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

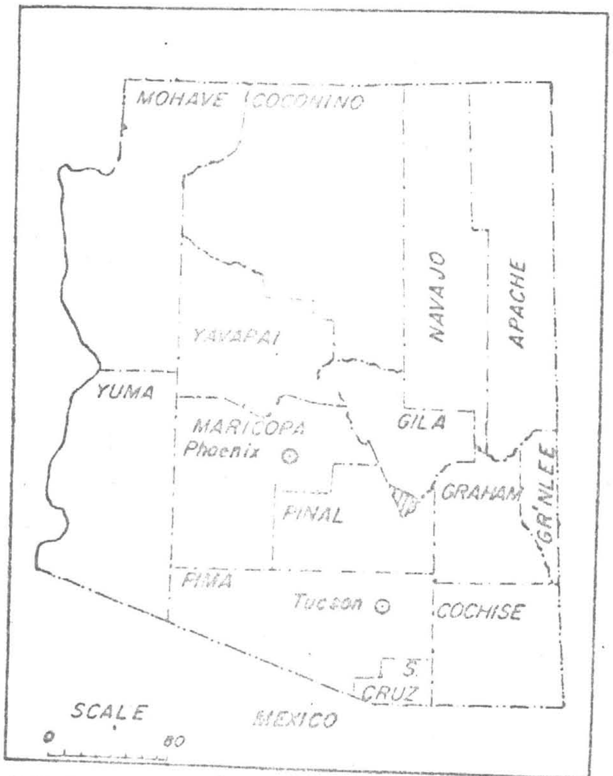


FIG. I — Index Map showing location of Banner Mining District, Arizona. (Shaded area)

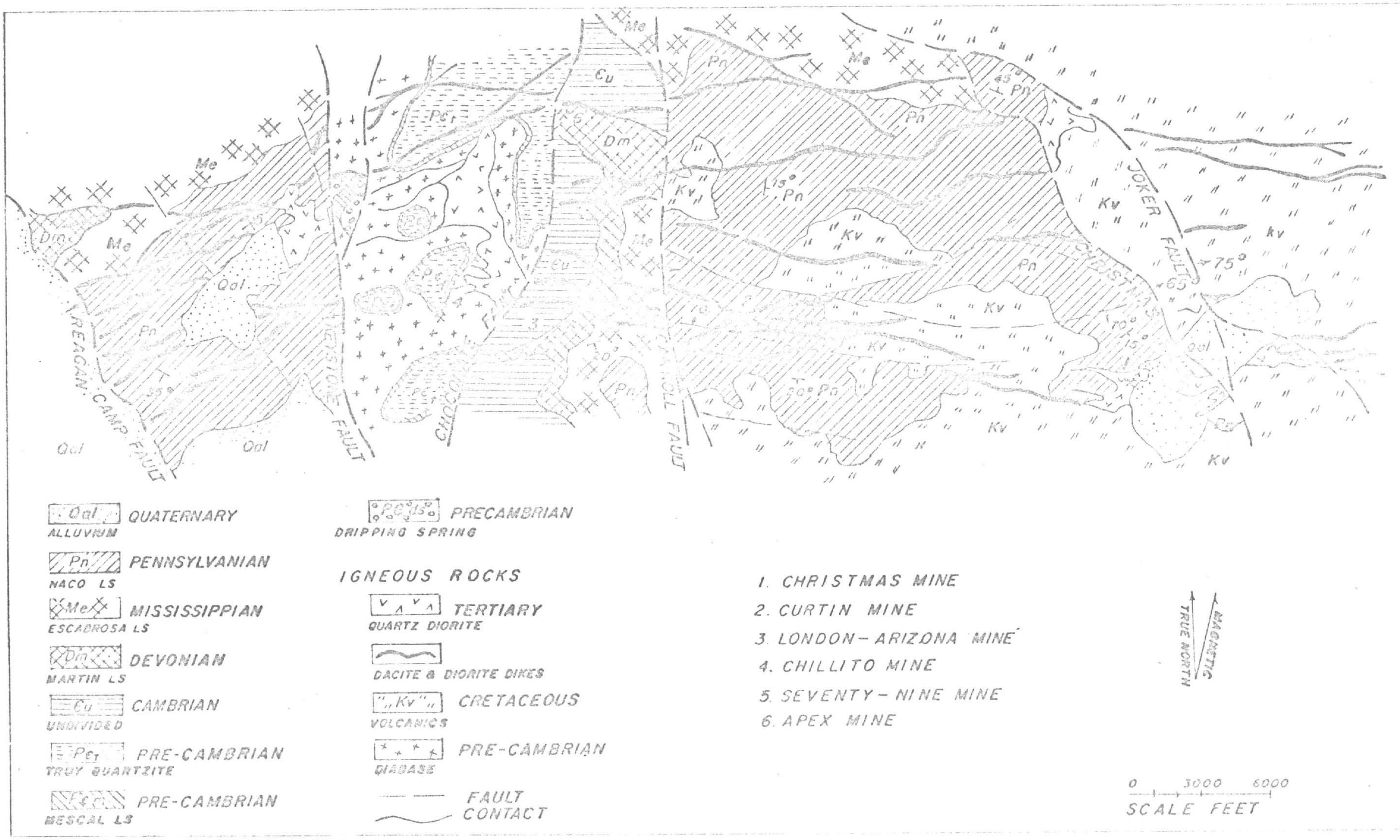


FIGURE 2.—Generalized geologic map of part of the Banner mining district, Arizona

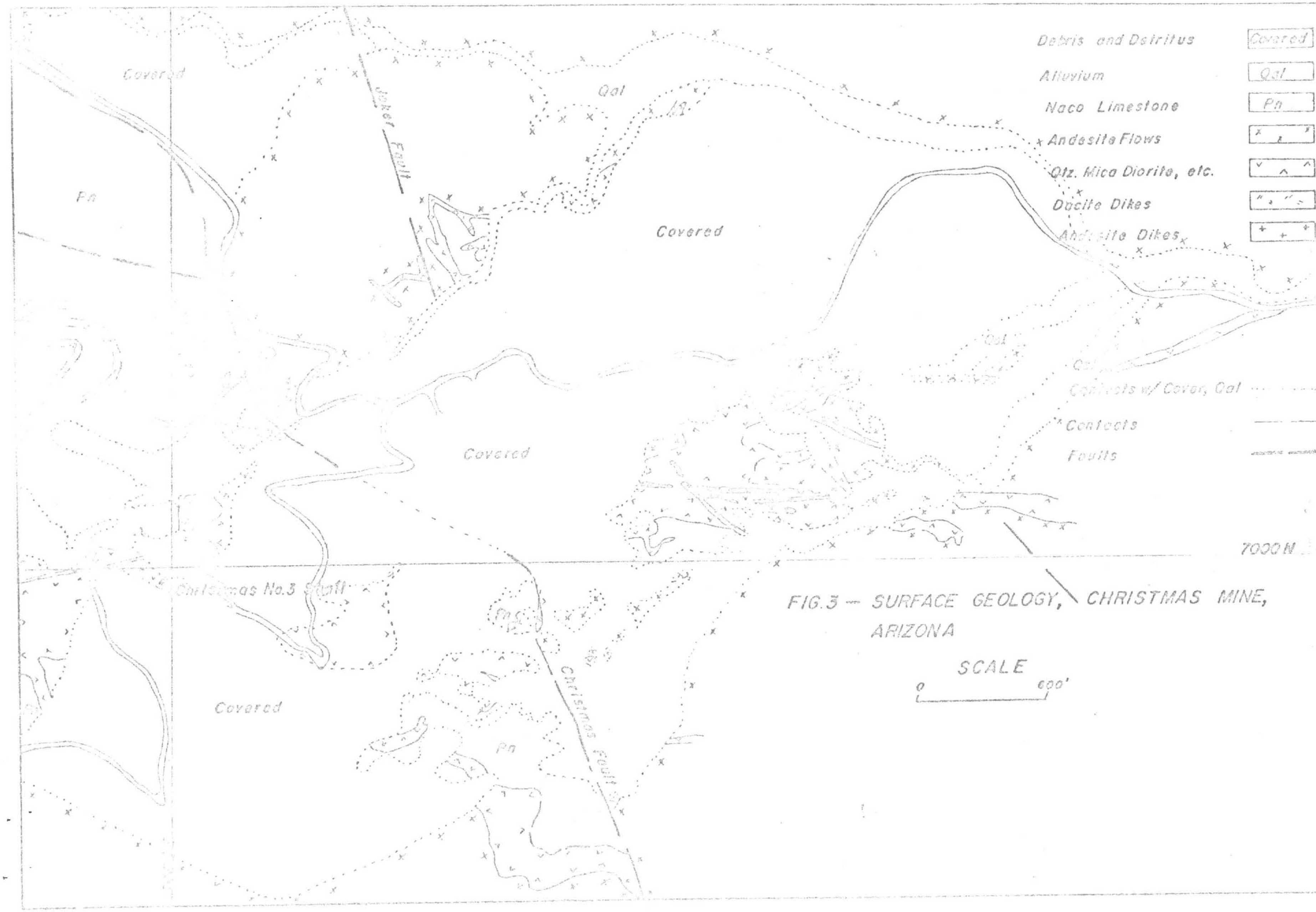
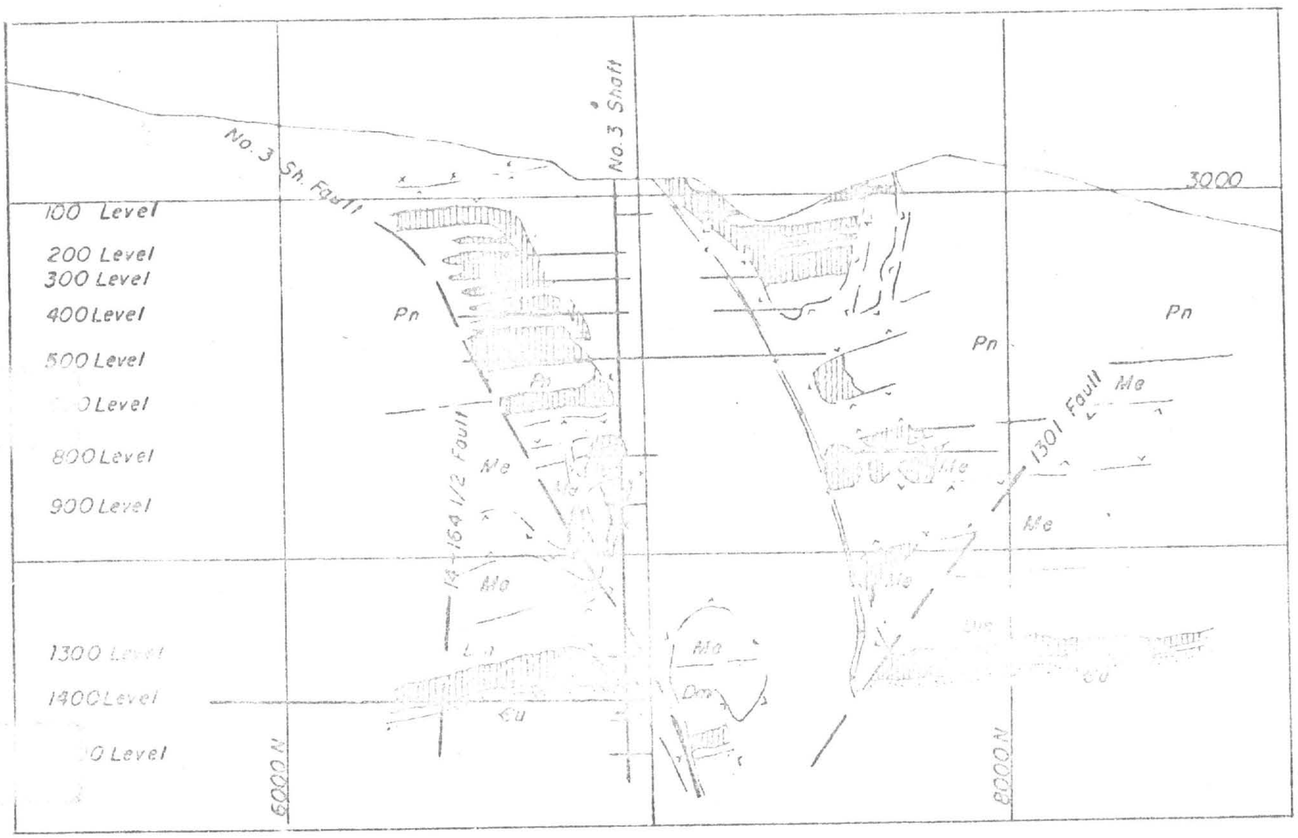


FIG. 3 — SURFACE GEOLOGY, CHRISTMAS MINE, ARIZONA

...STMAS MINE, ARIZONA

FIG. 4-- ... MAP OF LOWER LEVELS

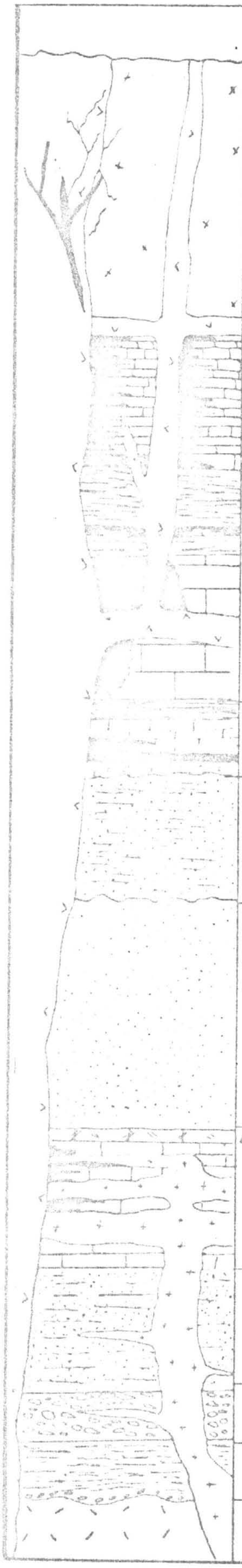


x x x	Andesite Flows	—+—	Workings
Pn	Naco Ls.	— —	Faults
Me	Escabrosa Ls.	— —	Contacts
Dm	Martin Ls.		
Cu	Undifferentiated Cambrian Sediments		
	Mineralization		
	Qtz. Mica Diorite, etc.		
+ +	Andesite Dikes		

CHRISTMAS MINE, ARIZONA

FIG. 5 — NORTH-SOUTH SECTION 16400E, LOOKING WEST

SCALE 0 — 500'



Alluvium			TERT.	
Andesite Flow	Christmas		CRETACEOUS	MESOZOIC
Sill Pinnacle Series J Series K Series L Series Las Novias Series M Series	Christmas 79 Curtin Reagan Camp	Naco Limestone	PENN.- PERM (?)	PALEOZOIC
Upper Escabrosa Sill Lower Escabrosa	Christmas Santa Monica [illegible]	Escabrosa Limestone	MISSISSIPPIAN	
Hornfels O'Carroll Bed	Christmas, London-Arizona, Apex	Martin Limestone	DEV.	
Unconformity Unconformity		Cambrian Rocks Undivided	CAMBRIAN	
		Troy Quartzite	PRE-CAMBRIAN	PROTEROZOIC
Basalt	Chilito Reagan Camp	Mescal Limestone		
		Dripping Springs Quartzite	APACHE GROUP	
		Barnes Congl.		
		Pioneer Shale		
		Granite or Schist		

FIGURE 6.—Correlation of major rock units and ore zones, Banner minning district, Arizona

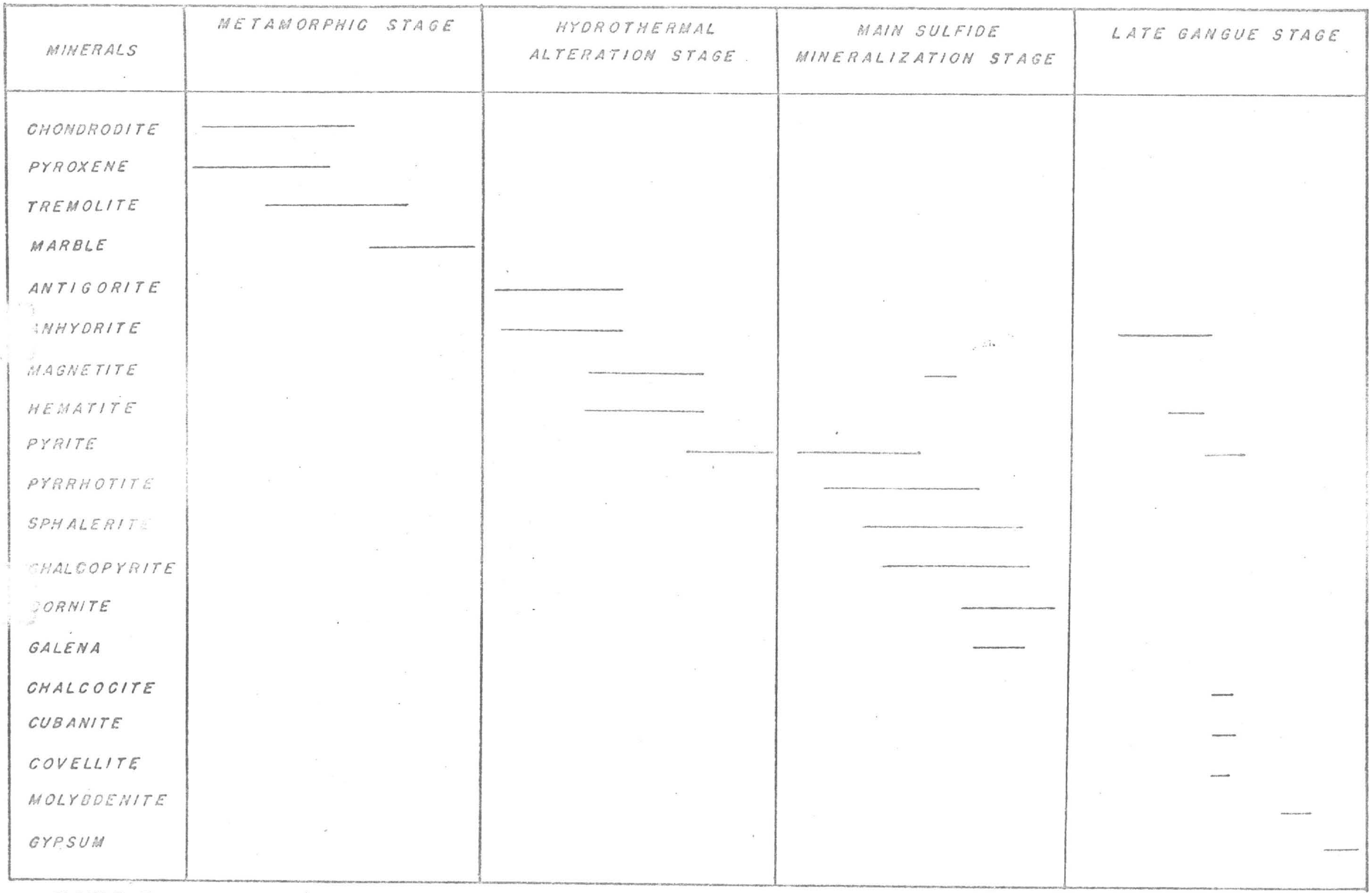


FIGURE 7.— PARAGENESIS OF MINERALIZATION AND ALTERATION IN THE LOWER MARTIN FORMATION

GEOLOGY OF THE CHRISTMAS MINE AND VICINITY,

BANNER MINING DISTRICT, ARIZONA

BY

JOHN T. EASTLICK

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ABSTRACT

The Banner mining district is about 70 miles northeast of Tucson in the southern part of Gila County, Arizona. Production from the district, valued at about $26 million, is chiefly from copper-silver-lead zinc ores.

The stratigraphic section consists of Precambrian conglomerates, quartzites, dolomites, and limestones, Cambrian quartzites; Devonian limestones, dolomites, and shales; Mississippian limestones; Pennsylvanian limestones and shales; and Cretaceous volcanic and sedimentary rocks. Deformation of these rocks presumably started near the end of the Cretaceous, and extended into the late Tertiary. The sedimentary rocks were folded, faulted, and intruded by fine grained diorite, quartz mica diorite, and dacite porphyry.

At least four distinct stages of mineralization are recognized. In the first stage of contact metamorphism and the second stage of hydrothermal alteration, favorable zones were prepared for ore deposition. Metallization occurs in three of the mineralizing stages. Magnetite, pyrite, and hematite were deposited near the end of the hydrothermal stage. The third stage includes the main deposition of sphalerite, chalcopyrite, bornite, and galena. In the fourth and final stage, minor amounts of sulfide minerals are associated with a late anhydrite and quartz gangue.

The ore deposits in the form of veins and veinlets, pipes, irregular massive replacements, and bedded replacements are localized by the extent and distribution of metamorphic and hydrothermal alteration, by the proximity to the intrusive contacts, and by the effects of structural development.

Oxidized ores of copper, lead, and zinc constituted the principal production of the district prior to 1940; (but for the most part,) supergene enrichment was of minor economic importance.

The ore bodies of the district are in the mesothermal class of deposits, occurring as normal metasomatic replacement and vein types.

INTRODUCTION

The Banner mining district (as shown by figure 1) is in the southern part of Gila County, Arizona, about 70 miles northeast of Tucson and (100 miles east of Phoenix.) Nearby major mines include those at Ray and Superior, respectively 16 and 27 miles to the northwest; those in the Globe-Miami district, 25 miles to the north; and those at San Manuel, 26 miles to the south.

Hayden and Winkelman, the only towns in the district, are located about one mile apart at the southern end. For livelihood these towns depend largely on the operations of the copper-treating facilities of the Kennecott Copper Corporation, and the American Smelting and Refining Company. They also serve as centers for an extensive cattle raising and farming industry. State Highway 77 connects the district with Tucson, 70 miles to the south, and with Globe, 25 miles to the north. (Westward from Winkelman, State Highway 177 extends to Superior where it joins U. S. Highway 60-70.) Secondary roads from the main highways lead to the various mines and prospects in the district.)

A branch of the Southern Pacific Railroad connects Winkelman and Hayden with the main line of the system at Florence, Arizona.

HISTORY AND PRODUCTION

Most of the ore deposits in the Banner mining district were discovered in the late 1870's and early 1880's, but little ore was produced until after 1900. In the early years of production, the isolated location of the district together with unstable economic conditions contributed to the difficulty of maintaining a steady or profitable operation for any length of time.

The total value of mineral production from the district to 1964 is about $26 million. Copper is the principal metal produced followed by lead and zinc. Gold ore has been mined from the several places, and both gold and silver are recovered as by-products from the copper, lead, and zinc ores. Minor amounts of vanadium have also been found in several prospects. Most of the copper ore deposits are uniform in grade, averaging between one to four per cent of copper, but local occurrences of oxidized ore containing up to 18 per cent copper were mined in the past. The greater portion of the lead produced came from bodies of oxidized lead ore. These ores were generally of high-quality, containing from 22 to 24 per cent lead and from 4 to 5 ounces of silver. Production of zinc was mainly from sulphide ores, but several shipments of high grade zinc carbonate ore are recorded. The gold ore found was rich but the bodies were small and pockety.

The Christmas mine is the largest in the district, and is the only mine operating at the present. Discovered in 1880, the mine is credited with a total production through 1963 of 2,370,700 tons of ore which has yielded 89,354,300 pounds of copper. Inspiration Consolidated Copper Company owns and operates the mine as its Christmas Division.

Notable amounts of ore have been produced from other mines in the district. Total production from the Seventy-Nine mine is valued between $3 to $4 million (Kiersch, 3, p. 66). The Chillito mine is credited with a production of $1,250,000 during World War I, and the London-Arizona mine has a recorded production of $1,050,000 between 1912 and 1928 (Dunning, 2, pp. 359, 368).

Production statistics for the Banner mining district for the years 1905 through 1963 are listed below in Table I.

TABLE I - Gold, silver, copper, lead and zinc production

in the Banner mining district 1905-1963

Years		Gold (Ounces)	Silver (Ounces)	Copper (Pounds)	Lead (Pounds)	Zinc (Pounds)	Value (Dollars)
1905-1949	(1)	22,689	702,786	68,973,911	34,284,199	4,593,733	$15,877,996
1950	(2)	257	6,130	1,352,200	59,200	2,500	304,148
1951		256	10,932	1,658,600	128,000	20,000	446,019
1952		149	7,720	1,359,400	63,100	51,500	359,920
1953		110	4,215	1,252,000	8,500	-	368,102
1954		152	5,153	1,465,400	-	-	442,277
1955		-	129	70,000	12,000	1,788	28,052
1956		3	293	241,400	-	-	102,965
1957		2	522	365,200	34,300	-	115,372
1958	(3)	-	-	254,559	-	-	43,833
1959	(4)	-	-	1,121,398	-	-	302,349
1960		-	-	334,794	-	-	151,669
1961		-	-	331,016	-	-	82,920
1962		-	-	4,465,319	-	-	1,654,337
1963		-	-	20,232,893	-	-	6,272,197

(1) Data for the years 1905-1949 compiled by J. W. Anthony from Minerals Resources of the U. S. and U. S. Minerals Yearbooks; published by Arizona Bureau of Mines as totals for district, Bulletin No. 158, 1951, p. 66.

(2) Data for the years 1950-1957 taken from U. S. Bureau of Mines Minerals Yearbooks.

(3) Production figures from 1958 to 1963 furnished by G. Wainwright, lessee of Chillito mine. Pounds of copper paid for by smelter. Published with permission.

(4) Production figures for years 1959, 1962, and 1963 include copper produced by the Christmas mine. Adjusted from net smelter returns. Published with permission.

PHYSIOGRAPHIC HISTORY AND PRESENT TOPOGRAPHY

The Banner mining district is in the southeastern part of the Dripping Springs Mountains, a northwest trending fault-block mountain range. The Dripping Springs range is aligned with the Pinal Mountains to the northeast and with the Tortilla Mountains to the southwest. Structural valleys separating these ranges are deeply filled with lacustrine and fluviatile deposits.

Drainage patterns are strongly reflective of a complex fault system. Strong fault zones with northwesterly trend show evidence of recent movement along the flanks of the range, and other major faults with northerly alignment form prominent drainage features in the O'Carroll, Chocolate, and Keystone Canyons. Further geomorphic influence is shown by the smaller subsidary faults and fractures, and by the character of the different rock formations.

The highest point in the district is Tam O'Shanter Peak at an altitude of 4639 feet above sea level. The lowest point is near Winkelman on the Gila River at an elevation of about 1950 feet. The mountainous area is rough and rugged with the surface dissected by many steep-sided gulches and canyons. Generally the higher points are capped by the harder, more resistant sedimentary formations, forming cliffs where the drainage has cut through into the softer beds below. Few flat upland areas remain.

The Gila River forms the southeastern boundary of the district where the channel cuts deeply into volcanic and sedimentary rocks. The riverbed ranges from a few hundred feet wide in its narrowest parts to more than a thousand feet in width at its confluence with the larger drainages of the area.

GEOLOGIC HISTORY

Stratigraphic Column

The southern part of the Dripping Springs Range is comprised of tilted, folded, and faulted blocks of sedimentary and volcanic rocks. Rock units range in age from Precambrian through Cretaceous, exceeding 6000 feet in total thickness.

Pre-Cretaceous sedimentary rocks, with the exception of the thick basal Cambrian and Precambrian quartzites, are largely of marine origin, consisting of limestone, dolomite, and shale.

The Cretaceous sequence include pyroclastic deposits and flows of basalt and andesite. Sedimentary beds occur at several places in the section but little is known of their extent or exact stratigraphic position.

The Precambrian Apache series (are) intruded by sills and irregular bodies of diabase. In turn all of the rocks through Cretaceous in age are intruded by sills, plugs, dikes, and stocks of diorite and quartz mica diorite, and by dikes of later age of dacite, andesite, and basalt. Details of stratigraphy, thickness and character of the rocks exposed throughout the district are summarized below.

Series	Formation	Thickness (in feet)	Character
Recent	Alluvium	100±	Gravel, sand, silt, clay, talus, and fanglomerate
			Unconformity
Tertiary	Gila Conglomerate	900±	Interbedded conglomerate, basalt, gravel, sand, sandstone, and gypsum, consisting of steam channel alluvium and lakebeds.
			Unconformity
Tertiary	Dikes		Narrow, generally N 5°- 25° W - trending olivine basalt dikes.
	Dikes		Hornblende andesite dikes trend generally N 50° - 60° E to east-west.
	Dikes		Dacite prophyry dikes - trend generally east-west, intruding diorite bodies and sedimentary rocks.
	Breccia dikes		Narrow dikelike bodies of injection breccia with quartzite and shale fragments in a matrix of comminuted quartz or diorite.

Series	Formation	Thickness (in feet)	Character
	Stocks, plugs, dikes, and sills		Intrusive bodies of quartz hornblende diorite, quartz biotite diorite, quartz monzonite porphyry, and granite porphyry.
Cretaceous and/or Tertiary	Aplite dikes and irregular masses		Irregular silicious dikes consisting of microcrystalline quartz and feldspar. Quartz mica diorite intrudes these these bodies.
	Stocks, plugs, dikes, and sills		Fine grained diorite
Unconformity			
Cretaceous	Unnamed	2000' - 3000' 5' - 10'	Andesite, basalt, and pyroclastic rocks with intercalated shale and limestone 5' to 10' conglomerate at the base of andesites near Christmas. Thickens to +1000' to the southeast into a sedimentary sequence of conglomerate, siltstone, sandstone, and shale.

XERO COPY XERO COPY XERO COPY XERO COPY

Series	Formation	Thickness (in feet)	Character
Unconformity			
Pennsylvanian	Naco formation (Upper member)	400±	Thick-bedded, light to dark gray crystalline limestone with local chert nodules and thin shaly layers, containing abundant fusilinids.
	(Middle member)	500±	Thin to medium beds of limestone and shale, locally cherty, with abundant fossil fragments of crinoids, brachipods, and horn corals.
	(Lower member)	100±	Two beds of granular quartzite separated by thick bedded, gray, crystalline limestone in the upper 60 feet; fine to coarse grained crystalline limestone below with 5 feet of dark shale at the base.

Series	Formation	Thickness (in feet)	Character
Mississippian	Excabrosa formation	550±	Massive light gray, fine to coarse grained crystalline limestone; locally thin-bedded and cherty in the upper part.
Devonian	Martin formation (Upper member)	65±	Thin-bedded shaly limestone, argillaceous and calcareous shales.
	(Middle member)	170±	Massive, light gray, fine grained crystalline limestone with thin quartzite beds in the upper part.
	O'Carroll member	30±	Thin-bedded dolomite with interbedded limestone, shale, and shaly limestone at the base.
Unconformity			

Series	Formation	Thickness (in feet)	Character
Cambrian	Undivided	500	Calcareous and argillaceous quartzites with thin shales and limestone layers in the upper part; granular quartzite with thin shale partings; angular conglomerate at the bottom.
			Unconformity
Precambrian	Troy formation	900	Hard, dense quartzite and sandstone; pebble conglomerate at the base. Reassigned to Precambrian by Krieger (5).
			Unconformity
Precambrian (Apache Series)	Basalt flow	50-75	Vesicular and amygdaloidal basalt
	Sills and irregular bodies		Diabase of several textural and compositional variations; intrudes all the rocks below the Troy formation.
	Mescal formation	250±	Sandy dolomites, cherty limestone, and marble

Series	Formation	Thickness (in Feet)	Character
Precambrian (Apache Series)	Dripping Springs formation (Upper member)	75±	Tan to gray, fine grained, feldspathic quartzite; generally medium thick-bedded.
	(Middle member)	150±	Interbedded red-brown to gray quartzite and red shale
	(Lower member)	100±	Medium to thick bedded, gray to tan quartzite
	(Barnes Conglomerate member)	15-50	Well-rounded pebbles of quartzite and quartz in a matrix of arkosic sand. Reduced to rank of member. (Willden, 9, p.E 12)
	(Pioneer shale)	200±	Reddish-brown to purplish shales, siltstones, and sandy siltstones; characterized by numerous small oval greenish-gray spots.

Series	Formation	Thickness (in feet)	Character
	(Scanlon conglo-merate	5-10	Well-rounded pebbles of quartzite and quartz in a matrix of arkosic sand. Reduced to rank of member (Willden, 9, P. E 12).
Unconformity			
Precam-brian	Granite		Red to red-brown, coarse grained quartz monzonite; igneous rock similar in character and composition intrudes schist in the Tortilla Mountains to the south and in the Pinal Mountains to the north.

STRUCTURE

The strata of the Dripping Springs Mountains form a complexly faulted, asymmetical, southeasterly-plunging anticlinal structure. Other principal structural features include a well-defined belt of intrusive stocks, dikes, and sills, and a series of strong north to northwesterly-striking faults.

Sedimentary beds along the northeast side of the range have generally south to southeasterly dips of 10° to 30° and along the southwest side are tilted to the southwest with dips ranging between 20° and 40°. Superimposed along both sides of the range are numerous small folds and flexures. Compressive stresses are further reflected by local rolls in the bedding, minor thrust faults, and slips along the bedding planes.

There are undoubtedly several different periods of faulting, dating from Pre-Devonian through Tertiary in age. The existence of early zones of crustal weakness are shown by the several sets of generally east-west trending intrusive dikes of quartz latite, quartz mica diorite porphyry, breccia, dacite porphyry, and andesite (illustrated by figure 2). It is probable that these bodies intruded, in part, along previous existing structures, and it is evident that later post-diorite, pre-mineral, and post-mineral faulting followed the same trends. The faults of this east-west group strike from N 65° E to N 70° W and dip from 50° N to 60° S.

Another system of pre-mineral faults strike approximately N 15° E to N 50° E and dip generally 50° - 65° northwest. Other pre-mineral structures include a complementary group with northwest trends.

Along the trend of the east-west dikes, several small stocks are exposed in the areas of the principal mines (See Figure 2). The largest acidic intrusive body in the district is exposed north of the Christmas area, intruding the Cretaceous volcanics and extending to the northeast under the Tertiary gravels at the edge of the Dripping Springs Wash.

At the Christmas mine, the main quartz mica diorite body is cut and offset by the Christmas-Joker fault zone. The surface outcrop forms an irregular elliptically-shaped mass, measuring approximately 4000 by 2000 feet with the long axis trending about N 70° E. The west end narrows into several dikes with marked westerly trends. Four separate pre-mineral intrusive stages are recognized at Christmas. Coarse grained quartz mica diorite porphyry intrudes earlier fine grained diorite and aplite, and later east-west trending dacite dikes invades and cut the coarser textured dioritic bodies.

Other small stocks occur at the Seventy-Nine and Chillito mines. At the Seventy-Nine mine, the outcrop of the stock is largely covered by alluvium, and its size can only be approximated. The northeast end is well-exposed and scattered surface exposures indicate its dimensions to be about 3000 feet by 1000 feet with the long axis trending about No 65° E. Later dikes of pre-mineral quartz porphyry and post-mineral basalt intrude the main intrusive body.

The intrusive body at the Chillito mine, in contrast with the other dioritic stocks in the area, trends about due north along its long axis, forming an oval-shaped outcrop approximately 3300 feet by 1000 feet in the largest dimensions. Several dikes of dacite porphyry intrude the main body of quartz mica diorite.

The major north-northwest trending faults divide the Dripping Springs Mountains into several linear blocks. Along the northeast side of the range, the Christmas Joker fault is traceable for about 7½ miles and its continuation to the northwest is suggested by physiographic evidence. At the Christmas mine, Cretaceous volcanics are displaced downward in contact with the Naco formation of the footwall block (note Figure 3). Further to the north, Gila conglomerate, showing evidence of recent movement, is in fault contact with the older Paleozoic rocks. Total displacement along the Christmas-Joker fault zone is indicated to be more than 2500 feet with a normal downthrow to the northeast.

Along the southwest side of the range to the west of the Seventy-Nine mine, another northwest striking fault zone, known as the Reagan Camp fault, is exposed. Movement is normal with a downthrown block moving to the southwest.

Between these two northwest-striking faults are a series of strong north-trending faults. From east to west, these include the O'Carroll, the Chocolate, and the Keystone faults. All have normal movement. The O'Carroll and the Chocolate faults dip to the east with displacements of about 1200 feet and 1400 feet, respectively. The Keystone fault dips west with a total displacement of over 2000 feet. Displacements along the major north to northwest fault zones appear to be largely post-mineral, evidently the result of late structural adjustment of the gravity type.

Numerous narrow post-mineral olivine basalt dikes represent the youngest stage of igneous intrusion. These steeply-dipping dikes trend generally north to northwest, paralleling the strike of the regional block-faulting pattern.

Age of Mineralization

The sequence of geologic events leading up to the period of ore deposition is well-established. The hypogene ore deposits are younger than the fine grained diorite, the aplite, the quartz mica diorite porphyry, and the dacite porphyry. They are older than hornblende andesite and the olivine basalt. Two separate periods--that of hydrothermal alteration and that of ore deposition--are recognized between the dacite and andesite intrusions. Both of these periods appear to have a close genetic relationship to structural events following the emplacement of the dacite porphyry dikes.

what kind of dating?

Recently, an age determination of biotite from the quartz mica diorite intrusive in the Christmas mine was dated at 62 million years (Creasey and Kistler, 1, p. D4). This would indicate an early Tertiary age for the emplacement of the quartz mica diorite stocks. Certainly from here, the chain of events leading up to metallization must have extended over a considerable time interval, a fact which would probably place the period of ore deposition into the middle or late Tertiary.

ECONOMIC GEOLOGY--PRIMARY ORE

Forms of Ore Bodies

The ore deposits of the Banner district occur in four structural types: (These are:) 1) bedded replacement in certain stratigraphic horizons, 2) irregular massive replacements along the edges of intrusive contacts, 3) pipelike replacements at the intersections of shear and fracture zones, and 4) vein deposits along fissures.

Bedded Replacement Deposits: The bedded deposits form the largest of the ore bodies and are the most common type in the district. Notable examples of these tabular deposits occur in Naco and Devonian limestones at the Christmas mine, in the Lower Devonian strata at the London-Arizona mine, in the Naco formation at the Seventy-Nine mine, and in the Mescal limestone at the Chillito mine.

X The most persistant ore-bearing bed (is) the lower twenty to thirty feet of the Devonian Martin limestone, locally known as the O'Carroll bed. At the Christmas mine, mineralization in the Martin formation extends from above the 1300 level on the north side of the intrusive contact to below the 1600 level on the south side (see Figure 4). Along the north contact zone, the mineralized zone is exposed for 2200 feet along strike and for 1100 feet at its widest part up-dip along the bedding. The mineralized deposit on the south side is about 3300 feet in strike length along the intrusive contact, extending approximately 1400 feet down-dip. Generally, the mineralization is thickest adjacent to the main intrusive mass; although, thicker sections sometimes occur along pre-mineral fissure zones and near the contacts of the smaller dioritic dikes. Heights vary between 55 to 80 feet in the thicker portions of the ore body to about 10 feet in thickness at the outer extremities.

At the London-Arizona mine, the lower Devonian ore body is well-exposed for about 3000 feet along the east and southeast side of Chocolate Canyon. Here the deposit has been stoped in the better mineralized zones for 150 to 200 feet down-dip along the bedding throughout a thickness of 10 to 30 feet. This mineralized bed is in the hanging wall block of the Chocolate fault, approximately 2000 feet to the southeast of the Chillito quartz mica diorite stock. The exposures of the London-Arizona ore deposit probably represent the outer peripheral zone of a major ore body with the portions towards the main intrusive contact being eroded away.

At the Christmas mine, the Naco ore deposits outcrop at the surface on both sides of the main quartz mica diorite intrusive mass, extending to below the 600 level at the north contact and to below the 800 level on the south side. At least six different stratigraphic zones are recognized, each of which is comprised of two or more distinct mineralized beds. These mineralized zones, constituting a total section of about 700 feet, are known locally as the Pinnacle series, the "J" series, the "K" series, the "L" series, the Los Novias series, and the "M" series. The individual beds that comprise these series are described in detail by Peterson and Swanson (5, pp. 365-368). These vary in thickness between 6 and 60 feet, with mineralization in certain beds extending laterally from 50 to 400 feet away from the central intrusive mass. Generally the purer limestones were more receptive to mineralization than the impure limestone beds; although, both rock types are the hosts to important ore bodies. Shales, hornfels, and fine grained diorite sills usually separate the different mineralized beds, and these, in places, are sufficiently mineralized to constitute ore.

To the east in the hanging wall side of the Christmas fault, the Naco beds are displaced downward approximately 1300 feet relative to those in the footwall block. Along the north side of the contact, the top most Pinnacle bed is found just below the 800 level, the part of the Los Novias series is exposed on the 1300 level. The upper mineralized portion of the "M" series is on the 1600 level. Within each of the fault blocks, faulting, igneous intrusion, and metamorphism, complicate the geological picture. Identification of the various units which comprise the Naco section have been in doubt in many cases, and it has been only recently that many of the geological problems have been solved.

The bedded ore deposits in the Naco sediments at the Seventy-Nine mine, as described by Kiersch (3, pp. 73, 74) are much smaller in extent than those at Christmas. Two of the larger bedded ore bodies--the Discovery ore body which outcrops at the surface and the Massive Pyrite ore body which is exposed between the 5th and 6th levels--average about 50 feet in thickness and generally extend only 200 to 300 feet laterally along the strike of the bedding. Mineralization in these bodies selectively replaces fractured, thin-bedded, calcareous shales and limestones, following along the dip of the beds for several hundred feet. At least five other bedded zones were locally well enough mineralized to be mined as shipping grade ore.

At the Chillito mine, ore was mined from several beds in the Mescal formation, the most important of which is just below the base of the Troy Quartzite. Ross (6, p. 63) describes the occurrence of the ore to be in discontinuous replacement deposits; however, extensive intrusion of diabase together with faulting complicates the geology of the area. Most of the mine workings are now caved and little is known about the extent of the ore bodies. There is little doubt, however, that the ore bodies at the Chillito and the London Arizona mines are parts of the same deposit.

Irregular Replacement Ore Bodies: In the district, the only important irregular replacement ore deposits are at the Christmas mine in the upper and lower parts of the Escabrosa formation.

The characteristics of these deposits are shown by the ore bodies developed in the upper part of the Escabrosa on and below the 800 level. The largest of these ore bodies occur as massive, irregular replacements adjacent to the north and south intrusive borders. Along the north side of the intrusive, the ore zone roughly parallels the contact for at least 1200 feet, averaging about 75 feet wide and 150 feet in height. A similar mineralized zone is developed along 1500 feet of the south side of the intrusive. Here, the vertical dimension averages about 300 feet in height with an horizontal thickness of 100 feet away from the contact. Other large deposits are found in blocks of limestones completely surrounded by quartz mica diorite, and in limestone embayments between westerly projecting dikes.

The vertical extent of mineralization is limited by thick diorite sills at the top and bottom of the ore section. Laterally away from the intrusive contacts, the ore bodies usually terminate against marbleized limestone.

Little is known of the extent of the ore deposits in the lower part of the Escabrosa. The few diamond drill hole penetrations through these mineralized zones indicate ore with the same general characteristics as that in the upper part of the formation.

Pipelike Ore Deposits: Recent work at Christmas proves the existence of several pipe or chimney ore bodies in the hanging wall of the Joker fault zone. These mineralized pipes occur within the main quartz mica diorite mass adjacent to the andesite-intrusive contact zone. The ore bodies extending from above the 800 level to below the 1300 level rake steeply to the northeast along the intersection of a series of N 20° E trending fissures with a N 80° - 85° W striking shear zone. Generally, these bodies are small with an average cross sectional area of about 60 feet long and 40 feet wide. The long axes of the pipes parallel the strike of the northeast fissure zones with mineralization narrowing into veins and veinlets to the northeast. Surrounding these pipelike ore bodies is a halo of weaker mineralization formed by a stockwork of numerous irregular veinlets of quartz and sulfide mineral.

Other pipelike replacement deposits form the main ore body or ore bodies of many of the smaller mines and prospects in the district. Commonly these bodies occur at the intersections of the east-west striking pre-mineral faults with northeast trending fracture and shear zones. Usually, where the pipes crosscut bedded sediments, some control of ore deposition by stratification can be observed.

Vein Deposits: Vein deposits are common throughout the district, but most are too narrow or discontinuous to be mineable for more than short distances. Ore deposition is localized along two different sets of faults, one set occurring as the east-west trending faults and the other as N 15° - 55° E faults. The most notable of the vein deposits occur at the Seventy-Nine and Apex mines. At the Seventy-Nine mine, discontinuous vein deposits were mined along the strike of a N 80° E trending dike of quartz prophyry. In another generally east-west trending vein at the Apex mine the ore occurs along a steeply dipping fracture zone in the Martin limestone. Ore was mined from a body about 300 feet in length, about 15 feet in height, and from a few inches to several feet in width (Ross, 6, p. 64).

Two N 20° E striking vein deposits at the Christmas mine, which give promise to be economically important, are exposed in the hanging wall of the Joker fault on the 1300 level. The veins have not been developed to any lateral or vertical extent, but both veins average good assay grades for over 15 feet in width. These veins together with the pipelike ore bodies previously described form part of a larger mineralized area consisting of a stockwork of fractures into which quartz and sulfide minerals have been introduced. The area has not been studied in detail, but it is interesting to note that this mineralization is similar in character to many of the porphyry copper deposits. The occurrence of several breccia dikes in the area, although not an exclusive characteristic of the prophyry coppers, show a common bond with many of them.

Stratigraphic Relations of the Ore Bodies

Within the Banner district certain formations are more favorable for ore deposition than others. In general, the formations which are comprised of limestone, dolomite, and calcareous shale are most favorable. Quartzite, conglomerates, and hornfels are unfavorable. The relationship of the ore zones to the major rock units are shown on figure 6.

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Ore deposits at the Christmas mine occur in altered dolomites of the lower and middle units of the Martin formation of Devonian age, in the massive limestones in the upper and lower parts of the Escabrosa formation of Mississippian age, and in the thin-bedded limestones of the Naco formation of Pennsylvanian age. Other deposits are stratigraphically associated with Cretaceous volcanic rocks. The Curtin and Seventy-Nine mines are in the middle member of Pennsylvanian limestones. The London-Arizona and the Apex mines are in the thin-bedded dolomites of Devonian age. The oldest of the mineralized beds is in the Mescal formation of Precambrian age at the Chillito mine.

Mineralogy of the Deposits

On a district-wide scale, mineralization within the separate mine areas demonstrates a general zonal distribution, probably reflecting an overall variance in temperature at the time of ore deposition. The Chillito-London-Arizona and the Christmas areas seem to represent central zones of copper mineralization. Surrounding these areas are other mineralized deposits containing a lower temperature assemblage of minerals such as galena, sphalerite, and gold.

The major economic hypogene ore minerals of the Banner district are chalcopyrite, bornite, sphalerite, and galena. Other primary minerals of lesser importance include chalcocite, covellite, cubanite, molybdenite, gold, and silver. Pyrite, magnetite, pyrrhotite, and hematite are the most abundant and widely distributed metallic minerals.

Within the Christmas mine, the various rocks have been altered and mineralized to varying extents, with each stratigraphic sequence showing a characteristic mineral assemblage and a well-defined pattern of zoning. In general, the ores of the upper stratigraphic horizons contain less iron, but with depth, magnetite and iron sulfide minerals become increasingly abundant.

In the Cretaceous section, the upper part of the pipelike ore bodies, exposed to the east of the Joker fault on the 800 level, are composed of a central core of quartz, bornite, chalcopyrite, and chalcocite. Surrounding these bodies are a halo of weaker mineralization consisting of a stockwork of numerous veinlets of quartz, chalcopyrite, and bornite. Laterally away from the central zone of mineralization, pyrite becomes more plentiful. The lower part of these bodies have not been exposed, but core from diamond drill intersections show some increase in primary chalcocite with depth.

The quartz mica diorite around these pipelike bodies appear to be silicified; however, thin section studies show no appreciable additons of silica. Actually the rock has undergone extensive hydrothermal alteration and recrystallization, resulting in the formation of abundant secondary quartz and orthoclase along with some sericite and clay. A few fragments of altered diorite are found within the pipes, appearing to be literally "soaked in quartz".

The widespread extent and distribution of mineralization in the quartz mica diorite and in the surrounding andesite has many features common to the prophyry copper deposits. Although rock alteration is comparatively mild, the development in the andesite of large amounts of secondary biotite and the alteration of the diorite into an aggregate of sericite and secondary quartz seem to fit the normal porphyry-type alteration.

Secondary enrichment in the Cretaceous section appears to be of minor importance. Some leaching and redeposition of copper minerals are localized along fracture and fault zones, but in places primary sulfides can be found at the surface. Secondary ore minerals include chalcocite, cuprite, melaconite-tenorite, native copper, and chrysocolla.

To the west of the Christmas fault zone along the north and south sides of the main intrusive mass, bedded deposits in limestones of Pennsylvanian age outcrop at the surface and are exposed in the mine workings on the 300, 400, 500, and 600 levels. In the hanging wall of the Christmas fault, down-dropped extensions of these beds are found along the north contact zone on the 800, the 1300, and the 1600 levels. Primary mineralization in these bedded replacement deposits consist mainly of magnetite and pyrite near the intrusive mass, grading laterally into an intermediate zone of chalcopyrite and bornite, and into an outer zone of chalcopyrite, pyrite, sphalerite, and minor galena. Generally the individual ore bearing beds average from 6 to 60 feet in thickness, with the thicker sections adjacent to the intrusive contacts. Gangue minerals are largely grossularite and andradite garnet with lesser amounts of quartz, idocrase, epidote, and wollastonite. Some clays, serpentine, and chlorite, resulting from hydrothermal alteration, are apparent near the intrusive contacts. Generally, in the outer zone, the lime silicate minerals decrease and marble becomes predominant.

Production from the Naco beds above the 300 level was mostly from oxidized and partly oxidized ores. Supergene enrichment was evidently of minor importance; although, local concentrations of chalcocite, copper carbonates, and native copper are found along some fracture zones. Oxidation along the Christmas and Joker fault zones extend to the 1600 level. Supergene ore minerals are chalcocite, cuprite, tenorite, malachite, azurite, dioptase, brochantite, and chalcanthite.

Lower in the sedimentary series, the irregular replacement ore bodies in the massive Escabrosa limestones exhibit their own distinctive mineral assemblage. The gangue minerals consist of garnet, marble, clays, chlorite, diopside, and tremolite. The clay minerals along with tremolite, diopside, and chlorite predominate near the intrusive contacts, grading into garnet and tremolite in the intermediate zone, and into garnet-marble to marble in the outer extremities. Where the ore bodies are completely surrounded by diorite, a central core of marble or garnet-marble will sometimes be present, depending on the size of the enclosed body.

Principal metallic minerals include magnetite, pyrite, chalcopyrite, bornite, and sphalerite along with some small amounts of specularite, molybdenite, and galena. Magnetite, pyrite, and chalcopyrite generally predominate adjacent to the intrusive contacts with sphalerite, specularite, and galena localized at the outer edges.

In the deeper levels of the Christmas mine, the lower Martin limestones and dolomites are extensively replaced by anhydrite and antigorite. These alteration products are interbedded with layers and lenses of other gangue minerals which include chondrodite, diopside, tremolite, actinolite, sericite, and chlorite. Several narrow veins of hedenbergite, barite, magnetite, and feldspar and numerous small veinlets of anhydrite, gypsum, brucite, and zoisite occur throughout the deposit, representing a late state in mineralizing activity.

Zonal arrangements of the gangue minerals have not been studied in any detail, but in general, three zones are recognized. They are a near-contact zone of anhydrite, chondrodite, and antigorite; a central zone of anhydrite, antigorite, and tremolite-actinolite; and an outer zone of antigorite, sericite-chlorite, anhydrite, and gypsum.

The metallic minerals are predominately magnetite, pyrite, pyrrhotite, chalcopyrite, bornite, and sphalerite with lesser amounts of hematite, molybdenite, galena, chalcocite, covellite, and cubanite. Magnetite occurs throughout the mineralized zone, forming from 15 to 25 per cent of the total mineral content. The later sulfide mineralization demonstrates a well-defined zoning, both in lateral and vertical extent. In the thicker sections, the footwall and hanging wall show a marked decrease in bornite grading away from the central zone with pyrite, sphalerite, and local galena becoming more plentiful towards the edges. Laterally away from the central intrusive mass, mineralization grades from a pyrite-chalcopyrite zone to a chalcopyrite-bornite intermediate zone to a pyrrhotite-pyrite-sphalerite-chalcopyrite outer zone.

In the London-Arizona workings, most of the ore in the lower Martin formation was enriched, containing local concentrations of chalcocite, cuprite, malachite, azurite, brochantite, and chalcanthite. Hypogene minerals still in evidence are magnetite, pyrite, chalcopyrite, and pyrrhotite in a gangue of serpentine and anhydrite.

The ore bodies in the Mescal limestone at the Chillito mine were largely oxidized, but some pyritic material enriched by a supergene chalcocite was found (Ross 6 p. 63). Recently, low-grade oxidized copper ore in the Troy quartzite was mined and shipped as smelter flux.

The relative positions of the lead-zinc ore bodies at the Seventy-Nine and Curtin mines suggest a zonal arrangement along the east-west trending fault and dike systems. Zoning is further indicated by the lead-gold ore deposits to the northwest at the Apex and Santa Monica mines, and by the silver-gold-lead-zinc deposits to the southeast across the Gila River in the Saddle Mountain district.

The ore deposits at the Seventy-Nine mine are described in detail by Kiersch (3, pp.77-78). Near-surface deposits consisted mainly of oxidized ores of lead. Some azurite, malachite, brochantite, and chalcanthite occurs throughout the oxidized zone, but nowhere are they abundant enough to constitute copper ore. Hypogene metallic minerals occur as pyrite, sphalerite, galena, chalcopyrite, hematite, and silver. Gangue minerals include quartz, garnet, argillic material, and kaolin. With depth the sulfide ores show an increase in the zinc-to-lead content, and pyrite becomes more plentiful in the deeper levels.

The ore bodies at the Curtin mine are almost completely oxidized. Some residual galena and pyrite remain, but oxidized ore minerals of anglesite, cerussite, and hemimorphite predominate along with lesser amounts of plumbojarosite, mottramite, and smithsonite. The gangue contains quartz, garnet, and kaolin.

Wallrock Alteration

Most of the rocks in the region are altered to some extent by processes related to plutonic intrusion and to later mineralizing activity. The amount of wallrock alteration produced has not been studied to any detail, but in comparison with other major ore deposits in central Arizona, the effects are relatively mild.

Hydrothermal alteration in the andesites around the Christmas ore deposit reflects the extent of the mineralizing solutions. Near the central intrusive mass, large amounts of fine grained secondary biotite together with numerous veinlets of quartz typically flood the andesites. Away from the deposit, a peripheral alteration zone, characterized by irregular patches and abundant veinlets of epidote, extends over a mile from the ore body.

Near the intrusive borders, the quartz mica diorite has been conspicuously and selectively altered. The original rock-forming minerals have undergone hydrothermal alteration and recrystallization to form large amounts of secondary quartz and orthoclase along with some calcite, clay, and sericite. This stage of alteration appears to be earlier than the main period of ore deposition, possibly occuring in conjunction with the extensive hydrothermal alteration of the Lower Devonian beds.

There is no doubt that most of the silication in the Naco and Escabrosa limestones and the silicification of the Naco and Devonian shales are due to contact metamorphism. In the upper limestones, many of the earlier metamorphic products are much in evidence; although, near the intrusive contacts, later hydrothermal action has altered, some of the original constituents to clay, serpentine, and chlorite.

Petrographic work indicates that the hornfel alteration of the Naco and Upper Devonian shales represents metamorphism of calcareous argillites with recrystallization of quartz. There is no evidence of introduction of silica.

Alteration of the Lower Devonian dolomites and dolomitic limestones is extensive, evidently the result of contact metamorphism followed by later hydrothermal activity related to ore deposition. Original metamorphic products include chondrodite, tremolite, marble, and possible pyroxene minerals. Later hydrothermal alteration converted part of the chondrodite and all of the pyroxene (?) to antigorite and probably at the same time altered the interstitial calcite in the marble to anhydrite. No remnant of carbonate is found within the mineralized zone. Most of the magnetite and hematite appear to have been deposited during this period.

Above the mineralized deposit, the beds are almost completely dolomitized and numerous irregular veinlets and apophyses of serpentine, anhydrite, and magnetite extend into the hanging wall. The footwall quartzite on the other hand contains much calcareous and argillaceous material. The diversity of alteration affecting the two adjacent rock types is surprising.

Mineralization in the lower Devonian beds at the London-Arizona mine consists largely of secondary minerals of copper in association with magnetite, serpentine, anhydrite, and gypsum. Similarly as at Christmas, very little carbonate remains within the mineralized zone.

In many of the other mines in the district, secondary mineralization also masks much of the original characteristics of the rocks, but some forms of hydrothermal alteration are apparent. Near the intrusive contacts at the Curtin mine, many of the shales and shaly limestone beds are strongly kaolinized. Kaolinization of the quartz mica diorite is also evident along the contact zones, with local occurrences of sericite and serpentine.

At the Seventy-Nine mine, Kiersch (3, p. 76) describes an argillized material, evidently of hydrothermal origin, that is associated with the better mineralized portions of the discontinuous vein deposits.

Paragenesis

The paragenesis of the principal ore and gangue minerals of the lower Devonian ores is shown diagrammatically figure 7. The paragenetic sequence is based on a preliminary thin-section study by Dennis P. Cox, formerly of the Anaconda Company, and on a later published section study by Wilson McCurry, a graduate student at the Arizona State University. The author, however, assumes all responsibility for interpretation of the data provided.

The mineralization is divided into an earlier metamorphic stage, a hydrothermal alteration stage, a main sulfide mineralization stage, and a late gangue stage. There evidently were considerable time intervals between the metamorphic stage and the start of the hydrothermal alteration stage, and between the end of the hydrothermal alteration stage and the start of the sulfide mineralization stage. It is probable, however, that once the sulfide mineralization started, it took place over several intervening structural events in a nearly continuous sequence.

The initial hydrothermal solutions must have been rich in sulfur and iron. In the lower Devonian beds, the early metamorphic products were extensively altered to anhydrite and antigorite, and abundant amounts of magnetite with some hematite were deposited under prevalent oxidizing conditions. The relative age of antigorite and anhydrite is now known. Chondrodite is replaced by antigorite, and anhydrite and chondrodite commonly occur together. Anhydrite is sometimes surrounded by antigorite, and in many instances they occur together along mutual boundaries. They are probably essentially contemporaneous. Magnetite and hematite are later than antigorite and anhydrite.

Pyrite is the earliest sulfide mineral. It veins magnetite and hematite and is disseminated in grains throughout antigorite and anhydrite. Pyrite occurs as relicts in sphalerite, chalcopyrite, and pyrrhotite. Pyrrhotite is veined and replaced by chalcopyrite and sphalerite. Chalcopyrite occurs as oriented blebs in sphalerite, probably as an unmixing pheonomena. Bornite veins and replaces sphalerite and chalcopyrite, but in some instances blades of chalcopyrite and chalcocite show exsolution intergrowth along the chrystallographic planes of bornite (McCurry, written communication, 1964). Galena is interstitual to sphalerite and chalcopyrite, possibly in part replacing them.

Late veinlets of anhydrite and gypsum cut all the above minerals. Associated with the later anhydrite veinlets, chalcocite and covellite selectively replace bornite, and cubanite occurs as parallel laths in chalcopyrite. Also in conjunction with this stage, pyrrhotite is sometimes altered to pyrite, to magnetite, and to hematite. Molybdenite is late and is commonly introduced with a late anhydrite gangue. Coarse calcite and botryoidal marcasite are the latest minerals, and at the present are still being locally deposited along open fractures from hot waters.

No detailed mineralogical study has been made of the ore deposits in the Escabrosa and Naco limestones. However, the stages of mineralization that are present in the lower Devonian beds are readily recognizable, even though different mineral assemblages prevail.

In the pipelike ore bodies in the hanging wall of the Joker fault, at least three periods of sulfide mineralization are apparent. In the first stage, quartz, bornite, and chalcopyrite appear to have been deposited at the same time, however, much of the quartz was probably formed earlier during the hydrothermal alteration stage. In the second period, steep veinlets of quartz containing disseminations of magnetite, chalcopyrite, bornite, and pyrite cut the earlier mineralization. Later bornite and chalcopyrite vein both earlier periods.

The paragenetic sequence of hypogene minerals from the lower levels of the Seventy-Nine mine is discussed by Kiersch (3, pp. 77, 78). Pyrite is commonly associated with specular hematite in some bodies, and is the earliest sulfide mineral formed. Deposition of pyrite and hematite, corresponding to the deposition of magnetite in the hydrothermal alteration stage at Christmas, ceased before the next stage of sulfide mineralization began. In this stage, sphalerite is early, containing numerous small blebs of chalcopyrite. Galena veins the sphalerite, and in some instances forms mutal boundaries with chalcopyrite. Galena and chalcopyrite are regarded as essentially contemporaneous. Quartz, representing the late gangue stage, cuts and replaces the sulfide ores.

Factors Controlling Form and Location of Ore Bodies

The principal ore deposits of the district are in altered carbonate rocks near the contacts with acidic intrusive bodies. Other smaller ore bodies occur in the vicinity of the contact zones within these intrusive bodies. Ore mineralization is directly proportional to the extent of metamorphism and hyrothermal alteration. These, in turn, are functions of proximity to the intrusive contact, of the characteristics of various rocks, and of certain structural controls.

Alteration Control: The distribution and extent of alteration by metamorphic and hydrothermal processes directly influenced the localization of ore bodies. At Christmas, ore mineralization selectively replaces the hydrothermally altered dolomites of the lower Martin formation, and the garnetized limestones of the Escabrosa and Naco formations. Within all these formations, the thicker portions of the ore bodies are adjacent to the intrusive contacts where the intensity of metamorphism and hydrothermal alteration was greatest.

Ore bodies in the Chillito and London-Arizona area are in hydrothermally altered dolomites and limestone of the Precambrian Mescal and the Devonian Martin formations. The thicknesses of these deposits are limited by the vertical extent of the altered zones.

Generally, in the smaller mines of the district, the most striking feature is the small extent of alteration in the sediments surrounding the intrusive bodies. Ore bodies in these areas are commonly localized in the altered zones near or adjacent to the intrusive contacts.

Structural Controls: At least three sets offault and fracture systems can be distinguished, all of which appear to have been developed prior to the period of mineralization. These systems include steep east-west faults, steep northeast faults, and steep northwest faults.

The most prominent of these systems are faults transverse to the regional trend of folding. This group, generally referred to as the east-westers, strike between N 65° E and N 70° and dip 70° S to 50° N. Original displacements along these zones served to localize the emplacement of the earlier fine-grained dioritic and aplitic bodies, and the later intrusions of quartz mica diorite and dacite porphyry. Recurrent movements along these zones, both before and after mineralization, are clearly demonstrated.

The east-west system must have been developed as strike-slip faulting complementary to the trend of regional compression, but well-defined slickensides give evidence that most of the recent post-mineral movement is normal.

Persistent northeast shear zones trike N 15° - 55° E and deip from 50° northwest to 65° southeast. The relationship of these structures to the east-westers is not clear. In some instances, they appear as tension shears in conjunction with the east-west faulting, but, for some of them a later age is indicated by northeast striking hornblende andesite dikes which crosscut the earlier diorite porphyry.

The northwest faults and fractures form a separate, well-defined system with N 5° - 40° W trends. The northwesters are later than the other groups appearing in many instances as tension shears between the northeast and east-west faults. Later post-mineral movement along the major northwest faults evidently followed these earlier zones of weakness.

Zones of alteration and mineralization, associated with east-west faulting, are traceable for approximately 6 miles across the district between the Christmas, Chillito, and London-Arizona, and Seventy-Nine areas (See figure 2). The east-west faults, while providing channels for the hydrothermal and mineralizing solutions, also influenced ore deposition at their intersections with favorable beds and with other structures. In a few occurrences, they form strongly mineralized veins.

The northeasters are most intensely mineralized at their intersections with the east-westers, forming several pipe-like ore deposits. These bodies commonly occur near an intrusive contact in either an altered sedimentary or intrusive rock. In most instances, however, the northeast system together with the northwest fissures form, at their intersections with favorable beds, the locus for sulfide mineralization.

The bedding characteristics of the carbonate rocks which comprise each formation played an important role in influencing the thickness and lateral extent of ore deposition. Flat-dipping, tabular deposits are commonly formed in the thin-bedded calcareous rocks of the Naco and Martin formations. In contrast, ore bodies in the massive Escabrosa limestones have a limited horizontal extent away from the intrusive contacts.

The importance of folding in ore localization appears to be minor; although, where the fold yielded to compressive stresses, thrust faulting and flat-dipping shears at a low angle to the bedding provided access for the lateral distribution of hydrothermal solutions. These structures were later instrumental in localizing ore along the bedding between the steeper structures.

Intrusive Contact Control: The quartz mica diorite stocks and related intrusive bodies had a direct effect in the localization of ore deposits. The rocks surrounding these intrusive bodies were extensively fractured, faulted, and metamorphosed. Hydrothermal solutions, evidently ascending along fault and fracture zones near their intersections with intrusive contacts, subjected and metamorphosed rocks to varying degrees of metasomatic alteration. Later ore solutions, undoubtedly traveling along the same channelways, formed the replacement ore bodies in favorably prepared areas.

Figure 5 illustrates the localization of ore near the contact of the Christmas tock. Ore fluids appruntly ascending along the contacts formed the thicker portions of the ore bodies adjacent to the main intrusive mass. The decrease in the intensity of ore mineralization outward from the intrusive contact zones, and inward toward the interior of the stock presents direct evidence of intrusive contact control. Furthermore, the zonal arrangement of ore minerals within each of the ore deposits throughout the stratigraphic section stresses the fact that the ore solutions must have been directed along restricted conduits before being introduced into the various zones favorable to ore deposition.

Vertical chimneys of ore occur in the Curtin mine workings, localized near the intrusive dike contacts, and mineralization decreases in intensity away from these pipe-like bodies. Other examples of intrusive contact control are demonstrated by the ore bodies along and within the North dike area at the Seventy-Nine mine. Here, the intrusive rock has been fractured, hydrothermally altered, and extensivaly mineralized.

ECONOMIC GEOLOGY - SECONDARY ORE

In the Banner district, oxidized and secondary enriched ores constituted most of the production prior to 1940. The principal minerals developed during oxidation of the primary ores are hydrous iron oxides, malachite, azurite, cuprite, tenorite, dioptase, chalcocite, native copper, anglesite, cerrusite, and hemimorphite. Small amounts of manganese oxide, chalcanthite, covellite, turquoise, hydrozincite, and plumbojarosite are generally present in certain oxided zones, and local occurrences of mottramite, vanadanite, wulfenite, smithsonite, and brochantite have been reported in various workings.

At the Christmas mine, secondary enrichment was poorly developed. Most of the ore mined above the 300 level was partly oxidized with some enrichment by secondary chalcocite and native copper. Except along certain fracture zones, the structure and composition of the Naco limestones are not favorable for the widespread migration of copper, and the topography of the area encourages the rapid runoff of surface waters. Oxidation is deepest and best developed along fracture and fault zones, extending to a maximum depth of 1400 feet below the surface along the Christmas and Joker faults. East of the Joker fault, sparse iron oxides and primary sulfide are found in the andesites at the surface, indicating that the possibility of finding any significant enriched zones in the Cretaceous section is small.

The ore mined in the Chillito and London-Arizona area was largely oxidized with some enrichment by supergene chalcocite (Ross 6, pp. 62-63). In the stopes which are now accessible, particularly in the London-Arizona workings, mining apparently was selective in the higher grade portions of the copper mineralization. Structure evidently was the dominant factor in the localization of these enriched zones.

Oxidation and supergene enrichment at the Seventy-Nine mine is briefly discussed by Kiersch (3, p. 79). Here the oxidized zone generally extends to about the 6th level, approximately 400 feet below the surface; however, along the North dike and within certain fracture zones, oxidation penetrates to below the 6th level. Generally, the oxide-sulfide boundaries are gradational in both horizontal and vertical extent; although abundant relict galena was reported in the upper stopes (Ross 6, p. 66). Zinc mineralization in the oxide zone has been largely subtracted.

Elsewhere in the district, structure appears to be the most important factor in the localization of secondary mineralization, but in some deposits the rock composition played an important part. At the Curtin mine, the pipe-like ore bodies are almost completely oxidized with little relict galena remaining. However, one of the most striking features here is that there was little apparent migration of the zinc. Evidently restricted circulation of the ground water together with unreplaced limestone in the gangue prevented the transportation of zinc away from the area.

ORE GENESIS

The development of geologic events leading to ore deposition within the Bonner district was regional in extent, presumably starting during the Laramide orogeny at the close of the Cretaceous. Crustal instability evidently continued into the late Tertiary and possibly extended into the Quaternary.

In the early stages of deformation, northeast-southwest compression developed northwest trending folds, and a generally east-west series of faults transverse to the fold axes. Undoubtedly some expression of both the northeast and northwest tension structures must have been developed at this time in conjunction with lateral movement along the east-west faults. These events were followed by intrusions of fine grained diorite and aplite.

After a period of quiescence, renewed compressive stresses resulted in continued readjustment along the east-west faults. Coarse grained quartz mica diorite porphyry intruded the earlier fine grained intrusives and sedimentary rocks, forming the Christmas, Chillito, and Seventy-Nine stocks together with numerous dikes and sills. Sedimentary and volcanic rocks surrounding these igneous bodies were subjected to varying intensities of metamorphism.

After a period of crustal stability, recurrent movement along the east-west fault system was followed by intrusion of dacite porphyry dikes. This period of intrusive activity is important for it appears to be closely related to the earlier stage of hydrothermal alteration and the later stage of ore deposition.

Following emplacement of the dacite dikes, movement recurred along the east-west faults. Hydrothermal solutions, traveling along these shattered zones near the intrusive contacts, thoroughly altered the limestones and dolomites of the Mescal and lower Devonian formations. Hydrothermal alteration in the Escabrosa and Naco limestones, and in the Cretaceous volcanics was restricted to the near-contact zones. Large amounts of magnetite were deposited in the Mescal and Lower Devonian beds with lesser amounts being introduced into the Escabrosa and Naco formations.

After a considerable time interval, recurrent activity along the pre-mineral fault and fracture systems was followed by ore fluids moving through the fracture zones near intrusive contacts. At the intersection of these fracture systems with favorable areas for replacement, the ore solutions moved laterally away from the contact zones, forming the bedded replacement deposits in the mescal, Devonian, and Naco formations. Ore deposition in the Escabrosa limestones was limited to the silicated areas adjacent to the intrusive contacts. Mineralization in the Cretaceous section was introduced through intersecting fissure zones near intrusive contacts from where it spread out into stockwork of veins and veinlets.

Later in the period of mineralizing activity, possibly near the end of the late gangue stage, hornblende andesite dikes were intruded into northeast and east-west trending structures, closing the period of hypogene ore deposition.

The Dripping Springs Mountains were uplifted with major readjustment occurring along the northwest and north trending fault zones. Emplacement of the olivine basalt dikes, erosion, and oxidation along with some supergene enrichment complete the geological picture.

CONCLUSIONS

The ore deposits of the Banner district show the inter-relationship of intrusive activity, metamorphism, hydrothermal alteration, and metallization. Within the district, the intrusive sequence is fine-grained diorite, aplite, quartz mica diorite porphyry, dacite porphyry, hornblende andesite, and olivine basalt. Hydrothermal alteration and ore deposition, in separate and distinct stages, are late in the intrusive sequence, occurring between the dacitic and andesitic intrusions.

The mineralogy of the deposits is not unique, but distrinctive mineralogical features within different geologic environments are well-illustrated, particularly at the Christmas mine. Here, ore deposits in the forms of stockworks of veinlets and veins, contact pipes, irregular massive replacements, and bedded replacements are localized by certain alteration effects and by structural developments that predate the period of ore deposition.

Throughout the district, the proximity of the intrusive contacts, the extent of metamorphism and hydrothermal alteration, and the intensity of pre-mineral fracturing are the dominant controls on the localization of the ore bodies. The widespread distribution of minerals characteristic of intermediate temperatures, places these deposits in the mesothermal class. While the mineral associations of these deposits are suggestive of a contact metasomatic or pyrometasomatic type, their character is clearly demonstrated to be that of normal replacement deposits.

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EAST HELVETIA AREA

Advance in DDH's from July 2, 1964 to September 4, 1964

Week Ending	DDH # A-815	DDH # A-817	DDH # A-819	DDH # A-820	DDH # A-821	DDH # A-822	DDH # A-823	DDH # A-824	Week's Total	Assume 48 drill shifts/wk.
7/2/64	N.A.	142	245	238					625	13
7/10/64	N.A.	123	239	255					617	12.8
7/17/64	Abandoned	33	56	218	115				422	8.8
7/24/64		(end)	(end)	86	384	235	10		715	15 –
7/31/64				(end)	26	302	132		460	9.6
8/7/64					117	155	238	62	572	12
8/14/64					198	295	158	223	874	18.3
8/21/64					247	38	274	267	826	17.2
8/28/64					254	250	94	204	802	16.7
9/4/64					335	104	173	261	873	18.2
9/11/64					60	114	56	137	367	7.6

(N.A.=no advance)

CONFIDENTIAL

October 7, 1963

OUTLINE OF MARCH 1, 1963 AGREEMENT BETWEEN ANACONDA AND BANNER

This outline should be used only as a guide. The exact wording of the Agreement should be checked to resolve any question of importance.

ARTICLE I - OPTION

SECTION 1. OPTION PERIODS.

Section 1(a) - Anaconda's Right to Examine and Investigate Banner's Properties -- Definition of "Subject Premises". Page 1

1. Real property:

(A) Anaconda has the right to examine all Banner's real property, interests in real property and contract and other rights of whatever nature in respect of real property that are owned or held by Banner as at March 1, 1963 and that are located in Pima County, Arizona. These include the properties described in Exhibit A under the following headings: MINERAL HILL PROPERTIES, TWIN BUTTES PROPERTIES, HELVETIA PROPERTIES, HELMET PEAK PROPERTIES and AMOLE PROPERTIES.

(B) Anaconda does not have the right to examine:

(i) the surface rights to the three tracts of land described in Parcel No. 2 under the heading EXCLUSIONS on pages xxxi and xxxii of Exhibit A; and

(ii) Banner's real property embracing the Cone Volumes and the ore and other materials that shall be excavated and removed from the Cone Volumes by Pima Mining Company pursuant to the contract dated November 23, 1959 between Banner and Pima.

(NOTE: This restriction is effective only so long as the Banner-Pima contract of November 23, 1959 is in effect. This contract presently is due to expire December 31, 1969.)

2. Personal property:

(A) Anaconda has the right to examine:

(i) all personal property of whatever nature that is owned by Banner as at March 1, 1963 and that is located in Pima County, Arizona; and

(ii) the oxide ore owned by Banner that has been and will be excavated from the upper cone volume of the Pima Cone.

(B) Anaconda does not have the right to examine the items of personal property listed on page xxxiii of Exhibit A.

3. Definition of "Subject Premises".

"Subject Premises" means all Banner's real property, interests in real property, and contract and other rights of whatever nature in respect of real property that are referred to under the following headings of Exhibit A: MINERAL HILL PROPERTIES, TWIN BUTTES PROPERTIES, HELVETIA PROPERTIES, HELMET PEAK PROPERTIES, AMOLE PROPERTIES and OTHER PROPERTIES. As to State Leases and similar interests in real property that are now limited as to time, the term "Subject Premises" includes extensions or renewals of State Leases and other such interests.

<u>Section 1(b) - Nature of Anaconda's Right of Examination.</u> Page 3

1. Anaconda's right to examine is broad -- it includes drilling and such studies and work as Anaconda may determine.

2. Anaconda may examine all Banner's records, data, etc., that relate to the properties covered by the Agreement, except Banner's records that are listed in Exhibit B.

(NOTE: Anaconda may exercise its right of examination during the Initial Option Period and the Extended Option Period.)

<u>Section 1(c) - Confidential Relationship.</u> Page 3

1. Each party has an obligation to treat as confidential any data, reports, records and other information that relates to the Subject Premises and that is furnished to such party by the other.

2. This obligation does not prevent a party from disclosing information to any one to whom it is necessary in connection with the performance of the Agreement.

3. This obligation shall remain in force for five years following termination or expiration of the Agreement; except that, if Anaconda does not enter into the Lease, Banner shall be free to disclose factual information received from Anaconda.

Section 1(d) - Banner's Obligation to Obtain Consents, etc. **Page 4**

Banner will use its best efforts to do all that is necessary to validly lease the Subject Premises to Anaconda. For example, if a part of the Subject Premises is covered by an agreement between Banner and another party and the consent of the other party is necessary before Banner can validly create a leasehold interest in Anaconda, Banner would be obligated to obtain the consent of such other party on a best-efforts basis.

(NOTE: All the notice provisions of this paragraph already have been complied with.)

Section 1(e) - Definitions of "Initial Option Period" and "Extended Option Period". Page 4

1. Initial Option Period -- March 1, 1963 to July 14, 1963.

2. Extended Option Period -- July 15, 1963 to April 15, 1964.

(NOTE: The April 15, 1964 date may, of course, be postponed from time to time by agreement of the parties.)

SECTION 2. NOTICE WITH RESPECT TO EXTENDED OPTION PERIOD; CONDUCT OF BANNER'S BUSINESS.

Section 2(a) - Notice -- Termination -- Sideline Agreements. **Page 5**

1. If Anaconda desires an additional option period (i.e., from July 15, 1963 to April 15, 1964), it must give notice to Banner on or before July 14, 1963. This notice already has been given.

2. During the Extended Option Period it is contemplated that Anaconda will negotiate sideline agreements covering certain areas of the Subject Premises.

3. Anaconda is to designate the sideline agreements it will negotiate by giving notice to Banner not later than October 31, 1963.

Section 2(b) - Banner's Right to Conduct Normal Business Operations During Option Periods. **Page 6**

Anaconda may specify a date prior to April 15, 1964 (or the agreed expiration date of the Extended Option Period if it has been postponed) as the Effective Date of the Lease.

1. Anaconda shall loan to Banner:

(A) $500,000 on March 1, 1963. (This has been done.)

(B) $500,000 on July 14, 1963. (This has been done.)

(C) Each sum listed below if it is requested by Banner* and if the Lease does not become effective prior to the date on which it is payable:

(i) $50,000 on October 15, 1963;

(ii) $50,000 on November 15, 1963;

(iii) $50,000 on December 15, 1963;

(iv) $50,000 on January 15, 1964;

(v) $50,000 on February 15, 1964; and

(vi) $50,000 on March 15, 1964.

2. Each sum loaned pursuant to Section 3 shall (i) be evidenced by Banner's promissory note in the specified form, (ii) bear interest at a rate of 1/4 of 1% above the prime commercial rate and (iii) be payable in three installments on March 1, 1966, March 1, 1967 and March 1, 1968.

3. Each promissory note issued pursuant to Section 3 is subject to surrender in accordance with Section 13.

*The request has been made.

SECTION 4. TERMINATION PRIOR TO EFFECTIVE DATE OF LEASE.

Section 4(a) - Events Causing Termination. Page 8

If Anaconda does not exercise its option to make the Lease effective, the Agreement automatically terminates on April 15, 1964 (or the agreed expiration date of the Extended Option Period if it has been postponed).

Section 4(b) - Banner's Obligation to Repay Section 3 Notes Survives. Page 8

Section 4(c) - Material to be Delivered to Banner upon Termination. Page 8

Section 4(d) - Inapplicability of Section 4 if the Lease Becomes Effective. Page 9

ARTICLE II - LEASE

SECTION 5. EFFECTIVE DATE OF LEASE. Page 9

The term "the Effective Date" is defined in the Agreement as the date on which the Lease becomes effective. This date would be whichever of the following dates is the earlier:

(i) the date within the Extended Option Period on which all the sideline agreements shall have been approved by Anaconda and approved and executed by Banner; and

(ii) the date specified by Anaconda in a notice given to Banner pursuant to Section 2(f).

(NOTE: If Anaconda exercises its option to make the Lease effective, it would be advisable for Anaconda to specify the Effective Date in a notice given to Banner pursuant to Section 2(f). Since so many events are keyed to the Effective Date, a dated notice will facilitate the administration of the provisions of the Agreement.)

SECTION 6. LEASE OF SUBJECT PREMISES.

Section 6(a) - Lease -- Definition of "Lease Operations". Page 9

1. The Lease affords Anaconda all substantial rights to effectively conduct mining operations.

2. The Memorandum of Agreement referred to in Section 6(a) already has been executed and recorded. The Memorandum of Agreement is dated March 1, 1963 and was recorded March 4, 1963 in the office of the County Recorder of Pima County, Arizona (Book 2065, pages 220-255).

3. The term "the Lease Operations" means operations of Anaconda on or in connection with the Subject Premises.

Section 6(b) - Subleases of State Leases to be Executed by Banner Immediately After Effective Date. Page 10

SECTION 7. TERM OF LEASE. Page 11

1. The initial term of the Lease is 60 years from the Effective Date. Anaconda has successive options to extend the initial term.

2. As used in the Agreement, "the Term" means the initial term of the Lease (as the same may be extended).

SECTION 8. ADDITIONS TO AND DELETIONS FROM THE SUBJECT PREMISES.

Section 8(a) - Acquisitions of Property by Banner. Page 11

1. Section 8(a) applies to any acquisition by Banner after March 1, 1963 of property, any boundary of which is within five miles of any part of the Subject Premises (as of March 1, 1963).

2. Banner is to give Anaconda notice of any such acquisition.

3. If Anaconda does not respond to such notice (i.e., if Anaconda does nothing), such property automatically becomes part of the Subject Premises effective 90 days after the giving of notice by Banner.

4. If within 90 days after the giving of notice by Banner, Anaconda gives Banner notice that Anaconda does not want the property for the Lease Operations, Banner has complete freedom of action in respect of such property.

Section 8(b) - Acquisitions of Non-Mineral Property by Anaconda. Page 12

1. Section 8(b) applies to any acquisition by Anaconda after March 1, 1963 of the following:

(A) property for essentially non-mineral purposes (e.g., water supply, plant facilities, dumping, tailings, leaching, etc.); and

(B) rights of way, easements, etc., for any purpose ancillary to the Lease Operations.

2. Anaconda retains title to such property, but the costs incurred by Anaconda in acquiring such property may be charged to the Lease Operations (i.e., a property-acquisition cost under Section 16(h)). If the property subsequently is sold, the net proceeds of such sale shall be credited against property-acquisition costs under Section 16(h).

3. Anaconda shall not transfer and encumber such property, except when such property ceases to be required for the Lease Operations.

Section 8(c) - Acquisitions of Certain Types of Property by Anaconda. Page 12

1. Section 8(c) applies to acquisitions by Anaconda after March 1, 1963 of property --

(A) any boundary of which is contiguous to, or in close proximity to, any part of the Subject Premises (as of March 1, 1963); and

(B) that is not covered by Section 8(b) above.

(NOTE: There may be some difficulty in determining the meaning of the phrase "in close proximity". For example, if property were acquired that was two miles from the present boundary of the Subject Premises, the question might arise whether it should be treated as an acquisition under Section 8(c) or under Section 8(d) below.)

2. Anaconda shall (i) give Banner notice of the acquisition of any such property and (ii) offer to convey such property to Banner by quitclaim deed.

3. If Banner consents to such conveyance within 90 days after the giving of such notice, the property shall (i) be conveyed to Banner as aforesaid and (ii) become part of the Subject Premises. All costs incurred by Anaconda in acquiring and conveying such property shall be charged to the Lease Operations.

4. If Banner fails to give its consent within 90 days after the giving of such notice, Anaconda has complete freedom of action in respect of such property.

5. In no event shall any conveyance be made pursuant to Section 8(c) prior to the Effective Date.

Section 8(d) - Other Acquisitions of Property by Anaconda. Page 13

1. Section 8(d) applies to acquisitions by Anaconda after March 1, 1963 of property --

(A) any boundary of which is located within five miles of any part of the Subject Premises (as of March 1, 1963); and

(B) that is not covered by Sections 8(b) or 8(c) above.

2. Anaconda shall offer to convey such property to Banner by quitclaim deed for an amount equal to the total costs incurred by Anaconda in acquiring and conveying the same.

3. If Banner accepts such offer within 90 days and if Banner makes payment in full, such property shall be conveyed to Banner and thereupon become part of the Subject Premises.

4. If such offer is not accepted by Banner, Anaconda has complete freedom of action in respect of such property.

5. In no event shall any such offer to convey be made prior to the Effective Date.

Section 8(e) - Surrender of Property. Page 14

1. Anaconda may at any time surrender to Banner any property that is included in the Subject Premises.

2. To do so Anaconda must give Banner at least 120 days notice and Anaconda must deliver to Banner an appropriate instrument that shall, if required, be in recordable form.

3. Upon delivery of such instrument, the surrendered property shall cease to be part of the Subject Premises and all rights and obligations of Anaconda and Banner under the Agreement shall terminate with respect to such surrendered property.

4. Anaconda shall make all property payments and perform all assessment and other work requirements with respect to such surrendered property during the 120 day notice period. The costs therefor are chargeable to the Lease Operations.

SECTION 9. RESPONSIBILITY FOR CERTAIN OBLIGATIONS.

Section 9(a) - Banner's Obligations During the Term. Page 14

1. Banner shall be responsible for making all payments (in whatever form) that are applicable to the purchase price of any real property included in the Subject Premises.

2. Banner shall be responsible for making all rental payments under State Leases.

(NOTE: During the Term, Anaconda shall make the royalty (but not rental) payments under State Leases, which payments are chargeable to the Lease Operations.)

3. For convenience Anaconda may make the property payments for which Banner is responsible and take appropriate credits therefor in accordance with Section 15.

Section 9(b) - Anaconda's Obligations During the Term. Page 15

1. Anaconda shall preserve the existing status and titles of the Subject Premises on a best-efforts basis.

2. Anaconda shall perform all obligations of Banner (except property payment obligations) under any lease, leases and options, contracts of purchase and other agreements that are part of the Subject Premises.

3. With respect to work requirements, Anaconda shall --

(A) comply with the requirements of all applicable laws with respect to assessment work at least 60 days prior to the last date prescribed by law for the compliance with such requirements; and

(B) file or record reports, affidavits or such other proof as to performance of assessment work as may be required by law. Upon request, Banner is entitled to receive a copy of such reports, affidavits or other proof.

4. Anaconda shall pay before delinquent all taxes, charges and assessments with respect to the Subject Premises and with respect to personal property installed or located on the Subject Premises for use in the Lease Operations. Upon request, Banner is entitled to receive evidence of payment of any such tax, charge or assessment.

Section 9(c) - Anaconda's Obligation During the Term with Respect to the State Leases. Page 17

1. Anaconda shall comply with the provisions of the State Leases and shall take such action as may be required to keep the State Leases in force and good standing.

2. Anaconda shall take such action as may be necessary or appropriate to obtain timely renewals or extensions of the State Leases.

3. Anaconda shall pay before delinquent all royalties, fees and other amounts with respect to the State Leases. Upon request, Banner is entitled to receive evidence of such payments.

4. Anaconda shall perform all other obligations imposed upon Banner by the State Leases. Upon request, Banner is entitled to receive evidence of such performance.

Section 9(d) - Surrender of State Leases. Page 18

Anaconda shall not surrender or release to the State of Arizona any State Lease without the prior consent of Banner.

SECTION 10. LEASE BONUS. Page 19

Anaconda shall pay to Banner $230,000 on or before the 30th day following the Effective Date.

SECTION 11. ADVANCED ROYALTIES Page 19
SECTION 12. MINIMUM ROYALTIES Page 19

Anaconda shall pay to Banner $1,500,000 on January 10 of each year of the first five years of the Term (an aggregate sum of $7,500,000). For example, if the Effective Date of the Lease were April 1, 1964, the following would be the payment schedule under Sections 11 and 12:

(i) $1,500,000 on January 10, 1965;

(ii) $1,500,000 on January 10, 1966;

(iii) $1,500,000 on January 10, 1967;

(iv) $1,500,000 on January 10, 1968; and

(v) $1,500,000 on January 10, 1969.

SECTION 13. LOAN BY ANACONDA. Page 19

1. Anaconda shall lend to Banner $1,000,000 on or before the 15th day following the Effective Date.

2. Said $1,000,000, together with the sum of the principal and accrued interest then outstanding under Banner's promissory notes referred to in Section 3, shall be evidenced by a single promissory note of Banner in the specified form and shall bear interest at a rate 1/4 of 1% above the prime commercial rate. Compound interest shall be computed annually beginning January 1, 1969.

3. Prepayments on account of interest and principal of such promissory note shall be made in accordance with Sections 14(c) and 14(d) or may be made at any time by Banner. Provision is made for payment of the note in the event of termination of the Agreement.

4. Upon issuance of such promissory note, Banner's promissory notes previously issued pursuant to Section 3 shall be delivered to Banner for cancellation.

SECTION 14. PRODUCTION ROYALTIES.

Section 14(a) - Definitions of "Production Royalty" and "Recoverable Advances". Page 20

Section 14(b) - Payment of Production Royalty. Page 21

In general, Anaconda shall pay to Banner an amount equal to 55% of the Net Profit (determined in accordance with Section 16) for each calendar year during which there is commercial production, payable on February 28 of the next succeeding calendar year. For example, if commercial production were to begin in the calendar year 1969, Anaconda would pay to Banner on February 28, 1970 an amount equal to 55% of the Net Profit for 1969.

Section 14(c) - Deductions from Production Royalty in Calendar Year in which an Advanced Royalty or Minimum Royalty Has Been Paid. Page 21

SECTION 15. SPECIAL ADJUSTMENTS TO ROYALTIES.

The royalties described in Sections 11, 12 and 14 are subject to reduction by the amount of any property payments that Anaconda makes in Banner's behalf and by and other amounts (other than loans) then owing by Banner to Anaconda.

SECTION 16. NET PROFIT OR LOSS.

In accordance with Amendment No. 1 to the Agreement, disputes shall be settled by Price Waterhouse & Co.

SECTION 17. MANAGEMENT OF LEASE OPERATIONS.

1. Anaconda shall conduct the Lease Operations in accordance with good mining practice.

2. Anaconda shall have complete and exclusive control and direction of the Lease Operations.

1. Anaconda must expend $1,000,000 for the following purposes:

(A) drilling for additional reserves in extending the Daisy Oxide orebody; and

(B) other exploration and development work on the Subject Premises.

2. The $1,000,000 amount can be spent at any time between March 1, 1963 and the end of the second year following the Effective Date. If during the option periods, for example, Anaconda spends $1,000,000 on exploration and development work on the Subject Premises (some part of which is used for drilling for additional reserves in extending the Daisy Oxide orebody), Section 17(b) will have no application.

1. Anaconda shall pursue a systematic program of exploration and development in and on the Subject Premises.

2. Anaconda shall engage in mining, milling, leaching or other processes for treating commercially profitable ores or products therefrom extracted from the Subject Premises.

3. Anaconda shall not as a policy place the ore reserves in the Subject Premises "on the shelf".

4. Anaconda agrees to bring into production in an orderly manner and consistent with sound business practice such commercially profitable sulphide orebodies as Anaconda shall have developed.

5. Anaconda shall make a determination of the commercially profitable sulphide ore developed and indicated in the Subject Premises and shall promptly advise Banner of that determination. This may be done at some time during the first two years following the Effective Date after at least $1,000,000 has been expended in exploration and development work on the Subject Premises. Accordingly, if at least $1,000,000 shall have been expended in exploration and development work during the option periods there is no reason why such determination could not be made, and Banner advised of the same, shortly after the Effective Date.

6. Anaconda shall build and equip a metallurgical plant for the concentration or treatment of sulphide ore if Anaconda determines that the Subject Premises contain a reserve of commercially profitable sulphide ore (as defined) aggregating at least ~~1,000,000~~ 100,000,000 tons. This determination is to be made during the first two years following the Effective Date and the construction of the plant is to begin not later than the end of such two year period.

7. Anaconda shall ensure the availability of facilities for the concentration or treatment of such commercially profitable sulphide ore as the Subject Premises may contain if Anaconda determines that the Subject Premises do not contain a reserve of commercially profitable sulphide ore (as defined) aggregating at least ~~1,000,000~~ 100,000,000 tons. This determination is to be made during the first two years following the Effective Date and arrangements for such facilities are to be made not later than the end of such two year period.

(NOTE: The plant referred to in 6 above or the facilities referred to in 7 above, as the case may be, shall have a minimum rated capacity to handle 15,000 tons of ore per day and shall be ready for operation not later than four years following the Effective Date.

The term "commercially profitable sulphide ore" means a reserve of sulphide ore that is the economic equivalent of the reserve of sulphide ore estimated by Anaconda to be within the lode claims "Poor Boy", "Flying Saucer", "Rich Boy", "Rebecca Ann", "Rhoda" and "Little Eva".)

8. Anaconda shall not curtail production under the Lease Operations to an extent materially greater than the curtailment of production at Anaconda's other domestic copper operations.

9. Anaconda shall not be required to conduct the Lease Operations under circumstances that will produce a Net Loss.

Section 17(d) - Smelting and Refining -- Marketing. Page 31

1. Anaconda shall not engage in smelting or refining operations on the Subject Premises except in connection with one or more processes that Banner supplies at the request of Anaconda.

2. Anaconda may enter into smelting and refining contracts for treatment of ores produced from the Lease Operations on the best terms and conditions that are available.

3. All copper and other metals produced from the Lease Operations shall be marketed by Anaconda Sales Company pursuant to a contract which shall contain specified provisions as to the sale of copper and as to the sale of other metals and mineral products.

Section 17(e) - Banner's Process for Treating Oxide Copper Ores. Page 31

1. Anaconda is obligated (i) to study Banner's patented process for treating oxide copper ores, (ii) to advise and consult in connection with such process and (iii) to advise and consult in connection with the operation of Banner's pilot plant for the testing of such process.

2. Anaconda is not obligated to use such process (or some other available process) unless --

(A) Anaconda and Banner each shall decide that such process (or such other available process) is the most effective and economical method of treating the oxide copper ores contained in the Subject Premises (such decision to be based on opinions of metallurgists and other technical personnel); and

(B) Anaconda shall determine that such process (or such other available process) will provide "a fair return and be a reasonably prudent business investment" for the Lease Operations.

Section 17(f) - Books and Accounts Page 32

1. Anaconda shall keep separate books and accounts covering the Lease Operations.

2. Banner shall have the right to audit such books and accounts.

3. After the Effective Date Anaconda shall prepare quarterly or monthly statements of assets, liabilities and profit and loss of the Lease Operations and shall furnish to Banner a copy of each such statement.

Banner's consent must be obtained before Anaconda may make any contract or arrangement with third parties as to the mineral reserves contained in the Subject Premises or the mining or milling thereof, if such contract or arrangement would adversely and materially affect Banner's royalty income under the Agreement.

SECTION 18. AGREEMENTS OF BANNER.

1. Banner grants to Anaconda (with certain exceptions) a nonexclusive royalty-free license to use in the Lease Operations all inventions, improvements, techniques and know-how now or hereafter owned or controlled by Banner.

2. Any improvement made by Anaconda on any invention or technique licensed to it by Banner shall be assigned to Banner, subject to the license referred to in 1 above.

Banner represents that it is the sole owner of United States Letters Patent relating to the process for treating oxide copper ores.

1. Banner is to make available, upon request, any title data it may have.

2. Banner shall cooperate with Anaconda in any effort by Anaconda to ascertain the status of title and in all reasonable efforts to clear clouds or defects in title.

3. In connection with patent proceedings Banner shall appoint Anaconda's designees to perform on behalf of Banner surveys, assays and other patent work and to file on behalf of Banner (but not without its consent) applications and other appropriate documents.

4. The expenses of patent proceedings are chargeable to the Lease Operations.

Section 18(d) - Restrictions on Banner's Right to Transfer and Encumber the Subject Premises During the Term. Page 34

Section 18(e) - Restrictions Against Recording. Page 35

Section 18(f) - Sideline Agreements. Page 35

During the Term, Banner shall execute sideline agreements if they are satisfactory to Anaconda and to Banner.

SECTION 19. WATER RESOURCES. Page 35

The parties shall cooperate in order to provide sufficient water resources for the Lease Operations, but Banner has the right to use the water located in the presently existing underground mines for Banner's office and for the oxide plant that it may construct.

SECTION 20. HELVETIA PROPERTIES.

Section 20(a) - Definition of "Helvetia Properties". Page 35

The term "the Helvetia Properties" means the properties listed in Exhibit A under the heading HELVETIA PROPERTIES and any property that subsequently becomes part of the Subject Premises and that is within five miles of any properties listed in Exhibit A under the heading HELVETIA PROPERTIES.

Section 20(b) - Helvetia Payments Page 36

1. The term "Helvetia Payments" means payments on account of the purchase price under any contract relating to the Helvetia Properties.

2. Banner shall make all Helvetia Payments that become due and payable prior to January 1, 1965.

Section 20(c) - Submission of Plan for Helvetia Properties. Page 36

1. On or before October 31, 1964 Anaconda is to submit to Banner a plan or plans (defined in the Agreement as "the Plan") with respect to the Helvetia Properties.

2. The Plan will contain the following:

(A) a provision with respect to the scope of the work proposed to be performed for the development of the Helvetia Properties;

(B) a provision with respect to the engineering background thereof;

(C) a statement of the period of time during which such work is proposed to be performed;

(D) a provision that, upon acceptance of the Plan, Anaconda shall make Helvetia Payments that become due and payable during the period beginning January 1, 1965 and ending on the date that the work under the Plan is proposed to be completed; and

(E) a provision that, upon acceptance of the Plan, Anaconda shall perform all obligations of Banner with respect to the Helvetia Properties during the period covered by the Plan.

(NOTE: Helvetia Payments made by Anaconda pursuant to any plan accepted by Banner are considered property-acquisition costs under Section 16(h).)

Section 20(d) - Procedures Following Submission of the Plan. Page 36

1. Within 30 days after submission of the Plan, Banner is to give notice of its acceptance or rejection of the Plan.

2. If Banner accepts the Plan, the Plan will be put into effect according to its terms.

3. If Banner rejects the Plan (or simply fails to give notice), Anaconda may make all or certain Helvetia Payments on its own. If Anaconda wishes to make such payments, it must give Banner notice of such intention within 45 days after submission of the Plan. Thereafter, notice must be given to Banner when Anaconda intends to discontinue such payments.

4. If Banner rejects the Plan and if Anaconda does not wish to make Helvetia Payments (i.e., if Anaconda fails to give the notice referred to in 3 above), then Banner may make all or certain Helvetia Payments. If Banner wishes to make such payments, it must give Anaconda notice of such intention within 60 days after submission of the Plan. Thereafter, notice must be given to Anaconda when Banner intends to discontinue such payments.

(NOTE: Helvetia Payments that Anaconda may make on its own after Banner's rejection of a plan shall be deemed advances to Banner and shall be recovered, together with interest, only by deduction from Production Royalties (if any) attributable to operations on the Helvetia Properties. They shall not be treated as property-acquisition costs under Section 16(h).)

Section 20(e) - Supplementary Plans. Page 38

Anaconda may submit a supplementary plan or plans with respect to the Helvetia Properties. Each such plan should cover the subjects described under Section 20(c) above and should be submitted at least 60 days before the expiration of the accepted plan then in effect.

Section 20(f) - Time When Helvetia Properties No Longer are Part of the Subject Premises. Page 38

The Helvetia Properties shall be deemed no longer included in the Subject Premises --

(i) in the event that (at any time after January 1, 1965) Anaconda shall not be making Helvetia Payments; and

(ii) in the further event that Banner shall terminate and surrender all its interests under any contracts relating to the Helvetia Properties.

(NOTE: This provision is in addition to Section 8(e). Anaconda may, of course, surrender any of the Helvetia Properties in the manner prescribed by Section 8(e).)

This section applies only to the Helvetia Properties covered by the four contracts referred to as parcels Nos. 1, 2, 3 and 4 in Exhibit A under the heading HELVETIA PROPERTIES.

SECTION 21. TWIN BUTTES PROPERTIES.

1. The term "the Twin Buttes Properties" shall mean those parts of the Subject Premises that are identified in Exhibit A under the heading TWIN BUTTES PROPERTIES and any additions thereto in accordance with Section 8.

2. The term "Twin Buttes Production Royalties" means production royalties attributable to the Lease Operations on the Twin Buttes Properties.

1. Anaconda is to pay Banner amounts not to exceed $500,000 on February 28 of each year next succeeding the tenth anniversary of the Effective Date until $2,500,000 shall have been paid. These payments are the maximum amounts payable pursuant to Section 21; in certain circumstances they may be less. Such payments, if made, are recoverable only from Twin Buttes Production Royalties.

2. No payments at all would be made under Section 21 if production royalties attributable to operations on the Twin Buttes Properties amounted to $2,500,000 prior to the tenth anniversary of the Effective Date. Section 21 also would be inapplicable if Anaconda surrenders the Twin Buttes Properties prior to the tenth anniversary of the Effective Date.

SECTION 22. TERMINATION OF LEASE.

1. Anaconda may terminate the Lease at any time by giving Banner at least 180 days' notice of such termination.

2. In the event of such termination, provision is made for the sale to Banner of property owned by Anaconda and located on or used in connection with the Subject Premises.

3. The provisions of Section 22(a) apply also in the event of termination of the Lease for Anaconda's default pursuant to Section 24.

Section 22(b) - Termination Other Than by Anaconda. Page 42

Section 22(b) is intended to cover the possible termination of the Lease for causes other than voluntary termination by Anaconda or default by Anaconda. Provision is made for the disposition of Anaconda's property located on or used in connection with the Subject Premises.

SECTION 23. WITHDRAWAL FROM PREMISES. Page 43

In general, Anaconda has two years after the expiration of the Term or termination of the Lease within which to withdraw its personnel and remove its property.

SECTION 24. DEFAULT.

Section 24(a) - Banner's Right to Terminate the Lease for Certain Events of Default. Page 44

Banner may terminate the Lease only after both of the following events shall have occurred:

(i) Anaconda shall have defaulted --

-- in making any payment due to Banner under the Agreement; or

-- by failing to build and equip the metallurgical plant or to ensure the availability of facilities as the case may be, as provided in Section 17(c); or

-- by becoming the subject of any bankruptcy or reorganization proceeding; and

(ii) any such default shall have continued unremedied for 90 days after Banner shall have given notice to Anaconda specifying the default.

Section 24(b) - Remedies of Banner for Other Events of Default. Page 44

If Anaconda shall have defaulted in the performance of any obligations under the Agreement other than those listed in Section 24(a), Banner's only remedy is to seek equitable relief and/or damages by bringing an action in the Federal Court of Arizona or in the Superior Court of Arizona.

<u>Section 24(c) - Remedies of Anaconda for Banner's Default.</u> Page 44

If during the Term, Banner shall have defaulted in any of its obligations under the Agreement, Anaconda's only remedy is to seek equitable relief and/or damages by bringing an action in the Federal Court of Arizona or in the Superior Court of Arizona.

<u>Section 24(d) - Exclusivity of Remedies.</u> Page 45

ARTICLE III - PURCHASE

SECTION 25. PERSONAL PROPERTY. Page 45

1. Banner is to transfer to Anaconda not later than 15 days after the Effective Date all Banner's personal property described in Exhibit A.

2. Anaconda is to pay Banner $1,261,636.54 for such property not later than 60 days after the Effective Date.

SECTION 26. OXIDE ORE. Page 46

1. Banner is to transfer to Anaconda not later than 15 days after the Effective Date all the oxide ore owned by Banner that has been and will be excavated from the upper cone volume of the Pima Cone.

2. Anaconda is to pay Banner $1,000,000 for such oxide ore at the time of such transfer.

3. Upon payment the oxide ore shall be the sole and exclusive property of Anaconda, except that Banner has the right to purchase for certain purposes any oxide ore located on the Subject Premises for $1.00 per ton.

4. If Anaconda treats any such oxide ore in a facility connected with the Lease Operations, the cost of such treatment shall not be chargeable to the Lease Operations.

5. Anaconda has the right to stock the oxide ore on Banner's property without charge until such property is required for mining operations.

ARTICLE IV - GENERAL

SECTION 27. FORCE MAJEURE. Page 47

If force majeure prevents a party from carrying out any of its obligations under the Agreement, the performance of such obligations shall be suspended during the continuance of such force majeure. The occurrence of force majeure, however, shall not postpone or affect the obligations of Anaconda to make the loans to Banner pursuant to Sections 3 and 13 and to pay Banner the Advanced Royalties and Minimum Royalties pursuant to Sections 11 and 12.

SECTION 28. GOVERNING LAW. Page 48

The Agreement shall be governed by the law of Arizona.

SECTION 29. ACCESS TO INFORMATION AND TO LEASE OPERATIONS. Page 48

1. Banner has the following rights:

(A) access at all reasonable times to all factual geological and engineering data on the Subject Premises or applicable thereto;

(B) ingress and egress to and from the Subject Premises; and

(C) inspection of the Lease Operations at all reasonable times provided that such inspection does not interfere with the Lease Operations.

2. Banner assumes liability for its personnel on the Subject Premises.

SECTION 30. NON-WAIVER. Page 48

SECTION 31. FURTHER ASSURANCES.

SECTION 32. EFFECTIVENESS OF AGREEMENT. Page 49

The provisions of Section 32 have been complied with.

SECTION 33. NOTICES. Page 49

1. All communications required or permitted to be given by the Agreement shall be in writing. These include notices, requests, consents, waivers, offers, approvals, demands, directions, etc.

2. All notices and other communications described in 1 above should be given to Banner either by personal delivery to an officer of Banner or by <u>registered</u> mail addressed to Banner as follows:

Banner Mining Company
P.O. Box 5605
Tucson, Arizona

Attention: The Secretary

SECTION 34. ASSIGNMENT; SUCCESSORS.

<u>Section 34(a) - Assignment by Banner.</u> Page 50

1. Anaconda's consent must be obtained before Banner may assign or transfer the Agreement or any of its rights thereunder.

2. Anaconda's consent also must be obtained before Banner may dissolve or liquidate.

<u>Section 34(b) - Effect of Anaconda's Failure to Consent.</u> Page 50

If Anaconda withholds its consent to any proposed action of Banner pursuant to Section 18(d) (Restrictions on Transfer, etc.) or pursuant to Section 34(a) (Assignment, etc.), Anaconda has the burden of establishing that such proposed action by Banner materially and adversely affects Anaconda's interest under the Agreement.

1. Anaconda may without Banner's consent --

(A) assign the Agreement or any of its rights thereunder to any company controlled by Anaconda; and

(B) make block leases or clean-up leases normal in the mining industry with respect to any part of the Subject Premises.

2. Except as permitted in 1 above, Banner's consent must be obtained before Anaconda can assign the Agreement or any of its rights thereunder.

1. The Agreement supersedes all prior agreements and understandings relating to the same subject matter.

2. Any change, waiver or release with respect to the Agreement must be in writing.

Banner does not warrant or undertake to defend the status of its title to any part of the Subject Premises. Banner must, however, cooperate with Anaconda with respect to title matters in accordance with Section 18(c).

1. Banner is permitted to post notices of non-liability on the Subject Premises.

2. Anaconda is required to comply with all provisions of existing law relating to posting of "No Lien" notices.

2/13/64

Copies of letters from Van Cott, Bagley, Cornwall & McCarthy regarding title evidence on Banner Mining Company property were sent to:

	Oct. 8, 1963:	Henry Ladendorff, W.M.Kirkpatrick, Robert Dwyer, R.B.M.	
(Parcel 9)	Oct.10, 1963:		ditto
" 1	" " "		ditto
" 13	Nov.14, 1963	(not shown)	
(part of " 9	Jan.28, 1964		ditto, plus Bilgore
" 14	Feb. 3, 1964		ditto " "
" 5	Feb. 7, 1964		ditto " "

ORM 167

THE ANACONDA COMPANY

GEOLOGICAL DEPARTMENT

RECOMMENDATION FOR DEVELOPMENT WORK

MINE EAST HELVETIA
COUNTY Pima STATE Ariz.
REC. NO. 47

To:

Description: Diamond drill a vertical hole at approximate coordinate location N. 302,100, E. 860,700.

Object: A "wildcat" prospect for mineral about 1600 ft. south of DDH A-821.

Approximate Amount of Work 1800 ft.
Date of Recommendation Sept. 10, 1964
Date Started
Date Finished
Results:

Recommended by James L. Kelly
Approved by Roland A. Mulchay

cc Mr. V. D. Perry
Mr. J. B. Knaebel

THE ANACONDA COMPANY

25 Broadway

New York 4, New York

Legal Department

October 22, 1963

Mr. J. B. Knaebel
General Manger - New Mines
The Anaconda Company
Britannia Beach
British Columbia

Dear Jack

In connection with the Anaconda-Banner Agreement, I invite your attention to a matter than should be taken care of before the end of this month. Under Section 2(a) of the Agreement, Anaconda has agreed to designate to Banner, not later than October 31, 1963, the sideline agreements to be negotiated during the extended option period. It would seem to me a sufficient compliance with this provision if Anaconda were to furnish to Banner an all inclusive list of proposed sideline agreements, whether or not there is any present intention to execute them.

I am enclosing with this letter a memorandum to you of even date to which is attached an outline of the Anaconda-Banner Agreement for your use.

With kind regards,

Sincerely yours,

PAUL S. BILGORE

Paul S. Bilgore
Counsel

PSB:jf

cc: Messrs. C. Jay Parkinson
V. D. Perry
R. B. Mulchay

From

PAUL S. BILGORE

October 22, 1963

To: Mr. R. B. Mulchay

Attached hereto for your personal use is an outline of the March 1, 1963 Agreement between Anaconda and Banner. The outline is designed to serve as an aid in analyzing Anaconda's obligations under the Agreement. Since it also contains editorial comments, it has been marked "Confidential". Jay Parkinson has requested that his approval be obtained before the outline is given to anyone not listed below.

Paul S. Bilgore

Paul S. Bilgore

Distributed to: CEW, CMB, ESM, CJP, RSN, VDP, WEQ, RES, J.B.Knaebel, W.M.Kirkpatrick, R.B.Mulchay

THE ANACONDA COMPANY

25 Broadway

New York 4, N. Y.

LEGAL DEPARTMENT

October 23, 1963

Mr. J. B. Knaebel
General Manager
The Anaconda Company
New Mines Department
P. O. Box 3039
Tucson, Arizona

Dear Jack:

In connection with the Anaconda-Banner Agreement, I invite your attention to a matter that should be taken care of before the end of this month. Under Section 2(a) of the Agreement, Anaconda has agreed to designate to Banner, not later than October 31, 1963, the sideline agreements to be negotiated during the extended option period. It would seem to me a sufficient compliance with this provision if Anaconda were to furnish to Banner an all inclusive list of proposed sideline agreements, whether or not there is any present intention to execute them.

I am enclosing with this letter a memorandum to you of even date to which is attached an outline of the Anaconda-Banner Agreement for your use. I should like to stress that the outline is to be treated as confidential.

With kind regards,

Sincerely yours,
PAUL S. BILGORE

Paul S. Bilgore
Counsel

PSB:jf

cc: Messrs. C. Jay Parkinson
V. D. Perry
R. B. Mulchay

P.S. This letter supersedes a similar letter that was sent to you yesterday at Britannia Beach.

P.S.B.

From

PAUL S. BILGORE

October 23, 1963

To: Mr. R. B. Mulchay

Mul -- Attached hereto is revised page 14 that should be substituted for the corresponding page of the outline of the Anaconda-Banner Agreement that was sent to you yesterday. You will see that the change, which is underscored in red, is a rather substantial one.

Paul

P.S.B.

Attachment

5. Anaconda shall make a determination of the commercially profitable sulphide ore developed and indicated in the Subject Premises and shall promptly advise Banner of that determination. This may be done at some time during the first two years following the Effective Date after at least $1,000,000 has been expended in exploration and development work on the Subject Premises. Accordingly, if at least $1,000,000 shall have been expended in exploration and development work during the option periods there is no reason why such determination could not be made, and Banner advised of the same, shortly after the Effective Date.

6. Anaconda shall build and equip a metallurgical plant for the concentration or treatment of sulphide ore if Anaconda determines that the Subject Premises contain a reserve of commercially profitable sulphide ore (as defined) aggregating at least 100,000,000 tons. This determination is to be made during the first two years following the Effective Date and the construction of the plant is to begin not later than the end of such two year period.

7. Anaconda shall ensure the availability of facilities for the concentration or treatment of such commercially profitable sulphide ore as the Subject Premises may contain if Anaconda determines that the Subject Premises do not contain a reserve of commercially profitable sulphide ore (as defined) aggregating at least 100,000,000 tons. This determination is to be made during the first two years following the Effective Date and arrangements for such facilities are to be made not later than the end of such two year period.

(NOTE: The plant referred to in 6 above or the facilities referred to in 7 above, as the case may be, shall have a minimum rated capacity to handle 15,000 tons of ore per day and shall be ready for operation not later than four years following the Effective Date.

The term "commercially profitable sulphide ore" means a reserve of sulphide ore that is the economic equivalent of the reserve of sulphide ore estimated by Anaconda to be within the lode claims "Poor Boy", "Flying Saucer", "Rich Boy", "Rebecca Ann", "Rhoda" and "Little Eva".)

8. Anaconda shall not curtail production under the Lease Operations to an extent materially greater than the curtailment of production at Anaconda's other domestic copper operations.

9. Anaconda shall not be required to conduct the Lease Operations under circumstances that will produce a Net Loss.

*

MAR 25 1963

CONFIDENTIAL

Time Schedule under March 1, 1963 Agreement between Anaconda ("A") and Banner ("B")

1. March 1, 1963

Date of the Agreement; date of execution of the Agreement; and date on which the Agreement became effective in accordance with Section 32.

A to lend B $500,000 in exchange for B's promissory note. (This already has been accomplished.) Sec. 3.

2. March 31, 1963

On or before this date B is to give A notice of all premilinary acts, consents and instruments that B considers necessary to perform or obtain to permit the lease of properties contemplated by the Agreement (particularly Section 6) to become effective. Sec. 1(d).

3. April 30, 1963

On or before this date A is to give B notice if A considers it necessary for B to perform any further preliminary acts or obtain any further consents or instruments to permit the lease of properties contemplated by the Agreement (particularly Section 6) to become effective. Sec. 1(d).

4. July 4, 1963

On or before this date B is to give A notice of the status

3/21/63

of B's performance of such preliminary acts and the status of all such consents and instruments set forth in the notices referred to in items 2 and 3 above. Sec. 1(d).

5. July 13, 1963

On or before this date A is to give B notice that the Extended Option Period is to become effective. Although July 14, 1963 is the last day on which this notice can be given, it would be advisable to give it earlier. Sec. 2(a).

6. July 14, 1963

Expiration date of the Initial Option Period. Sec. 1(e)(i).

Date on which the Agreement automatically terminates if A does not give B the notice referred to in item 5 above. Sec. 2(a).

A to lend B $500,000 in exchange for B's promissory note. Sec. 3.

7. July 15, 1963

Date on which the Extended Option Period begins. Sec. 1(e)(ii).

8. October 15, 1963

A to lend B $50,000 in exchange for B's promissory note if B requests the loan and if the Lease has not theretofore become effective. Sec. 3.

9. October 31, 1963

On or before this date A is to designate to B the sideline

APR 12 1962

THE ANACONDA COMPANY

151 S. Tucson Blvd. — Room 221

Tucson, Arizona

Geological Department
Southwest Exploration Office

April 10, 1962

Mr. Roland B. Mulchay, Asst. Chief Geologist
The Anaconda Company
809 Kearns Building
Salt Lake City 1, Utah

Dear Mr. Mulchay:

On April 2, 1962 John M. Hoffman and I visited the Mineral Hill property of Banner Mining Company, south of Tucson, Pima County, Arizona. Mr. Allan B. Bowman, Vice President and General Manager of Banner, was very cooperative in describing Banner's operations in the Pima district. The following information was supplied by Mr. Bowman:

Concentrated at Min. Hill - no production from Min. Hill mine.

Banner is presently mining an average of 1000 tons/day of ore averaging 3% copper from their Mineral Hill Mine. The copper occurs as chalcopyrite and bornite in garnetized limestone beds which dip from 10° to 30° near an intrusive acidic rock, quartz monzonite(?), contact. The ore horizon is generally from 30 to 35 feet thick, and contains irregular amounts of molybdenite associated with the bornite. The 32% copper concentrates produced are shipped to A. S. & R.'s El Paso smelter. Plans are being made to enlarge the mill at Mineral Hill.

Untested - very high cost treatment process.

Metallurgical tests on the Daisy Shaft area copper oxide ores have been successful. A 50 ton/day pilot plant will be constructed at Mineral Hill by Stearns-Rodgers Manufacturing Company in the immediate future. This plant will treat ore from the Daisy Shaft area, and from the Helvetia district in the Santa Rita Mountains, approximately twenty airline miles east of Mineral Hill. Laboratory tests of the application of the recovery process to the mixed sulfide-oxide ores at Helvetia have been very satisfactory. Banner believes that they will be able to treat copper oxide ores from both areas in the same plant.

Granite at surface near Leader Shaft - called Bolsa by Schrader - is not basal granite.

Diamond drilling at Helvetia continues, and has disclosed some interesting geologic relationships. A "basement" granite which was regarded as Precambrian in age, was penetrated by one drill hole and found to be underlain by at least 1300 feet of sediments, mainly limestones.

Banner is also diamond drilling near Twin Buttes, about five miles southeast of Mineral Hill. Results have been encouraging, and it is believed that a large replacement-type deposit, similar to that at Mineral Hill, is present. Ore-grade copper sulfide minerals occur mainly near the contact of silicated limestone and the top of an acidic intrusive. Additional copper ore is expected at the lower contact of the sediments and intrusive.

Agreement provides for payment at stated grade at 92% recovery.

Pima Mining Company is currently stripping an area approximately 700 feet within the Banner Mining Company property as part of an agreement reached last year. Development of this extension of the Pima Pit has progressed to the copper oxide zone below the 200 feet of overburden. Pima will mine and mill about 250,000 tons of Banner ore per year until a total of 1,797,000 tons have been removed. This ore has an average copper content of approximately 1.0%.

No exploratory or development work is presently being done at the San Xavier Mine, which was purchased by Banner in 1961. The underground workings at the San Xavier Mine are being kept dry pending future development.

Underground development and drilling from both surface and underground in the Palo Verde Shaft area have developed the following tonnages to date:

Proved tonnage -	65,000,000	
Probable tonnage-	15,000,000	
Total	80,000,000	@ 0.95% copper

Gold, silver, and molybdenum values are apparently large enough to warrant recovery. Banner is currently assaying about 10,000 drill core samples for molybdenum by use of General Electric X-ray equipment. Besides the forementioned tonnage, 100,000,000 tons of quartz monzonite intrusive, assaying slightly more than 0.30% copper, with appreciable gold, silver, and molybdenum values, have been delineated by the drilling in the Palo Verde Shaft area. It is hoped that sufficient molybdenum will be found in this tonnage to make it economical to consider it with the 80,000,000 tons of replacement-type ore. Combined, these two tonnages would result in a total of 180,000,000 tons of material averaging 0.60% copper, and an undetermined amount of gold, silver, and molybdenum. Development of this tonnage would require stripping of about 200 feet of loose overburden, as has been done on the adjoining properties of Pima Mining Company and the Mission Unit of A. S. & R. Co. The replacement ore extends to the southeast to form a continuous orebody with A. S. & R.'s Mission deposit. One drill hole in the extreme southeast corner of Banner's property, east of the Palo Verde Shaft, intersected 50 to 60 feet of material assaying over 4.0% copper.

Mr. Bowman repeatedly stated that Banner would be interested in a possible joint venture with a large mining company in the development of the Palo Verde orebody. The inference interpreted by both Hoffman and myself was that Banner would be very willing to consider any proposal that Anaconda would make along these lines. Such an arrangement should be considered, as Banner appears to have control of a large amount of ore-potential property in the Pima, Twin Buttes, and Helvetia districts. Their exploration program apparently has produced favorable results to date, with a potential of developing a substantial amount of additional ore as it continues.

I suggest that this situation be strongly considered by The Anaconda Company.

Yours very truly,

G. A. Barber

G. A. Barber

Bowman visited by VDP - RBM - GAB AM 4/13/62

GAB:je

June 6, 1962

PERSONAL

Mr. V.D. Perry
Vice President and Chief Geologist
The Anaconda Company
25 Broadway - Suite 1850
New York 4, N.Y.

Dear Mr. Perry:

Following our telephone conversation on June 4th, I have reviewed briefly the legal investigation which must be made in connection with any business arrangement which may be made with the Banner Mining Company. From our previous contracts with other companies which are less complicated than Banner, it is evident that the legal investigation will be as important and lengthy as the proposed geological and mining examination. Following is a list of items which must be investigated; others may become apparent later.

LEGAL INVESTIGATION

TITLES TO PROPERTY

Claims

Patented
Unpatented
  Group assessment work requirements this year and in future
Claims now in patent proceedings
Abstracts
Present title conflicts, if any

State Leases

Surface
Mineral - royalty rates, duration, work requirements, etc.
Commercial

Outside Surface Agreements

Underlying Agreements

Mineral Hill - Twin Buttes
San Xavier Mine
Helvetia
  Payments - work requirements

Underlying Agreements (continued)

Morenci Properties
  Payments - work requirements
Banner Mine, Lordsburg
Tucson Mountain Park Claims
Water Rights
Dump Areas
Tailings Disposal Areas
All Other Mineral Interests

OPERATIONS

Sideline Agreements

Pima Mining Company
A. S. & R.
San Xavier Indian Reservation (A.S.& R. as lessees)

Other Agreements - On Operations; Easements, Access, etc.

Operations - Continue ?
Responsibility ?

Patents - Metallurgical
Others

TAXES

Property
Income (loss carry over ?)
Franchise, net proceeds (severance)

If an agreement is reached with the Banner Mining Company, it is my suggestion that at least two men from the legal department spend full time on thorough investigation of the above items, and that a complete analysis of titles and underlying agreements be submitted well in advance of the final date of the examination period. It should be emphasized in the contract that all of Banner's interests in mineral properties should be reserved to the Company unless specifically excepted in the contract. Nothing which has been of interest to Banner should be withheld for the possible future benefit of individual Banner stockholders.

The necessary legal investigation will be of utmost importance, and it is urged that it be pursued with the greatest diligence. It will, of course, be necessary for the operating departments to appraise present equipment, and to develop future operating plans and cost estimates.

Yours very truly,

Roland B. Mulchay

Roland B. Mulchay

RBM:S

4

40	2000
41	1700
42	1600
43	1700
44	2000
45	1700
46	1800
	12,500
47 (7187)	1800
48	2000
	16,300
	3,800
	12,500

302,100
862 900

From

PAUL S. BILGORE

October 22, 1963

To: Mr. R. B. Mulchay

Attached hereto for your personal use is an outline of the March 1, 1963 Agreement between Anaconda and Banner. The outline is designed to serve as an aid in analyzing Anaconda's obligations under the Agreement. Since it also contains editorial comments, it has been marked "Confidential". Jay Parkinson has requested that his approval be obtained before the outline is given to anyone not listed below.

Paul S. Bilgore

Paul S. Bilgore

Distributed to: CEW, CMB, ESM, CJP, RSN, VDP, WEQ, RES, J.B. Knaebel, W.M. Kirkpatrick, R.B. Mulchay

MERRILL LYNCH,
PIERCE,
FENNER & SMITH INC
KENNECOTT BUILDING
SALT LAKE CITY, UTAH 84111

SALT LAKE CITY, UTAH
AM
14 MAR
1966

SALT LAKE CITY
MAR 11 '66
UTAH

"ABCD" MAIL FOR
BETTER BUSINESS SERVICE

U.S. POSTAGE
.05
P.B. METER 805513

Mr. R. W. Mulchey
~~809 Kearns Building~~ 2732 Wren Road
Salt Lake City, Utah 84117

Figure 1. – Label Christmas

Figure 2 outline
Xmas tin area
(5) indistinct.
make coords ~~same~~
Locate operating shafts

Figure 3 Label Xmas Fault
on HW end.
Revise title +
legend
N. arrow.

Fig 4, N. arrow
Label faults at proper
level.

Fig 5. ~~Vista~~ of "mineralization"

Figure 6. Omit
Reagan Camp –
Santa Monica
unless discussed in
text.
Describe formations
LS – etc.

Figure 7 late gangue
stage – sulphide
minerals?
Magnetite part of
main min age

Leave out
or revise

Fridan calculator (3month rental period complete May 26, 1964
@ \$50.00/mo = \$150.00 deductable from any
machine we purchase)

Model STW-10 column \$880 (This is the model we are renting
" " 8 column \$820

" SW 10 column \$755
" SW 8 column \$695

} these models are not as automatic as the STW series, but are probably satisfactory for our needs. A test machine is on order

Baker expense acct.

5/12/64

809

376 - 682 = 306' - 0.83 ± 0.02

812 429 - 819 = 390' - 0.79 0.019

804 482 - 810 = 328' - 0.79 0.009

806 802 - 1349 = 547' - 0.80 0.029

2089 / 522'

4)1571 = 393 use 400'

E - W 1650
1200
2850
1425 × 1600 × 400

1425
1600
855000
1425
2280000
400
91200000
12) 96,000,000

± 0.86 ~~ ~~ 0.02 Mo

FORM 167 4-26-61 2M

SEP 11 1964

THE ANACONDA COMPANY

GEOLOGICAL DEPARTMENT

RECOMMENDATION FOR DEVELOPMENT WORK

MINE EAST HELVETIA

COUNTY Pima STATE Ariz.

REC. NO. 47

To:

Description: Diamond drill a vertical hole at approximate coordinate location N. 302,100, E. 860,700.

Object: A "wildcat" prospect for mineral about 1600 ft. south of DDH A-821.

Approximate Amount of Work 1800 ft.

Date of Recommendation Sept. 10, 1964

Date Started

Date Finished

Results:

Recommended by James L. Kelley

Approved by Richard B. Mieritz

cc Mr. V. D. Perry
Mr. J. B. Knaebel

FORM 167

THE ANACONDA COMPANY

GEOLOGICAL DEPARTMENT

RECOMMENDATION FOR DEVELOPMENT WORK

MINE: EAST HELVETIA
COUNTY: Pima STATE: Ariz.
REC. NO.: 47

To:

Description: Diamond drill a vertical hole at approximate coordinate location N. 302,100, E. 860,700.

Object: A "wildcat" prospect for mineral about 1600 ft. south of DDH A-821.

Approximate Amount of Work: 1800 ft.
Date of Recommendation: Sept. 10, 1964
Date Started:
Date Finished:
Results:

Recommended by: James L. Kelly
Approved by: Roland B. Mulchay

cc Mr. V. D. Perry
Mr. J. B. Knaebel

FORM 167

MINE	EAST HELVETIA
COUNTY	Pima
STATE	Ariz.
REC. NO.	47

THE ANACONDA COMPANY

GEOLOGICAL DEPARTMENT

RECOMMENDATION FOR DEVELOPMENT WORK

To:

Description: Diamond drill a vertical hole at approximate coordinate location N. 302,100, E. 860,700.

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Date of Recommendation Sept. 10, 1964

Recommended by [signature]

Date Started

Date Finished

Results:

Approved by [signature]

cc Mr. V. D. Perry
Mr. J. B. Knaebel ✓

FORM 167

THE ANACONDA COMPANY

GEOLOGICAL DEPARTMENT

RECOMMENDATION FOR DEVELOPMENT WORK

SEP 11 1964

MINE: EAST HELVETIA

COUNTY: Pima STATE: Ariz.

REC. NO.: 47

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Date of Recommendation: Sept. 10, 1964

Recommended by: James L. Kelly

Date Started:

Date Finished:

Results:

Approved by: Roland B. Mulchay

cc Mr. V. D. Perry
Mr. J. B. Knaebel

2/13/64

Copies of letters from Van Cott, Bagley, Cornwall & McCarthy regarding title evidence on Banner Mining Company property were sent to:

		Oct. 8, 1963:	Henry Ladendorff, W.M.Kirkpatrick, Robert Dwyer, R.B.M.	
	(Parcel 9)	Oct.10, 1963:		ditto
	" 1	" " "		ditto
	" 13	Nov.14, 1963	(not shown)	
(part of	" 9	Jan.28, 1964		ditto, plus Bilgore
	" 14	Feb. 3, 1964		ditto " "
	" 5	Feb. 7, 1964		ditto " "

THE ANACONDA COMPANY

25 Broadway

New York 4, New York

Legal Department

October 22, 1963

Mr. J. B. Knaebel
General Manger - New Mines
The Anaconda Company
Britannia Beach
British Columbia

Dear Jack

In connection with the Anaconda-Banner Agreement, I invite your attention to a matter than should be taken care of before the end of this month. Under Section 2(a) of the Agreement, Anaconda has agreed to designate to Banner, not later than October 31, 1963, the sideline agreements to be negotiated during the extended option period. It would seem to me a sufficient compliance with this provision if Anaconda were to furnish to Banner an all inclusive list of proposed sideline agreements, whether or not there is any present intention to execute them.

I am enclosing with this letter a memorandum to you of even date to which is attached an outline of the Anaconda-Banner Agreement for your use.

With kind regards,

Sincerely yours,

PAUL S. BILGORE

Paul S. Bilgore
Counsel

PSB:jf

cc: Messrs. C. Jay Parkinson
V. D. Perry
R. B. Mulchay

THE ANACONDA COMPANY

25 Broadway

New York 4, N. Y.

LEGAL DEPARTMENT

October 23, 1963

Mr. J. B. Knaebel
General Manager
The Anaconda Company
New Mines Department
P. O. Box 3039
Tucson, Arizona

Dear Jack:

In connection with the Anaconda-Banner Agreement, I invite your attention to a matter that should be taken care of before the end of this month. Under Section 2(a) of the Agreement, Anaconda has agreed to designate to Banner, not later than October 31, 1963, the sideline agreements to be negotiated during the extended option period. It would seem to me a sufficient compliance with this provision if Anaconda were to furnish to Banner an all inclusive list of proposed sideline agreements, whether or not there is any present intention to execute them.

I am enclosing with this letter a memorandum to you of even date to which is attached an outline of the Anaconda-Banner Agreement for your use. I should like to stress that the outline is to be treated as confidential.

With kind regards,

Sincerely yours,
PAUL S. BILGORE

Paul S. Bilgore
Counsel

PSB:jf

cc: Messrs. C. Jay Parkinson
V. D. Perry
R. B. Mulchay

P.S. This letter supersedes a similar letter that was sent to you yesterday at Britannia Beach.

P.S.B.

From

PAUL S. BILGORE

October 23, 1963

To: Mr. R. B. Mulchay

Mul -- Attached hereto is revised page 14 that should be substituted for the corresponding page of the outline of the Anaconda-Banner Agreement that was sent to you yesterday. You will see that the change, which is underscored in red, is a rather substantial one.

Paul

P.S.B.

Attachment

HELVETIA 7/10/64

STOP 819 — Move to Rec. 24 at 800' E of DDH 813

Next possibly to G 43 at 1150' NE of Rec. 24.

Continue to 1500'; ± 308,500 N.

820 Move to VDP rec. about 2650' NW of 820 861,100 E.

Prepare station on 305 300N at 2000' E of 816

817 Move to site on Sect 304,500N. (Due S, SW (prepared) or SE)

815 Move to Rec. 8 @ 400'± W of 806

Prepare most of additional sites to develop main ore zone

will give ± 12 more locations, including three near 815 + 817.

Investigate por. area to SW.

TWIN BUTTES.

903, 904 started near 681.

Rec 99 200' NE of 664

2 holes SW of 677

2 " " " 654

3 " SW of 624

3 " SW of 618

2 " SW of 633 — 1 hole NE of 673

1 " SW of 691

3 " on Sect 3200 E

Rec 89, 90, 100, (21)

other holes for knockee. to E and NE of 697.

Talk to Perry about 665 area, prints.

Have set of sections + plan sent near end of month to RBM, (Perry.)

Also plan of Sen. Morgan area.

Get rec. for 3 R drilling. Bids on drilling — geo-phys. data.

DAISY 5/11/64

811	1139 - 1163	Gray to gray green sil. Ls with FeS_2 irreg $CuFeS_2$ along thin partings - [illegible] - Few sandy layers.
	1163 - 1175	Gray and sil. Ls with qtzite bands, oxid. min - FeO_x and $CuCO_3$ FeO_x - little residual sulph.
	1175 - 1178	Qtzite with little FeO_x(?)
813	611 - 645	Gray sil. Ls with good fine dis FeS_2 $CuFeS_2$ born Cu_2S. 2' of partly ox. mat at end.
	645 - 676	Silty green gray partly silicated Ls very weak min. MoS_2 seam at 663
815	0 - 68.5	Iron ox stained arkose and cg. or agglom. of Cret. series.
812	1231 - 1249	Cry Ls with weak mixed ox - sul. min. Last 2' dead white f.q. little sulph.
808	1589 - 1612	Gray white alt cry Ls very weak mixed ox - sulph. min
814	532 - 540½	a.m. little FeO trace Cu ox

812 429 - 819 = 390' - 0.79% Cu - 0.019% Mo.

TWIN BUTTES 5/11/64

685	478 - 596	Q M all oxidized - some Cu ox. on fractures, generally weak min.
690	1028 - 1043	Alt. sil. Ls weak pyritic min
	1043 - 1058	Sil. Ls good seams and dis $CuFeS_2$ Tr MoS_2
	1058 - 1062	Alt gray silty Ls, weak pyritic min.
	916 - 949	Gray Q m little min
	949 - 1000	Greenish serp. Ls fair seams and dis $CuFeS_2$ FeS_2
	1000 - 1006	Gar. Ls good $CuFeS_2$ FeS_2
	1006 - 1028	Serp. Ls some gar. ~~matrix~~ weak to good min.
687	872 - 876.5	Qtzite with Cu stain
	876.5 - 904.5	F.g. silty Ls or impure qtzite with abundant staining + seams green Cu ox.
	904.5 - 996	Alt qtzite, oxid. trace Cu ox, some FeO_x
689	1201 - 07	Q. M. with included f.g. siltstone fragments
	1307 - 1340	Silicated, hard dense siltstone cut by irreg q.m. which locally absorbs siltstone - very weak min.
	3934 - 39	Serp. Ls weak min.
665	3939 - 4016	Heavy mass Fe_3O_4 $CuFeS_2$ FeS_x FeS_2(?) in chlor. Ls.
	4016 - 4019	Sil. - gar. Ls. min. much less intense than preceding section

1/23/64

641	2685 – 2762	Brown silstone cut by $CaSO_4$ and qtz seams – local good $CuFeS_2$ 1/16" thick in seams – none in rock – very low grade.
648	1508 – 1544.5	Gray green sil LS, some qm. badly broken, many small black slips at 15-30° with core – stronger zone at 1526.
637	2017 – 2084	Mass. gran. qm. LS with dis FeS_2 $CuFeS_2$ MoS_2(?), $CaSO_4$
	2084 – 2110	" " " " with heavy splochy $CuFeS_2$, some FeS_2 $CaSO_4$ little MoS_2
	2110 – 2112	Mass qm. LS $CaSO_4$ dis FeS_2 $CuFeS_2$.
643	2066 – 2179	Volc – (Barbara arkose) spec. 2175 At end and near end dense f.g. rock with many angular qtz. grains set in dense feldspathic matrix. Seams & dis FeS_2 irreg good $CuFeS_2$ in fine seams.
644	1693 – 1714	Br. qtz. monz. little min.
	1714 – 1773	Massive qtz at start of section – fine to variable grained qtz. monz., locally vuggy with MoS_2, $CuFeS_2$, Dark green (seep) inclusion (alt LS probably) at 1768' with good $CuFeS_2$ some MoS_2. Ragged qtz. green minerals with sulphides in fine q.m. at end.

TWIN BUTTES 11/23/64

DDH 653	1110 – 1114	Sil. gray to dark gray Ls dis. Fe_3O_4 $CuFeS_2$
	1114 – 1124.5	Broken, alt. brownish white gar. Ls little ox. min.
	1124.5 – 1125.5	heavy gran. qtz with MoS_2 – slip at 35° with core
	1125.5 – 1135	Gar + epi. Ls little min – slip at 40-45° with core at end (some ox. Cu.)
	1135 – 1150.5	Gray white and brown sil. and gar. Ls dis FeS_2 – strong MoS_2 at 1135
	1150.5 – 1151.5	Cellular qtz with splotchy $CuFeS_2$ in sil. qtzmite Ls
	1151.5 – 1160	Sil. and gar Ls, dis FeS_2 local good MoS_2
	1160 – 1174.5	Sil. and gar. Ls to 1168, mass. gar. below. Dis FeS_2 some MoS_2 $CuFeS_2$(–)
	1174.5 – 1182.5	Mass. brown gar. high grade MoS_2 – + 3%
	1182.5 – 1200	Mass brown gar. dis FeS_2 $CuFeS_2$ MoS_2 – probably low grade (0.3 - 0.4%)
DDH 654	855 – 896	Qtzite with some variations – broken, almost none (OK)
DDH 651	965 – 75	Gar. Ls little min – oxidized FeS_2
	975 – 995	Gar. Ls local good dis Cu_2S (Fe_3O_4 in part) $CuFeS_2$ FeS_2 qtz. – local oxidation 985 - 990,
	995 – 1068	Gar and sil Gray green Ls – spotty min FeS_2 $CuFeS_2$ MoS_2(–) Fe_3O_4
DDH 650	1480.5 – 1483	Green sil. Ls little min
	1483 – 1488.7	Mass $CaSO_4$
	1488.7 – 1520	Almost massive $CaSO_4$
DDH 647	688 – 763	Dense vol. – possibly some qtzite – weak dis $CuFeS_2$ FeS_2
DDH 652	666 – 679	Chlor. Ls dis $CuFeS_2$ FeS_2 MoS_2 some gar. $CaSO_4$
	679 – 682	chlor. Ls little Cu_2S and FeS_2
	682 – 692.5	gray white gran replaced Ls – chlorite $CaSO_4$ little min
	692.5 – 695.5	Impure greenish dense qtzite or vol. some dis FeS_2 $CuFeS_2$
	695.5 – 703	Gray green chlor. + serp. Ls dis + seams FeS_2 $CuFeS_2$ trace born.
	703 – 742	Gray white replaced granular Ls, $CaSO_4$, splotchy chlor. irreg FeS_2 – ½" glassy qtz. seam with $CuFeS_2$ at 707!
	742 – 758	Serp. and sil. Ls, little gar seams and very fine dis FeS_2 $CuFeS_2$, – local $CaSO_4$
	765 ±	1" FeS_2 seam parallel to core, weak walls along seam.
	765 – 778	Chlor serp Ls, $CaSO_4$ – seams + dis FeS_2 $CuFeS_2$ – several slips at 35° with core toward end.

DAISY 1/23/64

DDH 801.	2331 - 2378	Gray white finely cry LS, practically no min. From 2345 to 2354 dark fine grained rock with abundant chlorite - probably lamprophyre, apparent steep contact at 2343-45, < of 30-40° with core at 2354.
DDH 803	860 - 886	heavy Gar LS spotty weak ox. Cu min
	886 - 898	gar. LS, increasing gran. qtz. seams,
	898 - 941	Gar LS strong irreg qtz. seams - little visible green ox Cu. Fe_3O_4, some red Cu ox.
DDH 805	379 - 412	Dense groundmass to coarse frag. vol. rocks - traces green Cu ox, few gran. qtz. seams.
DDH 806	127 - 186	Coarse frag. vol. rocks, few qtz. seams - 170-186' abundant replaced areas FeS_2 Cu_2S(?) FeO_x, traces Cu oxide, - probably replacing small fragments which are, or were, iron silicate minerals (actinolite to hypersthene)
DDH 801	2147 - 2148	Gar + sil. LS min irreg with qtz. in vugs, FeS_2 $CuFeS_2$(?)
	2148 - 2163.5	heavy FeS_2, irreg $CuFeS_2$ some qtz; late $CuSO_4$ seams.
	2163.5 - 2170	Fine gran. gar. LS dis Fe_2O_3 Fe_3O_4, few qtz seams
	2227 - 2227	Short areas good $CuFeS_2$ FeS_2(?) in gar LS, late $CuSO_4$ seams.
	2208.5 - 2214	Fine gran. gar. LS brownish yellow? few qtz FeS_2 seams.
	2214 - 2217	hi grade $CuFeS_2$ replacement? with $CuSO_4$ FeS_2
	2217 - 2218	Gar LS cut by gran. $CaSO_4$

TWIN BUTTES 1/22/64 <u>649</u>

✓ DDH 654 795-832 Cret. – Gray dense rocks, probably qtzites and tuffs

✓ A643 1908 – 1982 Gray white fine gr. vol. (prob. tuff) many small qtz. eyes – abundant dis. FeS_2

✓ * A646 1500± – 1830 Qtz. por. no movement at upper contact at 1358'

✓ 637 1895 – 1924 Lightly alt sil. Ls, some chlorite, irreg Fe_3O_4 FeS_2 $CuFeS_2$

✓ 644 1607 – 1663 Q.M. Some dev. of chlor., very weak min.

870' Contact of ox. sed. above with little Cu_2S above lower limit of oxidation, then chlor. Ls with dis FeS_2 $CuFeS_2$

Clark est. min 0.3 – may be better.

637 1934 – 1951 Gray to green locally chlor sil. Ls irreg FeS_2 $CuFeS_2$ two small slips – low grade

1951 – 1998 Gar.(?) Ls weak min.

648 1161 – 1220 Gray white sil. Ls – little chlor. some gar. weak clay at 1164 Weak thin black slips 1164 – 1189 – weak min $CuSO_4$ FeS_2 $CuFeS_2$ MoS_2.

1012 – 1050 Strongly broken and brec. zone – many small slips min generally not strong.

1074 – 1091 Mass $CuSO_4$

1091 – 1099.5 Monz. – bleached + alt – pract. no min.

1099.5 – 1124 Very highly alt monz – f.g. – Sect 1100 – 1121 finely ground 1/8" pieces – little to no min.

1124 – 1131 Gar. Ls weak pyritic min. Few weak slips.

TWIN BUTTES 1/22/64

✓ DDH 641 2501 - 2607 Siltstone, little min.

✓ DDH 654 785 - 832 qtzite, little FeO staining. (Prob. Cret.)

✓ DDH 650 1372 - 1403 Alt. lightly sil. LS - green gray - few good FeS_2 $CuFeS_2$ seams, weak dis. min.

✓ 647 652 - 661 Gray qtzite or mixed qtzite and tuff - very little min.

✓ 651 812 - 870 Mass. granular brown gar., often vuggy - weak FeOx, but may be leached.

✓ 648 1324 - 1415 Highly alt. and softened gray green LS - cons. develop. of chlorite, talc etc. on numerous small seams, weak black shears and faults. Min gen. FeS_2 but some good $CuFeS_2$, MoS_2 Fe_3O_4? possibly Cu_2S.

1415 - 1461 Fair $CuFeS_2$ in same type of rock 1415-31. Possibly less min than above (1324-1415) in remainder of section. Stronger zone of movement, irreg black gouges 1444-59.

1461 - 1508 High grade $CuFeS_2$ in first foot; gray white lightly sil. LS little epidote, irreg splotchy + dis FeS_2 $CuFeS_2$. LS appears more competent but cut by many small black gougy seams. - Fault breccia thin black clay, abundant mineral, some may be later than breccia 1480-84. 20° ∠ with core. Some irreg weak min breccia? to end of section with increased chloritic walls at end.

✓ DDH 653. 948 - 971 Sil. + gar. gray LS, fair dis + seams $CuFeS_2$ FeS_2 possibly Cu_2S.

971 - 987 Alt. sil. LS locally softened, chlor., weaker min. - breccia zone at 976'

987 - 1025 Gar and sil. LS, gray white color - weak min - some dis MoS_2

✓ 652 620 - 639 Heavy gar LS with abundant min - partly oxidized - native Cu, Cu_2S(?), FeS_2, $CuFeS_2$, little chlor, epidote.

639 - 666 Chlor. LS, some gar., pyritic mineral with some Cu_2S decreasing downward - weak $CuFeS_2$ - Dark green color and may contain more Cu_2S than is readily apparent.

DAISY 3/23/64

808 TO 95' AH. frag. rock with gar, little min.
95-120' Strong splochy $CuFeS_2$ FeS_2 ZnS Cu_2S(?)

DDH 804 736.5-754 Good $CuFeS_2$ Cu_2S FeS_2 qtz in seams and dis in gar. Ls.

787-822 Mixed ox. sulph. in gar. Ls. Good $CuFeS_2$ in qtz seams increasing ox. downward - weak copper

830-866 gar. + sil. Ls with Feox little $CuFeS_2$ FeS_2 Cu_2S some ox. copper, not prominent - some qtz seams.

866-894 Gar Ls with qtz. seams - some residual $CuFeS_2$ FeS_2 Cu_2S - some cuprite, Feox

918-964 Gar. Ls oxid. little residual sulph. with Cu_2S, some native Cu. not strong.

806 2019-2056 Lightly sil. hard gray Ls - very little min - traces Feox $CuCO_3$ - some seams $CaSO_4$ - qtz.

198- - 2019 Good bornite bunch with $CuFeS_2$ at 1983½ - rest lightly sil. and recry Ls with practically no mineral. also born @ 1968

807 11-65 Frag. or Cg. rock some Feox fine FeS_2.

TWIN BUTTES.

DDH 676 334-362 Heavy gar Ls, some sil. completely oxidized, little Feox green Cu stain; few qtz - $CaSO_4$ seams

DDH 677 645-706 All oxidized poorly min Cret. - some gypsum, Feox

671 1726-1782 Gray white rock - probably sediment - $CaSO_4$ seams, 1791 no mineral.

668 1315-1399 Well altered white locally altered and soften q.m. - considerable dis pyrite $CuFeS_2$ qtz. -

664 1956-76 1956-60 Mass $CaSO_4$ replacement
1960-76 Massive hard brown gar. little banding $CuFeS_2$

2146-2204 Gar Ls and Ls with prom $CaSO_4$ weak min - possibly little stronger $CuFeS_2$ MoS_2 in last 10 ft.

665 1981-98 Green squeezed sil. Ls with abundant fine seams and dis. FeS_2 $CuFeS_2$ - good $CuFeS_2$ in last 8 ft. - Several def. slips in last 12" making angle of ±40° with core.

---

660 1200-1234 White recry. Ls some red Feox - often vuggy, broken.
1234-1273 Recry Ls, some Feox on seams at bottom - more broken at bottom

675 762-920 Gar. Ls with few recry. sections - little Feox - trace $CuFeS_2$ reported. Contact with heavy gar. mon at 976,

976-1082 Normal contact - little ox. Cu near contact.
Coarse white-gray. q.m. with little FeS_2 $CuFeS_2$(+) MoS_2(-)

TWIN BUTTES 3/23/64

673. 773 - 781 Siliceous brittle ox. q.m.

781 - 791 Alt: green fine gr. silicated Ls, following along seam 1/2 - 1" qtz. gan. FeS_2

791 - 807 Dense green hard sil. Ls little diss FeS_2 few seams.

672. 1465 - 1540 Dense gray frag. volcanic with few FeS_2 seams - little $CuFeS_2$(-)

1561 - 71 coarse a.

667. 2377 - 2386½ Mass. $CaSO_4$

2386½ - 2395 Sil. Ls, well altered - irreg dis & bunchy FeS_2 some $CuFeS_2$ $CuSO_4$.

2223 - 2377 Alternating sections massive $CaSO_4$, siltstone, and silicated Ls - irreg splochy $CuFeS_2$, locally good - average weak.

10/14/63 PM

A 623 2689 - 2702 Gan. Ls with splotchy FeS_2 ZnS FeS_2 $CuFeS_2$(+) $CaSO_4$
Trace of primary Cu_2S replacing ZnS at 2696.6.

2702 - 2721 Gan Ls little anhydrite ZnS banded parallel to core toward lower end.

2721 - 2793.5 White recryst Ls with gar. band parallel to core in area around 2775. Splotchy + dis Zn 2727 - 2733.

2793.5 - 2827 Mass yellow brown gar, little dis FeS_2 little qtz. $CaSO_4$.

608 3283 - 3475 heavy light brown - yellow gar ~~…~~ cut by greenish "epidote"?, $CaSO_4$ irreg FeS_2 $CuFeS_2$, MoS_2(-)

✓ 3141.5 - 3167.5 Well min q.m. dike or sill with MoS_2 $CuFeS_2$ FeS_2 qtz, little gar. Gray white color, almost no femags. Gar. as $CaSO_4$ above with six inch(±) contact zone going into gar. mass.

✓ 624 2140 - 2197 Brown siltstone, traces of FeS_2 $CuFeS_2$(--)

626 1590 - 1717 (1862) Dense gray white gran. rock with fibrous, radiating wollastonite? crysts Some ZnS PbS FeS_2 at 1708-1709
Local areas silty brown material being invaded by alteration front or fine igneous rock - Some fine banding about parallel to core

629. 695 To 695 well gar - brown to green (epidote?) with bunchy and dis. min

✓ 695-741.5 Gar. Ls - generally weak dis sulph. $CuFeS_2$ FeS_2
Some $CuFeS_2$ FeS_2 at 738' - No fault at qtzite contact.

741.5 - 794 Dense gray qtzite, some irreg red to yellow brown FeOx. Little FeS_2 $CuFeS_2$ Cu_2S(--), traces CuOx toward end.

Stop 623
608

DAISY 10/16/63

801 370-415 Ls Cq - generally little min.
At 392-95 Strong MnO_2 little red FeO in
squeezed zone.

802 347-456 Generally coarse white Ls, little sulph (FeS_2 Cu_2S) PbS
MnO_2 FeO_x - Min generally weak
Bedding may be 45-55° with vert.
456-500 Mass gray qtzite, very little min.

TWIN BUTTES.

629 905 qtzite

630
500-542.5 Volc. with gar. FeO_x etc.
542.5-556 Mass. gar. with FeS_2 $CuFeS_2$ (?) FeO_x
709 Good gar Ls with seams (?) $CuFeS_2$ FeS_2 good ore
556-600 Mass. gar. with irreg. $CuFeS_2$ FeS_2 Cu_2S
600-680 Gar. not quite as mass. with good $CuFeS_2$ in dis. + seams increasing downward.

631 630-646 Arkose?? or fine grained vol. with sandy layers. Little FeO_x CuO_x irreg - Cu not strong.

608. 3625 Mass gar.

631 594-604.5 dark fr. volc. probably latite or qtz. andesite.
604.5-625.5 Alt. q.m. with FeO_x some CuO_x MnO_2

616 ~~No advance.~~ 1843-60 Strong gar very little sulph - traces MoS_2 $CuFeS_2$

618 To 2545 gar. Ls weak min
2545-2565 little alt. fg. cryst Ls, tr sulph.

623 2881 2945 Interbedded lightly gar Ls, dark shale? and lightly silicated Ls.

626 to 1870 Porc. like ls, some shale or siltstone, sil. fg. Ls?
with banding at 15-20° with core.

627 1688-1752 Brown siltstone, some anhydrite weak sulp. - possible little qtzite.
634 in wash

TWIN BUTTES 10/10/63

DDH 629

532 - 542 Gar. + sil. LS FeOx Fe_3O_4?
native Cu (-)

542 - 550 Gar + chlor. LS. Fe_3O_4 native
Cu, little Cu ox. FeOx

550 - 558 Gar - + chlor. LS Fe_3O_4 (+) some
$CuFeS_2$ FeS_2, qtz.

558 - 591 Heavily gar. LS - sulph - not
strong - dis $CuFeS_2$ coated with
covellite - chalcocite. Some FeS_2 qtz.
Fe_3O_4

591 - 593 Heavy FeOx in alt. LS. - red-brown
some residual sulphides.

593 - 650 Heavy sulph FeS_2 $CuFeS_2$ Cu_2S
Fe_3O_4 in gar + chlor. LS.

650 - 667 Heavy brown gar. some FeS_2 qtz.
not strongly mineralized.

667 - 699 Gar LS scattered erratic
704 $CuFeS_2$ qtz. FeS_2 Fe_3O_4

				%Mo
532 - 550	18'	3.69% Cu	1.9 ox Cu	0.25
550 - 603	53	2.55	0.4	0.012

532 - 34	1.59	0.97
37	4.62	3.49
42	6.60	2.43
45	1.47	0.96
48	1.27	1.13
50	3.58	1.66
56	2.81	0.21
58	3.23	0.46
60	2.13	0.11
62	1.52	0.16
68	0.75	0.17
70	1.06	0.22
76	1.25	0.33
79	1.51	0.32
83	8.52	1.65
87	1.18	0.16
89	0.99	0.09
93	5.08	1.43
96.5	1.24	0.09
600	1.15	0.05
603	5.18	0.12

627 1577-81 Recry Ls little min
81-86 white q.m. little min.

✓ 616 Not going 1834-43 heavy gar. Ls, weak sulph.

618 2445 - 2464 Ls silicates, ~~little~~ fair dis. min.

630, 31 in overburden

630 500-545 Cret.? } dark
545-66 gar. Ls. }

9/9/63

619	1370 - 1405	Mass. brown gar with seams + bunches, dis. FeS_2 $CuFeS_2$, little qtz. Looks like mass gar. section in lower part of 188
	1405 - 1430	Mass gar. light colored, much less $CuFeS_2$ than preceding section. - some splochy $CuFeS_2$
	1430 - 1435	Good splochy and dis $CuFeS_2$ in mass brown-green gar.
	1435 - 1462	Some good seams $CuFeS_2$ through mass gar. little dis min.
	1462 - 1470	gar. LS $CaSO_4$ increased to small fault zone at 1470 at ± 20° with core -
	1470 - 71	highly broken, alt. gar. LS - little min.
~~623~~ 10/10/63 should be DDH 618.	904 - 987	F. g. well altered broken rock with some FeO_x Cu ox. min. Prob. fine grained vol.
	1105 - 1178	Dense vol. rocks, generally light colored
	1178 - 1184	Broken alt. chlor. rock, prob. vol. tr. min FeO_x
620	2359 - 2501	Dense f.g. gray + gray brown silicated sediments - probably diopside - wollastonite. - trace sul. - anhydrite.
	2630 - 2751	Similar in type to section 2359-2501 possibly more limy toward end?
622	942 - 998	Massive cry LS - irreg FeO_x traces Cu ox locally - min generally weak - little dis. CuS at 967 ft.
615	1835 - 1875	White qtz mon - $CaSO_4$ seam at end. - very little dis $CuFeS_2$ - practically no femags -
	1673 - 1691	Same type little more light green femags - dis FeS_2
	1475 - 1495	" " as 1673-1691
	1302 - 1340	Very dense, f.g. light colored igneous intrusive

9/9/63

DDH 608

2643 - 2692 Well min. gar. and sil. Ls with late $CaSO_4$ and good FeS_2 $CuFeS_2$ qtz$^{(-)}$ $MoS_2^{(-)}$ in seams bunches and dis. qtz? at 2648.5 $CaSO_4$ increases downward.

2692 - 2783 Sil. and gar. Ls flooded with $CaSO_4$ - locally almost massive $CaSO_4$ - seams $CuFeS_2$ FeS_2, some late MoS_2

2783 - 2812 Dark gray to green sil. Ls with some chlor - prob. diopside - hedenbergite as original alteration - spotty $CuFeS_2$ FeS_2 some MoS_2 in dis, splotches and fine to coarse seams.

2812 - 2816 Light colored alt. & sil. ls, - probably $CaSiO_3$? with diopside - little chlorite - fine seams, dis. of same sulph. as above but much less in amount.

DDH 616 1540 - 1542 Alt. Ls gray white, little chlorite, softened. Weak $CuFeS_2$ FeS_2 $MoS_2^{(-)}$

1542 - 1574 Alt. Softened Ls with 3" qtz FeS_2 $CuFeS_2$ at 1542, Abundant fine dis. $CuFeS_2$ MoS_2 thru dark gray green alt. Ls - some serp. chlor., silication but little garnetization.

DDH 618 1336 - 1407 Fine grained dark to light colored dense volcanic with some development of gar. Little sulph.

(Description 1369-1343 in 9/10 report probably wrong RBM.)

1407 - 1412 Heavily gar. silicated Ls with some dis. & splotchy FeS_2 $CuFeS_2$ MoS_2 anhydrite

DDH 617. 2643 - 2650 Sil. Ls some gar. weak sul. & anhydrite

2650 - 2655 Massive anhydrite, traces sulph.

2655 - 2679 Silicated Ls some gar. with FeS_2 $CuFeS_2$ Fe_3O_4 $CaSO_4$ traces ZnS?

2679 - 2748 Almost mass anhydrite

2748 - 2780± Dark to light very f.g. dense rock, little min. (siltstone??)

2780 - 2786 Softened sil. Ls, anhydrite in seams, soaking rock, $FeS_2^{(-)}$

11/11/63 MINERAL HILL—DAISY

DDH 802

670-681.5 0.51T-0.17ox
681.5-699.5 0.24T-0.12ox
699.5-786.5 87'-0.56T-0.22ox.
786.5-846 59.5'-0.85T-0.72

670-718 Highly alt LS, gar. and chlor-serp. cut by irreg. granular qtz. – Fe_2O_3 little $CuFeS_2$, fine black min.? (probably iron); irreg weak green Cu oxides, possibly little cuprite.

718-731 Gray green alt chlor-serp. LS very little qtz and very weak min.

731-817± Gar. and sil. LS – serp-epidote-chlorite with some irreg gran. qtz. little $CuFeS_2$ with Cu_2S rims – no prom. green cu. oxides, some FeS_2 in seams

817±-833± Same rock with prom. qtz. cons. green irregular Cu oxides.

846-875 29.0' 1.16T-

833-928 Mass. brown gar. LS with abundant fine dis. black min, probably iron, relatively little qtz. Below 870 increased qtz. irreg green cu oxides and some irreg. $CuFeS_2$ etc.

928-936 Mass. gar. little qtz, weak to no copper.

DDH 801

575-601 Gray massive LS few chlor slips.

724-802 0.32% cu

793.5-803.5 Broken softened gar. + silicated LS, FeO_x some chlor-serp. traces min.; possibly small fault with serp. slips at 803.5

802-828 0.84T .31 ox

803.5-815 Mass gar. LS with some gran. qtz. with $CuFeS_2$ native cu fine black min, little green Cu oxide

815-825 Gar + sil. LS with abundant gran. qtz. seams and flooding, green Cu oxides, cuprite.

828-870.5 42.5' 1.27T 0.77ox.

825-858 Mass gar. LS with fine black min, weak green Cu oxides, irreg gran. qtz.

870.5-899 28.5' 0.55T-0.04ox. 858-894 Gar and sil. LS, cons. gran. qtz. with little cu stain, FeS_2, $CuFeS_2$ little native Cu + cuprite, trace MoS_2, FeO_x

899-931 0.37T 0.04ox 894-930.5 chlor and serp. LS with short sections gar. LS, little qtz, Some dis. $CuFeS_2$, little pyrite, traces green copper oxides, cuprite, native Cu (?) possibly some chalcocite.

931-970 39'-0.53T-0.18ox 930.5-976 Gar and chlor-serp. LS – less dis. $CuFeS_2$ than previous section Some green cu oxides, little cuprite, chalcocite, FeS_2 seams, fine black min.

801 11/11/63

970-1029 59.0' 1.00T-0.60 ox

976 — 1033 Gar + sections chlor. Ls with much gran. qtz. some $CuFeS_2$ Cu_2S green Cu oxides?, cuprite, few thin $CuSO_4$ seams, FeO_x, fine black min. Probably low grade.

1029-1046.5 17.5' 0.32T-0.04 ox

1033 - 1052 Chlor-serp Ls, some gar, — abundant qtz. with some $CuFeS_2$ - Cu_2S — good $CuFeS_2$ Cu_2S at 1048. Little dis. min.

1046.5-1122 75.5' 0.7T.-0.42 ox.

1052 — 1113.5 Mass gar. Ls with qtz. — some green Cu oxides, little sulph. weakly min.

1122-1135 13.0' 0.21T-0.09

1113.5 — 1127.5 and 1128-29 Finely comminuted — up to 1/2" fragments gar. Ls, qtz. and possibly some late rock (pink)-granular — cementing fragments. Little late $CaCO_3$ cement breccia locally.

1127.5 - 1128 Silicated Ls, qtz, etc. — solid.

1129 — 1136 ± Gar. Ls with abundant qtz. — weak min —

1135-1178 43' 0.63T.

1136 — 1139.5 ± Breccia as 1113-1127 — practically no min. — fragments mostly qtz — some gar qtz FeO_x in matrix.

1139.5 — 1158 Mass. gar with qtz. flooding and seams — little min.

1158 — 1160 Breccia as above

1160 — 1222 Mass. gar. with some qtz. Locally broken and sealed with $CaCO_3$. Some finely dis. black min. (iron Fe_2O_3) little weak green oxide Cu min.

A 715

231 — 281 Silicated Ls some gar. with qtz. — very little Cu min.

281 — 295 Qtzite — practically no min.

TWIN BUTTES 11/12/63

630
634
636

DDH 638 started 200' SW of DDH 607

DDH 631. 1439 – 1730 Siltstone with abundant anhydrite, almost no mineral – little FeS_2.
1922 11/13 Ls Fe_3O_4 FeS_2 $CuFeS_2$

632 976 – 1025 Qtzite

DDH 632. 1025 – 1057 Broken qtzite; 1057 – 1063 Gar Ls – sandy loose little FeO_x local green Cu stain. 1063 – 1070 Breccia – broken Ls – qtzite with $CuCO_3$ MnO_2 cement – small pieces in breccia; 1070 – 1071 Ls with $CuFeS_2$ Fe_3O_4 little oxide, some brec. at end.
11/13 Ls with weak min at end, partly oxid.

DDH 633 1212 – 1425 Light colored volcanic – traces dis. FeS_2, some anhydrite
11/13 1526 1425 – 1446 Very poor core recovery – core in very small pieces, – appears all vol.
out of vol at 1516
Strong Ls good min. 1446 – 1469 Fine gr. frag. volcanic.

DDH 634
11/13 at 716 Grat.

DDH 635 723 – 753 Fine gr. vol., possibly little qtzite with softening and bleaching increasing downward, little FeO_x MnO_2
11/13 830'
weaker min Silty Ls. 753 – 790 Gar and sil. Ls with some dis $CuFeS_2$ locally good toward bottom; trace native Cu at 753.5; trace CuS – Cu_2S.

DDH 636 466 – 478 oxid. gar. Ls.
11/31 557 gar Ls 478 – 503 Qtz. mon weak oxid. min
oxid min no copper. 503 – 507 Qtz. monz. with green Cu ox. at start black MnO_2 or tenorite at end.
507 – 512.5 Qtz. monz. FeO_x
512.5 – 540 many gar + sil. Ls completely oxidized – chlor. FeO_x few qtz seams, some anhydrite. No copper stain or native.

DDH 629 1406 – 1465 Qtzite, – some good $CuFeS_2$ seams toward bottom.
11/13 1500 qtzite
some fair $CuFeS_2$ MoS_2

DDH 628 761 – 847 Siltstone or mudstone, almost no min; badly broken, but good core 786' to end.
11/13 915 Siltstone, soft.

TWIN BUTTES 11/12/63

DDH 616.

2532 - 47 Nearly completely replaced sil. Ls with $CaSO_4$ - weak $CuFeS_2$

2547 - 54 Sil. Ls weak min. some $CaSO_4$

11/13 2769' gar. Ls, fair min.

2554 - 2581.5 Nearly completely flooded sil. ls with irreg dis + seams $CuFeS_2$

2581.5 - 2601 Alternating sections sil. and gar. Ls with massive $CaSO_4$ Some to weak dis and seams $CuFeS_2$

2601 - 2615 Almost completely replaced sil. Ls with $CaSO_4$ - some weak $CuFeS_2$ MoS_2(?)

2615 - 2625 Sil + gar. Ls some min, bands of anhydrite some mineral.

2625 - 2659 Sil. and gar Ls with good seams and dis. $CuFeS_2$ local good MoS_2

2659 - 2689 Nearly completely flooded with $CaSO_4$ - little sil. Ls, gar, weak min. fair min at lower end of section

2689. - 2708.5 Gar + sil. Ls good $CuFeS_2$ little MoS_2

2708.5 - 2712 $CaSO_4$ splotchy good $CuFeS_2$

2712 - 22 Gar + sil Ls. irreg good $CuFeS_2$ - weak at end.

DDH 630 1666 - 1695.5 Sil. Ls with irreg good $CuFeS_2$, MoS_2 at 1691, $CaSO_4$

11/13 2071 gar Ls with silty Ls at end irreg $CuFeS_2$, weaker at end.

1695.5 - 1698 Mon z dike or sill

1698 - 1701 Sil. Ls 6" mm.

1701 - 1708 $CaSO_4$ with some $CaSO_4$ - $CuFeS_2$ MoS_2

1708 - 1721 Sil. Ls - some min - not strong

1721 - 1726 Qtzite

1726 - 1779 Fine grained sediment or water lain tuff - weak min siliceous dark gray.

1779 - 87 Anhydrite, some good min at start of section

1787 - 1806 Fine grained gray brown rock few $CuFeS_2$ seams some anhydrite - low grade. Possibly little dis. gar. at end.

1806 - 1828 Siltstone (?) with seams and dis $CuFeS_2$ anhydrite - increased over preceeding section.

1828 - 1844.5 Massive anhydrite, little sulph.

1844.5 - 1872 Sil. Ls and bands of anhydrite, generally weak sulph.

1872 - 1906 Sil Ls with irreg good $CuFeS_2$ MoS_2, some irreg. $CaSO_4$

1906 - 1919 Nearly mass. anhydrite, little min.

1919 - 1934 Sil. Ls irreg fair $CuFeS_2$ FeS_2 anhydrite

1934 - 2008 Sil Ls + gar Ls with good to strong FeS_2 $CuFeS_2$ anhydrite some MoS_2

2008 - 2023 gar Ls with weaker sulph. than section above.

TUCSON 11/14/63

Drill with one machine on line NE of 607-188-606 line and one machine to SW of this line

If no encouragement in 628 drill anomaly Rec. 25

Drill Rec. 46 at 300' NE of 631, 400' SE of 630 at first opportunity.

Start drilling 200' holes around 616-608-619.

East Helvetia Rec. 2 more machines for holes N. of 801, E of 802, wildcat holes

West Helvetia Move machine to Twin Buttes.

TUCSON 12/21/63

TWIN BUTTES

MOVE 628 TO Rec. 61

629 – continue temporarily 2952. Drill N. of 629 + 630 new recs.

632 stop after about 200' advance 2769' Move to Rec. 59.

633 2346' Cont. temporarily move to Rec. 51

635 Cont. temporarily – move to Rec 57. (1767)

637 Drill Bx.

640 1156 in monz. stop. Move to Rec 50

641 continue

642 Stop in few days. 720' – Move to Rec 56

643 Continue.

644 continue

645 "

646 "

Rec 55

Rec N of 188 150' – 200'

Rec 58

Rec 60

Rec. NE of 629

" NE of 630

Rec. 25.

Rec 47

Rec 49

E. HELVETIA.

802 Move to Rec 5 450' S of 802 (804)

801 Cont in cry Ls ± 200' Move to Rec 7.

803 Continue. 270' ±

Move extra machine to wildcat E. near porphyry.

Go ahead with Anglin-Byrd; Wilson; Chilson – after Jan. 1 – all seem anxious to give information.

Kelly will contact geophysicists about work on Wilson and Chilson groups.

53
67
120

Look thin section w/ review core
in 623
968-1014
1140-1243

636
637✓
639
641 check
644 No core yet.

TWIN BUTTES 12/19/63

DDH 638 1624-1661 Slickensides and weak shearing through alt. gray-green to dark green lightly silicated Ls - little min. No major movement thru this zone. Serp.-talc - and chlorite developed.

1661 - 1666 Cr. alt. and softened lightly silicated Ls. Last foot contains black slickensides and cr. material. Prob. Fault.

See section 1066-1128 Ls 1128-1661

1666 - 1704 Core in small pieces, lightly altered, probably somewhat crushed and broken

1704 6" cr. zone with black gougy material. Not solid gouge but prob. represents fault. - qtz. mon.

1704.5 - 1730.5 Lightly alt. prob. crushed qtz mon. many small slickensides. little pyritic min.

1730.5 - 1752 Qtz. mon. lightly alt., less crushed than above weak slickensides, little FeS_2

1752 - 54 Slick wall with black selvages irreg thru core, generally elongate with core. Qtz. mon.

1754 - 1781 Fairly blocky qtz. monz., few slips near end, little FeS_2

1781 - 1912.5 End. Qtz. monz. cr. and broken at top of section, but blocky and fresh downward, weak FeS_2 min. Weak black gouge at 1876. Blocky below this slip.

DDH 643 ±755 - 801 Gray green fine dense Vol. and possibly some qtzite, no bedding evident, weak FeS_2 $CuFeS_2$ min.

684 - 755 Mixed iron oxide - FeS_2 min in dense volcanics. (q.p.) No Cu stain.

DDH 635 1249 - 1336 Gran(?) Ls weak pyritic min.

1336 -

Hole to SW ± 200'

1542 - 46 Good splotchy MoS_2 some FeS_2 $CuFeS_2$ in gar Ls.

1546 - 1651 Hi grade $CuFeS_2$ in gar. Ls often with [illegible] appearance.

1651 - 1666 gar. Ls decreasing $CuFeS_2$ downward.

1666 - 1742 lightly sil Ls with light gray recry. sections at end, very weak min.

1742 - 1748 Lighty sil. gray green Ls, little FeS_2

TWIN BUTTES 12/20/63

DDH 641

1170.5 - 1178 Breccia of broken, greenish sil. LS - often vuggy - possibly some late qtzy f. g. rock (intrusive?) but matrix generally finely comminuted alt. LS. Little FeS_2 $CuFeS_2$.

1178 - 1246 Recurring short sections of breccia as above thru highly alt. lightly silicated silty LS. Weak min. Weak clay at 1211

1246 - 1260 Intensely brecciated lightly alt sil. LS, possibly variety of rock fragments - some of matrix material may be fine grained light colored igneous rock with some min. Min. later than breccia in irreg seams, strgrs, dis. composed of $CuFeS_2$ MoS_2 FeS_2 $CaSO_4$ qtz.

1260 - 66 ~~[illegible]~~ LS lightly brecciated zone in little sil. soft silty LS with some FeS_2 etc. Not as strongly brecciated as preceding section.

1084 - 1103 Broken lightly sheared gray green silicated LS, little min; banding est. 35-40° with core

DDH 638

1103 - 1128 Sheared broken, locally finely broken lightly sil. LS weak min FeS_2 $CuFeS_2$(-) MoS_2(-). Many small slips - shear, possible fault zone.

1128 - 1143 Broken sheared light colored qtz. monz. little min. Few weak clay covered surfaces - part of shear or fault zone

1143 - 1180 small Fault at 1149; 1163; 1177. Entire section broken, sheared qtz. mon. - slightly more solid than preceding section. Weak min.

1323 - 1394 Dense fine grained light colored qtz. monz (like 617?) with few femags - probably all dense feldspar + qtz. Locally bleached and softened, clay altered, some finely fragmented. Little shearing. Appearance probably due to alteration rather than mech. breaking.

1552 - 1563.5 Granular qm - locally has broken appearance, but prob. isn't.

1563.5 - 1569 Fault zone - sheared, some irreg black gouges at ± 15° with core in lightly silicated gray green LS - little min.

1569 - 1590 Sheared slickensided sil. LS with development of chlorite and serp. Prob. small planes of limited movement common.

1590 6" with black-green selvages, prob. at about 45° with core. Could be along bedding. Difficult to determine importance, but is limit of above zone.

1590 - 1624 Lightly sil. LS, thin steep gouge at 1618 - Same type of LS as above but more massive, little irreg. min.

632/802

TWIN BUTTES 12/19/63

DDH 629 – 2611 – 2666.5 — Gar. Ls with seams, splotches and dis. $CuFeS_2$ ($CuSO_4$) little FeS_2 traces MoS_2. Green lime silicates increase toward lower end.

2666.5 – 2826 — Sil. Ls – gar. Ls green lime silicates (trem-actinolite, possibly chlorite) cut by seams, dis. bunches $CuFeS_2$ MoS_2 FeS_2 $CuSO_4$. ± 0.9–1.0% to 2766, lower grade below ± 0.4–0.5. Good MoS_2 2701

cont.

2826 – 2866 — Same with splochy irreg good $CuFeS_2$ MoS_2.

2866 – 2913 — Same – min. probably weaker than that above – splochy.

12/20/63 2913 – 2952 — Gar. Ls – seams, dis FeS_2 $CuSO_4$ $CuFeS_2$ – broken at 2950. – good $CuFeS_2$ 2945–46

DDH 632. 2634.5 – 2672 — Recry. white Ls, few short section gray-brown gar. Near end fine local dis. and hairline seams $CuFeS_2$ bornite(+) – Some

stop

12/20/63 2672 – 2769 — $MnCO_3$? in seams (fine irreg.) – Cry. Ls fine dis born. $CuFeS_2$ Cu_2S. – weak.

DDH 633 2176 – 2201 — Recry. Ls, only traces of min. – lightly sil and min for 60' above.

2201 – 2262 — Same as 2262–79 – traces $CuFeS_2$ FeS_2 MoS_2

DDH 633 2262 – 79 — Dark gray black mottled Ls little silication, practically no mineral.

stop

2279 – 81 — Lighter colored, bleached little splotchy FeS_2 $CuFeS_2$

12/20/63 2281 – 2346 — Light to dark Ls little silication considerable fine Fe_3O_4 in last 10'.

DDH 628 1323 – 24.5 — Ls conglomerate, gar(+) – probably structural, not alteration

cont.

1324.5 – 1350 — Alt. silty Ls, some chloritic alteration, little to no min.

12/20 1350 – 1410 — Weakly min and alt. oxidized sil. Ls. – little green Cu. ox.

1410 – 1435 — Brec. Ls silicated, light colored igneous rock, cemented by dark gray igneous intrusive. May be old fault zone. Some oxide Cu, Fe_2O_3 possibly Cu_2S, $CuFeS_2$(+)

1435 – 1445 — massive light colored qtz. monz. $CuFeS_2$ FeS_2 dis. traces Cu_2S enrichment.

DDH 641 1133 – 1138 — lightly sil. Ls, little min.

cont.

1138 – 1155 — Light brown gar. Ls, some $CuFeS_2$

1155 – 1168 – 70.5 — Gar. and sil. ls, weak spotty $CuFeS_2$ FeS_2 – few globular qtz. seams.

DDH 645 320 – 333 — Gar and sil. Ls, little FeO_x, practically no min.

should hit hornfels at ± 1200'

DDH 642

424 – 526 — Strong gar. and sil. Ls FeO_x. traces Cu oxides.

526 – 546 — Qtz. mon. with qtz. FeO_x seams parallel to core.

546 – 601 — " " – heavy oxides qtz. seams about parallel with core.

DDH 640 1086 – 1095 — Almost unmineral. – Little dis $CuFeS_2$ – many qtz. eyes in qtz. monz (qtz. por.)

637 703 – 750 — Qtz. mon – some qtz seams, shearing – FeO_x (out of gravel into)

DAISY 12/19/63

DDH 803 140.5 - 171 ± 50% core recovery - all oxidized, - 140.5-160 ± 90% 160-171

140.5 - 146 sand.

146 - 153 very fine gr. dark gray-black rock, prob. vol. little min.

153 - 160 Light colored min rock, prob. vol. agglom.

160 - 171 Alternating light and dark colored rocks, weakly min. prob. vol.

DDH 801.

1711-1712.5 Finely broken core, some gougy, clayey material. May represent weak fault zone thru lightly alt. Ls.

1712.5-1718 Irregularly lightly sil. Ls, some alt. gar. + lime silicates, min.(-)

1718 - 1722 Finely broken, lightly alt. and sil. Ls. Some development of talc-serpentine on irregular faces - probably weak shear zone.

1722 - 1724 Lightly min, alt. partly sil. Ls, some chlorite - serp.

1724 - 1727 Red Iron stained, brecciated and recemented alt Ls; def. slickensides on weak fractures at 1726'

1727 - 1731.5 Broken slickensided alt gray Ls, some chlorite-serp., FeO; represents sheared zone.

1731.5 - 1734 Finely broken alt. Ls - probably only alteration effects

1734 - 1735.7 Gar. Ls, little FeO_x - solid.

1735.7 - 1766.5 Lacey, White Ls, irreg dis. and seams green malachite little FeO_x MnO_2, very little development of lime silicates. 100% core recovery.

DDH 802.

1275.5 - 1279 Well alt. Sil. Ls - some alt. gar. + Lime silicates, locally broken and slickensided - FeO_x(-)

1279 - 1306 Light colored, greenish gray, highly alt. softened, broken Ls, many talcy slickensides, some chlorite, $CuCO_3$, tremolite, serpentine. Could be zone of cons. movement in incompetent alt. Ls. Practically no min.

1306 - 08 No core 1308 - 1310 Little alt. sandy Ls.

1310 - 1329 Same type of alt. Ls as 1279 - 1306 - strongly broken and slickensided. Hole probably following steep-zone.

1329 - 1335 Lightly sil. Ls, $CuCO_3$, less fractured and alt. than preceding sections.

1335 - 1344.5 Same as 1279 - 1306 and 1310 - 1329. No min.

10/17/63 E. Helvetia

801 471 Ls with Ls Cg above

481.5 "

802 510 gray qtzite

519 " "

W. Helvetia 712 193

164 - 193 Sil. & gar. Ls.

very little min. some Mo S2

w Fe S2 born irreg probably

increasing toward bottom.

710 404 - 423 qtzite some

Fe ox

Ma 24 202

808

Perry -

More drills to Sen. Morgan

incl. holes at T. B.

TUCSON 10/18/63

TWIN BUTTES

MOVE 627 to 628

MOVE 626 TO LOCATION 480' N E of 142

PROB STOP 618 on Monday 10/18 2637' [illegible] sil. LS. Move to Rec. 31.

Hole 400' SE of 630'

Hole 400' SW of 631 ?

Hole 400' SE of 631

ON 1600 SE ? INCLINE HOLE SW @ -400 2150 ft.

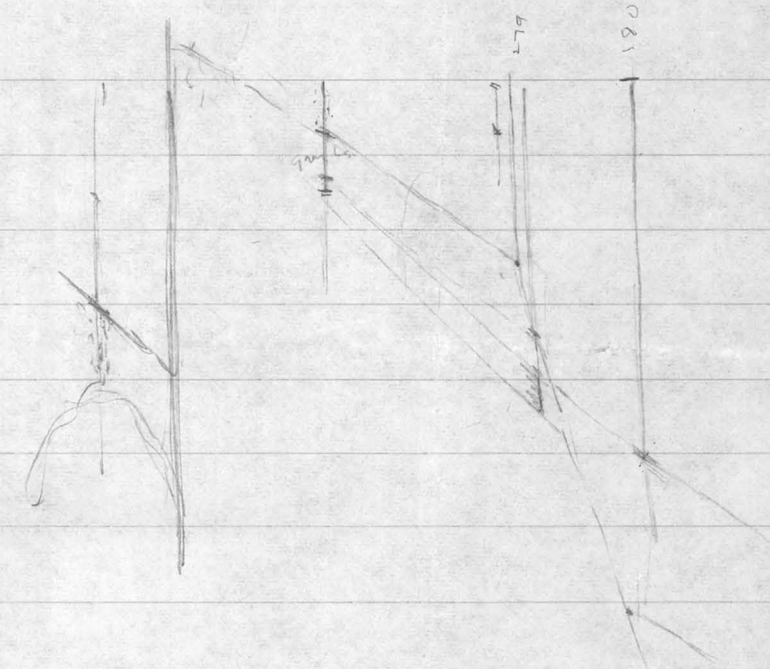
HOLES CLOSER TO PORPHYRY

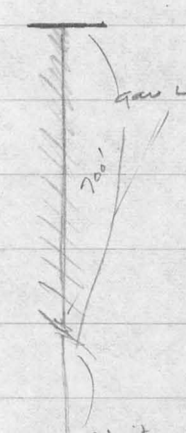
611, 612, 606, 607 SECTIONS

AT. W. HELVETIA

INCLINE HOLE W OF 711

" " N. OF 711





Fault N60 E
dip 55°? NW.
offset 300' +or-.
at 650' S 40°E
from Queen shaft
gray contact 42°
dips S.

507 1160 —
1164.5
[illegible] [illegible]

1174 – 1186 [illegible]
[illegible]

1191 Cry LS.
1265 [illegible]

508 584 [illegible]
well at.

7/31/63

616 Bedrock at 543

Spec. 587 Dense vol. - prot. rhy. to 575' Some FeO_x CuO_x

575-590 heavy native Cu in highly alt. brown

gran. rock, - quant $CuCO_3$ little green Cu ox

590-605.5 heavy gar. Ls weaker native Cu, FeO_x

605.5-610 chlor + serp. green Ls some FeS_2 trace $CuFeS_2$

610-616.5 heavy gar. Ls with good Cu_2S $CuS^{(-)}$ $CuFeS_2$ $FeS_2^{(-)}$

native Cu, FeO_x

616.5-627 Serp. Ls weak Cu_2S $CuS^{(-)}$ $CuFeS_2^{(-)}$ $FeS_2^{(-)}$ $CuCO_3$

seams + dis.

627-633 Strongly serp. Ls little gar - irreg $CuFeS_2$ native

Cu Cu_2S FeO_x.

Spec. at 634 633-635 Mass. sulph - FeS_2 $CuFeS_2$ Cu_2S.

635-639 Very poor core - FeS_2 (+) in partly ox. gar. Ls

639-643 Poor core recovery - oxid. (red brown) gar. Ls little evident Cu min.

643-654.5 Serp. Ls with FeS_2 $CuFeS_2$ born tarnish (prob. sec.)

(3' not seen) poor core - granular, soapy rock - high grade

$CuFeS_2$ born. Cu_2S at 651

7/31/63

608 1987 - 2072 Gar. and sil. LS massive; but
sparse sulph. $CuFeS_2$ (-) FeS_2 (-) some $CuSO_4$

2072 - ±2100 Increased FeS_2 $CuFeS_2$ some moly $CuSO_4$ seam

Spec. at 2147 2100 - 2154 Increasing $CuFeS_2$ dominant with local good
MoS_2, Magnetite FeS_2 $CuSO_4$ in heavily gar. LS.

614 1058 - 1201 Poorly min dark gray "granite" Few
areas of intrusive dark dike rocks (dacite - rhyolite??) 1145 - 1171
Weak FeS_2 traces dis $CuFeS_2$ thin $CuCO_3$ seams

TWIN BUTTES 8/2/63

A 608 1644 – 1731 Massive gar. with gypsum seams, little $CaCO_3$ – spots dis $CuFeS_2$ but very low grade over all.

1731 – 1736.5 Mass. brown + green garnet with $CuFeS_2$ $CaSO_4$

1736.5 – 1738 Green garnet – possibly early variety – weak min.

1738 – 1753 Gar – probably two ages with some $CaSO_4$, Fe_3O_4 $CuFeS_2$ FeS_2

1753 – 1759 Gyp-anhydrite with some included gar.

1759 – 1780 Early green lime silicate rock cut by brown gar. which is locally engulfed in qtz – feldspar rock with local strong MoS_2 $CuFeS_2$ $CaSO_4$

1780 – 1815 Brown gar. with included frag. early green lime silicate rock – considerable $CaSO_4$ irregularly thru rock and in seams – generally weak sulph. min. but more in brown gar. than in green rock.

2144 Bottom in mass. gar. with $CuFeS_2$ (+) $CaSO_4$

530 760' Black Ls with $CaCO_3$ seams – no min.

531 1662 Fr. have "granite"
To 1611 I gray arkosic rocks, traces FeS_2
1611-14 grad contact into granite

TWIN BUTTES 8/2/63

A 612 1503 - 1521 End Dark "hornfels" qtz seams
weak sulph.

A 609 1247 - 1261 (End) Similar to 612 end Dark
"hornfels" - weak sulph. some $CaSO_4$ - weak
gray, white alteration.

A 611 1454 - 1477 End. Same as two above
harder, fresher dark gray black
rock, ~~some~~ FeS_2 $CuFeS_2$ — some weak
alteration at end.

A 614 1338 - 55 Hard fresh "granite" with little
1376' dis $CuFeS_2$ FeS_2 few FeS_2 seams.

A 610 2190 - 2201' Sil. Ls some serp - irreg. gar.
2166' Ls with weak FeS_2 $CuFeS_2$
some gar, $CuFeS_2$ is streaky dis. - not strong
At 2223

A 613 1592 - 1616 Weakly min mag.

608 No advance machine repair 2162
616 " " ~~cement~~ ~~2166~~ 654-662 good gar $CuFeS_2$ Cu_2S
(672' weaker - qtz. vein
dolom - red gar) Stren. at 658' FeS_2

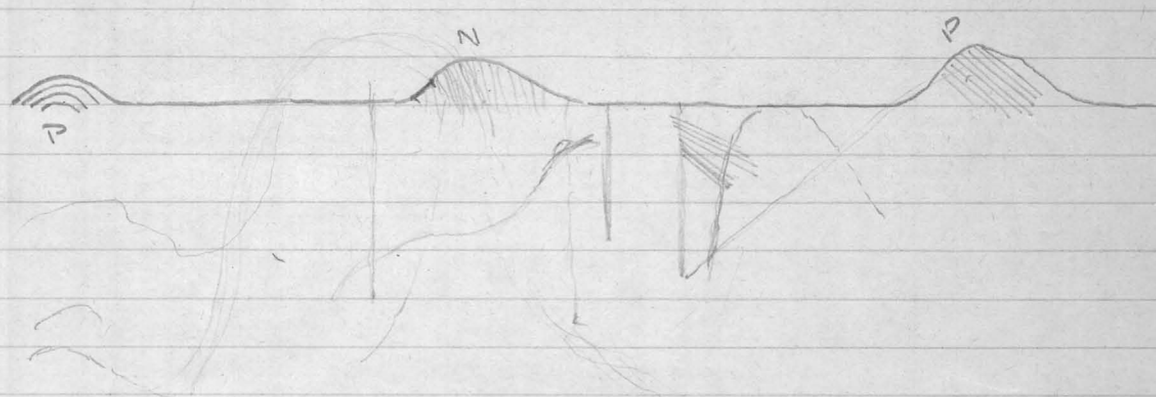
615 747 - 55 (6) Fract. white qtzite - dark coating on some
cavities may be a manganese - Cu ox.
minerals?

755 - 781 Alt. broken rock, probably limey with Fe ox
some Cu ox. near end.

619 230' in overburden.

608
610
614
615
616
617 — 600' ±
618 — 124' 8/1 323 8/2
619 228'

388 Feb 12 deepen for assess work.



8/2 8 AM

JACKSON SAYS ONE MORE DAY WILL FINISH. MUHEIM FIELD ENGINEERING WORK. MAP FINISHED BY ± 8/7 – EXPECTS FIELD LOCATIONS, AMENDMENTS. ETC TO BE DONE BY 8/17.

Banner has two DD rigs on Muheim property now – will complete assessment work.

8/2 Saginaw 1257' Contact breccia
Few siltstone fragments, little min.

Bonner 6/13/63 MINERAL HILL – P.V.

A 524 953 – 1003 strongly gar. Ls with little chlor. Few qtz. $CuFeS_2$ seams – irreg $CuFeS_2$ thru gar. Ls, some of copper at least fed through seams. Good $CuFeS_2$ to end.

A 523 End 1986 Gray white "granite". Feldspar rich rock with scattered biotite, hornblende? chlorite, magnetite. No sulphide. Little hematite reported
Contact normal at 1389.5 ft. – possible 1" dikelet at 1388.5 – white alt. Ls above intrus. light colored medium gr. granite, traces FeS_2 at 1378.5 – 79.5 1 breccia of limestone fragments cemented by black matrix — mud??

A 526 Contact of sed – gran at 752.5 – gradational contact. Bottom at 781; granite is irregularly chlor. rock and is apparently part of contact zone.
Sediments above are lightly altered – sparse mineral. Some irreg. beams gar. at 753' 6" is weakly broken (brecciated, and sealed with alt rock, little FeS_2 $CuFeS_2$. Beds near gran. contact are thin bedded limestone and shaly Ls with irreg spots of probably granitic magma.
At 752' – 752.5 piece of core appears to be marginal granite with fragments siliceous rock and alt. Ls – as before, is a peculiar appearing contact, and might represent fault zone replaced by intrusive rock.

TWIN BUTTES

✓A 604 N. of 196
1162 – 1239. Sil. Ls with local strong gar. + chlor, increased seams and dis of $CuFeS_2$ FeS_2 toward end. Probably not ore grade.

✓A 608 709 – 810 Probably qtzite with possibly f.g. volcanics cut by
S. of 603 819 siliceous f.gr. intrusive rhyolite or qtz. por. – qtz "eyes" small and numerous, resemble qtzit grains, but probably are not. contact phase intrusive? Little dis. FeS_2 Cu_2S, $CuFeS_2$ with sec. covellite, bornite, chalcocite in minute amounts.

142✓ 2340 – 2406 Fr. granite, prominent femags. Dis., small splotches $CuFeS_2$ specks MoS_2; at 2357 1/4 seam of MoS_2 dis. thru granite; at 2354 1" seam, glassy qtz. little $CuFeS_2$ specks MoS_2. 2350 – 53 darker granite with $CuFeS_2$ in femag areas.

6/13/63 RBM TWIN BUTTES

142. 2148–87 Generally medium to coarse gr. dark "granite" with 2–6' sections very dark Fe-mag areas. Granite coarse gr. toward end. Dis. $CuFeS_2$ little FeS_2 MoS_2 (–) – grade probably very low.

1862–67.5 light colored gran– few qtz. FeS_2 seams, some dis. $CuFeS_2$

1867.5–1877 Light colored gran, – FeS_2 qtz. seams, little talcy alteration – badly broken 1867.5–69.

1877–1878 – Poor core recovery – talcy alteration of granite, small slickensides, last foot finely granulated. Some pyritic mineral.

1879–1880 Light colored granite, talcy alteration, little mineral.

1880–89 coarse to f.g. light colored siliceous granite; – coarser again at 1889. Fine c 1/8" seams qtz. FeS_2 some $CuFeS_2$, dis. $CuFeS_2$, little MoS_2

1794–1813 Fr. medium grained granite – some dis and splotchy $CuFeS_2$ FeS_2 (?)

1608–18 Dark, relatively f.g. chloritic dark granite, local abundant dis. $CuFeS_2$, little MoS_2 FeS_2, fine seams FeS_2.

1323–43 Light colored med. gr. granite with dis and splotchy qtz. $CuFeS_2$ MoS_2 (?) FeS_2 – some chlor.

1123–31 Coarse light colored granite, dis. min.

1131–43 Irreg qtz. seams with FeS_2, some $CuFeS_2$, little good min. – increased qtz. seaming!

✓ 605 1254–1281 Weakly min. qtz. monz. – few grains of sulphide. Irreg. Feox and iron ox. staining. Traces Cu ox. stain.
N. of 188

✓ 602 1330–51 Dense f.g. sil. rock – qtzite?
Anomaly – cemented

A 606 912–920.5 Irreg gar. LS with fine $CuFeS_2$ —
NW of 188
920.5–931 Some gar. & recry LS – $CuFeS_2$ FeS_2 sec born? coating
931–942.5 Gar. and chloritized limestone (chlor. cuts gar.) with strong FeS_2 some $CuFeS_2$

A 607 586–613 Partly gar. and coarsely recry LS – Feox Mang – CO_3
SE of 188
624 little splotchy ox. Cu.

KITTEL REPORT 6/17/63

142 Pulling casing —

602 1385' broken qtzite.

604 1429' gar. Ls with dis FeS_2 $CuFeS_2$ ✓
N. of 196 300' to go to reach argillite-hornfels.

605 1477' q. m— to be stopped - moved to 291.
N of 188

606 1131' silicated vuggy Ls.
NW of 188

607 775' serp. Ls. will cement.
SE of 188

608 920' in gar. Ls - FeS_2 $CuFeS_2$ MoS_2 qtz.
into dol. Ls at 824.

609 150' NW of 279. toward 294
will be started with 142 machine.

McAlister rec. 650' SW. of 602

DDH 142

End of hole 1215'

755' – 1215 Relatively fresh coarse granitic rock with ½" plagioclase, cemented or interstitial chlorite, Fe_3O_4, qtz. Gray-white where lightly altered mottled gray green color where fresh. Dis. mineral spotty and generally sparse. Qtz seams, probably steep, 60-75°, contain $CuFeS_2$ MoS_2 FeS_2, occasionally orthoclase. Some irreg. oxidation down to 916'. Few narrow dark "andesite" dikes.

621 – 755 Gray-buff fine grained qtzite – some sparse dis. FeS_2 and FeO_x. Coarser grained at top. – no strong mineralization.

214 – 621 Generally well altered silicated LS, occasionally punky and crumbly. Generally weak dis mineral – some FeO_x $CaCO_3$ etc. Strongest mineral 594-609 – little FeS_2 Cu_2S, copper oxides, well alt. and oxidized, but originally poorly mineralized.

0 – 214 No core – probably alluvium.

DDH 289.

0 – 573 RDH No core

573 – 621 Silicated LS which has been alt. and oxidized. Some irreg. MnO_2 FeO_x $CaCO_3$ Cu ox. minerals.

573-704 129 ft. core 0.94%

621 – 638 Gray more siliceous fine grained sediment (LS), little MnO_2 FeO_x $CaCO_3$.

638 – 647½ Alt. lightly and irreg. gar. LS with some Cu oxides, MnO_2 FeO_x.

647½ – 652 Fine grained gray to dark gray rock – may be fine gr. silty altered sediment, or fine dense andesitic intrusive. Some FeO_x $CaCO_3$ in seams.

652 – 702(-) Fine grained dense irreg. brown to dark brown FeO_x stained rock – few very small feldspar phenocrysts. Much of FeO_x distributed as if it replaced clots of ferro-mag. minerals. Irreg. Cu ox. staining. Few mineralized seams.

702 – 720 Fine gr. well alt. LS. Good dis Cu_2S FeS_2 $CuFeS_2$ 712.2 – 713. Little other mineral except $MnO_2^{(-)}$ traces Cu ox. and $FeO_x^{(-)}$

720 – 724 Fine gr. siliceous rock ± $MnO_2^{(-)}$ $FeO_x^{(-)}$ – some very fine dis. black sulph? Alt. sediment or fine intrusive??

1/9/62

DDH 249

630 – 1021 Gray white granular qtzite. From 630 – 765 areas of dark gray black alteration minerals in rock locally called "hornfels" by Barker – mottled appearance probably is alteration effect from impure qtzite.

605 – 630 intrusive – fine grained to granular, probably monz.

583 – 605 Alternate sections of qtzite and fine black mineral alteration zones – probably biotite and ser. with feldspars.

562 – 588 Dark gray-black fine gr. rock called "hornfels" by Barker – same rock as alteration areas in qtzite.

545 – 562 Alternating section silicated LS – green-gray – with dark gray black areas similar to section 562 – 88

514 – 545 Dark gray black f.g. rock, few blue-gray eyes – probably originally LS – some fine sulph.

1/8/62

DDH
289

724 - 762	Alt. gray white Ls little FeO_x MnO_2 $CaCO_3$ traces Cu oxide some FeS_2 below 745'
762 - 797	Gray white f.g. Ls with little dis. FeS_2 few fine $CaCO_3$ seams.
797 - 847	Same as section above - locally little MnO_2 FeO_x and spots epidote, gar. Ls. increasing toward bottom of section.
847 - 875	Gray white f. g. Ls as above
875 - 887	Gar. Ls, light to brown color, little MnO_2 FeO_x staining, some $CaCO_3$.
887 - 947	Gray white f. g. Ls. very little min. traces Cu ox.(-) few fine silicate minerals.
947 - 1006	Gray white dense Ls. traces mineral; at 966 banding at 20° with core - may not be bedding. Other banding at 90° with core.

DDH
248

0 - 298	No core
298 - 480	Rapid look - gray cry. Ls, little gar. Bedding probably 20 - 35° with core - practically no mineral.
480 - 514	Gray white cry Ls with thin gar bands - banding at 15-20° with core at 487. Practically no mineral.
514 - 524	Gray cry Ls. little FeO_x tr. Cu stain.
524 - 550	Gar Ls with some gray cry Ls. Very little mineral, FeO_x.
550 - 586	Gar. Ls with short sections hornfels - dis. and irreg FeO_x MnO_2 tr. Cu stain.
586 - 622	Gar Ls with gray green hornfels sections - trace Cu stain. irreg MnO_2 FeO_x staining from alt. of gar. little mineral. Banding at 40-45° with core.
622 - 658	Gar. Ls and little hornfels - little min.; almost entirely oxidized above 651 ft. traces Cu stain.
658 - 674	Gray green hornfels and mass. gar. Ls - sparse FeO_x traces sul., Cu stain.
674 - 690	Gray green hornfels, weak min. banding at 683' at 40° with core.
690 - 752	Heavy gar. Ls. - scattered good sulph. min - but sparse. Native Cu specks at 730'
752 - 762	Hornfels? - dense gray f. g. silicated rock - some gar. min.(-)
762 - 855	Heavy silicated Ls - mostly green-brown garnet - generally sparse mineral. with $CuFeS_2$ occasionally coated with Cu_2S $CuFeS_x$ - few glassy qtz seams with sulph. - FeS_2 seams have black alt. zone through gar.
855 - 875 END	Well min. qtz mon. FeS_2 $CuFeS_2$ FeO_x $CaCO_3$ Cu_2S(-) in seams and diss. Cons. irreg oxid. Contact with silicated Ls above at 45-50° with core.

DDH
G-33

1/10/63

561 - 593 Gray cry. LS some dolomite? with short sect. of gar and serp.; very little min.

593 - 612 Alt. serp and gar. LS - greenish, sheared - native Cu at 606'

612 - 763 Strongly gar. + silicated LS - some weak Cu ox.
- 786 with stronger section at 740' - bunches $CuFeS_2$ at 695' - some qtz. seams.

786 - 804 Strong gar. LS. with qtzy areas, good green oxide Cu mineral.

804 - 876 829 1-2" qtz Cu ox. + Cu_2S.
Heavily gar. LS, weak oxide Cu min., traces sulph. - some qtz and $CaCO_3$ seams.

876 - 905 qtzite with short sections gar + silicated LS. - some good seams Cu ox. mineral and Cu_2S

905 - 928 Short sections def. qtzit some alt. sections which may be alt. sil. LS or highly alt. phase of bordering intrusive igneous rock - generally very weak mineral.

928 - 966.5 Heavily gar. and sil. LS, $CaCO_3$ seams, some red FeO_x, traces native Cu, green Cu oxides.

X 966.5 - 980 $FeS_2^{(-)}$ $CuFeS_2^{(+)}$ starts in green sil. and gar. LS - much associated with qtz seams

980 - 984 Cons. native Cu, some sulphides, qtz. seams, - sil. LS gangue.

984 - 996 Siliceous rock - probably gar + silicated LS irregularly silicified - dis and fine seams Cu oxides, $CuFeS_2$ Cu_2S, traces Native Cu, $CuCO_3$ FeO_x probably some Fe_3O_4

996 - 1022.5 Heavily gar. + sil. LS with qtz seams and flooding - good $CuFeS_2$ Cu_2S little oxidation. - much of sul. associated with qtz.

1022.5 - 1032 Qtz flooding and stringers with residual remnants silicated LS - some good $CuFeS_2$ $Cu_2S^{(-)}$, FeO_x.

1032 - 1076 Heavily gar. LS with dis and small splotches $CuFeS_2$ Cu_2S $FeS_2^{(--)}$, cons. qtz. in stringers and as flooding, little FeO_x. Section 1050-1076 probably lower grade than 1032-1050.

1076 - 1104 Much the same as preceding section - good dis + seams $CuFeS_2$ 1083-85

1104 - 1115 Gar. LS with seams and dis qtz, $CuFeS_2$ Cu_2S, - some Fe_2O_3 at 1106.

1115 - 1129 Some qtz flooding in serp. and gar. LS with greatly increased oxid. - some Cu native.

1129 - 1184 Heavily gar. LS with generally much less mineral than sections above - little sulph, traces Cu native.

1184 - 1188 Green copper oxides irreg in gar LS. - grade prob. low.

DDH
G-33

1/10/63

1188-1225	Mass. gar. + sil. Ls with cons. $CuCO_3$, irreg. green copper oxides, little Cu_2S native Cu.
1225-1238	Gar. + sil. ls with cuprite 1229-1231, strong native Cu 1234-38
1238-1274	Gar + sil. Ls with native Cu and cuprite(+) little sulph., $CaCO_3$, FeOx.
X 1274-1285	Alt. gar. Ls with green Cu oxides, little Cu and traces cuprite.
1285-1291	Good core recovery. Softened highly alt and bleached to considerable gray-green of white with traces of green Cu oxide staining. Prob. highly alt, gar. + sil. Ls.
1291-1297	Cavity.
1297-1305	1297-99 75-80% core. Silicated and gar. Ls with $CaCO_3$(+), some prominent Cu oxide from 1297-99 - cavity 1299-1301 Dark alt. Ls - dark - partly silicated, $CaCO_3$(+) red FeOx.
1305-1334	Cavity.
1334-1334.8	Recry gray white Ls, little Cu stain.
1334.8-1337	No core.
1337-1352 ↗ Probably should be 1342	Approx. 3.0' ft. material. First 2' apparently dried sludge. - calcareous material traces Cu oxides, FeOx. Last 1.0' highly alt. gran. Ls - partly silicated? - with Cu ox. stain weak, little FeOx
1342-1343.5	100% core. Recryst. Ls some FeOx MnO_2 alt sil. minerals? Traces Cu oxide
1343.5-1353	Cavity.
1353-57	90% core - recryst. alt. partly silicated Ls - some FeOx, $CaCO_3$ first 6" looks squeezed.
1357-1365.5	100% core Soft. and alt. partly silicated Ls, $CaCO_3$(+) some FeOx
1365.5-1368	cavity.
1368-73	First 2" highly leached cellular, brown-gray - little Cu st. - probably is same as slimy material first 2.0' ft. of section 1337-42 Highly alt and softened partly silicated Ls with $CaCO_3$ mangano-calcite seams; little Cu ox. and FeOx.
1373-1403.5	Mass. recryst. Ls - little irreg Cu stain, FeOx
1403.5-1408.5	Cavity - first 2" on lower side strong cellular dark brown Ls with little Cu stain
1408.5-1514	Recryst. gray white Ls, Local areas with green Cu oxides, little FeOx MnO_2(-)
1514-1587	Recrystallized Ls with increased amounts of alteration some irregular Cu ox. minerals, FeOx, MnO_2?, probably little development of lime silicates.
1587-1597	Some lime silicates in alt. recry. Ls.
1597-1635	Recry Ls some silication, irreg green Cu ox. minerals.
1635-1680	Recry Ls and silicated Ls with red FeOx some steep slips stained with FeOx, some green Cu oxides.
1680-1706	Recryst. Ls. Relatively less mineral and little development of lime silicates,

1/10/63

DDH
G-33

1706-1733 Recryst. Ls with several short sections gar. Ls. Increased irreg. green Cu oxides, dark FeOx mangano-calcite, $CaCO_3$.

1733-1783 Gray white re-cry Ls with little silication and weak mineral 1733-53. Increased FeOx Cu oxides with short sections gar. Ls and silicated Ls 1753-1783.

1783-1817 Generally gar. and silicated Ls, now well altered, developed from recryst. Ls. Some strong reddish FeOx zones, little native copper. Fe_3O_4 in garnet, very little green Cu oxide min.

1817-1829 Fine gar. Ls, FeOx on fract. and seams, no evident Cu

1829-1837 Mostly mass. recry. $CaCO_3$

1837-1859 Recryst. Ls with increasing amounts of lime silicate minerals downward - some FeOx, practically no evident Cu.

1859-1874 Silicated Ls and fine to coarse $CaCO_3$ - much fine black mineral - Fe_3O_4? (Cu_2S??) little fine dis FeS_2 $CuFeS_2$ (–), FeOx, Calcite seams

1874-1880 Gar Ls. fine dis. black mineral, probably hematite, $CaCO_3$ and FeOx

1880-1896 Gar + sil. Ls with dis and splotches $CuFeS_2$ - much fine black mineral. (Fe_2O_3?)

1896-1899 Cr. and alt. zone, some gougy material - mostly serp. Ls with weak sulph. Small fault or shear zone.

1899-1987½ White recryst. Ls — traces red FeOx staining very little other alteration.

1987½-1992 Contact with white lime shows little serpentine ∠ of 35° with core. Dark fine grained rock, possibly dike - very small dark phenocrysts may be Fe mags, and small possible feldspars are light colored. Contact at 1992 makes ∠ of 45° with core

1992-2028 Gray white cry. Ls. - little $CuFeS_2$ with serp.? in small fractures at 1992½. Banding at 1995 ± 25-30° with core. No core 2006-2016 - Little dark alteration (actinolite?) with ZnS etc. at 2001. Ls at end may be slightly more altered.

END

1/10/63

DDH
G-33

10 – 190 Alt. and soft. sil. Ls cut by few narrow dikes – little mineral

300 – 358 Gray white fragmented? qtzite. – peculiar broken appearance.

358 – Impure qtzite or limestone with some silication.

---

546 — 1898 0.65%

G-36	585 – 1110	0.82%	oxide principally
	1110 – 1160	1.12%	Sulph.
	1160 – 1180	0.92%	"
	1193 – 1257	1.09	"

last assay in ore

50 T
33 — 66

Cy 8 4685 K. Haakason →
D.

FORM 1168

MEMO

To Bob Campbell, Denver
Phone from RBM Ma. 3-7151
Place Eastman Oil Well Survey Co.
Present

Date 9/27/63 Time
To
Subject

15¢ / ft. for cased hole
9¢ uncased "
15¢ / mile from nearest office.

500 = 1000 round trip from Ld. area $150.00

608	3100'
619	2686
623	2132
	7918

RBM Est. 8000' @ 12¢ = 960.00
$1110 + $1300

960.

Keith Haynes, Provo. US Steel surveying.

3800' Bx E. Oil Well Survey. 238' drift
335' "
another 4100'

2nd call to Campbell —

Have coast representative call Barker or Kelly to arrange time. Told him we would survey 3 holes 2500-3000' deep, DDHs. Arrange time with Barker or Kelly after new machine on 608.

260
20
520

125
150
12.50
625

1st Trav. across hill

Alt. steep beds gar. Ls and siliceous Ls, some cry. N 60° W steep.

Last lower part 100' ± dark gray to gray white recry. Ls.

At 200' NW — Dead white recry. Ls at arroyo - strike N 60-65 W - boundary not sharp - alteration phase?

Atlanta Klondyke S corners.

2nd Trav. Up hill

500' E of common c. Atlanta - Klondyke

in arroyo N 60° W cry Ls steep.

up hill on slope 250' on gray and dark gray recry. Ls.

From that point to top of hill 150' E of △B steep N 55 W

lightly beds sil. and gar. Ls - some recry. Ls in thin beds and

irony areas. Traces min, but almost nil.

At △B N 55° W dip 85-90° NE.

3r. Trav. From Bullion shaft - Due S. 400-450' at arroyo

Mostly float

All steep dipping lightly sil. Ls - no cry. Ls. but caliche zone

last 20' toward arroyo.

4th Trav. At S 50 W ± 300' from Bullion shaft cry Ls.

strike? N 55° W. - approx. contact with sil. Ls.

From this point crossing hill 100' NW Bullion Sh. and

down N. side to wash cover - all steep dipping sil. + gar. Ls -

thin beds. strike N 55-60° dip 85-90 NE.

Large CDM S 70 E from Glance Sh. 1800' ± - 150' N of

Bullion Sh. road.

RBM.

861 – 1075.2 214.2 0.78 166.43

61
214.2

1075.2 — 1133.4 58.2 ft. 0.26 114.95

75.2
58.2

.26
58.2) 149.5
1164
3310
3492

1133.4 — 1286.0 152.6 0.50 75.85

133.4
152.6

.49.6
152.6) 75.8.5
6104
14810
13734
10760

425

861 — 1286 257.23

861
425
229
654

1515
1286
229

.605
425) 257.23 0.61
2550
2230
2125

TWIN BUTTES 4/24/63

188 1515- 1644 Fine gr. dark granular rock, probably meta. sediment, but doubtful that it can be called "qtzite" - few $CaCO_3$ seams with $CuFeS_2$ - ~~some~~ some introduced qtz. Generally weakly mineralized.

1659 ~~1656'~~ contact upper impure sed. with q.m. - traces MoS_2 etc.

861-1075.2	214.2	0.78%
1075.2-1133.4	58.2	0.26
1133.4-1286.0	152.6	0.50
861-1286	425.0	0.61

1664

196 632- 689 Bedding in erratically garnetized LS or dolomite at 60°-65 dip. Very little sulphide, traces FeS_2 Cu_2S(?) little FeO_x MnO_x.

689- 710 Traces Cu stain MnO_2 possibly some Fe_3O_4 near end

601 760-1259 Mapped as "arkose" Generally dense gray white siliceous - very fine gr. rock, locally with qtz. eyes, irregular shapes. Probably should be mapped as "rhyolite".

PALO VERDE.

509 577 Arkose - Weak min 1" Por. dike at 575'
712 In weakly min monz. - FeS_2 $CuFeS_2$ MoS_2(?) Ten??

510 325' Arkose - weakly mineral.

511 238' ~~779~~ Monz. with ox. min. - little $CaCO_3$.

512. 195-262 Weakly min q.m.p. - last 10' weak dis. min. sulph. - FeS_2 $CuFeS_2$

508 ~~881~~ Weakly min. monz.
891 " " "

Palo Verde Holes

A 511 -	N. 9915	E. 7555
Rec. # 21	El. ± 3230	
A-512	N. 9915	E. 7310
Rec # 22	El. ± 3240	
A-513	N. 9220	E. 9421
Rec # 13.	El. ± 3195	

4/19/63

188 1485' 4/20/-1565'

Last 20' good gar. Ls.

with Fe_3O_4 FeS_2 $CuFeS_2$

1515 3PM - Good $CuFeS_2$ at bottom.
2' unmin ls. at ± 15PDS

196 Start 330' in gar. Ls.

below overburden

Heavily gar. Ls - little min.

Brec. at 430'

Oxide Cu at 445'

Bottom at 498'
502' 2:45 PM bedding 45°50°

601. Bedrock 760'

Arkose to 1124 ft.

Badly broken in bottom.

PALO VERDE 1087 END
1079 4:20 PM.
A 505 END 1065 cry LS.

hi gr. min 1020-1050 $CuFeS_2$ ZnS.
1027.5-1028.3 hi grade MoS_2

A 506 1095 into LS at 1009.
Fair section above, to 970

Mos at 1154
A 507 End 1071 1156 5PM
contact 933 All LS
below - spotty gm. $CuFeS_2$
Prob. not ore.

Dec. 14 Pulling casing.
A 510

508 qtz mon 413 449 weakly
min q.m.

509 qtz mon. 280' q.m. 328
qm
$CuFeS_2$ (-)

5/9

5/10

196	1142	Hornfels	1238 hornfels & qtzite
	544		
602	634	qtzite.	670 into qtz. Ls
			680'
			709
249	928	[illegible].	937 [illegible].

44.6
15
2230
446
669,000,000

74

15000
15
225,000
300
67,500,000
10 years

875
15000
4375000
875
13,125,000

20,000,000

65 000 000

---

800 — 189 above 8 — high grade salt.

104 — part gone

92 — stoped 12-15' of section

95 — not stoped - drift.

84 — not stoped - in pillar.

203 — Barren?

249 — could be mined - water.

180 — stoped

156 — not found - in stoped area

245

5/8/63

<u>Discuss</u>

check assays - pulps, then rejects
from D 92 9035 sect.
D 123 9475 "

New hole alongside old one

by new holes on NW sections
to check continuity between
old sections.

Raises on DDHs - on L.G. sections.
300' + high.

Saginaw - steep hole?

45 million	1.02	0.5% cut off omit low grade	12 cu ft.
32 "	0.87	open pit. (easy)	
62.9 "	0.83	including L.G. in 45 million	
44.6 "	0.74	open pit. with included L.G.	0.5 cut off outside.

A 629

832 - 534	2.0	[illegible]	
	3.0	13.86	1.94
	5.0	33.00	12.1
	3.0	5.41	2.88
	3.0	3.81	3.39
	2.0	7.16	3.32
	6.0	16.86	1.26
	2.0	6.46	.92
	2.0	4.26	.22
	2.0	3.04	.32
	4.0	3.00	68
	4.0	4.24	88
	6.0	7.50	1.98
	3.0	4.53	.46
	4.0	34.08	6.60
	4.0	4.72	.64
	2.0	1.98	18
589 - 593	4.0	20.32	5.72
			55.51
	3.5	4.34	
596.5 - 600	3.5	4.03	
	3.0	15.54	
	1.0	3.82	
	2.0	5.96	
	3.0	6.84	
	4.0	12.60	
613 - 615	2.0	5.80	
	82.0		

.9
61) 55.51
549

22/61

615-616

	1.0	1.13
	2.0	7.84
	1.0	0.47
	0.5	2.48
	2.0	3.18
	2.5	3.48
	3.0	17.64
1.0 no [illegible]	2.0	10.54
	1.5	32.60
	2.5	13.48
634-36	2.0	2.02
	20.0	370.86
	83	
	103	

3.6

10.3) 370.86

309

618

618

A 629

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	5.0	33.00	12.15
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	103	

```
        3.6
103 ) 370.86
      309
       618
       618
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LEGAL INVESTIGATION

TITLES TO PROPERTY

CLAIMS

PATENTED

UNPATENTED — GROUP ASSESSMENT WORK REQUIREMENTS. THIS YEAR AND IN FUTURE

PATENT WORK IN PROGRESS

STATE LEASES

SURFACE

MINERAL

COMMERCIAL

OUTSIDE SURFACE AGREEMENTS

UNDERLYING AGREEMENTS

MINERAL HILL — TWIN BUTTES

HELVETIA — PAYMENTS - WORK REQUIREMENTS

MORENCI — PAYMENTS - WORK REQUIREMENTS.

WATER RIGHTS

DUMP AREAS

TAILINGS DISPOSAL AREAS

TUCSON MOUNTAIN PARK CLAIMS.

ALL OTHER MINERAL INTERESTS.

OPERATIONS

SIDELINE AGREEMENTS

PIMA

A. S. & R.

SAN XAVIER INDIAN RESERVATIONS (A S & R AS LESSEES)

OTHER AGREEMENTS

OPERATIONS — CONTINUE ?

RESPONSIBILITY ?

PATENTS — METALLURGICAL

OTHERS

TAXES

PROPERTY

INCOME (LOSS CARRY OVER ?)

FRANCHISE, NET PROCEEDS (SEVERANCE)

June 6, 1962

PERSONAL

Mr. V.D. Perry
Vice President and Chief Geologist
The Anaconda Company
25 Broadway - Suite 1850
New York 4, N.Y.

Dear Mr. Perry:

Following our telephone conversation on June 4th, I have reviewed briefly the legal investigation which must be made in connection with any business arrangement which may be made with the Banner Mining Company. From our previous contracts with other companies which are less complicated than Banner, it is evident that the legal investigation will be as important and lengthy as the proposed geological and mining examination. Following is a list of items which must be investigated; others may become apparent later.

LEGAL INVESTIGATION

TITLES TO PROPERTY

Claims

Patented
Unpatented
  Group assessment work requirements this year and in future
Claims now in patent proceedings
Abstracts
Present title conflicts, if any

State Leases

Surface
Mineral - royalty rates, duration, work requirements, etc.
Commercial

Outside Surface Agreements

Underlying Agreements

Mineral Hill - Twin Buttes
San Xavier Mine
Helvetia
  Payments - work requirements

Underlying Agreements (continued)

Morenci Properties
  Payments - work requirements
Banner Mine, Lordsburg
Tucson Mountain Park Claims
Water Rights
Dump Areas
Tailings Disposal Areas
All Other Mineral Interests

OPERATIONS

Sideline Agreements

Pima Mining Company
A. S. & R.
San Xavier Indian Reservation (A.S.& R. as lessees)

Other Agreements - On Operations; Easements, Access, etc.

Operations - Continue ?
Responsibility ?

Patents - Metallurgical
Others

TAXES

Property
Income (loss carry over ?)
Franchise, net proceeds (severance)

If an agreement is reached with the Banner Mining Company, it is my suggestion that at least two men from the legal department spend full time on thorough investigation of the above items, and that a complete analysis of titles and underlying agreements be submitted well in advance of the final date of the examination period. It should be emphasized in the contract that all of Banner's interests in mineral properties should be reserved to the Company unless specifically excepted in the contract. Nothing which has been of interest to Banner should be withheld for the possible future benefit of individual Banner stockholders.

The necessary legal investigation will be of utmost importance, and it is urged that it be pursued with the greatest diligence. It will, of course, be necessary for the operating departments to appraise present equipment, and to develop future operating plans and cost estimates.

Yours very truly,

Roland B. Mulchay

Roland B. Mulchay

RBM:S