall with 50-foot bank heights, 0.6:1 bank slopes, and 30-foot benches except at the base of the alluvium, where a 50-foot bench was left as protection against excessive sloughing. Final slopes in the rock are laid out at 1:1 with 40-foot bank heights, 0.375:1 bank slopes, and alternate 30 and 40 foot bench widths.

Working slopes in the alluvium are maintained at 1.35:1 with alternate 25 and 50-foot benches. Bank slopes and heights are the same as final slopes. Working slopes in the rock are usually held at 2:1 overall with 50 to 60-foot benches, 40-foot bank heights, and approximately 0.5:1 bank slopes.

An incline for the skip hoist trackage was left on the center of the north (final) slope. Cutting into the pit slope on the upper benches and allowing a slight readjustment on the lower benches permitted a 38° skipway incline to somewhat flatter than the overall final slope.

Utah Construction Company, which had been awarded the pre-stripping contract on the basis of low bid, started actual stripping in November 1955. MRS tractor units and Wooldridge 34-cubic yard scrapers were used in conjunction with one Marion 150-M shovel and four LeD Euclid trucks. Utah stripped approximately 6 million cubic yards during its contract (November 1 to October 1, 1956). Pima commenced stripping operations alongside the contractor in April 1956 and by the end of that year had moved about 3 million cubic yards. During stripping, Pima trained a competent group of employees to operate a the pit after Utah completed its contract.

Total pre-mine stripping amounted to a little more than 9 million cubic yards. About 3 million cubic yards of this was rock and the remainder alluvium.

At the present time stripping rate is about 4.0 cubic yards of waste per ton of ore. Rate for the remaining life of the mine will be about 2.6 cubic yards of waste per ton of ore.

Production

Daily mine production is set at approximately 4000 tons of ore on the basis of a 6-day week. Ore is mined on one shift and rock stripped on the other two shifts. Alluvium is stripped on all three. Normal practice in the pit is for two working conventions. Daily production averages 10,000 cubic yards or 10,000 cubic yards of ore (4000 tons), 1500 cubic yards of waste rock and 7500 cubic yards of alluvium. Output is therefore approximately 10 cubic yards per man-shift.

The clastic rocks, occurring in both harging and footwalls of the carbonate formation, are extremely fine-grained with a quartzitic appearance. They are composed of quartz, feldspar, and sericite, and texture is definitely clastic. In some places it is almost sedimentary; in other it has an igneous appearance. On the basis of petrographic work and visual examination of drill core, those at Pima believe that some of the clastic rocks formerly called "arkosite" may be better classified as pyroclastics. Even though they cannot be initially proven petrographically, these pyroclastics may contain local accumulations of sedimentary clastic and otherwise. In the hanging wall clastic rocks, pyrite is widely disseminated and there are zones of low grade disseminated chalcopyrite mineralization, which makes an open pit operation feasible.

The igneous rocks found at the mine are of intrusive nature and consist of rhyolite, syenite, and quartz monzonite porphyry. The rhyolites and syenites are unmineralized and occur in and above the hanging wall of the carbonate series. The bulk of the quartz monzonite porphyry is found in the footwall clastics and is slightly mineralized by pyrite and chalcopyrite.

Engineering

The engineering department works in close cooperation with the production departments and is responsible for operating layouts, estimates, pit schedules, and uniformity of mill feed. Present personnel consists of a chief mining engineer, pit engineer, ore control engineer, and draftsman and a field survey crew of three — an instrument man and two rodmen.

Mine operating layouts are prepared on the scale of a series of pit expansions. Each expansion is scheduled for completion of alluvium and waste rock stripping before the ore is exhausted in the previous expansion. Layouts are made on current pit maps on a scale of 1 inch to 50 feet. Volume estimates of ore and stripping are made on horizontal level maps on which the ore blocks are outlined. Cross sections on a scale of 1 inch to 50 feet are used in planning the layouts, although currently these are not used for estimating. Owing to the size and shape of the present pit, a more accurate estimate can be obtained from horizontal level maps.

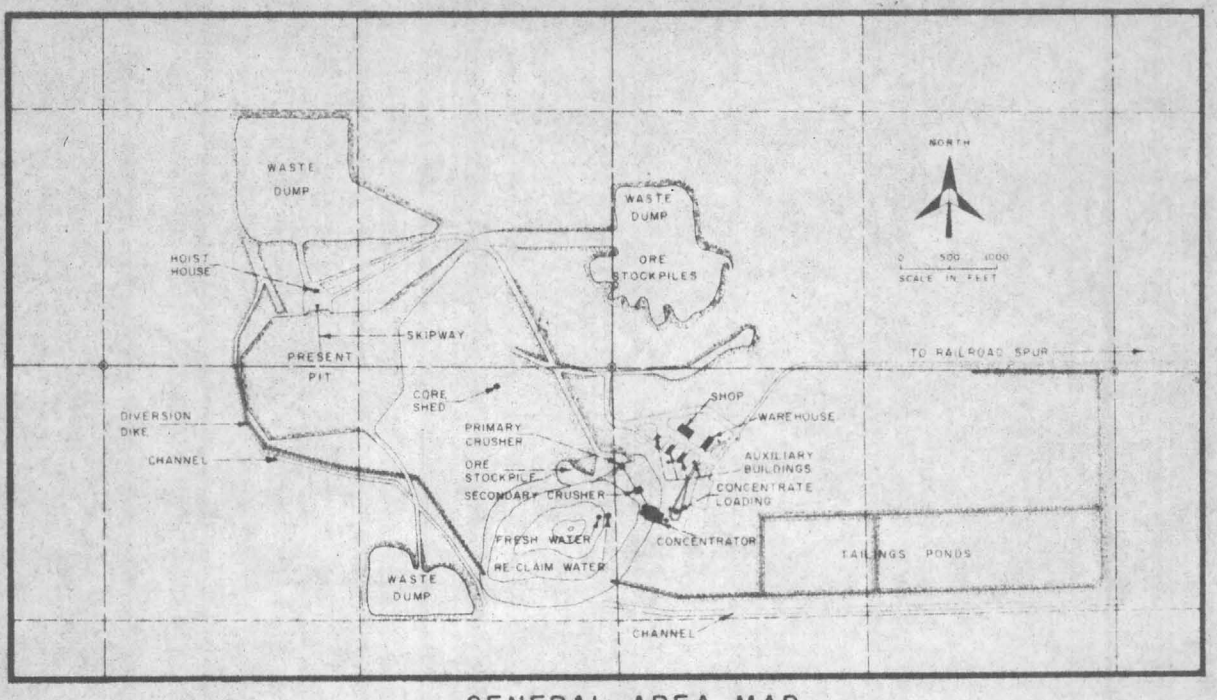
Volume estimates of material removed from the pit are made quarterly or specially prepared as need. To keep the pit map and ore control maps up to date the pit is surveyed each month, with a more accurate survey when a volume estimate is made.

For ore control, each individual drilled is sampled and assayed. From the established grade outlines, the material in each pit blast is classified and where necessary is segregated. Where two or more types of material are encountered in one blast, the outlines are flagged in the bank for the operators' guidance. From the assays of the ore material, a grid is established between various

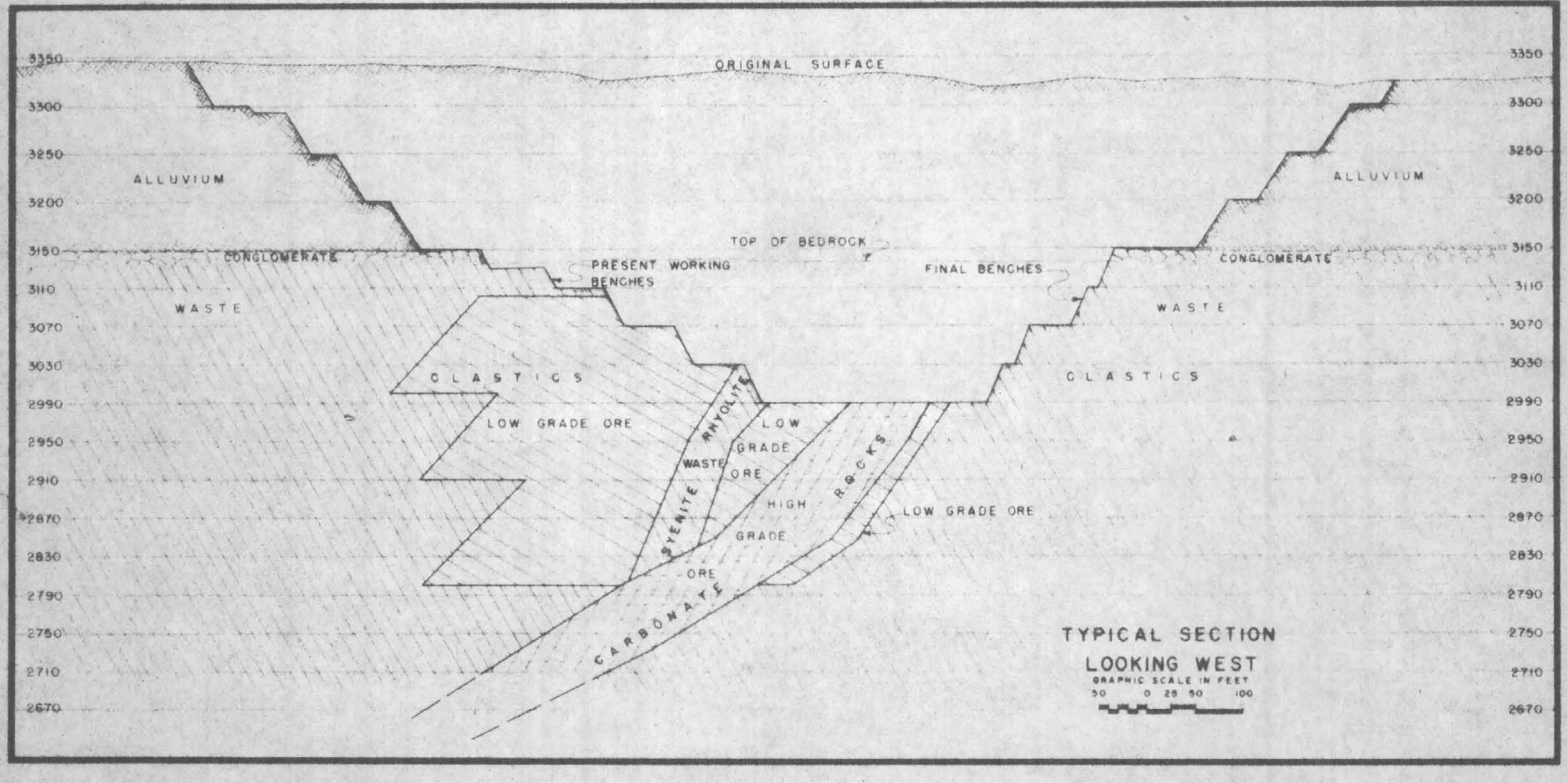
PIMA MINING COMPANY

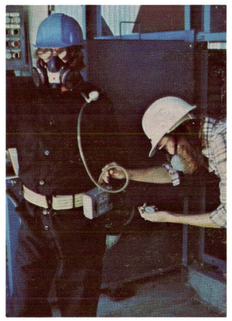
PIMA MINE

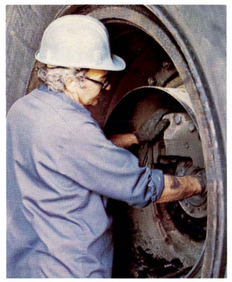
TUCSON, ARIZONA

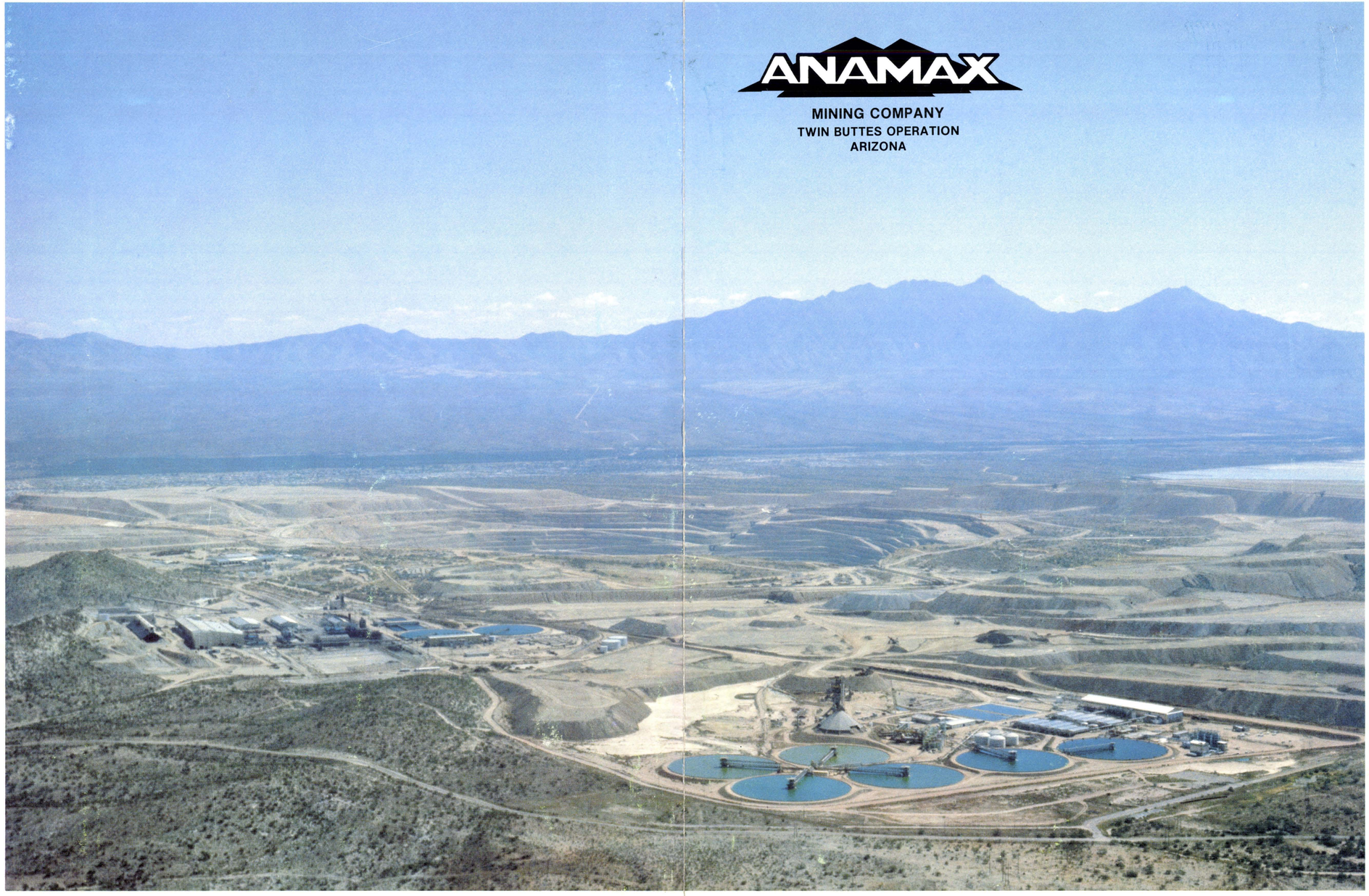


GENERAL AREA MAP







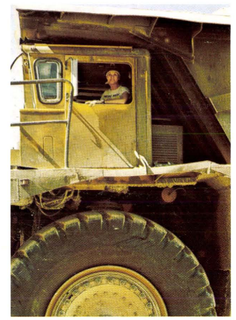


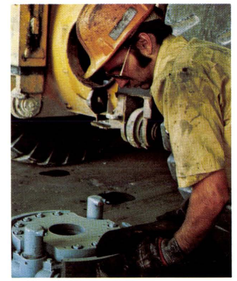
ANAMAX

MINING COMPANY

TWIN BUTTES OPERATION

ARIZONA





The Twin Buttes Story

Copper mining in the Pima Mining District of southern Arizona had its beginnings in the 1870s when prospectors found rich outcrops of copper ore. In the area known as Twin Buttes, many small mining operations flourished and failed.

The Banner Mining Company reactivated mining in the Twin Buttes area during the 1950s and gained extensive mineral holdings here over the next several years. In 1965, The Anaconda Company, under agreement with Banner, began an exploration and mining project far beyond the scope of those early day mines.

Arizona Historical Society

Miner and ore car at Twin Buttes, Arizona Territory.

After four years of development, Anaconda produced the first copper concentrate from the Twin Buttes mine in 1969. In a later expansion, Anaconda entered into a partnership with AMAX Inc., forming the Anamax Mining Company, in 1973.

Arizona Historical Society

Workers pose at Twin Buttes smelter, 1912.

An agreement by Anamax and ASARCO, Inc., in 1976, designates ASARCO as operator for the development and mining of the nearby Palo Verde copper property. A feature of this operation, known as the Eisenhower Project, is the 6.4-mile overland conveyor system for transporting ore to the Twin Buttes Mine for processing.

Hard Rock Mining

Anamax' Twin Buttes operation is an open pit copper mine. To reach the relatively low grade copper ore lying deep below the surface, 500-800 feet of waste material had to be removed. Since the project began in 1965, more than a billion tons of material have been moved.

Huge 34-yard electronic shovel loads alluvium into end dump truck.

True to modern mining methods, Anamax engineers make use of computers to assist them in pit design. Core samples from various holes are assayed, the results computerized, and from this data the engineers determine the configuration of the pit. Current design calls for the pit to be 1¾ miles long, 1¼ miles wide and 1700 feet deep, with the sides sloping downward in a series of 40 to 50 foot benches.

Daily blasting is the first of many steps in mining copper. For each blast a series of 80-100 holes, 47 feet deep, 12½ inches in diameter, are drilled at 30 foot intervals and loaded with explosives.

Blasting in Anamax pit loosens and fractures ore and rock.

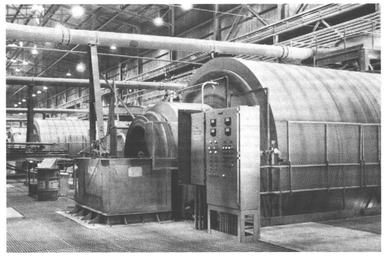
Once the ore and rock have been loosened and fractured by blasting, electric power shovels move in to load it onto 100- and 170-ton end-dump trucks. These trucks carry the ore and rock to one of three crushers in the pit which reduce it to a size that can be carried on five foot wide conveyor belts, up and out of the pit to processing points on the property or to waste.

Copper Recovery

Two distinct types of copper ore are mined at Twin Buttes — oxide ore, which is principally chrysocolla, and sulfide ore, which is principally chalcopyrite.

The Sulfide Mill

The Twin Buttes Sulfide Mill has the capacity to process 40,000 tons of ore per day, yielding 1200 tons of copper concentrate.



Sulfide ore, traveling up from the pit by conveyor, is sent through a secondary crushing stage. Upon reaching the Fine Ore Crusher, the ore is circulated through a series of giant cone crushers which eventually reduce it to a pebble size. The fine ore then is moved by conveyor to the Sulfide Concentrator, where it is fed into a series of rod and ball grinding mills (shown above).

A rod mill is a large steel drum, 18½ feet long and 14 feet in diameter, which rotates at a speed of 15 RPM. The inside of the mill is partially loaded with long steel rods, four inches in diameter and 17 feet long. The ball mills are slightly larger and are filled with 2-inch diameter steel balls. Fine ore, fed into these mills, is mixed with water and ground into a mud-like substance called slurry.

The slurry is mixed with chemical reagents and pumped into large flotation tanks. Here the mixture is agitated with air and whipped into a froth. The reagents cause the copper to float to the top of the tanks, coating the large bubbles which are formed. The froth holding the copper concentrate is then floated off, while the waste, called tailings, drops to the bottom and is pumped out. The concentrate goes through one final milling step, again using the flotation method, which separates out the molybdenum, an important by-product metal. Dried to black powder, the concentrate is shipped to copper smelters for further refining.

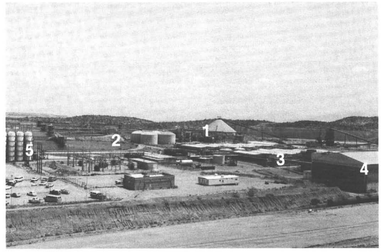
The Oxide Plant

The Anamax Oxide Leaching and Electrowinning plant is one of the first and largest of such facilities in the country incorporating a liquid ion exchange (solvent extraction) process. One hundred tons of pure copper can be produced here each day.

After crushing, oxide ore is fed into rod and ball mills and reduced to a slurry which is then pumped through a series of eight leaching tanks.[1] Sulfuric acid in the tanks leaches the copper minerals from the ore. After eight hours, virtually all the copper oxide has been removed from the ore and is in solution with the acid. It is then fed through a series of four thickener tanks[2] 400 feet in diameter, where the waste or tailing is separated from the acid leach solution.

Solvent extraction and electrowinning are the two final steps in producing pure copper from oxide ore. In solvent extraction[3] a chemical reagent called an organic extractant is mixed with kerosene and is used to transfer the copper out of the acid solution leaving other impurities behind. More acid is then added to separate the copper from the organic solution and prepare it for electrowinning.

In the tankhouse[4], where electrowinning takes place, the acid/copper solution, called electrolyte, is pumped into plastic lined concrete tanks. Each tank is filled with copper starting sheets. Each starting sheet is placed between two anodes. An electric current is passed through the tanks, causing copper in the solution to be deposited on the starting sheets. After seven days in the tanks, the finished sheets of copper, now called cathodes, are removed, washed and loaded into railroad cars for shipping. The finished cathodes, each 36 inches by 44 inches and weighing about 140 pounds, are 99.9% pure copper — a finished product ready for fabrication.



In the ores at Twin Buttes, copper content varies from .6 of one per cent to 1.5 per cent; about 100 tons of ore are required to produce one ton of copper.

In the same 100 tons of ore, other metals are present which can be feasibly extracted as by-products. Almost since the beginning of its operations, Anamax has recovered large quantities of molybdenum, a metal used by the steel industry to produce high-temperature-tolerant alloys for the aerospace industry. A recent pilot plant project has proven a recovery process for tungsten, which may be implemented in a few years when ore being mined is expected to contain more tungsten than that currently being mined. This rare metal is used in welding and in high-test tools and dies. Early in 1980, Anamax began recovering uranium. The uranium content in the ores at Twin Buttes is low — only 35 parts per million, compared with 1,000 to 10,000 parts per million in a working mine.

A sulfuric acid solution containing copper and uranium, from the thickening stage of the oxide process, is pumped through columns filled with resin beads. Here, uranium is absorbed into the resin beads, while copper, still in solution, continues unaffected along the normal copper recovery route. The resin beads then are rinsed with a stronger sulphuric acid solution to remove the uranium.

Recovered uranium then is concentrated into an ammonium sulfate solution by a process called solvent extraction. Ammonia is added to the concentrated solution to precipitate the uranium as a slurry. Uranium slurry is further processed to remove water. The final product is a dried, powdered form of processed uranium called yellowcake. It is packed into 55-gallon drums for shipping to processing points elsewhere in the country.

ANAMAX MINING COMPANY — TWIN BUTTES

GENERAL FEATURES, Continued

Blast Hole Data:

Blast Hole Spacing	25 ft. minimum centers
Hole pattern	Staggered
Bench height	40 ft.
Hole depth	47 ft.
Hole diameter	12¼ in.
Explosive used:	Ammonium nitrate + diesel fuel, slurry (wet holes)
Primers	C-3 14 oz.
Shot size	Minimum size + 50 holes
Delays	25 MS and 42 MS between rows
Type blast	Free face preferred
Burden blast	Few
Explosive — lbs./hole	Ave. 1000# slurry
Rock broken — tons/lb. of explosive	3.27

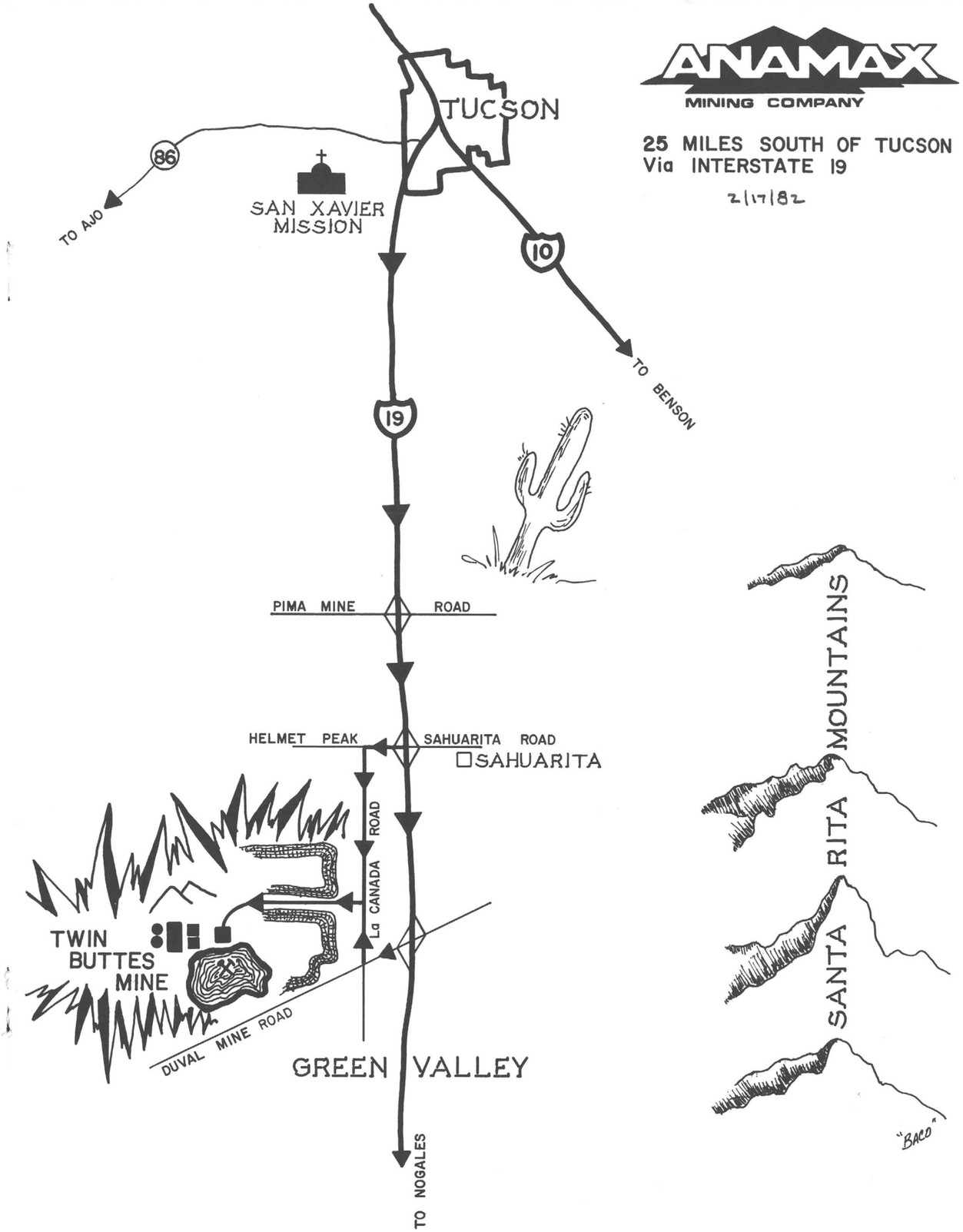
MAJOR EQUIPMENT

Loading Equipment

End Dump Trucks (Electric):	38	Unit Rig	100 ton	190 tons	1000
	21	Wabco	100 ton	190 tons	1000
	2	Unit Rig	170 ton	270 tons	1600
	2	Wabco	170 ton	270 tons	1600
Shovels (Electric):	3	Marian 191M	15 cu. yd.		
	1	P&H 1900B	10 cu. yd.		
	2	P&H 2100B	15 cu. yd.		
	3	P&H 2100BL	15 cu. yd.		
Rubber-Tired Front End Loaders	1	Dart D600	15 cu. yd.		
	1	Cat 992	10 cu. yd.		
	4	Cat 988	6 cu. yd.		
	1	Cat 950	3½ cu. yd.		
	2	Cat 930	2¼ cu. yd.		

Support Equipment

Tractor Dozers	Crawler	7	Cat D-9G	
	Crawler	2	Cat D-8, Side Room	
	Rubber Tired	8	Cat 834	
Road Graders		5	Cat #16	
		1	Cat 120	
Water Trucks		5	Cat 660	500 to 12,000 gal. ea.
		2	Cat 779	8000 gal. ea.
Scrapers		2	Cat 660B	54 cu. yd.
Drills		4	Bucyrus Erie 60R	(diesel)
		2	Gardner Denver 120	
Powder Trucks		2		
Primary Crusher		3	Nordberg 54" x 80"	5000 tons/hour



ANAMAX MINING COMPANY

25 MILES SOUTH OF TUCSON
Via INTERSTATE 19

2/17/82

THE TWIN BUTTES STORY

Copper mining in the Pima Mining District of southern Arizona had its beginnings in the 1870s when prospectors found rich outcrops of copper ore.

The original Twin Buttes village got its name from the two nearby peaks that overlooked the mining area. However, it wasn't long until the rich, easy-to-mine pockets of ore were mined out and the village abandoned.

In the early 1900s, the copper mines near Twin Buttes enjoyed a brief return to productivity. Copper prices were good; optimism was high to the degree that a railroad line was built from Tucson to service the area. This rebirth of mining activity was short lived, however, and it was not until the 1950s that new interest was shown in the mining district. Modern-day prospectors, geologists and engineers, armed with the most up-to-date tools for divining the secrets of the earth, began an intensive exploration of the district, hoping to find areas of mineralization suitable for mining.

In 1963, The Anaconda Company exercised an option on the properties of the Banner Mining Company and started a massive exploration project. After four years of development, Anaconda produced the first copper concentrate from the Twin Buttes mines in 1969. In 1973, Anamax Mining Company was formed when The Anaconda Company and AMAX Arizona, Inc. signed agreements that created a 50-50 partnership to operate and expand the Twin Buttes Mine. The agreement included the acquisition by AMAX of the Banner Mining Company.

The Anamax Twin Buttes operation is an open pit copper mine. To reach the relatively low-grade copper ore lying deep below the surface, 500 to 800 feet of waste material, mostly sand and gravel, had to be removed. Since the project began in 1965, more than a billion tons of material have been moved. This initial stripping was done with scrapers, belt conveyors and dump trucks.

Using modern mining methods, Anamax engineers make use of computers to assist them in pit design. Core samples from various holes are assayed and the results computerized. From this data the engineers determine the configuration of the pit. Current design calls for the pit to be 1¾ miles long, 1¼ miles wide and 1700 feet deep, with the sides sloping downward in a series of 40- and 50-foot benches.

Once the ore and rock have been loosened and fractured by daily blasting, electric power shovels load it onto 100- and 170-ton end-dump trucks. These trucks carry the ore and waste to one of three crushers in the pit, which reduce it to a size that can be carried on five-feet-wide conveyor belts, up and out of the pit to various processing points or waste piles.

Two distinct types of copper ore are mined at Twin Buttes — oxide ore, which is principally chrysocolla, and sulfide ore, which is principally chalcopyrite.

The oxide ore goes through a leaching and electrowinning process which results in finished sheets of copper called cathodes, each 36 inches by 44 inches and weighing about 140 pounds. The cathodes are 99.9 per cent pure copper — a finished product ready for fabrication. One hundred tons of cathode can be produced each day in this process.

The sulfide ore goes through crushing and grinding processes, then is mixed with water and ground into a mud-like substance called slurry. The slurry is mixed with chemical reagents, and, through a flotation process, copper concentrate is produced. Dried to a black powder, the concentrate is shipped to copper smelters for further refining.

Important by-products are extracted before each final process — uranium from the oxide ore and molybdenum from the sulfide ore.

All of this complex operation is designed to mine ore that averages less than seven-tenths of one per cent copper, or less than 14 pounds of copper per ton.

Approximately 1600 persons currently are employed by Anamax. G. R. Wyman is president.

ANAMAX MINING COMPANY — TWIN BUTTES

August 1, 1980

GENERAL FEATURES

Date Pit Started:	July 1965	
Present Dimensions:	Length = 7,300' Width = 5,600' Depth = 1,220'	
Total Tons To Date (To August 1, 1980)		
	Waste	1,092,476,682
	Copper Mineralized Rock (stockpiled and mill feed)	150,905,638
	Total	1,243,382,320

Production: (Based on 1980 budget)

Rock Mined	58,000 WST/shift
Sulfide Mill	
Ore Milling Rate	
Twin Buttes Ore	27,000 DST/day
Eisenhower Ore	13,700 DST/day
Copper Produced in Concentrate	
Twin Buttes Ore	88,674 tons/year
Eisenhower Ore	32,130 tons/year
Molybdenum Produced in Concentrate	
Twin Buttes Ore	1,816 tons/year
Eisenhower Ore	585 tons/year
Oxide Mill	
Ore Milling Rate	9,593 DST/day
Copper Cathode Produced	35,435 tons/year
Uranium (U_3O_8) Produced	72 tons/year

Haul Roads: Maintained = +25 miles; Width = at least 100 feet; Grade = Maximum 10%

Weather Data: Hot and dry +22° to +120°; Average rainfall ± 10.5" year; No snow.

Wall Slopes and Bench Detail:

Planned rock slope = 26.5° to 45°
Planned alluvium slope = 53°
Bench height:
Above 2800 level = 50 feet
Below 2800 level = 40 feet

Manpower

Salary	454
Hourly	1,081
Total	1,535

TWIN BUTTES MINE

Stripping at Twin Buttes Mine started in July 1965, and to date more than 1,240,000,000 tons of ore and waste have been mined. At present, the pit is over 7,300 feet long, 5,600 feet wide and 1,200 feet deep. The planned rock slopes in the pit are 26.5° to 45° with the alluvium slopes at 53°. Benches above the 2800 level are 50 feet high and below the 2800 level, the benches are 40 feet high. There are more than 25 miles of haul roads, which are maintained at a minimum width of 100 feet and maximum grade of 10 per cent.

The in-pit crushing and conveying system handles 85 per cent of all the pit material. The three crushers are Nordberg 54" x 80" gyratory crushers rated at 5000 tons per hour each. The belt system is over 72,000 feet long using a 60-inch belt, with a maximum grade of 25 per cent.

All drilling is 12¼" holes with spacing a minimum of 25 foot centers. The pattern is staggered with the hole depth being 47 feet for the 40 foot bench. Blasting is done using ammonium nitrate base blasting agents with 25 M.S. and 42 M.S. delays. The power factor averages 3.27 tons/lb. with most shot being over 50 holes and free face blasting preferred. The present drilling equipment consists of 4 Bucyrus Erie 60R drills and 2 Gardner Denver 120 drills; all drills are diesel electric type.

The loading and hauling is done with trucks and shovels, with 85 per cent of the material being hauled to the conveyor system, and 15 per cent of the waste material being hauled directly to the dumps. The shovels are all electric and consist of 3 Marion 191M 15 yard capacity, 1 P&H 1900B 10 yard capacity, and P&H 2100 B 15 yard capacity, and 3 P&H 2100BL 15 yard capacity. The truck fleet is all electric drive trucks: 38 Unit Rig 100 tons, 21 Wabco 100 tons, 2 Unit Rig 170 tons and 2 Wabco 170 tons.

Other support equipment consists of: 9 front end loaders, 9 crawler tractors, 8 rubber-lined tractors, 6 motor graders, 7 water trucks and 2 scrapers.

CABLE BELT
TECHNICAL DATA

Conveyor Length	33,512 ft.
Belt Width	42 in.
Conveyor Speed	800 F.P.M.
Actual Conveyor Speed	830 ft./sec. (Measured)
Conveyor Inspection Speed	233 F.P.M.
Rated Motor Horsepower	(2) — 1500 Total 3000 hp
Drive Unit Rating	Continuous
Average Capacity	2000 s/tons per hour
Rated Peak Capacity	2200 s/tons per hour
Material	Copper Ore
Material Weight	110 lbs. per cu. ft.
Material — Size	Minus 6 in.
Material — % of Largest Lumps	30%
Rope Size	1.6 in. diameter
Rope — Safety Factor at Average Capacity	3.3:1
Drive Unit Size	16
Drive Unit Koepe Wheel Diameter	120 in.
Rope Tension Sheave Diameter	76 in.
Line Pulley — Diameter	12 in.
Linestand Pitch — Approximate	15 ft. 6 in.
Return Linestand Pitch — Approximate	46 ft. 6 in.
Type of Discharge	Head Discharge
Special Features	Angle Transfer Unit
Earthworks	19,000 cu. yds.
Total Concrete	2000 cu. yds.
Main Tension Tower — Height	101 ft.
Main Tension Counterweight	34 tons
Rope Tension	9 ton (each rope)
Belt Tension	1000 lbs.
Rope Tension Track Travel	453 ft.
Total Number of Linestands	2164
Total Poly-Pulleys	13,000 ±

THE GEOLOGY OF THE TWIN BUTTES MINERALIZED ZONE

The Twin Buttes mine has been developed in a copper-molybdenum orebody that exists within a more widespread altered and mineralized zone. Sulfide mineralization, alteration and intrusion occurred within this zone, which was developed around a Laramide-age mineralization center. Paleozoic and Mesozoic sediments and intrusive rocks of Laramide age and older have been mineralized and altered within the Twin Buttes zone. After sulfide mineralization, erosion and oxidation of the upper part of the mineralized zone took place, and the orebody was covered with several hundred feet of alluvial overburden.

A wide variety of rock types occur in the Twin Buttes zone. Beneath the post mineralization overburden: altered, gently folded quartzose, Mesozoic sediments and volcanics overlie altered, folded, steeply dipping Paleozoic sediments. Near the center of the mineralized zone is a northwest-trending intrusive complex, portions of which have been dated at 58 million years. The geometry of the various rock units is portrayed in plan and section on Figures 1, 2, and 3.

The sediments and intrusive rocks in the mine area are variously altered. The carbonate-rich sediments have often been altered to a number of calcium-magnesium-iron silicates including garnet, diopside, wollastonite, actinolite and serpentine. Quartzose sediments, volcanics and earlier intrusive have been altered to assemblages that include: quartz-biotite-orthoclase, quartz-sericite, and chlorite-epidote. The alteration products present at any particular place depend on the original rock composition and on proximity and access to the mineralization center.

Beneath the zone of oxidation: copper, iron and molybdenum sulfide minerals occur as disseminations and within and adjacent to veins, often with quartz and anhydrite. Pyrite and chalcopyrite are by far the most abundant sulfide minerals in the orebody. Chalcocite, sphalerite and molybdenite are common, and bornite, galena and pyrrhotite occur in significant amounts. The sulfide concentrate at Twin Buttes usually contains several ounces per ton silver. Gold content is negligible. Small amounts of the tungsten bearing minerals, powellite and scheelite, occur throughout the orebody.

Higher grade copper mineralization occurs in altered carbonate rocks, and the adjacent quartzose sediments, volcanics and intrusives usually have significantly lower values. Areas of better grade mineralization are separated by low grade intrusives and are segmented by northeast-trending, near-vertical faults that have predominately post mineralization movement. The two largest of these late faults, the Twin Buttes Fault and the East End Fault (Figure 1), have southeast-side-down movement measured in thousands of feet.

A few to several hundred feet of oxidized bedrock occur above the sulfide orebody, and a generally thin zone of secondary chalcocite has formed directly beneath the oxide zone. The most common products of this oxidation and supergene alteration are: numerous clay minerals, chrysocolla, copper-manganese-iron wad, native copper, pyrolusite and a variety of yellow, brown and red iron oxides. Uranium values of a few parts per million are common in copper oxide ore.

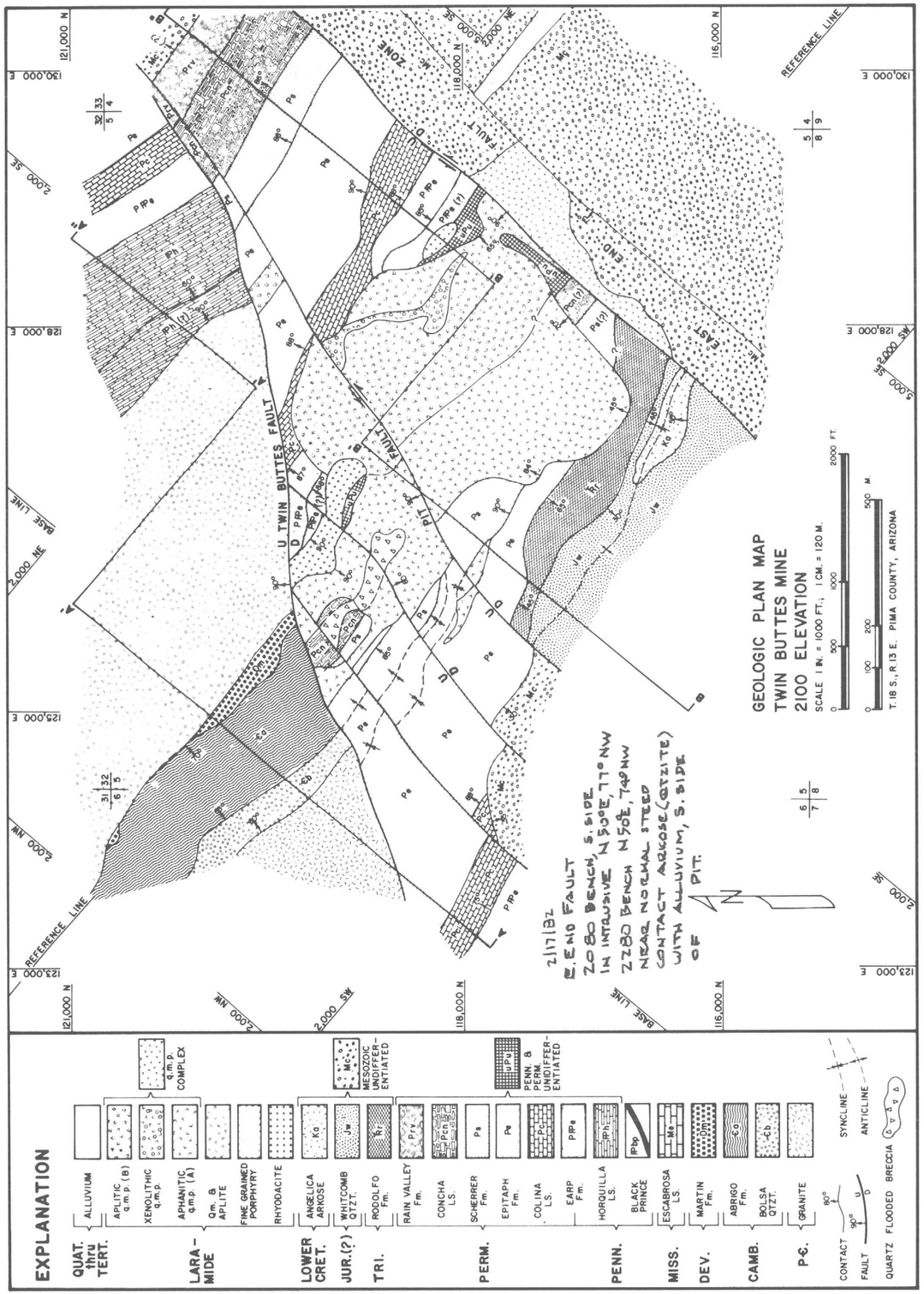


Figure 1

ANAMAX MINING COMPANY — TWIN BUTTES
OXIDE PLANT

In 1975 the Oxide Plant was placed into operation. All oxide copper ores are from the Twin Buttes open pit and are normally stockpiled before being processed by the plant. To leach the copper from the ore requires large quantities of sulfuric acid (1,000 tons per day). While leaching copper into solution small quantities of uranium are also leached into solution. A plant to extract this uranium was placed into operation in 1980.

CRUSHING PLANT — GRINDING AND LEACHING

The ore is moved by truck from stockpile and is first crushed in a jaw crusher (48" x 60"). The crushed material is then sent to one Symonds standard cone crusher (7') and two Symonds shorthead crushers (7') for further size reduction. After screening, the ore is one-half inch in size and is placed in storage prior to grinding and leaching.

There are two grinding sets consisting of one rod mill (11½" x 18½") and followed by one ball mill (12½" x 30'). The ore is ground very fine and is .008 inches (65 mesh) in size. The ground ore is sent to eight large agitated leach tanks (30' diameter) where the ore is mixed with sulfuric acid and the oxide copper mineral (chrysocolla) is leached and the copper and uranium go into solution. The material from the leach circuit is sent to the countercurrent decantation circuit.

COUNTERCURRENT DECANTATION — COPPER SOLVENT EXTRACTION

To clarify and separate the pregnant copper bearing solution from the leached solids, four 400-foot diameter thickeners are used. The clear solution overflows from the thickeners and flows countercurrent to the solids flow which finally discharges to the tailing ponds. The pregnant copper solution flows through two additional 400-foot diameter thickeners for additional clarification prior to going to the copper solvent extraction circuit.

The copper solution from the last clarifier passes through the Uranium Plant where uranium is extracted and then proceeds to the copper solvent extraction circuit. In the solvent extraction circuit the contained copper is concentrated and purified before going to the Electrowinning Plant. To accomplish this there are two solvent extraction trains of mixers and settlers. There are four extraction stages in each where copper is extracted into a kerosene phase with an extractant leaving behind undesired metals. There are two stripping stages where copper is stripped from the kerosene phase and placed back into solution in a purified form. This solution proceeds to the Electrowinning Plant where the copper is electrolytically deposited in a pure form.

ELECTROWINNING PLANT

The copper in the strong and purified solution is first deposited electrolytically onto titanium sheets for one day. After one day the thin pure sheets of copper are removed from the titanium blanks and placed back into the electrolytic cells where additional copper is electrolytically deposited onto it for an additional seven days. The pure copper (cathode copper at 99.9 percent purity) is removed from the electrolytic cells, washed and prepared for shipment. Because of the purity of the copper it is shipped to manufacturers who produce copper products.

URANIUM PLANT

As copper is leached into solution so are small quantities of uranium. Prior to the copper solvent extraction stage the solution is passed through uranium extraction columns. The six, 12-foot diameter absorption columns have small organic beads that selectively absorb uranium from the solution as it passes through the columns. Once a portion of the resin is loaded with uranium it is sent to one of three 6-foot diameter elution columns where the uranium is stripped from the beads using strong sulfuric acid. The beads are then reused.

The uranium contained in the sulfuric acid solution is strengthened and purified by using a single solvent extraction train. This train consists of four extraction stages, one scrubbing stage, and three stripping stages. Ammonia is added to the strong uranium solution and a yellow precipitate is formed (ammonium diuranate or yellow cake). The yellow cake precipitate is thickened, centrifuged, dried in a 4-hearth dryer and placed in 55-gallon drums for shipment.

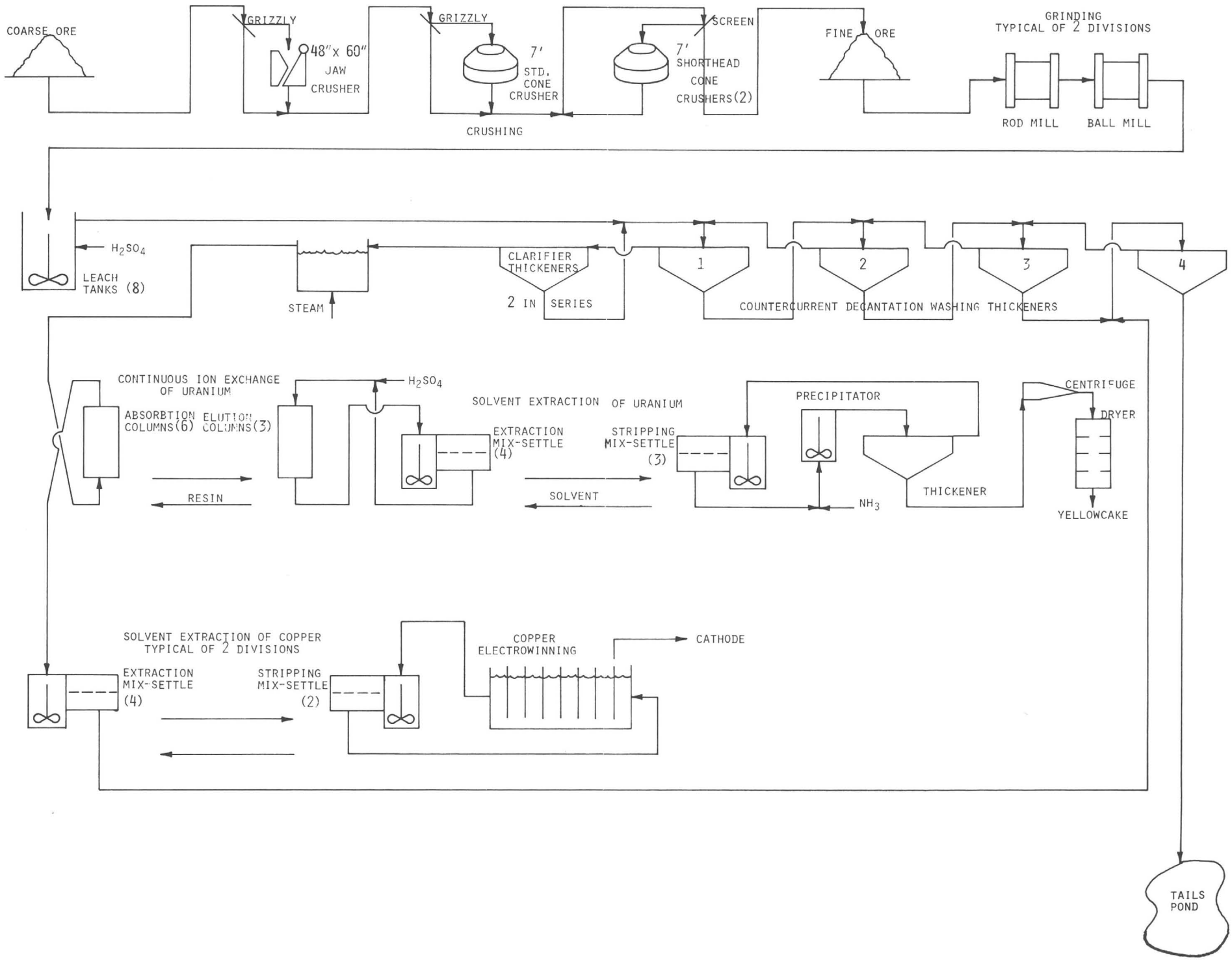


Figure 2

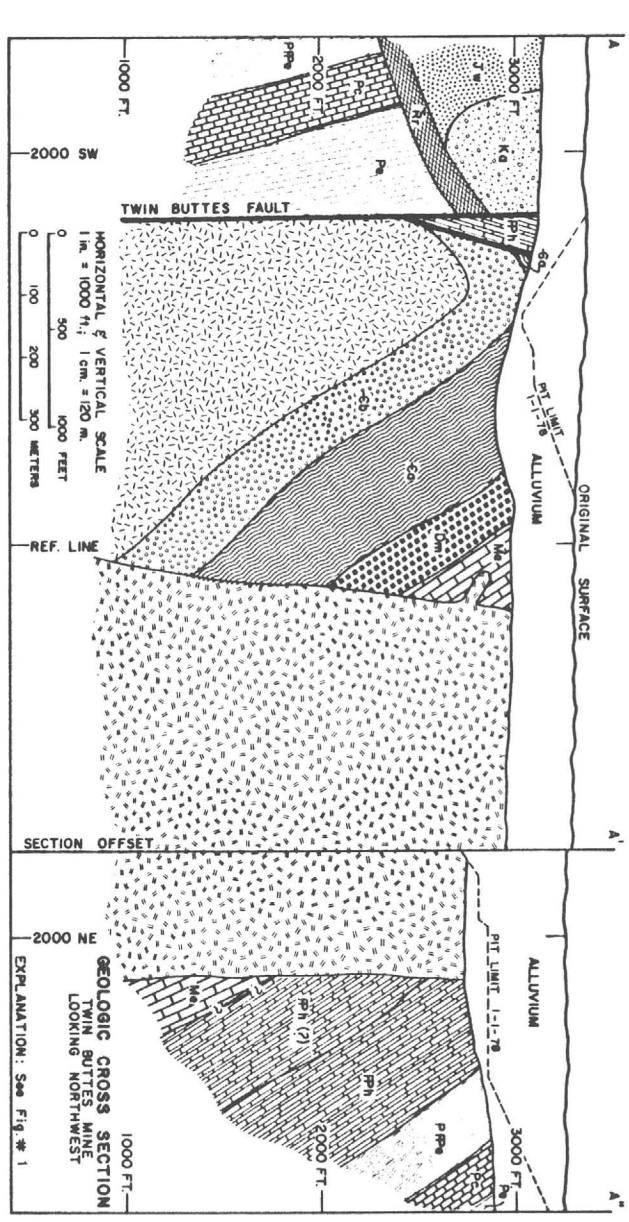
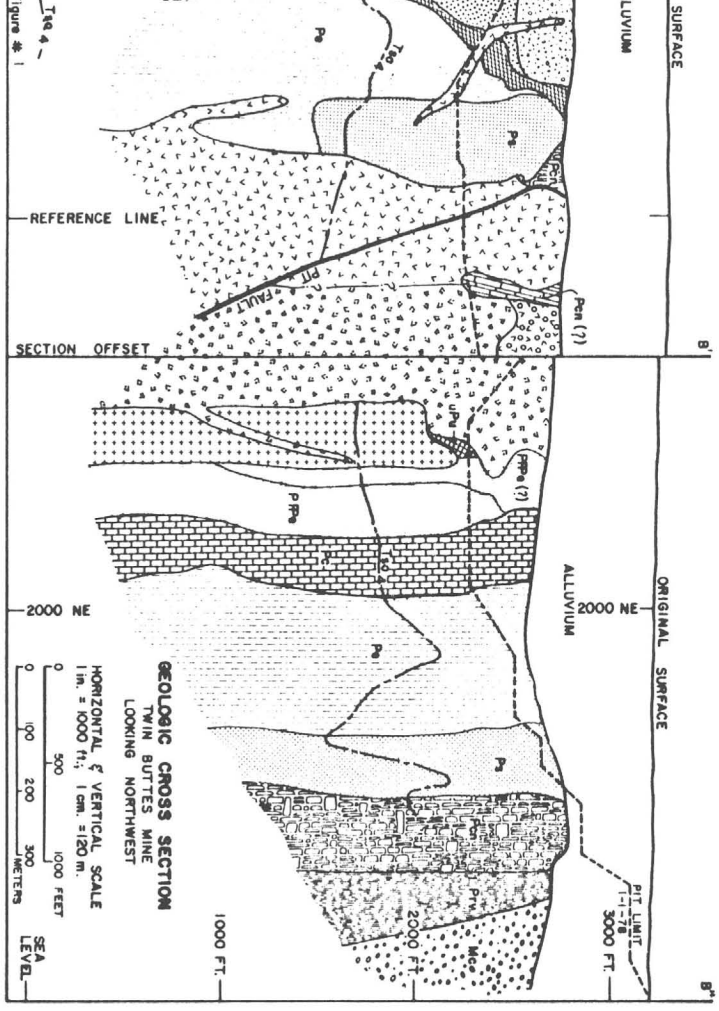
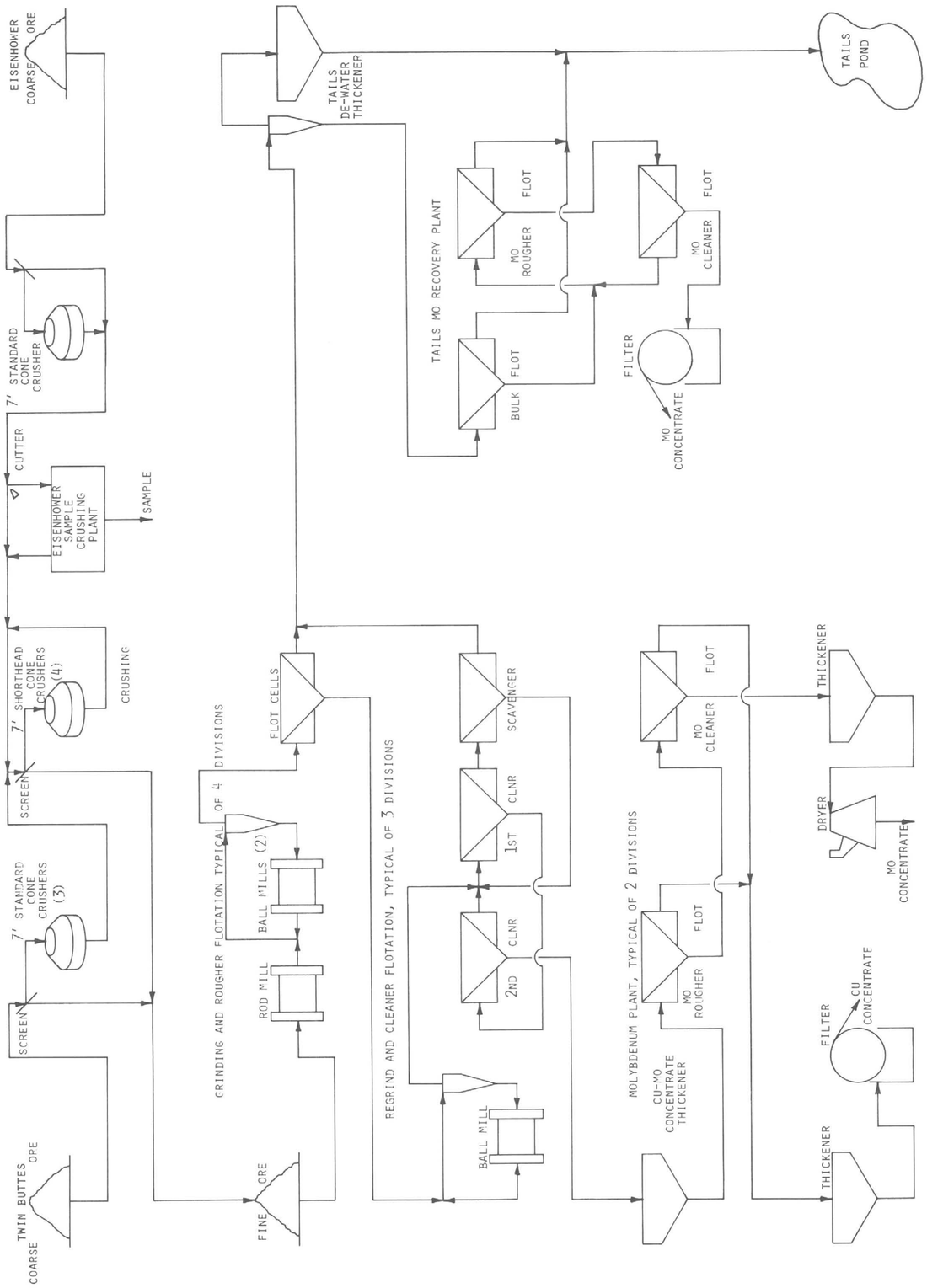


Figure 3





ANAMAX MINING COMPANY — TWIN BUTTES

SULFIDE PLANT

In the fall of 1969 the Sulfide Plant was placed into operation. The original plant processed 30,000 tons of ore per day but an expansion in 1974 raised the capacity to 40,000 tons. Ore from the Twin Buttes pit is supplemented by ore from the Eisenhower mine. The Eisenhower Mining Company, a partnership between Anamax and ASARCO Inc., was formed in 1976. Fourteen thousand tons per day of ore are transported from the Eisenhower mine to Twin Buttes by means of a 6.4 mile Cable Belt conveyor.

CRUSHING PLANT

There are two coarse ore storage piles, one for Twin Buttes ores and the second for Eisenhower ores. The ore in the Eisenhower stockpile is drawn from the bottom of the pile using feeders and conveyors and is sent to a single Symonds standard crusher (7'). After crushing, the ore is sampled in a sampling plant and then sent to join Twin Buttes ore for further crushing. Ore from the Twin Buttes stockpile is sent to three Symonds standard crushers (7') and then is crushed a second time, along with the Eisenhower ores, in four Symonds shorthead crushers (7'). Vibrating screens are used for product size control with the final product from the Crushing plant being one-half inch in size. This is stored prior to grinding in the Concentrator.

CONCENTRATOR

To liberate the desired copper sulfide mineral (chalcopyrite) from the host rock, the crushed ore is sent to four grinding divisions. Each division consists of a rod mill (14' diameter), the discharge of which is split to two ball mills (14'6'' diameter). The product size from the four division grinding sections is fine at 0.008 inches or 65 mesh when it is sent to the flotation section.

In the flotation machines (10') a froth is formed by adding air and reagents. The desired copper sulfide mineral is selectively brought into the froth and separated from host rock. The host rock remains in the flotation cell as a tailing. This is done once in the four rougher flotation sections, ground a second time in a regrind ball mill (7'6'' diameter), and floated two additional times in the three cleaner sections. The final copper concentrate from the cleaning section is sent to the Molybdenum Plant for further processing.

MOLYBDENUM PLANT

In the Concentrator, molybdenum sulfide (molybdenite) floats together with the copper sulfides. In the Molybdenum Plant, additional reagents are added which allow the molybdenum sulfides to float in the flotation machines (48'') but the copper sulfides remain in the machines as tailings. There are two divisions, each consisting of the first stage rougher flotation and seven stages of cleaner flotation. The final molybdenum product from the cleaner section is dried and placed in 55-gallon drums and sold to consumers. Most molybdenum is used in making alloy steels.

FILTER PLANT

The copper sulfides or tailing from the Molybdenum Plant are partially dewatered in thickeners (130') and then further dewatered using three drum filters (12' x 18'). The final copper sulfide product has less than 12 percent moisture and is shipped by rail elsewhere for copper smelting.

TAILING TREATMENT PLANT

The tailing from the Concentrator still retains minor amounts of molybdenum sulfide which are recovered at the Tailing Treatment Plant. The tailing from the Concentrator is first passed through cyclones (26'') to separate the coarse from the slime fractions. The coarse material is then floated for molybdenum using two large bulk flotation machines (1,000 ft.^{3}). The concentrate from these machines is sent to one stage molybdenum rougher and six stages of molybdenum cleaner flotation. The final product is filtered and barreled in 55-gallon drums for shipment to consumers.

GENERAL SUMMARY

(Feb 1964)

TWIN BUTTES

	TONS	% Cu	% Mo
NW AREA	44, 461,000	0.66	0.033
SE AREA			
UPPER (TO 1468')	32, 780, 100	1.34	0.051
LOWER TO +3000'	44, 364, 300	0.94	0.058
NE AREA			
UPPER	10,070 7, 150, 000	+ 1.00 0.63 } 0.88	0.035 0.135 } 0.068
LOWER (TO 2316)	3, 520, 000		
	132,275,400 T	0.94 Cu	0.049 Mo.

		TONS	SUL Cu.	
PALO VERDE.		59, 862, 000	0.63	(to 2400 Elev.)
THOMPSON.		13, 722, 000	1.43	
MILLAR (pit)		64, 000, 000	0.65	0.017 Mo
TWIN BUTTES		132, 275, 400	0.95	0.049 Mo
E. HELVETIA	OX	14, 845, 000	0.81 T − 0.520x	——— Mo.
	SUL.	7, 280, 000	0.88	0.029 Mo.
W. HELVETIA THOMPSON	? SULPHIDE	13, 744, 200	0.78	(prob. part oxide)
	OXIDE	9, 701, 000	0.72	OXIDE
		23, 445, 200	0.76	

TWIN B.	132, 275, 400
P. V.	64, 000, 000
E. HELV.	7, 280, 000
	203, 555, 400 @ ± 0.85 ± 0.030

Fel 1964

NE BLOCK

AROUND 648 - 665

UPPER BLOCK.

648	811-1481 =	670 ft.	1.53 Cu —	0.035 Mo
665 ±	824-1585 =	761 ft.	no assays.	
		1431		
		715		

$$\frac{715 \times \overset{50}{\cancel{600}} \times 200}{12} = 7,150,000 \text{ T.}$$

@

+ 1.0% — 0.035 Mo

715
×10000
7,150,000

LOWER BLOCK

648	1787-2316 =	529'	— 0.63 Cu — 0.135 Mo

$$\frac{\overset{44}{529} \times 400 \times 200}{12} = 3,520,000 \text{ T.}$$

@

0.63 Cu — 0.135 Mo.

17600
200
3,520,000

October 26, 1964

Mr. V. D. Perry
Vice President and Chief Geologist
The Anaconda Company
25 Broadway - Suite 1850
New York, N.Y. 10004

Dear Mr. Perry:

The enclosed preliminary ore reserve figures for the Twin Buttes area have been calculated by Mr. Kelly to give an idea of ore tonnages available for possible open pit and underground mining. The calculations were made from sections, and do not include the area around DDH 665. Completion of underground work from the shaft now being driven will permit more accurate estimates to be made on plan maps.

Yours very truly,

Roland B. Mulchay

RBM:S
Encl.
cc-Mr. J. L. Kelly

COPY

OCT 22 1964

THE ANACONDA COMPANY

151 South Tucson Blvd. — Room 221
Tucson, Arizona

Geological Department
Southwestern Office

October 19, 1964

Mr. Roland B. Mulchay, Asst. Chief Geologist
The Anaconda Company
809 Kearns Building
Salt Lake City, Utah

Dear Mr. Mulchay:

We recently made a preliminary ore reserve estimate for the Twin Buttes Area, Pima County, Arizona, for sulfide and oxide copper ore on the southwest side of the quartz monzonite porphyry. This estimate does not include any tonnages in the DDH A-698 area or the DDH A-665 area. A tabulation of tonnages and grades as described below is attached hereto.

The reserves were calculated from the geologic cross sections. A "cut-off" point of 0.40% total copper was used for both sulfide and oxide ore. However, in a few instances, intervals of less than 0.40% total copper were included to take advantage of high molybdenum averages.

Volumes were converted to tons with a factor of 11.74 cubic feet per ton. This factor is used by the New Mines Department and was determined by American Smelting and Refining Company to be the average factor for the Mission orebody in rocks similar to those at Twin Buttes.

Separate estimates have been made for sulfide and oxide copper ore tonnages in the Southeast and Northwest Areas. Tonnages in the Southeast Area include ore southeast of the northeast fault zone from Section 200 SE to Section 3000 SE. Tonnages in the Northwest Area are northwest of the northeast fault zone extending from Section 400 SE northwest to Section 1600 NW.

Sulfide ore estimates in the Southeast Area are reported for tonnages above the approximate 1800-ft. elevation, or about 1500 feet below surface, and tonnage below the 1800-ft. elevation. In addition, sulfide ore above the 1800-ft. elevation is divided into ore in arkosic and pyroclastic rocks overlying limestones, siltstones and quartzites on the southwest side, and ore in limestone, siltstones, quartzites and quartz monzonite porphyry underlying and northeast of the arkosic and pyroclastic rocks. Total tonnages also are shown for all sulfide ore above the 1800-ft. elevation and all sulfide ore in the Southeast Area.

Sulfide ore tonnages in the Northwest Area are reported for the main ore body extending from Section 400 SE to Section 1200 NW, and a small, low-grade ore block at Section 1600 NW as well as the total of these two tonnages. Sulfide ore in the Northwest Area is projected to a maximum depth of approximately the 1650-ft. elevation. A total sulfide ore tonnage therefore is given for the Northwest Area and Southwest Area above the approximate 1800-ft. elevation. The tabulation also shows the combined total tonnage of all sulfide ore in the Southeast and Northwest areas.

Oxide copper ore in the Southeast Area is divided into two classes; ore in siliceous rocks (arkose, pyroclastics, quartzite, and quartz monzonite porphyry) which may be amenable to acid leaching, and ore in altered limestone and siltstone. All oxide ore in the Northwest Area is in altered limestone and argillite. Total for both classes of oxide ore in the Southeast Area, total oxide ore in altered limestone, siltstone, and argillite for the Northwest and Southeast areas and total of all oxide ore are reported in the oxide ore tabulation.

Respectfully submitted,

James L. Kelly

James L. Kelly

JLK:je

Encl.

TWIN BUTTES AREA

Ore Reserve Estimate as of October 15, 1964

Northwest and Southeast Areas on South Side
of Quartz Monzonite porphyry Intrusive

SULFIDE ORE

	Tons	% Total Cu	% Mo
Southeast Area			
Ore above approximate 1800-ft. elevation:			
Ore in arkosic and pyroclastic rocks overlying limestones, siltstones, and quartzites on Southwest side	14,187,950	0.62	0.020
Ore in limestones, siltstones, quartzites and quartz monzonite porphyry underlying and northeast of arkosic and pyroclastic rocks	59,280,180	1.19	0.066
Total ore above approximate 1800-ft. elevation	73,468,130	1.08	0.057
Ore below approximate 1800-ft. elevation	78,483,810	0.80	0.049
Total all sulfide ore - Southeast Area	151,951,940	0.94	0.053
Northwest Area			
Main orebody (Section 400 SE northwest to Section 1200 NW	49,294,070	0.65	0.032
Ore block at northwest end at Section 1600 NW	2,507,660	0.47	0.016
Total sulfide ore - Northwest Area	51,801,730	0.64	0.031
Total Sulfide Ore - Southeast Area above approximate 1800-ft. elevation and Northwest Area	125,269,860	0.90	0.046
Total All Sulfide Ore- Southeast and Northwest Areas	203,753,670	0.86	0.047

TWIN BUTTES AREA

Ore Reserve Estimate as of October 15, 1964

Northwest and Southeast Areas on South Side
of Quartz Monzonite Porphyry Intrusive

OXIDE ORE

	Tons	% Total Cu	% Oxide Cu
Southeast Area			
Oxide ore in siliceous rocks (arkose, pyroclastics, quartzite, quartz monzonite porphyry)	15,787,630	0.59	0.35
Oxide ore in altered limestone and siltstone	9,894,540	0.95	0.68
Total Oxide Ore - Southeast Area	25,682,170	0.73	0.47
Northwest Area			
Total oxide ore all in altered limestone and argillite	22,693,460	0.61	0.42
Total Oxide Ore - Northwest and Southeast Areas - in altered limestone, siltstone and argillite	32,588,000	0.71	0.50
Total All Oxide Ore - Northwest and Southeast Areas	48,375,630	0.67	0.45