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November 12, 1990

J.D. Sell

Final Geologic Report
Yarnell Project
Yavapai County, Arizona

Attached is the final report on the "Geology of the Yarnell Gold Deposit." The body of the report addresses the following aspects of the project:

1. The geology and mineralization of the Yarnell gold deposit.

2. Discussion of drilling and sampling techniques and a general discussion of the ore reserves.

Numerous memos have been written during the project relating to sampling, assaying and ore reserves. This report will summarize these memos and reference them for the reader.

The Yarnell deposit is a structurally controlled epigenetic gold deposit hosted in Precambrian granites. The deposit is found within an "envelope" of phyllicly altered rocks with the Yarnell fault zone (YFZ) the most probable locus of gold mineralization. The YFZ is a low angle structure with an attitude of N30°-45°E dipping 30°-45°NW. Gold mineralization is associated with varying amounts of iron oxides and several stages of quartz. Mineralogic work has indicated that gold occurs in free form and also partially locked with iron oxides and quartz. The greatest majority of the gold is in the micron size range which will make it more amenable to heap leaching. Visible gold has been seen in the drill core on rare occasions always associated with quartz veins.

Reverse circulation drilling was done to define the deposit. A total of 96 holes were completed with 83 holes within the proposed pit limits. Most of the holes are located on 100' centers on drill fences perpendicular to the main structure. Correlation and continuity between the mineral intercepts is good.

Ore reserves were arrived at by two methods. Engineering and Computer Services calculated the reserve using an economic model known as the Cone Miner. Reserves were also calculated by J.D. Sell using an equal triangle method. Both methods are further discussed in the report.

I would like to acknowledge the dedicated help of the following people who were instrumental in the successful completion of this project: W.D. Gay who spent many hours surveying the surface and underground under sometimes very adverse conditions; John Malusa who handled the

daily logging of all the drill cuttings and the daily supervision of the drill; Steve Keehner, a local Yarnellian who was kind of a "jack of all trades"; and Jim Rasmussen who came to the project towards the end, but his suggestions and discussions resulted in a better and more quantitative understanding of the deposit.

MAM:mek
Att.

Mark A. Miller
Project Geologist

cc: W.L. Kurtz

YARNELL FINAL REPORT

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YARNELL PROJECT

Yavapai County, Arizona

I. SUMMARY AND CONCLUSIONS

The Yarnell Deposit is a structurally controlled (and prepared) hydrothermally altered zone that hosts economic gold mineralization in a configuration and thickness amenable to an open pit operation. The deposit is hosted in a Precambrian granite and occurs in and surrounding a low angle fault structure; the Yarnell Fault. The hanging wall of the fault has been extensively fractured and altered to sericite (phyllic alteration). Gold mineralization appears to be associated with secondary quartz veining, iron oxides, and the development and intensity of quartz veins stockwork which has been developed in the hanging wall. The footwall of the mineralized zone (below the Yarnell Fault) is phyllicly altered, but is usually unmineralized with respect to gold. The Yarnell Fault Zone (YFZ) continues both NE and SW from the main deposit and where exposed it contains gold mineralization; however, the thickness of the zone and the associated alteration envelope appears to be considerably less. Ninety-six reverse circulation and four diamond drill holes have been completed. A mineral inventory of 4.1 million tons at .055 opt Au (JDS reserve) has been estimated with a recovery by leaching of +70%. In addition there is 2.7 million tons at .017 opt Au in a low grade zone above the main mineralized zone.

Additional drilling is recommended to extend the mineral inventory both northeast and southwest from the known limits.

II. RECOMMENDATIONS (Plate 4)

Asarco has drilled off an inventory of +4 million tons at .055 opt Au (from J.D. Sell's calculated reserve). This is based upon 73 drill holes from a total of 96 holes. The remaining 23 holes are too far down dip to be included in the reserve calculations, too far away from other holes, or collared in the footwall of the mineralized zone. Projections of mineral trends and geologic mapping on 100 and 200 scale over the deposit indicates other areas of untested mineral potential that could be included in the mine plans and should be tested. The areas of interest are listed below.

AREA 1: SOUTHWEST EXTENSION OF THE MINERALIZED ZONE.

A potential for 600,000 - 800,000 tons of similar grade as the mineral inventory is indicated southwest of the last drilled fence of holes (YM-48, 64, 65). The alteration zone has been mapped along the projected trend of the Yarnell Fault. Scattered assays in this zone indicate that gold mineralization is continuous within the zone. The majority of the hanging wall zone is on a dip slope and difficult to accurately sample. Eleven holes are proposed to test the mineral potential of this area (Miller 2-5-90).

AREA 2: NE EXTENSION OF THE MINERALIZED ZONE

Mapping and sampling of the area (and particularly the small knob NE of the proposed pit) has indicated a zone of gold mineralization similar in occurrence to the main deposit. Mineralization appears to be related to a low angle fault structure; possibly a splay of the Yarnell Fault. Detailed rock chip sampling and trenching (on the structure) along the exploration roads that traverse the knob have indicated spotty values of +.01 opt Au with a zone in the trench averaging 30' at .048 opt Au. This trench was cut across the strike of the structure. Alteration is continuous from the base of the hill to the top with abundant sericite, moderate silification, and occasional quartz veining. One RC hole collared near the top of the hill had an interval of 20' which averaged .013 opt Au; not ore but certainly indicative of a mineralized system. A potential for +/-200,000 tons of similar grade to the mineral inventory is indicated. Two holes are proposed to test the mineral potential of this area (Miller 2-5-90).

AREA 3: DOWN DIP EXTENSION OF THE MINERAL INVENTORY

Additional drilling is recommended to test the downdip limits of the mineralized zone intersected in RC hole YM-26 (90' at .054 opt Au) and YM-33 (90' at .051 opt Au). A potential for 600,000T at >.05 opt Au exists with an ore to waste ratio around 3.0.

III. INTRODUCTION & HISTORY

The Yarnell Deposit is located within the Weaver/Rich Hill Mining District in Yavapai County, Arizona (see location map, Figure 1). Historical production from the Yarnell Mine was mostly underground with some limited production from the open cut. This amounted to +/-200,000T being mined between 1900-1941 on a very intermittent basis. The last operator of any consequence was the Winslow Mining Company which operated the property from 1939-1941, and constructed a cyanide agitation mill on the property. It was during this time period that the majority of the 200,000T were mined. Average grade was reported to be .2-.3 opt Au mined exclusively from the Yarnell Fault Zone. Overbreaking of the ore zone is evident as the ground conditions caused large and blocky roof falls of sub ore (for that time period) material. Actual grade of the ore may have been in the 0.1+ opt Au range. The mine was shut down in 1941 by L-208; the Federal Gold Mine Closure Order. Asarco's recent interest in the property was through a news release in the George Cross News Letter, a Vancouver B.C. promotional news letter. Norgold

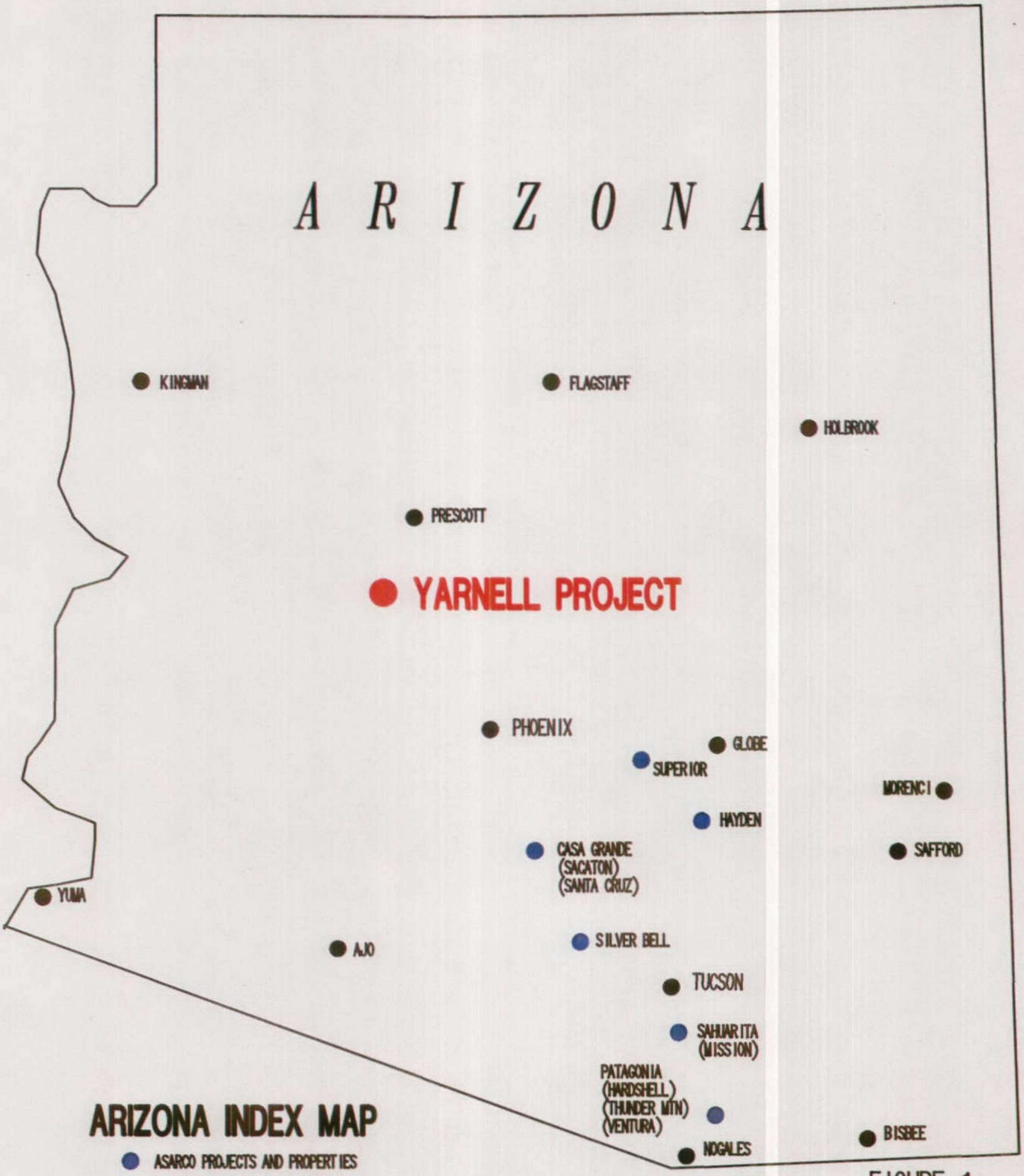


FIGURE 1
ASARCO Incorporated
YARNELL PROJECT
INDEX MAP
YAVAPAI CO., ARIZONA

mn YR900701 MAM/dcm tuc 07/02/90

Resources, the Canadian junior mining company that controlled the property, reported the results of a reconnaissance rock chip sampling program (GCNL #177 9/14/88). The length of the sample lines and resultant grade suggested a bulk tonnage open pit target. The property was examined in November 1988, at which time it was sampled. Assay results confirmed Norgold's values. It was sampled in greater detail in December with again confirming results. A letter agreement was signed with Norgold Resources in late January 1989 for an exploration option on the property. Detailed sampling and mapping at 1" = 200' was completed and a nine hole R.C. program was proposed and completed (Miller 5-11-89). The results of the drilling strongly suggested the possibility of a bulk tonnage open pit deposit and additional holes were completed. A total of 96 R.C. holes and 4 diamond drill holes (which are twins to the R.C. holes) were completed during the exploration program.

IV. LOCATION & TOPOGRAPHY

The Yarnell Gold Deposit is located in the Weaver Mining District on the SW side of the Weaver Mountains in Yavapai County, Arizona (Index Map, Figure 1). The deposit is situated very close to the drainage divide between the Yarnell/Peoples Valley watershed and the Congress Valley watershed. Highway 89, a US maintained highway, is within 300' of the deposit and access is year-round. The present drilled mineralized orebody within the computer model benches, is between the 5100 and 4640 benches. Topography and attitude of the deposit are very amenable to open pit mining. The climate is also conducive to year-round operation.

V. LAND STATUS & GENERAL AGREEMENT (Table 1, Plate 1)

The project is a joint venture between ASARCO Incorporated and Norgold Resources, a Vancouver junior mining company. Property under control in the JV area consists of the following (Figure 2):

Patented Lode Claims	5	+/-100 Ac.
Unpatented Lode Claims	56	+/-1120 Ac.
State Leases	2	480 Ac.
Total		+/-1700 Ac.

Details of the agreement are complex, but are summarized as follows: Asarco will become a 51% partner and operator after spending $250,000 in exploration on the property, make payments to Norgold thru 1991; assume all underlying agreements and provide Norgold with a feasibility study by July 1991 and a commitment to mine within 3 years from the date committed. The schedule of payments (Table 1) details the underlying payouts. Norgold will share in these costs once the 51/49 JV is enacted.

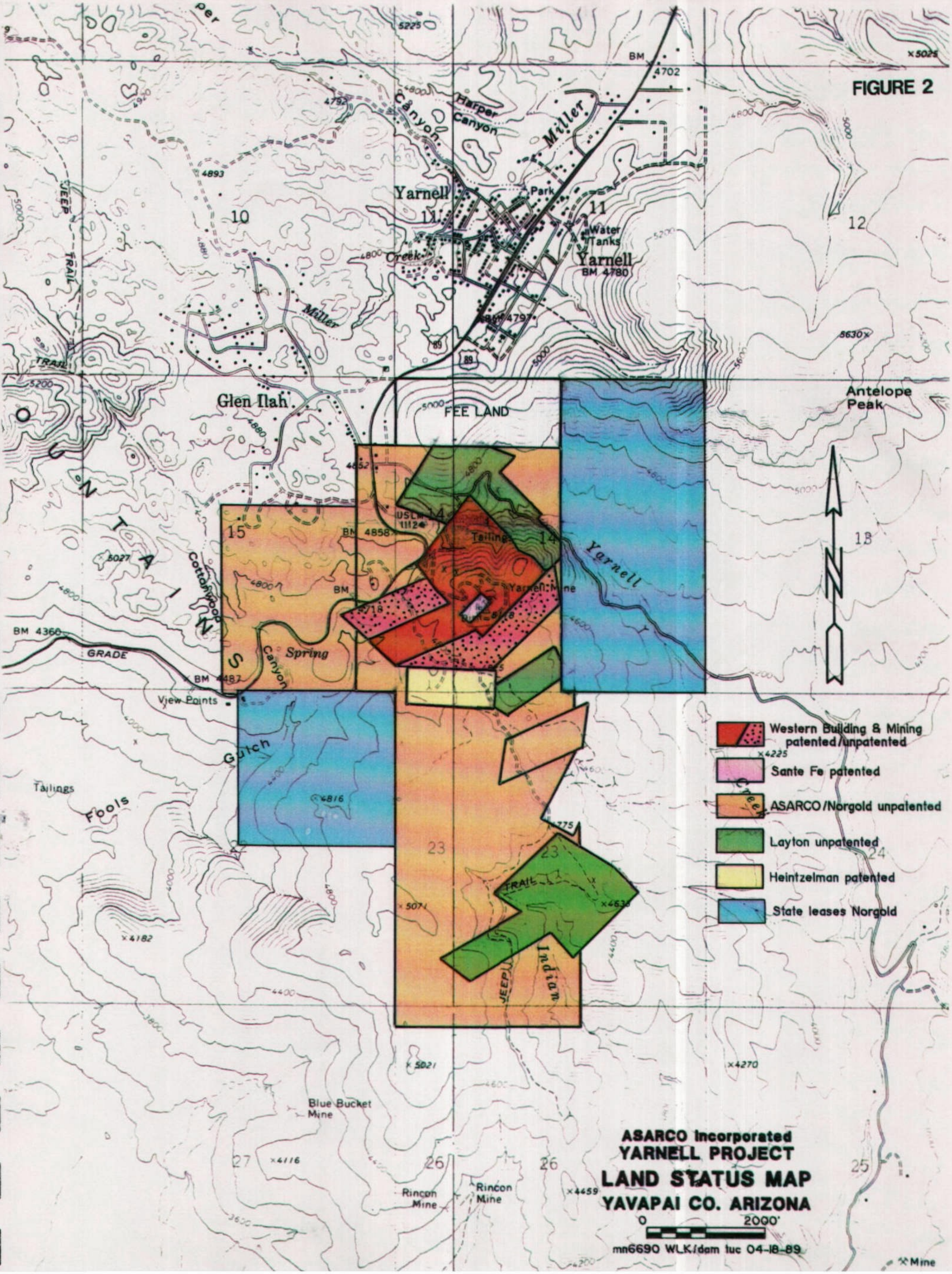


FIGURE 2
Western Building & Mining patented/unpatented
Sante Fe patented
ASARCO/Norgold unpatented
Layton unpatented
Heintzelman patented
State leases Norgold
FEE LAND
Yarnell
Glen Ilah
Antelope Peak
Yarnell Mine
Blue Bucket Mine
Rincon Mine
ASARCO Incorporated
YARNELL PROJECT
LAND STATUS MAP
YAVAPAI CO. ARIZONA
0 2000'
mn6690 WLK/dam tuc 04-18-89

PAYMENT & ROYALTY SCHEDULE

YARNELL PROJECT

Table 1

Payment Schedule beginning June 1, 1989.

Year	(Pat. & Unpat.) Roman	(Unpat.) Layton	(Patented) Heintzelman	Sub Total	Norgold	Total
1989	$ 7,000	$ 10,000	$ 15,000	$ 32,000	$ 30,000	$ 62,000
1990	100,000	15,000	12,500	127,500	40,000	167,500
1991	100,000	25,000	12,500	137,500	50,000	187,500
1992	100,000	40,000	12,500	152,500	25,000*	177,500
1993	150,000	60,000	--	210,000	25,000*	235,000
1994	--	100,000	--	100,000	25,000*	125,000
	$457,000	$250,000	$ 52,500	$759,500	$195,000	$954,500

*To be paid if Asarco has not begun development on property.

Royalty (NSR IN %)

Al Roman	Layton	Heintzelman
2% year 0 - 2 1% year 3 - 4 .5% ad infinitum	1% or Advance Royalty (Greater of the two)	None

Payments not to exceed $175,000/yr

VI. GEOLOGY (Plate 2)

A. GENERAL STATEMENT OF ROCK TYPE FOUND

The gold deposit occurs within a Precambrian (1000-1400 myo) medium to coarse grained equigranular biotite granite/granodiorite; however, the petrographic description by Russ Honea is closer to a quartz monzonite. Included within this intrusive complex are schistose xenoliths and the angular nature of some of these xenoliths suggest that "stoping" by the intrusive has occurred. These xenoliths have been seen in the altered and unaltered rocks, but are insignificant in occurrence within the mapped areas. The fresh unaltered intrusive is light gray/green in color with up to 10-15% black biotite, and the remainder of the rock is composed of microcline (~50%), quartz (~15%) and plagioclase feldspar (~25%). As the rock weathers it becomes light brown in color; probably due to the leaching of the iron oxide minerals and the biotite. Jointing is very common in both unaltered and altered rocks creating very large boulders (elephant rocks) in the unaltered rocks typical of a granite terrane.

Felsic dikes (shown as purple on map) occur especially in the southern portion of section 14 and the northern part of section 23. These dikes/sills are associated with the late stage quartz veins and quartz vein float. The felsic dike structures trend N20-40°E and dip to the NW at 30-80°. They are usually 2-4' in width and appear to have a sheared/stretched appearance. It is evident that the dikes follow the predominant regional structural direction; however, their relationship to the Yarnell Fault is unknown.

Diorite dikes and/or sills (shown as brown on map) also occur within the mapped area and have been seen in association with other deposits in the district. These dike structures trend both N10-20°W to E-W within the Yarnell Area. The NW trending structures dip +/-80° to the SW while the E-W trending structures appear to dip +/-30°N. These dikes are much thicker than the felsic variety; up to +10' in thickness. Based upon the mapping, it appears that the diorite may postdate the felsic dikes. The largest diorite dike trending N10-20°W dipping 80°SW appears to postdate the latest movement on the Yarnell Fault as there is no <u>obvious</u> displacement of the dike across the fault. The dikes do not show any of the NE regional structure suggesting emplacement after this event. Quartz veining is commonly associated with the diorite dikes. The quartz veins appear to be late stage white quartz which is often auriferous in the Yarnell area. There are also indications of diorite in the footwall of the mineralized zone as noted in some to the RC holes. The significance of the footwall diorite at the Yarnell Deposit is not known.

The existence and occurrence of diorite dikes and sills associated with gold deposits in the district has been reported. Diorite is mentioned at the Alvarado Mine, the Octave Mine, Congress Mine and other mines and prospects within the Weaver District associated in some way with gold mineralization.

The existence of diorite associated (at least spatially) with the Yarnell Deposit suggests a similar relationship. However, only trace amounts of gold have been assayable from the diorite. The quartz veins, however, are commonly auriferous. This suggests that this stage of quartz veins with gold was emplaced along the weak structural zones along the diorite granite contacts.

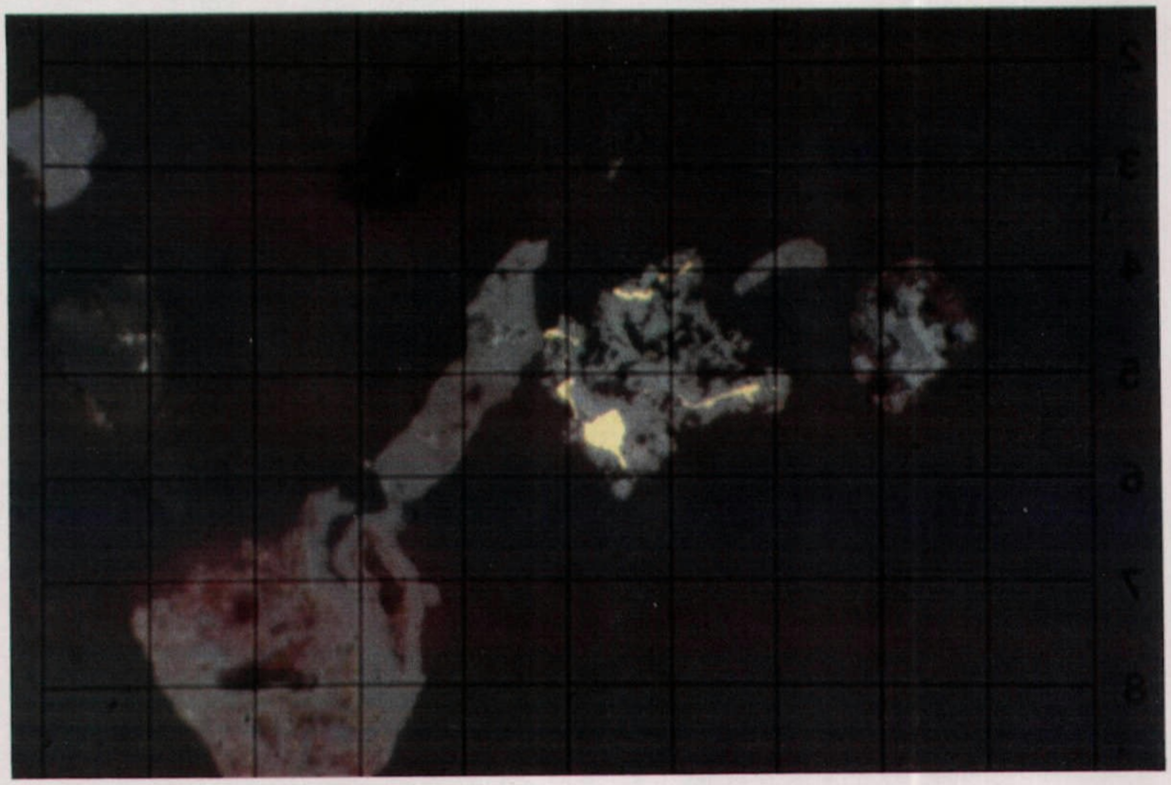
Aplite Dikes (not shown on map) - These dikes are very minor in occurrence and are found in the unaltered granite. They do not appear to be related to alteration/mineralization. The aplite dikes are probably a late feature of granite crystallization as they have the same mineralogy as the intrusive; only finer grained. Thicknesses of the dikes vary from hairline to 6".

B. STRUCTURE

The principal structure which controls and localizes gold mineralization is the Yarnell Fault Zone (YFZ). This is a 4'-6'+ zone as mapped on surface and underground workings, composed of strong gouge, mylonite, microbreccias (tectonically derived), quartz veins and silica replacement and fault breccia. Abundant clay is present in this zone, probably from the fault gouge. The Yarnell Fault is a low angle structure trending N40-60°E with dips to the northwest ranging from 25-40° along its mapped and exposed length. This is a regional structure and has been traced by surface exposure for 2+ miles to the southwest before it disappears under alluvial cover. The northeast extension is less clear as it trends into a thick valley fill capped by volcanic flows. Associated with the YFZ are numerous faults/fractures which occur in the hanging wall of the structure and are often mineralized with quartz and various types of iron oxides (goethite, hematite, specularite, etc.). These fractures were probably the conduits for the gold bearing fluids to move away from the Yarnell Fault Zone and create the "Disseminated Deposit." Several prominent joint sets have been identified striking N10°E x N70°W. These sets are frequently mineralized with iron oxides and occasionally gold.

C. GOLD MINERALIZATION & OCCURRENCE

On the basis of core logging, field observations, and limited mineralogical work by Russell Honea (consultant mineralogist)



YM71 - 85-90'. Polished section photomicrograph of native gold in small particles locked gy goethite. Plain light, X435. Each square of grid is 32 microns on an edge.

FIGURE 3

gold appears to have several modes of occurrence. It occurs in the free state and associated with iron oxides (goethite). Mr. Honea prepared a pan concentrate of a very high grade gold zone encountered in the drilling which assayed 1.02 opt Au (YM-71; 85-90'). He reported that 38 particles of gold were seen; 14 of which were liberated (free) and 24 which showed some degree of locking with goethite (18) and quartz (6) (Honea 12-7-90). Of particular interest is a photomicrograph (Figure 3) which shows included gold within a oxidized pyrite cube. Size ranges of all the free gold particles range from <1 to 110 microns (1 micron = .001mm or 1/25,000"). Some of this "Free" gold may have been liberated by the sample preparation process (to prepare the pan concentrate). How much, however, is not known. The locked gold particles range in size from <1 to 26 microns. Honea's study indicates that the size range of free gold is small (18.3 microns average) and even smaller in the locked particles (5.4 microns average). Thus the Yarnell Deposit is a micron gold deposit. The locked particles may not be accessible to the cyanide without some beneficiation. However, the very small size of the free gold suggests the possibility of a shorter leach time in the heaps.

I have compared size ranges of other micron gold deposits in the Mohave Region. Particle size of gold at the Mesquite Mine is +/-10 microns in the oxidized zone. Literature on the Picacho Mine reports gold particles up to 1000 microns in size; however, average size is not reported. Within the Carlin Trend in Nevada particle size at the Gold Quarry Mine is <1 to 10 microns.

Mr. Honea has indicated that the greatest majority of the sulfides have been oxidized to goethite. Free gold has also been seen within the quartz vein stockwork zone (YDDH-4) in association with grey quartz and quartz/specularite veins. Higher gold assays have been found in the quartz stockwork with adularia. The occurrence of adularia (potassic addition) seems to favorably effect the gold grade. Gold is also associated with relict sulfides. In field observation the occurrence of pyrite pseudomorphs and red hematite patches usually indicates a higher than usual gold content. High grade gold mineralization (+.1 opt) is found within the Yarnell Fault Zone with abundant red hematite and quartz. This was the main zone that the old time miners were following and ranges from .1 to 1.0 opt Au. However, little visible gold has been seen in this zone.

D. ALTERATION (TABLE 2) (PLATE 2)

We have recognized three zones of alteration during the mapping. These zones are roughly tabular envelopes outward from the plane of the Yarnell Fault and are described from outside to inside to the Yarnell Fault (weakest -->

strongest)(Figure 6). Each zone will be described from field observation and hand sampling identification. This will be followed by the petrographic description of the zones based upon Russell Honea's observations with interpretations (Table 2).

Weak Alteration (Propylitic)

The zone is characterized by the weak replacement of biotite by iron oxides (hematite?). This usually occurs along the margins of the biotite and can be easily seen with a 10X hand lens. Replacement occurs as a reddish/brown rim along the biotite grain margin. Both microcline (K spars) and plagioclase feldspars are very weakly sericitically altered. There is also the beginning of alteration of biotite -> chlorite which increases into the transition zone (Figure 4A). From the unaltered granite boundary this zone is +/-50-150' thick (measured from the plane of the Yarnell Fault).

Petrographic Description

The zone contains up to 9% biotite which is approximately equal to the unaltered granite. There is a small increase in the amount of sericite in the secondary mineralogy (K-spars & biotite var. converted to sericite) and the primary plagioclase minerals which are being variably converted to sericite for a total of 9-16% sericite.

Transition zone (subzone between weak & moderate alteration)

As seen in the field, this zone takes on the characteristics of both the weakly altered and moderately altered zone. These 1"-6"+ strongly altered areas are characterized by the absence of biotite, higher degrees of silicification, sericitic alteration of the feldspar (plagioclase) and occasional limonite pseudomorphs. The stronger altered zone increases in abundance as the overall degree of alteration increases. There is a strong suggestion of chlorite in this zone as seen in the drill core (and as described in the previous zone). The biotite appears to be altered to chlorite before being altered to sericite as the level of alteration increases (Figure 4B).

Petrographic Description - No thin sections were cut.

Moderate Alteration (Phyllic) Oxidized

This zone is characterized by the complete replacement of biotite by sericite and plagioclase to sericite.. This zone is also characterized by pink potassic feldspar (adularia?) rimming quartz veins and other feldspars (photo - Figure 5). As the intensity of alteration increases the ground mass becomes increasingly more sericitic and the secondary feldspars become more prominent through the ground mass. Calcite is absent in the oxidized zone. The zone is also characterized by an increase in silica as quartz vein stockwork and "flooding." However, this will be discussed in later sections. The zone (oxidized) occurs principally in the hanging wall of the Yarnell Fault and is from 50-200' thick.

Moderate Alteration (Phyllic) Unoxidized

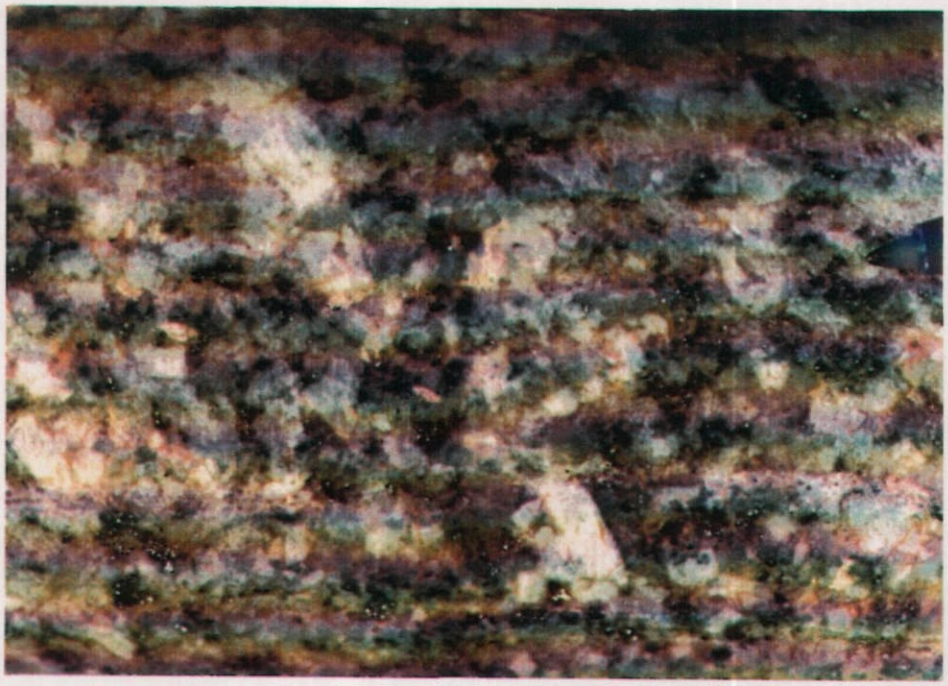
As previously mentioned, the alteration zones appear to form an envelope around the Yarnell Fault Zone, the probable egress of the mineralizing fluids. As shown in surface mapping and in drill holes, the moderate altered zone also occurs in the footwall of the YFZ complex. However, a portion of this zone is unoxidized and the unoxidized zone is characterized by the replacement of biotite to sericite (6% of biotite to sericite) and up to 20% secondary sericite. The ground mass and matrix appear to be strongly silicified (flooded). Quartz veining is very rare and no stockwork is present in the footwall. Fresh pyrite occurs as discrete cubes and as "pseudobands" of sulfides up to 3-5% locally. Specularite is locally very abundant up to 10% averaging 3%+/-. The rock has a greenish cast, due to sericite (Malusa 6-19-90). K-spars are noticeably pink and appear to be primary? and unaltered. Rare calcite is present in "gash" veins.

Petrographic Description

The mineralogy of the hanging wall and footwall moderately altered zones are very similar (attached chart) with up to >20% sericite as secondary minerals and almost complete replacement of primary plagioclase minerals to sericite. A minor difference between the mineralogy of the unoxidized vs. oxidized portions of the zone is the notable occurrence of chlorite in the unoxidized portion (2% vs. 0%). The amount of iron oxides as goethite is much greater in the moderate oxidized zone (3%+/-) compared to nil to trace in the unoxidized section.

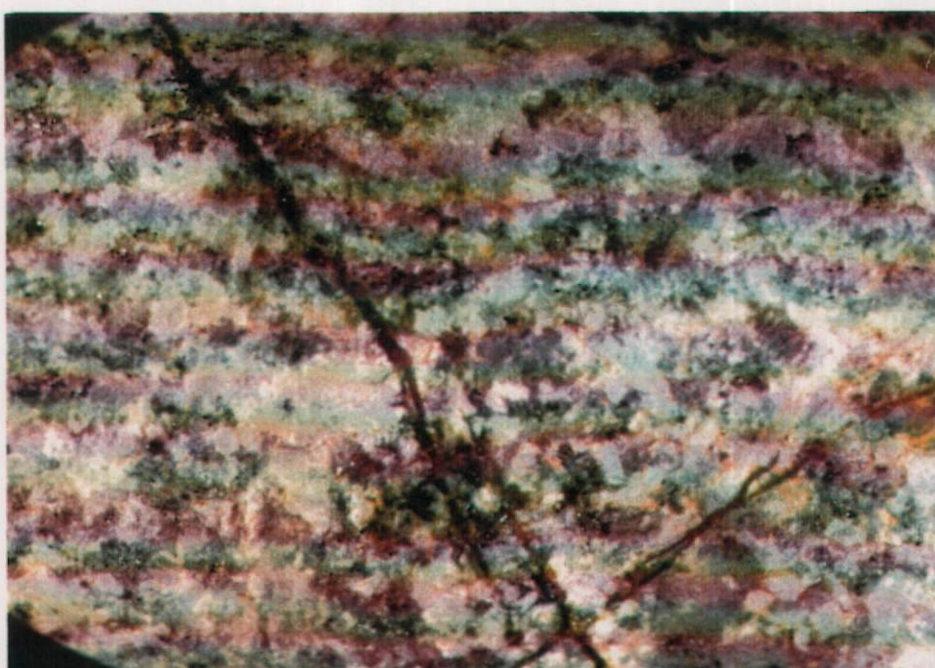
Moderate Alteration - Yarnell Fault Zone Complex

COLOR ART



4A

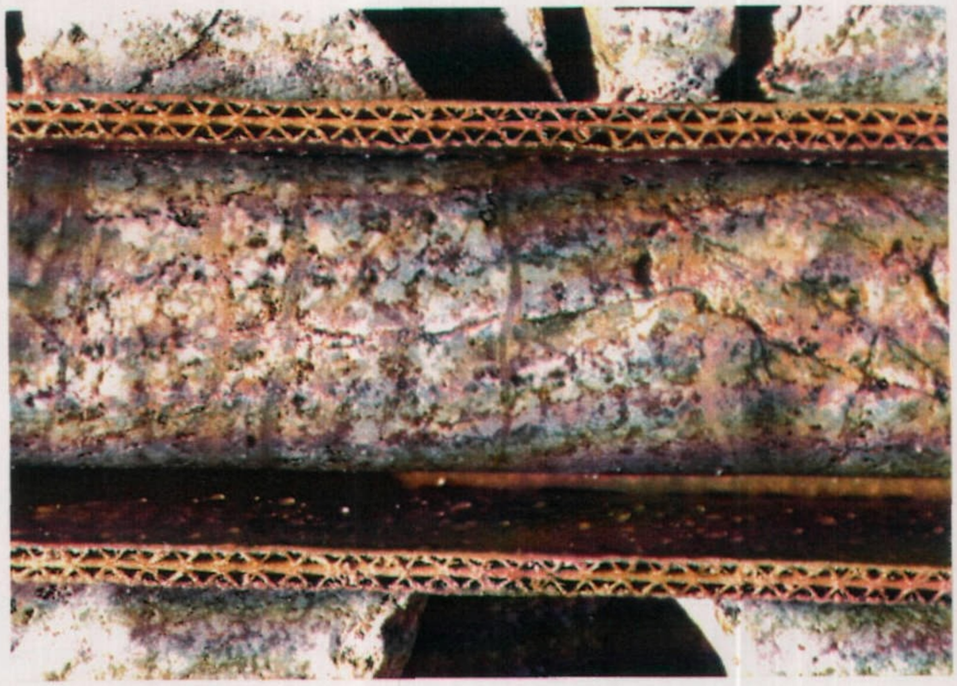
8A - DDH - 3 @ 18-19 feet - Weak Zone
host rock (plagioclase - biotite - alkali feldspar - quartz; granodiorite or quartz-monzonite?) showing weak alteration including formation of specularite (slightly magnetic) ± pyrite at biotite sites, and greenish hue in feldspars. (Page, 10-24-89)



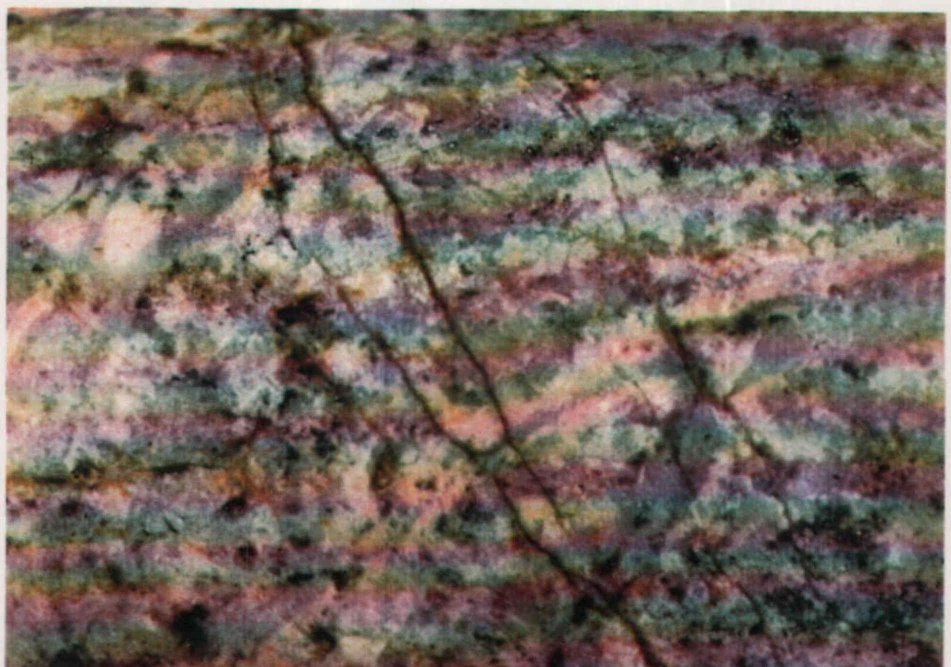
4B

10A - DDH - 3 @ 103 feet - Transition → Moderate Zone
incipiently altered host rock (as above) but with limonite ± specularite veinlets; note green hue in feldspars, most biotite is 'washed out' and crystal boundaries are deteriorating. (Page, 10-24-89)

FIGURE 4



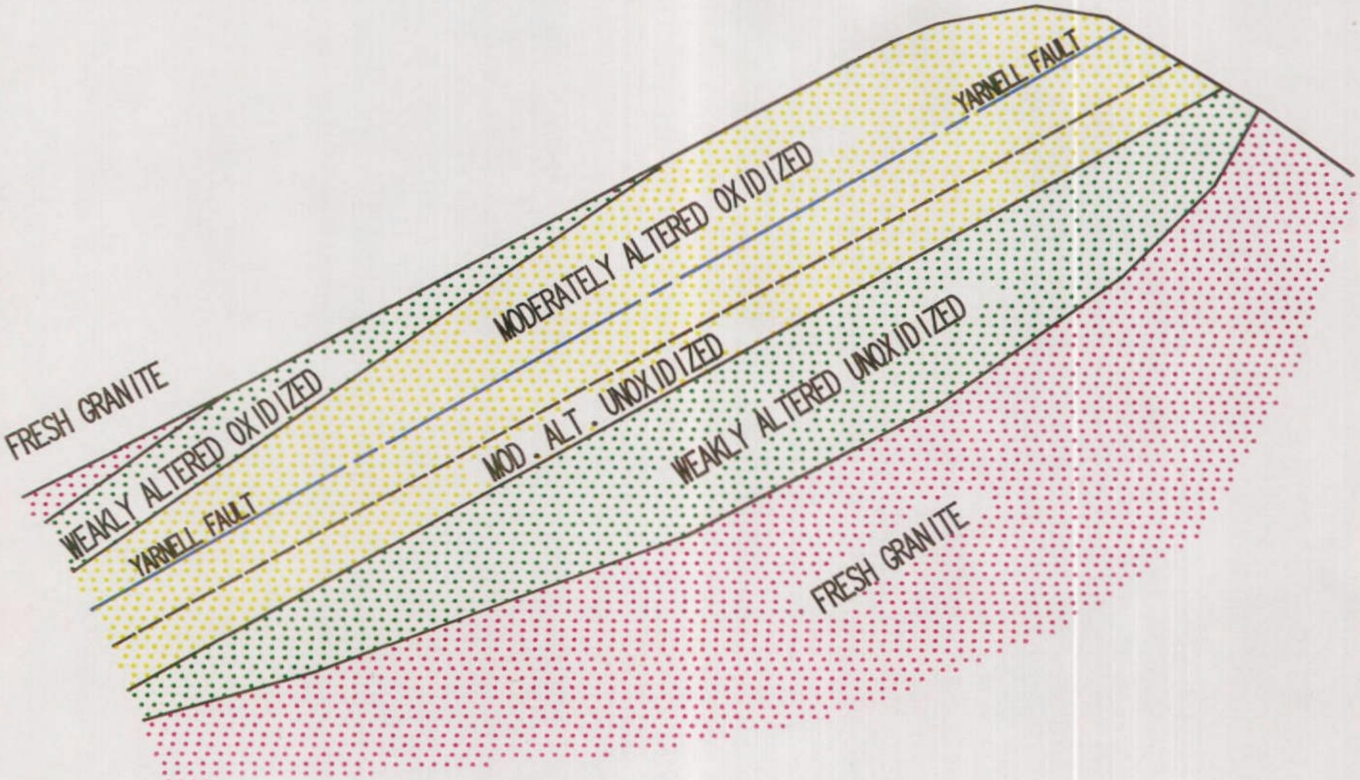
14A - DDH - 3 @ 142 feet - Moderate Zone
stockwork mineralization showing quartz stringers subparallel to main Yarnell structure; later finer fractures contain mixed specularite and Mn-ox; minor pseudomorphs of limonite after pyrite occur locally. Note potassic hue adjacent to both quartz stringers and specularite ± Mn-ox fractures. (Page, 10-24-89)



12A - DDH - 3 @ 126 feet - Moderate Zone
stockwork mineralization; pinkish potassic alteration occurs as a selvage about grey quartz veinlet containing specularite; note that adjacent feldspars have assumed a 'potassic' pinkish hue. Specularite ± Mn-ox ± limonite is disseminated locally and occurs in later veinlets. (Page, 10-24-89)

FIGURE 5

FIGURE 6



ASARCO Incorporated
YARNELL PROJECT
SCHEMATIC CROSS SECTION
ALTERATION ZONES
YAVAPAI CO.,ARIZONA
mn 6949 MAM/dam tuc 05-04-90
file YAR-6949.dwg

Yarnell Project

Petrographic Descriptions - Russ Honea

Table 2

Sample No.	Alteration Zone	Primary Minerals %: Plagioclase	Primary Minerals %: Microcline	Primary Minerals %: Quartz	Primary Minerals %: Biotite	Secondary Minerals %: Sericite	Secondary Minerals %: Clay	Secondary Minerals %: Chlorite	Secondary Minerals %: Calcite	Secondary Minerals %: Epidote	Secondary Minerals %: Leucoxene	Silica %: Quartz/Adularia	Silica %: Chalcedony/Opal	Iron Oxides %: Hematite/Magnetite	Iron Oxides %: Limonite/Pyrite(Fresh)	Iron Oxides %: Goethite	Iron Oxides %: Fe Oxides (Undiff.)
150	Fresh (Weathered)	25	50	16	7	6	-	1+	-	3	-	-	-	1/1	-	-	-
151	Fresh (Unweathered)	25	45	18	10	-	3	3	-	-	-	-	-	-	-/<1	-	-
152	Weak	30	44	15	9	9	-	-	-	2*	<1	-	-	-	-	-	1+
162	Weak	28	38	20	8	18	-	-	-	-	1	4	-	-	-	3+	-
163	Weak/Moderate	(35)	40	15	(8)	17	-	-	-	-1	1	3	-	-	1+/-	-	3
164	Weak/Moderate	(32)	43	16	(6)	16	-	-	-	-	2	2	-	-	-	-	1+
165	Moderate	(44)	29	20	(5)	28	-	-	-	-	<1	5	-	<1	-	2	-
166	Moderate	(30)	55	10	(3)	8	-	-	-	-	1	15 (Veins)	-	2	-	2	-
154	Mod.Unoxidized	(35)	45	12	(6)	20	4	2	-	-	1	-	-	1	-/2	-	-
155	Mod. Oxidized	(35)	41	12	(10)	20	-	-	-	-	1	-	-	-	-	1**	2
	Moderate: Yarnell Fault Zone																
157	Syenite?	(27)	66	3	(2)	2	3	2	-	-	<1	-	-	-	-	1	2+
161	Potassic Rims	(24)	66	5	(2)	7	-	-	-	-	1	10/15	-	<1	-	-	-
158	Quartz Stockwork	(36)	40	15	(8)	27	-	-	-	-	1	5	-	-	-	2	3+
159		(38)	28	25	(7)	35	2	-	-	-	1***	15	-	-	-	-	2
160		(20)	62	12	(5)	10	10	-	-	1*	<1	22	<1/<1	-	-	2	4
161	Syenite?	(24)	66	5	(2)	7	-	-	-	-	1	10/15	-	<1	-	-	-
167	Mod.	(38)	32	20	(7)	20	-	-	-	-	2	3	-	-	-	3 (Hm)	-
168	Mod./Silic?	(39)	(33)	20	(6)	12	-	-	-	-	1	4	-	1	1	2	-

(27) - Original Mineral Now altered to Sericite

*(Clinozoisite)
**Pseudomorphs
***Rutile

As seen in the field and in drill core this zone is highly sheared and granulated. Moderate abundant clay (gouge) up to 15-20% is also present in this zone. This zone is also characterized by massive quartz veins parallel to the Yarnell Structure from 1-2' thick. Silica also occurs as banded chalcedony and opal (from field observations). Rock texture is destroyed; probably due to the faulting and crushing and not due to the alteration. As seen in core, the rock is a fine grained almost cryptocrystalline rock with no obvious granitic textures. The Yarnell Fault zone complex has been seen up to 70' in thickness in YDDH-2. The actual Yarnell Fault Zone, however, is only 4-6' thick.

Petrographic Description (Table 2)

The rock has been identified as a syenite by Honea indicated by 3-5% primary quartz. The percent of secondary quartz in the rock is 15-22%; much higher than overlying zones. This may be due to silica depletion of the original rock (now a syenite) and redeposition of silica into quartz veins and quartz flooding. The syenite may also represent a different phase of the intrusive which has been emplaced along the Yarnell Fault. The zone also shows strong potassic addition as shown by the mineral adularia up to 15% by volume.

E. SILICIFICATION

Within the Yarnell Deposit silica is seen in several modes of occurrence. Quartz (SiO_2) occurs as discrete quartz veins and as quartz vein stockworks. These quartz veins are found both parallel and cross cutting the principal Yarnell structure. On the basis of field observations and diamond drill core, the following paragenesis of quartz veining is suggested.

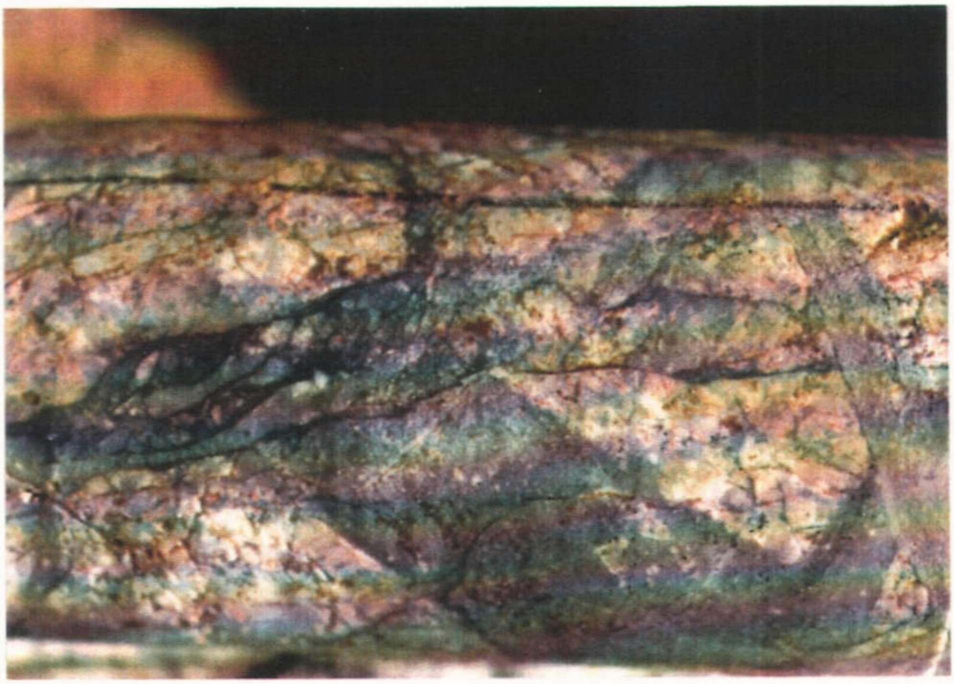
1. Early gray quartz +/- associated with specularite in vugs parallel to quartz veins.

2. Dark gray quartz - Some brecciation in the vein; dark color probably due to presence of specularite.

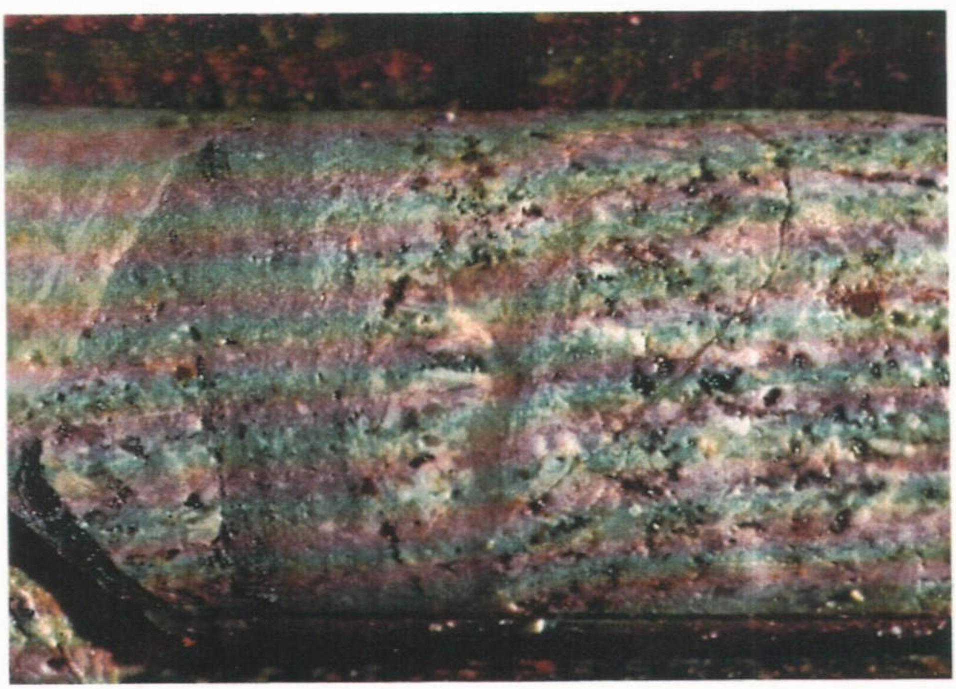
3. Lighter gray quartz with disseminated limonite pseudomorphs usually on the margin of the vein.

These three generations of quartz are usually seen as small veins and veinlets +/- 1/4" thick, locally up to 1/2" and have been seen up to 3" thick (Figure 7).

4. White Quartz - We have identified two stages of white quartz. These veins appear to cross-cut all of the other



15A - DDH - 3 @ 167 feet
stockwork mineralization above stope with early grey quartz cut by very dark grey specularite ± manganese rich quartz and breccia in turn cut by later grey quartz; note potassic alteration, minor disseminated limonite after pyrite, and minor vugs. (Page, 10-24-89)



13A - DDH - 3 @ 121 feet
crosscutting relationships; early vertical grey veinlet with specularite cut by wide horizontal grey quartz with specularite in turn cut by lighter, nearly white quartz. (Page,10-24-89)

FIGURE 7

stages. The white quartz veins are the thickest (6" in core to 1'). These have also been seen in the field up to 20' thick. We have assayed these veins in the field and they will consistently assay gold from .01 opt to .8 opt Au (average .05-.07). We have seen visible gold in diamond drill holes (YDDH-4) in similar looking veins. Perhaps the late stage veins are remobilizing gold from the deposit and redepositing as coarser gold.

Silica also seems to occur as a pervasive flooding into the wallrock and the intensity of flooding appears to be related to the degree of quartz veining and quartz vein stockwork development. The flooding postdates the phyllic (sericite) alteration as it appears to overprint the alteration zones.

The Yarnell Fault Zone contains quartz veins, banded chalcedonic quartz and opal; classic epithermal textures. Honea also noted chalcedony and opal in the zone in thin section.

F. DRILLING SUMMARY (PLATE 3)

Ninety-six reverse circulation holes were completed by Drilling Services Inc. totaling 24,207' from February to October 1989. Four N.C. diamond drill holes were completed by Boyles Brothers Drilling Company, totaling 1295'. The diamond drill holes were twins to four reverse circulation holes. Direct drilling costs for the R.C. holes were \$8.73/ft. (7.50 base rate). Diamond drill costs were \$23.40/ft. (base rate \$17.00/ft.).

Assay results for the "B" zone interval are shown on Plate 3. All Reverse Circulation Geologic logs with assays are included in bound volumes with this report. Geologic Cross Section (Plates 5A-M) show the style of alteration and mineralization discussed previously in this report. All drill holes were plugged and abandoned upon completion per DWR recommendatiuons and abandonment reports were filed. The four diamond drill holes were surveyed using a Sperry Sun single shot down hole camera and hole deviation was $<1^{\circ}$ at TD (350-400'). All collar evaluations and locations were surveyed by W.D. Gay and coordinates were transferred to the ECS (Engineering & Computer Services) data base. Most of the holes were drilled dry. However, upon encountering the water table, water was injected for more uniform sample return.

Stoped Areas - Drilling Technique

It became readily apparent that the area to be explored was honeycombed with stopes of which >50% were inaccessible (Plate 6). To assure the best possible sample retrieval, the following drilling technique was adopted:

a. Intersect stope with hammer drill.

b. Probe to bottom of stope - record back + floor footage.

c. Pull rods and change to a tricone bit.

d. Reenter hole and continue +/-40' below stope floor.

This technique was used for all reverse circulation holes past YM-5 when stopes or openings were encountered and resulted in better sample return below the stopes.

G. DIAMOND DRILLING SUMMARY

Four diamond drill holes were completed during the project. The purpose of the diamond drilling was threefold:

1. Twin existing reverse circulation hole to check assays.
2. Provide a complete geologic section through the deposit from hanging wall through the footwall.
3. Provide material for metallurgical testing, if needed, at a larger size than the rotary cuttings.

Summary of Results

Four R.C. Holes were twinned with diamond drill holes, as follows:

R.C.	TD	Diamond	TD
YM-8	350	DDH-1	350
YM-40	400	DDH-2	400
YM-63	240	DDH-3	325
YM-75	220	DDH-4	220

All of the holes has been assayed and compared to the R.C. holes. Based upon this study there is good correlation within the assay interval but notable and sometimes significant variation within the individual assays. The variation in individual assays may be due in part to nugget effect. A report detailing the procedures and results was submitted (Miller 4-27-90).

H. GEOLOGIC OBSERVATIONS FROM DIAMOND DRILLING

Holes were collared in the weakly altered and moderate zone and were designed to drill through the section and bottom below the footwall of the mineralized zone. The observations listed below are derived from the geologic logging and interpretation of the diamond drill holes.

1. The weakly altered through transition zone is propylitically altered. The change of the biotite to sericite is gradational and appears to pass through a chloritic stage. There is also evidence of the beginning of iron replacement on the edges of the biotite grains (pink rims).

2. A prominent quartz vein stockwork which occurs above the Yarnell Fault Zone has been seen in some of the holes. This stockwork zone is composed of the various stages of quartz as previously discussed in the Geology Section. In addition there is a definite area of potassic addition as adularia which rims the quartz veins and moves outwards into the ground mass (Figure 5).

3. The pervasive nature of the silica flooding becomes very evident from the drill core. There is a definite relationship between the amount of quartz veining, quartz stockwork, and the magnitude of quartz flooding. As the amount and intensity of quartz veining/quartz stockwork increases the amount of flooding increases until it pervades the entire ground mass.

4. Free visible gold has been seen in and associated with quartz veins. It is interesting to note that the areas with visible gold in YDDH-4 which occurs within a quartz veins stockwork assayed .011 and .026 opt, respectively, for the equivalent rotary interval. Free gold was also seen in YDDH-2 in the Yarnell Fault Zone. Assay values for the equivalent rotary interval is .177 opt Au. A possible explanation of this might be that the gold in the quartz stockwork in YDDH-4 may be later remobilized gold which apparently does cause a nugget effect in the assays. This type of gold occurrence would be unaccountable in the assay (and reserves), but might be recoverable in a leach circuit. The Yarnell Fault Zone, however, is more uniform in gold content and would probably consistently assay in the 0.1-0.2 opt range. It might be advisable to reassay (with multiple assays or larger sample size) rotary cuttings with indicated higher (than usual) quartz content.

5. The Yarnell Fault Zone is a strongly sheared almost cryptocrystalline rock which has undergone strong tectonism. The Yarnell Fault Zone complex as seen in drill core ranges from 5' in YDDH-1 to 70' in YDDH-2. Assay values within this 70' zone support the thickness of the zone.

6. The footwall of the mineralized zone is unoxidized and is moderately altered. Biotite is absent. Pyrite and specularite is moderately abundant as discussed in previous sections of this report. The unoxidized rock has a greenish tint which has been determined to be sericite (Malusa 6-19-90). Quartz stockwork abruptly ends within the Yarnell Fault. Rare quartz and limonite veinlets are seen within this unoxidized zone and the rock appears to be strongly silicified (very pervasive quartz flooding). Copies of diamond drill logs with assays are included as Attachment A.

VII. SAMPLE COLLECTION

Samples were collected on a continuous basis every 5' from the collar to the bottom of the hole. The sample was collected in a cyclone and then run through a tri-level splitter (supplied by the contractor). The tri-level splitter reduced the throughput sample size to 1/8 of the original. The 1/8 remaining was then split into two equal functions labelled A & B. The "A" sample was then sent to the assay lab for analysis. The "B" sample was stored for future use. We have <u>not</u> used the "B" sample for check assaying. The "A" sample was fire assayed by Triad Minerals using a 1 assay ton sample size. Gold content was determined by gravimetric means.

A. Assay Standard

The Asarco standard created by Darby Fletcher was used extensively during the drilling program. There are two standards in use; .006± opt Au and .022 opt Au. These standards were inserted as odd numbers into the sample stream (example, 171-179'). We tried to get equal high and low standards within each hole. Standards were inserted every 20-50 samples within the sample stream. Results of the standards indicate that contamination within the lab was not a problem. The purpose of the assay standards as used during the project was to spot any contamination in the sample stream, or erratic results due to procedure or equipment. From this end the standards procedure was successful. Future programs using sample standards should utilize rocks from the area; i.e., drill cuttings, rejects and a suite of standards designated to be site specific. This will allow better control on the assays.

B. Reruns of Assay Intervals

Reruns of both pulps and rejects were done to check for repeatability of assay results. Seventy-five pulps were run by Triad and Skyline to check for comparative results (Assay Checks memo 7-13-89). The results of this study indicated that while there was some variation between labs, the average for the 75 samples was almost identical.

Another check on assay results was done much later in the drilling program (Miller 9-9-89). Entire ore intervals were rerun under different hole number designations and compared with the original assay results. The "A" rejects were submitted as reruns (not the pulps). The results of this study indicated a percent change of 0-30% from original pulp vs. new pulp (prepared from resubmitted "A" rejects). The new pulp generally returned a higher assay than the original pulp. The greatest amount of variation seemed to be in the earlier drill holes suggesting a period of time within the first 36 holes where the lab was reporting lower values.

C. Reverse Circulation vs. Diamond Drilling

Three diamond drill holes (assays) were compared with the corresponding reverse circulation holes for assay comparison. The conclusions from the study are controversial and not all concerned are in agreement; but it appears that the reverse circulation and diamond drill results compare within .01 opt Au for the entire assayed interval (per hole). But individual assays show variation, sometimes of considerable magnitude between DDH vs. R.C. (M.A. Miller 4-27-90). However, there is no bias with either drilling technique.

VIII. SPECIFIC GRAVITY

The specific gravity of the deposit was determined through a suite of hand samples scattered throughout the deposit and by three drill cores taken in the weak, moderate, and footwall zones. Values obtained from McClelland Labs in Reno were 2.55 gm/cm^3 or 12.56 ft^3/ton vs. the values obtained by Metcon in Tucson which were 2.66 gm/cm^3 or 12.05 ft^3/ton. The Metcon technique is probably the most accurate (D.E. Crowell's memo 11-1-89). A value of 12 ft^3/ton was used in all reserve calculations.

IX. STOPED OUT AREAS (PLATE 6)

Determination and Calculation of Stoped Area and the Relationship to the Ore Reserves.

Numerous memos have been written on this subject since 17% of the 96 holes intersected stopes. Excluding holes outside of the ultimate pit limits, twenty percent of the 83 holes within the ultimate pit have intersected stopes.

The methodology to determine the tonnage and grade of material previously mined and necessary to subtract from the reserve is as follows: (most recent calculation)

1. The accessible areas of the underground were mapped; however, this amounted to ~30-40% of the stoped area. The

remaining 60% was estimated by projecting an <u>approximate</u> area from drill holes that intersected open stopes. Based upon an experience factor, all stope openings were cut to 20'. The approximate and projected stope outline was planimetered by W.D. Gay (2-1-90) and 25% was kept in for pillars. The grade was determined by similar means assigning values to the stopes that are more realistic of the grade mined.

Once the tonnage and grade have been determine for the stoped areas we can then subtract this tonnage and grade from the total reserve. This study was completed and detailed in a report (Miller 2/22/90).

X. <u>ORE RESERVES</u>

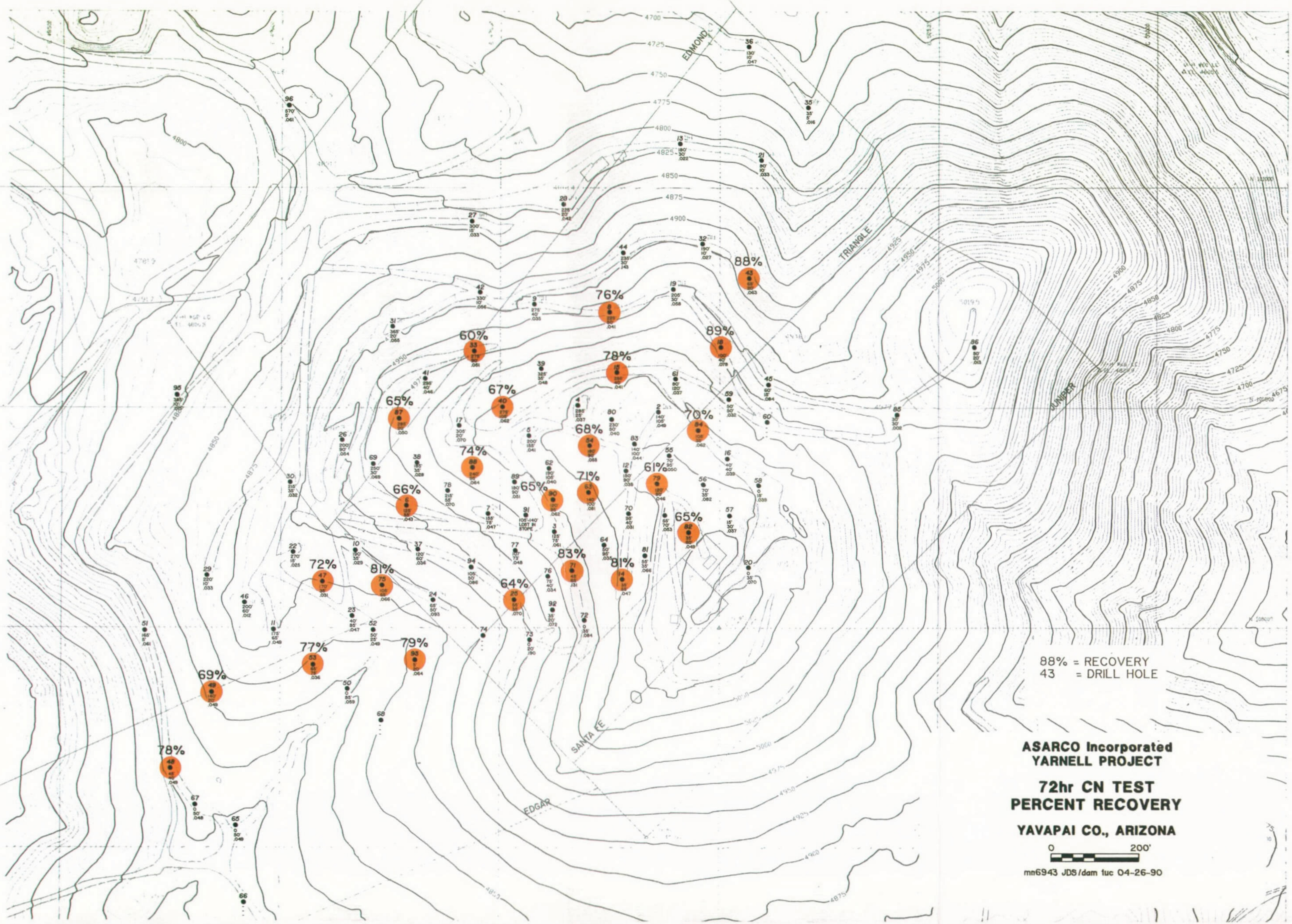
Ore reserves were determined by two means. Numerous memos explaining the techniques of calculation have been written; however, I will attempt to summarize the methods.

Reserves were calculated by J.D. Sell (12-20-89) using an equal triangle method. Triangles were drawn between drill holes and modified with respect to pit walls and outcrop of the mineralized zone. The grade of the triangles was calculated by using the weighted average of the holes comprising the triangles. The tonnage of the triangles was determined by measuring the volume of the triangles divided by the rock - ton factor. A pit slope of 50° was used for the downdip limits of the proposed pit. This model does not use economic parameters.

Reserves were also calculated by ECS (Engineering & Computer Services) using the cone miner. This method uses economic parameters mining costs, plant & operating costs, taxes, royalty, etc. and mines out the deposit within these parameters. The program also uses various grade and recoveries to calculate the final reserve. The details of the cone miner method are discussed in Sy Lakosky's Intermediate Feasibility Report (2/16/90).

Comparing the two methods, the results are as follows:

<u>JDS Reserve</u>	<u>ECS Reserve</u>
(Recalc. by MAM Removing Stopes)	(Removing Stopes @ 250,000T @ .053 & 10% Mining Dilution)
4,131,505T @ .055 opt. Au	4,829,000T @ .049 opt Au
	Removing Stopes at the same amount as MAM Recalc. of JDS Reserve 4,849,500T @ .047 opt Au



ASARCO Incorporated
YARNELL PROJECT

72hr CN TEST
PERCENT RECOVERY

YAVAPAI CO., ARIZONA

mn6943 JDS/dam tuc 04-26-90

These numbers may be subject to additional recalculation. The current reserves are still waiting revision by ECS.

XI. METALLURGICAL TESTING

Phase 1 of metallurgical testing is completed. This phase of testing used material mined from the open cut, composited as run of mine ore, and then column leached. The phase of the testing was conducted by McClelland Labs in Sparks, Nevada, and was overseen by D.E. Crowell of Asarco's Mineral Beneficiation Dept.

Three columns were run using different size fractions of the ore. A complete description of the testing is detailed in the McClelland Report dated 2/12/90 and summarized in a memo by D.E. Crowell (2/2/90). Results of the column leaching are summarized below.

80% passing size	Column Size	Leach Time (Days)	Head Assay opt	Tail Assay opt	Extraction
6 inch	24-in dia. x 18 ft	111	0.046	0.022	52.2%
2 inch	15-in dia. x 18 ft	102	0.051	0.015	70.6%
1/2 inch	12-in cia. x 18 ft	79	0.055	0.013	76.4%

Additional test work was recommended by D.E. Crowell (2/2/90) which included small columns leaching diamond drill core, 2 parallel columns at 1 1/2" size with and without clay, and a low grade column (from the underground sample) at 1 1/2" size.

In addition to the column leaching, twenty-four RC holes were picked and the "B" zone interval was composited into one sample per hole. Holes picked throughout the deposit were anticipated to give a representative average of the leachability of the ore zone. A 72 hour cyanide leach program was completed on the drill cuttings. Recoveries ranged from 59.7 to 88.8%. A report detailing the study was submitted by J.D. Sell (4/25/90). Figure 8 shows the hole locations with percent recovery.

XII. EXPLORATION POSSIBILITIES AND OTHER TECHNIQUES

The Yarnell Deposit provides us with an excellent opportunity to determine exploration parameters for these type deposits which will aid in the search for other deposits in the district. We have recognized an alteration assemblage and mineralization associated with this deposit and this will provide a model in the exploration for similar type deposits.

A reconnaissance magnetometer survey and geochemical survey were completed at Yarnell. In addition, we flew a HEM survey over the deposit and surrounding areas. The results are summarized below.

Magnetometer Survey - A ground magnetometer survey was completed on the property. Five lines were run both perpendicular to and parallel to the strike of the Yarnell Fault. The results of the survey suggest that the alteration causes destruction of the magnetic minerals and a resultant magnetic low. The study has been detailed in a report by J.J. Malusa (3-9-90).

Trace Element Geochemistry - A trace element orientation survey was conducted around the Yarnell Deposit to determine the geochemical signature of the Yarnell Report. J.D. Rasmussen (3-20-90) has detailed and summarized the study in his report and his conclusions are that rock chip sampling is more definitive than soils in locating anomalous gold concentrations. Arsenic is associated with gold and base metals are depleted within the altered zone. The soil survey appears to show the broad anomaly whereas the rock chip sampling will allow one to "zero" in on the mineralization. Gold is the best geochemical indicator, but silver dispersion appears to be larger than gold, and, therefore, would probably be detected in a reconnaissance sampling program. It is important to note, however, that orientation surveys need to consider rock types as threshold values will vary from rock to rock.

<u>HEM Surveys</u> - A HEM (Helicopter Electro Magnetic) survey was flown over the Yarnell Deposit on 1/16" mile centers (330') perpendicular to the Yarnell Structure. The survey was expanded outside of the mine area on 1/4 mile (1320') to cover the SW side of the Weaver Mountains. Results are preliminary, but there is a strong expression of the Yarnell Fault Zone as seen in the geophysics which trends SW towards and beyond (into pediment) the Alvarado Mine. Refinement of data is in progress.

In summary, all of the above techniques need to be used with good geologic basis. These techniques may be useful for following mineralized/altered zones beneath shallow pediment and may help in defining drill targest within an area of alteration/mineralization.

REFERENCES

Crowell, D.E. — Specific Gravity Determination on Yarnell Samples; 11-1-89; Internal Company Report

Crowell, D.E. — Yarnell Testwork Status; 2-2-90; Internal Company Report

Gay, W.D. — Estimation of Tonnage Removed by Prior Mining from the Yarnell Mine; 2-1-90; Internal Company Report

Honea, R.M. — Yarnell Project, Petrographic Descriptions; 12-7-89, 1-6-90, 1-27-90, 2-20-90, 3-10-90, 3-14-90; Private Consultant Report

Lakosky, S.L. — Intermediate Feasibility Report, Yarnell Project; 2-16-90

Malusa, J.J. — Ground Magnetometry; Yarnell Project, Yavapai Co., AZ; 3-9-90; Internal Company Report

Malusa, J.J. — Green Mineral, Yarnell Footwall Core; 6-19-90; Internal Company Report

McClelland Labs — Report on Preliminary Heap Leach Amenability Evaluation, Yarnell Bulk Ore Composite MLI Job No. 1378 2/12/90

Miller, M.A. — Original Pulp Assays vs. Reject New Pulp Assays, Yarnell Project, Yavapai Co., AZ; 9-9-89; Internal Company Report

Miller, M.A. — Extension Drilling, Yarnell Project, Yavapai Co., AZ; 2-5-90; Internal Company Report

Miller, M.A. — Recalculation of Stope Intercepts + Drilled Reserves; Yarnell Project, Yavapai Co., AZ; 2-22-90; Internal Company Report

Miller, M.A. — "B" Zone Assay Comparison, RDH vs. DDH Study, Yarnell Project, Yavapai Co., AZ; 4-27-90; Internal Company Report

Miller, M.A. — Yarnell Project EA #0444, Yavapai Co., AZ; 5-11-90 Internal Company Report

Miller, M.A. — Yarnell Project, Triad vs. Skyline, Assay Checks; 7-13-89; Internal Company Report

Page, T.C. — Description of Alteration/Mineralization, Yarnell Project; 10-24-89; Personal Communication

Rasmussen, J.D. — Trace Element Geochemistry Orientation Study, Yarnell Mine; 3-20-90; Internal Company Report

Sell, J.D. — Drill Indicated Reserve, Yarnell Project; 12-20-89 Internal Company Report

Sell, J.D. — CN Leach Tests, Yarnell Project, Yavapai Co., AZ; 4-25-90; Internal Report

YARNELL FINAL REPORT

List of Figures, Tables, Attachment, and Plates