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ASARCO

Southwestern Exploration Division

JDS

January 29, 1990

M.A. Miller

Recalculation of Intercepts
Yarnell Project
Yavapai County, AZ

To evaluate the possible change in ounces of gold available at Yarnell by involving the adding of the probable stope values to the drill holes, which in turn would influence the block grade, will be undertaken. You are assigned this study.

The following format is recommended:

A. From Table 1 - Zone Interval Tabulation, recalculate the assay grade in the drill holes which indicate a stope intercept. In the past study, the values in Table 1 were equated to the value of the remaining set of values in the hole. See Attachment A for the methodology to be used in the new study.

   Recalculate the Main or "B" zone interval in a new Table 1.

B. Using the map showing the triangular blocks, and Table 4 - Main "B" Zone (12/20/89), recalculate the assay for the triangular block, and prepare a new Table 4 showing the old and new values.

   See Attachment B for the methodology to be used.

C. Using the new Table 4, multiply the tons in the triangle by the new recalculated grade (oz/ton) and total new for ton-ounces new as in Table 4 (12/20/89), and calculate new grade figure.

   Construct new Table 4-A, adding the new "Ton-Oz" figure. See Attachment C for methodology.

D. Add a note at the bottom of the new Table 4-A expressing the change in ounces using the recalculated values vs. the previous value of 12/20/89.

James D. Sell

James D. Sell

JDS:mek
Att.

cc: R.L. Brown
F.T. Graybeal
W.L. Kurtz

ATTACHMENT A. Recalculation of Assay Intercept in Drill Holes with Stopes.

Using Table 1 of 12/20/89 report (attached) take the stope interval and add, from base upward, 5 feet of 0.100 opt gold for upward of 15 feet. If the stope was in excess of 15 feet, add 0.050 opt gold for the remaining upward values.

Tabulate changes to be made for the computer program.

Example:

Drill Hole	Stope Thickness	Intervals	New Value
YM-1	20'	100-105	0.050
		105-110	0.010
		110-115	0.010
		115-120	0.010
YM-2 etc.			

Prepare new Table 1 - Zone Interval Tabulation, showing previous data and new recalculated value

Drill Hole	Zone*	From	To	Footage	12/20/89 Grade, opt Au	Recalculated Grade, opt Au

ATTACHMENT B. Recalculation of Assay Grade in Triangular Blocks, using new stope values involved.

Example Work Sheet Format:

Triangle	Hole	Thickness	Recalc. Grade		Recalc. Ft.oz.
4	16	40	new	=	new
	58	20	0.68	=	new
	60	--	--	=	--
		60/3=20'	new		new

Take the recalculated Ft-oz and divide by the total thickness (in T-4 above, 60') to arrive at new grade of Triangle block.

Note that the average thickness, i.e. 20' in above example, will be the same as in the Table 4 (12/20/89).

ATTACHMENT B (continued)

From the worksheet list generated as above, prepare a new Table 4 - Main "B" Zone showing the old and new values.

Example:

Triangle No.	Volume ft^3	Thickness ft	Grade oz/ton (12/20/89)	Recalc. Grade oz/ton

ATTACHMENT C: Recalculation of Ton-oz in triangular blocks.

Example:

Triangle No.	Tons (12/20/89)	Grade oz/ton (12/20/89)	Recalc. Grade oz/ton	Recalc. Ton-oz

Tabulate in new Table 4-A as shown in example.

Compare the 12/20/89 oz/ton grade with the new recalculated oz/ton grade.

YARNELL PROJECT

Yavapai County, Arizona

Table 1 - Zone Interval Tabulation

Drill Hole	Zone*	From	To	Footage	Grade (opt Au)
YM-1	A	5	55	50'	0.025
YM-1	B	55	125	70'	0.053, incl. 20' stope
YM-2	A	45	140	95'	0.017
YM-2	B	140	245	105'	0.049, incl. 40' stope
YM-3	A	20	125	105'	0.011
YM-3	B	125	200	75'	0.060 stope 147-155
YM-4	A	15	230	175'	0.013, 40' gap
YM-4	B	285	310	25'	0.037
YM-5	A	150	200	50'	0.005
YM-5	B	200	355	155'	0.041, incl. 35' stope
YM-6	B	125	180	55'	0.042
YM-7	B	155	230	75'	0.047, incl. 5' stope
YM-8	A	30	225	195'	0.022
YM-8	B	225	275	50'	0.041
YM-9	B	275	315	40'	0.035
YM-10	A	130	190	60'	0.021
YM-10	B	190	225	35'	0.029
YM-11	B	175	240	65'	0.049
YM-12	A	40	150	110'	0.013
YM-12	B	150	240	90'	0.039, incl. 15' stope
YM-13	B	180	210	30'	0.022
YM-14	B	15	90	75'	0.040

YARNELL PROJECT - Table 1 - Zone Interval Tabulation

Drill Hole	Zone*	From	To	Footage	Grade (opt Au)
YM-15	A	25	140	115'	0.015
YM-15	B	140	295	155'	0.034
YM-16	A	0	40	40'	0.017
YM-16	B	40	80	40'	0.039, incl. 5' stope
YM-17	A	210	285	75'	0.015
YM-17	B	285	325	40'	0.047
YM-18	A	0	100	100'	0.022
YM-18	B	100	140	40'	0.078
YM-19	A	10	85	75'	0.015
YM-19	B	205	235	30'	0.058
YM-20	B	0	35	35'	0.070
YM-21	A	25	55	30'	0.019
YM-21	B	80	90	10'	0.033
YM-22	A	215	225	10'	0.036
YM-22	B	270	285	15'	0.025
YM-23	B	40	125	85'	0.047
YM-24	B	65	115	50'	0.093, incl. 10' stope
YM-25	B	55	90	35'	0.070
YM-26	B	200	290	90'	0.054
YM-27	A	35	265	90'	0.015, 140' gap.
YM-27	B	300	315	15'	0.033
YM-28	A	95	225	130'	0.022
YM-28	B	225	245	20'	0.042
YM-29	B	220	230	10'	0.033
YM-30	A	170	200	30'	0.012
YM-30	B	215	250	35'	0.032
YM-31	A	115	135	20'	0.017
YM-31	B	365	385	20'	0.055
YM-32	A	0	190	155'	0.012, 35' gap.

YARNELL PROJECT - Table 1 - Zone Interval Tabulation

Drill Hole	Zone*	From	To	Footage	Grade (opt Au)
YM-32	B	190	200	10'	0.027
YM-33	A	15	55	40'	0.015
YM-33	B	275	365	90'	0.051
YM-34	A	110	130	20'	0.013
YM-34	B	not reached - assume from other holes.			
YM-34	B	240	250	10'	0.025
YM-35	B	15	40	25'	0.010
YM-36	A	35	55	20'	0.023
YM-36	B	130	140	10'	0.048
YM-37	B	120	180	60'	0.036
YM-38	B	185	220	35'	0.028
	Note: if no fault in area, then above may be "A" Zone.				
YM-39	A	0	325	75'	0.024, 250' gap.
YM-39	B	325	360	35'	0.048, end in ore.
YM-40	A	20	80	60'	0.014
YM-40	B	275	380	105'	0.062
YM-41	B	295	335	40'	0.046
YM-42	B	330	340	10'	0.056
YM-43	B	65	85	20'	0.063
YM-44	A	115	235	120'	0.024
YM-44	B	235	265	30'	0.143
YM-45	B	60	75	15'	0.084
YM-46	B	200	260	60'	0.012
YM-47	A	120	170	50'	0.014
YM-47	B	170	205	35'	0.031
YM-48	B	45	85	40'	0.049
YM-49	B	140	160	20'	0.049
YM-50	B	0	85	85'	0.059

YARNELL PROJECT - Table 1 - Zone Interval Tabulation

Drill Hole	Zone*	From	To	Footage	Grade (opt Au)
YM-51	B	165	170	5'	0.061
YM-52	B	50	75	25'	0.049
YM-53	B	65	140	75'	0.036
YM-54	A	55	125	70'	0.015
YM-54	B	180	270	90'	0.054
YM-55	A	0	70	70'	0.011
YM-55	B	70	165	95'	0.050, incl. 15' stope.
YM-56	A	0	45	45'	0.012
YM-56	B	70	105	35'	0.082
YM-57	A	0	15	15'	0.011
YM-57	B	15	60	45'	0.035, incl. 13' stope.
YM-58	B	0	20	20'	0.034
YM-59	B	50	100	50'	0.032
YM-60	In FW	-	-	-	-
YM-61	B	80	200	120'	0.037, incl. 15' stope.
YM-62	A	115	190	75'	0.015
YM-62	B	190	295	105'	0.040, incl. 40' stope.
YM-63	A	10	140	130'	0.011
YM-63	B	140	240	100'	0.081, end in ore.
YM-64	A	50	110	60'	0.025
YM-64	B	110	145	35'	0.053
YM-65	B	0	50	50'	0.049
YM-66	In FW	-	-	-	-
YM-67	B	0	50	50'	0.048
YM-68	In FW	-	-	-	-
YM-69	A	185	250	65'	0.011
YM-69	B	250	280	30'	0.069

YARNELL PROJECT - Table 1 - Zone Interval Tabulation

Drill Hole	Zone*	From	To	Footage	Grade (opt Au)
YM-70	A	60	95	35'	0.011
YM-70	B	95	135	40'	0.031
YM-71	B	45	110	65'	0.131
YM-72	B	0	35	35'	0.084
YM-73	B	0	20	20'	0.190
YM-74	In FW	-	-	-	-
YM-75	A	65	105	40'	0.023
YM-75	B	105	170	65'	0.066
YM-76	A	0	75	75'	0.012
YM-76	B	75	115	40'	0.034, incl. 15' stope.
YM-77	A	70	107	37'	0.022
YM-77	B	107	180	73'	0.048, incl. 13' stope.
YM-78	A	130	215	85'	0.011
YM-78	B	215	270	55'	0.070
YM-79	A	10	120	110'	0.019
YM-79	B	120	170	50'	0.046
YM-80	A	140	230	90'	0.023
YM-80	B	230	280	50'	0.040
YM-81	A	5	55	50'	0.015
YM-81	B	55	90	35'	0.066
YM-82	A	0	35	35'	0.015
YM-82	B	35	95	60'	0.049
YM-83	A	0	140	140'	0.014
YM-83	B	140	240	100'	0.044, incl. 20' stope.
YM-84	A	10	105	95'	0.017
YM-84	B	105	140	35'	0.062
YM-85	In FW	-	-	-	-
YM-86	B?	50	70	20'	0.013

YARNELL PROJECT - Table 1 - Zone Interval Tabulation

Drill Hole	Zone*	From	To	Footage	Grade (opt Au)
YM-87	A	245	285	40'	0.010
YM-87	B	285	305	20'	0.050
YM-88	A	180	240	60'	0.020
YM-88	B	240	295	55'	0.064
YM-89	A	40	180	140'	0.010
YM-89	B	180	270	90'	0.051
YM-89	Subzone	270	340	70'	0.016
YM-90	A	10	120	110'	0.012
YM-90	B	120	215	95'	0.062
YM-90	Subzone	215	235	20'	0.019
YM-91	A	10	95	85'	0.010
YM-91	B	Hole lost in stope - assume from other holes.			
YM-91	B	95	180	85'	0.051
YM-92	B	35	55	20'	0.072
YM-93	B	5	25	20'	0.064
YM-94	B	105	155	50'	0.086, incl. 30' stope.
YM-95	B	385	395	10'	0.015
YM-96	B	570	575	5'	0.061

*Zone A - Upper low-grade zone.
*Zone B - Main Yarnell Fault Zone & envelope.

YARNELL PROJECT

Yavapai County, Arizona

Table 4 - Main "B" Zone

Using 12.0 ft.^{3}/ton factor

Triangle No.	Volume ft.^{3}	Thickness ft.	Tons	Grade oz/ton
1	87,375	23.3	7,281	0.037
2	208,250	35.0	17,354	0.057
3	382,500	30.0	31,875	0.068
4	117,600	20.0	9,800	0.037
5	182,250	30.0	15,188	0.035
6	189,810	33.3	15,818	0.047
7	149,184	33.3	12,432	0.051
8	119,699	31.7	9,975	0.054
9	232,187	56.7	19,349	0.054
10	221,130	56.7	18,428	0.050
11	191,403	41.7	15,950	0.043
12	280,292	63.3	23,358	0.047
13	308,424	78.3	25,702	0.051
14	505,084	91.7	42,090	0.041
15	486,850	70.0	40,571	0.044
16	681,298	63.3	56,775	0.049
17	989,495	66.7	82,458	0.041
18	298,880	46.7	24,907	0.050
19	169,070	58.3	14,089	0.047
20	255,500	50.0	21,292	0.054
21	190,515	51.7	15,876	0.057
22	205,920	60.0	17,160	0.055
23	211,723	78.3	17,644	0.045
24	256,880	95.0	21,407	0.044
25	373,700	100.0	31,142	0.048
26	290,105	85.0	24,175	0.045
27	280,740	93.3	23,395	0.046
28	232,000	80.0	19,333	0.047
29	667,076	126.7	55,590	0.039
30	994,194	108.3	82,850	0.036
31	557,304	103.3	46,442	0.040
32	339,398	76.7	28,283	0.036
33	180,290	55.0	15,024	0.047

YARNELL PROJECT - Table 4 - Main "B" Zone

Triangle No.	Volume ft.^{3}	Thickness ft.	Tons	Grade oz/ton
34	490,428	71.7	40,869	0.037
35	856,800	80.0	71,400	0.038
36	188,100	55.0	15,675	0.054
37	188,370	48.3	15,698	0.050
38	154,837	53.3	12,903	0.045
39	205,800	60.0	17,150	0.039
40	331,840	76.7	27,650	0.056
41	438,510	93.3	36,543	0.059
42	474,789	98.3	39,566	0.058
43	551,291	116.7	45,941	0.044
44	535,500	90.0	44,625	0.045
45	532,950	95.0	44,413	0.048
46	402,050	55.0	33,504	0.055
47	674,960	76.7	56,247	0.056
48	728,660	78.3	60,722	0.055
49	144,417	48.3	12,035	0.049
50	137,625	36.7	11,469	0.049
51	238,000	50.0	19,833	0.051
52	414,426	71.7	34,536	0.064
53	258,750	90.0	21,563	0.068
54	278,300	100.0	23,192	0.061
55	211,565	85.0	17,630	0.058
56	233,700	95.0	19,475	0.051
57	324,684	93.3	27,057	0.047
58	436,458	116.7	36,372	0.043
59	547,500	100.0	45,625	0.048
60	639,450	105.0	53,288	0.052
61	350,175	66.7	298,181	0.060
62	434,985	61.7	36,249	0.055
63	371,371	58.3	30,948	0.083
64	242,820	58.3	20,235	0.076
65	153,643	46.7	12,804	0.092
66	263,749	58.3	21,979	0.085
67	340,303	71.0	28,359	0.078
68	124,115	59.3	10,343	0.075
69	245,532	77.7	20,461	0.053
70	272,727	77.7	22,727	0.049
71	265,560	83.3	21,130	0.050
72	352,207	73.3	29,351	0.054
73	237,786	66.7	19,815	0.060
74	181,125	48.3	15,094	0.058
75	243,563	43.3	20,297	0.049
76	213,553	33.3	17,796	0.047
77	205,416	31.7	17,118	0.041
78	145,745	28.3	12,145	0.048
79A	93,375	25.0	7,781	0.103

YARNELL PROJECT - Table 4 - Main "B" Zone

Triangle No.	Volume ft.^{3}	Thickness ft.	Tons	Grade oz/ton
79B	81,250	25.0	6,771	0.109
80A	95,924	31.7	7,994	0.055
80B	79,123	31.7	6,594	0.060
81	85,973	18.3	7,164	0.114
82	206,123	49.3	17,177	0.049
83M.	311,355	45.0	25,946	0.084
84	209,420	28.3	17,452	0.084
86M.	319,800	53.3	26,650	0.069
87M.	294,962	52.7	24,580	0.065
88	643,243	69.3	53,604	0.044
90M.	277,611	61.0	23,134	0.054
91	478,865	63.3	39,905	0.048
92	297,675	56.7	24,806	0.049
93	200,445	48.3	16,704	0.049
94	192,000	40.0	16,000	0.045
95	349,800	58.3	29,150	0.063
96	313,031	53.3	26,086	0.047
97	362,500	50.0	30,208	0.037
98	360,000	40.0	30,000	0.045
99	366,751	26.7	30,563	0.043
100M.	39,000	30.0	3,250	0.069
101	215,129	23.3	17,927	0.085
102	247,260	31.7	20,605	0.075
103	280,200	46.7	23,350	0.073
104	157,643	58.3	13,137	0.054
105	315,040	61.7	26,253	0.051
106	235,980	45.0	19,665	0.047
107	143,623	28.3	11,969	0.029
108M.	181,125	22.5	15,094	0.054
109	363,720	43.3	30,310	0.058
110	431,653	61.7	35,971	0.048
111	245,258	61.7	20,438	0.043
112	672,975	75.0	56,081	0.044
113	502,238	61.7	41,853	0.045
114M.	210,000	50.0	17,500	0.043
118	1,188,594	66.7	99,050	0.048
119	765,000	45.0	63,750	0.042
120	665,184	53.3	55,432	0.043
121	415,911	48.3	34,659	0.034
122M.	91,000	20.0	7,583	0.049
124	1,282,600	58.3	106,883	0.054
127M.	388,890	30.0	32,408	0.049
128	279,000	25.0	23,250	0.075
129M.	125,000	25.0	10,417	0.060
135M.	77,520	40.0	6,460	0.057
136	468,000	40.0	39,000	0.065

YARNELL PROJECT - Table 4 - Main "B" Zone

Triangle No.	Volume ft.^{3}	Thickness ft.	Tons	Grade oz/ton
137	513,827	41.7	42,819	0.041
138	607,200	55.0	50,600	0.046
144	507,400	40.0	42,283	0.052
145M.	118,300	65.0	9,858	0.049
146M.	89,250	30.0	7,438	0.050
147M.	54,000	20.0	4,500	0.050
148	258,251	46.7	21,521	0.057
149	92,364	56.7	7,697	0.049
150	751,162	56.7	62,597	0.049
151M.	92,000	20.0	7,667	0.064
152M.	321,563	52.5	26,797	0.060
153M.	813,484	68.0	67,790	0.055
154M.	580,000	50.0	48,333	0.049
156M.	172,500	50.0	14,375	0.049
162M.	389,034	18.0	32,420	0.072
163M.	97,650	17.5	8,139	0.063
165M.	36,000	8.0	3,000	0.084
166M.	852,600	42.0	71,050	0.049
167M.	693,000	42.0	57,750	0.053
168M.	362,250	23.0	30,188	0.059
169M.	2,835,000	45.0	236,250	0.048
170M.	400,125	27.5	33,344	0.057
TOTALS		271,014,989.8 ft.-tons	4,361,005 tons	223,912.203 ton-oz.
TOTAL		62.1 vertical	4,361,005 tons	0.051 opt gold
Previously Mined			250,000	0.051
Total Remaining		53.8 Perpendicular to YF structure	4,111,005 tons	0.051 opt gold

JDS

ASARCO

Southwestern Exploration Division

February 1, 1990

J.D. Sell

Estimation of Tonnage
removed by prior mining
from Yarnell Mine

As per your request I have worked up an ore tonnage removed from the underground workings of the Yarnell Mine (Main Zone Mineralization).

The following is the approach used in estimating:

1. An estimate of the underground workings (outline) was determined by actual survey, observation and drill holes that penetrated the inaccessible workings.

2. Drill holes that penetrated more than 20 ft. of workings were reduced to 20 ft. because all workings that were actually seen indicated an average height of 20 ft.

3. Contours of floor and back were drawn and planimetered on intervals of 20 ft.

4. Tonnage factor was 12 $ft.^3$/ton.

Using this method ±229,500 tons have been removed.

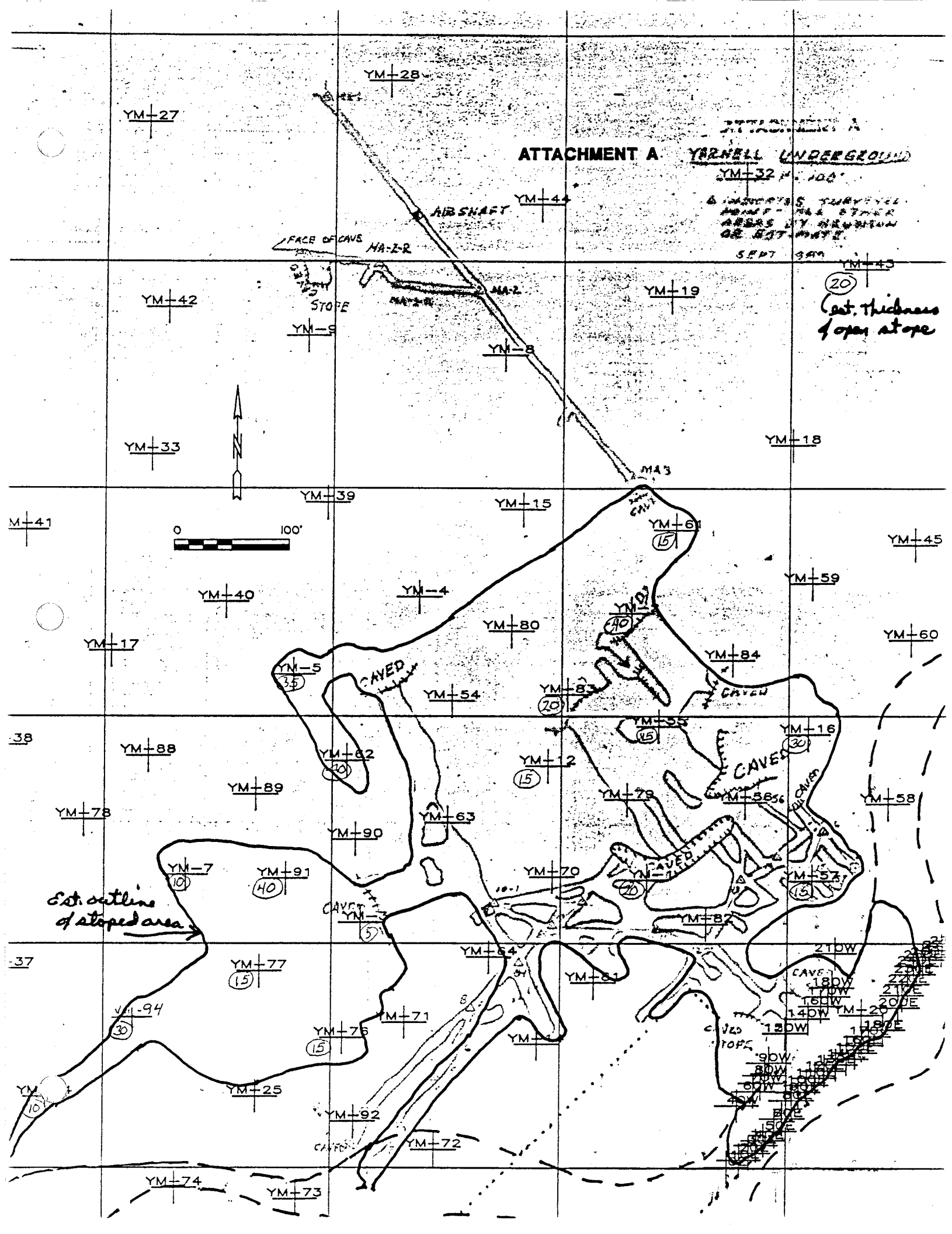
This compares to a previous estimate of 271,500 tons using a 24 ft. thickness, or 204,000 tons using an 18 ft. thickness.

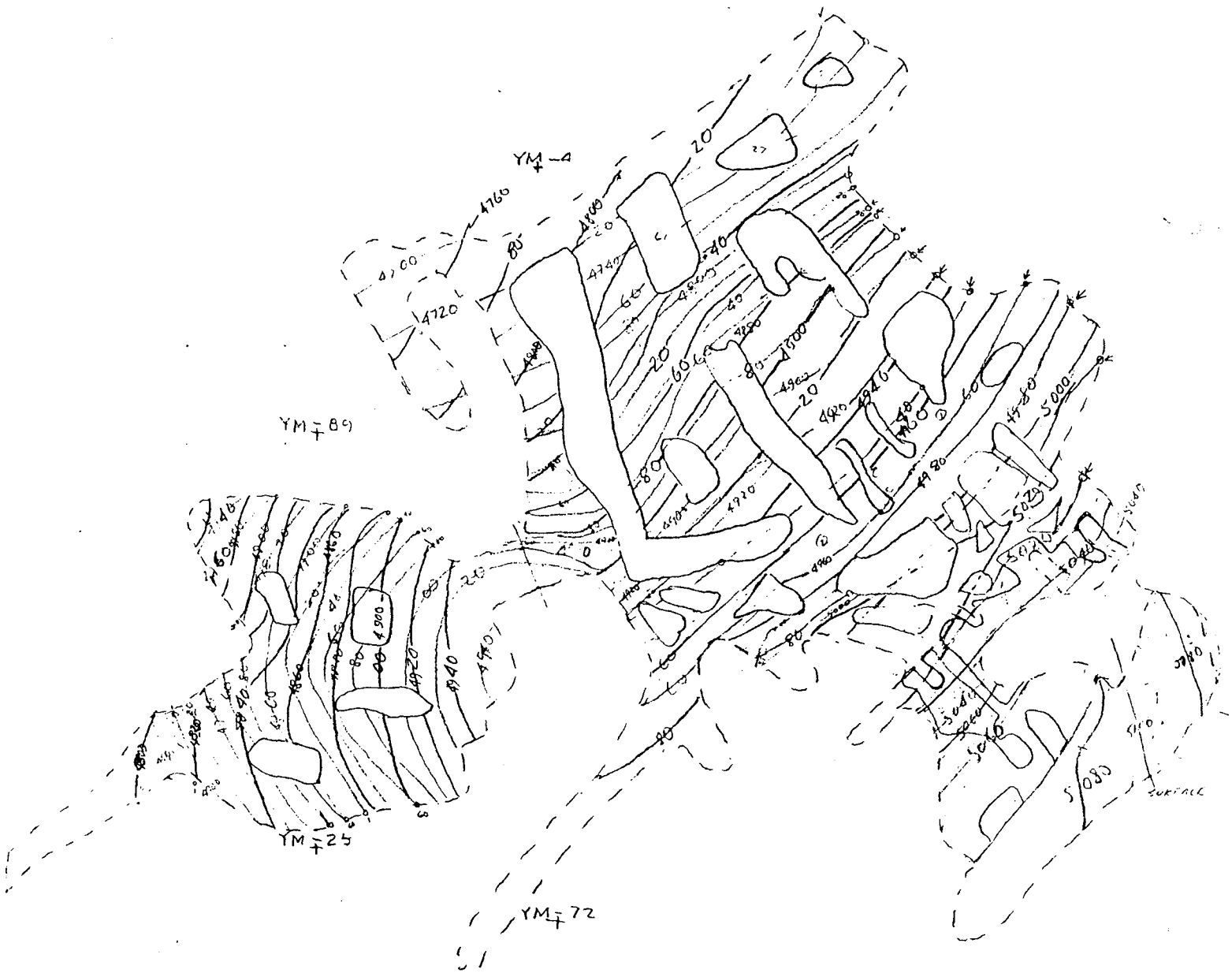
W. D. Gay

W. D. Gay

WDG:mek
Att.

cc: W.L. Kurtz
M.A. Miller
S.L. Lakosky


ATTACHMENT A
YARNELL UNDERGROUND
AIR SHAFT
FACE OF CAVE
MA-2-R
MA-2
MA-3
STOPE
0
100'
N
CAVED
Est. thickness of open stope
Est. outline of stoped area
YM-28
YM-27
YM-44
YM-43
YM-42
YM-19
YM-9
YM-8
YM-33
YM-18
YM-39
YM-15
YM-41
YM-45
YM-40
YM-4
YM-59
YM-80
YM-17
YM-60
YM-84
YM-5
YM-54
YM-83
YM-16
YM-88
YM-62
YM-12
YM-89
YM-79
YM-58
YM-78
YM-63
YM-90
YM-7
YM-91
YM-70
YM-57
YM-82
YM-64
YM-77
YM-81
YM-71
YM-76
YM-25
YM-92
YM-72
YM-74
YM-73
21DW
18DW
17DW
16DW
14DW
12DW
9DW
8DW
6DW
4DW
20DE
18DE
15DE
8DE



YARNELL PROJECT
CONTOUR MAP
of
ESTIMATED AND SURVEYED
UNDERGROUND WORKINGS
JAN. 90

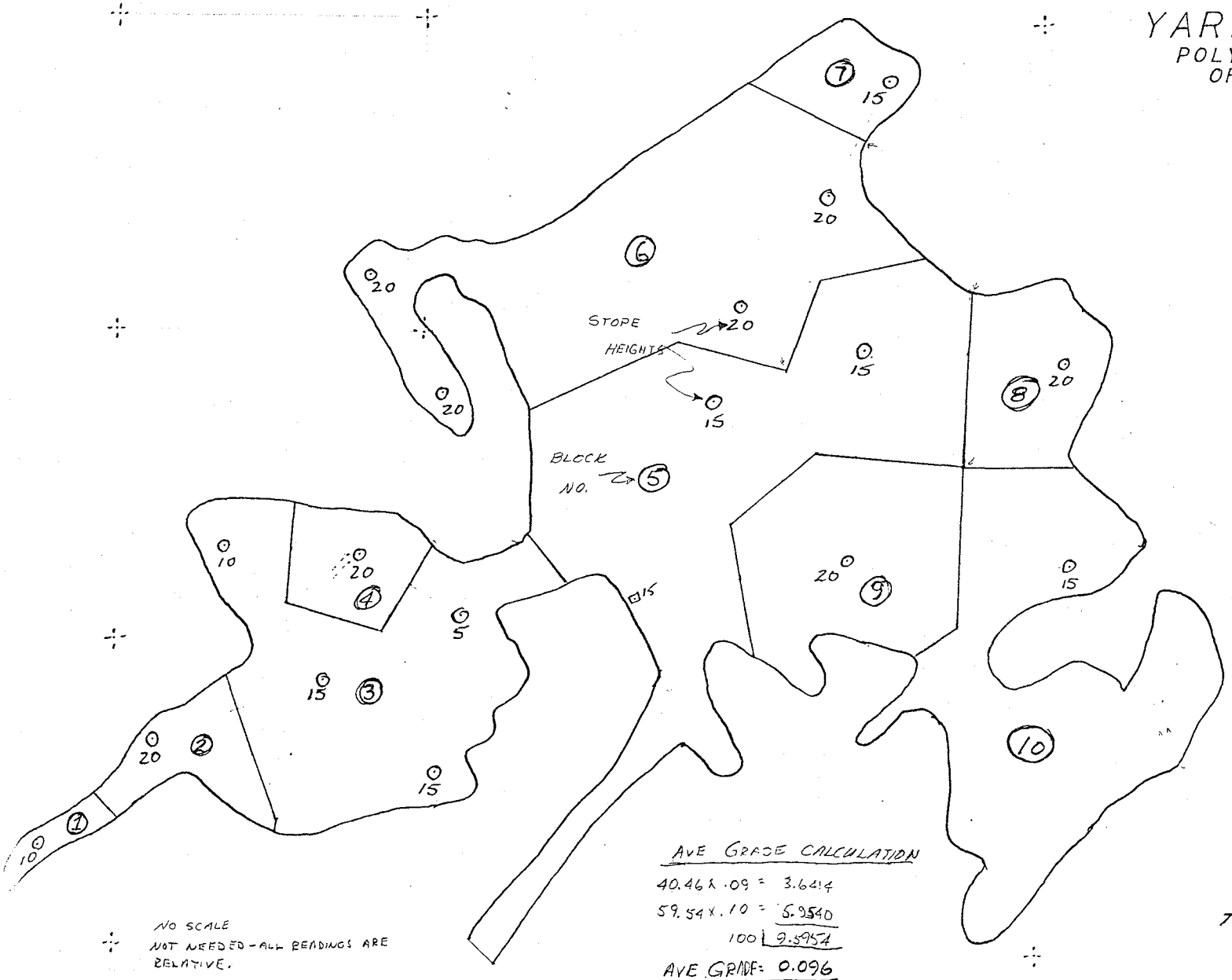
THIS MAP USED TO QUANTIFIER AND CALCULATE ESTIMATED EXTRACTION BY PREVIOUS MINING.

—— BACK CONTOURS
—— FLOOR CONTOURS

YARNELL PROJECT

POLYGON MAP FOR ESTIMATE OF UNDERGROUND ORE GRADE

7 FEB. 90
WDG



NO SCALE
NOT NEEDED - ALL READINGS ARE RELATIVE.

20' 2, 4, 6, 8, 9 } AVE. = 0.09

.05	15-20
.10	10-15
.10	5-10
.10	0-5
0.35	

ANY THING < 20' 1, 3, 5, 7, 10 } = 0.10

BLOCK	DLANIMETER READING
1.	39
2	133
3	712
4	142
5	1115
6	952
7	119
8	238
9	428
10	801
TOTAL	4679

CALCULATIONS

NO.		NO.	
2	133	1.	39
4	142	3	712
6	952	5	1115
8	238	7	119
9	428	10	801
TOTALS	1893		2786

% of 0.09

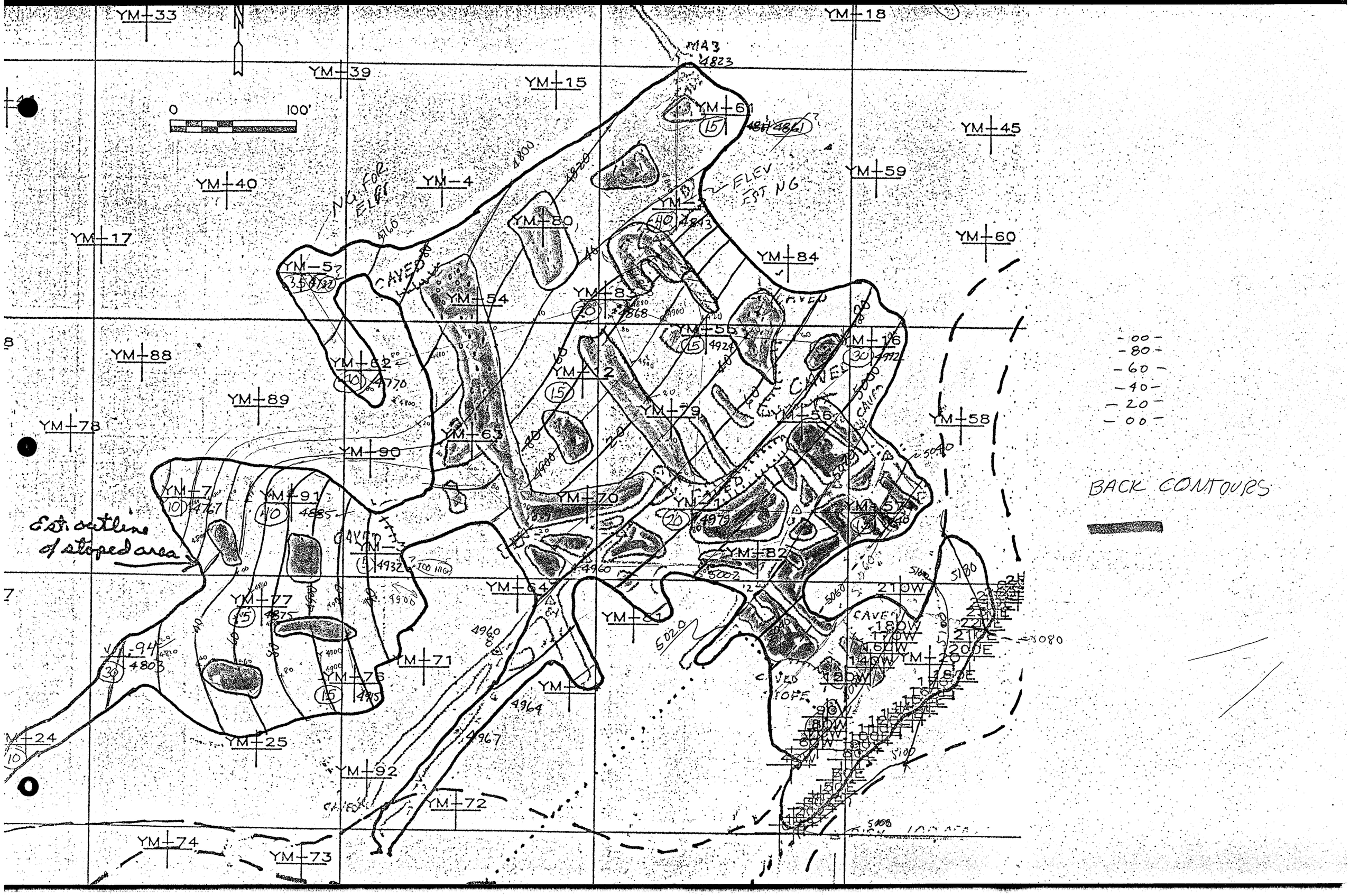
$\frac{1893}{4679}$ = 40.46% (0.09)

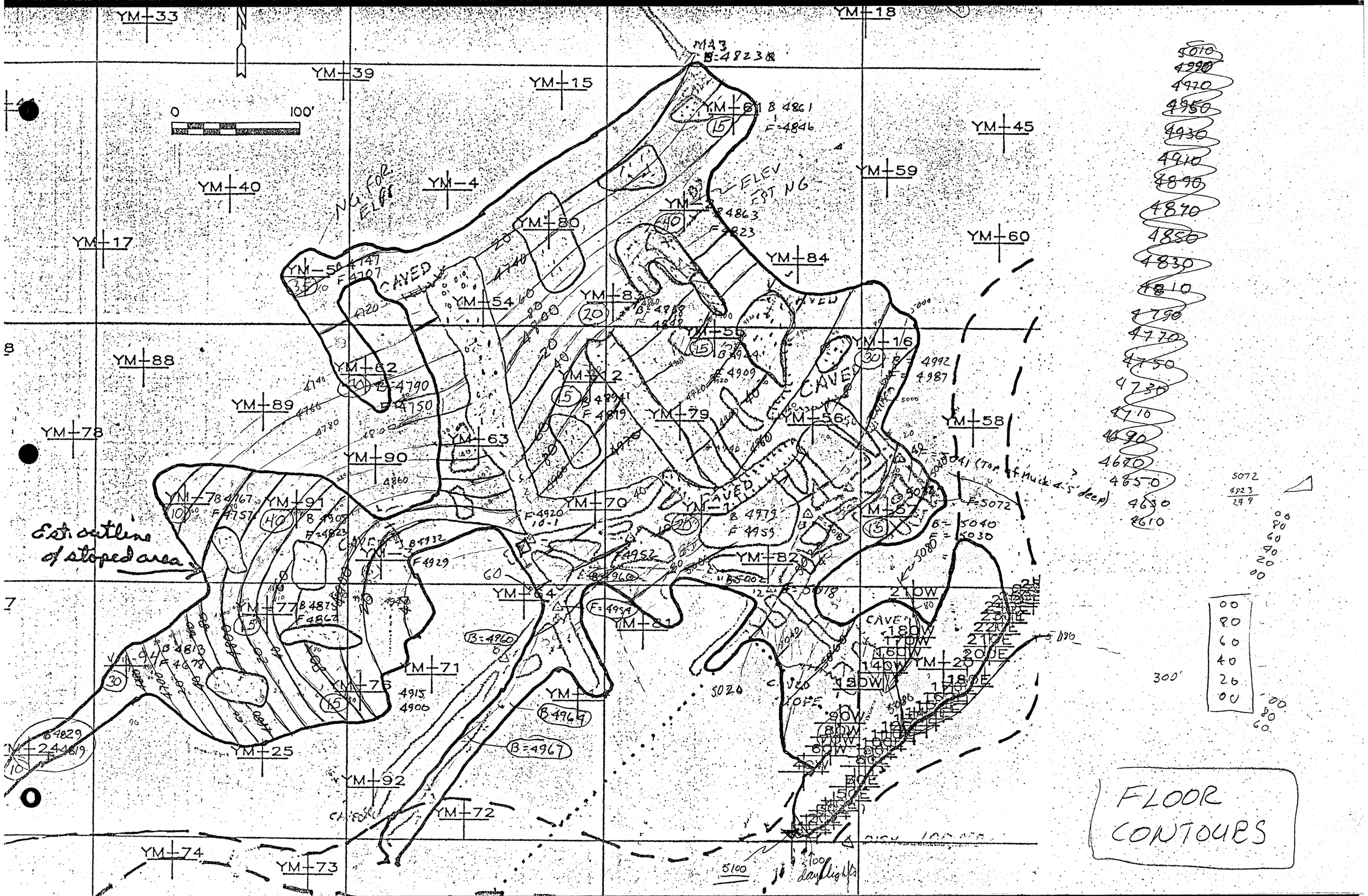
% of 0.10

$\frac{2786}{4679}$ = 59.54% (0.10)

AVE GRADE CALCULATION

40.46 x .09 = 3.6414
59.54 x .10 = 5.9540
100 | 9.5954
AVE GRADE: 0.096

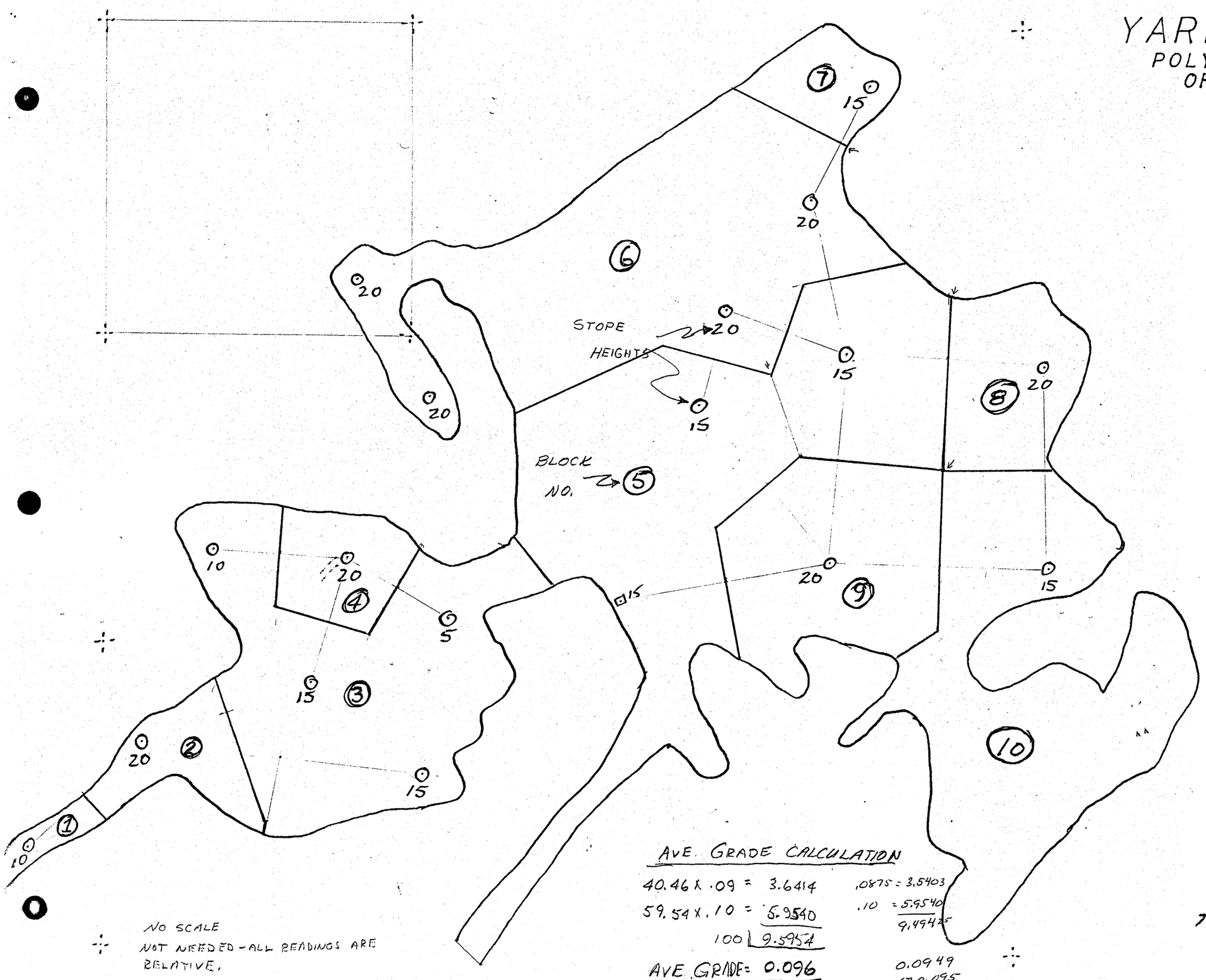

0
100'
YM-33
YM-39
YM-15
YM-18
YM-45
YM-40
YM-4
YM-59
YM-17
YM-60
YM-84
YM-80
YM-54
YM-88
YM-89
YM-78
YM-90
YM-63
YM-79
YM-58
YM-70
YM-82
YM-64
YM-81
YM-71
YM-25
YM-92
YM-72
YM-74
YM-73
YM-24
YM-61
YM-57
YM-56
YM-2
YM-8
YM-7
YM-91
YM-77
YM-76
YM-94
YM-62
YM-20
Est. outline of stoped area
NG FOR ELEV
ELEV EST NG
TOO HIGH
CAVED
BACK CONTOURS


FLOOR CONTOURS
0 100'
Est. outline of stoped area
CAVED
YM-33
YM-39
YM-15
YM-18
YM-45
YM-40
YM-4
YM-59
YM-17
YM-60
YM-80
YM-84
YM-54
YM-88
YM-89
YM-78
YM-90
YM-63
YM-79
YM-56
YM-58
YM-91
YM-70
YM-82
YM-64
YM-81
YM-77
YM-71
YM-76
YM-25
YM-92
YM-72
YM-74
YM-73
YM-20
210W
180W
170W
160W
140W
130W
90W
80W
70W
60W
40W
30W
20E
21OE
22OE
23OE
18OE
19OE
5100
300'

YARNELL PROJECT

POLYGON MAP FOR ESTIMATE OF UNDERGROUND ORE GRADE

7 FEB. 90
WDG



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100 | 9.5954
AVE. GRADE = 0.096

.0875 = 3.5403
.10 = 5.9540
9.49425

0.0949
or 0.095

File Note

Estimated Grade of
Removed Stope Material
Yarnell Project
Yavapai Co., AZ

In the February 1, 1990 report by WDGay (Estimated tonnage removed by prior mining from Yarnell Mine), he estimated that 329,500 tons had been removed.

In that study, assumptions were made as to the probable stope pillars left at the present time. Some of the information was from present survey data.

WDG then took the map of workings and broke the area into various polygons of equal thickness. By planimeter he then calculated the percentage of area of 15' or less of stope height and the percentage of area of 20' stope height. By multiplying the percentage [illegible] grade he arrived at a new grade for the stope interval tonnage as shown on Figure 1 attached.

The new estimated average grade is 0.096 opt gold for the removed tonnage.

This is the best estimate available and follows the same parameters as established for the new study involving stope intervals.

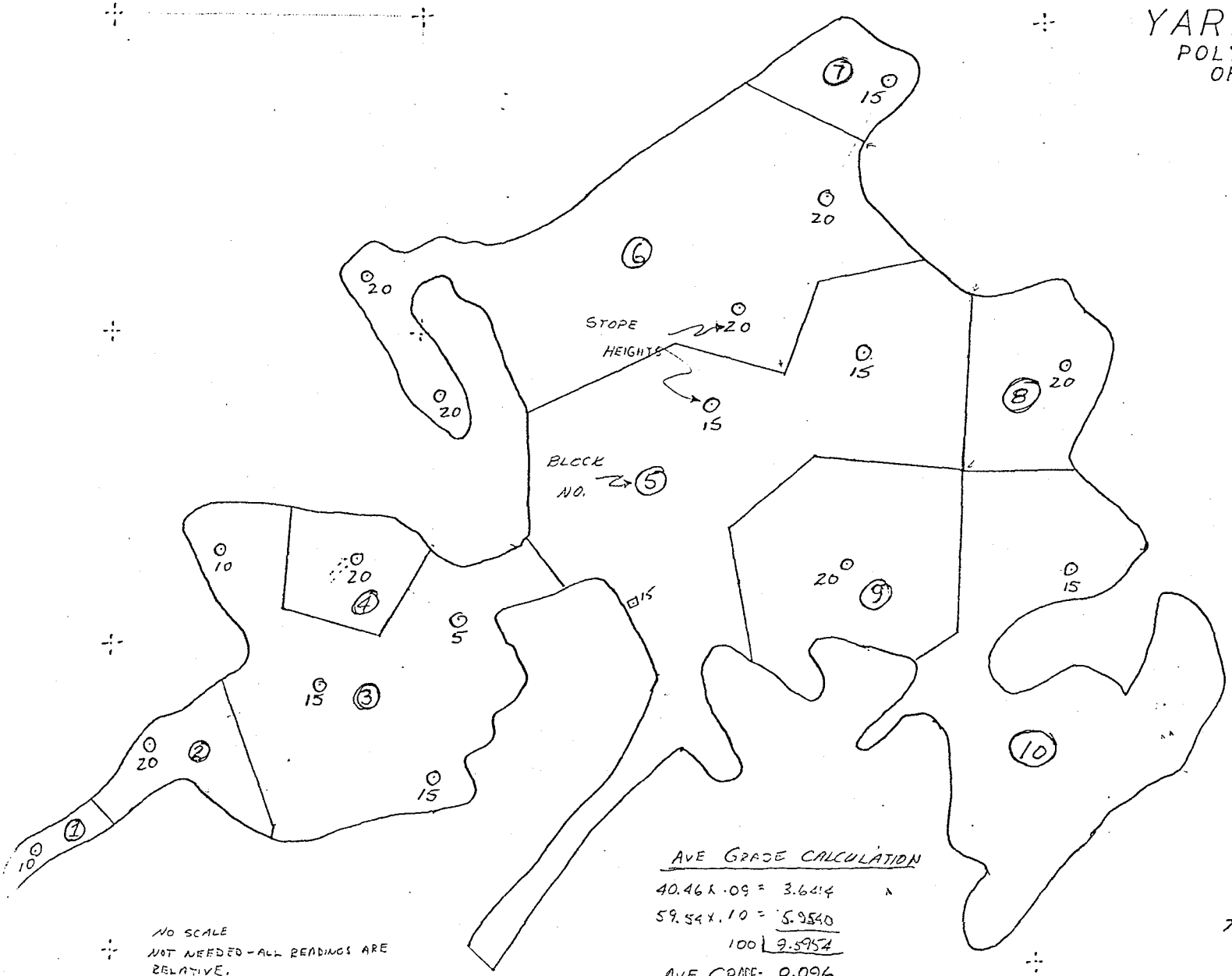
A slight adjustment might be made for the variation in tonnage within the two stop heights, but I believe this would not be any appreciable improvement over the method/results now available

James D Sell

YARNELL PROJECT

POLYGON MAP FOR ESTIMATE OF UNDERGROUND ORE GRADE

7 FEB. 90
WPG



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100 | 9.5954

AVE. GRADE = 0.096

ASARCO Southwestern Exploration Division JDS

February 6, 1990

R.L. Brown/F.T. Graybeal
New York Office

Trial Comparison of Two Triangles
Drill Indicated Reserve
Yarnell Project
Yavapai County, Arizona

At the suggestion by Mr. F.T. Graybeal, two triangles from the 12-20-89 Drill Indicated Reserve study have been recalculated.

In the original study of 12-20-89, in the Main "B" zone assays, the stope footage was not valued nor included in calculating the grade value in the remaining part of the hole, but was then assigned the value found in the remaining part of the hole and the full drilled footage including the stope was used for the thickness in the hole.

In this new study in progress, the stope footage was assigned 0.100 opt gold for the lowest 15 feet or any portion of 15 feet, and the additional footage from 15 on up was assigned a value of 0.050 opt gold and the entire footage then recalculated.

Triangles 82 and 91 were chosen for the trial test.

In Triangle 82, drill holes YM-25, -76, -77, were involved, with the latter two holes having stope intercepts of 15' and 13'. Recalculating the triangle block grade increased the grade to 0.061 opt gold.

In Triangle 91, drill holes YM-7, -37, -78, were involved with only the first hole having a stope intercept of 5'. Recalculating the triangle block grade increased the grade to 0.051 opt gold.

Table 1 shows the triangle number, the tonnage, the original (12-20-89) grade, the original (12-20-89) ounces, the recalculated grade, the recalculated ounces, and the gain in total ounces for the block by using the updated stope assays, and the percentage change.

Table 1 shows the gain when two holes are in the stope (block 82) was 24%, whereas in block 91, with only a thin stope intercept in one hole, only had 8% increase. The weighted total change in the two examples was 13% gain using the updated stope assays.

The change in ounces, when the full study underway is completed, will be modified by the fact that the grade of the tonnage removed by previous mining of the stope area will be higher than the original 12-20-89 figure and thus the total ounces removed by stopes will be increased.

Mr. W.D. Gay's report on the new estimated tonnage removed is 230,000 tons at 0.0875 ounces gold (20,125 oz.) vs. the 12-20-89 report use of 250,000 tons at 0.051 ounces (12,750 oz.). Mr. Gay's full report will be submitted along with the M.A. Miller report.

James D. Sell

James D. Sell

JDS:mek
Att.

cc: W.L. Kurtz

2/6/90
JDS

YARNELL PROJECT

Yavapai Co., AZ

Table 1. - Change in Ounces, and %,
Using the Recalculated Stope Values

Triangle No.	Tonnage	Original 12-20-89 grade,opt	Original 12-20-89 ounces	Recalcu. grade	Recalcu. ounces	Difference ounces	Difference %
82	17,177	0.049	841.673	0.061	1,047.797	+206.124	+24.49
91	39,905	0.048	1,915.440	0.052	2,075.060	+159.620	+ 8.33
Totals			2,757.113		3,122.857	+365.744	+13.27

JDS

ASARCO

Southwestern Mining Department

February 9, 1990

File Memo:

Yarnell Ore Reserve Study

The Engineering and Computer Services department recently completed an evaluation of the Yarnell computer models and ore reserves. Currently there are two (2) computer models in existance (named <Au> and <Au96>). One computer model <Au> uses stope assays of zero (0) through the stoped areas in the deposit. The other computer model <Au96> substituted an assay of 0.053 Au in the model for the stoped areas. The differences between these two computer models are shown below:

COMPARISON OF TWO COMPUTER MODELS

	MODEL <Au> WITH (0) STOPE ASSAYS				MODEL <Au96> WITH 0.053 STOPE ASSAYS		
	TONS		OZ/T	% CHANGE IN OZ Au	M TONS		OZ/T
INVENTORY USING J.D.SELL PIT OUTLINE	3004	@	0.050	+27%	3749	@	0.051
ECONOMIC @ $400 Au	2169	@	0.060	+ 2%	2295	@	0.058

Recent program enhancements in the Asarco Mine Planning System (AMPS) allow the display of the actual block model values in cross section along with the drill hole composites. While testing this new software, we discovered blocks in the Yarnell computer model, named <Au96>, which had not been assigned a value. These empty blocks have a zero assay and were masked by other surrounding model blocks whose assays were below the display cutoff used on previously available plan maps.

During the process of transferring data points into the horizontal block model from the rotated block model (which lies in the plane of the Yarnell structure), certain blocks remained unfilled due to the different geometries of the two models. Occasionally, two different blocks from the rotated model would

fall inside the same block of the horizontal model and thereby leave an adjacent block empty. These empty blocks are counted as waste by both the cone miner and the reserve programs.

We have implemented a new algorithm for transferring points from rotated to horizontal models which accounts for their geometric differences. The horizontal block model now contains the closest data point from the rotated block model which falls within a uniform sphere of influence whose radius is the size of one block (20 feet in this case).

Using this algorithm, a new horizontal block model has been built from the rotated block model. The new model, named <4796>, has been examined closely in cross section and plan view and shows no unexpected empty blocks. It also demonstrates a good correlation between the drill hole composites and the block model values.

A comparison of the <Au96> and the new <4796> block models is summarized below.

COMPARISON OF TWO COMPUTER MODELS

	MODEL <Au96> WITH 0.053 STOPE ASSAYS (EMPTY BLOCKS)				MODEL <4796> WITH 0.053 STOPE ASSAYS (FILLED BLOCKS)		
	M TONS		OZ/T	% CHANGE IN OZ AU	M TONS		OZ/T
INVENTORY USING J.D.SELL PIT OUTLINE	3749	@	0.051	+30%	4797	@	0.052
ECONOMIC @ $400 Au USING PREVIOUS PIT OUTLINE No.<2023>	2295	@	0.058	+33%	2953	@	0.060

A new cone mine run was made on the <4796> model using $400 Au price and new costs of $7.34 per ton of ore versus $6.67 per ton of ore on the previous economic model <2023> (above). The ore reserves from this new cone mine run are shown below:

COMPARISON OF TWO ECONOMIC RESERVES
FROM THE NEW MODEL <4796>

	MODEL <4796> WITH 0.053 STOPE ASSAYS FILLED BLOCKS USING ORIGINAL PIT <2023>				MODEL <4796> WITH 0.053 STOPE ASSAYS FILLED BLOCKS USING NEW ECONOMIC DESIGN <7223>		
	M TONS		OZ/T	% CHANGE IN OZ AU	M TONS		OZ/T
ECONOMIC RESERVES @ $400 Au	2953	@	0.060	+27%	3755	@	0.060

All three of the computer models have been made using polygonal interpolation in the plane of the Yarnell structure. Plan maps and cross sections through the rotated model clearly show the affect and extent of each composite. Since these changes to the computer model have such a dramatic effect on the ore reserves I feel we should schedule another meeting to determine:

A) Should we re-model using a 1/D2 interpolation ?
This would surely reduce the grade and increase the tonnage.

B) The type of plan maps and cross sections to be made.
Color or B/W, color cutoffs, type of drill hole display, etc.

Please contact us if you have any questions or to arrange the next meeting.

L. J. Jansen

cc: WLK
FTG

5MM .048

ASARCO Southwestern Exploration Division

JDS

February 13, 1990

File Note

Estimated Grade of
Removed Stope Material
Yarnell Project
Yavapai County, Arizona

In the February 1, 1990 report by W.D. Gay (Estimate of Tonnage removed by prior mining from Yarnell Mine), he estimated that 229,500 tons had been removed.

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James D. Sell

James D. Sell

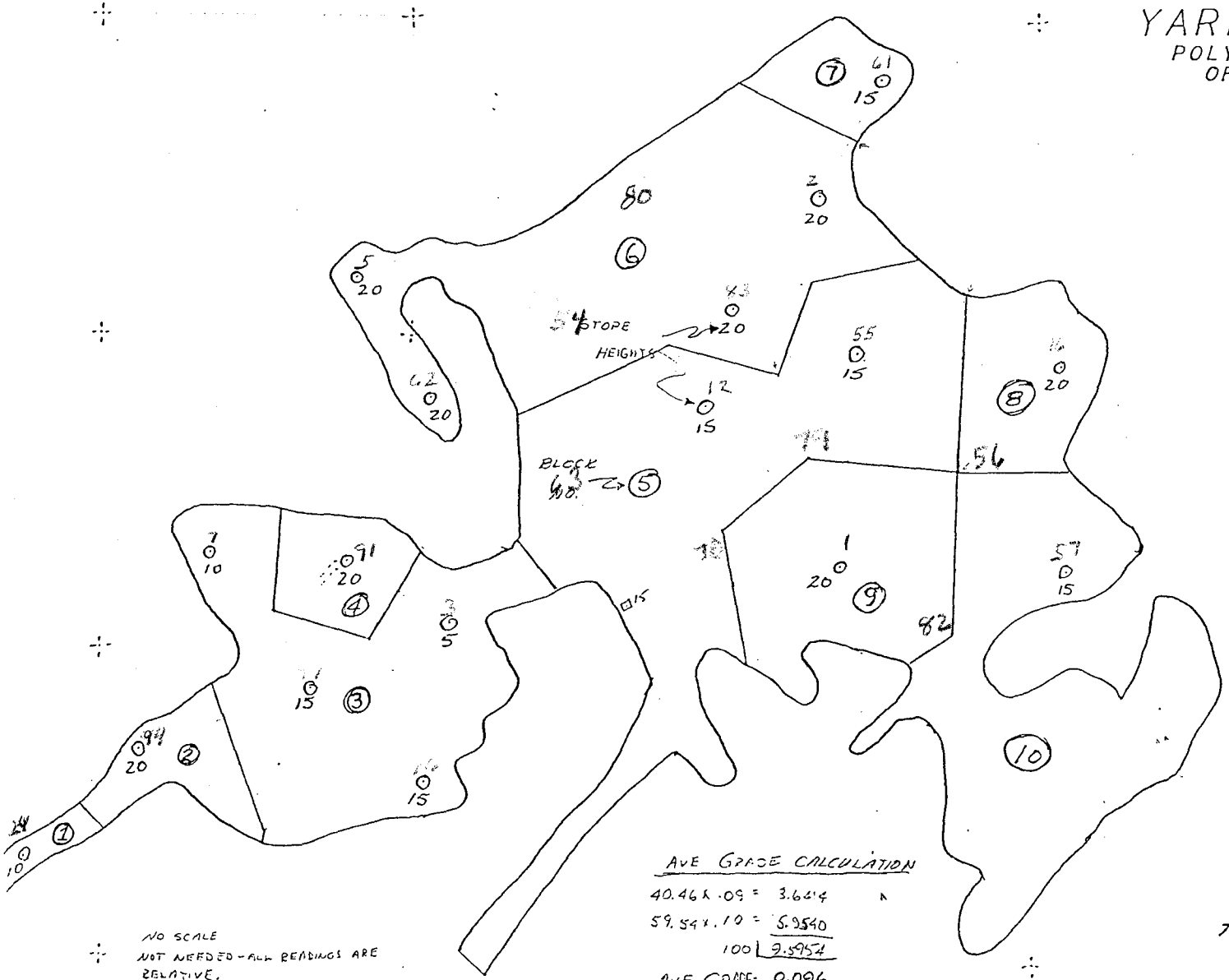
JDS:mek
Att.

cc: R.L. Brown
F.T. Graybeal
W.L. Kurtz
W.D. Gay
L.J. Jansen
S.L. Lakosky
M.A. Miller

YARNELL PROJECT

POLYGON MAP FOR ESTIMATE OF UNDERGROUND ORE GRADE

7 FEB 90
WDG



20' 2, 4, 6, 8, 9 — AVE. = 0.09

.05	15-20
.10	10-15
.10	5-10
.10	0-5
0.35	

ANY THING < 20' 1, 3, 5, 7, 10 : 0.10

BLOCK	DIAMETER READING
1.	39
2	133
3	712
4	142
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6	952
7	119
8	238
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59.54 x .10 = 5.9540
100 | 9.5954

AVE GRADE: 0.096

17

RDH 7

2/14/90

FTG Thoughts on Garnell Report.

Introduction
✓ Geology
✓ Structure
✓ Alteration & Mineralization
✓ Drilling
✓ Sampling
✓ Assaying
✓ Checks
✓ Rechecks
✓ Cutting Assay (~~how etc~~

✓ yes? Hi-veins
No? Continuity in 'B'
'Why Not!'

Various Tables
Contour maps
Isograde maps
Thickness maps
Gold maps.
Metallurgical Samples
Recheck of Bottle Roll
Specific Gravities
Rotary
Core
Surface
Adjustment of Reserve
Why (old stopes)
Where etc

Variation of cut-off vs one included assay error.
Continuity in mining, blending necessary? Recovery, etc.

FTG

Ore Reserve

Assays

Cutoff Grade

Specific Gravity

Pit Slope

Mining Width

Measurement & Calculation of Reserve

~~Measurement~~

Dilution

Mine Plan

Variability of Ore Reserve Methods

Additions to Reserves

Metallurgy

Sept 5 89 Methods of Bloom

Sept
Mullen 9-9-89 Original vs Reject
April 27-90 RBM vs RBM Study
July 7-15-89 Assay checks -

cf
T. Page
10-24-89
Pb-magnetite ex
chemistry

MAM never he just got it in!

May 24 1989

JDS

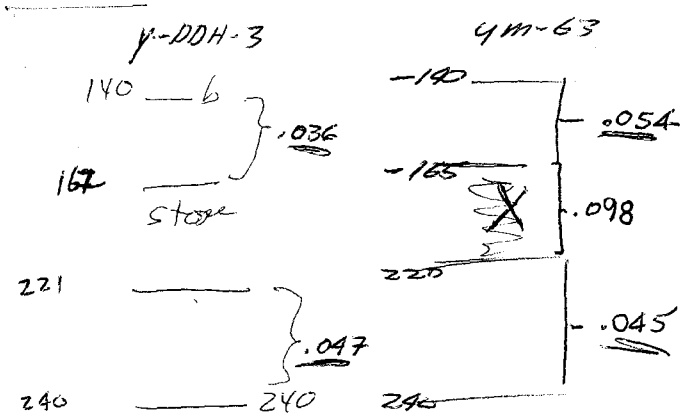
FROM: J. D. SELL 8-19-90

TO: MAIN

Calculate for me:

	Assay Bzone	Thickness feet	Recoveries of Rotary Pulps
DDH-3	140 - Stope		
	Stope - 240		

YM-63 Same



OVER →

Standard Deviation 95% Confidence.

	X	X^2
n		
ΣX_i		ΣX_i^2

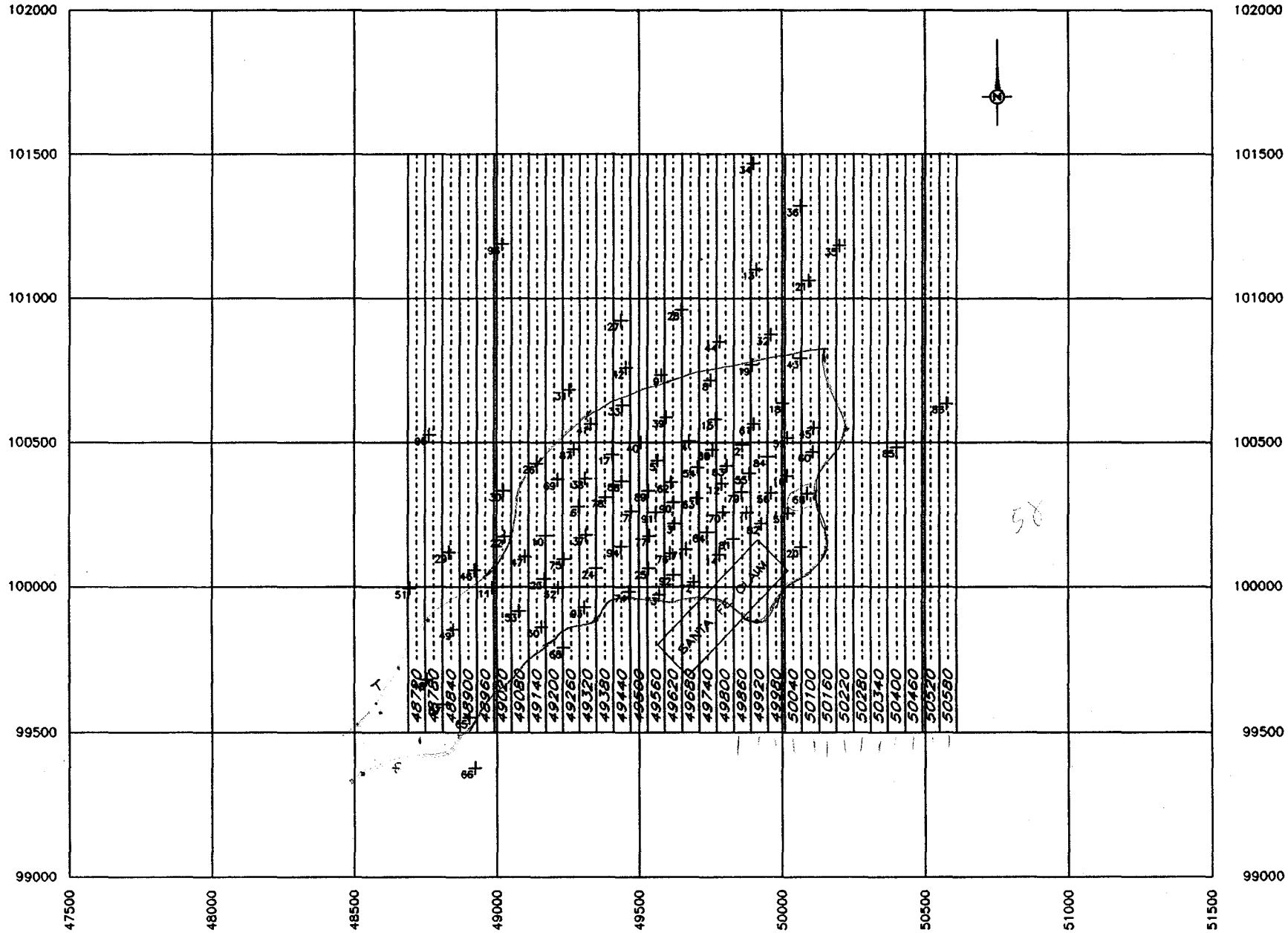
$(\Sigma X_i)^2 =$

$$SS = \Sigma X_i^2 - \frac{(\Sigma X_i)^2}{n}$$

$$s^2 = \frac{SS}{n-1}$$

Std Dev $= \sqrt{s^2}$

SECTION LOCATION MAP



Sections Looking West

LEGEND

Weakly altered biotite granite
biotite fresh to slightly altered to specularite
weak sericitic feldspar
± silica veinlets

Moderately altered biotite granite
biotite absent / ~~[illegible]~~ specularite masses
~~[illegible]~~ ~~moderate~~ ~~sericite~~
moderate / strong sericite repl. feldspars

Strongly altered biotite granite
argillic alteration – kaolinite, clay.

As above, overprint of interstitial to
flooded silica, with ± minor quartz veins

25 Quartz veins, major, with dip / strike

Limonite pseudomorphs of pyrite and red
hematite of oxidized specularite / pyrite

Yarnell Fault. 35 Yarnell fault as mapped
, as projected
, as inferred

35 Strike/dip of major structures.
30 Strike/dip of jointing

ASARCO

Southwestern Exploration Division

~~JDS~~ I thought we agreed when I (JDS) was here that you (JDS) were going to write the report to be then commented, added, changed etc by me? mek 2/15/90

February 15, 1990

M.A. Miller

Format for Report
Yarnell Project
Yavapai County, AZ

yes, but no reason MAM should not clean-up his report also. JDS

Format and address your Yarnell Project report to follow the F.T. Graybeal Wiluna report as applicable.

Addressing these numerous questions now will save much rewriting later.

In his cover letter, Graybeal summarized what was in the body of the report, his methods of calculations and the reserve table; then a Table of Contents (attached).

In the Text format details, he included:

- Introduction
- Geology
- Style of Mineralization
- Previous Mining
- Drilling and Sampling
- Assaying
- Ore Reserve
  - Assays
  - Cutoff Grade
  - Specific Gravity
  - Pit Slope
  - Mining Width
  - Measurement and Calculation of Reserve
  - Dilution
  - Mine Plan
  - Variability of Ore Reserve Estimate
  - Comparison with Other Reserve Methods
  - Additions to Reserves
  - Metallurgy
- Concluding Remarks.

Note his Figure titles as they express some of the detail problems addressed in the Text and visualized by use of figures (and perhaps, to be in Tables in some instances at Yarnell).

Put together a preliminary Table of Contents detailing the topics to be covered in your report, for review.

A copy of the F.T. Graybeal Wiluna Report, except for the Appendix material is with the File Copy only.

James D. Sell

James D. Sell

JDS:mek
Atts.

cc: F.T. Graybeal, W.L. Kurtz

Benchmark LEGAL PAD 32-125 CANARY 32-225 WHITE

2-15-90

Yarnour Report

Table of Contents

I Summary + Conclusions

II Recommendations.

III Introduction + History

1) History

2) Location + Topography.

IV Land Status.

V Geology

(1) Lithology

(2) Structure

(3) Alteration + Silicification

4 Mineralization

VI Drilling Results

Rotary Drilling w/ Attachments

Diamond Drilling (Discussion

Ore Reserves JDJ + MRM Attachments

ASARCO Southwestern Exploration Division

JDS

February 15, 1990

M.A. Miller

Format for Report
Yarnell Project
Yavapai County, AZ

Format and address your Yarnell Project report to follow the F.T. Graybeal Wiluna report as applicable.

Addressing these numerous questions now will save much rewriting later.

In his cover letter, Graybeal summarized what was in the body of the report, his methods of calculations and the reserve table; then a Table of Contents (attached).

In the Text format details, he included:

- Introduction
- Geology
- Style of Mineralization
- Previous Mining
- Drilling and Sampling
- Assaying
- Ore Reserve
  - Assays
  - Cutoff Grade
  - Specific Gravity
  - Pit Slope
  - Mining Width
  - Measurement and Calculation of Reserve
  - Dilution
  - Mine Plan
  - Variability of Ore Reserve Estimate
  - Comparison with Other Reserve Methods
  - Additions to Reserves
  - Metallurgy
- Concluding Remarks.

Note his Figure titles as they express some of the detail problems addressed in the Text and visualized by use of figures (and perhaps, to be in Tables in some instances at Yarnell).

Put together a preliminary Table of Contents detailing the topics to be covered in your report, for review.

A copy of the F.T. Graybeal Wiluna Report, except for the Appendix material is with the File Copy only.

James D. Sell

James D. Sell

JDS:mek
Atts.

cc: F.T. Graybeal, W.L. Kurtz

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	9,550 9,700 9,950	
	9,562.5 9,725 9,975	
	9,575 9,750 9,987.5	
	9,587.5 9,775 10,000	
	9,594 9,800 10,025	
	9,600 9,810 10,050N	
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Appendix D East Lode Main Shaft
1) Summary of reserves by section p. D1
2) Summary of reserves by ore block p. D2
3) 1:500 cross sections (10)

10,075N	10,250
10,100	10,300
10,125	10,350
10,150	10,400
10,200	10,450N

Note: Distribution of gold mineralization is shown on the East Lode pit area map

Appendix E East Lode North Extension
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3) 1:500 scale sections (27)

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9,850	10,075	10,275
9,900	10,100	10,300
9,912.5	10,125	10,325
9,925	10,150	10,350
9,950	10,175	10,400
9,975	10,200	10,500
10,000	10,225	10,550
10,025	10,237.5	10,600N

4) Map showing distribution of gold mineralization

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9,950	10,175	10,400
9,975	10,200	10,500
10,000	10,225	10,550
10,025	10,237.5	10,600N

4) Map showing distribution of gold mineralization

ASARCO

Exploration Department
Frederick T. Graybeal
Chief Geologist

March 3, 1986

D.F.S.

APR 4 1986

Mr. R. L. Brown, Jr.
Vice President
Exploration Department
ASARCO Incorporated
New York Office

Cross Section Ore Reserve
Wiluna Project
Western Australia

Dear Sir:

Herewith please find 3 copies of the Wiluna ore reserve. Proven and probable ore reserves using a cross-section method are summarized on Table 1 which follows this letter. Individual cross sections and drill maps are appended. Estimates were also made for possible mineralization, not presently considered ore because of marginal economics, uncertain metallurgy, or unproven continuity. The calculations distinguish between oxidized ore and transition ore which have different metallurgical characteristics. Definitions of reserve class and ore types are given on Table 1. The cross-section method has been used at a number of recently developed open pit gold mines in Western Australia and early data indicate it provides an accurate estimate of reserves as long as the geology of the deposit is understood.

Estimates use a 1.0 gm Au cutoff, a 3 meter minimum horizontal mining width, and are not diluted. Proven and probable oxide ore is a mineable reserve available in 45° pits and totals 1,239,000 tonnes averaging 4.07 gm Au in four separate areas. Waste/ore in these areas varies from 2.9-8.5. Recent dewatering of the underground workings has revealed that glory hole walls are stable and it is likely that pit slopes in excess of 45 degrees may be used.

Aggregate reserves in all categories indicated by drilling are 2,580,000 tonnes averaging 3.7 gm Au. It is possible that up to 1.3 million tonnes could be added from areas adjacent to old workings which can't be intersected by surface drilling and from below existing reserves. Exploration of numerous other mineralized zones within the area of the Wiluna Joint Venture will add further to these estimates.

Mineralization occurs along north-striking shear zones which dip 75° east. True width of individual ore zones at a 1.0 gm Au cutoff varies, but for the East Lode pit it is about 20 meters in the center of the reserve area thinning to about 7 meters at each end. The ore mineral is native gold

Mr. R. L. Brown, Jr. March 3, 1986

which is very fine grained. The absence of coarse gold eliminated the nugget effect which simplified sampling and, combined with the tendency for higher grade assays to cluster predictably in certain areas of the ore reserve, justified the use of all assays at face value. Continuity of the various ore zones is good and correlations between drill holes at 12.5 meter spacing along sections drawn at 25 meter intervals were rarely ambiguous. Continuity was confirmed by drilling a number of holes between the 25 meter sections and by drilling several shallow 3 x 5 meter grid patterns. Surface depletion of gold is not significant.

The mine plan, ore control procedures, and mill design will require flexibility to deal with variations in clay content which becomes less abundant at depth, competence of the rock which becomes harder with depth, and different ore types which contain variable amounts of sulfide below 20-30 meters. Recognition of these variables, in addition to on-going exploration, pit wall stability studies, and geologic mapping of ore, will require full-time experienced resident geologists.

Finally, I acknowledge the personal commitment to the success of the Wiluna Project made by Mr. H. C. Williamson, Managing Director of Asarco (Australia), under whose direction the discovery, acquisition of some 450 sq. km. of mineral tenements, and 5 years of exploration and pre-development work were accomplished.

Very truly yours,

F. T. Graybeal

F. T. Graybeal

FTG:lb:bc

cc: RJKupsch - 1 Copy
HCWilliamson- 2 Copies
KIngram - 2 Copies

WILUNA ORE RESERVE

The ore reserve illustrated in Table 1 is presented in Metric Tonnes. Convert to short tons by multiplying by 1.1023.

The total proven and probable reserve in short tons becomes as follows:

	Tons	Gm Au
Oxide - Proven & Probable	1,365,443	4.07
Transition - Proven & Probable	294,427	4.77
TOTAL	1,659,870	4.19

		Oz/Ton Au
ASARCO 50% Share	829,935	0.12

TABLE 1. WILUNA ORE RESERVE[1]

OXIDE ORE TYPE[2]

Area	Proven[3] Tonnes	Proven[3] gm Au	Probable[4] Tonnes	Probable[4] gm Au	Total Proven + Probable Tonnes	Total Proven + Probable gm Au	Waste[9] Tonnes	Waste[9]/ Proven Oxide Ore
E. Lode Pit	743,586	4.16	100,952	3.56	844,538	4.08	2,196,518	2.9/1
E. Lode Main Shaft	32,519	3.63	1,382	2.51	33,901	3.59	206,413	6.3/1
E. Lode N. Extension	79,457	3.88	3,642	3.80	83,099	3.88	534,696	6.7/1
West Lode	211,417	4.45	65,768	3.25	277,185	4.17	1,793,828	8.5/1
Totals	1,066,978	4.18	171,744	3.44	1,238,722	4.07		

TRANSITION ORE TYPE[5]

Area	Proven[6] Tonnes	Proven[6] gm Au	Probable[7] Tonnes	Probable[7] gm Au	Total Proven + Probable Tonnes	Total Proven + Probable gm Au
E. Lode Pit	46,699	7.04	83,615	3.65	130,314	4.86
E. Lode Main Shaft	-	-	7,460	2.92	7,460	2.92
E. Lode N. Extension	11,492	9.19	14,445	2.89	25,937	5.68
West Lode	2,571	2.93	100,821	4.40	103,392	4.36
Totals	60,762	7.27	206,341	3.97	~~251,016~~ 267103	4.77

1,505 825

POSSIBLE MINERALIZATION[8]

Area	Oxide Tonnes	Oxide gm Au	Transition Tonnes	Transition gm Au
E. Lode Pit	40,203	2.34	35,364	4.08
E. Lode Main Shaft	4,912	3.67	-	-
E. Lode N. Extension	11,533	3.10	-	-
West Lode	78,217	2.05	104,355	3.14
Essex	100,000	2.0		
Happy Jack	360,000	3.0		
Bulletin	230,000	2.7		
Moonlight	110,000	5.5		

[1]Established by drilling using 1.0 gm Au cutoff, 45° pit slope, 3 meter minimum horizontal mining width. All units are metric.

[2]Oxide Ore Type. Specific gravity = 2.10. No sulfides remaining in the rock.

[3]Proven Oxide. Inside a 45° pit; continuity established both down dip and along strike at 12.5 m hole spacing on 25 m section spacing.

[4]Probable Oxide. Inside a 45° pit designed for proven oxide; continuity uncertain at 12.5 m hole spacing or 25 m section spacing, but will be mined to conform pit to optimum geometry for extraction of proven oxide.

[5]Transition Ore Type. Specific gravity = 2.50. Variable amounts of partly oxidized sulfides.

[6]Proven Transition. Inside 45° pit designed for proven oxide; continuity established both down dip and along strike at 12.5 m hole spacing and will be mined to conform pit to optimum geometry for extraction of proven oxide.

[7]Probable Transition. Below floor of 45° pit, but not more than 50 m deep; continuity down dip and along strike based on variable drill hole spacing and projection from overlying zones.

[8]Possible Mineralization.
a) East and West Lodes. Material adjacent to 45° pit walls with variable continuity down dip and along strike; either submarginal grade for required stripping or uncertain metallurgy.
b) Essex, Happy Jack, Bulletin, Moonlight. Material within 30 m of the surface for which there are only wide-spaced drill hole intersections, but where continuity can be reasonably assumed based on proximity to underground workings and geologic inference.

[9]Waste. Specific gravity = 2.80. All material less than 1.0 gm Au in 45° pit designed to extract proven oxide ore only. Waste/proven oxide ore does not include probable or possible material which will reduce ratio if ultimately proven to be ore.

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4) Map showing distribution of gold mineralization

CROSS SECTION ORE RESERVE
WILUNA PROJECT
WESTERN AUSTRALIA

INTRODUCTION

Wiluna is located 550 miles northeast of Perth, Western Australia in the East Murchison Goldfield (Fig. 1). It is the fourth largest gold district in Western Australia having produced roughly 2.08 million ounces of gold from 10.3 million tons of ore during 1896-1947. In 1980 Asarco (Australia) geologists under the direction of H. C. Williamson recognized the potential for disseminated gold mineralization in the walls of two old open cuts at Wiluna. In 1981 Asarco executed a joint venture option with Western Alluvials for ground in the central portion of the district including the East and West Lodes. Vesting was completed in July 1985. On-going land acquisition has accumulated roughly 120 square miles or about 95% of the Wiluna District (Fig. 2).

This report summarizes a manual cross section ore reserve based on geological interpretation of assay data, a technique used widely in Western Australia for shallow oxidized gold ores. Limited operating data acquired from numerous visits to operating open pit gold mines in Western Australia indicate the technique is accurate as long as the geologic environment of the ore is understood.

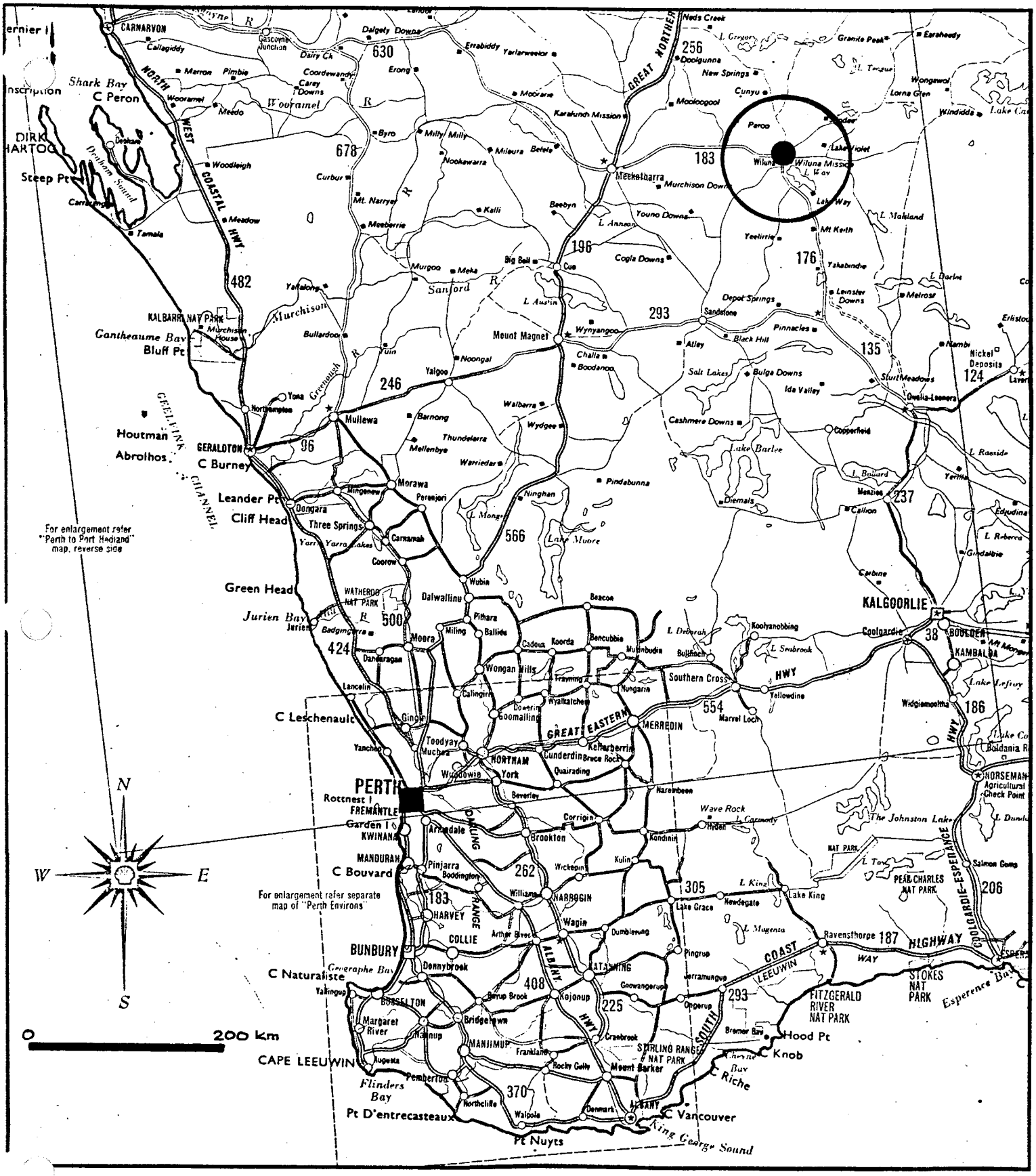
GEOLOGY

Pre-1980 geologic information about Wiluna is limited. The only general summary is by Edwards (1953; see Appendix A) which was compiled from unpublished reports written in 1936 and 1937. Most of the mineralized outcrops are covered by a surface wash and all underground workings are flooded. Detailed surface mapping by Asarco (Australia) confirms the area is underlain by a sequence of weakly metamorphosed northwest-striking and steep-dipping mafic volcanic flows with rare thin interbedded felsic tuffs. The sequence has been modestly dilated by several mafic sills and rare post-mineral dikes are inferred from a study of longitudinal mine sections.

Structure is dominated by two north-striking shear zones which can be traced for several miles in surface and underground workings and along which as much as several thousand feet of right lateral offset may have occurred. Each shear zone may be up to several hundred feet wide with numerous internal faults which split unpredictably. Dips are 75°E to vertical.

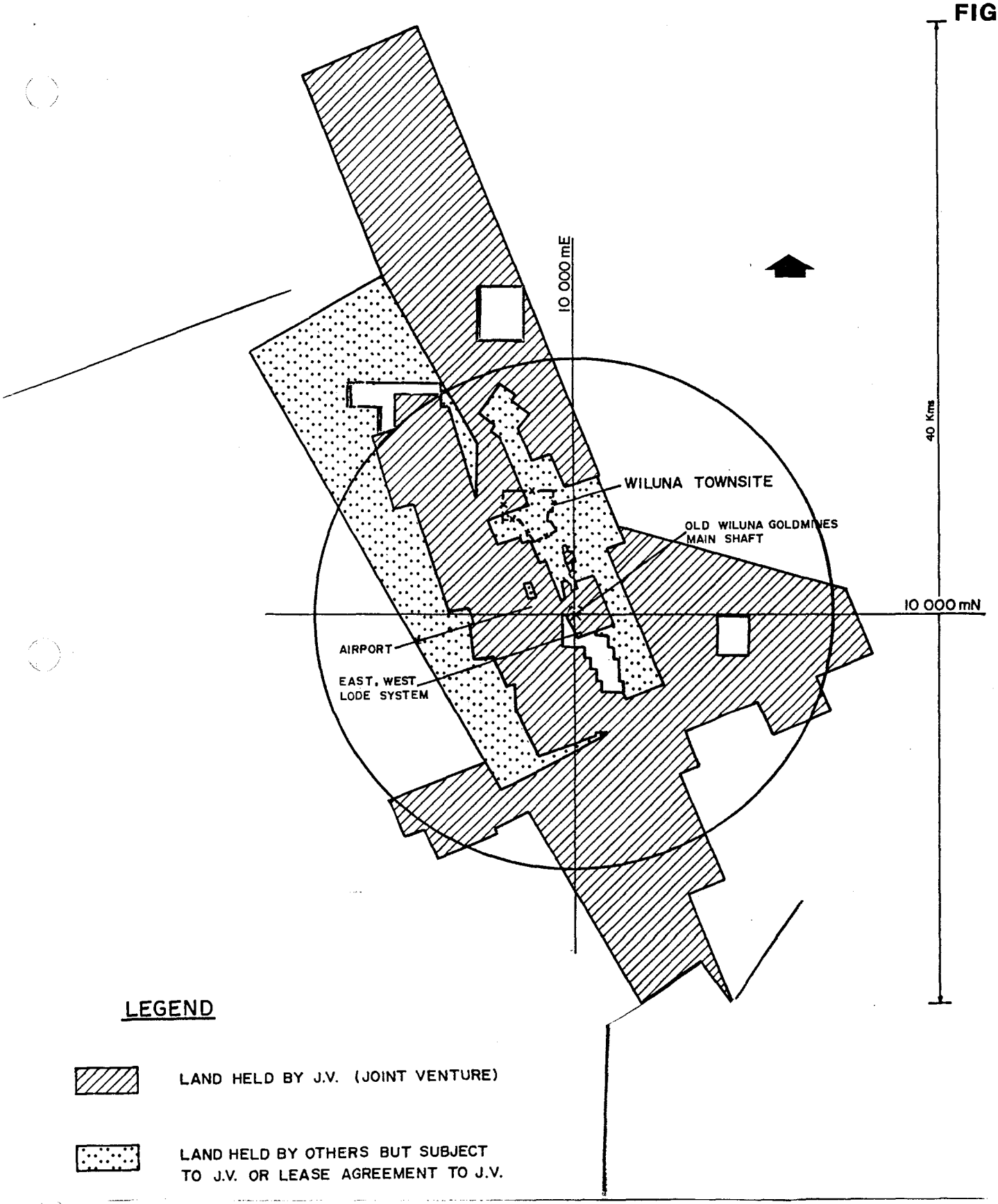
The various mineralized areas explored in the central part of the district are shown on Figure 3. All mineralization drilled to date is confined to certain shear zones. Additionally, the East Lode and West Lode orebodies, the largest presently known, appear confined to an area where the associated

FIGURE 1



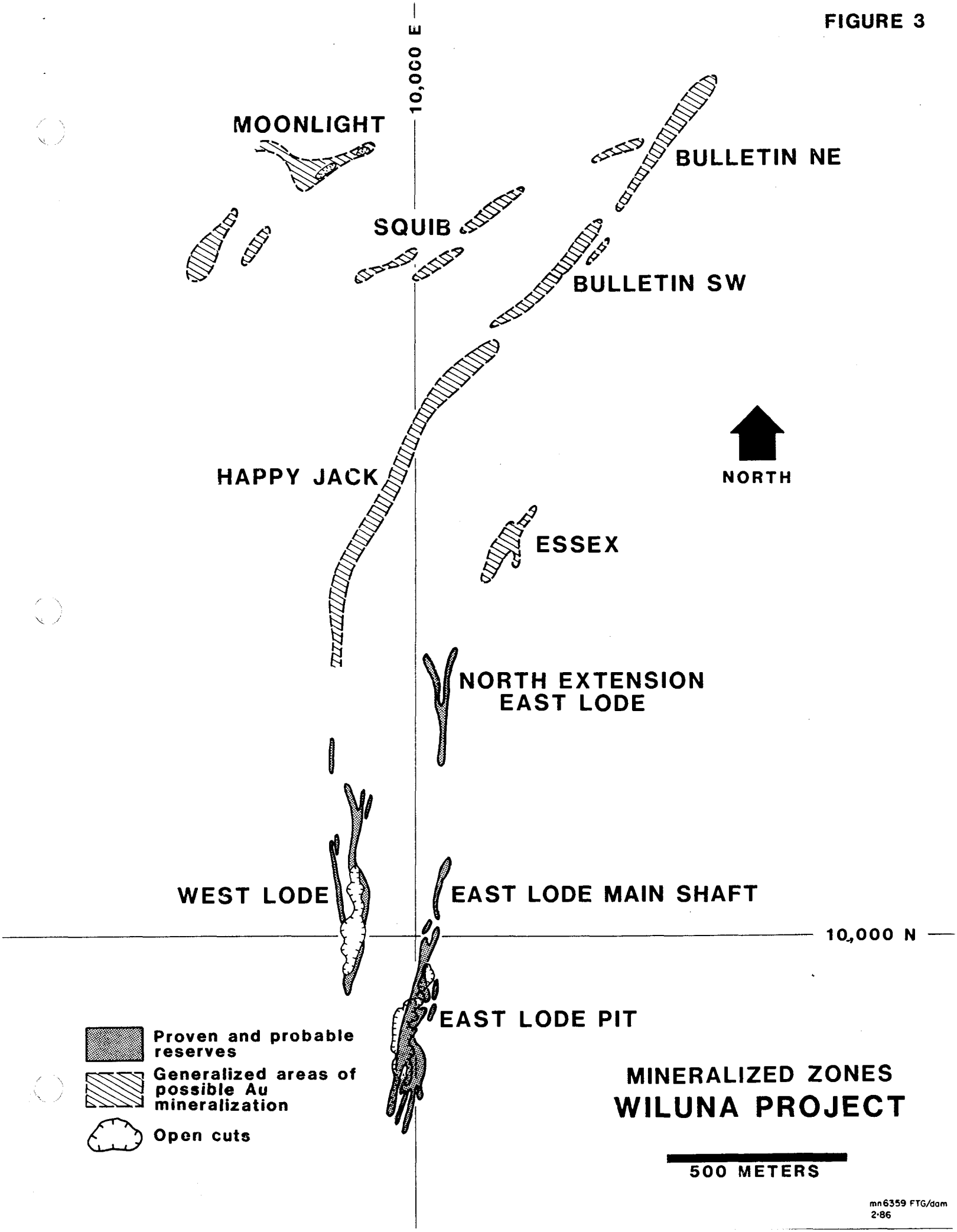
LOCATION MAP, WILUNA, W.A.

FIGURE 2



TENEMENT HOLDINGS — WILUNA AREA

FIGURE 3



MINERALIZED ZONES
WILUNA PROJECT

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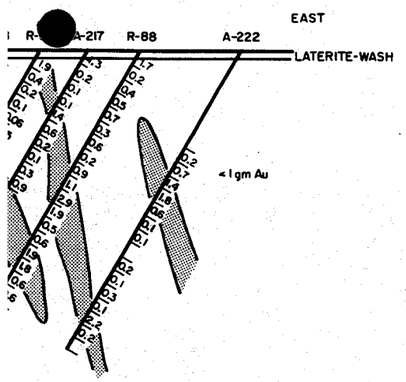
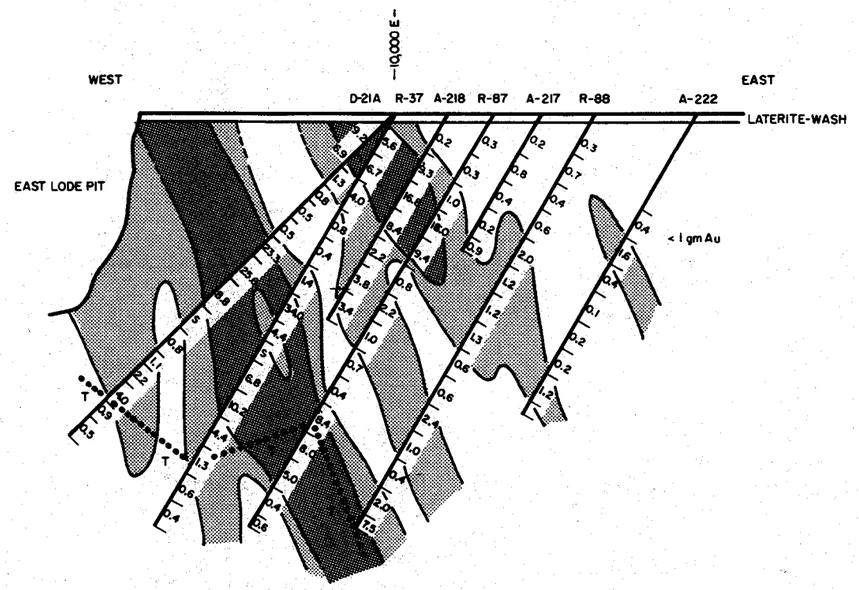
FIGURE 4

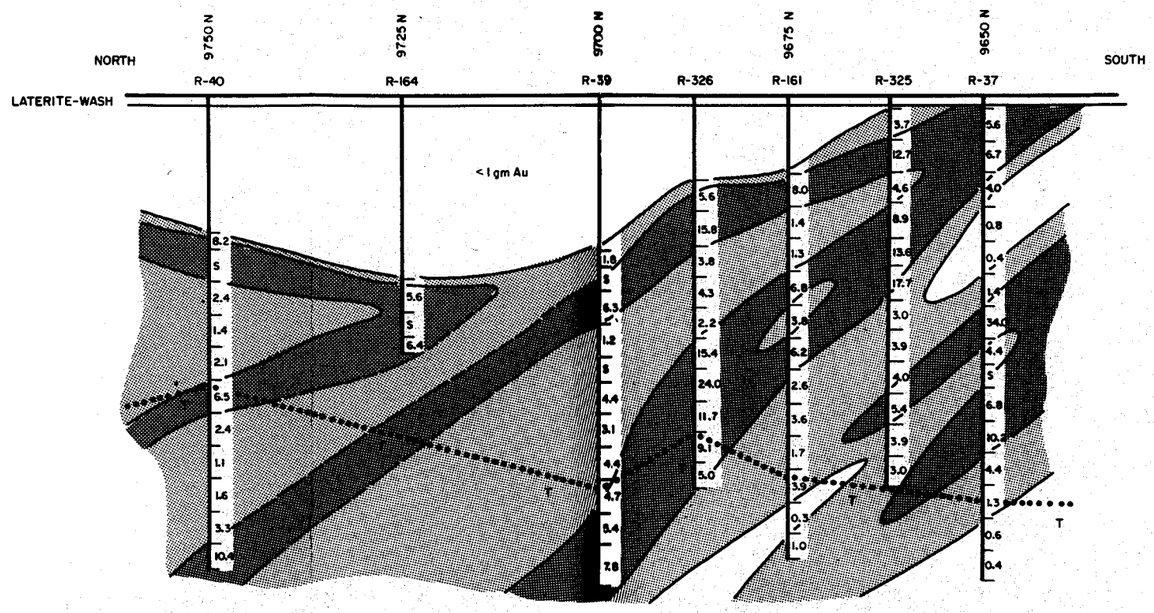


INTERVAL

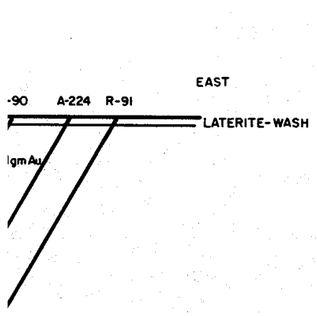


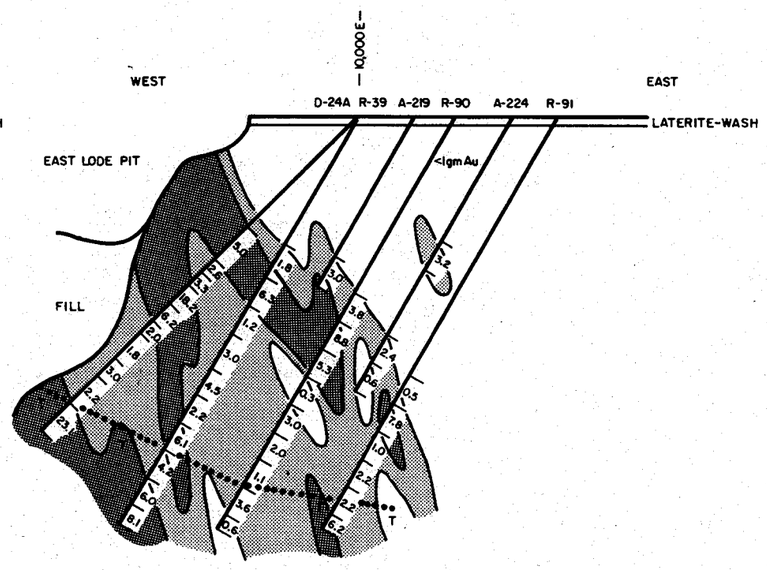
4 METER ASSAY INTERVAL

SECTION 9650 N EAST LODE PIT AREA



INCLINED SECTION ALONG 10,000 E DIPPING WEST AT 60°
(DRAWN IN THE PLANE OF ALL DRILL HOLES: LOOKING DOWN TO THE EAST)
EAST LODE PIT AREA
4 METER ASSAY INTERVAL





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4 METER ASSAY INTERVAL

SECTION 9700 N EAST LODE PIT AREA

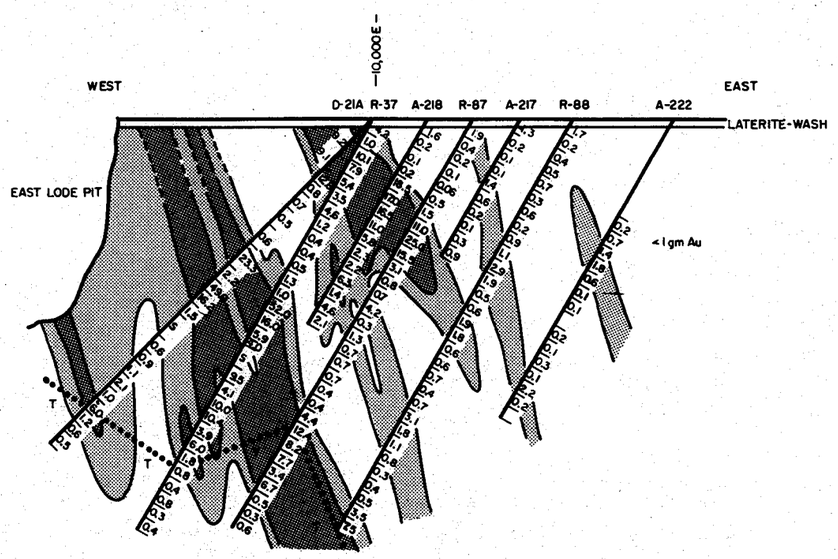
EXPLANATION

- Drill hole showing assay in gm Au (S = stope)
- + 5.0 gm Au zones
- 1.0-5.0 gm Au zones
- Top of Transition zone

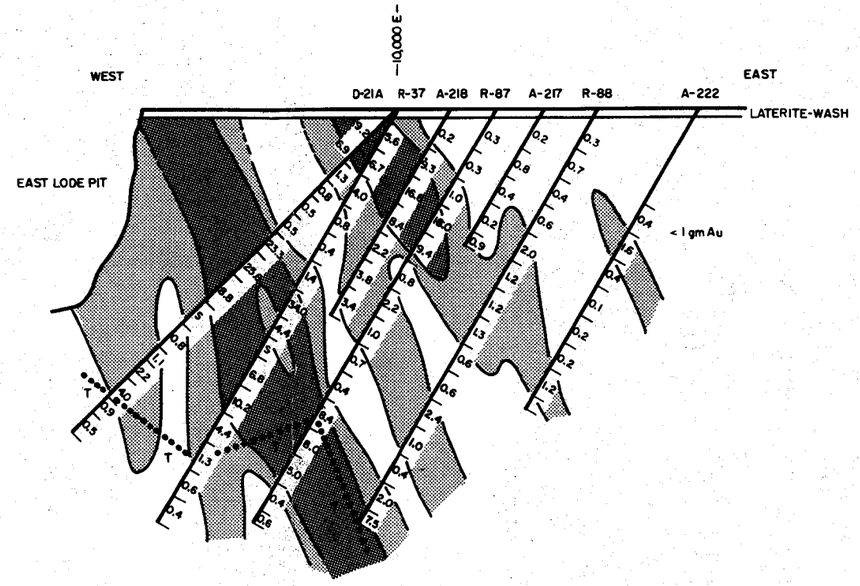
ASSAY CONTOUR SECTIONS
EAST LODE PIT AREA
WILUNA PROJECT, W.A.

0 10 20 METERS

mn6361

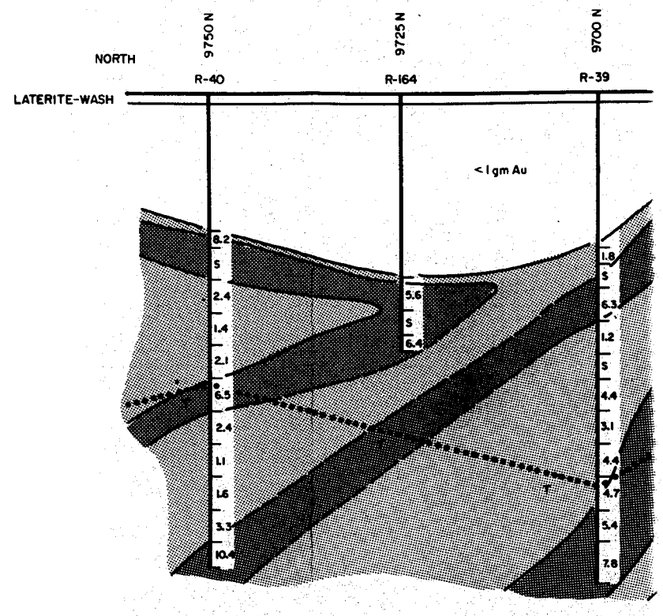


2 METER ASSAY INTERVAL



4 METER ASSAY INTERVAL

SECTION 9650 N EAST LODE PIT AREA



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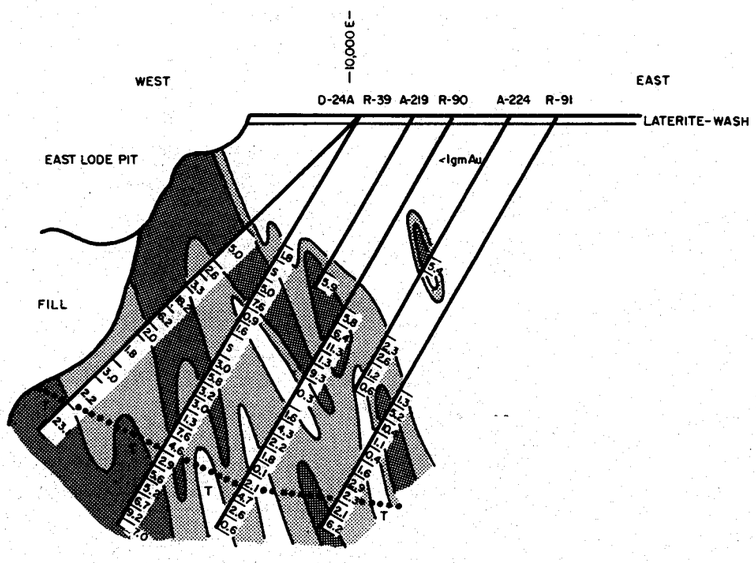
4 METER ASSAY



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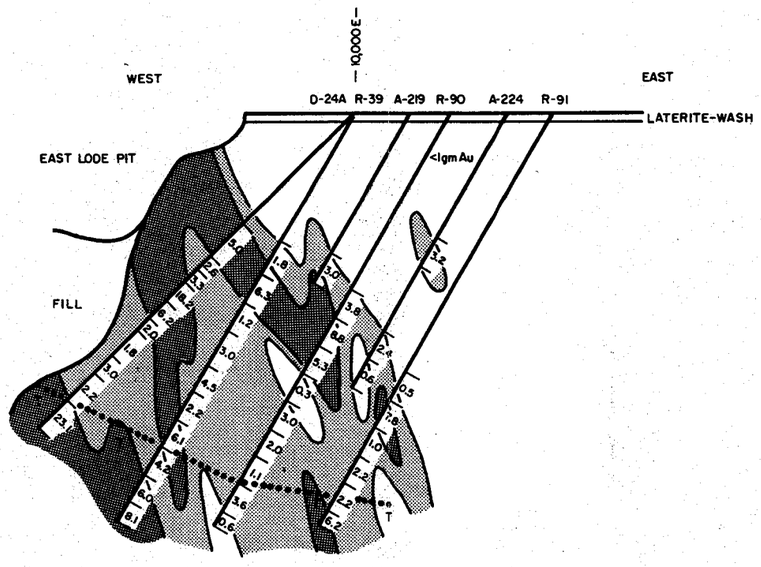

4 METER ASSAY INTERVAL

SECTION 9700 N EAST LODE PIT AREA

EXPLANATION

- Drill hole showing assay in gm Au (S = stope)
- + 5.0 gm Au zones
- 1.0 - 5.0 gm Au zones
- Top of Transition zone

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shear zones cut a highly magnetic basalt flow with abundant pillow structures. Although details are unclear, the implication is strong that lithology exerts a strong control on the distribution of gold mineralization and the mere presence of a strong structure does not guarantee continuity of ore grade values or mineable widths. Alteration associated with ore consists of quartz-carbonate-pyrite-arsenopyrite replacement of wall rock. Quartz occurs as discrete, discontinuous veins up to one foot or so thick within faults and as irregular stockworks along the faults. Stibnite is present in the Moonlight zone and at the north end of the West Lode.

The ore mineral is native gold. In the sulfide zone of the East and West Lodes, Edwards (1953) reports that gold occurs largely as inclusions in arsenopyrite. Sulfide ores at Wiluna were termed refractory and required flotation, roasting of the sulfide concentrate, and cyanide leaching of the calcine to produce acceptable recovery. Edwards' comment that ore in the upper levels of the East Lode had an assay hangingwall indicates that sulfides were disseminated. Most of the ore mined at Wiluna was in the sulfide zone.

Oxidation due to severe weathering has destroyed all sulfides to maximum depths of 50 meters in the East Lode, 40 meters in the West Lode, and in excess of 50 meters in the Happy Jack-Bulletin zone. Oxidation is of fundamental importance because it has liberated gold from arsenopyrite, resulting in an ore type which responds well to conventional carbon-in-pulp (CIP) technology, a much lower cost process than the float-roast-leach process required for Wiluna sulfides. Weathering has also resulted in the formation of highly variable and unpredictable amounts of clay minerals and fine-grained silica which are generally more abundant close to the surface.

Within the zone of complete oxidation of sulfides, referred to as the oxide zone, logging of drill chips has attempted to define a weathered ore type and an oxidized ore type. Generally, the weathered material contains more clay and is more disintegrated than the underlying oxidized ore type. The important metallurgical difference between the two is that the oxidized type is harder and will likely require longer grinding time to achieve similar size distribution and perhaps more blasting during mining. However, the change to a harder rock with increasing depth is gradational and does not occur abruptly at the boundary of the two ore types. In addition, the abundance of clay and supergene silica is highly variable even within the weathered ore type and it is likely that the abundance of clay and silica, and degree of disintegration of the rock are more variable within the weathered ore type than between the weathered and oxidized ore types. Clay and silica content do not significantly impact recovery of gold which will be 90% by CIP in both ore types. Mine scheduling must plan for unpredictable variations in mineralogy and hardness throughout the oxide zone, regardless of ore type, and sufficient faces in ore should be maintained so that an acceptable blend of these variations can be delivered to the plant.

Gold in the oxidized zone is generally very fine grained. Most grains observed microscopically are less than 10 microns across and, to my knowledge, free gold in the East and West Lode orebodies has never been observed with the unaided eye in hand specimen. The characteristic fine grain size of gold has greatly reduced sampling problems associated with the nugget effect as a source of uncertainty in the interpretation of grade and continuity of ore at Wiluna. The silver content of Wiluna ore has not been studied in detail, but is believed to be less than 3 gm and not of economic significance.

The oxide zone is roughly U-shaped in cross section, being deepest in the central parts of the shear zones where permeability was presumably greater. The base of the oxide zone is marked by the appearance of small amounts of sulfide which increase erratically and unpredictably with depth through a 10-20 meter thick transition zone to clean sulfides. Metallurgical test work indicated CIP recovery of gold in the transition zone will vary from 25-90% with low recovery corresponding to abundant sulfide. Insufficient work has been done to know where the higher recovery zones are and whether they are continuous enough to be mined for the CIP circuit. The boundary between the oxide and transition zones will likely be found by mining to be more irregular than shown on the attached cross sections, but because it is gradational and because sulfides can be easily recognized severe mixing of oxide and transition zone ores should not be a problem during mining.

Supergene movement of gold at Wiluna has not been assessed in detail. A review of cross sections suggests that some enrichment of gold has occurred because outcropping ore zones drawn at a 1 gm Au cutoff appear to narrow downward. Further, the 7 ore reserve blocks which average over 10 gm Au are all within 25 meters of the surface and average 15 meters depth. This enrichment does not appear to have been concentrated within single quartz veins because one meter assays above about 50 gm Au are rare. Rather, enrichment appears to have overprinted existing hypogene patterns throughout the stockwork veined and faulted portions of the shear zones, resulting in a general increase in gold content of all previously mineralized rock. The source of the gold is presumed to have been in updip portions of the shear zone which have since been eroded. Enrichment has not resulted in a uniformly upward-expanding geometry of all +1 gram Au ore zones, some of which narrow upward, but rather has increased the width of the preexisting hypogene ore zones near the surface.

Numerous examples of supergene enrichment and leaching (depletion) have long been recognized within the Yilgarn Shield of Western Australia, often with examples of both within the same district. The phenomenon is of considerable practical importance and nearly impossible to predict from geologic assessment alone. It is complicated by the fact that near-surface depletion may occur in orebodies which have experienced a net enrichment within the entire oxidized zone. Eight separate examples of surface depletion of gold were reviewed during a recent visit to Western Australia and in most

depletion went unrecognized during exploration drilling. This is because most ore zones are narrow and steep dipping and are explored using angle holes collared outside the surface projection of the ore. In the eight documented examples depletion has reduced grades by 20-50% down to depths of roughly 15 meters. Depletion not only reduced the grade, but does so in a very irregular way so that the continuity of local higher grade remnants is limited and dilution during mining is severe. Grade control techniques which are usually optimized during the early stages of mining don't work because of unrecognized depletion. The result leads to confusion during the early stages of a project when a greater-than-normal amount of attention is being focused on the operation.

Although a number of exploration holes at Wiluna were collared within ore zones, the possibility of depletion could still be inferred from the geometry of some ore zones which narrow upward and where inspection of cross-sections could not confirm whether the narrowing was a hypogene feature or due to supergene leaching. As an initial test both of the accuracy of projected 1 gm Au ore zone boundaries and for the presence of supergene leaching, three areas were drilled using vertical rotary air blast (RAB) methods on a 3x5 meter grid to a depth of 5-6 meters. Although these tests are not all-encompassing, comparisons of RAB intersections showed that the interval from 1-3 meters depth was often within 10% of the RAB interval from 3-5 meters depth and could be higher or lower. Comparisons of RAB assays with intersections in deeper exploration holes generally agreed within 20%, with RAB assays again both higher and lower than the exploration hole assays. The details of this work will be discussed in a later section, but indications are that supergene leaching, if present, is not significant. On a local scale, mineralization is either weakly leached or strongly enriched, resulting in a greater variability of grades within 5-15 meters of the surface. In Western Australian mining districts where supergene leaching has been documented, surface workings are often random and small, even though numerous. In areas where supergene leaching is absent or minor, old surface workings tend to be very large such as Wiluna. The conclusion is that near-surface depletion of gold in the East and West Lode pit areas is likely to be minor. The extent of depletion in other zones within the Wiluna Joint Venture remains to be determined.

The oxidized mineralization is covered by a discontinuous deposit of surface alluvial material and severely weathered bedrock. It is both soft and hard and nearly always contains 1-2 gm Au over and outside the surface projection of deeper ore intersections. It is not known to what extent gold in the surficial layer is due to sheet-flood contamination from adjacent tailings (including sulfide), but the first meter has been excluded from all ore reserve calculations. Due to highly suspect mineralogy, this material should not be milled without blending with deeper material. Water-soluble chlorides and sulfates may form up to 2% of near-surface material and decrease in abundance with depth.

STYLE OF MINERALIZATION

Accessible exposures of mineralization at right angles to the interpreted strike of the ore zones do not exist and interpretations of continuity have been assembled from observations along pit walls, diamond drill core, study of various plans of underground workings, and exploration drill data. The lack of well-developed exposures of mineralization for careful geologic study is perhaps the single weakness in the interpretations of continuity of mineralization.

The style of the mineralization, defined by a 1.0 gm Au cutoff, reflects a hypogene geometry which has been modified to an unknown extent by supergene processes. It is obvious from a quick look at the open cuts, maps of underground workings, and maps showing the distribution of gold mineralization in Appendices C, E, and F that mineralization in the East and West Lode areas occurs in elongate, north-striking zones which are relatively narrow in proportion to their length. Ore zones drawn at a 1.0 gm Au cutoff are continuous along strike, unless interrupted by pre-1919 stopes, for 700 meters in the East Lode, 400 meters in the West Lode, and 300 meters in the East Lode North Extension. Multiple ore zones are present at right angles to the strike which split from and rejoin the overall north-south trend in a braided pattern. This pattern is particularly well developed in the East Lode pit where the average true width of individual splits varies from 20 meters in the central portion of the pit to 7 meters at each end. Average widths in the other reserve areas are under 10 meters.

The strike and dip of the mineralization at a 1.0 gm Au cutoff was so predictable that not a single interspaced hole drilled to measure proven ore failed to cut mineralization; most cut mineralization where predicted and generally within the anticipated grade range. Therefore a high degree of confidence exists in the interpretations of ore zone geometry along strike and down dip as shown on all plans and sections appended to this report. Confidence in ore zone geometry is greatest in the central part of the East Lode pit from 9,625-9,750N where the ore zones are thickest. Confidence, even in areas of proven mineralization, is somewhat less in the peripheral areas of all ore zones, in the West Lode pit area where backfilled stopes could not be penetrated by drilling, and for all thin or low grade ore zones.

All ore zones have assay walls and mineralization is largely disseminated. The highest grades occur within the central portion of the ore zones and decline outward to the 1.0 gm Au cutoff and beyond. Assay graphs often approximate a bell-shaped curve, with thicker ore zones having several high grade peaks. Loss of high grade values, which carry a disproportionately high amount of the metal in the deposit, by dilution with adjacent waste will not be a problem during mining.

Although higher grade mineralization generally occurs within and not along the edge of ore zones, the distribution of these values is not easily

correlated between drill holes by grade contours. Some continuity of higher grade values appears present along strike and down dip in the central part of the East Lode pit area as shown on Figure 4 where ore zones are somewhat thicker than elsewhere. Here, contour lines at a 5 gm Au cutoff show good continuity in plan and section and are parallel to the 1 gm Au contour as long as values are averaged across 2 or 4 meter assay intervals. Presumably, a moving average would generate even better continuity. Contours drawn at intermediate and higher values are far more erratic than the 1 and 5 gm Au contours on Figure 4. Close-spaced RAB drilling described below in more detail also indicates that high grade zones defined at certain but not all cutoff values exhibit good continuity. This type of continuity should facilitate selective mining of higher and lower grade zones in some areas and thereby enhance grade control procedures.

PREVIOUS MINING

Mining operations in the oxidized zone ceased about 1919. The large open cuts in the south lobe of the East Lode pit were developed as glory holes with ore being removed probably through the 100 and 150 ft. levels. The north lobe of the East Lode pit may not have been mined to the surface and could be floored by a collapsed crown pillar. Portions of this pillar might contain high grade mineralization, but because its nature is uncertain and it could not be penetrated by drilling, it is not included in the ore reserve calculation. Formation of the West Lode pit, which might be similar to the north lobe of the East Lode pit, is unclear because it is almost entirely filled with rubbish and waste.

For purposes of ore reserve calculations I have assumed relatively large glory holes which narrow at depth to connect with deeper workings. Rib or crown pillars (intact or collapsed) which may be present in the glory holes were excluded from the ore reserve because they could not be sampled and their volume was uncertain. The extent to which stope sizes have been overestimated, laterally or at depth, is unclear. Dewatering of the East Lode pit has indicated that initial estimates of the near-surface cross-section area of the glory holes were reasonably accurate, but that assumed extensions of these stopes below about 30 meters may be too large.

Because of the importance of local high grade zones to the ore reserve, considerable effort and expense were made to intersect ore zones directly below the glory holes and pillars. These efforts were not particularly successful due to back-filled stopes which collapsed on angle holes, cracks along which post-mine rock failure had occurred and in some cases along which movement occurred during drilling, and geometry which required long, low angle holes that also experienced caving problems. Workings were mostly open in the East Lode and back-filled in the West Lode. It is unlikely that any undetected workings exist within the oxide zone which would significantly reduce the oxide reserve estimate. Dewatering to the 140 ft. level should

nevertheless be completed and accessible workings inspected for large unrecorded stopes which might endanger open pit operations or cause significant loss of ore by collapse into deeper workings.

DRILLING AND SAMPLING

From 1981 to the present 21,085 meters were drilled in reverse circulation holes, 6,315 meters in air core holes, and 1,763 meters in diamond drill holes. The drill grid was established by theodolite using the Wiluna shaft as 10,000N, 10,000E. Hole spacing used for proven ore was 12.5 meters along east-west cross sections at 25 meter north-south intervals. The grid varied where access was a problem and interspaced holes were drilled to confirm the grade and continuity of unusually high grade zones. Two 1:2,500 scale drill hole location maps are included in Appendix B. Most holes were inclined 60° below horizontal and drilled on a due west bearing. Holes averaged 40-50 meters long unless lost due to water or workings at more shallow depths. Collar elevations were not surveyed because for any given reserve area elevation does not vary by more than 1/2 meter. No down-the-hole directional surveys were made, but several holes intersected workings within 1-2 meters of where shown on old underground maps so deviation of drill holes is not considered significant.

Reverse circulation utilized both air hammer or rotary bits on a double-wall drill stem with sample intake ports one meter behind the bit. Bit diameter was 5.5 inches. Several contractors were used and equipment capabilities varied, but the technique was generally able to drill 50-60 meter holes. Sampling of the first meter of depth was crude and involved collection of material accumulated around the collar. Recovery of sample for the second meter of depth was variable depending on the amount of sample which escaped to the surface between the hole walls and drill rods. Thereafter sufficient back pressure was established to direct virtually all the sample to the intake ports and up through the outer ring of the double-wall stem. Sample material moved from the drill stem through a hose to a collection drum, and was then reduced in a Jones splitter to approximately 5 lbs., and stored in canvas bags for assay. All reverse circulation samples were 1 meter long.

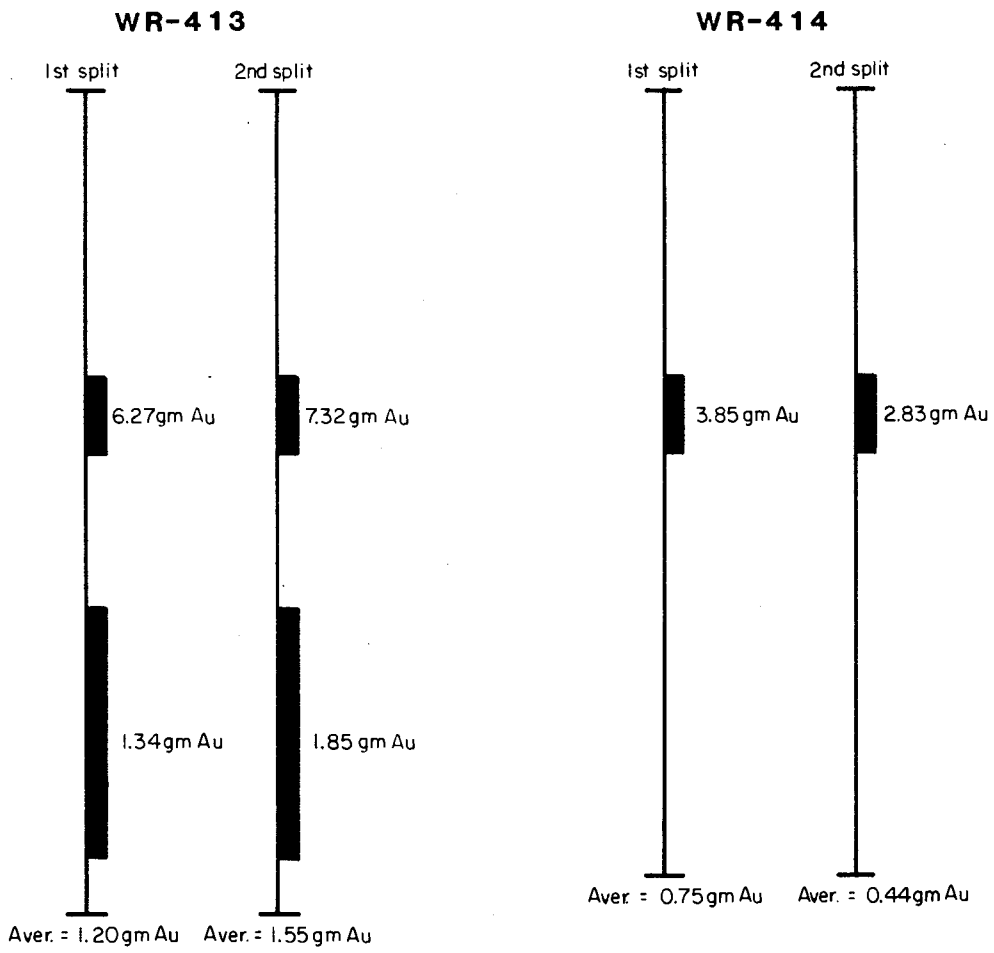
The cursory check on the reproducibility of splitting reverse circulation drill cuttings to a 5 lb. assay sample was made by taking duplicate splits of 1 meter intervals from holes R-311, 412, 413, and 414. The relative deviation of the assays for all sample intervals (135) was 12%. Relative deviation is the average of the deviations of individual samples from the population mean expressed in percent. The relative deviation for 4 separate ore zones (1 gm Au cutoff over minimum 4 meter length) was 10%. Subtracting the relative deviation caused by assaying suggests that on-site splitting

of the sample may introduce an additional 4% variation beyond the 6% caused by the assay procedure. Insufficient check work of this type was conducted to provide a reliable statistical base or to determine optimum sample size. Although grade variation was possibly greater than desired, the position and length of +1.0 gm Au intersections were identical for both high and low grade intervals as shown on Figure 5 which gives considerable intuitive confidence to the reliability of splitting techniques. Further, the 4 holes were drilled in outlying portions of the ore reserve where the distribution of values is visibly less predictable, so the relative deviations noted may be above average for the deposit as a whole.

Sample recovery for reverse circulation was generally 90% or above. No attempt was made to measure precise recoveries because of locally significant variations in specific gravity. Problems were encountered in collecting a fully representative sample for the first 1-2 meters of depth as noted above. Collection problems were also encountered when the drill neared the water table and sticky sample material built up on the collection drum. Sample recoveries were occasionally low in what were probably clay-rich zones below the water table, although this was an infrequent problem. Total sample loss was also incurred in the one meter interval below open stopes and partial loss usually continued for an additional meter before the rods above the sample intake port could achieve an effective seal against the walls of the hole.

The advantage of reverse circulation techniques over single-wall air hammer drilling is that sample contamination by abrasion and washing of intervals higher in the hole is minimized. Some contamination is still possible from the uncased one meter interval above the bit through which cuttings must travel before entering the sample ports. In a rock of uniform hardness contamination would be equal throughout with a net zero effect on average grade. However, if high grade zones occur in relatively soft or broken rock which is more susceptible to abrasion or washing than adjacent lower grade zones, the net effect may result in an upgrading of the actual gold content of the one meter interval below the high grade zone.

A visual inspection of all cross sections revealed that in reverse circulation holes the grade of the 1 meter interval immediately below the highest grade 1 meter interval in an ore zone is higher than the grade of the 1 meter interval immediately above the highest grade interval about 20% more frequently than in diamond drill or air core holes where the sample enters the drill stem immediately. An attempt to quantify this effect by comparing assays of reverse circulation holes with twin diamond or air core holes (1-5 meter collar separation) was unsuccessful. It appears that if contamination of reverse circulation samples has occurred the effect is obscured by natural variations of grade along strike or dip and in splitting and assaying procedures. Measurement of contamination by weight of sample recovered is not possible due to significant variations in specific gravity.



HOLE WR-412 : no intersections of 1 gm Au over 4m
1st split average for hole = 0.29 gm Au
2nd split average for hole = 0.25 gm Au

HOLE WR-311 1st split 17m = 4.69 gm Au *
2nd split 17m = 4.94 gm Au *
1st split entire hole = 3.75 gm Au
2nd split entire hole = 3.94 gm Au

* 17 1meter samples selected from a 29meter intersection of +1.0 gm Au

COMPARISON OF ASSAYS FROM DUPLICATE CUTS OF 1 METER RCD SAMPLES

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Reverse circulation techniques were used both above and below the water table. Washing of the wall of the hole below the water table can be a severe problem and is commonly eliminated by more costly diamond drilling. Indications from early work at Wiluna were that the rock was fairly competent below about 10 meters depth and that contamination would not be a problem. This was largely confirmed in 1983 when 4 diamond drill twins of reverse circulation holes were completed. The results, shown on Figure 6, suggest contamination is not significant.

It is also possible that contamination has operated to downgrade assays, particularly in the first 10 meters where surface weathering has generated locally abundant clay in barren as well as mineralized rock. Further, the apparent downward drag of high gold values in reverse circulation holes may partly be due to supergene enrichment of gold on the footwall side of the shear zones by downward-moving meteoric water. The conclusion is that, if contamination has occurred, the effect has not been systematic or severe enough to be quantified, and the impact on ore reserve estimates is thought to be minimal.

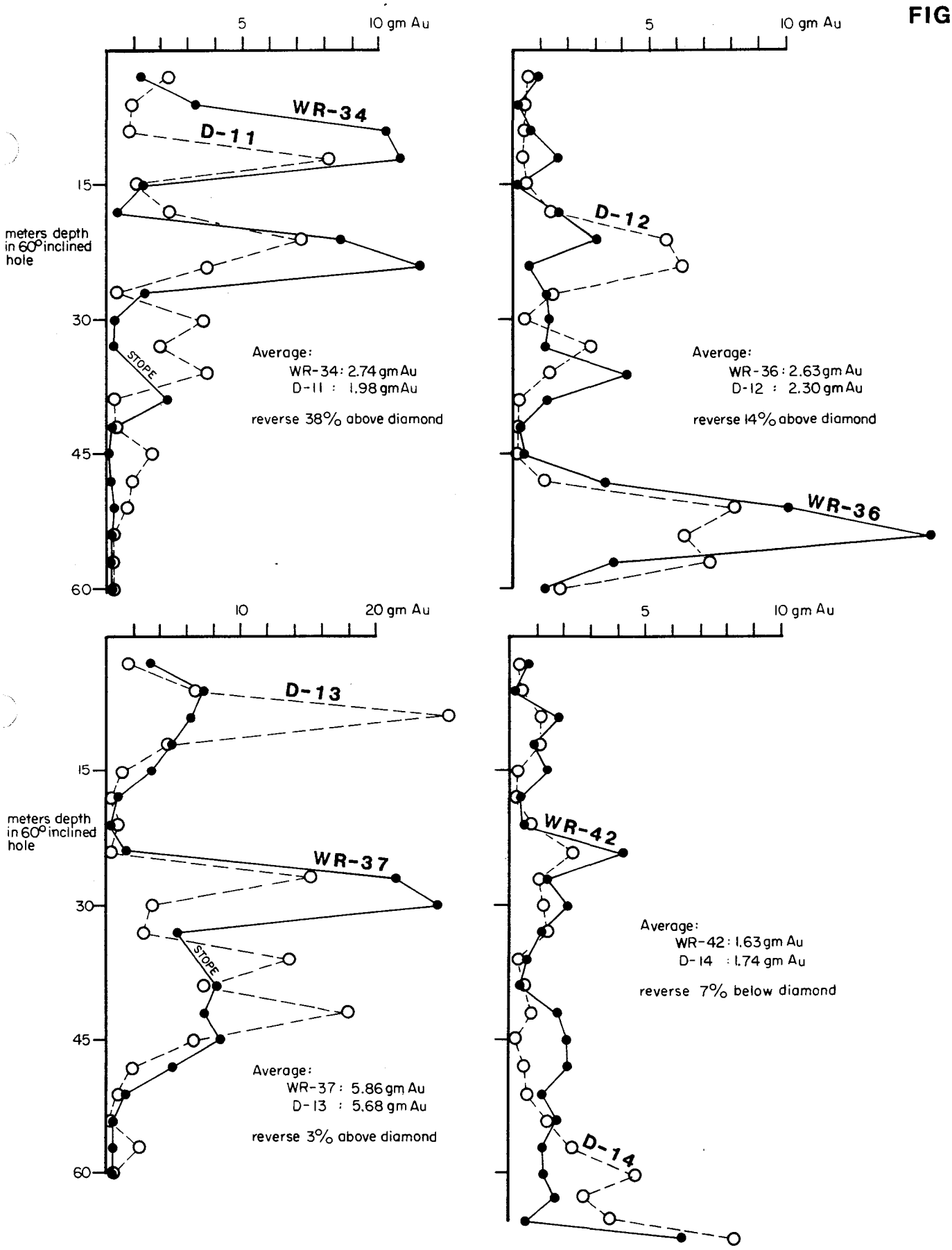
Diamond drilling was done 1) in the early stages of the project when deeper mineralization was considered a target (1981), 2) to twin reverse circulation holes as a check for contamination, continuity, and to gather metallurgical samples (1983, 1985), and 3) to intersect ore zones where low angle capability was required. Core sizes used were HQ, NQ, and BQ. Core recoveries mostly exceeded 97% except in the 1985 work when average recoveries were 60-70%. Recovery in the 1985 work was generally lower in the nearsurface severely weathered zones averaging 50% from 0-10 meters and 69% below 10 meters hole depth. Although 90% of the ore grade intervals were drilled below 10 meters hole depth, recoveries were still lower in higher grade zones averaging 77% in 1-2 gm Au rock and 61% in rock averaging over 2 gm Au, presumably due to stronger shearing in the higher grade zones. Prior to 1985 core was split for assay; core drilled in 1985 was crushed with a split taken of the total core reject for assay. All core from +1 gm Au zones has since been consumed for metallurgical testing.

Air core drilling techniques were utilized for portions of the project when suitable reverse circulation contractors were unavailable, mostly in 1984. Although, effective in clay-rich zones the 3.5 inch bit was unable to cut harder, quartz-rich zones and many air core holes were bottomed above target depth. Overall, air core techniques were not suitable for East and West Lode mineralization.

ASSAYING

All reverse circulation and air core holes were assayed on 1 meter intervals; diamond drill core assay intervals varied. Assays were run on

FIGURE 6



COMPARISON OF TWIN REVERSE CIRCULATION AND DIAMOND DRILL HOLE ASSAYS

WILUNA PROJECT, W.A.

(assays are 3 meter averages of 1 meter assay intervals)

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a 50 gm sample by fire assay fusion followed by acid dissolution of the fire assay bead and readout by atom absorption. Detection limit by this technique was 0.005 gm Au.

Routine assaying was by Analytical Services who ran numerous duplicates on resplit pulp. Their precision on +1.0 gm Au samples, expressed as the relative deviation, was 6.3%. Extensive check work on +1.0 gm Au sample pulps by an independent laboratory (SGS Australia) averaged 1.1% lower than Analytical Services. Since the difference between the two laboratories was substantially less than the routine precision of either laboratory, the difference is not significant and the Analytical Services work is taken as accurate. Check analyses of +1.0 gm assays were also run on a resplit of coarse reject material. The relative deviation was 7.5% for 24 samples, virtually identical to the 6.3% internal precision achieved by Analytical Services from checking pulp splits. Although extensive statistical analysis was not undertaken, the relative deviation does not vary either at higher or lower levels of gold, or as a function of the duplicate sample cut. These findings tend to confirm limited petrographic work that coarse gold is not abundant.

One problem arose in 1984 when it was found that Analytical Services has accidentally switched identification on certain groups of 8 or 16 samples which had been fired and were waiting for cupelling. The problem was recognized when it was noted that certain ore zones with good continuity along and between cross sections developed abrupt discontinuities in the assay pattern from later interspaced drilling. Check work involving some 1500 samples was completed in January 1985 and mechanical procedures at Analytical Services were modified. It is unlikely that any serious problems remain within the ore zones as drawn on the accompanying sections.

A second source of uncertainty not believed significant arose in the reporting of assays. In perhaps 5-10 holes certain assay values appeared with improbably high frequency. A typical example was R-106 on section 9,850N in the East Lode pit area. From 20-27 meters depth 1 meter assays were 1.6, 1.6, 2.1, 2.8, 2.1, and 2.8 gm Au reflecting a clear preference for certain numbers. This was discussed with the laboratory manager who argued randomness, but such non-random reporting naturally disappeared thereafter.

Assaying during the early 1981 drilling was by atomic absorption without fire assay. These samples were all reassayed by combined fire-AA and the latter values plotted on the sections. All 1 meter values plotted on sections are the first assay made of an interval; average values of several assays were not plotted and only Analytical Services values were used where values from several labs were available.

ORE RESERVE

Ore reserves were calculated using a manual cross section method. Proven and probable reserves are summarized on Table 1 at the front of this report and occur in four separate areas including the East Lode pit, East Lode Main Shaft, East Lode North Extension, and West Lode pit (Fig. 3). Cross sections and detailed reserve tables for each area are found in Appendices C-F of this report. This section reviews the various parameters and method used to calculate the ore reserve.

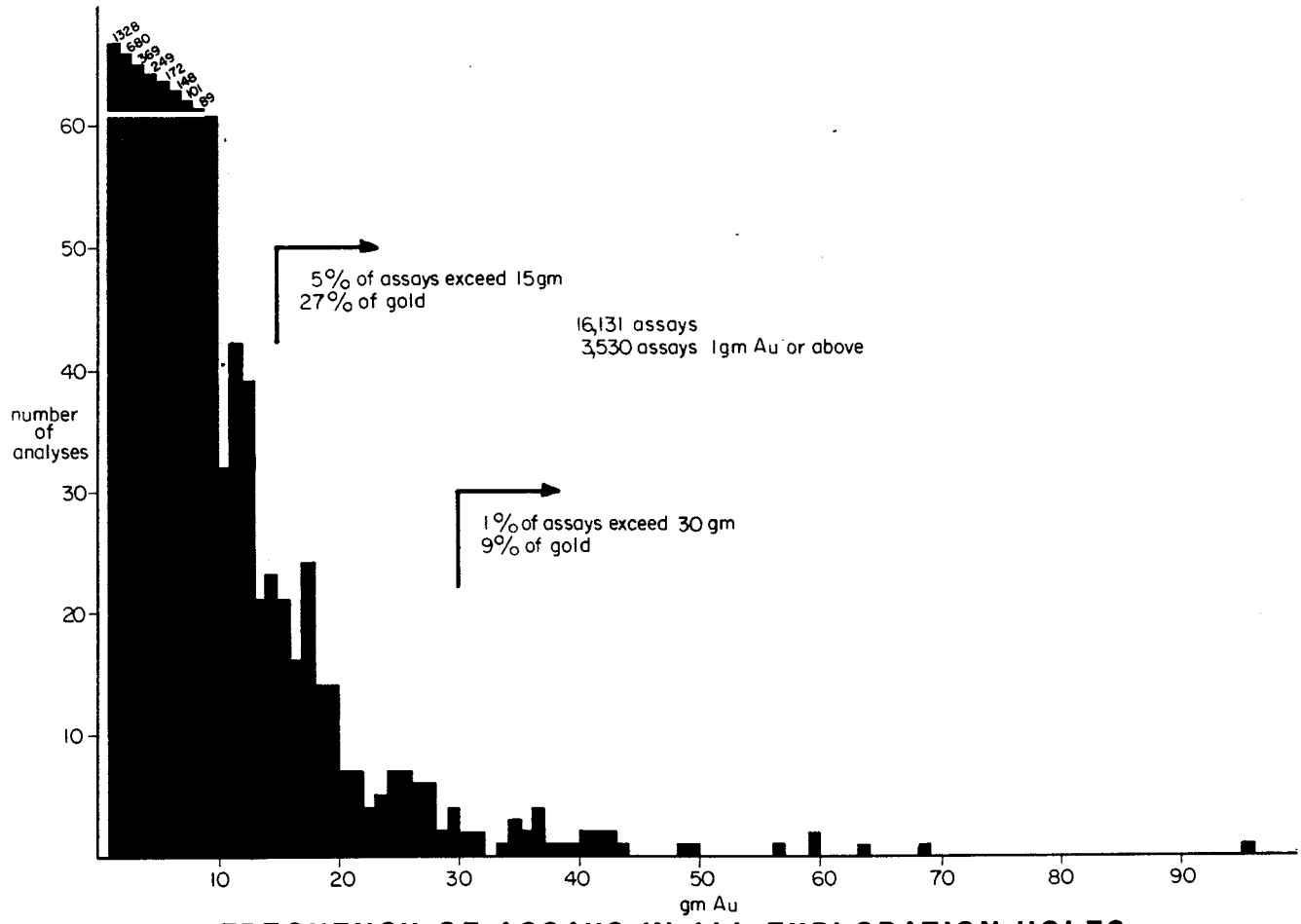
Assays. All assays were used at face value for the reserve calculations. Frequency plots on Figure 7 show gold values are lognormally distributed, both in exploration drill samples and in RAB grid assays, and an argument can be made that high gold values should be cut. The decision not to cut high grade assays was based on the lack of coarse gold in the deposit, the tendency for high values to cluster in adjacent 1 meter intervals in a drill hole and within certain areas of the orebodies, an assessment of the continuity of high grade zones (Fig. 4), and a study of the occurrence of each assay over 20 gm Au in the deposit. Further, the outlying assays on Figure 7 are not as anomalous as they appear, in that they are part of an originally more continuous frequency distribution which existed prior to the glory hole mining of the high grade oxides.

Due to a lack of experience, most new open pit gold mines in Western Australia had cut high assays in exploration samples used for ore reserve calculations; thresholds and arithmetic varied widely. Some of the mines had such spatially random or high values that some cutting of assays was clearly justified. Most mines have not operated long enough to test the validity of cutting assays; however, several of those which did cut assays are now reporting that more gold is being recovered than was predicted in the reserve estimate. Many which cut high exploration samples are not now cutting ore control assays.

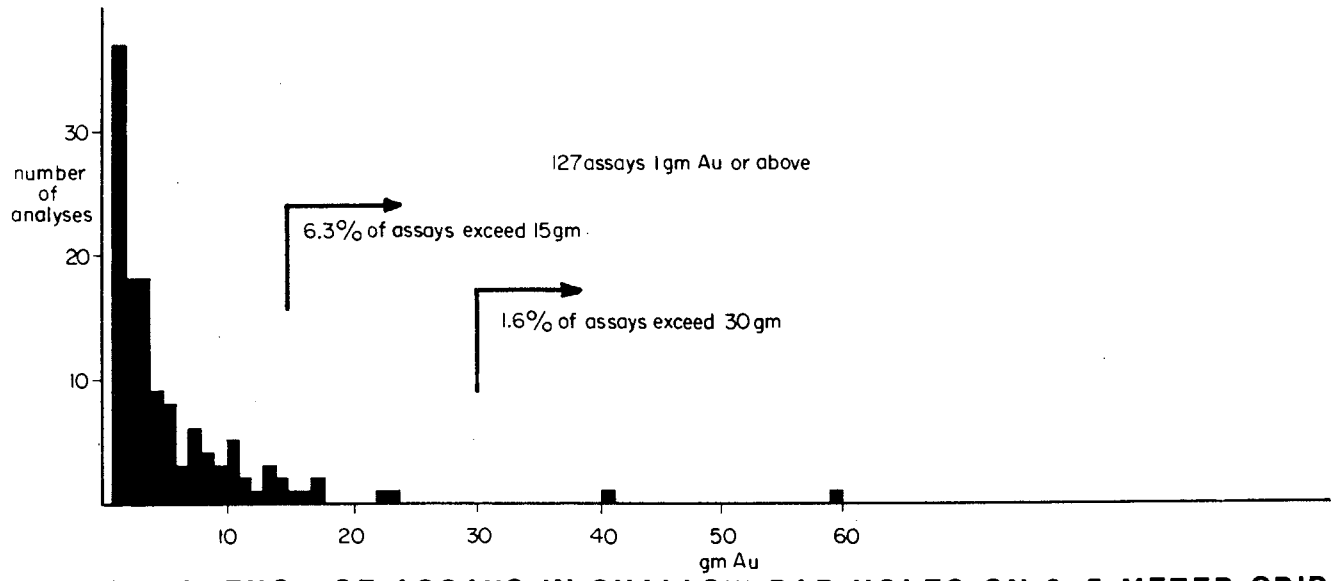
Assays of pre-1919 vintage on maps of the underground workings were not used in the reserve calculations due to considerable imprecision below 2-3 gm Au. The underground assays were used to reconstruct the position of ore zones where drill data were unavailable and influenced interpretations of continuity, particularly in the West Lode.

Cutoff Grade. Cutoff grade for reserve calculation was 1.00 gm Au. Operating breakeven grade without amortization varies from roughly 1.35-1.60 gm Au at 90% recovery depending on size of the operation and gold price. However, material in the 1-1.5 gm Au range would recover milling cost plus enough of the mining cost incurred for material which must be moved to cost the operation less than if it were taken to the waste dump. Further, the continuity of lower grade ore zones was improved by using 1.0 gm Au rather than some higher cutoff value. Most of the new open pit gold mines in

FIGURE 7



FREQUENCY OF ASSAYS IN ALL EXPLORATION HOLES
EAST LODE AND WEST LODE AREAS



FREQUENCY OF ASSAYS IN SHALLOW RAB HOLES ON 3x5 METER GRID
EAST LODE AND WEST LODE AREAS

WILUNA PROJECT, W.A.

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Western Australia use cutoffs in the vicinity of 1.0 gm Au.

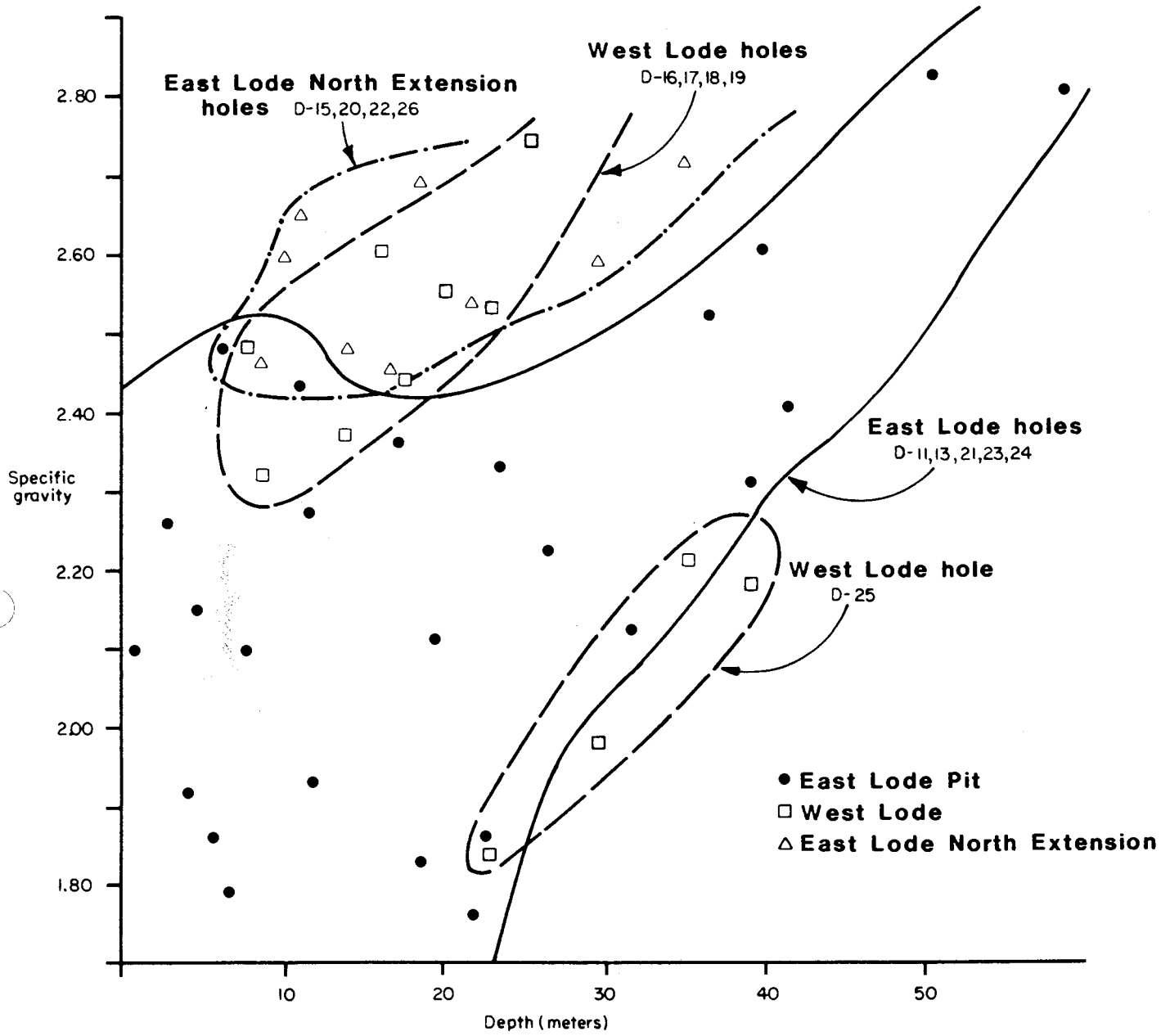
Specific Gravity. Specific gravity was measured on 3-4 inch pieces of diamond drill core which had dried naturally to ambient humidity, but which were not oven dried for the measurement. Values used for reserve calculations were 2.10 for oxidized ore, 2.50 for transition ore, and 2.80 for waste. Figure 8 shows that specific gravity generally increases with increasing depth. Within the zone of complete oxidation it varies from 1.752.70 regardless of depth and there may be significant geographic variations. This extreme scatter is likely due to strong weathering and makes an average value, regardless of the number of measurements, meaningless. The numerical average of East Lode pit samples was 2.26, but measurements were run on intact (solid) pieces of core. It is likely that zones of strong clay where no intact core was available may have had relatively lower specific gravities and that the numerical average is biased toward higher values. Additional measurements on drill core or pyncnometer measurements on reverse circulation cuttings would not have resolved uncertainties so a lower value of 2.1 was arbitrarily chosen based on what intuitively seemed geologically reasonable. The extent to which zones of extremely low or high specific gravities will constitute blocks of rock large and uniform enough to yield several days of ore for the mill is unknown. The impact of a low specific gravity, high clay ore on the mill might be sufficiently troublesome to justify either stockpiles by ore type (in addition to grade stockpiles) at the primary crusher or several faces of ore active simultaneously, or both. An average specific gravity was chosen to simplify ore reserve calculations, but wide variations may occur from place to place on a large enough scale to complicate mining and milling and the mine plan should incorporate flexibility to deal with these variations.

Specific gravity of transition ore was not accurately measured, but an average of 2.50 seemed reasonable being in the upper range of oxidized ore and close to that of clean sulfide ore. Specific gravity of sulfide ore was not measured. Specific gravity of fresh barren basalt (waste) was about 2.80. Much of the waste mined will be relatively lightweight oxidized material in the 0.1-1.0 gm Au range, so it is certain that the specific gravity of waste has been somewhat overestimated.

Pit Slope. A 45° pit slope was designed to extract only proven oxide ore and has not been engineered for haul roads. If underlying transition or sulfide mineralization is mined the pit will have to be wider or steeper pit slopes used. Pit slopes in other open pit gold mines in Western Australia at 45-60° have experienced numerous small and a few significant slope failures, particularly in rocks with a high talc content.

The Wiluna rocks do not contain abundant talc. Furthermore, walls of the two glory holes in the East Lode pit have been stable for about 70 years at angles up to 75° for depths of 35 meters and a recent geotechnical

FIGURE 8



SPECIFIC GRAVITY MEASUREMENTS OF DIAMOND DRILL CORE

WILUNA PROJECT, W.A.

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study suggests that pit slopes steeper than 45° can be used at Wiluna. Whatever pit slope is used, continuous careful geologic mapping should be required.

Mining Width. A number of Western Australia open pit gold operations mine to a 0.8 meter width, the minimum practical width of digging buckets, but this is only done in free-digging ore (does not have to be ripped or blasted). Most of the oxide ore at Wiluna will require blasting and the resulting dilution will require a wider minimum mining width for adequate grade control. Therefore, for ore reserve calculations, a minimum horizontal mining width of 3 meters was used.

A 3 meter wide ore zone (in plan) is the geometric equivalent of a 4 meter long intersection drilled against the dip of a structure inclined at 75°. Therefore, the grade of the 3 meter horizontal width is determined by 4 assays (all assays on one meter intervals). Although a single high grade assay could alone carry a 4 meter width, the strike or dip continuity of a single assay is highly subjective in the absence of an observed ore control. Therefore, a modest additional requirement was that any ore zone must have at least 2 assays at or above 1 gm Au to be included in the ore reserve. Where 2 assays carried the entire 4 meter drill hole length, the ore zone boundary was expanded into mineralization averaging less than 1.0 gm Au in order to accumulate a minimum mining width. If a choice was available, the zone was expanded in the direction of the higher of the less than 1.0 gm Au assays. Internal zones of waste less than 3 meters wide were included in the ore zones and if inclusion of waste reduced the adjacent ore grade rock to less than 1 gm Au the aggregate width was excluded from the reserve.

The result of the minimum mining width parameter is that the appearance of the ore reserve sections appended to this report differs somewhat from geologic sections prepared by myself and others which also contain several long ore grade zones 1-2 meters thick. Selective mining may recover some ore grade material from these narrow zones, but the impact on the overall reserve will not be significant.

Measurement and Calculation of Reserve. Ore reserves were calculated on 1:500 scale east-west cross sections spaced at 25 meter north-south intervals. Additional cross sections are included in the appendices for interspaced drill holes. Holes in ore were included in the reserve calculation regardless of location. For twinned holes (less than 4 meters separation) the average of both was used, if the drill technique was the same. Where reverse circulation holes were twinned by air core or diamond core, only the reverse circulation assays were used. All calculations exclude the first meter.

Reserve estimates involved calculation of ore grade intersections in drill holes followed by correlation of these intersections between adjacent drill holes on each section. Concurrently, level maps were constructed for each reserve area to assess the continuity of individual ore zones between

sections. These plans are included in the appendices at 1:1,000 scale. Ore zones are identified on all plans and sections by a capital letter inside a circle.

Ore blocks were constructed on 25 meter sections. Each block is bisected by an ore grade drill intersection and extends up and down the dip one-half the distance to an adjacent drill hole. Within 12.5 meters of a drill hole, ore was classified as proven and beyond that distance probable or possible (see Table 1 for definitions of ore classes). Most of the ore blocks are less than 12.5 meters in aggregate dip length. Ore blocks were also extended north and south of the section one-half the distance to an adjacent section where correlations on level maps indicated that continuity was present. Ore blocks do not mix ore types so the boundary between the oxidized zone and the transition zone limits many ore blocks.

The assay assigned to an ore block was the grade of the associated drill hole intersection. Ore intersections in holes drilled between the 25 meter cross sections were used in ore block assays by taking the arithmetic average of 1) the on-section and interspaced hole intersection as half of the ore block assay and 2) the on-section intersection on the 25 meter section as the other half.

The area of each ore block was measured by Mr. W. D. Gay of Asarco's Southwestern Exploration Department using a planimeter and dimensions recorded on the tables in the appendices for each ore reserve area. The tonnage of each ore block was reduced by the volume of underground workings within the block. No reserve block extends below a depth of 50 meters. Sulfide ore reserves were not tabulated.

Waste was tabulated at a uniform specific gravity of 2.80, whether bedrock or glory hole rubble, and was not reduced by the volume of underground workings, a very modest conservative step. The waste tabulation includes only that material removed to allow mining of proven oxide ore and was calculated for each cross section separately. Waste/transition ore cannot be determined until the economics of transition ore metallurgy are known.

All ore reserve tables distinguish between ore types and all blocks are classified by the confidence of the estimate (proven, probable, and possible). The definitions of each classification given on Table 1 follow the 1981 recommendations of the Australasian Institute of Mining and Metallurgy,

Because of the wide drill and section spacing in the Happy Jack, Bulletin, Essex, and Moonlight areas, tabulations of individual ore blocks were not made and individual sections are not included in this report. Up-to-date sections from these areas at 1:500 scale are on file in the Perth office of Asarco (Australia).

Dilution. The ore reserve on Table 1 does not include external dilution from mining. Addition of a 1 meter wide envelope adjacent to the 1.0 gm Au ore zone boundaries in the East Lode pit would add 239,000 tonnes averaging 0.59 gm Au, a 32% increase in tonnage and would change East Lode pit undiluted proven oxide ore from 744,000 tonnes at 4.16 gm Au to 983,000 tonnes at 3.27 gm Au. The effect in the other 3 reserve areas will be more severe where the grade of the mineralization drops more quickly outward from the center of the ore zones than in the East Lode.

The impact of dilution noted above can be significant, emphasizing that the design of the mine plan and mill should be compatible with the size of the ore zones. Overdesign may lead to excessive dilution both in areas where ore zones are relatively narrow and during production from near-surface zones where softer ore may permit operation at 25% or more above rated capacity.

Some visual control on dilution during mining should be possible because the ore zones are all shades of brown, red, yellow, or white in sharp contrast to barren rock which is dark green to black in the East and West Lode pit areas.

Mine Plan. This ore reserve study does not contain a mine plan. Nevertheless the estimates on Table 1 do constitute mineable ore given the parameters used in the study. The highest grade and widest ore zones with the greatest continuity located nearest the surface and with lowest waste/ore occur around section 9,650N in the East Lode pit area. Collectively sections 9,600-9,700N contain roughly 331,000 tonnes averaging 5.08 gm Au and, assuming rapid payback of invested capital is the primary objective of the project, this area is an obvious place to start mining.

Variability of Ore Reserve Estimate. Among sources of variation in the reserve estimate are 1) accuracy of sampling and assaying, 2) assumptions of continuity of ore in plan and section, and 3) extent to which high grade values should be used. The accuracy of sampling and assaying was discussed above. Assumptions of continuity were tested by drilling shallow, vertical rotary air blast (RAB) holes on a close-spaced grid along the surface projection of ore zones defined by exploration holes. The results of this work are summarized on Figure 9. Although the RAB grids were not always complete, the correlation between the surface projections of ore zones from exploration holes and the distribution of +1.0 gm Au defined by the RAB grid is reasonably good both in position and in grade.

Correlations are marginal between 9,575-9,600N in the East Lode pit area where ore zones appear to split and braid. Nevertheless, the average grade of RAB holes within the surface projection of the ore zones is generally close to that predicted for the ore block by the exploration hole, even though several RAB holes containing less than 1.0 gm Au were included in

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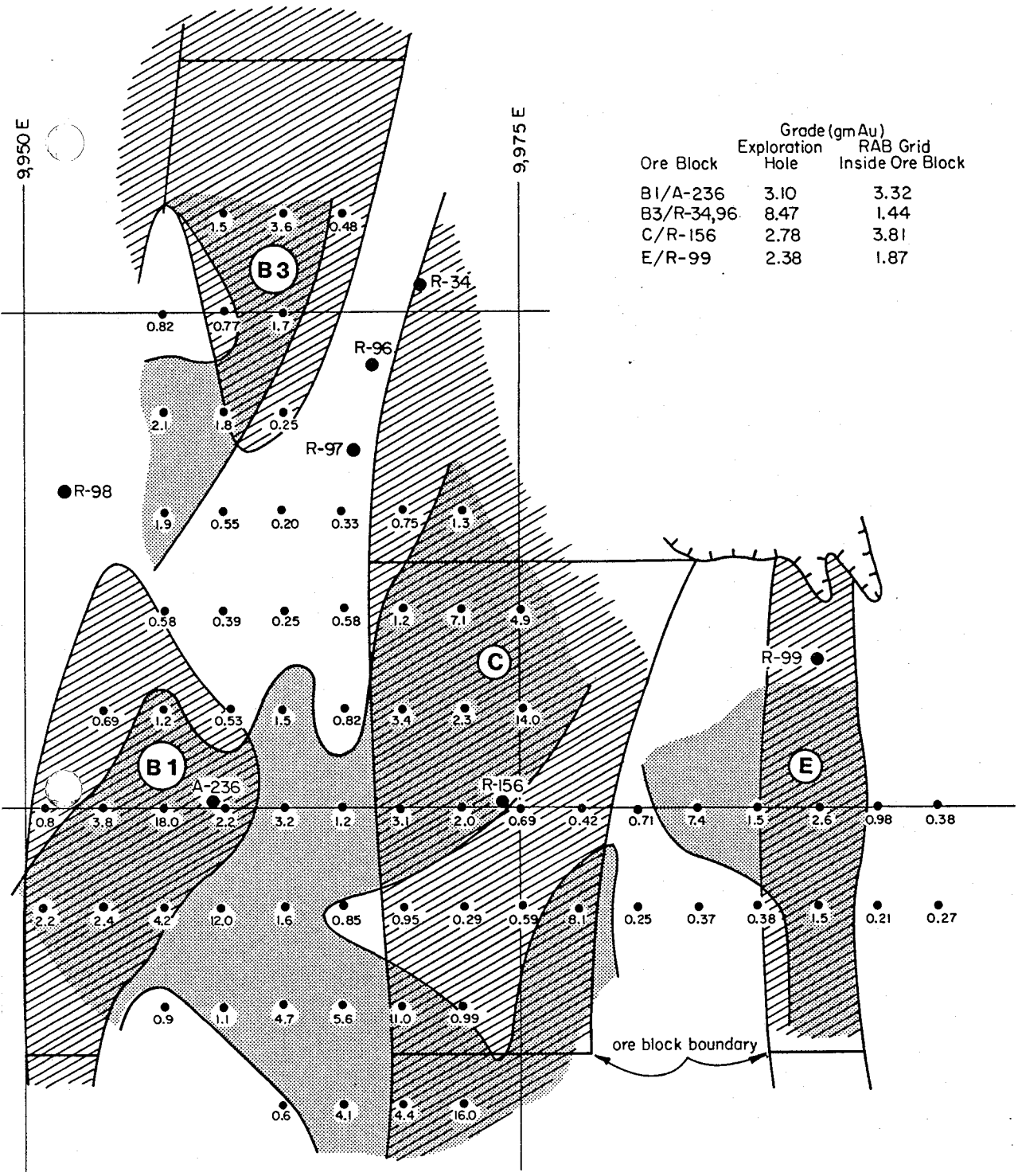
FIGURE 9



Ore Block	Grade (gm Au) Exploration Hole	RAB Grid Inside Ore Block
B1/A-236	3.10	3.32
B3/R-34,96	8.47	1.44
C/R-156	2.78	3.81
E/R-99	2.38	1.87

SURFACE PLAN ALONG SECTION 9575 N
EAST LODE PIT AREA

COMPARISON OF SURFACE POSITION OF ORE ZONES FROM RAB GRID AND EXPLORATION DRILL DATA

WILUNA PROJECT, W.A.

0 25 METERS

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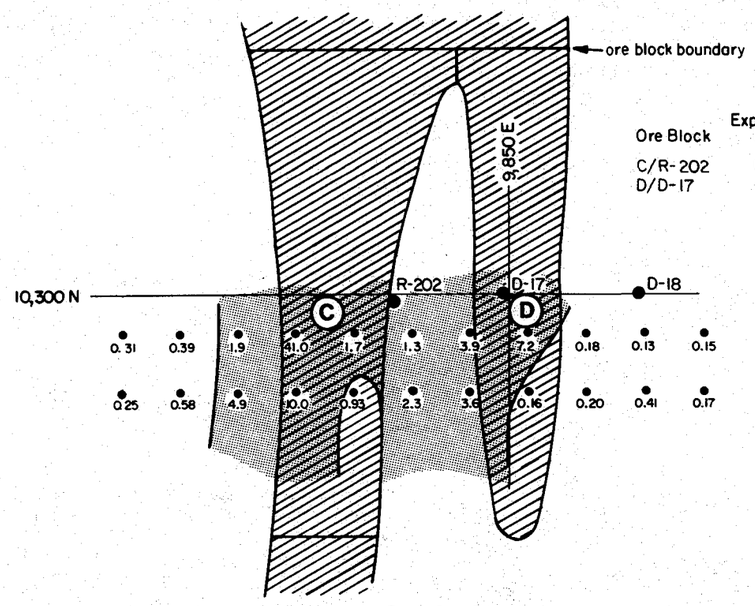
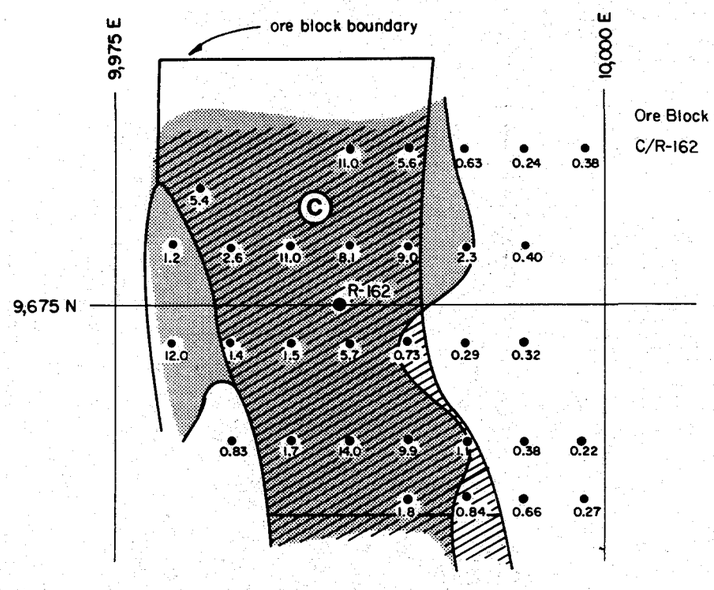
FIGURE 9



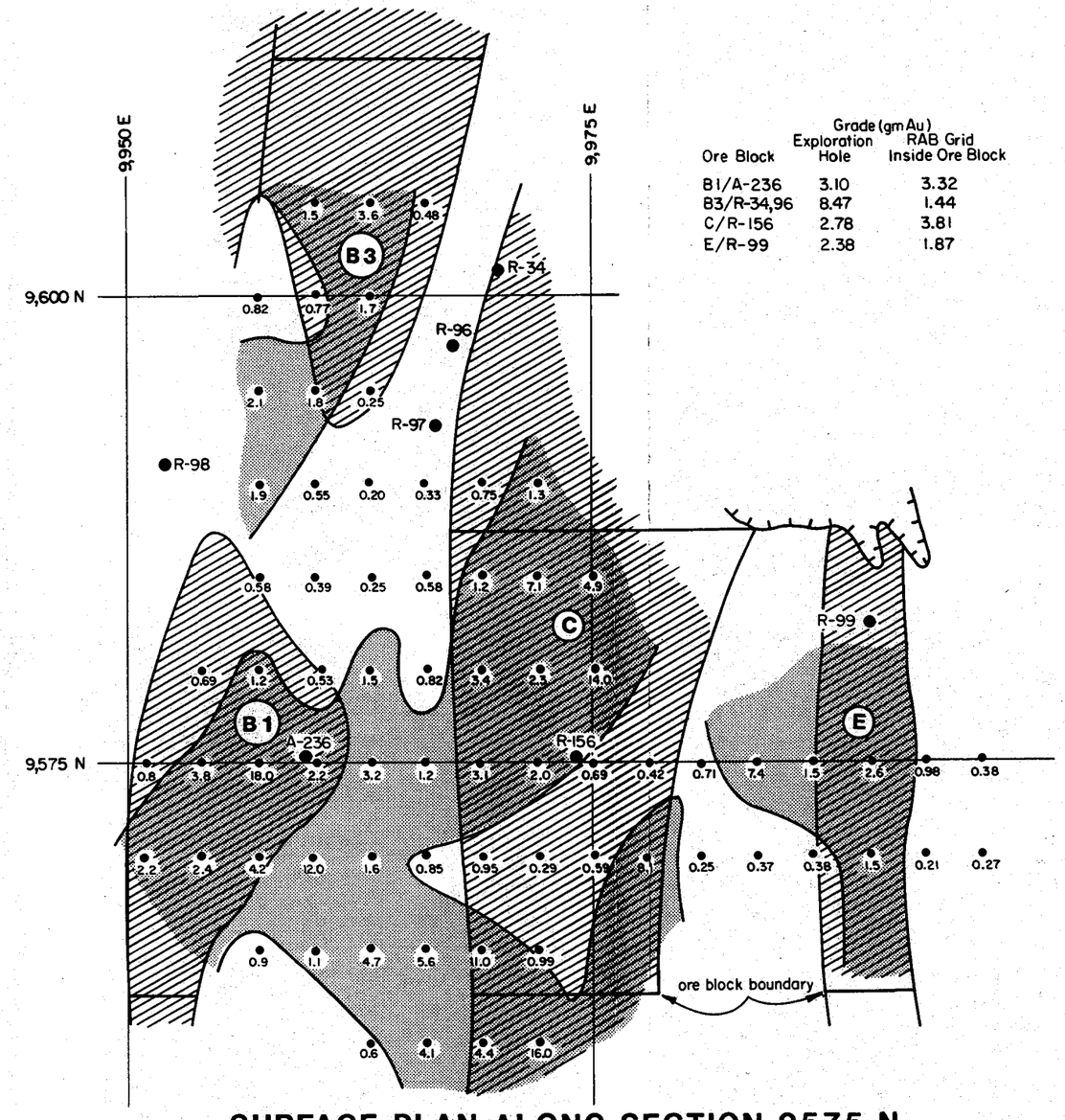
Ore Block	Grade (gm Au) Exploration Hole	RAB Grid Inside Ore Block
C/R-202	16.45	13.41
D/D-17	1.26	3.72

SURFACE PLAN ALONG SECTION 10,300 N
WEST LODE AREA



Ore Block	Grade (gm Au) Exploration Hole	RAB Grid Inside Ore Block
C/R-162	5.72	5.33

SURFACE PLAN ALONG SECTION 9675 N
EAST LODE PIT AREA



Ore Block	Grade (gm Au) Exploration Hole	RAB Grid Inside Ore Block
B1/A-236	3.10	3.32
B3/R-34,96	8.47	1.44
C/R-156	2.78	3.81
E/R-99	2.38	1.87

SURFACE PLAN ALONG SECTION 9575 N
EAST LODE PIT AREA

EXPLANATION

- 14.0 — Vertical RAB hole assay in gm Au for 1-3 meters depth (1-4 meters along 10,300N West Lode section)
- Ore Zones (1.0 gm Au cutoff) from RAB grid
- R-156 — Exploration drill hole
- D — Interpreted surface position of ore zone (1.0 gm Au cutoff) projected from ore reserve sections using exploration holes

COMPARISON OF SURFACE POSITION OF ORE ZONES FROM RAB GRID AND EXPLORATION DRILL DATA

WILUNA PROJECT, W.A.

0 — 25 METERS

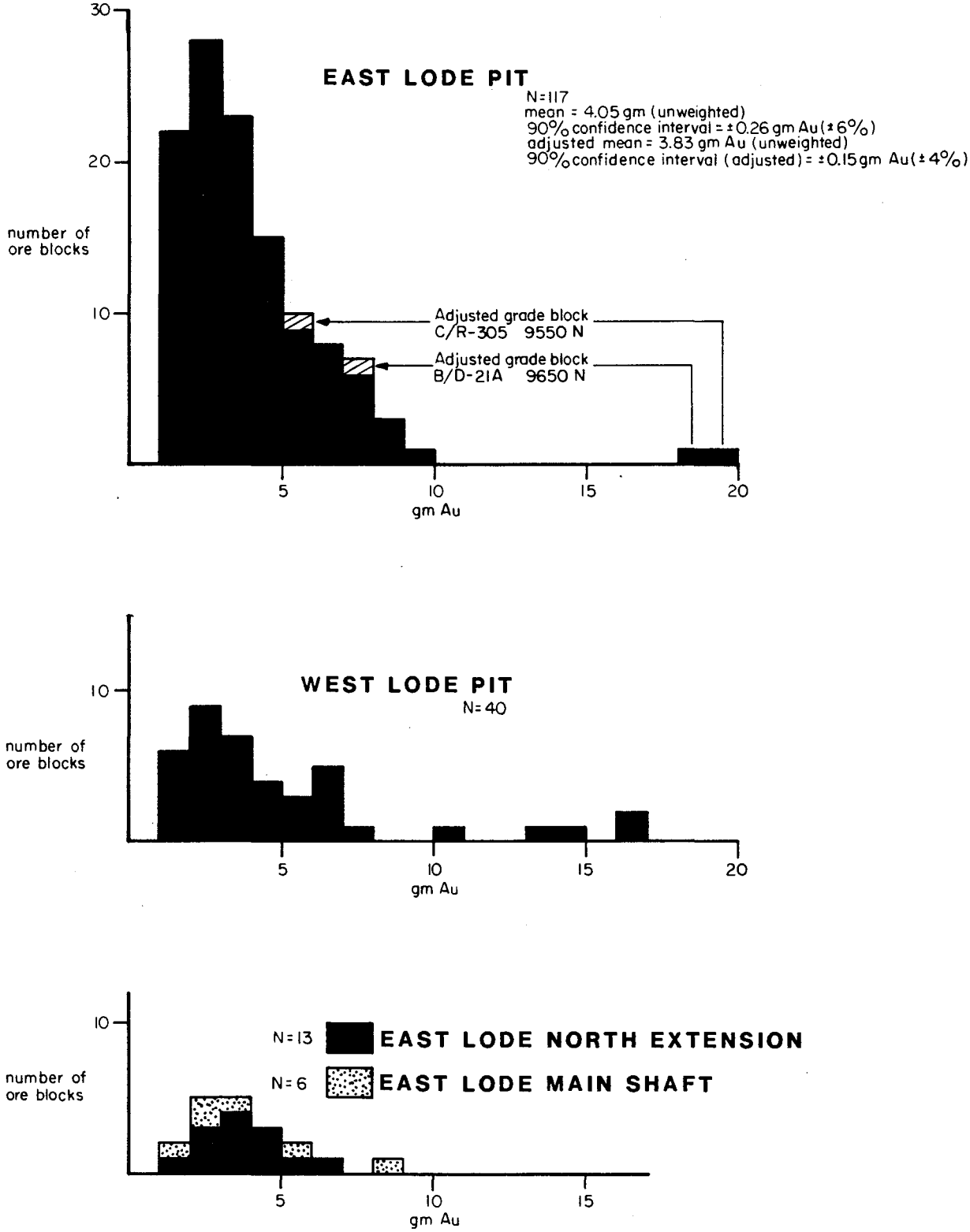
the average and some ore blocks were not completely covered by the RAB grid. Some of the zones of internal waste in ore block C/R-156 (C is the ore zone, R-156 is the exploration drill hole which penetrates the ore block) on Figure 9 are large enough to be mined separately reducing tonnes recovered, but increasing grade. In addition, there is a large volume of ore indicated by the RAB grid both east and west of ore block C/R-156 where exploration drilling had indicated waste. The net result is that the area around section 9,575N on Figure 9 will produce about the same or more tonnes of ore than predicted and more grams of gold. The area around section 9,600N (Fig. 9) at ore block B3/R-34,96 suggests near-surface mining will produce much lower grade material than predicted, although the ore block is incompletely drilled and tonnes of ore should be about the same as predicted or higher.

The exercise of checking the near-surface position and grade of ore reserve blocks by RAB grid drilling increases the confidence in predicted positions and grades of ore blocks defined by the exploration drilling. This exercise was not extensive in scope and further RAB grid drilling, perhaps using inclined holes, should be done prior to mining. Hopefully, grade control holes could also be used for blasting to hold down mining costs. Some variation in predicted position and grade of the various ore blocks will occur and the mine plan will have to be flexible enough to adjust for them.

Frequency distributions for proven oxide ore blocks are shown on Figure 10. Gold assays generally follow a lognormal distribution and are tedious to transform for estimates of error. However, the coefficient of variation for East Lode pit blocks is 0.84 and Koch and Link (in Statistical Analysis of Geological Data, 1971) suggest that where the coefficient of variation is below 1.2 untransformed values may be used to estimate the population mean. Using uncut assay values for all East Lode proven oxide ore blocks the unweighted mean is 4.05 gm Au. The error in this estimate is $\pm$0.26 gm Au or 6% at the 90% confidence interval. Two of the East Lode pit ore blocks contain assays which appear anomalously high in comparison to other ore blocks. Reduction of the grades of these two ore blocks using the average of assays from all adjacent blocks reduces the unweighted mean of all East Lode pit ore blocks by 0.23 gm Au, improving the error in the estimate of the mean to $\pm$0.15 gm Au or 4% at the 90% confidence interval.

Cutting the grades of the two outlying ore blocks from the East Lode reduces the error in the estimate, but the percent improvement in the accuracy of the estimate is only marginal. Further, a geological assessment of the two high grade ore blocks indicates they both occur in an area of numerous higher than average gold assays and it is reasonable, on an intuitive basis, to accept that some high grade ore blocks will be present. Additionally, the two high grade ore blocks are not as anomalous for the East Lode pit area as Figure 10 suggests, because the population represents that ore remaining after extraction of the relatively high grade oxide ore mined prior to 1919. The gap in the East Lode histogram from 10-18 gm Au overlaps the grade mined prior to 1919 and it is likely that the two high grade blocks were part of

FIGURE 10



FREQUENCY OF ASSAYS OF PROVEN OXIDE ORE BLOCKS

WILUNA PROJECT, W.A.

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an originally continuous population. The philosophy of whether or not to cut assays will always be a subject of debate, but evidence from the East Lode pit suggests the ore block assays can be accepted at face value without risk of serious error.

Frequency distribution plots of proven oxide ore in the other reserve areas are also shown on Figure 10. Statistical assessments of uncertainty in the mean ore grade estimate for these areas have not been attempted and, although the percent error in the estimate may be higher for these areas, inspection of Figure 10 suggests the error will not be serious and cutting of assays is not justified based on available data.

The uncertainties discussed above pertain to grade. Estimates of error in caculations of tonnage are more difficult to quantify. Criteria for proven oxide ore were quite rigorous and I do not anticipate the tonnage will change by more than 5% from that measured on the 1:500 scale sections. Any changes will be largely determined by the amount of dilution accepted during mining and variations in stope geometries within 50 meters of the surface. For the most part, stope outlines shown on the sections are thought to be maximum dimensions. Although additional ore may be mined in areas where excessively large stopes were assumed, some may be lost in the various larger and smaller stopes which are still open, either by dilution with waste or possibly by falling into deeper stopes below the limit of open pit mining, and no net loss or gain can be assumed.

Comparison With Other Reserve Methods. Visits to numerous recently developed open pit gold mines in Western Australia revealed that most used hand-drawn sections and the cross section method described above for ore reserve estimates and mine planning. Several companies have followed up the cross section work with various computer-generated reserve estimates and mine plans and new software packages have been designed for this work. The hand-drawn cross section measurements were said to check well with early mining experience, although few of the mines visited had been in operation more than a few years. Mined grades were mostly higher than predicted from cross-section estimates, perhaps due to excessive cutting of high assays.

Messrs. D. F. Skidmore and L. J. Jansen of Asarco's Southwestern Mining Department calculated East and West Lode reserves using an inverse distance squared technique with 3 meter ore blocks and the same general model of northstriking ore zones used for the cross section method. The inverse distance technique found 1,330,861 tonnes averaging 3.40 gm Au in contrast to the cross section technique which found 1,066,979 tonnes averaging 4.18 gm Au for proven oxide ore. The differences in grade and tonnage relate entirely to differences in the two techniques. Total grams in the reserve check to within 1.5%. No other independent reserve estimates of mineable ore have been made and none are believed necessary.

Additions to Reserves. Additions to reserve estimates on Table 1 may come from several areas. The glory hole pillars in the East Lode pit and collapsed crown pillars in both pits lie along strike of mineralization mined prior to 1919,and likely contain 20,000-100,000 tonnes averaging 4-10 gm Au. Additional transition ore may be mined in areas where the volume of workings below 30 meters depth was overestimated and below 50 meters depth where little drilling has been completed. Although this deeper material may have a relatively high sulfide content much of it lies directly below high grade oxide material. The potential might be 200,000 tonnes averaging 4-5 gm Au. If the surficial 1 meter thick layer of lateritic weathered and wash material can be treated it would add about 50,000 tonnes of 2 gm Au to reserves. Perhaps 100,000 tonnes of oxidized 1-3 gm Au material in the Main Shaft, North Extension, and northern end of the West Lode which is presently sub-marginal might be added at a higher gold price. These zones are shown on the plans and sections, but are excluded from the reserves.

A substantial increase to reserves will be made if the pre-1919 assays in the oxide zone shown on underground maps are accurate. Reserve calculations by D. F. Skidmore and L. J. Jansen using an inverse distance squared technique found that if underground assays were included with drill hole assays, grade was increased by 26% and tonnage increased by 29% above estimates obtained using only exploration data. If the impact on the cross-section technique is similar, proven plus probable oxide ore which now stands at 1,239,000 tonnes of 4.07 gm Au would be increased to 1,598,000 tonnes of 5.09 gm Au.

Uncertainties were also involved in estimates of mineralization in the Happy Jack, Bulletin, Essex, and Moonlight areas which were not generally drilled at closer than 50 meter section spacing or 25 meter drill hole spacing (see drill hole location map, Appendix B). Assumptions of continuity in these areas are based on the presence of numerous workings. However, several different rock types intersect the Happy Jack-Bulletin structure with possible disruption of continuity and metallurgical response is unknown. The uncertainty in the estimate of tonnes if ±50%. Happy Jack, Bulletin, and Essex grades are lower than other oxidized zones drilled to date so waste/ore using a 45° pit slope was used to limit the reserve shown on Table 1 to a maximum depth of 30 meters. However, if steeper pit slopes can be used and if higher gold prices are prevailing, the Happy Jack-Bulletin zone might be mined to the base of oxidation at about 50 meters adding another 500,000 tonnes.

Summarizing, it is possible that up to 1.3 million tonnes averaging 4 gm Au might be added to reserves listed on Table 1 from within the area shown on Figure 3. Most of this material will await identification as mining proceeds into areas not easily drilled, as underground workings are sampled (if accessible), as metallurgical work is completed on transition material, and future gold prices. The total of all proven, probable, possible, and inferred additions discussed in this report is 3.8 million tonnes and, if

dilution is added from outside the 1.0 gm Au ore zone boundaries, in excess of 4 million tonnes will be mined from the area of Figure 3. Discoveries of ore in one or more of the numerous identified prospects outside the area of Figure 3, but still within the Wiluna Joint Venture, would further increase reserves.

No attempt was made to drill or estimate clean sulfide reserves accessible in an open pit, and the economics of sulfide metallurgy have not been researched. Depending on the volume of old stopes an open pit sulfide reserve might be developed, but waste/ore will be high, and ore zones will not be as wide as in the oxidized zone. Low grade mineralization which might respond profitably to heap leach techniques has not been inventoried, but on the order of one-half to 1 million tonnes of oxidized material averaging 0.4-0.5 gm Au will otherwise be mined as waste.

Metallurgy. Metallurgical testing of oxidized mineralization (both weathered and oxide zones) is complete. Mr. A. R. Raihl believes parameters have been identified which allow response of the ore to be predicted within 20%. Sample material for the tests came from diamond drill holes which are representative of the variations present in the East and West Lode areas. Core recovery was generally low in 1985 holes drilled in the East Lode North Extension and in the West Lode; however, most of the core used in the tests came from 1983 holes in the East Lode pit area where core recovery exceeded 98%.

Results of metallurgical work have been reported separately by Mr. Raihl. The various geological features which will affect mill response have been reported earlier. It is of particular importance that features which may vary significantly on a daily basis will be very difficult to predict in advance of mining and the flexibility to deal with these variations will have to be designed into the mill and ore blending techniques at the primary crusher.

Heap leach treatment of material below the cutoff ultimately chosen for milling ore remains a possibility. Initial column leach tests conducted in 1983 indicated reasonably high recoveries were achievable following agglomeration of fine material. Design of the mine plan should consider possible heap leach stockpile areas. Finally there has been no test work of consequence done on transition material or on any mineralization in the Happy Jack, Bulletin, Essex, or Moonlight areas.

CONCLUDING REMARKS

Outcome calculations on proven and probable oxide reserves at Wiluna at $A470/oz Au give DCFROI = 30-50% indicating the reserve is ore. Operating costs should be $A200/oz Au before amortization. The volume of proven and probable material is sufficient for a 4 year life at 300,000 tpy. Although

further discoveries of ore are likely within the area drilled in detail to date and elsewhere within the Wiluna Joint Venture area, the plant capacity should be designed for ore in sight not unproven potential.

The mining operation will require daily involvement of geologists familiar with the ore reserve for geologic and geotechnical mapping and grade control work. Several of the open pit mines visited in November 1985 had full-time geologists responsible for ore control who had no idea how the ore reserve was calculated, where the calculated reserve was supposed to be, or how and why actual mining results differed from those predicted. This information is required if ore control practice and adjustments in the mine plan are to be effective. Geologists will also be required to conduct on-going exploration within the Mining Joint Venture block and to coordinate this work with exploration on the Exploration Joint Venture.

FTG
Mar. 1986

JDS

ASARCO

Southwestern Exploration Division

February 22, 1990

W.L. Kurtz

Recalculation of Stope
Intercepts and Recalculation
of Drilled Mineral Reserve
Yarnell Project
Yavapai County, Arizona

I submit Mark A. Miller's report on the recalculation of stope and main "B" zone intervals using the methodology determined to be the best-fit on the available data.

The summation (Table 4-A Revised) by Miller suggests that nearly 15,000 ounces of gold are tied up in pillars and near wall areas which had been underestimated in the original report on this subject.

The present study was the result of reexamination of the drill holes which penetrated the pillars within the stope outline or cut the walls near the stopes. The reexamination results indicated a higher value were in the stope pillars and walls than had originally been used in the report of December 20, 1989 (Drill Indicated Reserve, J.D. Sell).

The December report used the triangle method of calculating the grade of the triangle block, by using the grade in the three adjacent holes. When these holes which penetrated open stope were used, the earlier "assumed" grade disproportionally lowered the average grade of the block. The total change is related to the number of stope holes, the thickness of the stope intercept to the total intercept, and the nearness to the stope wall. A trial comparison using two triangles with stope holes and the results indicated a positive change (memo of 2-6-90, J.D. Sell).

Miller has recalculated all the drill hole intervals which penetrated stopes (Table 1-A Revised) and has recalculated the average grade of all the involved triangles (Table 4-A Revised). The tonnage within the triangles remains the same, with the contained ounces of gold increasing.

Also changed was the tonnage and grade of the removed stope material. The stope reexamination and recalculations for tonnage and grade were detailed in two memos by W.D. Gay (2-1-90 and 2-13-90).

The new interval values (Table 5) are on a computer disk and are available for any additional computer runs.

James D. Sell

James D. Sell

JDS:mek
Atts.

cc: R.L. Brown
F.T. Graybeal
M.A. Miller
S.L. Lakosky

ASARCO

Exploration Department

February 22, 1990

J.D. Sell

Recalculation of Stope
Intercepts & Recalculation
of Drilled Reserves
Yarnell Project
Yavapai County, Arizona

I have recalculated the Yarnell ore reserve (per J.D. Sell's memo of 1/29/90) using different values for the open stope intervals. Intervals were recalculated as follows:

Bottom 15' of open stope = 0.10 opt Au
Remainder of stope above 15' = 0.05 opt Au
Grade of Stope = Weighted Average of above values.

The attached Tables 1-A and 4-A are revisions of J.D. Sell's 12/20/89 report on Drill Indicated Reserves.

Table 1-A Revised lists the recalculated grade in opt Au for the entire interval including the recalculated stopes.

Table 4-A Revised lists the recalculated grade in opt Au and the recalculated ton-ounce values. The bottom of Table 4-A summarizes and compares the original estimate vs. the recalculated estimate.

The recalculated stope tonnage and grade is based upon studies completed by W.D. Gay on February 1, 1990 and February 7, 1990 in which he planimetered the stope thickness for tonnage removed, and planimetered the area of influence of each of the drill holes that intercepted the stope and calculated the grade of the removed ore. W.D. Gay's stope results were 229,500 tons removed at a calculated grade of 0.096 opt gold (using the method of recalculation described in this memo). These values were used to recalculate the final tonnage and grade used in Table 4-A Revised. The recalculated tonnage and grade after subtracting the tonnage mined is 4,131,505T @ 0.055 opt Au compared to 4,111,005T @ 0.051 opt Au from the original (12/20/89) calculation.

Mark A. Miller
Project Geologist

MAM:mek
Atts.

cc: R.L. Brown
F.T. Graybeal
W.L. Kurtz
S.L. Lakosky

YARNELL PROJECT

Yavapai County, Arizona

Table 1-A Revised - Zone Interval Tabulation

Drill Hole	Zone*	From	To	Footage	12/20/89 Grade (opt Au)	2/19/90 Recalc.Grade (opt Au)
YM-1	A	5	55	50'	0.025	
YM-1	B	55	125	70'	0.053	0.063
YM-2	A	45	140	95'	0.017	
YM-2	B	140	245	105'	0.049	0.056
YM-3	A	20	125	105'	0.011	
YM-3	B	125	200	75'	0.060	0.064
YM-4	A	15	230	175'	0.013	
YM-4	B	285	310	25'	0.037	
YM-5	A	150	200	50'	0.005	
YM-5	B	200	355	155'	0.041	0.048
YM-6	B	125	180	55'	0.042	
YM-7	B	155	230	75'	0.047	0.050
YM-8	A	30	225	195'	0.022	
YM-8	B	225	275	50'	0.041	
YM-9	B	275	315	40'	0.035	
YM-10	A	130	190	60'	0.021	
YM-10	B	190	225	35'	0.029	
YM-11	B	175	240	65'	0.049	
YM-12	A	40	150	110'	0.013	
YM-12	B	150	240	90'	0.039	0.049
YM-13	B	180	210	30'	0.022	

YARNELL PROJECT - Table 1-A Revised - Zone Interval Tabulation

Drill Hole	Zone*	From	To	Footage	12/20/89 Grade (opt Au)	2/19/90 Recalc.Grade (opt Au
YM-14	B	15	90	75'	0.040	
YM-15	A	25	140	115'	0.015	
YM-15	B	140	295	155'	0.034	
YM-16	A	0	40	40'	0.017	
YM-16	B	40	80	40'	0.039	0.047
YM-17	A	210	285	75'	0.015	
YM-17	B	285	325	40'	0.047	
YM-18	A	0	100	100'	0.022	
YM-18	B	100	140	40'	0.078	
YM-19	A	10	85	75'	0.015	
YM-19	B	205	235	30'	0.058	
YM-20	B	0	35	35'	0.070	
YM-21	A	25	55	30'	0.019	
YM-21	B	80	90	10'	0.033	
YM-22	A	215	225	10'	0.036	
YM-22	B	270	285	15'	0.025	
YM-23	B	40	125	85'	0.047	
YM-24	B	65	115	50'	0.093	0.094
YM-25	B	55	90	35'	0.070	
YM-26	B	200	290	90'	0.054	
YM-27	A	35	265	90'	0.015	
YM-27	B	300	315	15'	0.033	
YM-28	A	95	225	130'	0.022	
YM-28	B	225	245	20'	0.042	
YM-29	B	220	230	10'	0.033	
YM-30	A	170	200	30'	0.012	
YM-30	B	215	250	35'	0.032	

YARNELL PROJECT - Table 1-A Revised - Zone Interval Tabulation

Drill Hole	Zone*	From	To	Footage	12/20/89 Grade (opt Au)	2/19/90 Recalc.Grade (opt Au
YM-31	A	115	135	20'	0.017	
YM-31	B	365	385	20'	0.055	
YM-32	A	0	190	155'	0.012	
YM-32	B	190	200	10'	0.027	
YM-33	A	15	55	40'	0.015	
YM-33	B	275	365	90'	0.051	
YM-34	A	110	130	20'	0.013	
YM-34	B	not reached - assume from other holes.				
YM-34	B	240	250	10'	0.025	
YM-35	B	15	40	25'	0.010	
YM-36	A	35	55	20'	0.023	
YM-36	B	130	140	10'	0.048	
YM-37	B	120	180	60'	0.036	
YM-38	B	185	220	35'	0.028	
	Note:	if no fault in area, then above may be "A" Zone.				
YM-39	A	0	325	75'	0.024, 250' gap.	
YM-39	B	325	360	35'	0.048, end in ore.	
YM-40	A	20	80	60'	0.014	
YM-40	B	275	380	105'	0.062	
YM-41	B	295	335	40'	0.046	
YM-42	B	330	340	10'	0.056	
YM-43	B	65	85	20'	0.063	
YM-44	A	115	235	120'	0.024	
YM-44	B	235	265	30'	0.143	
YM-45	B	60	75	15'	0.084	
YM-46	B	200	260	60'	0.012	
YM-47	A	120	170	50'	0.014	
YM-47	B	170	205	35'	0.031	

YARNELL PROJECT - Table 1-A Revised - Zone Interval Tabulation

Drill Hole	Zone*	From	To	Footage	12/20/89 Grade (opt Au)	2/19/90 Recalc.Grade (opt Au
YM-48	B	45	85	40'	0.049	
YM-49	B	140	160	20'	0.049	
YM-50	B	0	85	85'	0.059	
YM-51	B	165	170	5'	0.061	
YM-52	B	50	75	25'	0.049	
YM-53	B	65	140	75'	0.036	
YM-54	A	55	125	70'	0.015	
YM-54	B	180	270	90'	0.054	
YM-55	A	0	70	70'	0.011	
YM-55	B	70	165	95'	0.050	0.058
YM-56	A	0	45	45'	0.012	
YM-56	B	70	105	35'	0.082	
YM-57	A	0	15	15'	0.011	
YM-57	B	15	60	45'	0.035	0.053
YM-58	B	0	20	20'	0.034	
YM-59	B	50	100	50'	0.032	
YM-60	In FW	-	-	-	-	
YM-61	B	80	200	120'	0.037	0.044
YM-62	A	115	190	75'	0.015	
YM-62	B	190	295	105'	0.040	0.051
YM-63	A	10	140	130'	0.011	
YM-63	B	140	240	100'	0.081, end in ore.	
YM-64	A	50	110	60'	0.025	
YM-64	B	110	145	35'	0.053	
YM-65	B	0	50	50'	0.049	
YM-66	In FW	-	-	-	-	

YARNELL PROJECT - Table 1-A Revised - Zone Interval Tabulation

Drill Hole	Zone*	From	To	Footage	12/20/89 Grade (opt Au)	2/19/90 Recalc.Grade (opt Au
YM-67	B	0	50	50'	0.048	
YM-68	In FW	-	-	-	-	
YM-69	A	185	250	65'	0.011	
YM-69	B	250	280	30'	0.069	
YM-70	A	60	95	35'	0.011	
YM-70	B	95	135	40'	0.031	
YM-71	B	45	110	65'	0.131	
YM-72	B	0	35	35'	0.084	
YM-73	B	0	20	20'	0.190	
YM-74	In FW	-	-	-	-	
YM-75	A	65	105	40'	0.023	
YM-75	B	105	170	65'	0.066	
YM-76	A	0	75	75'	0.012	
YM-76	B	75	115	40'	0.034	0.059
YM-77	A	70	107	37'	0.022	
YM-77	B	107	180	73'	0.048	0.057
YM-78	A	130	215	85'	0.011	
YM-78	B	215	270	55'	0.070	
YM-79	A	10	120	110'	0.019	
YM-79	B	120	170	50'	0.046	
YM-80	A	140	230	90'	0.023	
YM-80	B	230	280	50'	0.040	
YM-81	A	5	55	50'	0.015	
YM-81	B	55	90	35'	0.066	
YM-82	A	0	35	35'	0.015	
YM-82	B	35	95	60'	0.049	
YM-83	A	0	140	140'	0.014	
YM-83	B	140	240	100'	0.044	0.053

YARNELL PROJECT - Table 1-A Revised - Zone Interval Tabulation

Drill Hole	Zone*	From	To	Footage	12/20/89 Grade (opt Au)	2/19/90 Recalc.Grade (opt Au
YM-84	A	10	105	95'	0.017	
YM-84	B	105	140	35'	0.062	
YM-85	In FW	-	-	-	-	
YM-86	B?	50	70	20'	0.013	
YM-87	A	245	285	40'	0.010	
YM-87	B	285	305	20'	0.050	
YM-88	A	180	240	60'	0.020	
YM-88	B	240	295	55'	0.064	
YM-89	A	40	180	140'	0.010	
YM-89	B	180	270	90'	0.051	
YM-89	Subzone	270	340	70'	0.016	
YM-90	A	10	120	110'	0.012	
YM-90	B	120	215	95'	0.062	
YM-90	Subzone	215	235	20'	0.019	
YM-91	A	10	95	85'	0.010	
YM-91	B	Hole lost in stope - assume from other holes.				
YM-91	B	95	180	85'	0.051	
YM-92	B	35	55	20'	0.072	
YM-93	B	5	25	20'	0.064	
YM-94	B	105	155	50'	0.086	0.088
YM-95	B	385	395	10'	0.015	
YM-96	B	570	575	5'	0.061	

*Zone A - Upper low-grade zone.
*Zone B - Main Yarnell Fault Zone & envelope.

YARNELL PROJECT

Yavapai County, Arizona

Table 4-A Revised - Main "B" Zone

Using 12.0 ft.^{3}/ton factor

Triangle No.	Volume ft.^{3}	Thickness ft.	Tons	Grade oz/ton	Recalc. Grade	Recalc. Ton-oz.
1	87,375	23.3	7,281	0.037	--	269.397
2	208,250	35.0	17,354	0.057	--	989.178
3	382,500	30.0	31,875	0.068	--	2167.500
4	117,600	20.0	9,800	0.037	.043	421.400
5	182,250	30.0	15,188	0.035	.039	592.332
6	189,810	33.3	15,818	0.047	.056	885.808
7	149,184	33.3	12,432	0.051	.065	808.080
8	119,699	31.7	9,975	0.054	.057	568.575
9	232,187	56.7	19,349	0.054	.060	1160.940
10	221,130	56.7	18,428	0.050	.056	1031.968
11	191,403	41.7	15,950	0.043	.045	717.750
12	280,292	63.3	23,358	0.047	.051	1191.258
13	308,424	78.3	25,702	0.051	.057	1465.014
14	505,084	91.7	42,090	0.041	.046	1936.140
15	486,850	70.0	40,571	0.044	.048	1947.408
16	681,298	63.3	56,775	0.049	.053	3009.075
17	989,495	66.7	82,458	0.041	.045	3710.610
18	298,880	46.7	24,907	0.050	.053	1320.071
19	169,070	58.3	14,089	0.047	.055	774.895
20	255,500	50.0	21,292	0.054	.062	1320.104
21	190,515	51.7	15,876	0.057	.061	968.436
22	205,920	60.0	17,160	0.055	.062	1063.920
23	211,723	78.3	17,644	0.045	--	917.488
24	256,880	95.0	21,407	0.044	--	1134.571
25	373,700	100.0	31,142	0.048	--	1712.810
26	290,105	85.0	24,175	0.045	--	1257.100
27	280,740	93.3	23,395	0.046	--	1216.540
28	232,000	80.0	19,333	0.047	--	985.983
29	667,076	126.7	55,590	0.039	.043	2390.370
30	994,194	108.3	82,850	0.036	.039	3231.150
31	557,304	103.3	46,442	0.040	.042	1950.564
32	339,398	76.7	28,283	0.036	--	1018.188

YARNELL PROJECT - Table 4-A Revised - Main "B" Zone

Triangle No.	Volume ft.^{3}	Thickness ft.	Tons	Grade oz/ton	Recalc. Grade	Recalc. Ton-oz.
33	180,290	55.0	15,024	0.047	--	706.128
34	490,428	71.7	40,869	0.037	--	1512.153
35	856,800	80.0	71,400	0.038	--	2713.200
36	188,100	55.0	15,675	0.054	.059	924.825
37	188,370	48.3	15,698	0.050	.055	863.390
38	154,837	53.3	12,903	0.045	.050	645.150
39	205,800	60.0	17,150	0.039	.044	754.600
40	331,840	76.7	27,650	0.056	.060	1659.000
41	438,510	93.3	36,543	0.059	.062	2265.666
42	474,789	98.3	39,566	0.058	.062	2453.092
43	551,291	116.7	45,941	0.044	.049	2251.109
44	535,500	90.0	44,625	0.045	.049	2186.625
45	532,950	95.0	44,413	0.048	.052	2309.476
46	402,050	55.0	33,504	0.055	--	1842.720
47	674,960	76.7	56,247	0.056	--	3149.832
48	728,660	78.3	60,722	0.055	--	3339.710
49	144,417	48.3	12,035	0.049	--	589.715
50	137,625	36.7	11,469	0.049	--	561.981
51	238,000	50.0	19,833	0.051	.053	1051.149
52	414,426	71.7	34,536	0.064	.065	2244.840
53	258,750	90.0	21,563	0.068	.070	1509.410
54	278,30	100.0	23,192	0.061	.064	1482.288
55	211,565	85.0	17,630	0.058	.063	110.690
56	233,700	95.0	19,475	0.051	.056	1090.600
57	324,684	93.3	27,057	0.047	.050	1352.850
58	436,458	116.7	36,372	0.043	.049	1782.228
59	547,500	100.0	45,625	0.048	.052	2372.500
60	639,450	105.0	53,288	0.052	.055	2930.840
61	350,175	66.7	298,181	0.060	--	17890.860
62	434,985	61.7	36,249	0.055	--	1993.695
63	371,371	58.3	30,948	0.083	--	2568.684
64	242,820	58.3	20,235	0.076	--	1537.860
65	153,643	46.7	12,804	0.092	.098	1254.792
66	263,749	58.3	21,979	0.085	.087	1912.173
67	340,303	71.0	28,359	0.078	.082	2325.438
68	124,115	59.3	10,343	0.075	.084	868.812
69	245,532	77.7	20,461	0.053	.060	1227.660
70	272,727	77.7	22,727	0.049	.053	1204.531
71	265,560	83.3	21,130	0.050	.051	1077.630
72	352,207	73.3	29,351	0.054	.055	1614.305
73	237,786	66.7	19,815	0.060	--	1188.900
74	181,125	48.3	15,094	0.058	--	875.452
75	243,563	43.3	20,297	0.049	--	994.553
76	213,553	33.3	17,796	0.047	--	836.412
77	205,416	31.7	17,118	0.041	--	701.838
78	145,745	28.3	12,145	0.048	--	582.960

YARNELL PROJECT - Table 4-A Revised - Main "B" Zone

Triangle No.	Volume ft.^{3}	Thickness ft.	Tons	Grade oz/ton	Recalc. Grade	Recalc. Ton-oz.
79A	93,375	25.0	7,781	0.103	--	801.443
79B	81,250	25.0	6,771	0.109	--	738.039
80A	95,924	31.7	7,994	0.055	.065	519.610
80B	79,123	31.7	6,594	0.060	.071	468.174
81	85,973	18.3	7,164	0.114	--	816.696
82	206,123	49.3	17,177	0.049	.061	1047.797
83M.	311,355	45.0	25,946	0.084	.085	2205.410
84	209,420	28.3	17,452	0.084	.084	1465.968
86M.	319,800	53.3	26,650	0.069	.070	1865.500
87M.	294,962	52.7	24,580	0.065	.069	1696.020
88	643,243	69.3	53,604	0.044	.049	2626.596
90M.	277,611	61.0	23,134	0.054	.059	1364.906
91	478,865	63.3	39,905	0.048	.052	2075.060
92	297,675	56.7	24,806	0.049	--	1215.494
93	200,445	48.3	16,704	0.049	--	818.496
94	192,000	40.0	16,000	0.045	--	720.000
95	349,800	58.3	29,150	0.063	.064	1865.600
96	313,031	53.3	26,086	0.047	--	1226.042
97	362,500	50.0	30,208	0.037	--	1117.696
98	360,000	40.0	30,000	0.045	--	1350.000
99	366,751	26.7	30,563	0.043	--	1314.209
100M.	39,000	30.0	3,250	0.069	--	224.250
101	215,129	23.3	17,927	0.085	--	1523.795
102	247,260	31.7	20,605	0.075	.076	1545.375
103	280,200	46.7	23,350	0.073	--	1704.550
104	157,643	58.3	13,137	0.054	--	709.398
105	315,040	61.7	26,253	0.051	--	1338.903
106	235,980	45.0	19,665	0.047	--	924.255
107	143,623	28.3	11,969	0.029	--	347.101
108M.	181,125	22.5	15,094	0.054	--	815.076
109	363,720	43.3	30,310	0.058	--	1757.980
110	431,653	61.7	35,971	0.048	--	1726.608
111	245,258	61.7	20,438	0.043	--	878.834
112	672,975	75.0	56,081	0.044	--	2467.564
113	502,238	61.7	41,853	0.045	--	1883.385
114M.	210,000	50.0	17,500	0.043	--	752.500
118	1,188,594	66.7	99,050	0.048	--	4754.400
119	765,000	45.0	63,750	0.042	--	2677.500
120	665,184	53.3	55,432	0.043	--	2383.576
121	415,911	48.3	34,659	0.034	--	1178.406
122M.	91,000	20.0	7,583	0.049	--	371.567
124	1,282,600	58.3	106,883	0.054	--	5771.682
127M.	388,890	30.0	32,408	0.049	--	1587.992
128	279,000	25.0	23,250	0.075	--	1743.750
129M.	125,000	25.0	10,417	0.060	--	625.020
135M.	77,520	40.0	6,460	0.057	--	368.220

YARNELL PROJECT - Table 4-A Revised - Main "B" Zone

Triangle No.	Volume ft.^{3}	Thickness ft.	Tons	Grade oz/ton	Recalc. Grade	Recalc. Ton-oz.
136	468,000	40.0	39,000	0.065	--	2535.000
137	513,827	41.7	42,819	0.041	--	1755.579
138	607,200	55.0	50,600	0.046	--	2327.600
144	507,400	40.0	42,283	0.052	--	2198.716
145M.	118,300	65.0	9,858	0.049	--	483.042
146M.	89,250	30.0	7,438	0.050	--	371.900
147M.	54,000	20.0	4,500	0.050	--	225.000
148	258,251	46.7	21,521	0.057	--	1226.697
149	92,364	56.7	7,697	0.049	--	377.153
150	751,162	56.7	62,597	0.049	--	3067.253
151M.	92,000	20.0	7,667	0.064	--	490.688
152M.	321,563	52.5	26,797	0.060	--	1607.820
153M.	813,484	68.0	67,790	0.055	--	3728.450
154M.	580,000	50.0	48,333	0.049	--	2368.317
156M.	172,500	50.0	14,375	0.049	--	704.375
162M.	389,034	18.0	32,420	0.072	--	2334.240
163M.	97,650	17.5	8,139	0.063	--	512.757
165M.	36,000	8.0	3,000	0.084	--	252.000
166M.	852,600	42.0	71,050	0.049	--	3481.450
167M.	693,000	42.0	57,750	0.053	--	3060.750
168M.	362,250	23.0	30,188	0.059	--	1781.092
169M.	2,835,000	45.0	236,250	0.048	--	11340.000
170M.	400,125	27.5	33,344	0.057	--	1900.608

	Original 12/20/89	Recalculated 2/19/90
Tons	4,361,005	4,361,005
Grade, opt Au	.051	.057
Total Oz	223,912	247,960
Mined		**Mined**
Previously Mined	250,000	229,500
Grade, opt Au	.051	.096
Total Oz	12,750	22,032
Totals	**Remaining**	**Remaining**
Tons	4,111,005	4,131,505
Grade, opt Au	.051	.055
Oz	211,162	225,928

YARNELL PROJECT

Yavapai County, Arizona

Table 5 - Recalculated Stope Intercepts

Hole No.	Footage		Recalc. Grade opt Au
YM-1	100.	105.	.05
YM-1	105.	120.	.10
YM-2	200.	225.	.05
YM-2	225.	240.	.10
YM-3	147.	155.	.10
YM-5	295.	320.	.05
YM-5	320.	335.	.10
YM-7	220.	230.	.10
YM-12	180.	195.	.10
YM-16	65.	70.	.10
YM-24	65.	75.	.10
YM-55	150.	165.	.10
YM-57	50.	60.	.10
YM-61	175.	190.	.10
YM-62	250.	275.	.05
YM-62	275.	290.	.10
YM-76	75.	90.	.10
YM-77	107.	120.	.10
YM-83	205.	210.	.05
YM-83	210.	225.	.10
YM-94	127.	135.	.10

DO REPORT 2-23-90

See Lou + get x-sect & Bench Plans.

✓ Weighting stage workings. WDG.

YM-1 → 5 hammer thru stage

YM-6 → hammer to stage - trieuse beyond stage

JDS

ASARCO

Exploration Department
Western USA

February 23, 1990

J.D. Sell
Tucson Office

Yarnell Ore Reserve

As I have discussed with you, you must critically review the Yarnell drill hole assays, the "Sellian Reserve," and the newly created computer inventory and economic ($400) pit reserve. You must generate a new ore reserve that the exploration department can sign off on.

Your review and work should take into consideration, as a minimum, what assays, if any, should be cut and how much; should any changes be made in the projection of values, if so, in all the deposit or in just certain places; and should assign the geologically most realistic values to the drill holes passing through stopes and rubble. These changes should be incorporated into calculating your final reserve and should be used in the computer inventory and economic pit calculations.

I believe the data already generated by Jansen (cross section data; 20' level plans) can be edited to speed up your work, but if not, so be it. You should call upon anyone necessary to help complete this work, since the Mining Department hopes to complete a feasibility at the end of March. You should certainly consult with Mr. Anzalone on the cutting of values and assignment of values to the stopes, and Mr. Lakosky should be kept informed and understand the reasons for any changes.

If you run into any computer scheduling problems, please inform Mr. Brown or Mr. Graybeal.

W. L. Kurtz /mek

W.L. Kurtz

WLK:mek

cc: R.L. Brown
F.T. Graybeal
T.E. Scartaccini
S.L. Lakosky
S.A. Anzalone
L.J. Jansen

YARNELL WORK REMAINING (FTG 1-25-90)

Ore reserves

1.) LJJ - do $1/D^2$ inventory to confirm $1/D^2$ model same as JDS triangle.

2.) Obtain exact parameters in all reserves re stopes in or out, (needed on pinbots) assay treatment of areas influenced by holes in stopes from LJJ

3.) JDS - revise stope area influence 15 ft of 0.1, remainder is 0.05, 0.1 goes at bottom. (due tables determined (w LK) by stope cut by assay) reck each hole.

a.) JDS - give new assays to LJJ (reprint by LJJ for check. results FTG)

b.) JDS - calc. oz in external triangles added by adjusting assays. (compare old w new)

c.) JDS - map showing justification for adjustment of stope shell. (redo stope)

d.) JDS - map showing known and hypothesized stope pillar location

e) Redo ~~stope location~~ volume thickness times grade oz.

4.) Discuss with LJJ how stopes to be removed from inventory and economic cost model reserve calculations.

5.) LJJ - do economic reserve \$400, \$450 Au with stopes at ① 0.00 oz Au, ② 0.05 oz Au, ③ 0.05 with internal 0.1 oz Au using $1/D^2$.

6.) JDS - report on rationale for increasing grade in skin around stopes with maps, assessment of potential volume remaining inside stopes as pillars - estimate of grade in pillars, how this will be entered in LJJ reserve estimate.

7.) LJJ - bench plots of $1/D^2$ blocks at 0.021 and 0.023 oz Au cutoffs; report by WLK / JDS re where reserve increase comes from.

Metallurgy

Phase 2: a.) 2 tests 1½" crush in 12" columns both agglomerated, one with (20% clay) added one without
discuss

8-1 300#
40-2 635#
75-4 390#
63-3 ±1890#

(b) 3 tests + mini 3/8" crush of diamond drill core using assay reject (in 8-1) in 6" columns both agglomerated using core from deep in deposit. McLell says 3/8" elimin skin effect for drill core of 2 7/8" diameter and no wall effect if ratio of column diameter / crush size > 4.
12" column cost $3000 for 60 days.
3/8" test will compare to 3/8" test on pit so geographic variation can be studied.

72% to mesh 72-hr

ck DRC on bottle roll tests - need others? To confirm continuity or change before core column test.

on hold due to TES based on feasibility 2-14-90

Can we find variation in out thru bottle-roll. conclude additional open-cut samples.
also test hi-grade & remainder individually.

Phase 3: DRC will want a 4 ft diameter column of final parameters after Phase 2.

DRC - needs to comment whether sufficient clay leached where most of Au is.
DRC needs to summarize all met. to date. 50% recovery of low grade at 3/8", 0% recovery at 6".

To date 70% recovery of 2" crush non agglom, 76% recov - 3/8" agglom; no column or gouge, 48 hr bottle got 70%.
Estimate 1½" crush will get 72% recovery in 60-90 days and will allow 2 stage crush, eliminating tertiary crusher
Agglom. on conveyors.

Other:

Geol. map marginal —

(JDS) Geol on sections marginal — only geol is the assay. One section to test thoughts then drill hole w/attention bec. twinholes bec RCH vs DDH

Hold feasibility until better reserve estimate; capital costs absurdly high; nothing in file for Norgold to request.

Trip for Sy L. to heap leach operations, visit other heap leach people who did it on the cheap to write into feasibility how to get costs down. Gilbanis Bernas (Chorpuano) Padre Mocky mopper to do Santafe USM (big saw) Gold Strike, UT Coker (Nevada)

Get cash flows and capital costs and operate cost/oz. from Sy for $400 pit, $450 pit

WLK — list of heap leaches for capital cost/daily ton of ore ratio for recent heap leach developments; inquire if any unusual items

Quantitative core logging — JDS write headings, vein orientations.

MAM do some contour maps; thickness B; grade of B etc, geol. sections, to show continuity

JDS, comment if RCD hole good enough to do this work

5 assay ton assaying select 5 holes + do interval B zone

comparative assaying remaining drill holes. saw, assay 20' bench!?

sections to Norgold — JDS call Philpotts and determine if necessary

Drilling recommendation to expand reserve to west — 1 R, 1 map.

Comparative logging core vs RCD. do NOW

AAL Ann. Rept. to Moat.

Conventional mining of high grade?

Assay histogram, check assay, drill, sample desc, SG, see Wilma report.

Draft report. re How done all the way.

ck ASARCO standard vs Trial

no cutting of assays } all assaying techniques reclude native assayer check — 2 warm plates.

FILE

ASARCO

Exploration Department
Western USA

February 23, 1990

J.D. Sell
Tucson Office

Yarnell Ore Reserve

As I have discussed with you, you must critically review the Yarnell drill hole assays, the "Sellian Reserve," and the newly created computer inventory and economic ($400) pit reserve. You must generate a new ore reserve that the exploration department can sign off on.

Your review and work should take into consideration, as a minimum, what assays, if any, should be cut and how much; should any changes be made in the projection of values, if so, in all the deposit or in just certain places; and should assign the geologically most realistic values to the drill holes passing through stopes and rubble. These changes should be incorporated into calculating your final reserve and should be used in the computer inventory and economic pit calculations.

I believe the data already generated by Jansen (cross section data; 20' level plans) can be edited to speed up your work, but if not, so be it. You should call upon anyone necessary to help complete this work, since the Mining Department hopes to complete a feasibility at the end of March. You should certainly consult with Mr. Anzalone on the cutting of values and assignment of values to the stopes, and Mr. Lakosky should be kept informed and understand the reasons for any changes.

If you run into any computer scheduling problems, please inform Mr. Brown or Mr. Graybeal.

W. L. Kurtz /mek

W.L. Kurtz

WLK:mek

cc: R.L. Brown
F.T. Graybeal
T.E. Scartaccini
S.L. Lakosky
S.A. Anzalone
L.J. Jansen

3-1-90

Dana,

MAPS of ATTACHMENTS FOR Tarnach Final Report

Location Map
Land Status Map 1"=500' (REVISED)
Geologic Map 1"=100'
Geologic Sections 1"=100' → still w/ me.
Drill Hole Map w/ Assays 1"=100'
Ore Reserve Map J.D. Sell draw a map — 1"= 100'
(WE ALSO NEED TO PUT ON LOCATION of U.G. workings from ~~J.D. re~~ WDG Report.) ON THIS MAP

Map of Proposed Extensions of Drilling — (Recent Report. THAT you DRAFTED)

Thanks —

Walt

cc J.D. Sell

JDS

ASARCO

Southwestern Exploration Division

March 12, 1990

J.D. Sell

Various Stope Calculations
Yarnell Project
Yavapai County, Arizona

Per your request I have calculated various scenarios for the estimated grade of the stoping area. By using W.D. Gay's contours of the floor and back of the stoping area and projections based upon geology, I have calculated a grade for the stope equivalent ground. This is the area that is by elevation equivalent to the stopes, but are either pillar holes or perimeter holes to the stope. These holes have not been cut by stoping. Tabulated results are attached, but are summarized as follows:

Drill holes within stoping area but are in pillars
.090 opt Au.

Perimeter holes to the stopes ±50 ft. from estimated and/or surveyed stope outline
.076 opt Au.

There are several possible explanations for the difference in both techniques.

1. The methodology used to determine the approximate elevation of the stopes is by estimate and is subject to considerable error. Error in elevation would change the stope equivalent ground elevations and would change the assays.

2. The miners took the best ore they could, thus leaving the "leaner" walls and therefore "leaner" perimeter holes.

MAM:mek
Att.

Mark A. Miller
Project Geologist

cc: W.L. Kurtz

Drill Holes Within Stoping Area

That Did Not Hit Open Stopes (Pillars)

Hole #	Elevation	Intercept	Thickness	Cum.Grade
54	5060	225 - 230	20	.116
56	5078	85 - 110	25	.155
63	5045	205 - 225	20	.098
70	5058	115 - 135	20	.040
79	5076	135 - 155	20	.084
80	5067	250 - 270	20	.069
82	5092	70 - 95	25	.066
Average			21.4	.090

Drill holes Not Cut By Stopes

But Equal to Stope Width (Perimeter Holes)

Hole #	Elevation	Intercept	Thickness	Cum.Assay
4	5052	300 - 320	20	.032
14	5050	65 - 80	15	.095
15	5037	275 - 290	15	.059
20	5075	0 - 35	35	.070
25	4947	55 - 75	20	.062
58	5056	0 - 20	20	.034
64	5041	100 - 120	20	.065
71	5011	70 - 90	20	.048
72	5009	20 - 30	10	.166
81	5067	55 - 75	20	.080
84	5052	110 - 135	25	.071
89	5017	250 - 270	20	.122
90	5027	185 - 210	25	.122
92	4985	35 - 45	10	.085
14			275/14	
Average			= 19.6	.076 opt Au

Stopes

Stope ft ≅ assay	Hole #	Top	Assay	Bottom	Assay
20-.088	1	90 - 100	.056	120 - 130	.036
40-.069	2	190 - 200	.041	240 - 250	.015
10-.100	3	135 - 145	.026	155 - 165	.049
45-.067	5	285 - 295	.063	335 - 345	.073
10-.100	7	210 - 220	.059	230 - 240	.011
15-.100	12	170 - 180	.052	195 - 205	.034
5-.100	16	55 - 65	.038	70 - 80	.046
10-.100	24	55 - 65	.004	75 - 85	.173
15-.100	55	140 - 150	.141	165 - 175	.012
10-.100	57	40 - 50	.048	60 - 70	.026
15-.100	61	165 - 175	.046	190 - 200	.022
40-.069	62	240 - 250	.060	290 - 300	.022
15-.100	76	65 - 75	.012	90 - 100	.046
15-.100	77	95 - 105	.036	120 - 130	.015
20-.088	83	195 - 205	.065	225 - 235	.029
10-.100	94	125 - 125	.209	135 - 145	.07
18 @ .085	Average		.060		.042

Stope ft ≅ assay

20-0.088

40-0.069

-5.07

.04-.069

.02-.039

3/14/90

YARNELL PROJECT ROCK SAMPLES

For Russ Honea

		Report
Y-150	Fresh Weathered Unaltered Granite?	1/6/90
Y-151	Fresh Unweathered "Core" Granite?	1/27/90
Y-152	Weathered - Weakly Altered	1/6/90
Y-153	No Sample	
Y-154	Mod Alt - Unoxidized	1/6/90
Y-155	Mod Alt - Oxidized	1/6/90
Y-156	Mod/Strong Alt - Oxidized	
Y-157	Strong Alt - Oxidized	1/6/90
Y-158	Stockwork Quartz Mod/Strong Alt - Open Cut	1/6/90
Y-159	Strong Alt - Open Cut	1/27/90
Y-160	Strong S_1O_2- Open Cut - Strong Alt?	1/6/90
Y-161	Strong Alt - K-Spar Addition	1/6/90

Polished Sections
YM-71 85-90'
12/7/89

IG 35-40
3/10/90
(YM-40, 315-320)

Main Adit Traverse

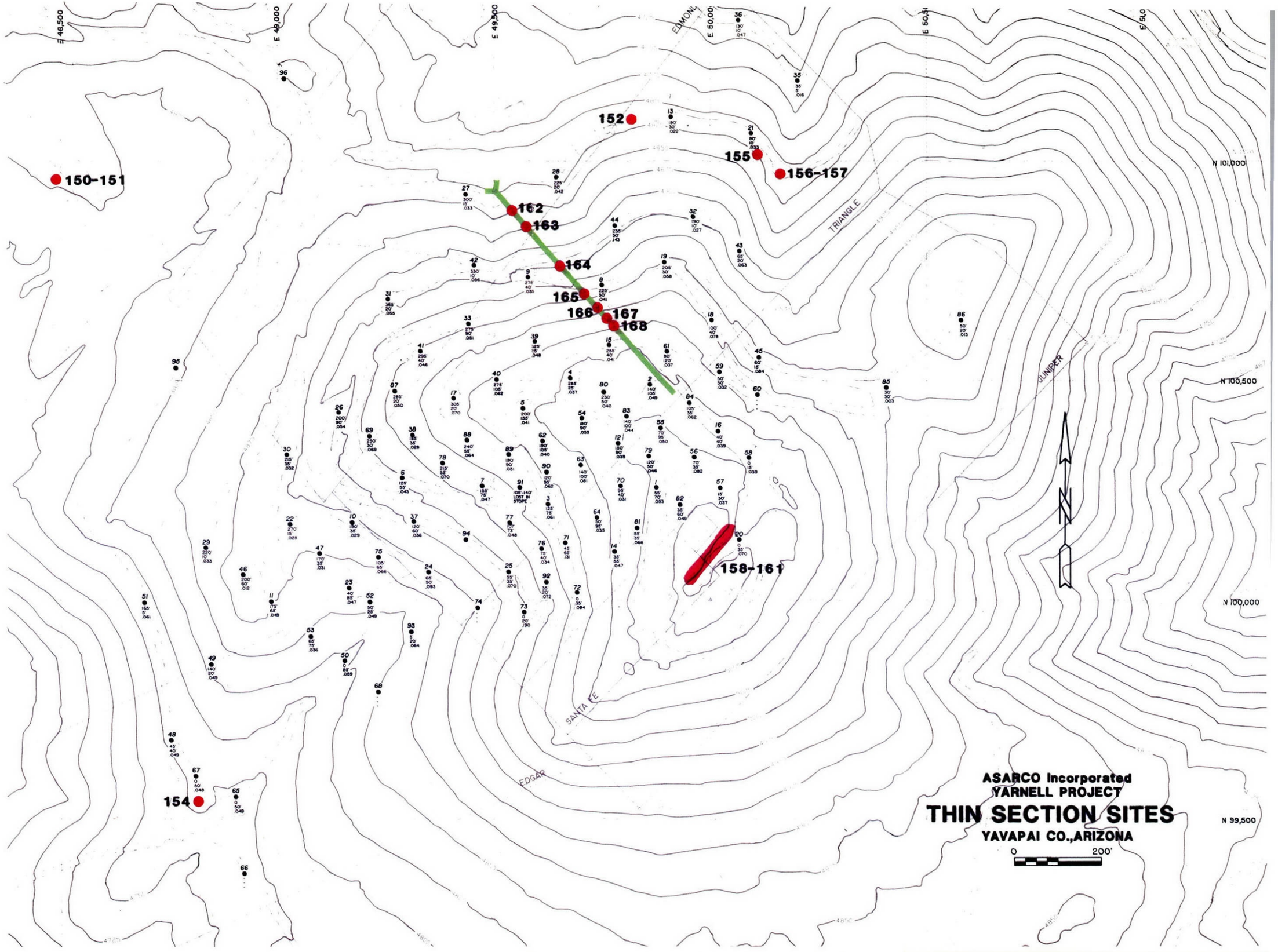
Y-162	+50' Wk Alt	1/27/90	
Y-163	+100' Wk Alt	1/27/90	
Y-164	+220' Mod Alt	1/27/90	
Y-165	+310' Mod Alt	1/27/90	3/14/90
Y-166	+350' Mod Alt	1/27/90	3/14/90
Y-167	+385' Mod/Strong?		3/14/90
Y-168	+400' Mod/Strong - Silic		3/14/90

First Priority

Y-150	1/6/90		
Y-152	1/6/90		
Y-154	1/6/90		
Y-155	1/6/90		
Y-157	Polished Section	2/20/90	1/6/90
Y-158	Polished Section	2/20/90	1/6/90
Y-160	Polished Section	2/20/90	1/6/90
Y-161	1/6/90		

Second Priority

Y-162 - Y-168 1/27/90 3/14/90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TRIANGLE
JUNIPER
SANTA FE
EDGAR
150-151
152
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156-157
162
163
164
165
166
167
168
158-161
154
ASARCO Incorporated
YARNELL PROJECT
THIN SECTION SITES
YAVAPAI CO.,ARIZONA
0
200'

RMH 12-7-89

JDS

ASARCO

Southwestern Exploration Division

January 19, 1990

W.L. Kurtz

Polished Section Mineralogy
Yarnell Project
Yavapai County, Arizona

Attached is the polished section report by Russell M. Honea from the hi-grade zone in YM-71, 85'-90'.

This is within the Yarnell Fault Zone and the assay interval returned 1.05 opt gold.

James D. Sell

James D. Sell

JDS:mek
Att.

cc: R.L. Brown
F.T. Graybeal
M.A. Miller

Russell M. Honea
Consulting Geologist

AC 303 466-9719

Office
1105 BELLAIRE
BROOMFIELD, COLORADO 80020

Mailing Address
P.O. BOX 323
BROOMFIELD, COLORADO 80020

December 7, 1989

Mr. Mark A. Miller
ASARCO Incorporated
P. O. Box 5747
Tucson, Arizona 85703

Re: Polished section mineralogy

Dear Mark:

Enclosed are results of polished section examination of the sample forwarded under your cover letter of November 4, 1989. The sample was examined in sections prepared from both the "as received" head ground to minus 70 mesh and from a panned concentrate prepared therefrom. As usual, photomicrographs are included to illustrate occurrence of gold in the material.

Native gold was observed as 38 particles - 14 of which are liberated and 24 of which are locked by either goethite (18) or quartz (6). Particle size ranges from less than one to 110 microns, and the average for all observed particles is 18.3 microns. Size of locked particles ranges from less than one to 26 microns, and averages 5.4 microns. Thus, particle size for native gold is relatively small, and is smallest for locked particles.

Small amounts of remnant pyrite and galena are preserved from the primary sulfide suite, but most sulfides have been oxidized to goethite. The oxide is accompanied by minor amounts of jarosite and the manganese oxide psilomelane.

Please let me know if there are questions regarding the data. Have received your latest sample set, and they have been submitted for preparation of thin and polished sections.

Sincerely,

Russell M. Honea

Encl.

YM71 - 85-90'. Liberated and locked relatively fine grained native gold with minor remnants of pyrite and galena in a strongly oxidized ore assemblage.

Native gold - -1% - Dark golden yellow color - indicating relatively low silver content, isotropic but does not show complete extinction because of polishing scratches, low hardness and is well polished. Observed as 38 particles - 14 of which are liberated and 24 of which are locked by goethite (18) and quartz (6). Grain size varies from less than 1 to 110 microns, and average diameter for all particles is 18.3 microns. Size variation in liberated particles is from 3 to 110 microns and average is 40.4 microns. Size of locked particles varies from less than 1 to 26 microns, and average is 5.4 microns. A few of the larger particles have a complex dendritic texture. The relatively abundant and very small locked gold particles in goethite oxidation pseudomorphs after pyrite suggest a potential for sulfide locking problems in reduced or unoxidized ore.

Pyrite - -1% - Pale yellow, either isotropic or with weak anomalous anisotropism and very faint blue to purplish polarization colors, hard and is well polished. Occurs as scarce liberated remnants - that often show oxidative corrosion at grain margins. Also as rare remnants in interiors of goethite oxidation pseudomorphs. As noted above, originally enclose some of the fine grained gold.

Galena - -1% - Light grayish white, isotropic and with well developed cubic cleavage, low hardness and is well polished. Present as remnant cleavage fragments, and only rarely shows oxide rimming. Lack of oxide coating no doubt reflects perfect cleavage that results in breaking loose of oxidation products during grinding.

Goethite - 3% - Light to medium gray, anisotropic but with polarization effects masked by strong reddish to brown internal reflections, highly variable hardness and with moderate to good development of polish. Occurs as complex and finely banded aggregates that form both as oxidation

YM71 - 85-90'.

pseudomorphs after original sulfides and as apparent cavity fillings.

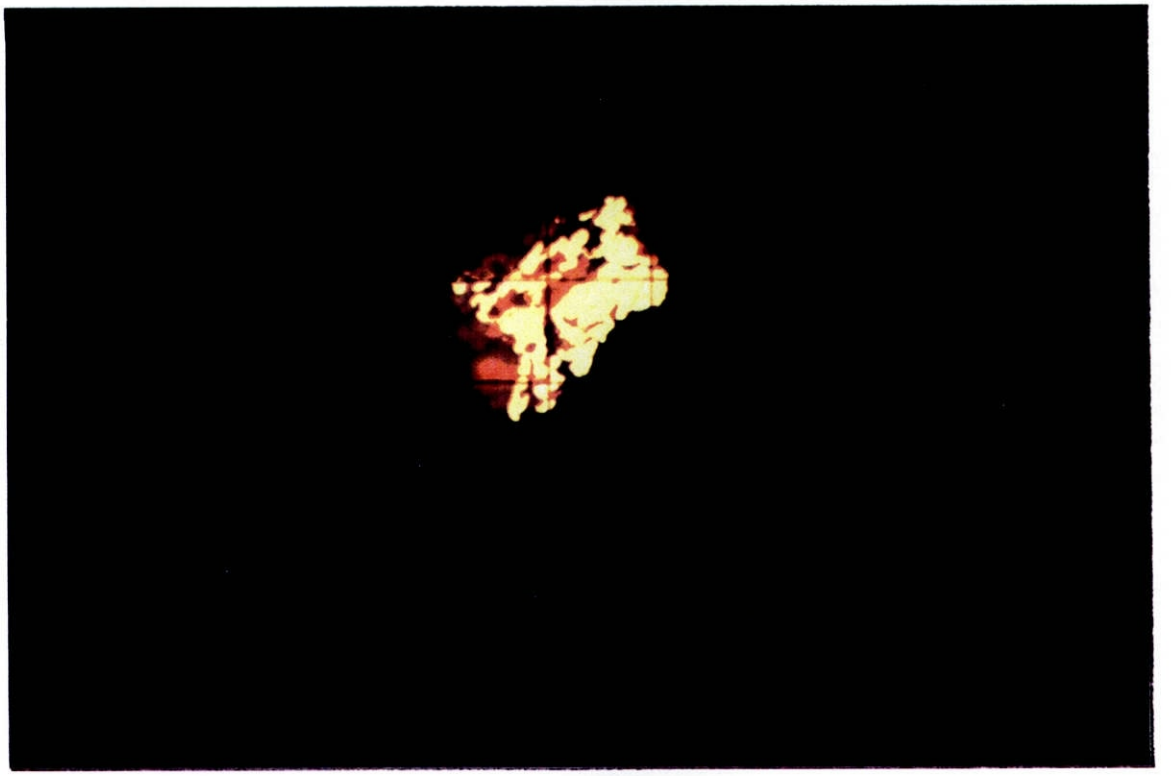
Jarosite - -1% - Medium to light gray, anisotropic and with polarization effects masked by strong pale yellow internal reflections, soft and with variable perfection of polish. Present alone and with goethite as an oxidation product of original sulfides.

Psilomelane - -1% - Light to medium bluish gray, moderately anisotropic and with polarization colors of blue to gray, moderate hardness and is usually well polished. Occurs alone and with goethite in subradial aggregates of acicular to almost fibrous material deposited as cavity fillings in oxidation environment.

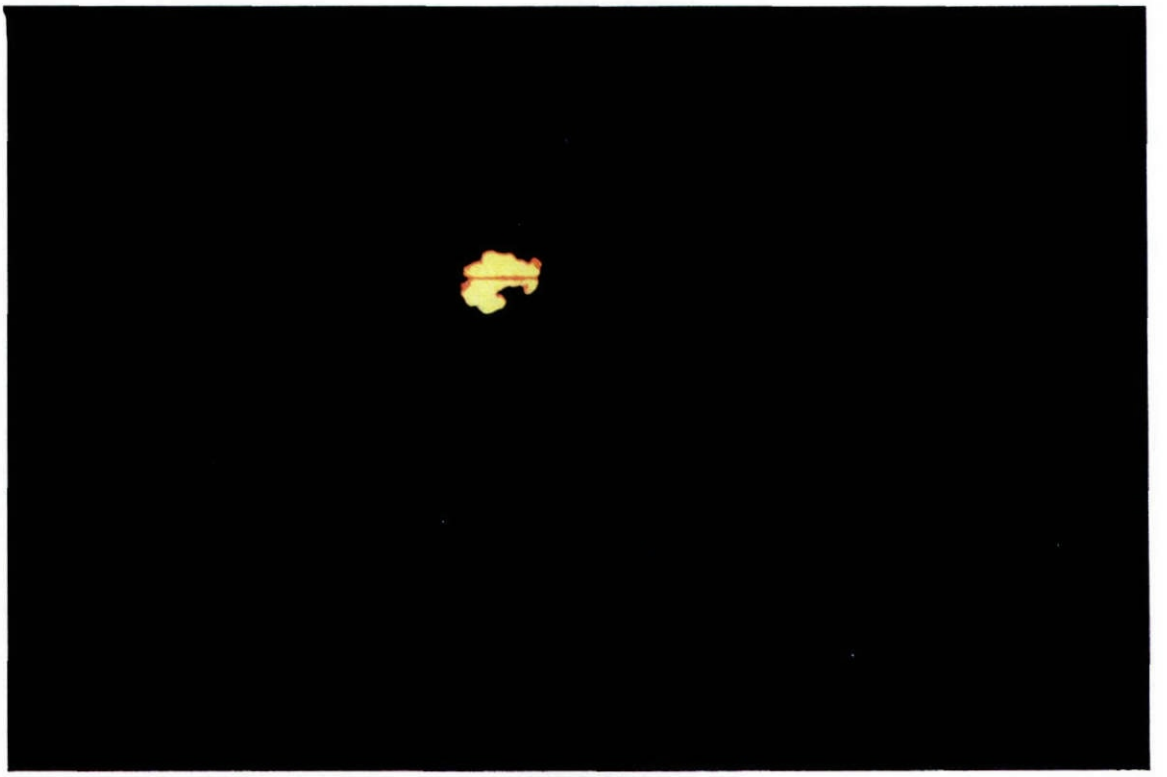
Trash iron - -1% - White metallic, isotropic, moderate hardness and is well polished. Present as curved shavings that were added during sample preparation.

Non-metallic gangue - 96% - Comprised very dominantly of silicates.

*Note: Two polished sections were prepared and examined - one of the head sample ground to -70 mesh and one of a panned concentrate prepared therefrom.



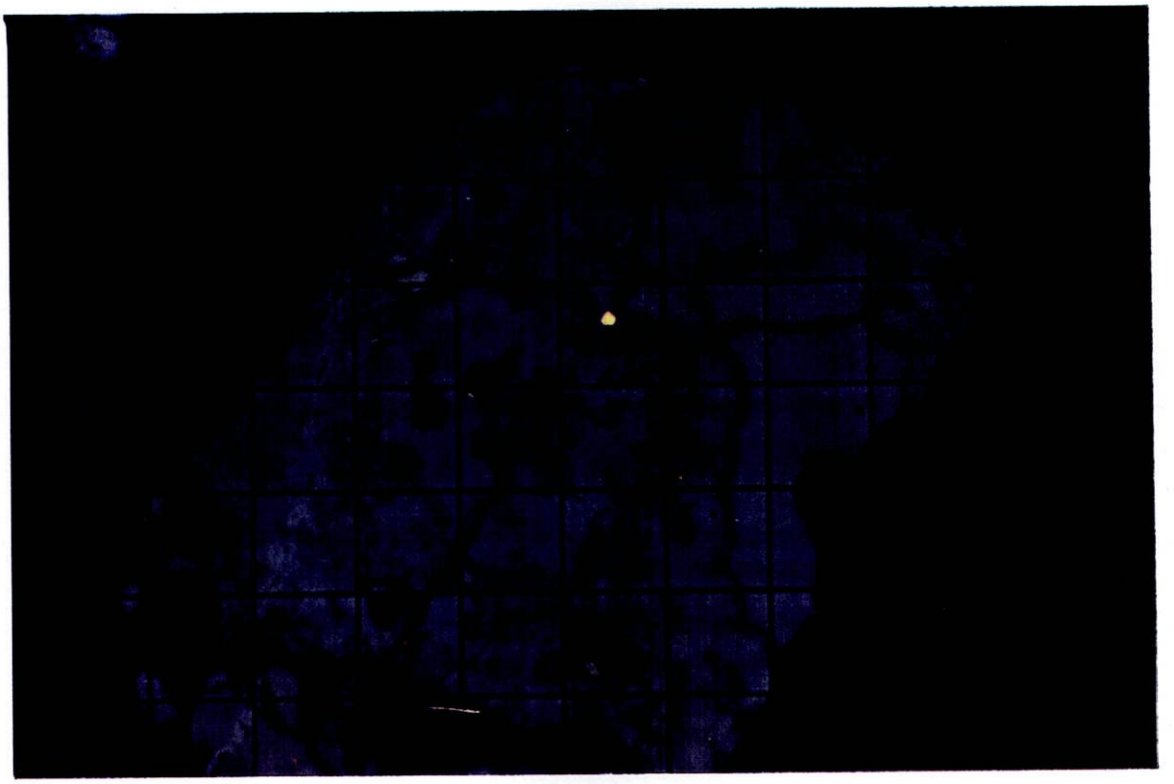
YM71 - 85-90'. Polished section photomicrograph of liberated dendritic aggregate of native gold. Plain light, X435. Each square of grid is 32 microns on an edge.



YM71 - 85-90'. Polished section photomicrograph of liberated native gold particle with associated quartz gangue. Plain light, X435. Each square of grid is 32 microns on an edge.

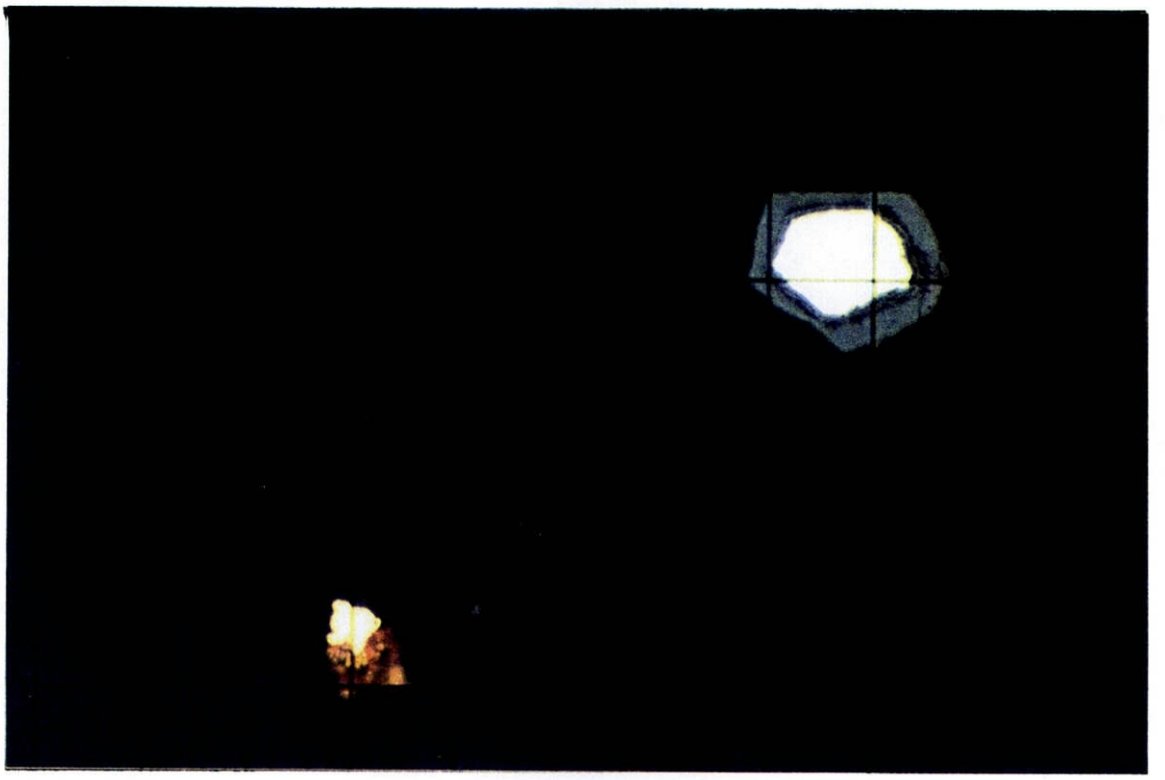
YM71 - 85-90'. Polished section photomicrograph of liberated native gold particle with associated quartz gangue (dark), goethite (center), and galena (far left). Plain light, X435. Each square of grid is 32 microns on an edge.

YM71 - 85-90'. Polished section photomicrograph of liberated native gold particle. Plain light, X435. Each square of grid is 32 microns on an edge.



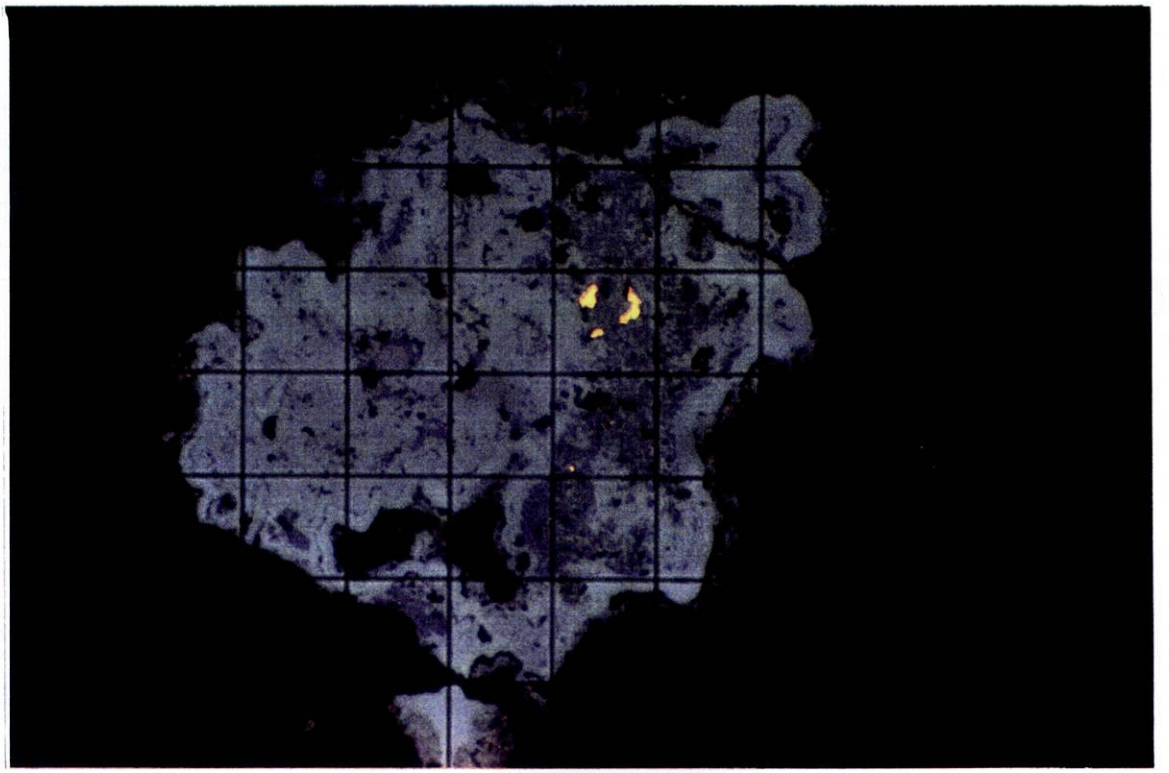
YM71 - 85-90'. Polished section photomicrograph of small native gold particle locked by goethite oxidation pseudomorph. Plain light, X435. Each square of grid is 32 microns on an edge.

YM71 - 85-90'. Polished section photomicrograph of liberated native native gold particle. Plain light, X435. Each square of grid is 32 microns on an edge.



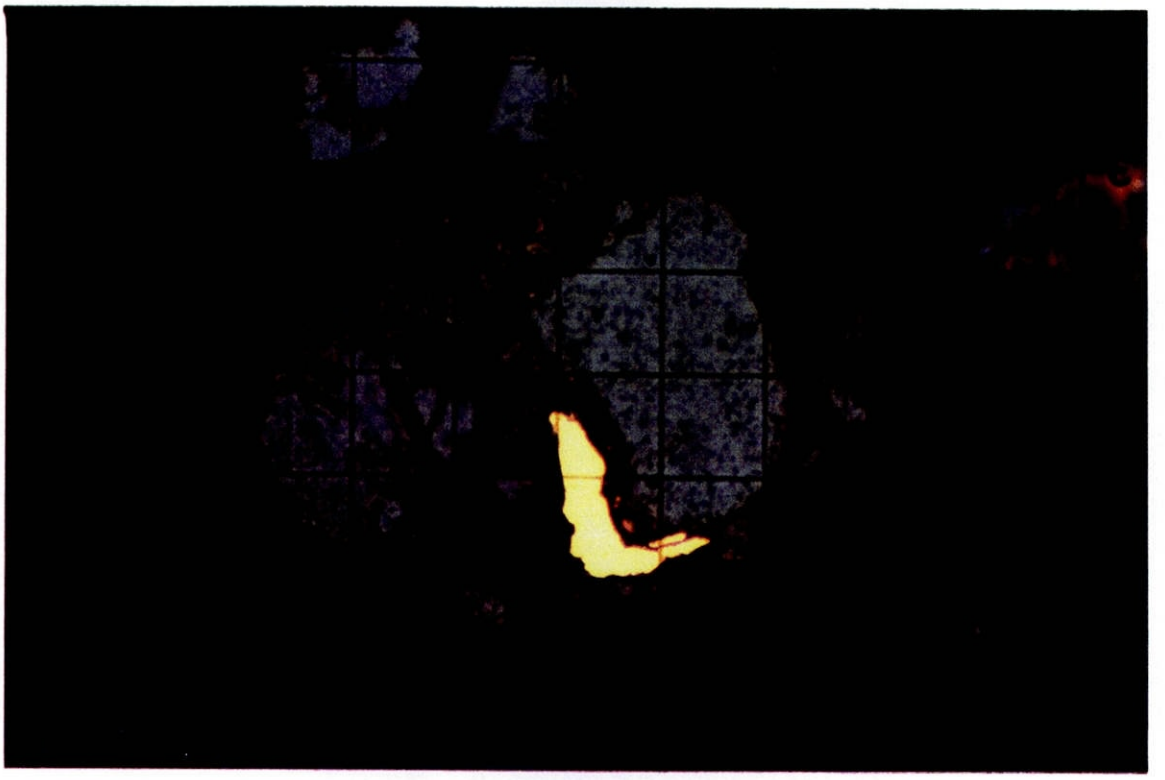
YM71 - 85-90'. Polished section photomicrograph of native gold in liberated particle associated with pyrite remnant rimmed by goethite oxidation pseudomorph. Plain light, X435. Each square of grid is 32 microns on an edge.

YM71 - 85-90'. Polished section photomicrograph of liberated native gold particle (center) with goethite-jarosite fragment (upper center). Plain light, X435. Each square of grid is 32 microns on an edge.

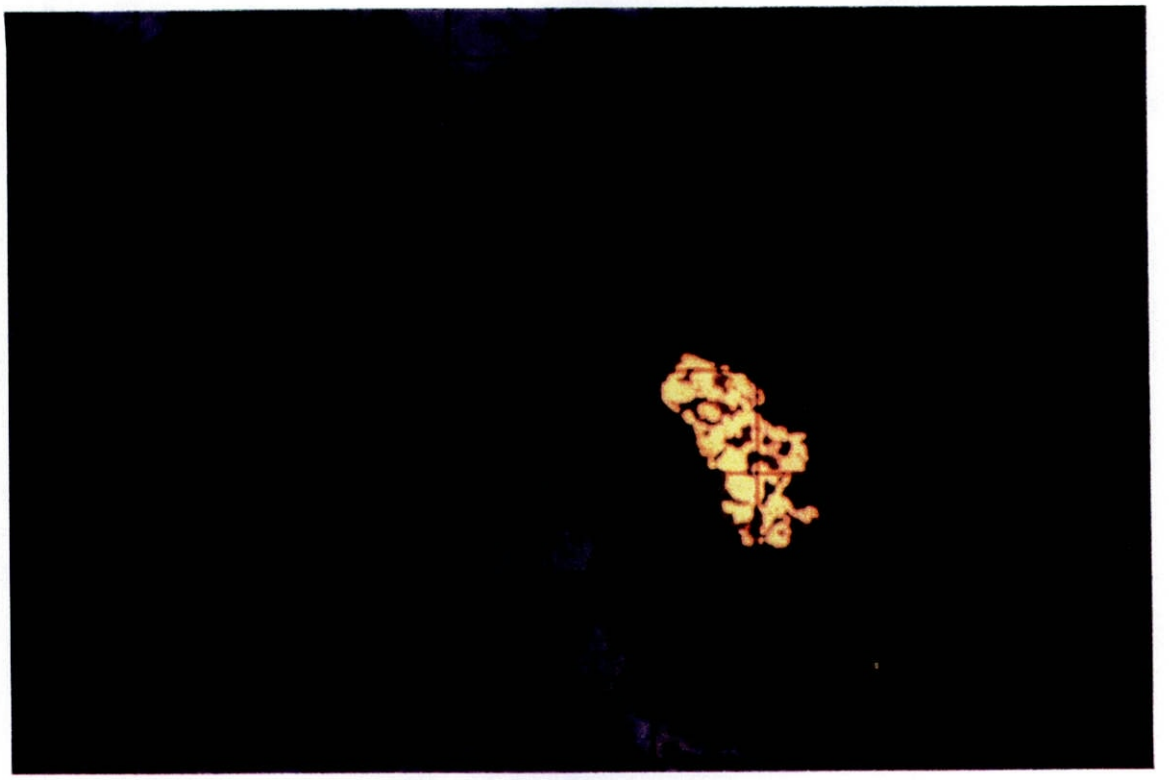


YM71 - 85-90'. Polished section photomicrograph of locked native gold particles in goethite fragment. Plain light, X435. Each square of grid is 32 microns on an edge.

YM71 - 85-90'. Polished section photomicrograph of small liberated native gold particles associated with goethite and trash iron fragments. Plain light, X435. Each square of grid is 32 microns on an edge.

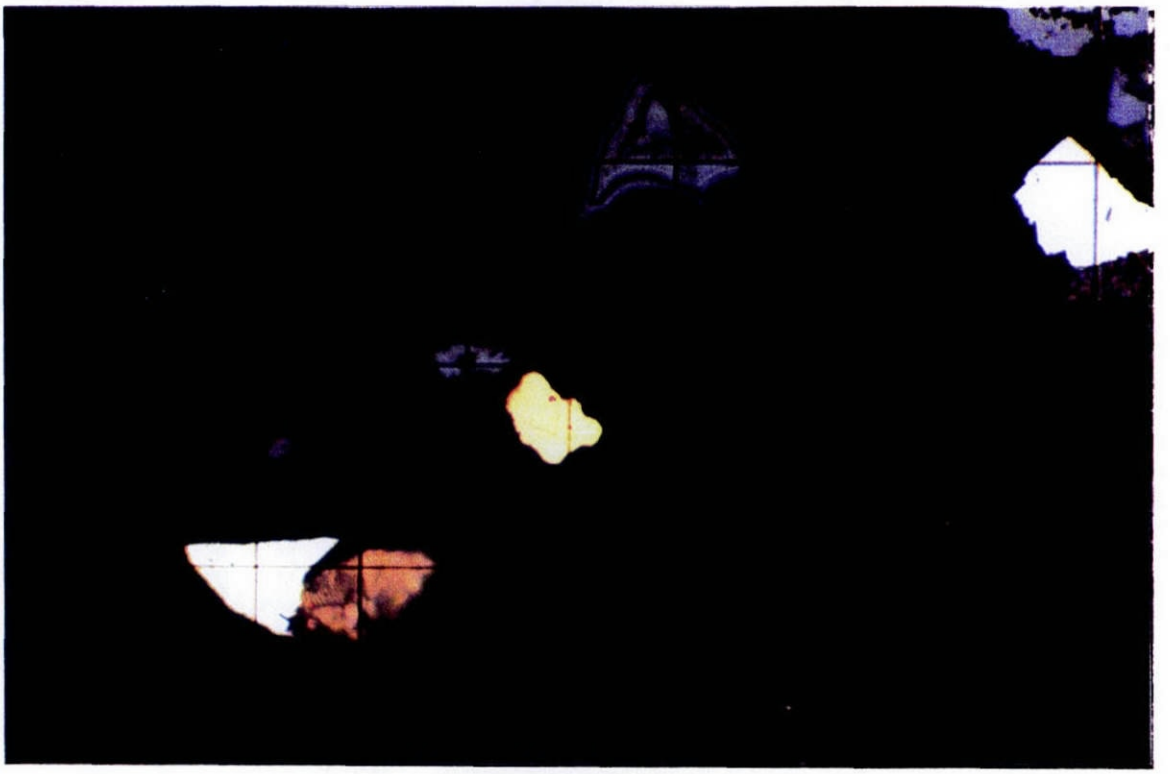


YM71 - 85-90'. Polished section photomicrograph showing composite grain with native gold and goethite. Plain light, X435. Each square of grid is 32 microns on an edge.



YM71 - 85-90'. Polished section photomicrograph of liberated and dendritic native gold aggregate associated with goethite-gangue fragments. Plain light, X435. Each square of grid is 32 microns on an edge.

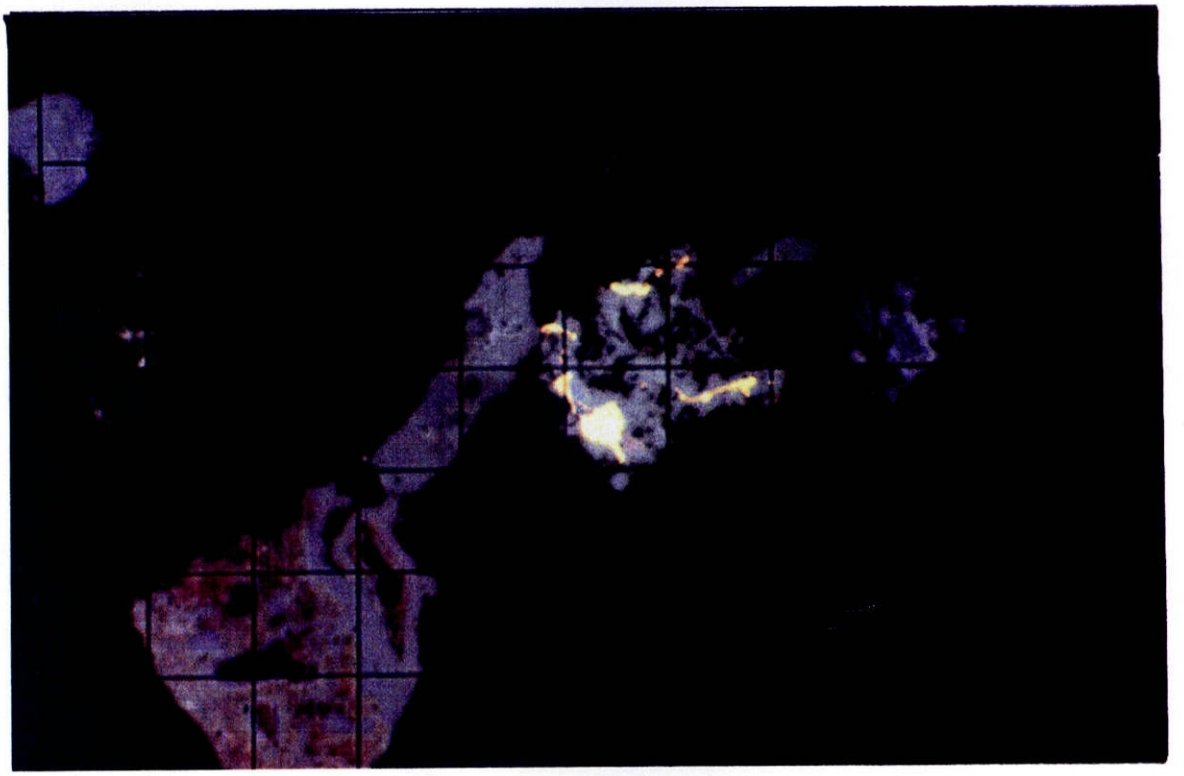
YM71 - 85-90'. Polished section photomicrograph showing small native gold particle locked in goethite that also forms composite grain with larger native gold particle. Plain light, X435. Each square of grid is 32 microns on an edge.



YM71 - 85-90'. Polished section photomicrograph of liberated native gold particle associated with separate fragments of goethite (upper center), galena (upper right), and pyrite (lower left). Plain light, X435. Each square of grid is 32 microns on an edge.

YM71 - 85-90'. Polished section photomicrograph of liberated native gold associated with quartz gangue (dark) and goethite (bluish gray). Plain light, X435. Each square of grid is 32 microns on an edge.

YM71 - 85-90'. Polished section photomicrograph of native gold in liberated particle with associated goethite and quartz gangue. Plain light, X435. Each square of grid is 32 microns on an edge.



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.

YM71 - 85-90'. Polished section photomicrograph of native gold in liberated particle associated with goethite. Plain light, X435. Each square of grid is 32 microns on an edge.

YM71 - 85-90'. Polished section photomicrograph showing small liberated particle of native gold (upper center) with quartz gangue. Plain light, X435. Each square of grid is 32 microns on an edge.

RMH 1-6-90 JDS

ASARCO

Southwestern Exploration Division

January 19, 1990

W.L. Kurtz

Thin Section Work
Yarnell Project
Yavapai County, AZ

Attached is one of the Russell M. Honea petrographic-polished section reports on samples collected at Yarnell by M.A. Miller.

This report is the first priority suite samples, and other reports, including the polished sections showing the native gold relationships will be distributed as they become available.

James D. Sell

James D. Sell

JDS:mek
Att.

cc: R.L. Brown
F.T. Graybeal
M.A. Miller

ASARCO

Southwestern Exploration Division

JDS

January 10, 1990

J.D. Sell

Thin Section Work
Yarnell Project
Yavapai County, AZ

The attached report by Russ Honea describes rock samples that we have taken at Yarnell. Sample sites (attached) were selected to assist in the confirmation of the alteration assemblage we are describing for the Yarnell Deposit. Samples were taken from fresh rock through the strongly altered zone (150-161'). Samples were also taken from weakly altered rock located well into the hanging wall of the Yarnell structure to moderate/strongly altered rock at the Yarnell Fault Zone (162-168'). This suite was taken in the main adit tunnel. Results from the tunnel suite will be available within two weeks.

Mark A. Miller/mek

MAM:mek
Atts.

Mark A. Miller
Project Geologist

cc: R.L. Brown
W.L. Kurtz

Russell M. Honea
Consulting Geologist

AC 303 466-9779

Office
1105 BELLAIRE
BROOMFIELD, COLORADO 80020

Mailing Address
P.O. BOX 323
BROOMFIELD, COLORADO 80020

January 6, 1990

Mr. Mark A. Miller
ASARCO Exploration
P. O. Box 5747
Tucson, Arizona 85703-0747

Re: Yarnell Project, AZ

Dear Mark:

Enclosed please find petrographic descriptions for the first priority group of samples from the suite forwarded under your cover letter of November 28, 1989. As usual photomicrographs are included to illustrate some of the pertinent mineralogic and textural characteristics.

The sample suite is comprised of weakly (propylitic) to moderately altered (sericitic) sheared granite. In addition to superimposed hydrothermal alteration there is an early late magmatic or deuteric alteration of plagioclase to sericite. A quartz-poor syenitic phase with lesser amounts of contained biotite is also present (Y-157 and Y-161). This could be a compositional variant of the granite (with local depletion of silica), or it may be a separate intrusive phase. It is also rather strongly crushed, and as noted in our telephone conversation yesterday I am uncertain at this stage whether the K-feldspar in the crushed matrix is dominantly from recrystallization of primary K-feldspar or of hydrothermal origin. Will have more to say about that problem after examining the remaining sections.

Please let me know if there are questions or problems regarding the data. The remaining descriptions will follow in about two weeks.

Sincerely,

Russell M. Honea

Encl.

ASARCO Incorporated
JAN 10 1990
SW Exploration

Y-150. Rather weakly propylitized (epidotized and chloritized) biotitic granite with early sericitic alteration of plagioclase.

Primary Minerals	Percent	Description
Essential Constituents		
Plagioclase-$An_?$	25	Subhedral, rather poorly preserved Carlsbad plus albite twinning. Present as separate crystals with weak to moderate replacement by sericite and epidote, and as finer aggregates enclosed by microcline microperthite. Sericite may be late magmatic rather than classical hydrothermal.
Microcline	50	Subhedral, poorly developed grid twinning, microperthitic. Shows little alteration, and contains small crystal inclusions of plagioclase and quartz.
Quartz	16	Anhedral aggregate-textured material occurs interstitially to feldspars. Has strongly undulatory extinction. Rutile needle inclusions.
Varietal accessory minerals		
Biotite	7	Subhedral plates, strongly pleochroic in yellowish to greenish brown, high birefringence. Occurs with quartz interstitially to feldspars. Shows rather weak alteration to chlorite. Often bent or deformed by shearing or deformation.
Minor accessory minerals		
Sphene	1	Sub- to euhedral prisms, extreme positive relief and high birefringence, strongly inclined extinction. Relatively large grains are mostly near contacts of interstitial quartz aggregates with feldspars.
Apatite	-1	Small colorless subhedral prisms with moderate positive relief and low birefringence, mostly enclosed by feldspars and biotite.
Monazite	-1	Very small short prisms with very high positive relief and high birefringence, slightly inclined extinction. Present as inclusions in biotite and is surrounded by small radiation damage halos.

Y-150.

	Percent	Description
Zircon	-1	Small prisms with extreme positive relief and high birefringence. Rarely present as inclusions in biotite and feldspar minerals.
Tourmaline	-1	Fine grained, subhedral prismatic, strongly dichroic in grayish blue to dark bluish brown, moderate positive relief and moderate birefringence. Aggregates border biotite.
Rutile	-1	Very tiny needle-like crystals with extreme positive relief, present as inclusions in quartz.
Magnetite	1	Subhedral equant prisms in feldspar and bordering biotite, largely altered to hematite.
Secondary Minerals		
Sericite	6	Fine to very fine grained colorless mica aggregates with high birefringence, present mostly in plagioclase and is likely of deuteric or late magmatic origin.
Chlorite	1+	Green color, low birefringence. Present as an alteration product of some biotite and at times present with epidote replacing plagioclase.
Epidote (Clinozoisite)	3	Subhedral prismatic, very fine grained, pale greenish yellow color, very high positive relief and high birefringence, inclined extinction. Present alone and with sericite and minor chlorite replacing plagioclase. Some also present in sheared quartz aggregates. Present with chlorite replacing biotite.
Hematite	1	Opaque aggregates with red internal reflections, present with remnant magnetite in accessory grains.

Texture: Medium grained phaneritic, equigranular. Shows some shearing and interstitial granulation of primary mineral suite.

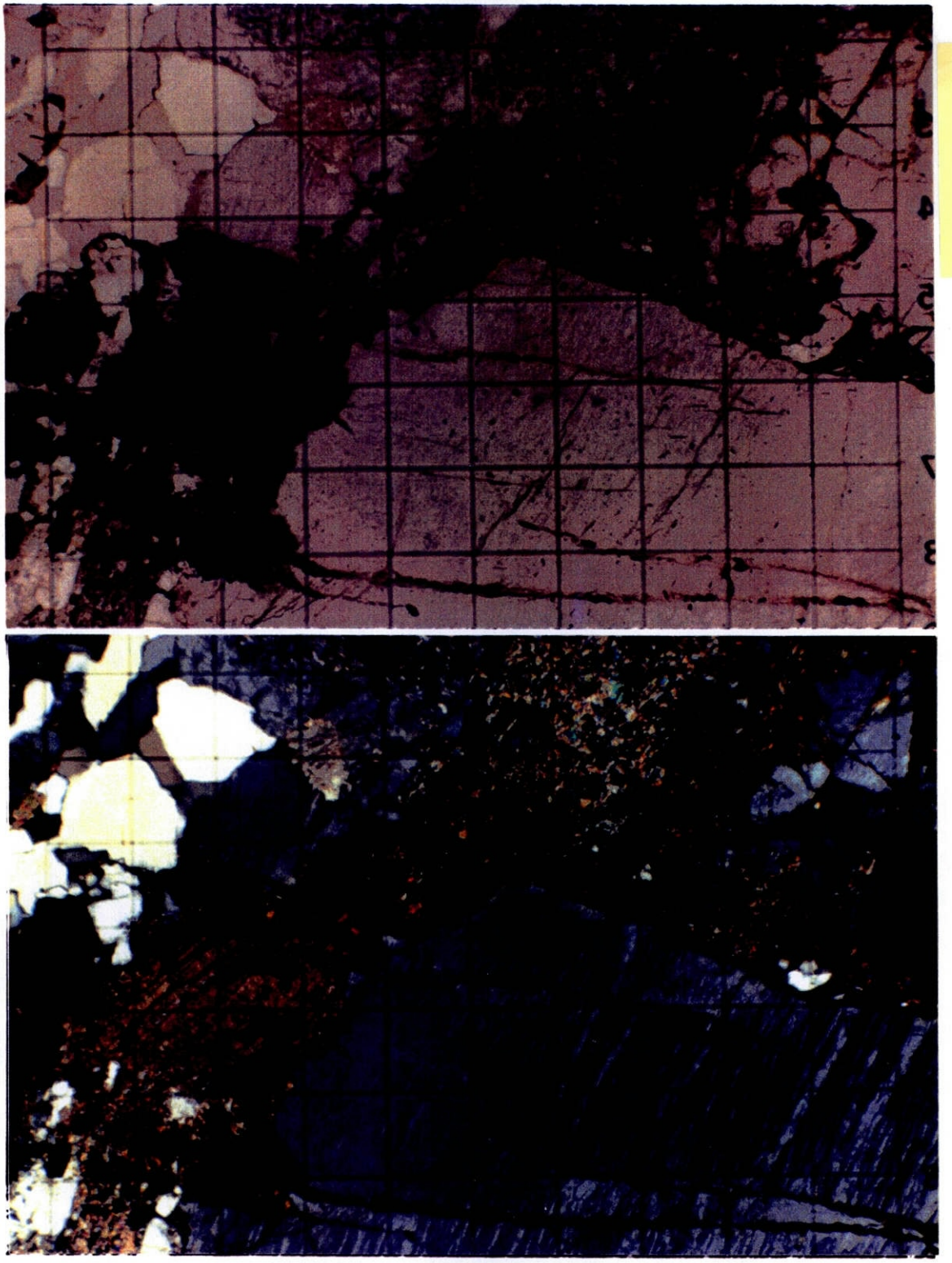


Figure 8

Y-150. Thin section photomicrograph of sheared granite showing sericitized plagioclase (upper center) and weak chlorite-epidote replacement of biotite (left and across center) along with unaltered microcline and quartz. Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.

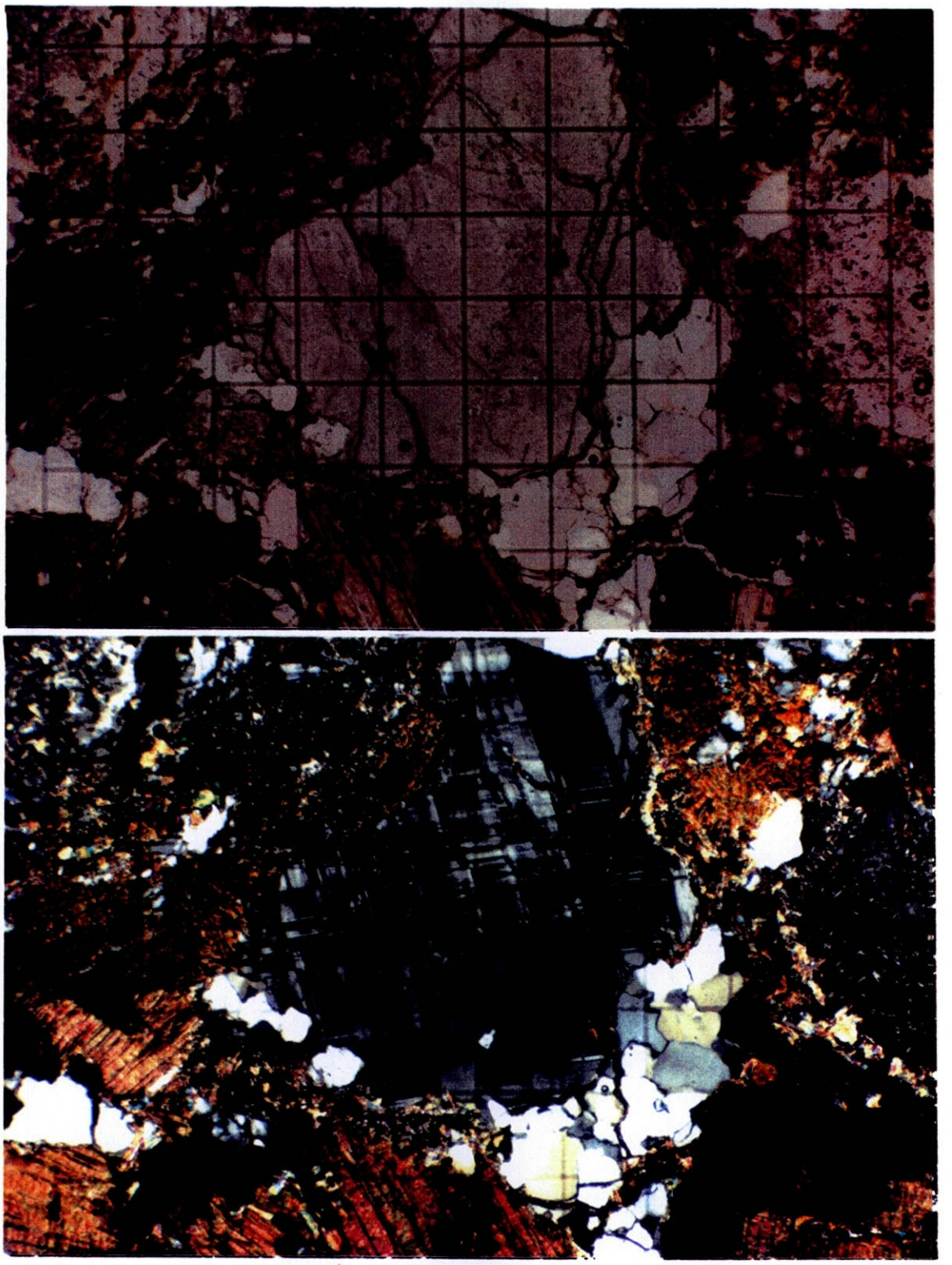
Y-152. Sheared and granulated biotitic granite with weak epidotization (propylitic alteration) and apparently earlier sericite alteration of plagioclase.

Primary Minerals	Percent	Description
Essential Constituents		
Plagioclase-$An_?$	30	Subhedral blocky prisms, Carlsbad plus albite twinning, shows weak to strong replacement by relatively coarse and early sericite and by epidote.
Microcline	44	Subhedral blocky to anhedral, moderate to good development of grid twinning, microperthitic and with irregular patches of plagioclase. This feldspar is essentially unaltered.
Quartz	15	Fine grained granular mosaic aggregates with strongly undulatory extinction. Present interstitially to feldspars. Contains rutile needle inclusions.
Varietal accessory minerals		
Biotite	9	Medium grained, subhedral, pleochroic in shades of brown, often shows some shearing and granulation. Some is bleached to colorless with separation of opaques. Minor parallel growths of muscovite.
Muscovite	-1	Scarce and small colorless mica flakes with high birefringence adjacent to and in parallel growth with some of biotite. May possibly be of deuteric origin.
Minor accessory minerals		
Sphene	-1	Fine grained, subhedral wedges and prisms, extreme positive relief and high birefringence. Scattered through host and is at times associated in space with biotite.
Apatite	-1	Small colorless prisms with moderate positive relief and low birefringence, present as inclusions in biotite and feldspars.
Tourmaline	-1	Medium size subhedral prisms, strongly dichroic in grayish blue to brownish blue, moderate positive relief and moderate birefringence. Crystals are often broken and are associated in space with biotite.

Y-152.

	Percent	Description
Zircon	-1	Very small prisms with extreme positive relief and high birefringence, enclosed by feldspars and biotite.
Monazite	-1	Small prisms with very high positive relief and high birefringence, slightly inclined extinction. Enclosed by biotite and is surrounded by weak radiation damage halos.
Rutile	-1	Very tiny needle-like crystals with extreme positive relief are present as inclusions in quartz aggregates.
Magnetite	1	Small equant opaque crystals are mostly associated in space with biotite. Is now altered to hematite.
Ilmenite	-1	Fine grained, subhedral tabular, black opaque. Associated in space with altered magnetite.
Secondary Minerals		
Sericite	9	Fine grained colorless mica aggregates with high birefringence, present mostly in plagioclase and has textural characteristics suggesting a deuteric or late magmatic origin. Also minor amount associated with biotite.
Clinozoisite	2	Very fine grained, subhedral prismatic to anhedral, very high positive relief and high birefringence, almost colorless or at times with pale greenish yellow pleochroism and color. Present in alteration aggregates replacing plagioclase and in minor amount with biotite. Optics indicate low iron epidote or clinozoisite.
Leucoxene	-1	Extremely fine grained opaque white aggregates of Ti oxides present in bleached biotite flakes.
Iron oxides	1+	Very fine to extremely fine grained opaque red aggregates replacing accessory magnetite and as a dusting of orange red oxides in some of fractured or granulated material.

Texture: Medium grained phaneritic, equigranular. Shows moderate shearing and some granulation along grain margins to form finer grained interstitial aggregates - especially of biotite and quartz.



Y-152. Thin section photomicrograph of sheared and weakly altered granite showing biotite along with associated microcline, quartz, and altered plagioclase (right center). Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.

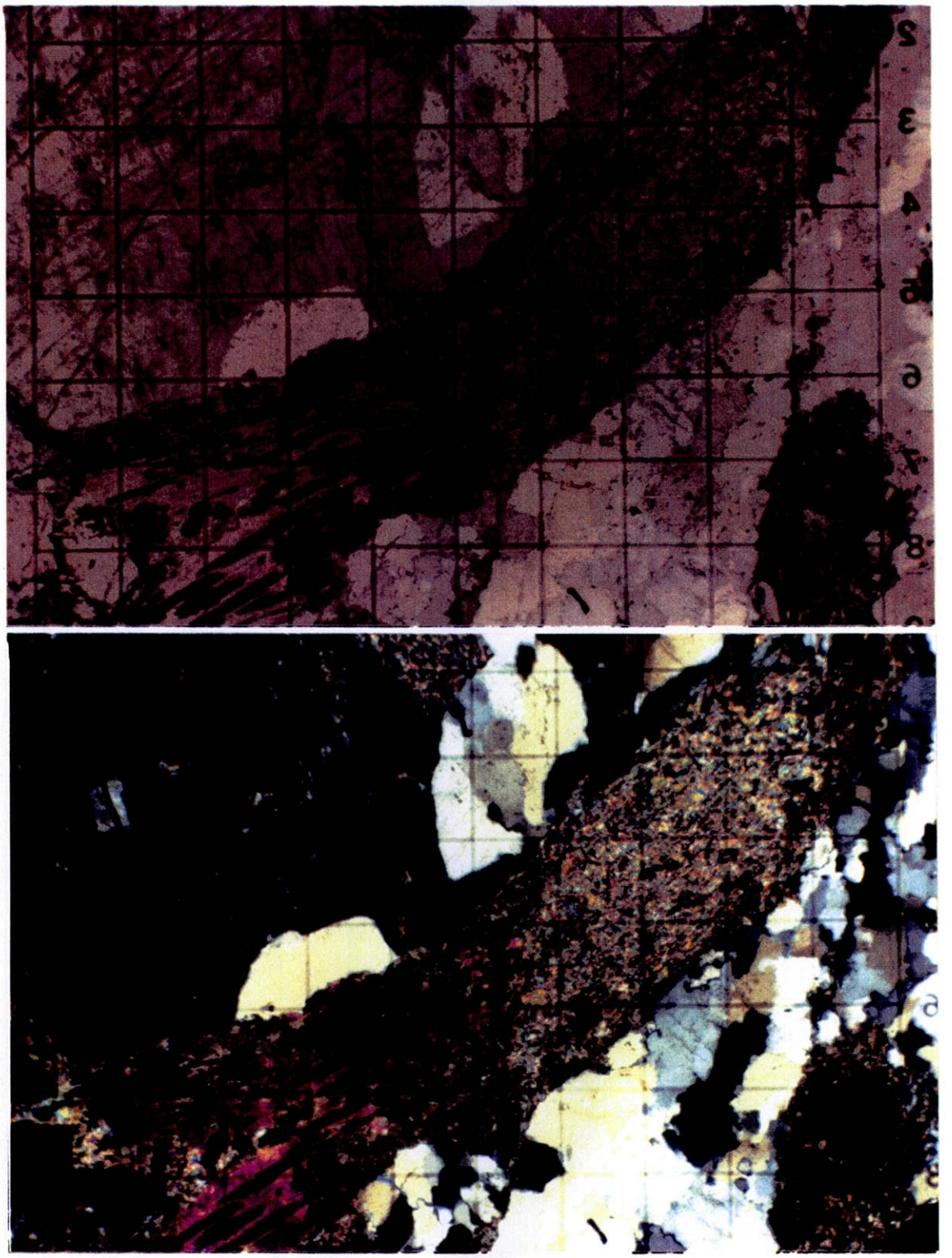
Y-154. Moderately sericitized granite with minor chlorite-calcite-quartz and pyrite (Phyllic alteration).

Primary Minerals	Percent	Description
Essential Constituents		
Plagioclase-$An_?$	35	Subhedral short prismatic, Carlsbad plus albite twins, shows moderate to complete alteration by fine grained sericite aggregates.
Microcline	45	Subhedral stubby prisms to anhedral, well developed grid twinning, microperthitic. Either unaltered or with minor sericite and calcite along microfractures.
Quartz	12	Fine to medium grained, anhedral and with sutured to granular mosaic contacts, rutile needle inclusions. Has strongly undulatory extinction.
Varietal accessory minerals		
Biotite	6	None preserved. Former subhedral flakes are now completely bleached to colorless sericite with accompanying separation of opaques.
Minor accessory minerals		
Sphene	-1	None preserved. Former wedge-shaped to prismatic crystals are now completely replaced by leucoxene.
Apatite	-1	Small colorless prisms with moderate positive relief and low birefringence, enclosed by feldspars and by altered biotite.
Zircon	-1	Small prisms with extreme positive relief and high birefringence, enclosed by altered biotite and feldspars.
Monazite	-1	Small short prisms with very high positive relief and high birefringence, slightly inclined extinction. Enclosed by altered biotite.
Rutile	-1	Scarce and very small needle-like inclusions present in quartz.
Magnetite	1	Small equant subhedral black opaque grains associated in space with altered biotite. Most has been altered to hematite.

Y-154.

	Percent	Description
Secondary Minerals		
Quartz	2	Very fine grained aggregates with sutured contacts present with sericite-chlorite-calcite filling fractures cutting host.
Sericite	20	Very fine grained colorless mica aggregates with high birefringence, present as essentially complete replacement of biotite and plagioclase from the primary assemblage. Some may be of deuteric origin.
Chlorite	4	Very fine grained, pale green to greenish yellow, low birefringence. Occurs with sericite and calcite replacement aggregates after biotite and plagioclase, and in fracture fillings.
Calcite	2	Fine to very fine grained colorless aggregates, strong differential relief and high birefringence. Present in fracture fillings and replacement aggregates.
Leucoxene	1	Extremely fine grained opaque white Ti oxide aggregates formed from alteration of both biotite and sphene.
Pyrite	-1	Small cubic crystals, opaque yellow metallic in oblique incident light. Present in small amount with sericite-chlorite-calcite replacement aggregates.
Hematite	1	Very fine grained opaque aggregates with red internal reflections, present as an alteration product of accessory magnetite.

Texture: Medium grained phaneritic, equigranular. Shows some shearing and rather strong alteration.



Y-154. Thin section photomicrograph of sericitized granite with completely sericitized biotite and plagioclase associated with microcline and quartz. Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.

Y-155. Moderately sericitized granite with minor oxidized pyrite.

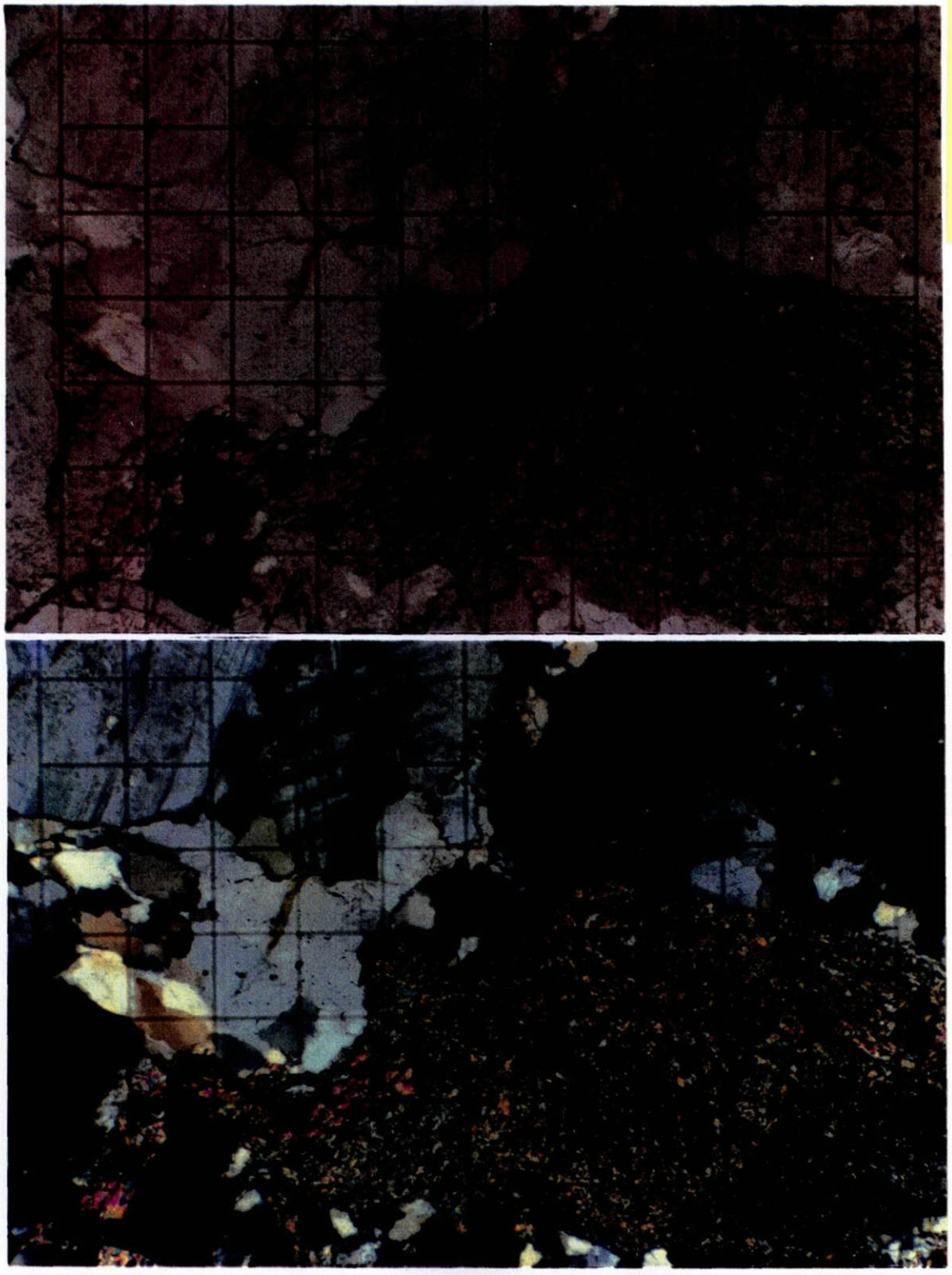
Primary Minerals	Percent	Description
Essential Constituents		
Plagioclase-An_7	35	Subhedral short prismatic, Carlsbad plus albite twinning. Is mostly replacement by sericite - of probable deuteric (coarser) and hydrothermal (finer) origin.
Microcline	41	Subhedral stubby prisms to anhedral, moderately well developed grid twinning, microperthitic. Grains are essentially unaltered.
Quartz	12	Fine grained aggregates with sutured contacts and undulatory extinction. Occurs interstitially to feldspars. Contains abundant rutile needle inclusions.
Varietal accessory minerals		
Biotite	10	None preserved. Former subhedral flakes and aggregates are now completely replaced by sericite (bleached) and show accompanying separation of opaque oxides.
Minor accessory minerals		
Sphene	-1	None preserved. Former subhedral prisms are now completely altered to leucoxene.
Apatite	-1	Subhedral prisms, colorless, moderate positive relief and low birefringence. Associated in space with altered biotite and enclosed by feldspars.
Zircon	-1	Subhedral prisms with extreme positive relief and high birefringence, enclosed by feldspars and altered biotite. At times associated in space with magnetite.
Rutile	-1	Very tiny needle-like crystal inclusions with extreme positive relief, present in quartz and at times forming oriented hexagonal patterns.
Monazite	-1	Subhedral prisms with very high positive relief and high birefringence, slightly inclined extinction. Single crystals and aggregates are enclosed by altered biotite.

Y-155.

	Percent	Description
Magnetite	1+	Equant subhedral opaque aggregates are often associated in space with altered biotite. In part oxidized to hematite.
Ilmenite	-1	Subhedral tabular black opaque grains, usually associated in space with magnetite.
Secondary Minerals		
Sericite	20	Fine to very fine grained colorless mica aggregates with high birefringence, present as complete replacement of biotite and as almost complete replacement of plagioclase. The coarser material in plagioclase replacement aggregates may be of deuteric origin.
Leucoxene + Rutile	1	Occurs as extremely fine grained aggregates formed by alteration of biotite and sphene and in needle-like to acicular crystals separated from biotite during alteration.
Pyrite	(1)	None preserved. Former small cubic crystals with sericite are now oxidized to goethite.
Iron oxides	2	Extremely fine grained opaque red to brown aggregates present as an oxidation product of accessory magnetite and from secondary pyrite.

Texture: Medium grained phaneritic, equigranular. Very minor shearing in this sample.

Figure 5



Y-155. Thin section photomicrograph of altered granite showing sericite replaced plagioclase with associated microcline, quartz, and sericite replace biotite. Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.

Y-157. Sheared and granulated rather weakly altered syenite with goethite staining. Shows minor clay and sericite in sheared areas.

Primary Minerals	Percent	Description
Essential Constituents		
Plagioclase-An_7	27	Subhedral short prismatic, Carlsbad plus albite twinning, frequently fractured and shows some bending of twin lamellae. Locally replaced by clay and sericite along shears. Contains rutile needle inclusions similar to those in quartz. Some of crystals are antiperthitic - contain very small and irregularly shaped inclusions of microcline.
Microcline	66	Subhedral short prismatic to anhedral, moderately well developed grid twinning, either unaltered or with minor clay formation on some of fractures. Crystals are microperthitic.
Quartz	3	Fine to medium grained, anhedral, undulatory extinction, rutile needle inclusions. Occurs in minor amount interstitially to feldspars.
Varietal accessory minerals		
Biotite	2?	None preserved. Scarce former small subhedral flakes are now sheared and bleached to colorless with accompanying separation of opaques.
Minor accessory minerals		
Sphene	-1	None preserved. Former subhedral prisms and wedges are now completely altered to leucoxene.
Apatite	-1	Subhedral colorless prisms with moderate positive relief and low birefringence, enclosed by feldspars. Also in sheared or granulated aggregates.
Zircon	-1	Small prisms with extreme positive relief and high birefringence, enclosed by feldspars and in sheared aggregates.
Monazite	-1	Scarce short prisms with very high positive relief and high birefringence, slightly inclined extinction. Present mostly with sheared and interstitial altered biotite aggregates.

Y-157.

	Percent	Description
Rutile	-1	Extremely fine grained needle-like crystals with extreme positive relief, present as inclusions in both quartz and plagioclase.
Magnetite	1	Small equant opaque grains with altered biotite in sheared aggregates.
Secondary Minerals		
Sericite	2	Very fine grained colorless mica aggregates with high birefringence, present in small amount as an alteration product of biotite and plagioclase in sheared portions of host.
Clays	3	Very fine to extremely fine grained aggregates with low birefringence, present either alone or with sericite in fractures cutting host and in granulated aggregates.
Leucoxene	-1	Extremely fine grained opaque white Ti oxide aggregates formed by alteration of accessory biotite and sphene.
Pyrite	(1)	None preserved. Former subhedral cubic crystals in sheared host are now replaced by goethite oxidation pseudomorphs.
Iron oxides	2+	Extremely fine grained opaque red to brown aggregates formed from magnetite and by oxidation of pyrite.

Texture: Medium grained phaneritic, equigranular. Sheared and shows some intergranular crushing or granulation.

Y-157. Thin section photomicrograph showing sheared and goethite-stained plagioclase and microcline of syenite host. Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.

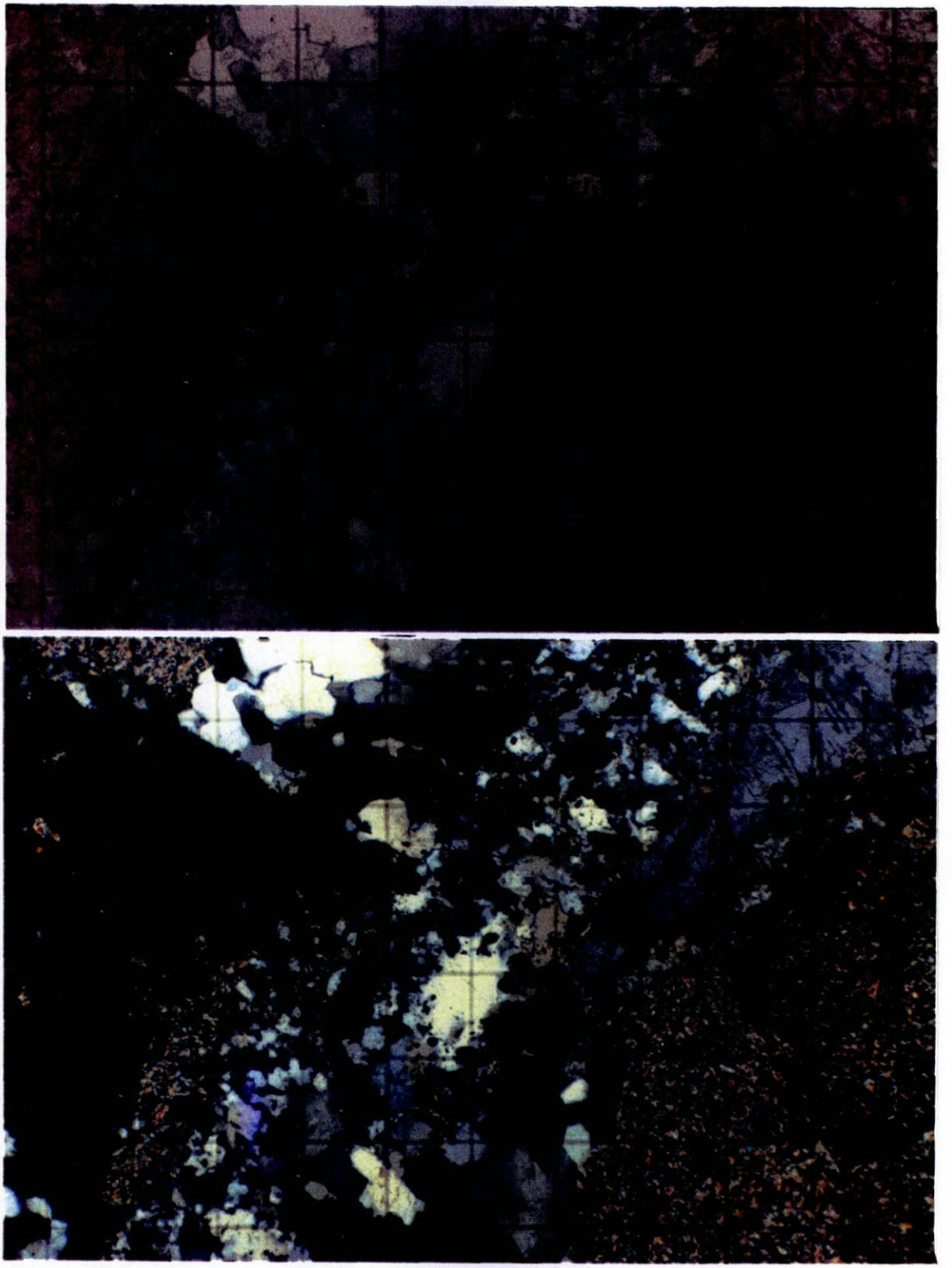
Y-158. Moderately granulated and sericitized granite cut by fracture fillings containing quartz-sericite-goethite.

Primary Minerals	Percent	Description
Essential Constituents		
Plagioclase-$An_?$	36	Subhedral prismatic, Carlsbad plus albite twinning, separate crystals are strongly replaced by sericite. Also present as small and irregularly shaped inclusions in microcline.
Microcline	40	Subhedral blocky prisms to anhedral, moderately well developed grid twinning, microperthitic. Is essentially unaltered - but is cut by fractures containing sericite and showing granulation.
Quartz	15	Fine grained, anhedral, sutured contacts, present interstitially to feldspars. Has strongly undulatory extinction and contains rutile needle inclusions.
Varietal accessory minerals		
Biotite	8	None preserved. Former subhedral flakes and aggregates are now bleached to colorless or replaced by sericite - with accompanying separation of opaque oxides.
Minor accessory minerals		
Zircon	-1	Small euhedral prisms with extreme positive relief and high birefringence, most is associated in space with altered biotite but some also in feldspars.
Apatite	-1	Subhedral short prisms, colorless, moderate positive relief and low birefringence. Same mode of occurrence as for zircon.
Sphene	-1	None preserved. Former subhedral wedges and prisms are now altered to leucoxene.
Rutile	-1	Extremely fine grained needle-like crystals with extreme positive relief, present as inclusions in quartz.
Monazite	-1	Scarce short prisms with very high positive relief and high birefringence, slightly inclined extinction. Present in altered biotite aggregates.

Y-158.

	Percent	Description
Ilmenite	-1	Rare and very fine grained black opaque aggregates enclosed by quartz and feldspar. Some is altered to iron oxide and leucoxene aggregates.
Secondary Minerals		
Quartz	5?	Fine to very fine grained colorless aggregates with granular mosaic contacts, present alone and with sericite as filling of small veinlets cutting host minerals.
Sericite	27	Fine to very fine grained colorless mica aggregates with high birefringence. Present mostly as replacement of plagioclase - but also replacing biotite and as partial filling of fractures.
Leucoxene	1	Extremely fine grained opaque white Ti oxide aggregates formed from both sphene and biotite.
Pyrite	(2)	None preserved. Former small cubic to pyritohedral crystals are now completely replaced by goethite.
Goethite	3	Very fine to extremely fine grained yellowish brown to orange brown aggregates present both as oxidation pseudomorphs after pyrite and with leucoxene in altered biotite. Also in fracture fillings.

Texture: Medium grained phaneritic, equigranular. Shows moderate degree of shearing and some granulation along grain margins.



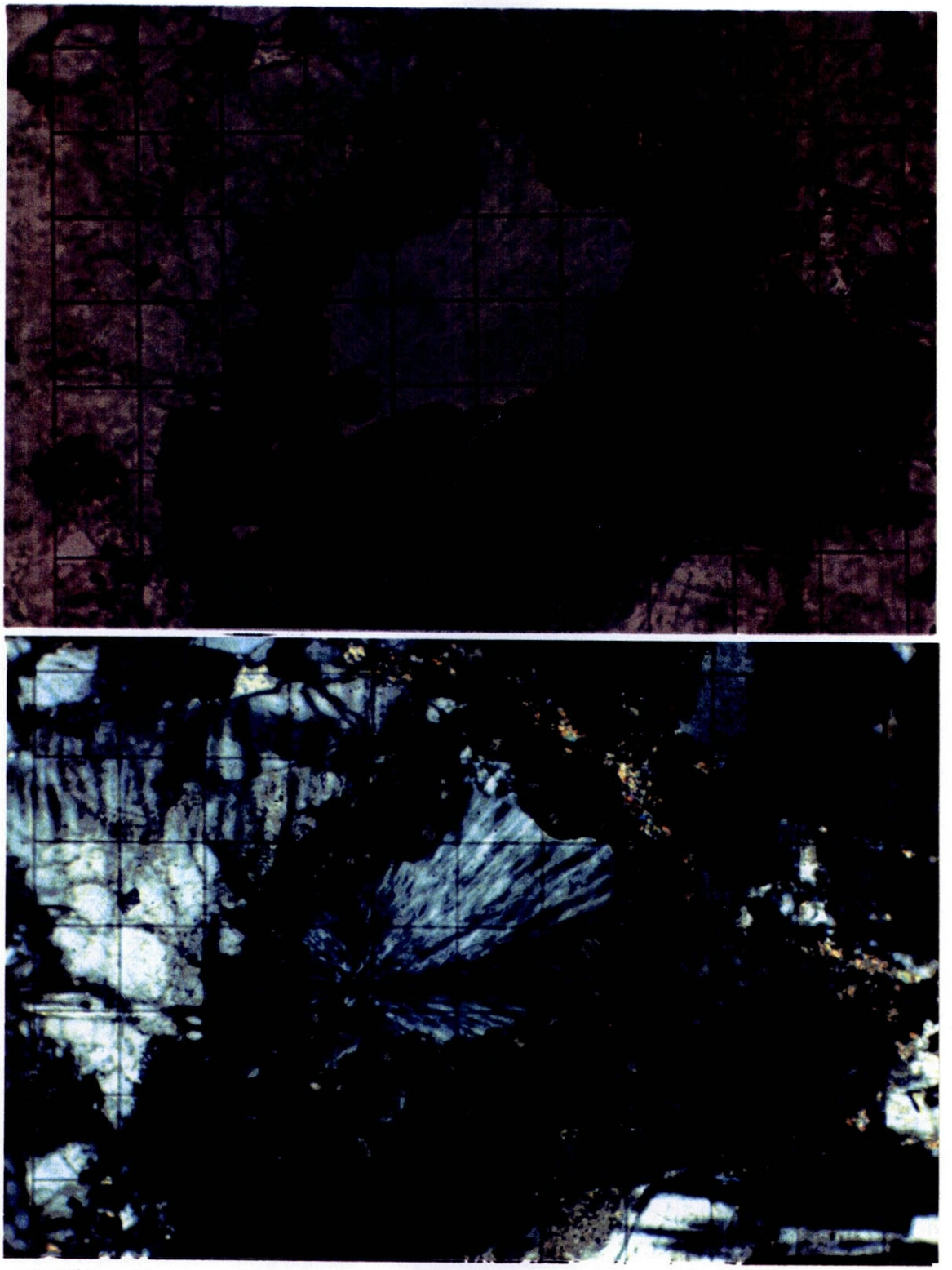
Y-158. Thin section photomicrograph of sheared granite showing quartz veinlet with opaque goethite cutting matrix of microcline, quartz, and sericitized plagioclase (lower right and left). Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.

Y-160. Strongly sheared and granulated granitic host with quartz-sericite-clay alteration and veinlets and with goethite formation. Minor chalcedony and opal in cavity fillings.

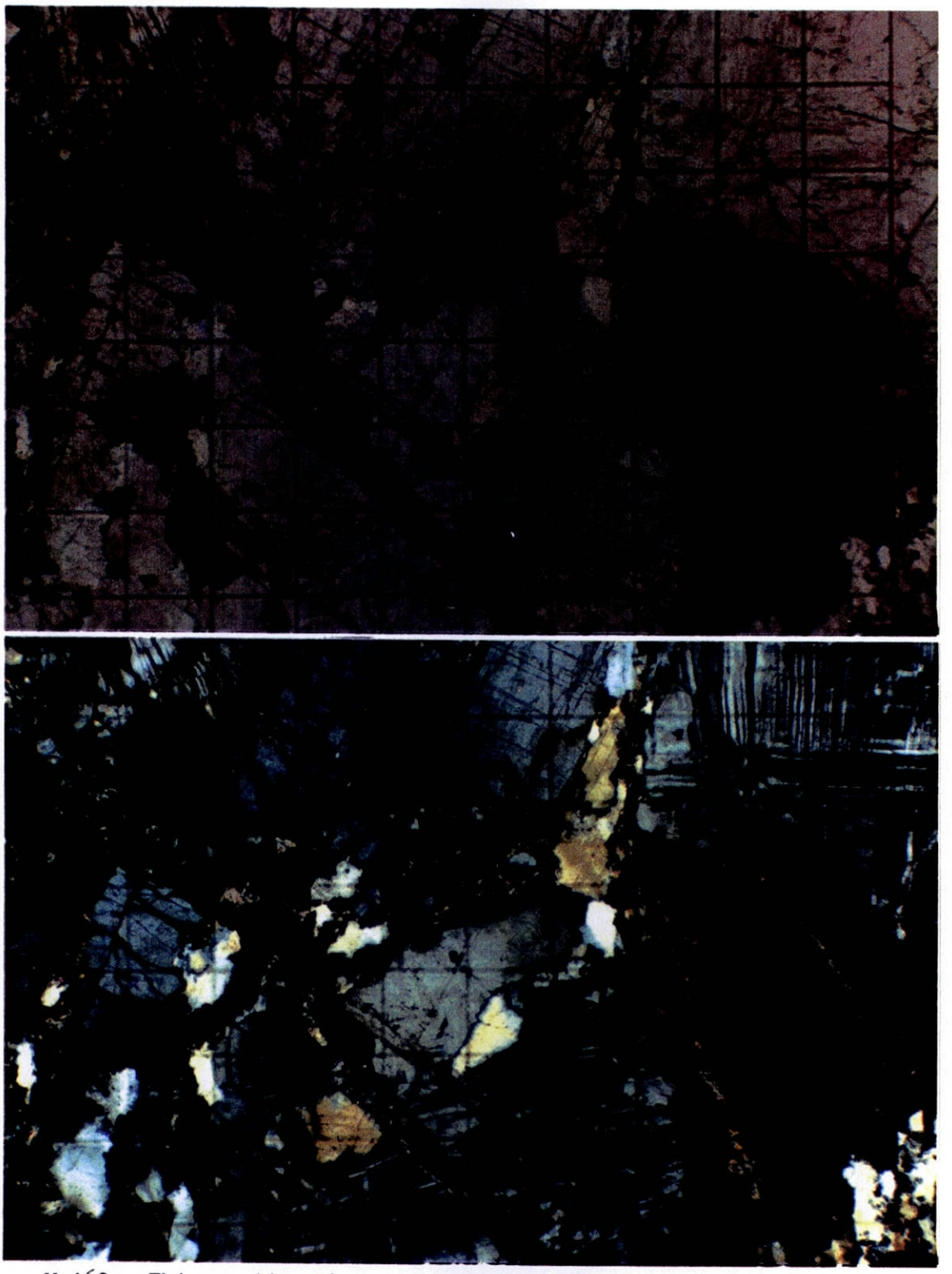
Primary Minerals	Percent	Description
Essential Constituents		
Plagioclase-$An_?$	20?	Subhedral short prisms to anhedral, rather poorly developed Carlsbad plus albite twins. Larger crystals show dusting of clay alteration and there is some sericite replacement in granulated material.
Microcline	62	Subhedral blocky prisms to anhedral, moderately well developed grid twinning, microperthitic. Grains are essentially unaltered.
Quartz	12	Fine to medium grained aggregates with sutured contacts, occurs interstitially to feldspars. Strongly undulatory extinction and often contains rutile needle inclusions.
Varietal accessory minerals		
Biotite	5	None preserved. Former relatively scarce flakes are now rather strongly crushed and altered to sericite with accompanying separation of opaque oxides.
Minor accessory minerals		
Apatite	-1	Colorless subhedral prisms with moderate positive relief and low birefringence, enclosed by feldspars and with sheared biotite.
Zircon	-1	Small prisms with extreme positive relief and high birefringence. Scarce inclusions in feldspars and with sheared biotite.
Rutile	-1	Very tiny needle-like crystals with extreme positive relief, present as inclusions in quartz.
Sphene	-1	None preserved. Former subhedral prisms are now completely replaced by leucoxene.
Secondary Minerals		
Quartz	22?	Fine to very fine grained, granular mosaic contacts, undulatory

	Percent	Description
		extinction. Occurs alone and with other secondaries as filling of veinlets and as matrix cementing crushed or granulated host material.
Chalcedony	-1	Very fine grained and feathery-textured subradial aggregates present in minor amount overlieing opal deposited at cavity walls.
Opal	-1	Minor amount present as finely banded aggregates at walls of cavities filled by chalcedony. Isotropic or amorphous and with strong differential relief.
Sericite	10	Very fine grained colorless mica aggregates with high birefringence, present in shears and in granulated matrix. Formed from both biotite and plagioclase.
Clay	10	Extremely fine grained dusting of low birefringence clay is formed from plagioclase in the host assemblage. In part stained by iron oxides.
Clinozoisite	1	Very fine grained prismatic aggregates, essentially colorless in section, very high positive relief and high birefringence. Present in minor amount as partial filling of shears in association with sericite.
Leucoxene	-1	Extremely fine grained opaque white Ti oxide aggregates formed from alteration of sphene and biotite.
Pyrite	(2)	None preserved. Former small cubic crystals in fractures and sheared matrix are now completely altered to goethite oxidation pseudomorphs.
Goethite	4	Extremely fine grained opaque reddish to orange brown aggregates formed as oxidation pseudomorphs after pyrite, filling fractures, and as a stain in altered silicates.

Texture: Strongly sheared and granulated, originally medium grained phaneritic and equigranular.



Y-160. Thin section photomicrograph showing chalcedony filling cavity lined by opal in crushed granite with fragments of quartz and microcline. Plain light and crossed nicols, X110. Each square of grid is 130 microns on an edge.



Y-160. Thin section photomicrograph of sheared and veined granite with clay-altered plagioclase (right) and microcline (grid twinning) in goethite stained host. Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.

Y-161. Crushed or granulated quartz-bearing syenite with weak to moderate sericite alteration and with cementation by quartz and K-feldspar.

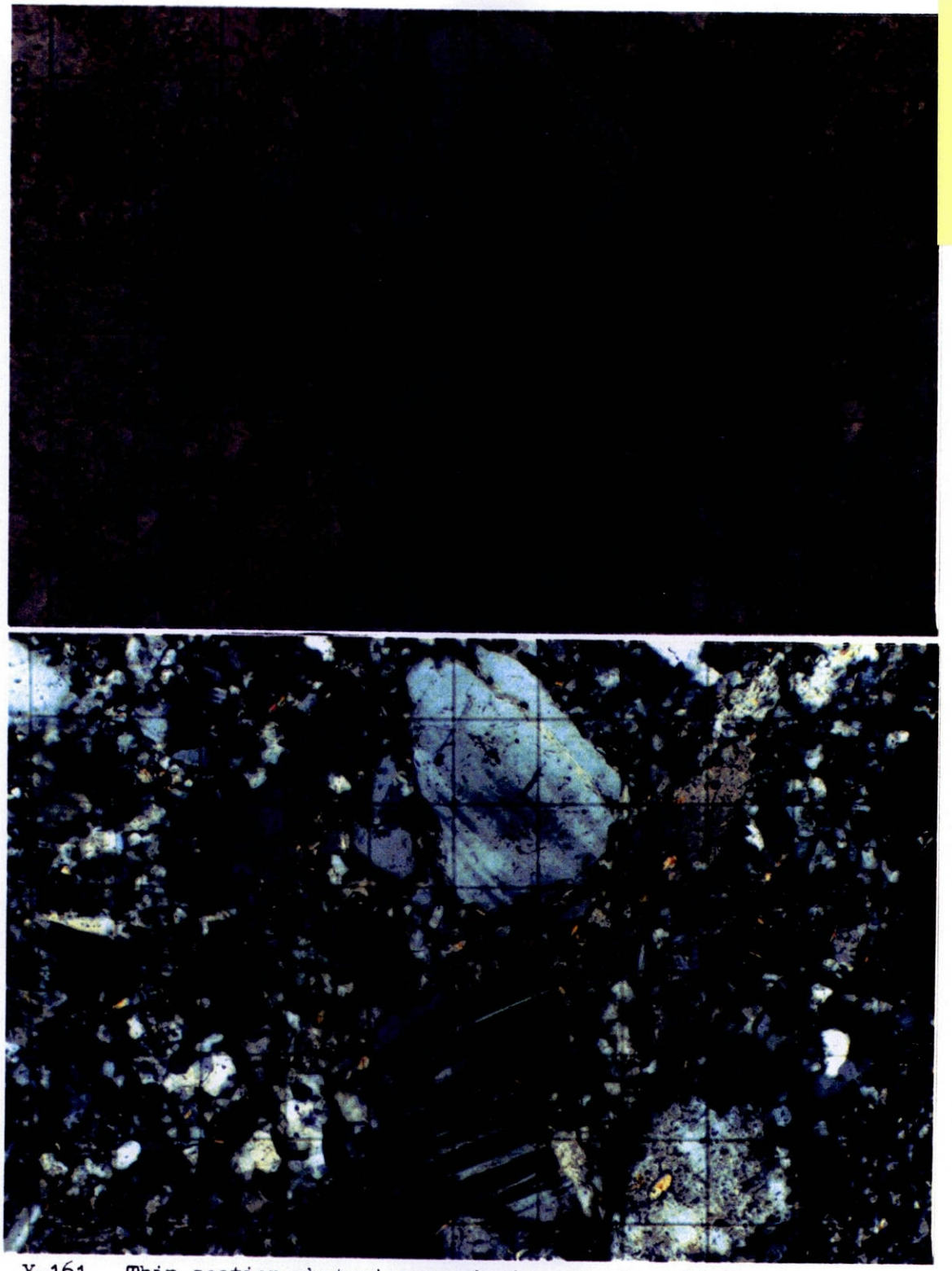
Primary Minerals	Percent	Description
Essential Constituents		
Plagioclase-An_7	24	Subhedral short prismatic to anhedral, Carlsbad plus albite twinning, shows weak to moderate replacement by sericite.
Microcline	66	Subhedral stubby prisms to anhedral, Carlsbad plus rather well developed grid twinning, microperthitic. Crystals are essentially unaltered.
Quartz	5?	Relatively minor fine grained and anhedral aggregates occur interstitially to feldspar minerals.
Varietal accessory minerals		
Biotite	2	None preserved. Scarce former flakes are now crushed and replaced by sericite with accompanying separation of leucoxene.
Minor accessory minerals		
Zircon	-1	Small prisms with rounded terminations, extreme positive relief and high birefringence, enclosed by feldspars and with altered biotite.
Rutile	-1	Small subhedral prisms and aggregates, translucent brown, extreme positive relief and high birefringence. Associated in space with relatively abundant ilmenite.
Monazite	-1	Subhedral prismatic, very high positive relief and high birefringence, slightly inclined extinction. Rarely present with altered biotite.
Ilmenite	3	Subhedral tabular black opaque aggregates, present in aggregates that are interstitial to feldspars.
Apatite	-1	Minor small colorless prisms with moderate positive relief and low birefringence, enclosed by feldspars.
Secondary Minerals		
Quartz	10?	Very fine grained aggregates present with K-feldspar and as matrix cementing

Y-161.

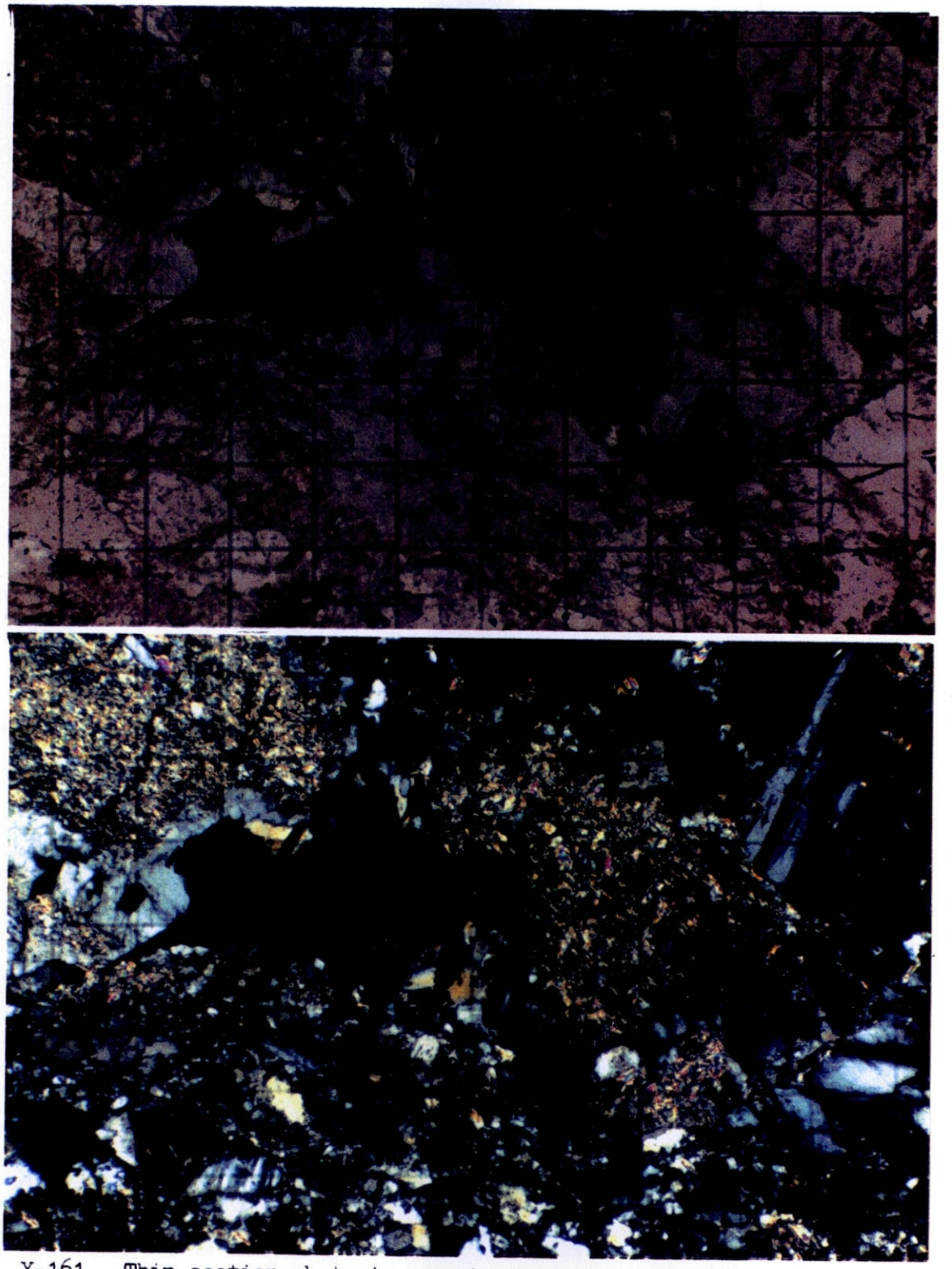
	Percent	Description
		the strongly crushed host silicates.
K-feldspar	15?	Very fine grained, untwinned, scarce rhomb-shaped crystals typical of adularia, lower birefringence and indices than for quartz. Present in matrix cementing crushed silicates. I am uncertain how much is recrystallized from the host suite and how much is introduced as a hydrothermal phase.
Sericite	7	Very fine grained colorless mica aggregates with high birefringence, present in minor to moderate amounts as an alteration product of plagioclase and from alteration of biotite. Occurs in both strongly crushed and less granulated portions of host.
Leucoxene	1	Extremely fine grained translucent to opaque white Ti oxide aggregates formed from alteration of sphene(?) and biotite.
Hematite	-1	Extremely fine grained opaque red aggregates present in small amount with leucoxene from alteration of biotite.

Texture: Originally medium grained phaneritic, equigranular. Now shows locally strong crushing or granulation and cementation by quartz and K-feldspar.

Figure 3
Garnell fault-zone



Y-161. Thin section photomicrograph showing microcline and opaque ilmenite fragments in rather finely crushed and recrystallized quartz-K-feldspar matrix. Plain light and crossed nicols, X110. Each square of grid is 130 microns on an edge.



Y-161. Thin section photomicrograph of altered syenite showing sericitized plagioclase with microcline and ilmenite bordered across bottom by finely crushed host cemented by quartz and K-feldspar. Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.

RMH 1-27-90 JDS

ASARCO

Southwestern Exploration Division

June 5, 1990

W.L. Kurtz

Thin-Section & Polished Sections
Yarnell Project
Yavapai County, Arizona

Attached are the last three Russell M. Honea petrographic-polished section reports on the material sent by M.A. Miller.

James D. Sell

James D. Sell

JDS:mek
Att. (3)

cc: R.L. Brown (w/atts.)
F.T. Graybeal (w/atts.)
M.A. Miller (w/atts.)

Russell M. Honea
Consulting Geologist

AC 303 466-9719

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January 27, 1990

Mr. Mark A. Miller
ASARCO Exploration
P. O. Box 5747
Tucson, Arizona 85703-0747

Re: Yarnell Project, AZ

Dear Mark:

Enclosed are additional petrographic descriptions for your Yarnell sample suite. As usual, photomicrographs are included to illustrate some of the pertinent mineralogic and textural features.

The enclosed descriptions show characteristics very similar to those for the previous group - except that the "weakly altered" samples (Nos. Y-162 and Y-163) show characteristics of moderate sericitic alteration as compared to the prior data. Sample No. Y-151, which was omitted from the previous group of descriptions, shows the least alteration of any of the samples examined to date. Sample Y-159, also omitted from the previous group, is a granite sample from your strong alteration zone in the open cut, and shows distinct quartz veining in addition to strong sericitic alteration of both plagioclase and biotite.

After our conversation on the telephone this morning I went back and have looked again at the data for the two "syenite" samples from the more strongly altered zone. I am still uncertain as to whether they are a separate intrusive phase or a sheared and altered variant of the granite. Both lack the fine grained micas in plagioclase present in all the granite samples, and the rather coarse (and usually altered) sphene and minor tourmaline seen in almost all granite samples. I will go back to the thin sections to have a look at other characteristics, and give more data in the final report.

Please let me know if there are questions regarding the data. The remaining thin and polished section descriptions will follow soon.

Sincerely,

Russell M. Honea

Encl.

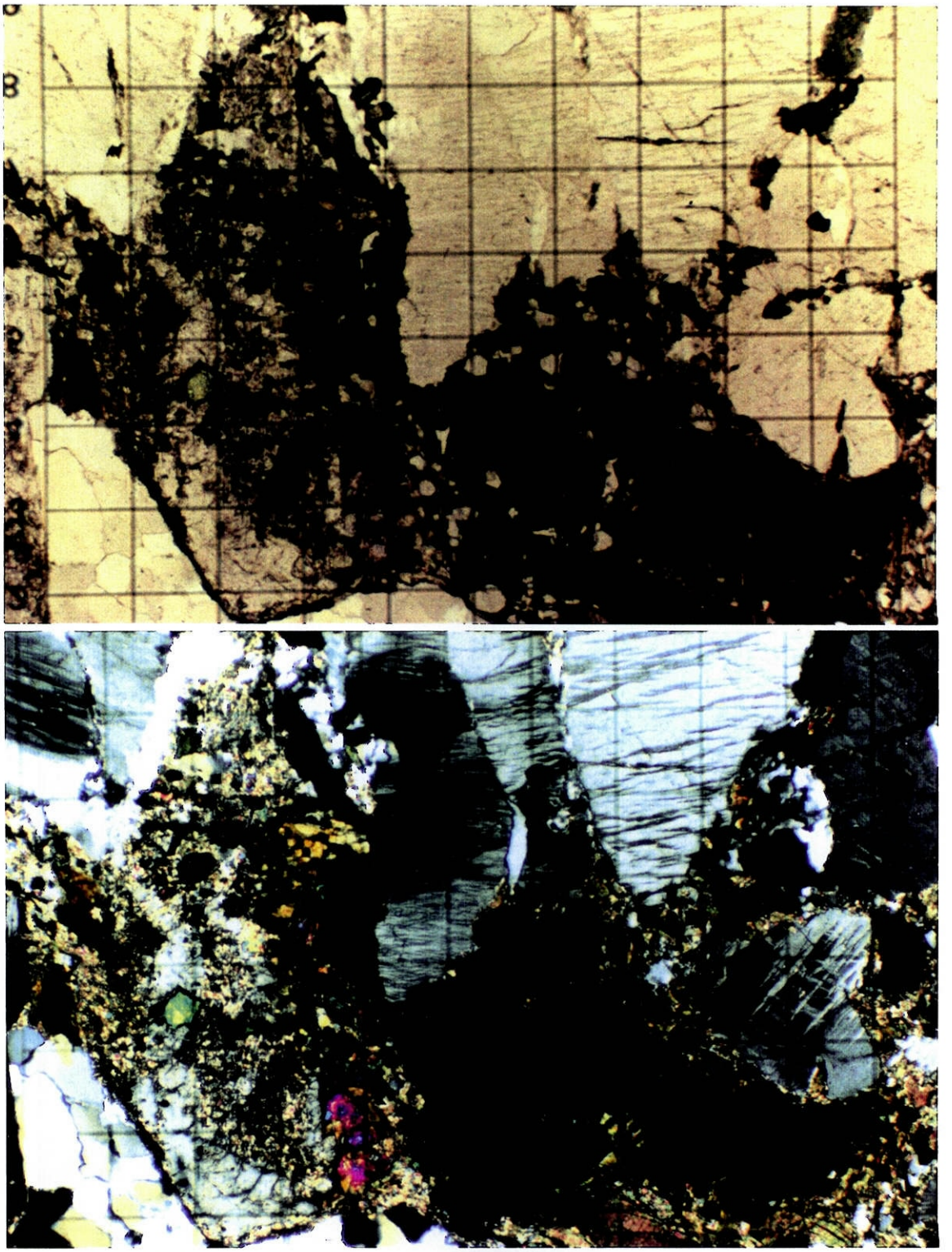
Y-151. Sheared and rather weakly propylitized granite with some deuteric alteration of plagioclase.

Primary Minerals	Percent	Description
Essential Constituents		
Plagioclase-An_7	25	Subhedral blocky prisms, Carlsbad plus albite twinning, contains very fine grained muscovite (sericite) inclusions that are of probable late magmatic or deuteric origin. Also shows some fracturing and replacement by late epidote and clay.
Microcline	45	Subhedral blocky to anhedral, scarce Carlsbad twins and with well developed grid twinning, microperthitic and with stringers of albite. Is essentially unaltered.
Quartz	18	Fine grained, anhedral, undulatory extinction, present as sutured to granular mosaic aggregates interstitial to feldspar minerals.
Varietal accessory minerals		
Biotite	10	Subhedral flakes and aggregates, pleochroic in shades of olive green, high birefringence. Often shows some shearing and occurs mostly with quartz interstitially to feldspars. Shows local replacement by chlorite and epidote.
Minor accessory minerals		
Sphene	1	Subhedral prisms and wedges, extreme positive relief and high birefringence, inclined extinction. Relatively large crystals are mostly associated in space with biotite.
Monazite	-1	Small prisms with very high positive relief and high birefringence, slightly inclined extinction. Present as inclusions in biotite and is surrounded by radiation damage halos.
Apatite	-1	Small colorless prisms with moderate positive relief and low birefringence, associated with biotite and usually enclosed by quartz.
Tourmaline	-1	Subhedral prismatic, moderate positive relief and moderate birefringence, strongly dichroic in grayish green to pale greenish brown, strongest

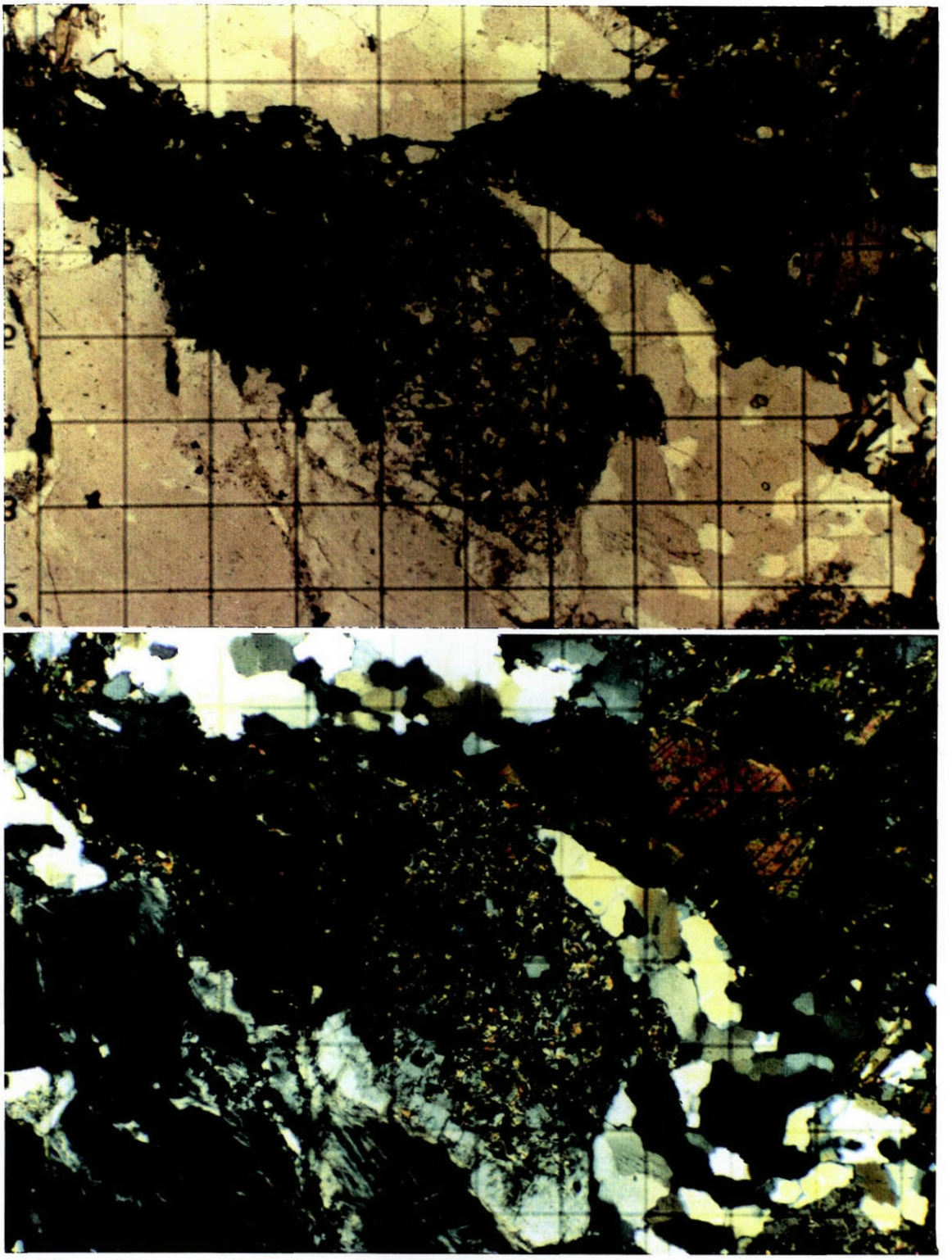
Y-151.

Primary Minerals	Percent	Description
		absorption is E - W. Scarce prismatic aggregates are enclosed by plagioclase.
Allanite	-1	Subhedral prisms with high positive relief, strongly pleochroic in shades of brown, low birefringence. Present with biotite and is at times altered to or rimmed by epidote.
Zircon	-1	Small prisms with extreme positive relief and high birefringence, associated in space with biotite and is enclosed by feldspars and associated with magnetite.
Magnetite	1	Small equant black opaque grains and aggregates are usually associated in space with biotite.
Secondary Minerals		
Clay	3	Extremely fine grained dusting of low birefringence clay present in association with epidote as an alteration product of plagioclase.
Chlorite	3	Fine grained, green color, weakly pleochroic, low birefringence or with abnormal blue interference colors. Formed as an alteration product of biotite.
Epidote	5	Fine to very fine grained, subhedral prisms, very high positive relief and with low to high birefringence, inclined extinction. Occurs with chlorite as an alteration product of biotite and in varying amounts replacing plagioclase.
Pyrite	-1	Fine grained, anhedral, pale yellow metallic in oblique incident light. Occurs with chlorite bordering and in part replacing magnetite.

Texture: Medium to coarse grained phaneritic, equigranular. Shows some shearing and granulation.



Y-151. Thin section photomicrograph of granite showing sericitized and epidotized plagioclase (left and lower right) with weakly chloritized biotite and microcline. Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.



Y-151. Thin section photomicrograph weakly sheared and altered granite showing biotite with microcline, quartz, and sericitized plagioclase. Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.

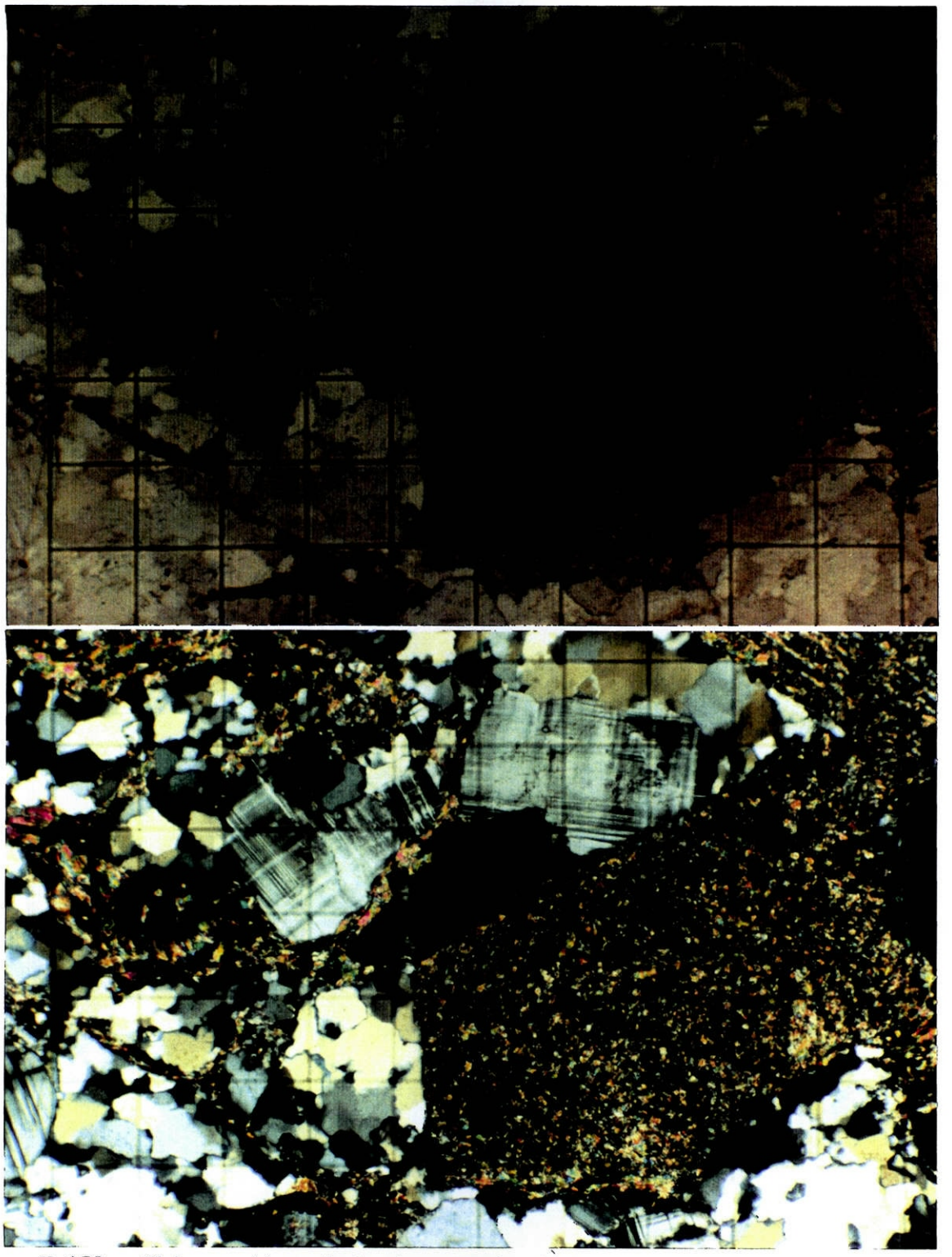
Y-159. Sheared, sericitized and silicified granite cut by quartz veinlets.

Primary Minerals	Percent	Description
Essential Constituents		
Plagioclase-An_7	38	Subhedral prismatic, Carlsbad plus albite twinning, shows partial to complete replacement by very fine grained sericite.
Microcline	28	Sub- to anhedral, Carlsbad plus grid twinning, most is fresh and unaltered.
Quartz	25	Fine to medium grained, granular mosaic to sutured contacts, undulatory extinction. Present in aggregates that are interstitial to feldspars and is finer grained than those minerals. Contains oriented rutile needle inclusions.
Varietal accessory minerals		
Biotite	7	None preserved. Former flakes are now sheared and altered to colorless sericite - with accompanying separation of opaques.
Minor accessory minerals		
Zircon	-1	Short prisms with extreme positive relief and high birefringece, mostly associated in space with altered oxides and biotite.
Monazite	-1	Small short prisms with very high positive relief and high birefringence, slightly inclined extinction. Rare and small crystals are enclosed by altered biotite.
Apatite	-1	Very small colorless prisms with moderate positive relief and low birefringence, enclosed by altered biotite and by quartz.
Rutile	-1	Very tiny needle-like crystals enclosed by quartz. Shows orientation in planes perpendicular to the c-axis.
Magnetite	1+	Former subhedral equant opaque grains are now largely altered to hematite. Often associated with ilmenite and zircon.

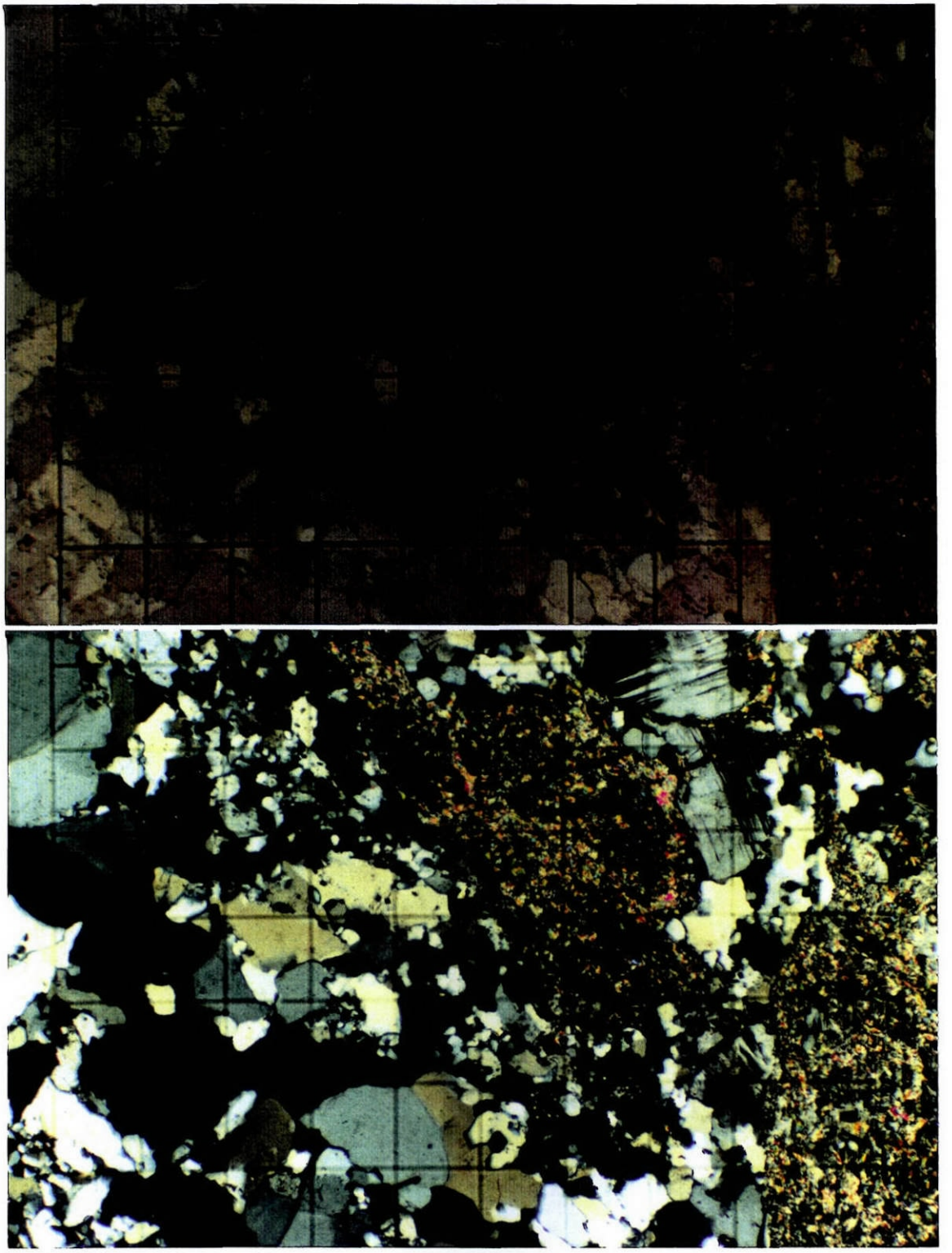
Y-159.

	Percent	Description
Ilmenite	-1	Small tabular to anhedral black opaque grains are associated in space with altered biotite and with magnetite.
Sphene(?)	-1	None preserved. Former prisms and anhedral grains that border ilmenite are now completely altered to leucoxene.
Secondary Minerals		
Quartz	15	Very fine to medium grained, sutured contacts, undulatory extinction. Present as filling of small veinlets cutting sheared host and also in finer aggregates intergrown with sericite replacing plagioclase. Vein quartz lacks the rutile inclusions present in primary quartz.
Sericite	35	Very fine grained colorless mica aggregates with high birefringence. Occurs as partial to complete replacement of biotite and as almost complete replacement of plagioclase.
Clay	2	Small iron oxide stained clusters with low birefringence, present mostly in host adjacent to veinlets.
Leucoxene (Rutile)	1	Extremely fine grained opaque anhedral aggregates replacing original sphene and also as needle-like crystals with sericite from alteration of biotite. Latter may be of primary origin.
Iron oxides	2	Extremely fine grained opaque red hematite from oxidation of accessory magnetite, and opaque brownish goethite from oxidation of pyrite and as a stain in some host silicates. There are no remnants of pyrite.

Texture: Originally coarse grained phaneritic, equigranular. Is now sheared and granulated and cut by late quartz veinlets.



Y-159. Thin section photomicrograph of sheared and altered granite showing sericitized plagioclase with biotite and unaltered microcoline and quartz. Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.



Y-159. Thin section photomicrograph showing quartz vein (upper left to lower right) cutting altered granite with sericitized plagioclase and biotite accompanited by quartz and unaltered microcline. Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.

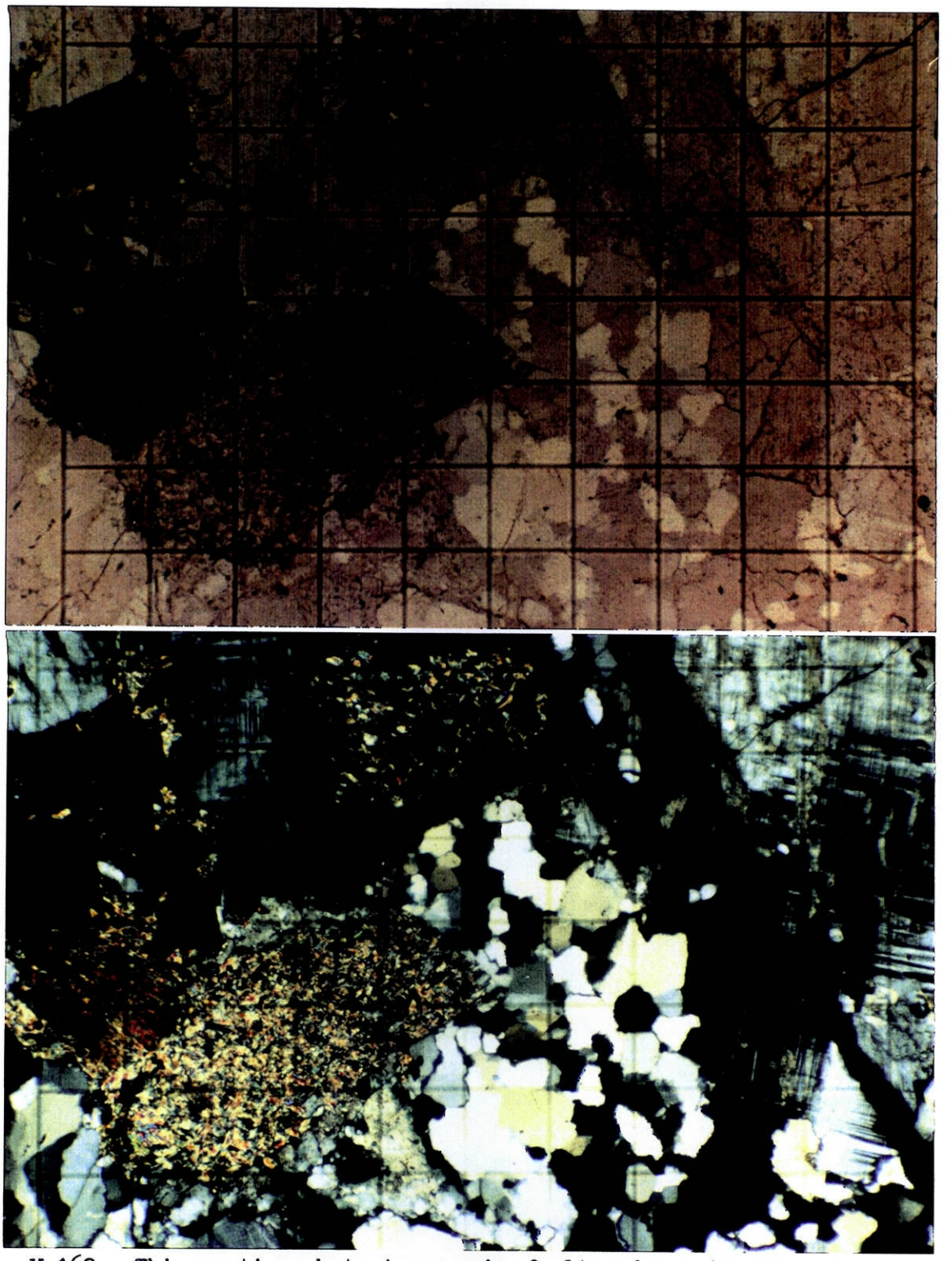
Y-162. Moderate to strong sericitic alteration of plagioclase in biotitic granite containing complex minor accessory mineral suite.

Primary Minerals	Percent	Description
Essential Constituents		
Plagioclase-An_8	28	Subhedral short prismatic, Carlsbad plus albite twins, shows moderate to strong replacement by sericite.
Microcline	38	Subhedral stubby prisms to anhedral, Carlsbad plus albite twinning, slightly microperthitic. Crystals are essentially unaltered.
Quartz	20	Fine to medium grained, sutured contacts, undulatory extinction. Occurs in aggregates interstitial to feldspars. Contains needle-like rutile inclusions.
Varietal accessory minerals		
Biotite	8	Medium grained, subhedral, pleochroic in brown to olive green, shows some shearing and bleaching, is sagenitic - contains oriented rutile needle inclusions.
Minor accessory minerals		
Zircon	-1	Short prisms with extreme positive relief and high birefringence, mostly associated in space with biotite and magnetite.
Apatite	-1	Small colorless prisms with moderate positive relief and low birefringence. Associated in space with biotite aggregates.
Monazite	-1	Scarce and very small prisms with very high positive relief and high birefringence, slightly inclined extinction. Enclosed by biotite and is surrounded by weak radiation damage halos.
Sphene	-1	None present. Former small prisms associated in space with biotite are now altered to leucoxene.
Magnetite	2	Equant opaque crystals and aggregates are associated in space with biotite and now replaced by hematite.

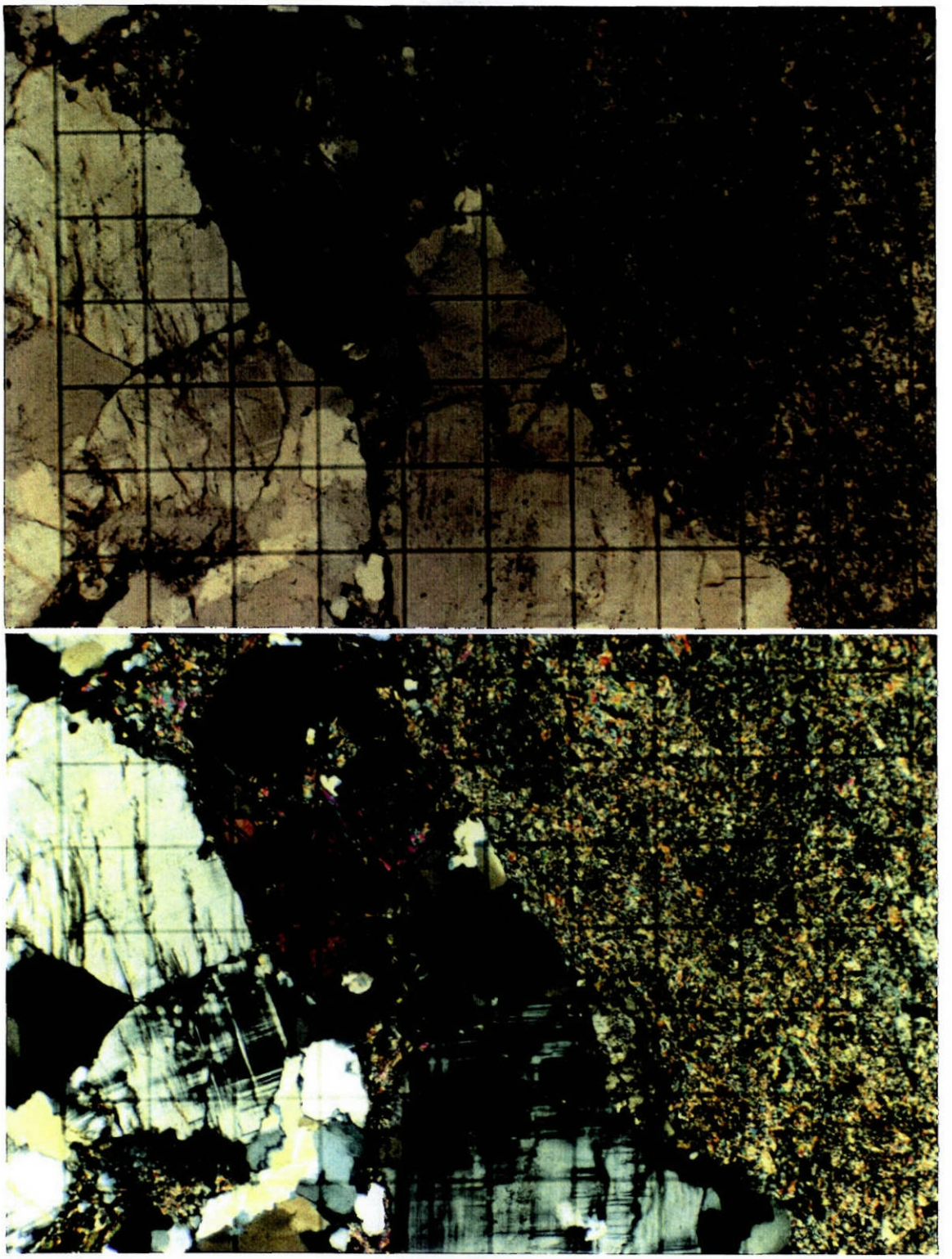
Y-162.

	Percent	Description
Ilmenite	-1	Small tabular black opaque subhedral crystals are enclosed by and associated with biotite.
Rutile	-1	Very tiny needle-like crystals present as primary inclusions in both quartz and biotite.
Tourmaline	-1	Small aggregates of prisms, strongly dichroic in shades of blue to grayish blue, moderate positive relief and moderate birefringence. Associated in space with biotite.
Secondary Minerals		
Quartz	4	Occurs as very fine grained colorless aggregates intergrown with sericite replacing plagioclase. Not seen as separate aggregates.
Sericite	18	Very fine grained colorless mica with high birefringence, present as partial to almost complete replacement of plagioclase. Also minor amount replacing biotite.
Leucoxene	1	Extremely fine grained opaque white to tan aggregates present as an alteration product of sphene and at margins of bleached and altered biotite aggregates.
Hematite + Goethite	3	Extremely fine grained opaque red hematite occurs mostly as an oxidation product of original accessory magnetite, while goethite is present mostly as a stain in altered biotite aggregates.

Texture: Medium to coarse grained phaneritic, equigranular.



Y-162. Thin section photomicrograph of altered granite showing sericitized plagioclase with associated quartz, microcline, and biotite (left). Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.



Y-163. Thin section photomicrograph of altered granite with sericitized plagioclase (right) associated with microcline, quartz, biotite, and opaque magnetite. Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.

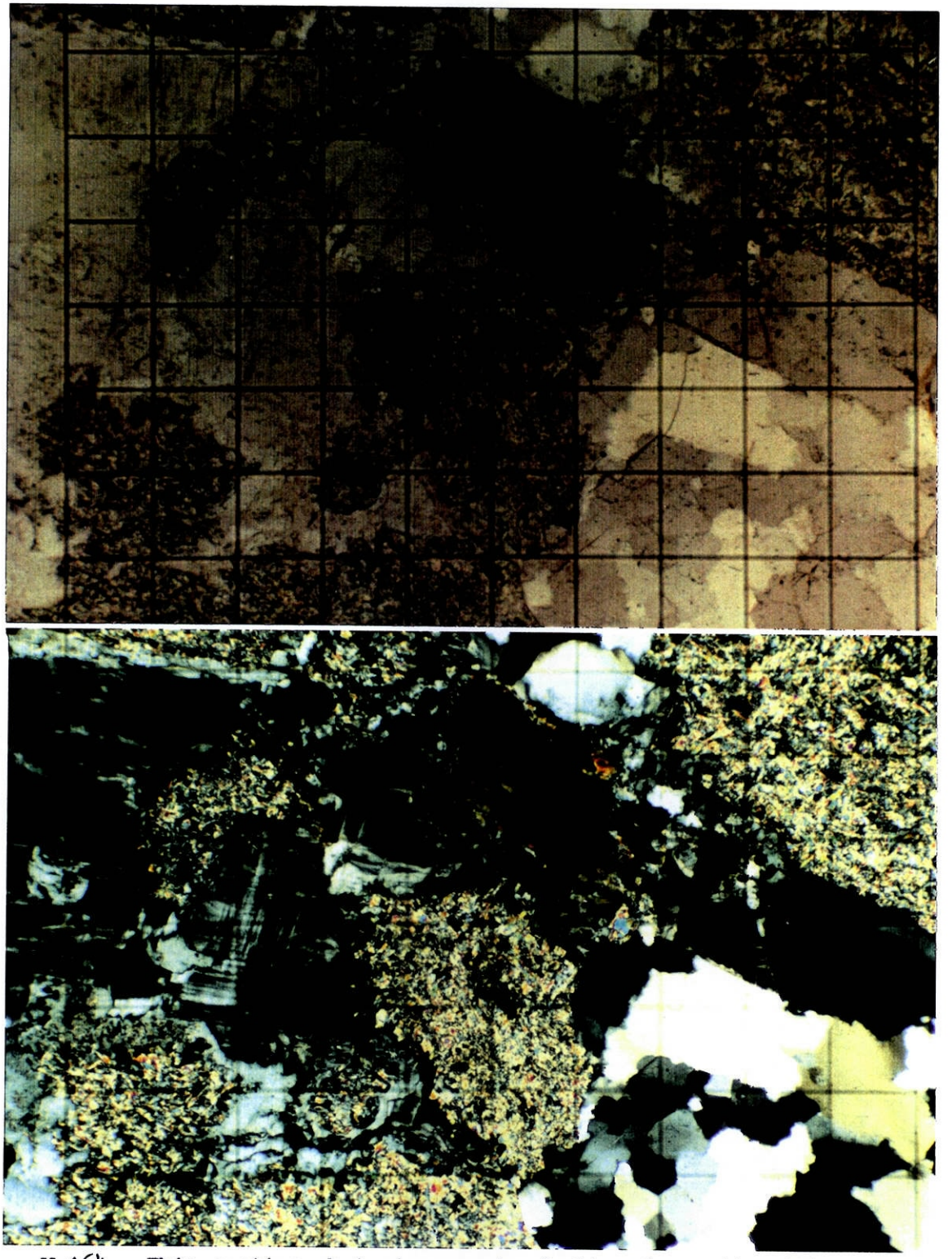
Y-164. Granite with moderate sericitic alteration of plagioclase and containing a complex suite of minor accessory minerals

Primary Minerals	Percent	Description
Essential Constituents		
Plagioclase-An_8	32	Subhedral short prisms with Carlsbad plus albite twinning, shows weak to strong replacement by sericite. Also minor amount as inclusions in microcline.
Microcline	43	Subhedral short prismatic to anhedral, grid twinning and with scarce Carlsbad twins, essentially unaltered. Is microperthitic.
Quartz	16	Fine to medium grained, anhedral, sutured contacts, undulatory extinction. Present in aggregates interstitial to feldspars. Contains needle-like inclusions of rutile.
Varietal accessory minerals		
Biotite	6	Medium grained, subhedral, pleochroic in shades of green to brown, is often deformed by shearing. Some flakes are replaced by sericite with accompanying separation of opaques.
Minor accessory minerals		
Sphene	1+	None preserved. Former prismatic to wedge-shaped crystals are now replaced by leucoxene. Original crystals were relatively large.
Zircon	-1	Short prisms with extreme positive relief and high birefringence, most is associated in space with biotite and magnetite.
Apatite	-1	Small colorless prisms with moderate positive relief and low birefringence. Often associated in space with biotite and magnetite.
Rutile	-1	Very small needle-like crystals with extreme positive relief, present as inclusions in quartz.
Tourmaline	-1	Small prisms in slightly radial aggregates, strongly dichroic in shades of brown to dark blue, moderate positive relief and moderate birefringence. Surrounded by interstitial quartz aggregates.

Y-164.

	Percent	Description
Ilmenite	-1	Very fine grained, subhedral tabular to anhedral, black opaque in oblique light. Present as inclusions in altered sphene and associated with biotite.
Magnetite	1	Equant opaque grains are now altered to hematite. Most is associated in space with biotite.
Secondary Minerals		
Quartz	2	Very fine grained colorless aggregates are intergrown with sericite replacing plagioclase.
Sericite	16	Fine to very fine grained colorless mica aggregates with minor quartz, replaces plagioclase and present with opaques replacing some of biotite. Minor amount also present in fractures that cut other primary silicates.
Leucoxene	2	Extremely fine grained opaque white to pale tan aggregates formed by alteration of sphene and with sericite from biotite.
Hematite + Goethite	1+	Extremely fine grained opaque red hematite formed as an oxidation product of magnetite, and orange brown goethite is present with sericite from alteration of biotite.

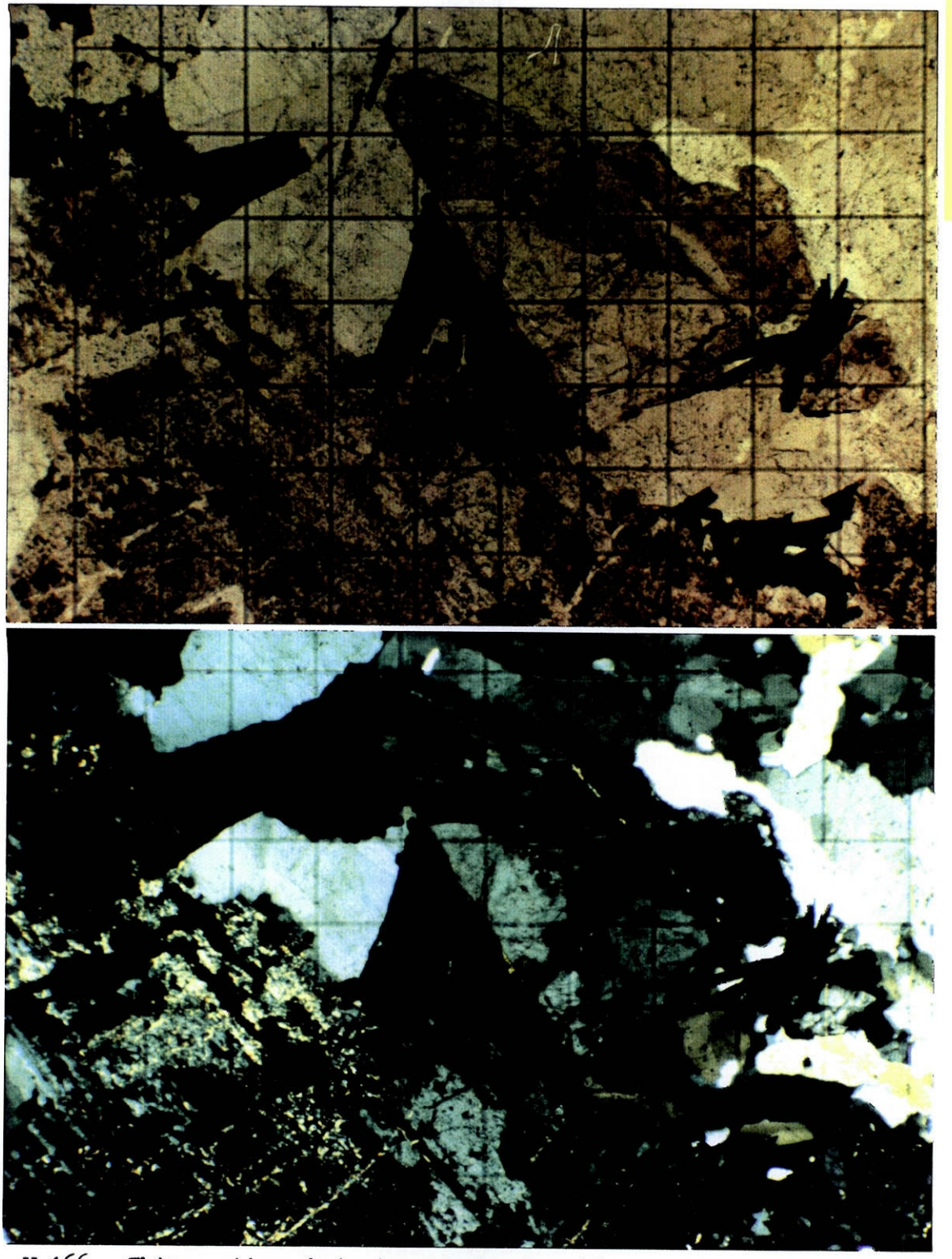
Texture: Medium to coarse grained phaneritic, equigranular. Shows rather weak shearing and development of some microfractures and intergranular crushing.



Y-164. Thin section photomicrograph of altered granite with strongly sericitized plagioclase associated with microcline, quartz, and biotite. Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.

Y-165. Thin section photomicrograph of altered granite showing sericitized plagioclase (right) and biotite (left) with associated microcline and quartz. Plain light, X55. Each square of grid is 260 microns on an edge.

Figure 6



Y-166. Thin section photomicrograph of weakly argillized microcline (upper right) and weakly sericitized plagioclase (lower left) with quartz and hematite plates (opaque) in fractured and rehealed host granite. Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.

RMH 2-20-90

JDS

ASARCO

Southwestern Exploration Division

February 23, 1990

W.L. Kurtz

Polished-Thin Section
Yarnell Project
Yavapai County, AZ

Au & Ag particles

Attached is the latest report from R.M. Honea in which he found additional gold locked in the iron oxide mineral.

Again the free gold is in very small particles.

James D. Sell

James D. Sell

JDS:mek
Atts.

cc: R.L. Brown
F.T. Graybeal
M.A. Miller

JDS

ASARCO

Southwestern Exploration Division

February 23, 1990

J.D. Sell

Additional Polished Sections
Yarnell Project
Yavapai County, AZ

The attached polished sections are from part of the Yarnell Alteration Suite that Mr. Honea has been working with. These polished sections show the same relationships seen in other pan concentrate sections. However, this is the first time that we have seen gold in one of its mode of occurrence in the rock (PS Y-160). This section shows gold associated with goethite in quartz vein filling. The gold is extremely fine in the 3-4 micron range. Partial locking appears to occur but mainly within goethite. Mr. Honea has also identified native silver in the sample as fracture filling (PS Y-158).

Mark A. Miller

MAM:mek
Atts.

Russell M. Honea
Consulting Geologist

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February 20, 1990

Mr. Mark A. Miller
ASARCO Exploration
P. O. Box 5747
Tucson, Arizona 85703-0747

Re: Yarnell Project, AZ

Dear Mark:

Enclosed are results of polished section examination of both solid samples and panned concentrates for three mineralized samples from your Yarnell suite. As usual, photomicrographs are included to illustrate some of the important mineralogic and textural characteristics.

Native gold is present in polished sections of two of the three samples (Y-157 and Y-160). Particle size varies from 5 to 75 microns, and color of the gold suggests a low to moderate silver content in the mineral structure. Very minor native silver is present in the solid sample polished section of Y-158, and occurs in quartz fracture fillings. The samples are all rather strongly oxidized, and contain minor amounts of remnant pyrite (all samples) and arsenopyrite (one sample). Goethite or limonite is the dominant opaque mineral, and is formed both as oxidation pseudomorphs after original sulfides and as apparent fracture fillings. The polished surfaces also show minor amounts of hematite, rutile, monazite, and zircon from the minor accessory and alteration suites of the host.

Data for the few remaining thin sections and the last mineralized sample will follow. Meanwhile, please let me know if there are questions or problems regarding the data.

Sincerely,

Russell M. Honea

Encl.

P.S. Y-157. Native gold with minor remnant pyrite in strongly oxidized and mineralized material.

Native gold - -1% - Medium golden yellow color - suggesting low to moderate silver content, isotropic but does not show complete extinction because of polishing scratches, low hardness and is rather well polished, high reflectivity. Present as single particle in concentrate prepared from solid sample - and here forms a composite grain with minor associated goethite in a fragment having a maximum dimension of 75 microns.

Pyrite - -1% - Pale yellow color, either isotropic or with weak anomalous anisotropism and very faint blue to purplish polarization colors, hard and is well polished. Present as rare remnants of corroded equant crystals in liberated fragments, and as rare inclusions in interiors of goethite oxidation pseudomorphs. Most of original sulfide has been oxidized to goethite.

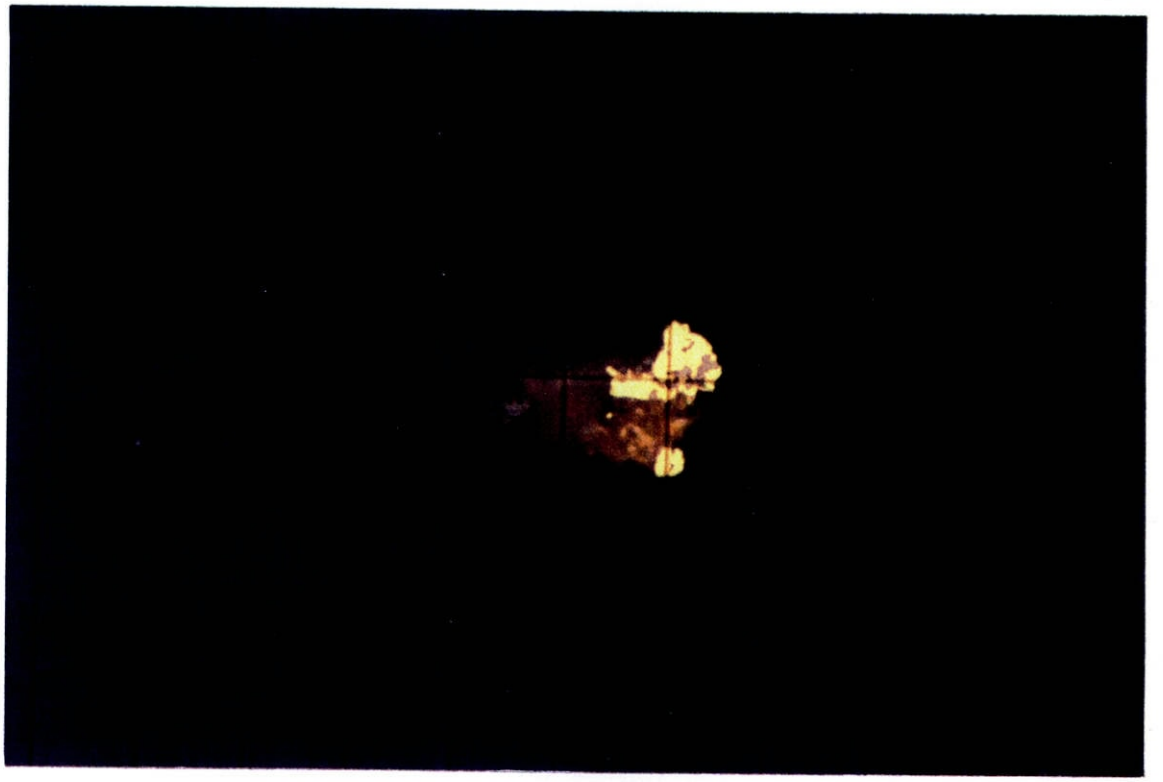
Goethite - 2% - Light to medium gray and with slight bluish tint where better polished, anisotropic but with polarization colors masked by strong red to brown internal reflections, highly variable hardness and perfection of polish. Present both as oxidation pseudomorphs after original equant pyrite crystals and in more irregularly shaped aggregates that fill small fractures cutting the host.

Rutile + Zircon - -1% - Light to medium gray, anisotropic but with polarization colors masked by strong colorless to white internal reflections, hard and is well polished. Present as small short prisms (zircon) and anhedral aggregates (rutile) enclosed by silicate host. Zircon is remnant from the minor accessory suite of host while rutile is formed by alteration of original titanian minerals from host.

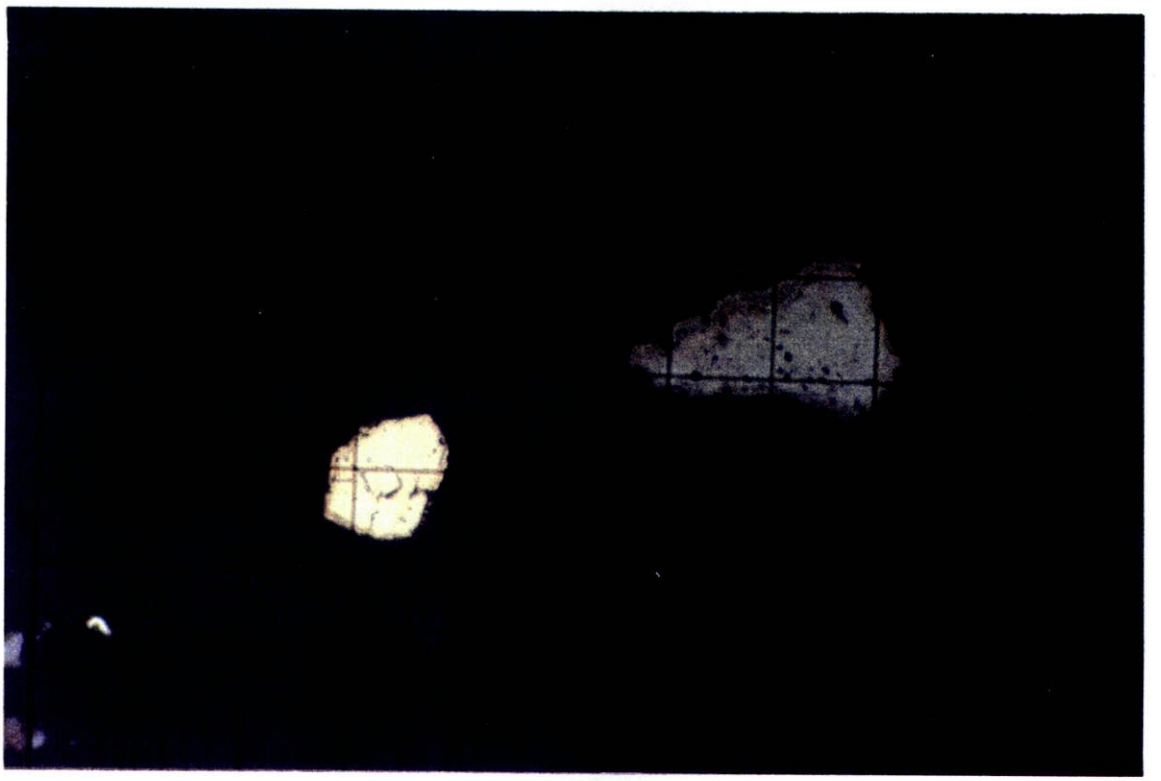
Trash iron - -1% - White metallic, isotropic, moderate hardness and is well polished. Scarce curved "shavings" were added during sample preparation.

Non-metallic gangue - 97% - See thin section description for details of mineralogy and occurrence.

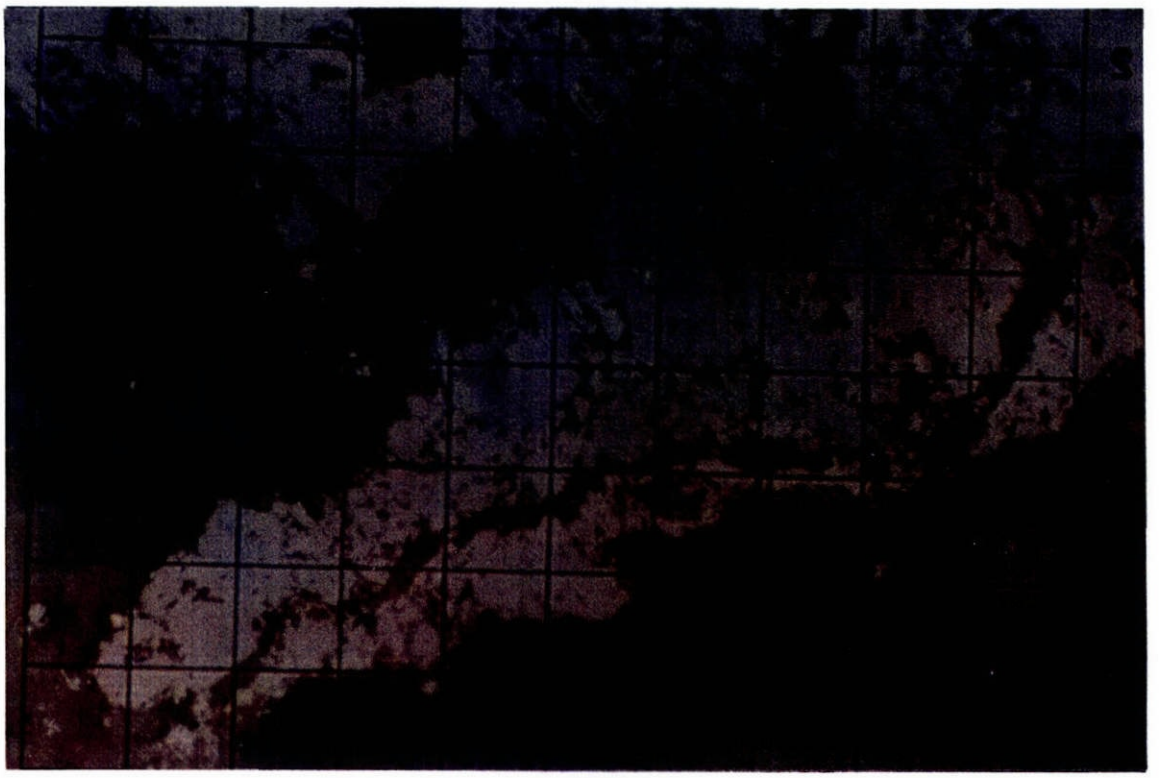
*Note: Two polished sections were prepared and examined - one of the solid sample "as received" and one of a panned concentrate prepared from this sample after grinding to -70 mesh.



P.S. Y-157. Polished section photomicrograph of native gold in composite grain with goethite. Most of grain is present beneath polished surface. Plain light, X435. Each square of grid is 32 microns on an edge.



P.S. Y-157. Polished section photomicrograph of pyrite remnant presnt with goethite fragment. Plain light, X435. Each square of grid is 32 microns on an edge.



P.S. Y-157. Polished section photomicrograph of goethite filling fracture in sheared and oxidized host. Plain light, X435. Each square of grid is 32 microns on an edge.

P.S. Y-158. Very fine grained native silver with minor remnant pyrite and dominant goethite oxidation pseudomorphs and fracture fillings.

Native silver - -1% - White with faint creamy tint, isotropic but does not show complete extinction, low hardness and with moderate perfection of polish. Present as very small (2 to 48 microns) and irregularly shaped grains in fractures cutting host and enclosed by quartz.

Pyrite - -1% - Pale yellow, either isotropic or with weak anomalous anisotropism and very faint blue to purplish polarization colors, hard and is well polished. Scarce corroded remnants of equant to pyritohedral crystals, and as rare remnants in interiors of goethite oxidation pseudomorphs. Most of original pyrite has been thus oxidized.

Goethite - 4% - Light to medium gray and with bluish tint where better polished, anisotropic but with polarization colors masked by strong reddish brown internal reflections, highly variable hardness and perfection of polish. Occurs as complexly and finely banded aggregates formed as oxidation pseudomorphs after pyrite crystals, and as irregularly shaped aggregates filling fractures in host.

Hematite - -1% - Light bluish gray, anisotropic and with polarization in shades of gray, shows deep red internal reflections, hard and is well polished. Scarce and small aggregates of platy crystals are present in host, and probably formed from alteration of original host minerals.

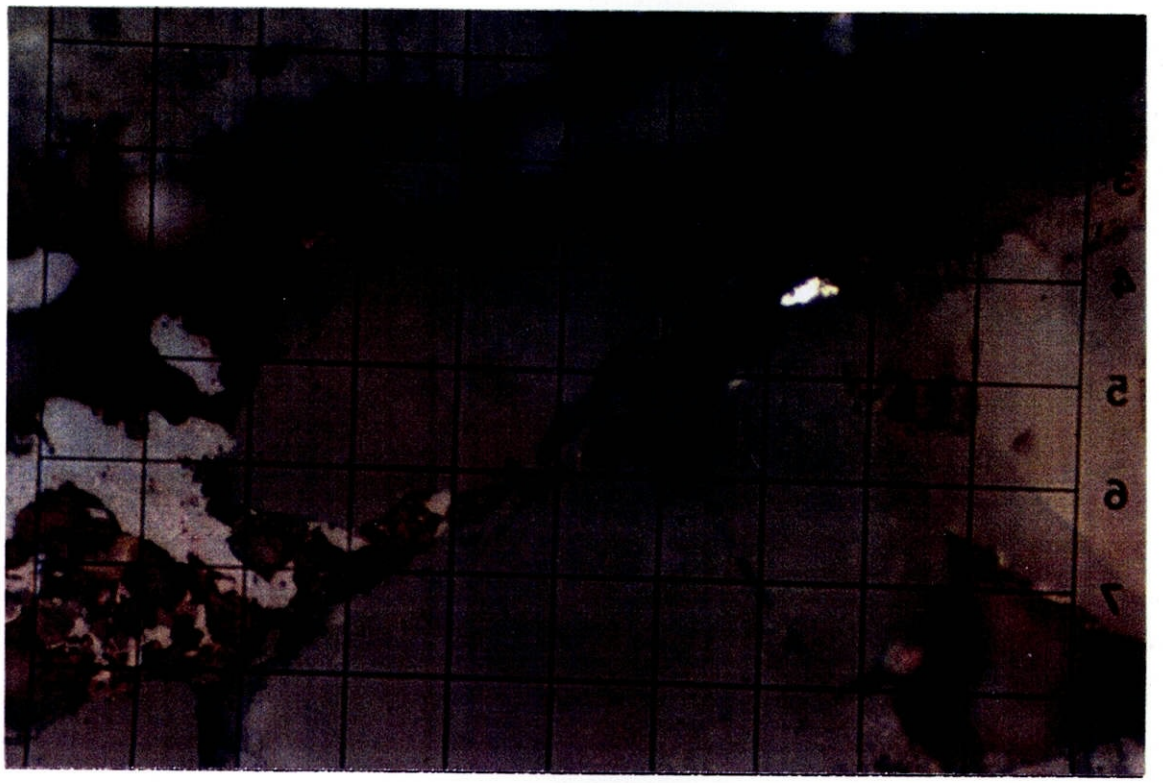
Zircon + Rutile - 1% - Light to medium gray, anisotropic but with polarization colors masked by strong colorless to pale pinkish and yellowish internal reflections, hard and is well polished. Present as small tetragonal prisms (zircon) and as anhedral aggregates (rutile) scattered through host. Zircon is from minor accessory suite and rutile is an alteration product of original host minerals.

Trash iron - -1% - White metallic, isotropic, moderate hardness and is well polished. Present as curved shavings in the concentrate sample - that were added during sample preparation.

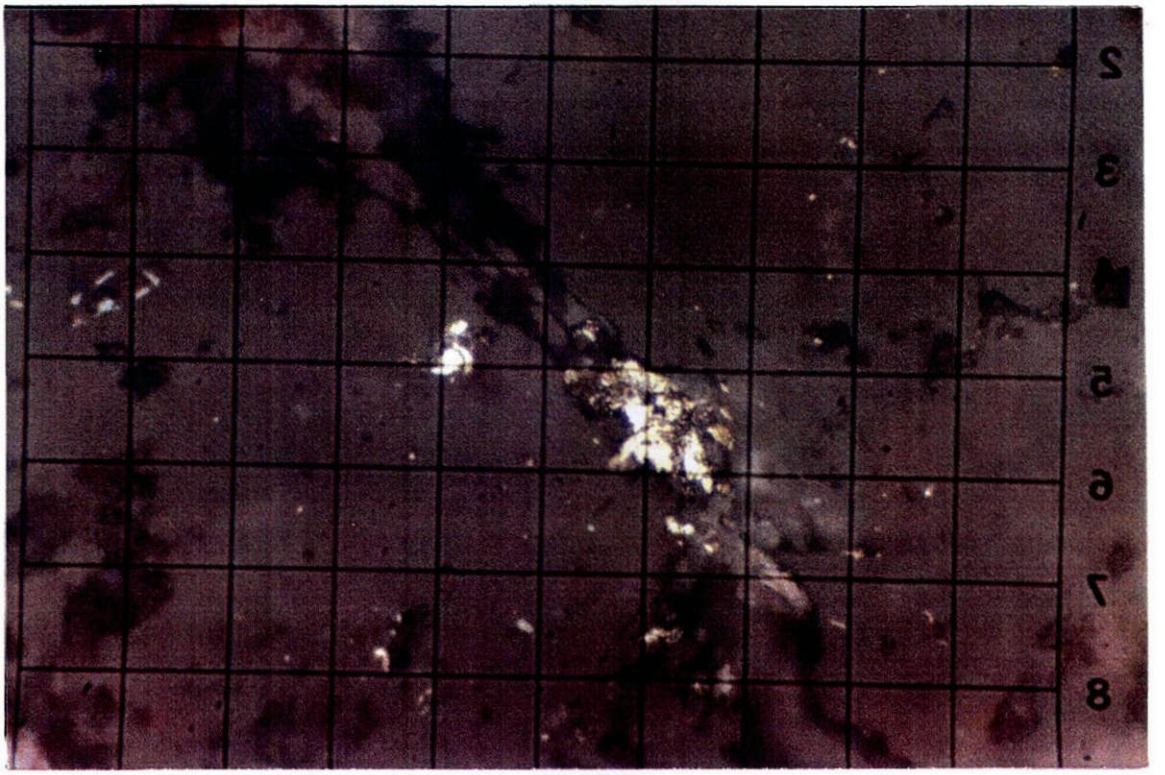
P.S. Y-158.

Non-metallic gangue - 95% - See thin section description for details of mineralogy and occurrence.

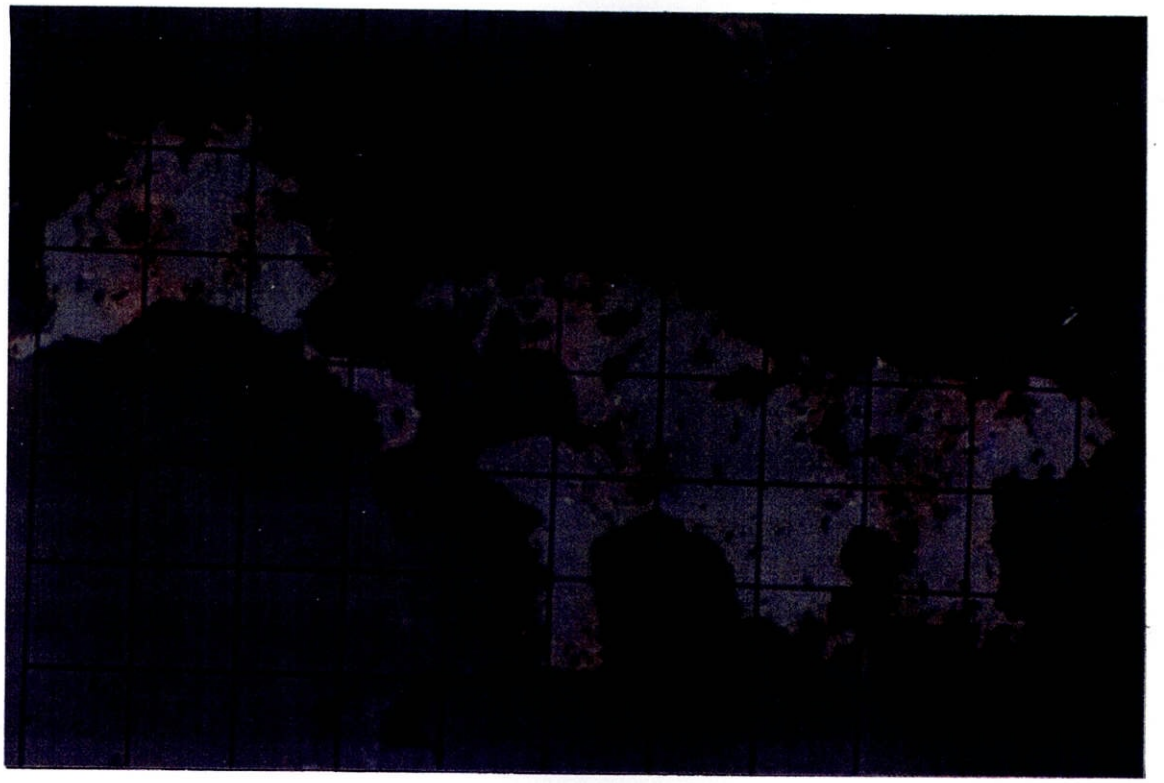
*Note: Two polished sections were prepared and examined - one of the solid sample "as received" and one of a panned concentrate prepared therefrom.



P.S. Y-158. Polished section photomicrograph of native silver particle in fracture filling cutting altered host. Associated with poorly polished goethite. Plain light, X435. Each square of grid is 32 microns on an edge.

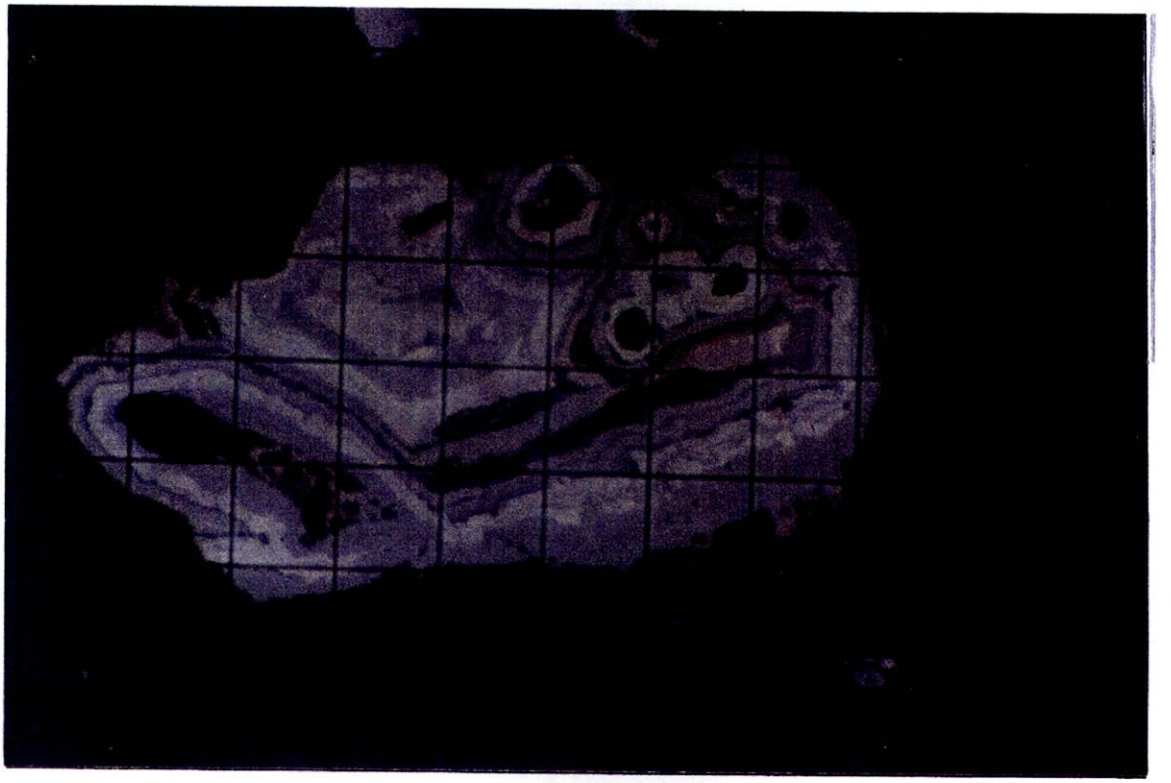


P.S. Y-158. Polished section photomicrograph of native silver in fracture filling cutting altered host. Plain light, X1090. Each square of grid is 13 microns on an edge.



P.S. Y-158. Polished section photomicrograph showing goethite filling fracture cutting altered host. Plain light, X435. Each square of grid is 32 microns on an edge.

P.S. Y-158. Polished section photomicrograph of pyrite remnant in fracture with goethite. Plain light, X435. Each square of grid is 32 microns on an edge.



P.S. Y-158. Polished section photomicrograph of complexly banded goethite aggregate formed as an oxidation pseudomorph after pyrite. Plain light, X435. Each square of grid is 32 microns on an edge.

P.S. Y-160. Extremely fine grained native gold locked in poorly polished goethite oxidation pseudomorph after pyrite in fractures cutting host.

Native gold - -1% - Medium golden yellow color - suggesting low to moderate silver content, isotropic but does not show complete extinction, low hardness and is relatively well polished. Observed as two very small (5 and 6 microns) particles enclosed by goethite oxidation pseudomorphs after original pyrite. One of these has a somewhat cellular texture.

Pyrite - -1% - Pale yellow, either isotropic or with weak anomalous anisotropism and very faint blue to purplish polarization colors, hard and is well polished. Rare and small remnants with corroded margins, present as liberated grains, as rare locked particles in silicate gangue, and as rare remnants in interiors of goethite oxidation pseudomorphs. Most of original sulfide material has been oxidized to goethite.

Arsenopyrite - -1% - White with faint creamy tint, anisotropic and with polarization colors of blue to yellowish orange, hard and is well polished. Present in polished section as single remnant prismatic grain showing minor corrosion at grain margins. No clues as to paragenetic position.

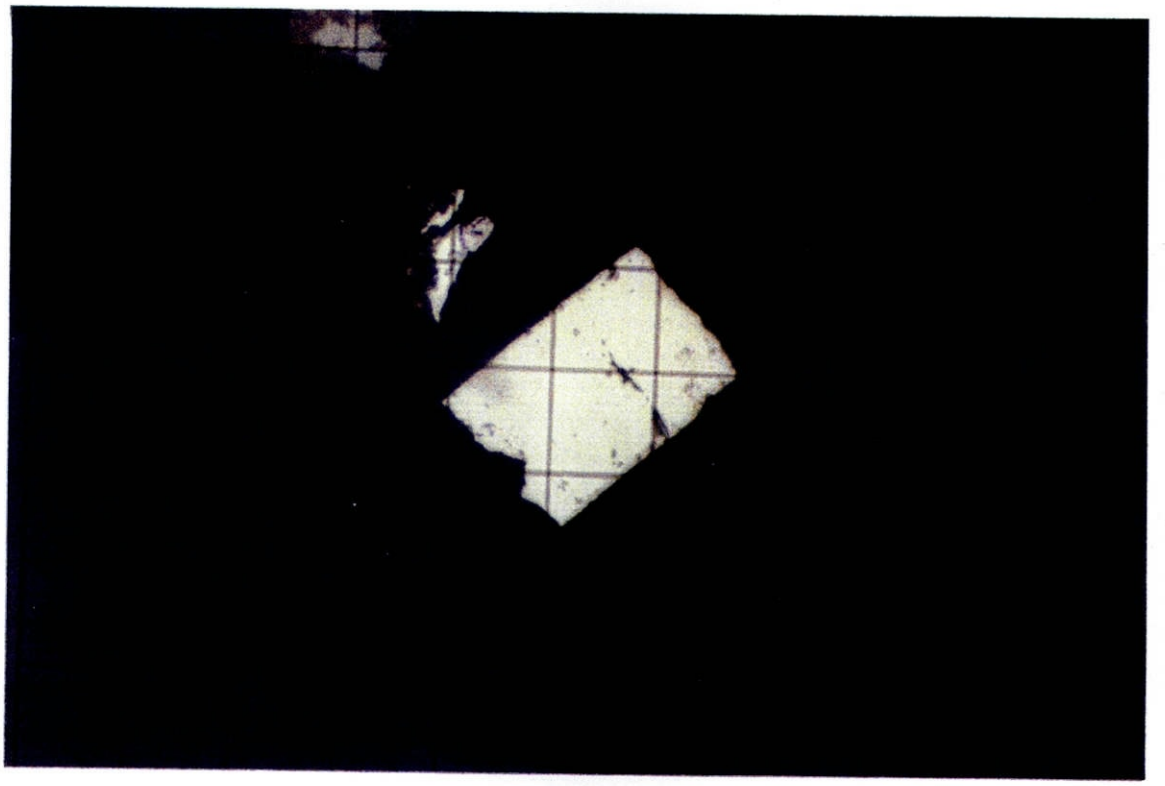
Goethite - 3% - Light to medium gray where better polished and with bluish tint, anisotropic but with polarization colors masked by strong reddish brown internal reflections, highly variable hardness and varies from powdery and unpolished to aggregates having moderate polish. Occurs both as finely and complexly banded oxidation pseudomorphs after original pyrite and as filling of small fractures cutting host.

Zircon + Monazite + Rutile - 1% - Light to medium gray, anisotropic but with polarization colors masked by strong colorless to pale yellowish to white internal reflections, hard and is well polished. Present as small grains derived from minor accessory suite (zircon and monazite) and from alteration suite (rutile) of host.

P.S. Y-160.

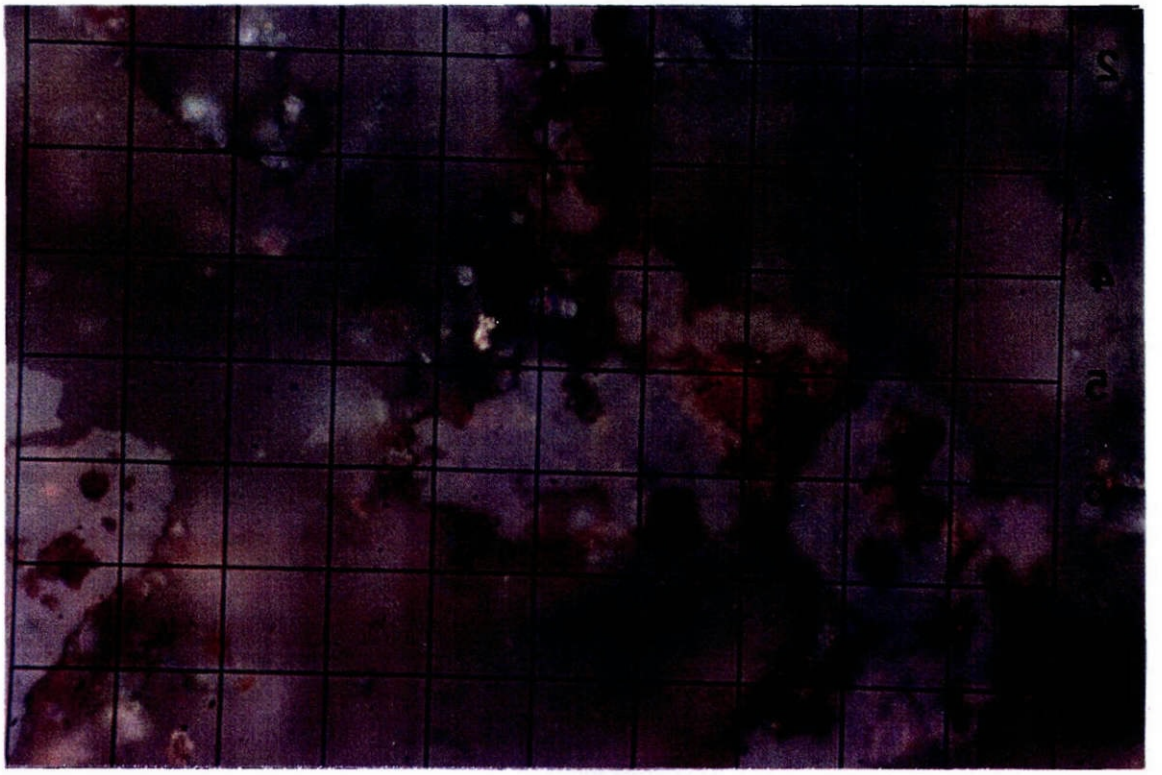
Trash iron - -1% - White metallic, isotropic, moderate hardness and is well polished. Small curved particles are widely scattered through concentrate - and were added as an impurity during sample preparation.

Non-metallic gangue - 96% - See thin section description for details of mineralogy and occurrence.



P.S. Y-160. Polished section photomicrograph of arsenopyrite fragment with associated trash iron. Plain light, X325. Each square of grid is 32 microns on an edge.

P.S. Y-160. Polished section photomicrograph of very small gold particle with goethite in quartz vein filling. Plain light, X1090. Each square of grid is 13 microns on an edge.



P.S. Y-160. Polished section photomicrograph showing very small native gold particle with poorly polished goethite in fracture filling. Plain light, X1090. Each square of grid is 13 microns on an edge.

RMH 3-10-90

JDS

ASARCO

Southwestern Exploration Division

June 5, 1990

W.L. Kurtz

Thin-Section & Polished Sections
Yarnell Project
Yavapai County, Arizona

Attached are the last three Russell M. Honea petrographic-polished section reports on the material sent by M.A. Miller.

James D. Sell

James D. Sell

JDS:mek
Att. (3)

cc: R.L. Brown (w/atts.)
F.T. Graybeal (w/atts.)
M.A. Miller (w/atts.)

Russell M. Honea
Consulting Geologist

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March 10, 1990

Mr. Mark A. Miller
ASARCO Exploration
P. O. Box 5747
Tucson, AZ 85703-0747

Re: Yarnell Project, AZ

YM-40 315-320.

Dear Mark:

Enclosed are results of polished section examination of your sample 1G - 35-40. The sample is relatively high grade, and contained five gold particles in a polished surface prepared from a penned concentrate of the cuttings. These particles are variously locked, liberated, and in composites. Average particle size of observed grains is 92 microns. Associated with the gold is minor remnant pyrite, dominant goethite, and minor magnetite and hematite from the host minor accessory suite.

Please let me know if there are questions or problems regarding the data. Will have the last of the petrographic descriptions in the mail early next week.

Sincerely,

Russell M. Honea

Encl.

ASARCO Incorporated
MAR 14 1990
SW Exploration

1G - 35-40'. Liberated, locked, and composite native gold particles with minor remnant pyrite in strongly oxidized (goethite-rich) assemblage*

Native gold - -1% - Dark golden yellow color - suggesting low silver content, isotropic but does not show complete extinction because of polishing scratches, low hardness and is moderately well polished. Present in polished surface as 5 particles - one of these (114 microns) forms a composite with goethite, and the smallest of which (3 microns) is locked by goethite formed as an oxidation pseudomorph after original pyrite. The remaining 3 particles (7, 14, and 320 microns) are liberated.

Pyrite - -1% - Pale yellow color, either isotropic or with weak anomalous anisotropism and faint blue to purplish polarization colors, hard and is well polished. Scarce remnants show oxidative corrosion at grain margins. Most of original pyrite has been oxidized to goethite.

Goethite - 53% - Light to medium gray and with bluish tint where better polished, anisotropic but with polarization colors masked by strong reddish brown internal reflections, variable hardness and perfection of polish. Finely banded aggregates are present mostly as oxidation pseudomorphs after pyrite. Some was also deposited as fracture or cavity fillings.

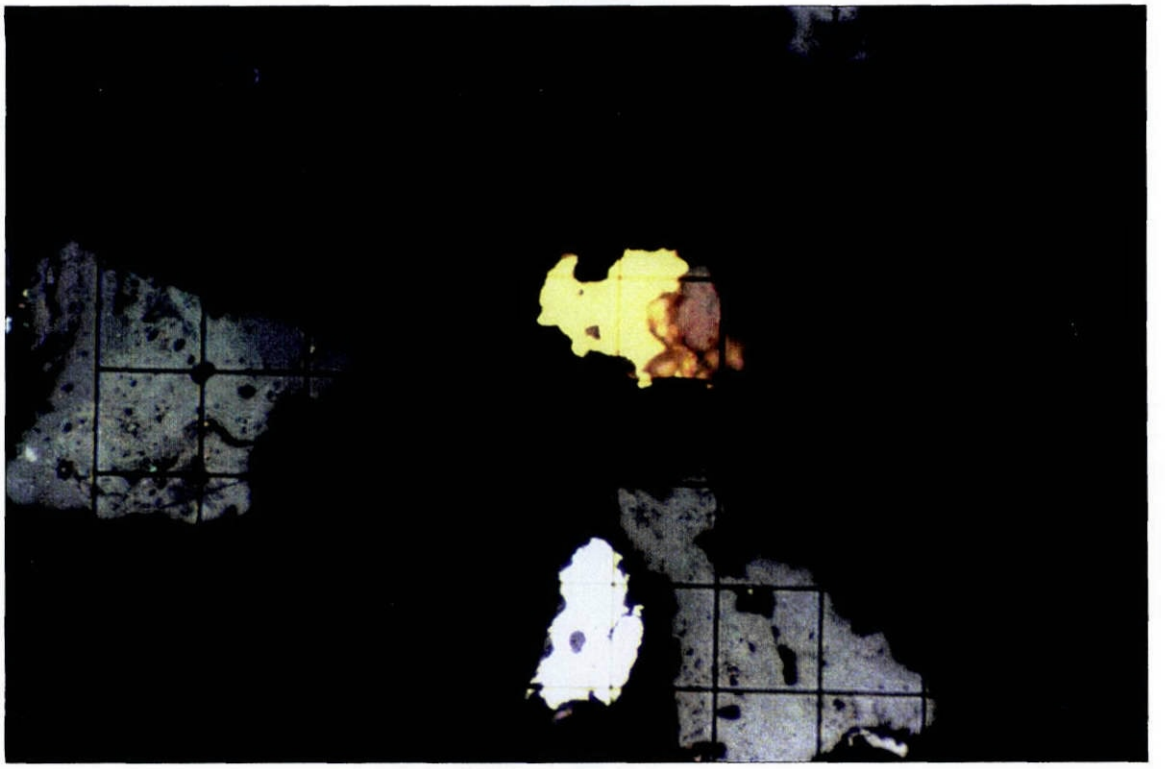
Hematite - 1% - Light bluish gray, moderately anisotropic and with polarization in shades of gray, hard and is well polished. Occurs both as composites with magnetite - in which formed by oxidation of that mineral, and as separate liberated particles containing no remnant magnetite.

Magnetite - -1% - Light grayish brown, isotropic, hard and is well polished. Present as composites with hematite oxidation aggregates, and is remnant from the minor accessory suite of the host rock.

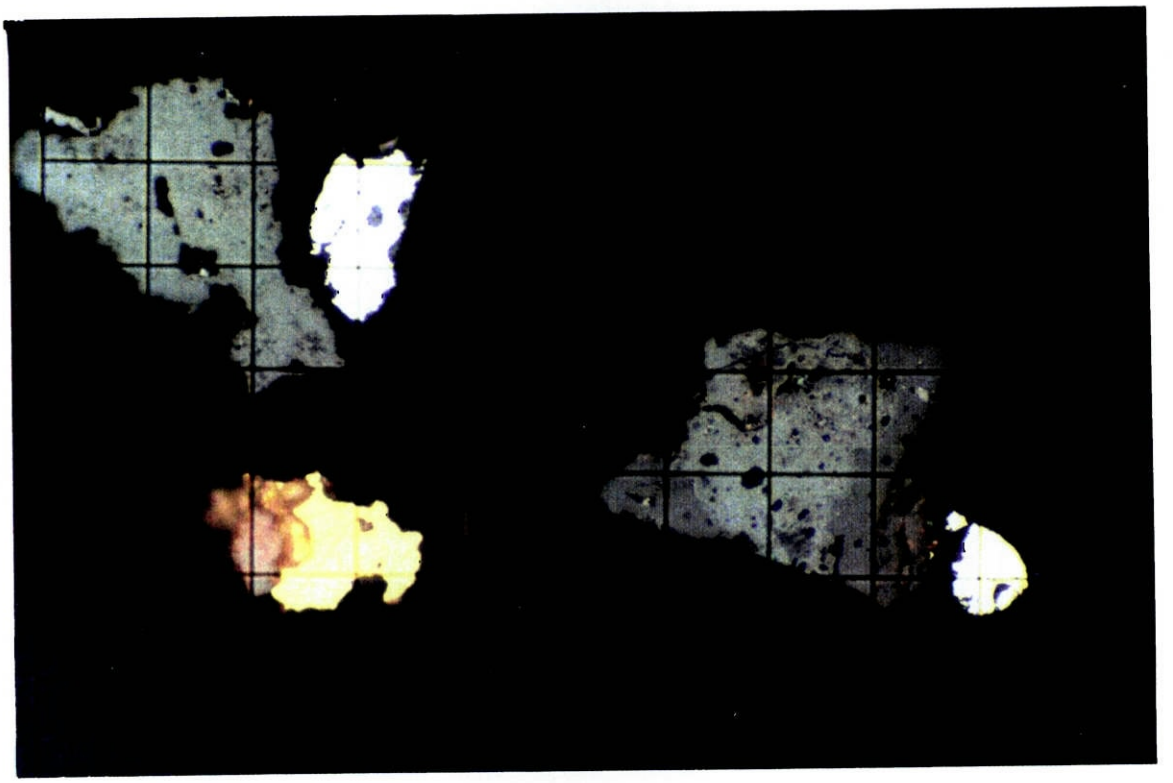
Trash iron - 5% - White metallic, isotropic, moderate hardness and is well polished. Present as curved "shavings" that were added as a contaminant during sample preparation.

Non-metallic gangue - 40% - Comprised of silicate minerals.

*Note: Sample examined in a panned concentrate prepared from the head sample ground to -70 mesh.

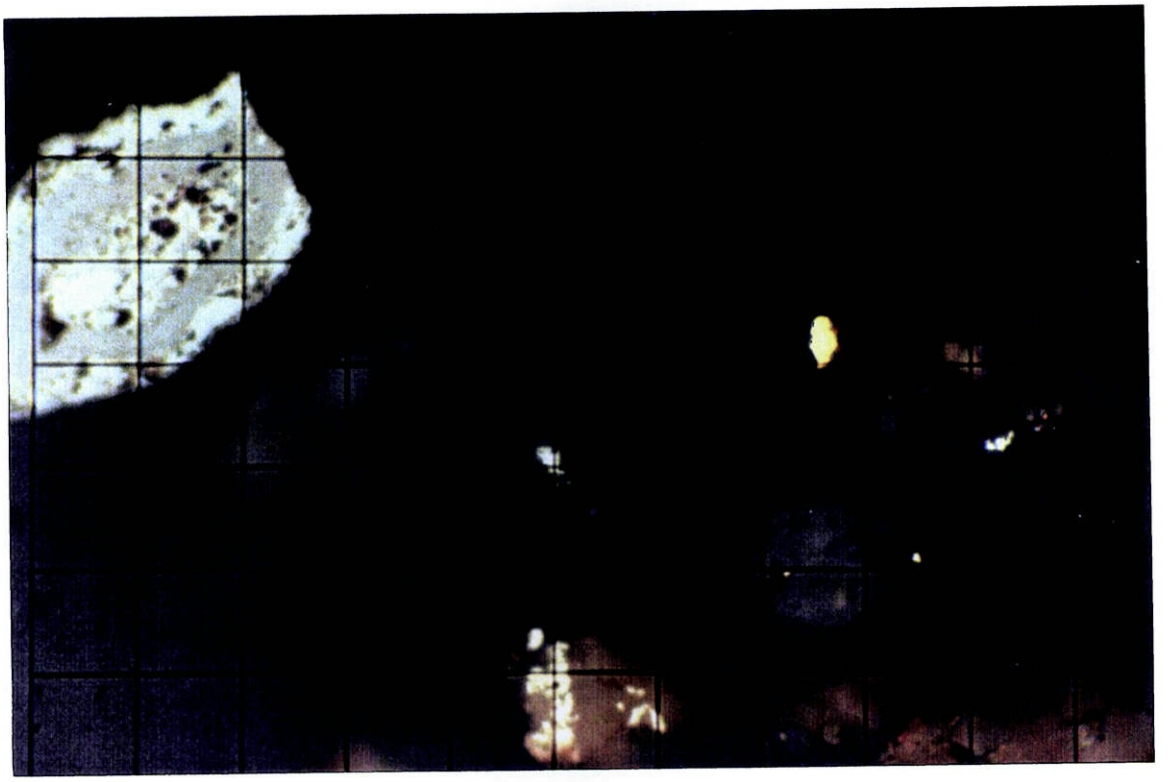


1G - 35-40'. Polished section photomicrograph showing particles of native gold and goethite. Trash iron fragment at lower center. Note that most of gold particle is present beneath polished surface. Plain light, X435. Each square of grid is 32 microns on an edge.

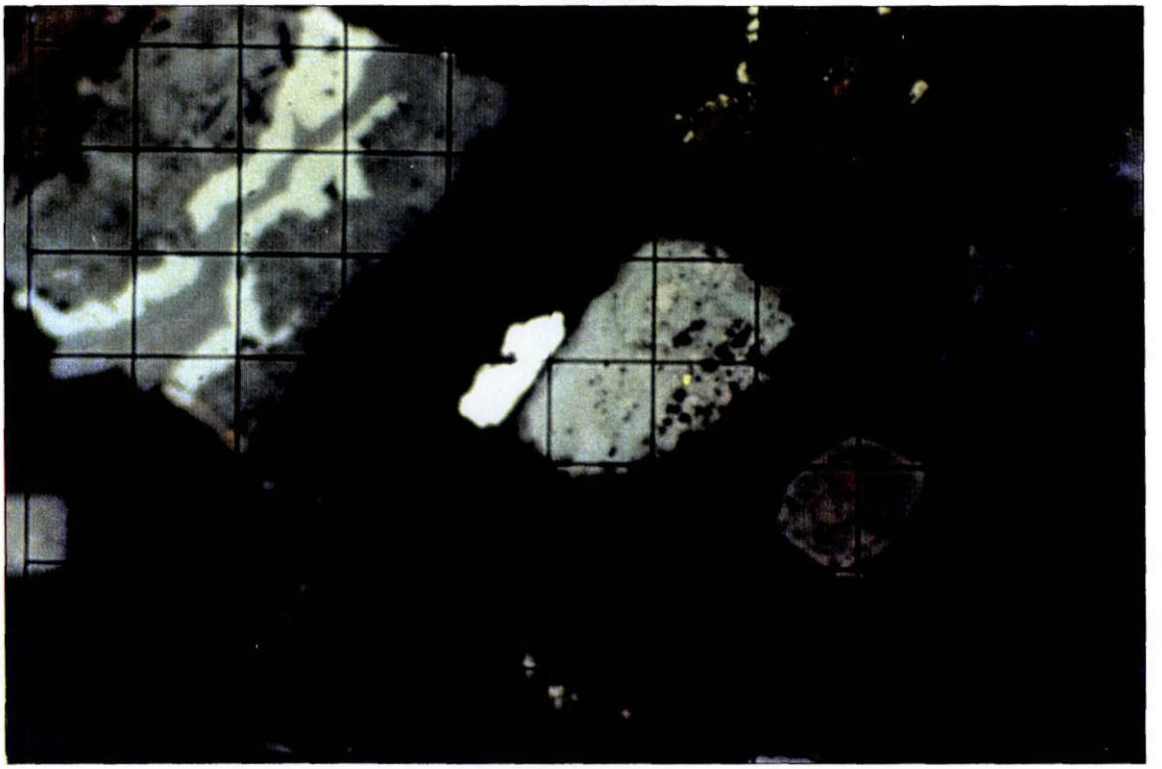


1G - 35-40'. Polished section photomicrograph of native gold associated with fragments of goethite and trash iron. Plain light, X435. Each square of grid is 32 microns on an edge.

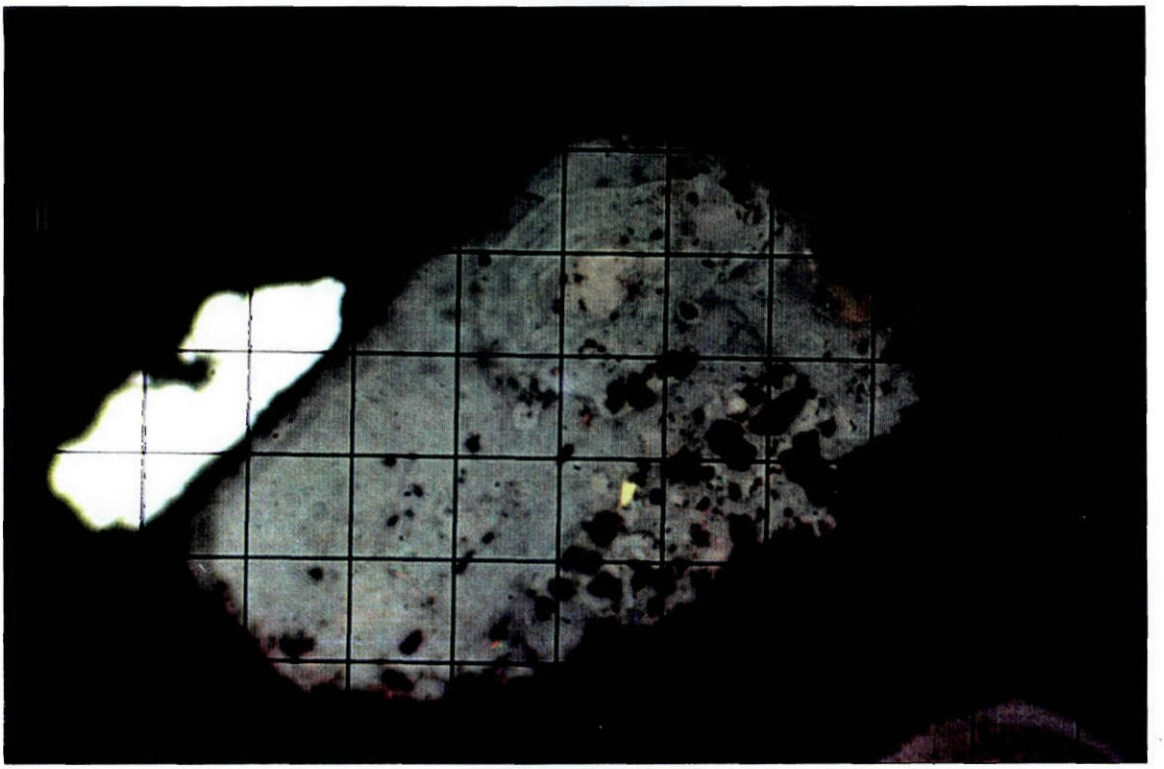
same photo as before, only rotated 180°



1G - 35-40'. Polished section photomicrograph showing small liberated fragment of native gold associated with goethite and gangue. Plain light, X435. Each square of grid is 32 microns on an edge.

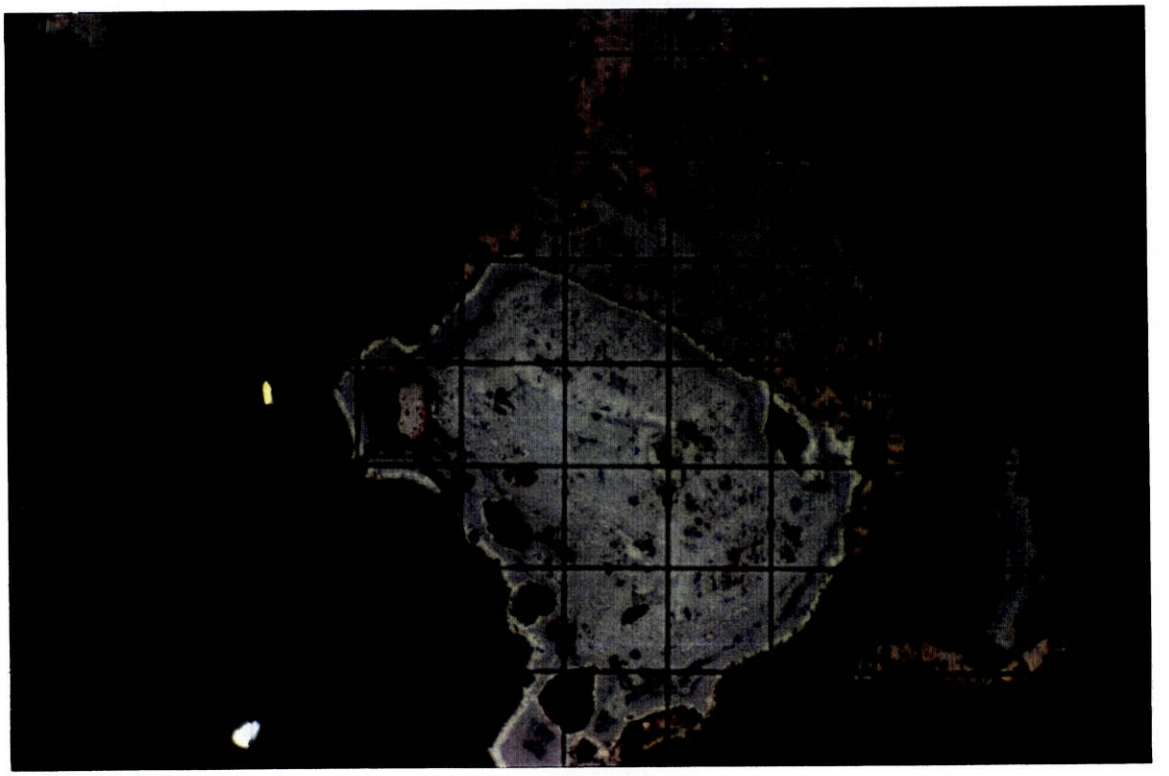


1G - 35-40'. Polished section photomicrograph showing very small native gold particle locked in goethite fragment (right center) and with other goethite, trash iron, and non-metallic gangue fragments. Plain light, X435. Each square of grid is 32 microns on an edge.

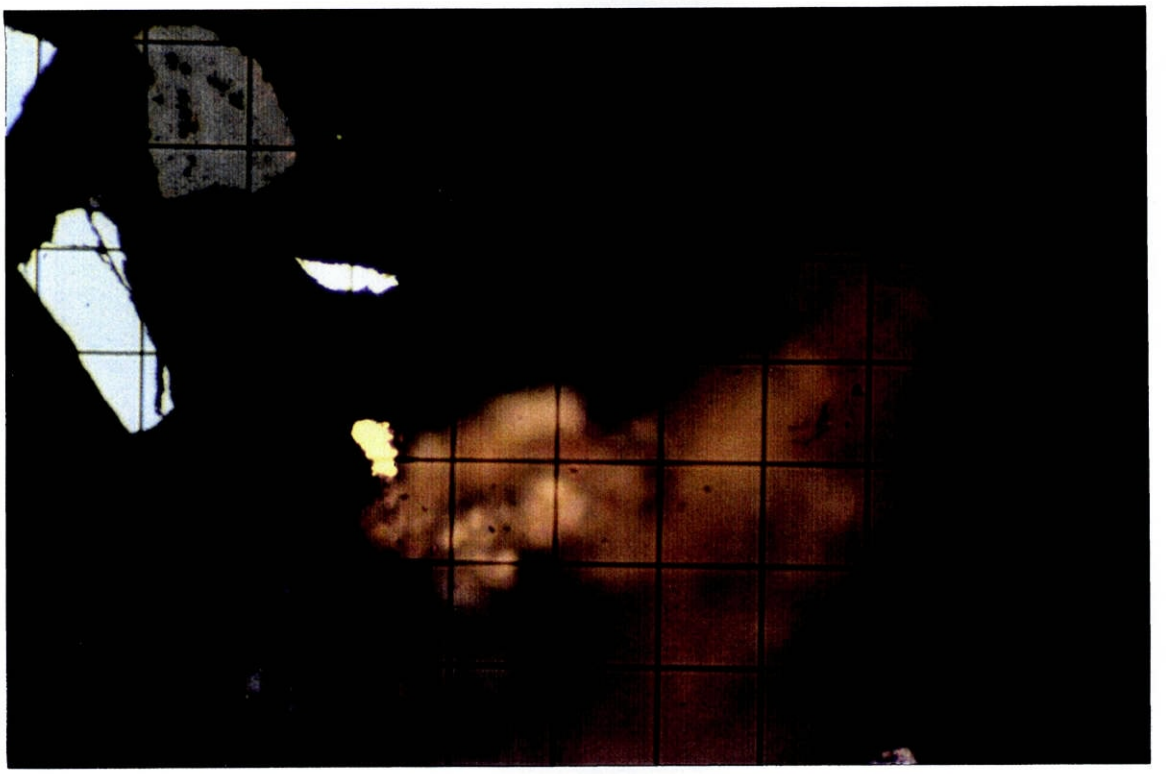


1G - 35-40'. Polished section photomicrograph showing enlarged view of very small native gold particle in goethite oxidation pseudomorph after pyrite associated with trash iron. Plain light, X1090. Each square of grid is 13 microns on an edge.

previous photo



1G - 35-40'. Polished section photomicrograph of small liberated native gold particle in plastic mounting medium adjacent to goethite oxidation pseudomorph. Plain light, X435. Each square of grid is 32 microns on an edge.



1G - 35-40'. Polished section photomicrograph showing liberated native gold particle in which only a small part of the grain is exposed in the polished surface. Associated at upper left are goethite, hematite, and trash iron. Plain light, X435. Each square of grid is 32 microns on an edge.

ASARCO

RMH 3-14-90

JDS

Southwestern Exploration Division

June 5, 1990

W.L. Kurtz

Thin-Section & Polished Sections
Yarnell Project
Yavapai County, Arizona

Attached are the last three Russell M. Honea petrographic-polished section reports on the material sent by M.A. Miller.

James D. Sell

James D. Sell

JDS:mek
Att. (3)

cc: R.L. Brown (w/atts.)
F.T. Graybeal (w/atts.)
M.A. Miller (w/atts.)

Russell M. Honea
Consulting Geologist

AC 303 466-9779

Office
1105 BELLAIRE
BROOMFIELD, COLORADO 80020

Mailing Address
P.O. BOX 323
BROOMFIELD, COLORADO 80020

March 14, 1990

Mr. Mark A. Miller
ASARCO Exploration
P. O. Box 5747
Tucson, AZ 85703-0747

Re: Yarnell Project, AZ

Dear Mark:

Enclosed are the last of the petrographic descriptions for your Yarnell sample suite. As usual, photomicrographs are included to illustrate some of the important mineralogic and textural relationships.

The samples are comprised of weakly to moderately granulated and sericitized granite - with significant quartz introduction in some samples. Again, there is a complex minor accessory mineral suite, but I did not see tourmaline in any of these samples.

Please let me know if there are questions regarding the data.

Sincerely,

Russell M. Honea

Encl.

ASARCO Incorporated
MAR 16 1990
SW Exploration

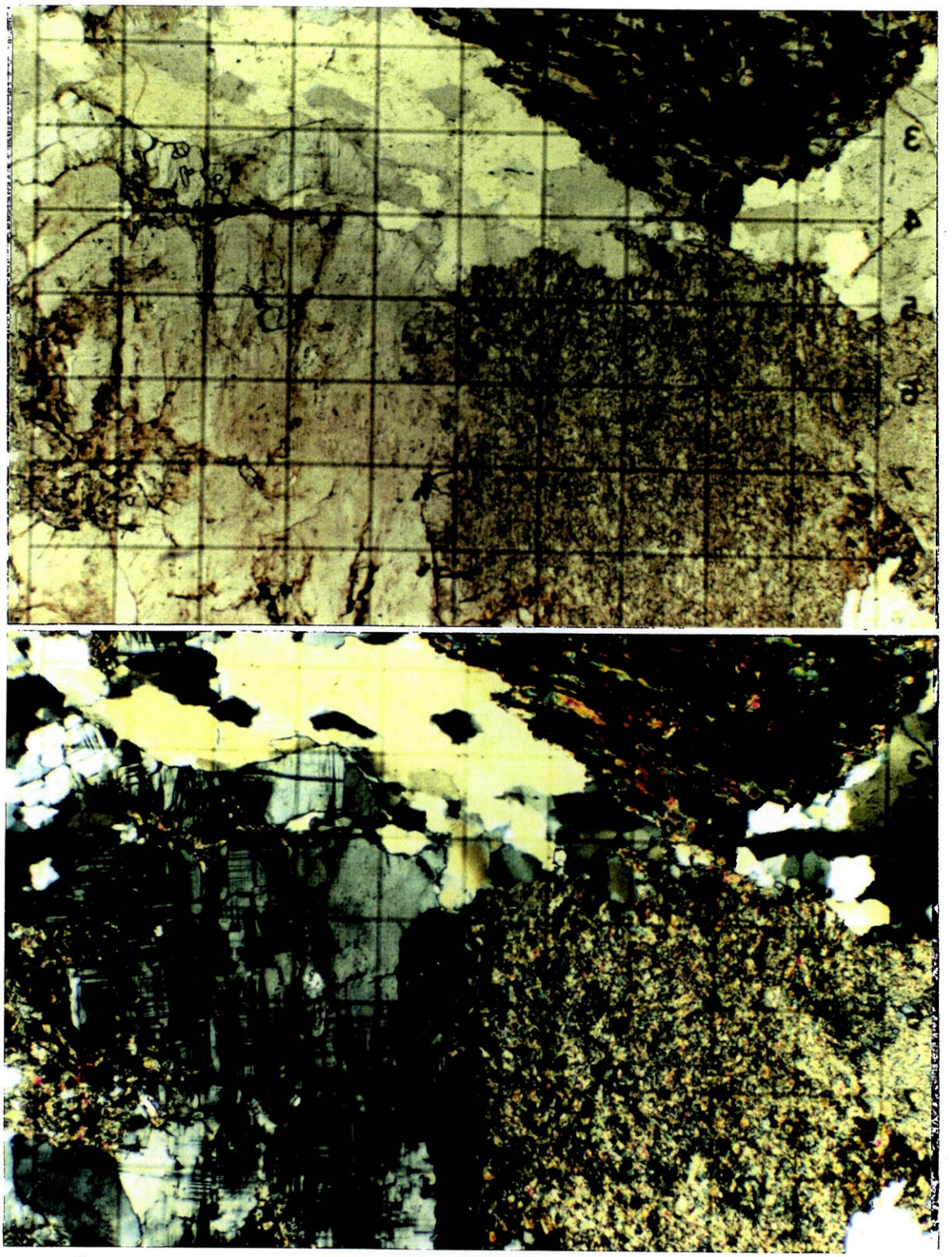
Y-165. Weakly granulated and moderately sericitized granite.

Primary Minerals	Percent	Description
Essential Constituents		
Plagioclase-$An_{12?}$	44	Subhedral prismatic, Carlsbad plus albite twinning, shows moderate to strong replacement by sericite.
Microcline	29	Sub- to anhedral, well developed grid twinning, microperthitic and with patches and stringers of albite. The microcline is essentially unaltered.
Quartz	20	Medium grained, anhedral, undulatory extinction. Occurs as grains and aggregates interstitial to feldspar minerals. Locally granulated and recrystallized to finer grained material. Contains needle-like inclusions of rutile.
Varietal accessory minerals		
Biotite	5	None preserved. Original flakes are completely replaced by colorless sericite with accompanying separation of opaques.
Minor accessory minerals		
Apatite	-1	Small colorless prisms with moderate positive relief and high birefringence, present as inclusions in altered biotite, feldspars, and quartz.
Zircon	-1	Small short prisms with extreme positive relief and high birefringence, pale pinkish color in transmitted light. Enclosed by feldspars and by altered biotite.
Monazite	-1	Scarce short prisms with very high positive relief and high birefringence, slightly inclined extinction. Enclosed by altered biotite.
Ilmenite	1	Small tabular black opaque crystals are present with magnetite in association with altered biotite.
Rutile	-1	Scarce oriented needle-like crystals with extreme positive relief are present as inclusions in altered biotite and also present in quartz.

Y-165.

	Percent	Description
Magnetite	-1	Small equant sub- to anhedral opaque grains are enclosed by altered biotite and feldspars. Most is oxidized in part to hematite.
Sphene	-1	None preserved. Former wedge-shaped crystals are associated in space with biotite and now completely replaced by leucoxene. Crystals are relatively large.
Secondary Minerals		
Quartz	5	Fine to very fine grained granular mosaic to sutured aggregates present at times with sericite replacing both biotite and plagioclase. Some of the finer aggregates interstitial to feldspar have undergone granulation and recrystallization.
Sericite	28	Fine to very fine grained colorless mica aggregates with high birefringence, present as partial to complete replacement of plagioclase and completely replacing biotite.
Leucoxene	-1	Extremely fine grained opaque tan to white Ti oxide aggregates present with sericite replacing biotite and accessory sphene.
Goethite-hematite	2	Extremely fine grained opaque brownish goethite present with sericite replacing biotite and in microfractures. Hematite occurs as partial replacement of accessory magnetite.

Texture: Medium grain phaneritic, equigranular. Shows some interstitial crushing or granulation and accompanying recrystallization of quartz.



Y-165. Thin section photomicrograph of granite showing sericitized plagioclase and grid twinned microcline with quartz and goethite-stained sericitized biotite. Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.

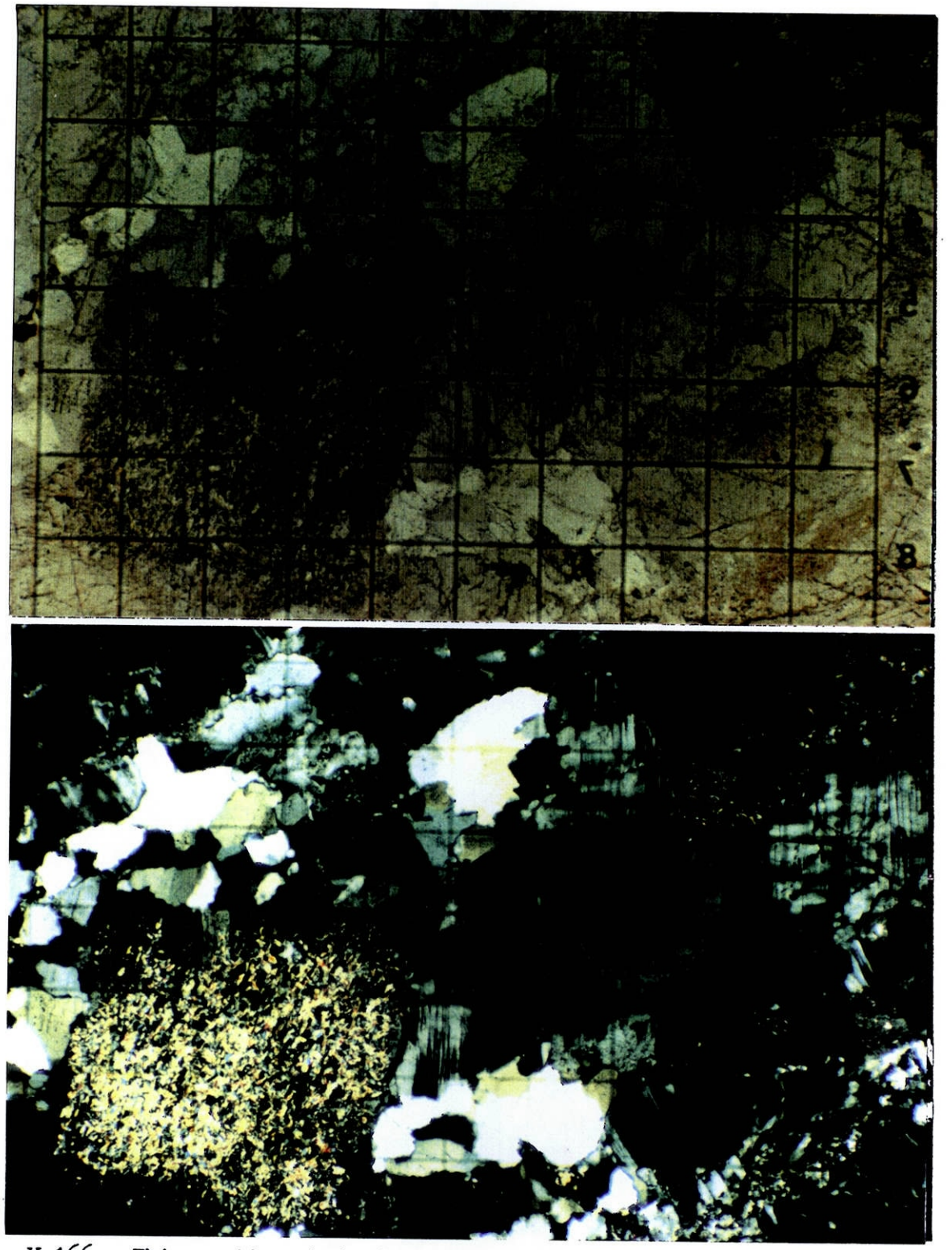
Y-166. Quartz-hematite veins cutting weakly sericitized granite with some interstitial granulation.

Primary Minerals	Percent	Description
Essential Constituents		
Plagioclase-An_9	30	Subhedral prisms, Carlsbad plus albite twinning, varies from unaltered to crystals showing moderate replacement by sericite. Twin lamellae at times deformed by crushing.
Microcline	55	Anhedral, Carlsbad plus well developed grid twinning, patchy microperthite. is essentially unaltered.
Quartz	15	Fine grained, anhedral, undulatory extinction. Occurs interstitially to feldspars and shows some granulation and recrystallization. Contains very tiny needle-like rutile inclusions.
Varietal accessory minerals		
Biotite	3	None preserved. Former subhedral flakes are now replaced by colorless sericite with accompanying separation of opaques. Also some quartz in replacement aggregates.
Minor accessory minerals		
Apatite	-1	Small colorless prisms with moderate positive relief and low birefringence, enclosed by altered biotite, feldspars, and quartz.
Zircon	-1	Small prisms with extreme positive relief and high birefringence, inclusions in altered biotite and in feldspars.
Monazite	-1	Scarce short prisms with very high positive relief and high birefringence, slightly inclined extinction. Enclosed by altered biotite.
Sphene	-1	None preserved. Former relatively large wedge-shaped crystals are now completely replaced by leucoxene.
Rutile	-1	Very tiny needle-like crystals are present as inclusions in quartz.
Ilmenite	-1	Small tabular black opaque grains present mostly in association with altered biotite.

Y-166.

	Percent	Description
Magnetite	-1	Small equant opaque grains are associated in space with altered biotite and ilmenite. Is almost completely replaced by later hematite.
Secondary Minerals		
Quartz	15	Fine grained, sutured contacts, undulatory extinction. Occurs mostly as filling of fracture controlled veins that cut host. Also with sericite replacing biotite and plagioclase.
Sericite	8	Fine to very fine grained colorless mica aggregates with high birefringence, present with quartz and opaques replacing biotite and in varying amounts replacing plagioclase.
Leucoxene	1	Extremely fine grained opaque white Ti oxide aggregates formed as an alteration product of biotite and from accessory sphene.
Hematite	2	Fine grained black opaque platy aggregates of specular hematite are present near margins of quartz veins cutting host. Also at times present as the sole filling of fractures. Some is also formed as an oxidation product of accessory magnetite.
Goethite	2	Extremely fine grained translucent to opaque orange brown aggregates present in microfractures and with altered biotite.

Texture: Medium grained phaneritic, equigranular. Fractured and with vein fillings as well as granulation and some recrystallization.



Y-166. Thin section photomicrograph of altered granite with sericitized plagioclase (lower left) plus grid twinned microcline and quartz. Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.

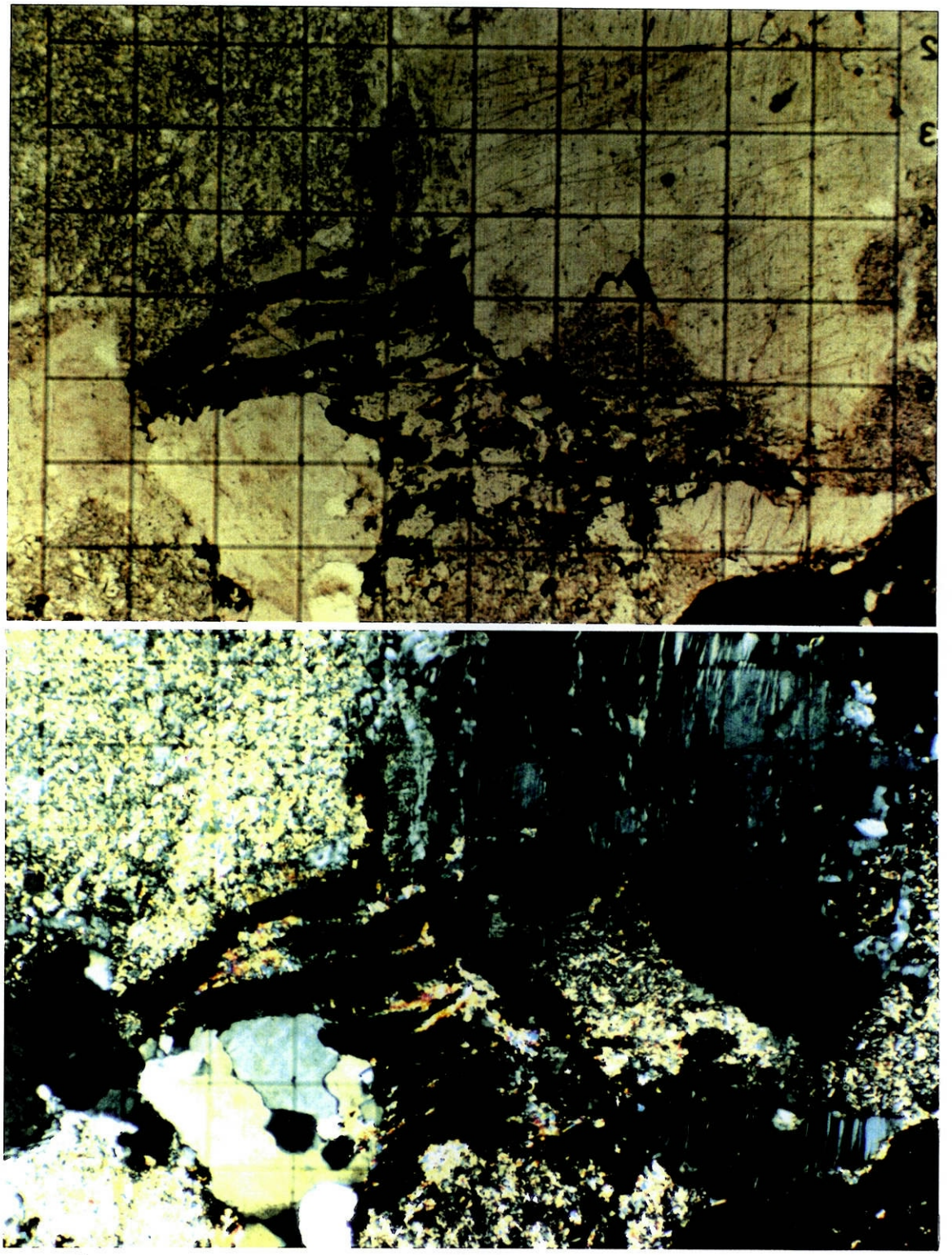
Y-167. Moderately sericitized granite with some interstitial granulation and recrystallization.

Primary Minerals	Percent	Description
Essential Constituents		
Plagioclase-$An_{7?}$	38	Subhedral prismatic, Carlsbad plus albite twinning, shows moderate to complete replacement by sericite.
Microcline	32	Subhedral prisms to anhedral, Carlsbad plus grid twinning, microperthitic and with small stringers and patches of plagioclase. Is essentially unaltered.
Quartz	20	Fine to medium grained, anhedral, undulatory extinction. Occurs interstitially to feldspars and has undergone some granulation and recrystallization.
Varietal accessory minerals		
Biotite	7	None preserved. Former subhedral flakes are replaced by colorless sericite - that is accompanied by separated opaques. A few of colorless flakes are probably primary muscovite.
Minor accessory minerals		
Apatite	-1	Small colorless prisms with moderate positive relief and low birefringence, enclosed by all of the above silicates.
Zircon	-1	Small prisms with extreme positive relief and high birefringence, enclosed by altered biotite and by feldspars.
Sphene	1	Sub- to euhedral wedge-shaped crystals are now completely altered to very fine grained leucoxene-ilmenite aggregates. Present as clusters of crystals that are relatively large for the species.
Monazite	-1	Small short prisms with very high positive relief and high birefringence, present in crystals enclosed by altered biotite.
Rutile	-1	Extremely small needle-like crystals with extreme positive relief are present as oriented inclusions in quartz.
Ilmenite	-1	Fine grained, subhedral tabular, black opaque. Present in separate crystals associated in space with magnetite and most often near altered biotite.

Y-167.

	Percent	Description
Magnetite	1	Small equant opaque grains are often associated with altered biotite and ilmenite. Most is now oxidized to hematite.
Secondary Minerals		
Quartz	3	Very fine to fine grained, granular mosaic to sutured contacts, undulatory extinction. Finer material with sericite aggregates replacing plagioclase and biotite. Also a recrystallization product in areas with granulation.
Sericite	20	Very fine to fine grained, subhedral flakes, high birefringence. Occurs mostly in aggregates replacing plagioclase - but also as complete replacement of biotite and in small fractures that cut quartz and microcline.
Leucoxene	2	Very fine to extremely fine grained aggregates with extreme positive relief, white in oblique incident light. Formed by alteration of biotite and sphene.
Goethite + Hematite	3	Very fine to extremely fine grained opaque yellowish brown goethite present mostly in altered biotite and in microfractures cutting host. Hematite occurs as an alteration product of accessory magnetite in this sample.

Texture: Medium grained phaneritic, equigranular. Shows minor shearing and interstitial granulation.



Y-167. Thin section photomicrograph of granite showing microcline with quartz, sericitized plagioclase, and sericite-replaced biotite with accompanying opaque leucoxene. Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.

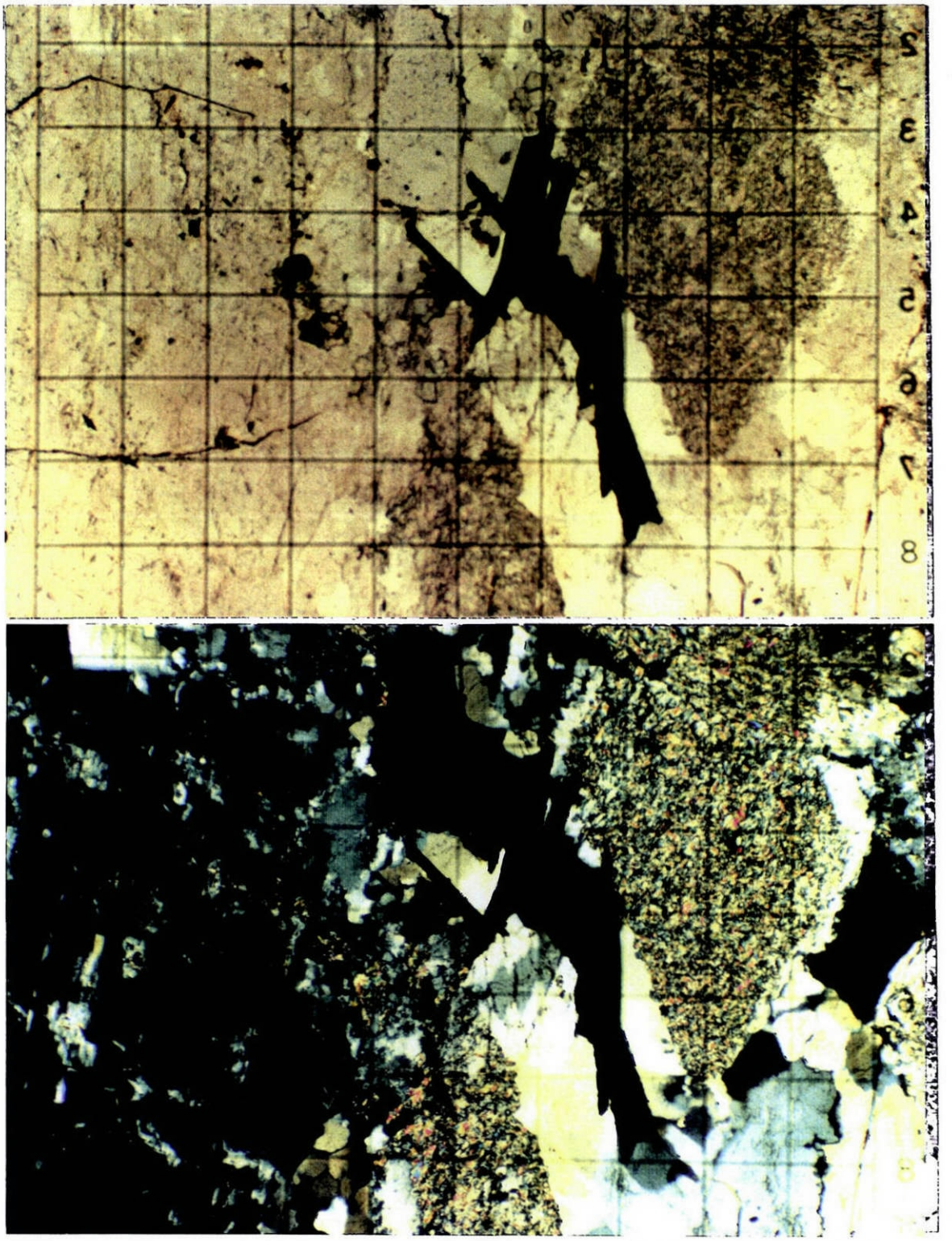
Y-168. Quartz-hematite veins cutting weakly sheared and sericitized granite.

Primary Minerals	Percent	Description
Essential Constituents		
Plagioclase-$An_{8?}$	39	Subhedral prismatic, Carlsbad plus albite twinning, shows weak to moderate replacement by sericite.
Microcline	33	Anhedral, Carlsbad plus grid twinning, microperthitic and with both patches and stringers of albite. Is essentially unaltered.
Quartz	20	Fine to medium grained, anhedral, undulatory extinction. Occurs interstitially to feldspars and shows some granulation and recrystallization. Contains very small rutile needle inclusions.
Varietal accessory minerals		
Biotite	6	Subhedral flakes are pleochroic in shades of green to olive green, high birefringence. Most is altered to colorless sericite with accompanying separation of opaques.
Muscovite	1	Subhedral flakes, colorless, high birefringence. Occurs interstitially to feldspars and lacks the opaque mineral separated from altered biotite.
Minor accessory minerals		
Apatite	-1	Small aggregates and single crystals, prismatic, colorless, moderate positive relief and low birefringence. Enclosed by all of the minerals described above.
Zircon	-1	Small prisms with extreme positive relief and high birefringence, most is associated in space with biotite and sometimes marginal to magnetite.
Monazite	-1	Short prismatic, very high positive relief and high birefringence, slightly inclined extinction. Associated in space with biotite.
Rutile	-1	Extremely fine grained needle-like crystals with extreme positive relief, enclosed by quartz.

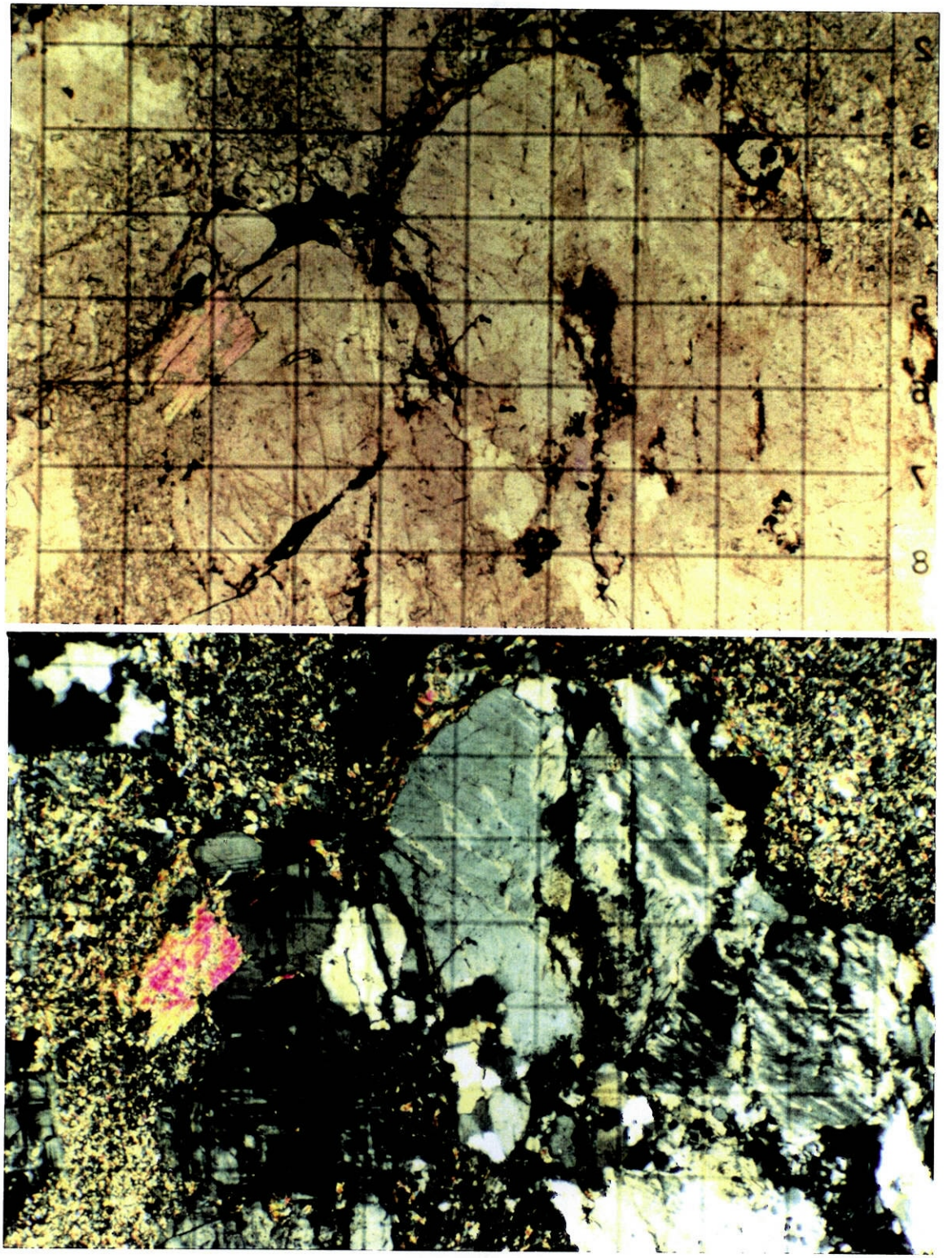
Y-168.

	Percent	Description
Sphene	-1	Few larger than usual wedge-shaped crystals that are now completely altered to leucoxene.
Ilmenite	-1	Small tabular black opaque grains are mostly associated in space with biotite.
Magnetite	-1	Equant black opaque grains are associated with biotite and show partial oxidation to hematite.
Secondary Minerals		
Quartz	4	Fine to very fine grained, colorless, granular mosaic to sutured contacts. Present as fracture fillings or veinlets with hematite and in small amount as finer grained aggregates with sericite after plagioclase and biotite.
Sericite	12	Very fine to fine grained colorless aggregates with high birefringence, present as replacement of both plagioclase and biotite. Also in small amount in fractures.
Leucoxene	1	Extremely fine grained opaque white Ti oxide aggregates formed from alteration of accessory biotite and sphene.
Pyrite	(1)	None preserved. Former small euhedral cubic crystals are now completely oxidized to goethite.
Hematite	1	Fine to very fine grained, platy specularite aggregates of opaque grains with red internal reflections, present both as vein mineral with quartz and as an oxidation product of magnetite.
Goethite	2	Extremely fine grained opaque orange to reddish brown aggregates present as an alteration product of pyrite, with leucoxene from alteration of biotite, and in microfractures cutting host.

Texture: Medium grained phaneritic, equigranular. Shows some shearing and veining - plus some interstitial granulation and recrystallization.



Y-168. Thin section photomicrograph of granite showing hematite plates with quartz in crushed zone interstitial to sericitized plagioclase and microcline. Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.



Y-168. Thin section photomicrograph of granite showing sericitized plagioclase with microcline (right), small muscovite flake (left), minor quartz, and sheared and altered biotite (top). Plain light and crossed nicols, X56. Each square of grid is 260 microns on an edge.

JDS

ASARCO

Southwestern Exploration Division

Via FAX

March 23, 1990

R.L. Brown

Revision of Computer Reserve
Yarnell Project, Arizona

I received a set of the twenty-foot blocks on cross-sections in the second week of March, and the twenty-foot block bench plans on March 21-22.

In reviewing the computer information, three items deserved a conference review, and this was done with L. Jansen, S. Lakosky, M. Miller and me. The three items were:

1. Areas showing hi-values up in the hanging wall, which were based on a drill hole intercept and the values spread in all directions.

2. Drill hole values spread into the footwall below the apparent cutoff at the base of the main mineralization.

3. The computer gap in interpreted values within the mineral zone which was caused by insufficient drill hole information, and thus outside the influence of the surrounding drilling holes during the computer search.

After discussion among the four of us, item number 1 was resolved by bringing up the plans on the screen and changing the values so that an indication of mineral is known, but no mining block is shown. The ore grade value is present as a narrow steeply-dipping vein and is probably recoverable along the strike direction, but not spread laterally as done by the computer.

Items 2 and 3 are concerns and will be addressed by the joint team of M.A. Miller, S.A. Anzalone, S.L. Lakosky, and J.D. Sell, with the computer input by L.J. Jansen. This will involve agreement on the values to be placed or deleted and manual adaptation of these values, block-by-block, on the computer bench plans.

In the present computer model, the "stope" values are placed in at 0.053 opt gold. Mr. Jansen assures me that this is unnecessary to add in and then subtract the tonnage value. When the stope configuration and pillar drill holes are in the model, then the model will call the stopes as waste and give the pillar holes their due influence and realistically assess the situation. The "stope" waste will be taken out of the stripping tonnage in the final tabulation.

The group agreed that with item No. 1 clarified, the remaining items 2 and 3 appeared to balance out in that the stope excess and the footwall excursion excess probably balanced out the computer gaps, and the values to be reached in the present preliminary will be in the ballpark for the parameters now being presented.

Corrections of items 2 and 3 will be ongoing and a final adjusted model will be available as agreement is reached by the various members of the group and computer time is available.

Mr. Sal Anzalone was unavailable during the bulk of the discussions, but was advised of the situation and agrees to the viewpoints and projected resolvement.

James D. Sell

JDS:mek

James D. Sell

cc: F.T. Graybeal
W.L. Kurtz
S.A. Anzalone
S.L. Lakosky
L.J. Jansen
M.A. Miller

ASARCO

Southwestern Exploration Division

[illegible] - to be updated

~~May 3,~~ 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 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 as known limits.

II. RECOMMENDATIONS (Plate 4)

Asarco has drilled off an inventory of (+4 million tons at .05-.06 opt Au). 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 indicated 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. The footwall of the potential mineralized zone is exposed where it is in contact with fresh granite. 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. A report and proposal have been submitted for approval.

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. Mineralization appears to be related to a fault structure, possibly a splay of the Yarnell Fault. Detailed rock chip sampling along the exploration roads that traverse the knob and trenching on the structure 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 good mineralization. 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.

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 new release in the George Cross News

Letter, a Vancouver B.C. promotional news letter. Norgold Resources, the junior Canadian mining company that controlled the property, reported the results of a reconnaissance rock chip sampling program. The length of the sample lines and resultant grade suggested a bulk tonnage O.P. target. This property was examined in November 1988, sampled with results confirming Norgold's values. It was sampled in more 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. 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.

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 (location 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. Preliminary studies indicate a <3:1 waste/ore ratio. The climate is also conducive to year-round operation.

V. LAND STATUS & GENERAL AGREEMENT (Plate 1, Figure 2)

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:

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 attached schedule of payments details the underlying payouts. Norgold will share in these costs once the 51/49 JV is enacted.

PAYMENT & ROYALTY SCHEDULE

YARNELL PROJECT

Figure 2

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 Payments not to exceed $175,000/yr	1% or Advance Royalty (Greater of the two)	None

VI. GEOLOGY (Plate 2)

A. GENERAL STATEMENT OF ROCK TYPE FOUND

The gold deposit occurs within a Precambrian (1400 my) 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. 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 ferro mag 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.

Aplite dikes 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 aplite structures trend N20-40°E and dip to the NW at 30-80°. These dikes are usually thin (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 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 aplite variety, up to +10' in thickness. Based upon the mapping, it appears that the diorite may postdate the aplite dikes. The largest diorite dike trending N10-20°N appears to cut the Yarnell Fault as there is no <u>obvious</u> displacement across the fault. The dike(s) 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. 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 unclear at this time.

The existence and occurrence of diorite dikes and sills

associated with gold deposits in the district is well documented. 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.

B. STRUCTURE

The principal structure which controls and localizes gold mineralization is the Yarnell Fault Zone (YFZ). This is a 4'-6'+ zone 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 YF is a low angle structure trending N40-60°E with dips to the northwest ranging from 25-40° along its mapped and exposed length. The YFZ 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.

C. GOLD MINERALIZATION & OCCURRENCE

On the basis of core logging, field observations, and limited mineralogical work by Russell Honea (consultant mineralogist) 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) (Attachment B). Of particular interest was 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 = .00mm 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. This study indicates that the size range of free Yarnell 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 size gold deposits in the Mohave Region. Particle size of gold at the Mesquite Mine operated by Goldfields U.S. 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 of 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. Strong 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.

Additional gold mineralization (based upon assay results) along the northeast and southwest extension of the YFZ occurs indicating continuous gold mineralization along the fault extensions.

D. ALTERATION (ATTACHMENT C) (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). 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 (consultant mineralogist) observations with interpretations (Attachment D).

Weak Alteration (Propylitic)

This 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. 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. From the unaltered granite boundary this zone is +/-50-150' thick (measured from the plane of the Yarnell Fault).

Petrographic Description (Attachment D)

This 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

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 and occasional limonite pseudomorphs. The stronger altered zone increases in abundance as the 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.

Petrographic Description - No thin sections were cut.

Moderate Alteration (Phyllic) Oxidized

This zone is characterized by the complete replacement of biotite by sericite. This zone is also characterized by pink feldspar (adularia?) rimming quartz veins and other feldspars (photo - Figure 4). As the intensity of alteration increases the ground mass becomes increasingly more sericitic and the secondary feldspars appear to become more prominent through the ground mass. Calcite is absent in the oxidized zone. This zone is also characterized by an increase in silica as stockwork and

"flooding." This will be discussed in later sections. The zone (oxidized) occurs principally in the hanging wall 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 hole, 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, possibly due to chlorite. K-spars are noticeably pink and appear to be primary? and unaltered. Rare calcite is present in "gash" veins.

Petrographic Description (Attachment D)

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 --> trace in the unoxidized section.

Moderate Alteration - Yarnell Fault Zone Complex

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 complex zone is 4-->20' in thickness. The

actual Yarnell Fault Zone is only 4-6'+ thick. Strike of the mineralized zone is N40-60°E dipping northwest 30-40° northwest.

Petrographic Description (Attachment D)

The petrography of the rock suggests a quartz poor (3-5% primary quartz) phase. Russ Honea has called this rock a syenite, but is unsure whether this may be due to remobilization of the silica from the original rock and redeposition as secondary quartz veins and interstitial silica. The amount of secondary, additional quartz as seen by Honea is 15-22% which is more than any other zone. It is also possible that this syenitic rock may represent a different phase of intrusive which has been emplaced along the Yarnell Fault Zone. The details of this rock are not known at this time. Within this zone is moderately strong potassic addition as adularia (15%). This also is seen throughout portions of the oxidized moderate zone where the amount of quartz vein stockwork is the greatest. Russ Honea (personal communication) has stated that in his experience there is a close relationship between the quartz adularia systems and gold mineralization. Some of the higher gold values are within the quartz stockwork adularia zones.

E. SILICIFICATION

Within the Yarnell Deposit silica is seen in several modes of occurrence. Quartz (S_iO_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.

4. White Quartz - We have identified two stages of white quartz. These veins appear to cross-cut all of the other stages. The white quartz veins are the thickest (6" in core to 1'). These have also been seen in the field and

have been seen 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 RESULTS (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.).

The assay results of the reverse circulation drilling are summarized on the attached map showing "B" zone only (Plate 3). All drill logs and assays are included in bound volumes. The attached cross sections through the drill holes show the style of alteration and mineralization discussed in previous sections. All drill holes were plugged and abandoned upon completion per D.W.R. requirements, and abandonment reports were filed. The geologic details of the diamond drilling are summarized in the next section. The four diamond drill holes were surveyed using a Sperry Sun single shot down hole camera and hole deviation was <1° 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. 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.

G. DIAMOND DRILLING OBJECTIVES

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 is attached (Attachment J).

H. GEOLOGY OBSERVATIONS

All holes were collared in the weakly altered zone and were designed to drill through the section into the footwall of the mineralized zone. A number of observations were made that

influenced the geologic picture. Many of these observations have been included in other sections of this report but they will be reiterated here. These are as follows:

1. The weakly altered through transition zone shows moderate developed propylitic alteration. 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 has been seen in some of the holes which occur above the Yarnell Fault Zone. 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 which rims the quartz veins and moves outwards into the ground mass (Figure 4).

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 and stockwork. 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 vein. 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 as seen in drill core ranges from 5' in YDDH-1 to 90' in YDDH-2. Assay values within this 90' 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 suggesting the occurring of chlorite. 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 the four diamond drill logs are attached (Attachment E).

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 through pit 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 not 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. The attached tabulation (Table A) by John Malusa lists all of the standards with the assayed values. The second tabulation (Table B) shows the chronology of the samples when a sample was used multiple times. 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, attached). The results of this study indicated that while there was some variation between labs, the

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average for the 75 samples was almost identical.

Another check on assay results was done much later in the drilling program (Attachment H). 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.

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 + 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, Attachment F). A value of 12 ft^3/ton was used in all reserve calculation.

IX. STOPED OUT AREAS

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 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 approximate 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 cut line was planimetered by W.D. Gay 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 to J.D. Sell on 2/22/90.

X. ORE RESERVES

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 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:

JDS Reserve	ECS Reserve
(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

These numbers may be subject to additional recalculation.

XI. METALLURGICAL TESTING

Phase 1 of metallurgical testing is completed. This phase of testing used materials mined from the open cut and composite as run of mine ore and then column leached. Results are attached. This phase of the testing was under the direction of D.E. Crowell.

Additional work is in progress. Twenty-four drill holes were selected and the assay intervals were composited into one sample per hole (Attacment I). A program of bottle rolls have been completed. Holes picked throughout the deposit are anticipated to give a representative average of the leachability of the ore zone.

XII. EXPLORATION POSSIBILITIES AND OTHER TECHNIQUES

The Yarnell Deposit provides us with an excellent opportunity to determine exploration parameters for these type deposits and to aid in the search for other deposits in the district. At Yarnell we have recognized an alteration assemblage and mineralogy which comprise the gold deposit. The large alteration "halo" seen at Yarnell has not been duplicated elsewhere to date; however, we have seen smaller occurrences with similar alteration and mineralization.

We have completed two orientation surveys over the deposit. A four line soil geochemical survey was completed using the GSI 15 element detection package. All of the elements were plotted on histograms and statistically graphed to determine threshold values. In addition to the soils, two rotary holes (rejects) were resample and the main tunnel adit rejects resampled in order to better understand the orebody and to have a rock/soil comparison. Having performed all of the statistics the results are as follows:

A. Scattered anomalies of base and volatile element (As, Sb, Bi, Hg) occur especially in the hanging wall of the deposit.

B. A large geochemical halo of gold and possibly silver appears to surround the deposit. This suggests that these type deposits should be able to be detected with a wider spacing reconnaissance soil sampling program. In addition to the geochemistry, a ground magnetometer survey was completed. Six ground lines were run across the deposit with two of the lines run along the roads roughly perpendicular to the strike of the deposit. After reducing the data in various ways and looking at the published data within the area, it appears that the Yarnell Deposit is situated on a steep magnetic gradient, and appears to show through the gradients in the moderately altered and oxidized zone. There appears to be more magnetic destruction within this zone compared to other zones. This conclusion suggests that this tool can be used for following altered zones under cover.

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ATTACHMENT D

Yarnell Project

Petrographic Descriptions - Russ Honea

Sample No.	Alteration Zone	Primary Minerals %				Secondary Minerals %						Silica %		Iron Oxides %			
		Plagio-clase	Micro-cline	Quartz	Biotite	Sericite	Clay	Chlorite	Calcite	Epidote	Leuco-xene	Quartz/ Adularia	Chalce-dony/Opal	Hematite/ Magnetite	Limonite/ Pyrite(Fresh)	Goethite	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

JDS

ASARCO

Southwestern Exploration Division

June 14, 1990

J.D. Sell

Geologic Revision of the ECS
Block Reserves
Yarnell Project
Yavapai County, Arizona

The geologic revision of the ECS block model ore reserves has been completed. The revised model awaits another economic evaluation using the cone miner program and will be done as ECS time permits. The changes made in the block reserve fell into two categories: continuity of mineralization between drill hole intercepts for the "B" zone and projection of the reserve blocks outside the geologic limits of the "B" zone mineralization.

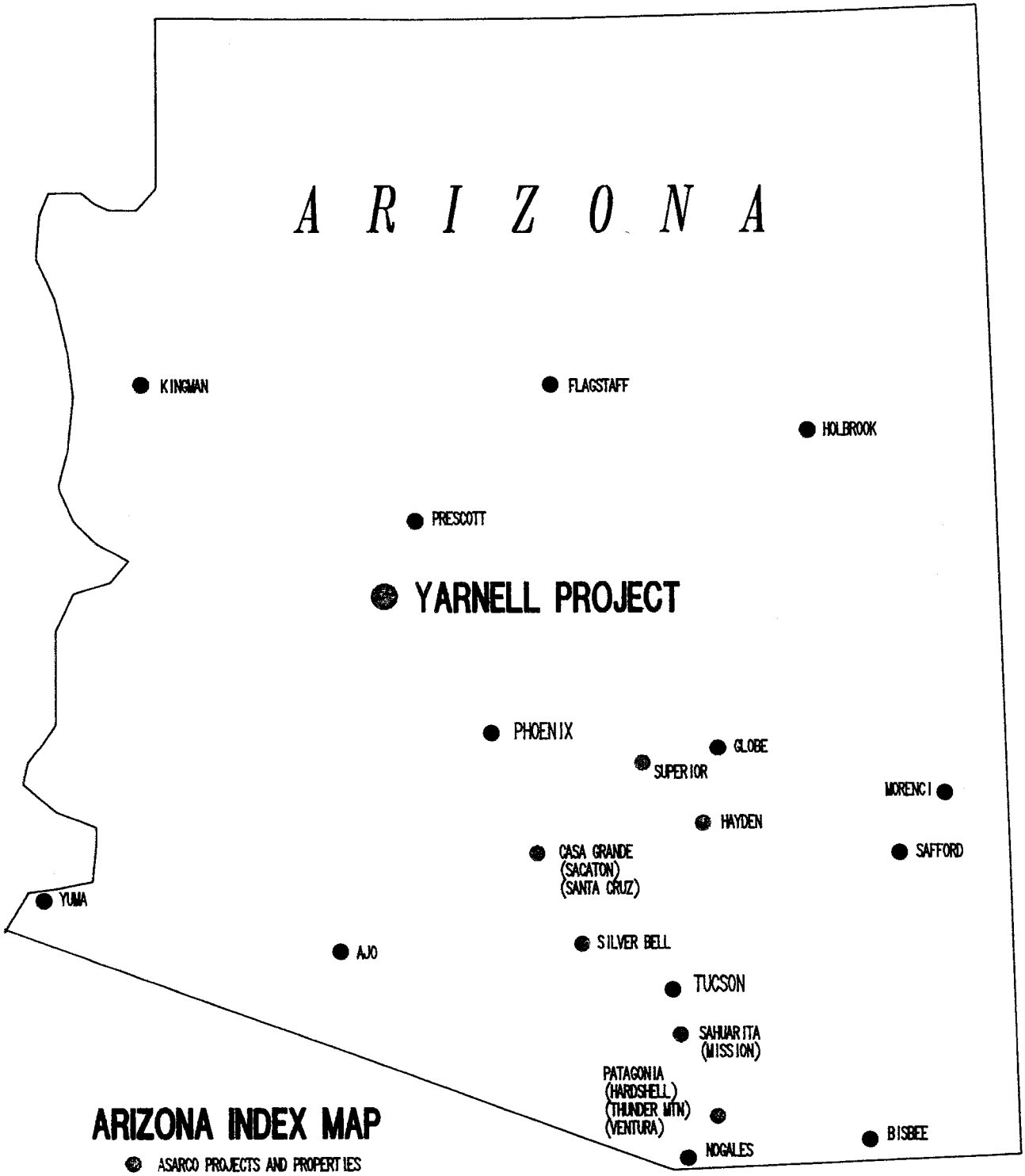
Based upon all available data, surface mapping, subsurface projection of drill hole intercepts, underground mapping and sampling, etc., a geologic model was designed with constraints on the "B" zone mineralization. The ECS model was evaluated within these constraints and modified as needed to fit the model. Reserve blocks that were located below the footwall of the "B" zone were removed. Reserve blocks located within the "B" zone were evaluated for additional continuity and were upgraded to show this continuity when the geologic model allowed it.

The reserve was modified by the following methods. North-south sections were printed on 60' centers by ECS. These sections were used to determine whether the reserve blocks for the particular section agreed with the geologic constraints. The hanging wall and footwall were picked using all the available geologic data as described above and blocks that were below the footwall of the "B" zone were taken out of the reserve. Blocks above the hanging wall were evaluated as to whether they were part of the "A" zone. Approximately 24 sections were evaluated. Once the changes were made on the sections, the changes into the computer were made on the plan maps, level by level. This was done because at this time, it is not possible to make computer changes on the sections.

Mark A. Miller

MAM:mek

cc: W.L. Kurtz



ARIZONA INDEX MAP

ASARCO PROJECTS AND PROPERTIES

ASARCO Incorporated
YARNELL PROJECT
INDEX MAP
YAVAPAI CO., ARIZONA

mn YR900701 MAM/dam tuc 07/02/90

JDS

ASARCO

Southwestern Exploration Division

July 12, 1990

M.A. Miller

Final Report
Yarnell Project
Yavapai Co., AZ

I send your Final Report back with a number of comments. I find the report ill-put together which makes for confusion for anyone trying to follow text and all you Attachments-Plates-Tables-Figures.

You should not date your cover letter if all your supporting data is not ready to go. Date when you are ready to submit.

Some observations:

1. Geology map, Plate 2

   a. You did not label the "granite" in the explanation column. You only said it was fresh/altered.

   b. Is the diorite/felsite/granite in relative age-relationships, from youngest to oldest?

   c. Where does the inferred Yarnell fault go from your trench at the north base of the eastern knob?

   d. As I recall, the claim YAR-43 was to be the narrow slot between the Juniper and the Alvin J. If so, a short arrow should point to this slot. Your map has YAR-42 here! What is correct?

   e. What then is the YAR-42 on the northeast end of Juniper? It's the real YAR-42?

   f. You have several zones with , such as near rotary hole 65, and rotary hole 30. No explanation in the explanation column.

2. On plate 5A, you have a fault with considerable offset. No note of this structure on Plate 2. Same with Plate 5F, and 5G.

3. On you Plates 5A thru 5M, you often stopped at a drill hole, on others you projected the information on up to the surface. I had asked you to be consistent and pull all the info to the surface. Any reason not to?

4. On your Arizona Index Map, no explanation for the difference in black circle for Globe vs. blue circle for Superior? What is the distinction?

5. On your Attachment C, Schematic Cross Section, you have the band of unoxidized granite under the Yarnell fault, then go back into oxidized granite. Three of the 4 diamond drill holes indicate a base of oxidation. Did most of the rotary holes also stop in pyrite, and thus indicate a based of oxidation? No comments on change from unoxidized back into oxidized at depth either in your discussion of Attachment C (Section D of your report) or Section H - Geologic Observations. Where do you get support for a considerable thickness of oxidized rock between the moderate altered unoxidized and the fresh granite? Should be discussed somewhere.

6. Drill log YDDH-3, why hasn't the core been logged from 221-230?, and your log brought up-to-date?

7. On list of Attachments and Plates - E. Diamond Drill Lugs; misspelled.

8. On page 3 of your report, you call the location map - Figure 1, but in you List of Attachments its Attachment A.

9. Same with Land Status. Can't be both Plate 1 and Figure 2. Your Plate 1 is called a Land Status map in index, but Plate 1 is claim map with no list of who is who, thus the Status is unknown. Your Figure 2 on page 4 is a Table of payments and royalties and Figure would seem to be a misnomer, or at least confusing, since it is not listed in any Table of Contents or List of Attachment - Plates.

10. Under Geology - General Statement you say ... Included ... are schistose xenoliths ... in the altered and unaltered rocks .... Yet, none of these show up on your Geology Map of Plate 2. Why not? Same with "Aplite Dikes," none on map. Shouldn't this be stated in the text as to why they are not on the map?

11. In the SW part of Plate 2 - Geology map you have a diorite dike trending E-W and dipping 20° north subparallel to the Yarnell fault (is this not a "sill" by definition?). Also have a diorite sill which is perpendicular to the previous diorite and perpendicular

(in outline) to the major structure joint direction, though it has no other strike - dip designation, is not this a "dike" like mass as it cross cuts up topography quite sharply?

12. Under your discussion C. Gold Mineralization (p. 6), you mention Honea's work as Attachment B, then say see "Figure 3." No Figure 3 in Honea's report or elsewhere in your pile of Attachments, et al.

13. Your Plate 2 is labelled Geology map, but most of untitled legend is alteration, and is so discussed under part D of your text (p. 7).

14. Complete the record information on your diamond drill record sheets. Coordinates, started, terminated, etc.

15. Plates 3 & 4 are labelled "Proposed Drilling," and are on one sheet. But in text, Plate 3 is the past drilling and the "B" zone assays while Plate 4 (in text), is the proposed drilling. Should have both labels.

16. You mention "bound volumes" of all drill holes and assays. Yet nowhere do you say where these can be found. Do you intend to distribute the drill hole-assay volumes along with your final report?

17. On text page 11, part F. Drilling Results, -- a confusion exists when you say ... the attached cross sections through the drill holes show ... discussed in the previous section. But the previous section was part E. Silicification and had no cross-sections, and nothing in text to indicate where the sections would be found -- in "bound volumes" or in Plate 5A thru 5M (not discussed in text)!!

18. Then you say ... the geologic details of the diamond drilling are summarized in the next section ... however, the next section is part G. Diamond Drilling Objectives -- and has no geologic detail.

19. Under part G. Diamond Drill Objectives you note an Attachment J. No Attachment J was in your packet. In your list of Attachments-Attachment J RDH vs. DDH memo - M.A. Miller to J.D. Sell 9/27/90. I submit that September 27, 1990 is not yet here while this report is dated May 3, 1990, which I received in early July.

20. Under part H. Geological Observations, you state ... all holes were collared in the weakly altered zone ..., yet, as your Plate 2 shows, many of the holes were collared in your "moderate" alteration.

21. Under part H, item 2, you state there is a "Figure 4," but no Figure 4 is in the packet.

22. Under part H, item 5, you state ... The Yarnell Fault Zone as seen in drill core ranges from 5' in YDDH-1 to 90' in YDDH-2; but on YDDH-2 log is only from 310-380±, or 70'±. On your Plate 5 sequence you only show a single line for the Yarnell Fault for the diamond drill twins of rotary holes 8 and 40. Nothing in text or plates to indicate that the plates are schematic.

23. You have a section location map between your Plate 4 sequence and your Plate 5 sequence which is not labelled otherwise, nor is it in your List of Attachments - Plates. What's it to be?

24. Under part VII. Sample Collection, item A, you mention Table A and Table B, but no Tables are in your packet.

25. Under part VII, item B you mention ... (Assay Checks memo 7-13-89, attached). This should have the Attachment letter notation

26. In that July 13, 1989 memo you state that ... results are within 10% of each other ...; however, your pencil notes show that it's nearly 2/1 of more than 10% deviation vs. less than 10% deviation, so it would appear that the words "greatest majority" might be questioned.

27. In your Attachment H, have you rechecked everything? In Table 1, page 1, YM-5, Original Pulp, I came up with 0.033 as composite grade. Also in YM-7 the composite footage is 70', not 60', and in YM-56, new pulp is 35' not 35". Other mistypes/miscalculations? Fill out all the values to three decimal places to clarify.

28. Under part VIII. Specific Gravity what is ... weak, moderate + footwall ... ?

29. Under part VI - D you have Attachment "D"; part VI - G, Att. "J"; part VI - E, Att. "E" etc. etc. you've gone back and forth in the Attachment notations and it will be difficult for readers to go back and forth. Rearrange the attachments in logical sequence. Same with plates (Plates 4-A-G, 5A-M and 6 not mentioned in text). Figures 1 thru 4 mentioned in text but none in packet (except for 2 which I indicated earlier might better be called a Table) and Tables A & B in text not found anywhere, either in text or contents. Clean up your text to go with all the appended items.

30. Under XI. Metallurgical Testing, you say D.E. Crowell's results are attached, but give no Attachment notation; then later talk about the 24 drill holes being selected and ... one sample per hole (Attachment I), but Attachment I is Crowell's report and has nothing to do with the 24 drill hole bottle roll tests mentioned.

31. XII. Exploration Possibilities - well, I'm getting tired of all these question being raised, but here we are finally at the end and you're telling us about geochemistry, but ... not a clue as to where we can find it, who wrote it, and when. Is this not as important as Attachment F, Attachment I, and bottle rolls?

32. And, of course, I don't like Plates 3 and 4 on same sheet, then have Plate 4A through 4G which are never mentioned in text.

33. Let us, you and I, get together and decide what you need in your Final Report as appendages, and what might be referenced to in a bibliography section.

James D. Sell

JDS:mek James D. Sell

CC: W. L. Kurtz

in press, 1990

8/14/90

YARNELL FINAL REPORT

by M. A. Miller

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Figure 1 - Index Map - Yarnell Project
Figure 2 - Land Status Map
Figure 3 - Photomicrograph YM-71, 85-90
Figure 4 - Photographs - DDH-3 Alteration
Figure 5 - Photographs - Potassic Alteration Associated with quartz veins
Figure 6 - Schematic Cross Section of Alteration Zones
Figure 7 - Photographs - DDH-3 Showing Quartz Vein Relationships

Table 1 - Payment and Royalty Schedule
Table 2 - Petrographic Descriptions - Russel Honea

Attachment A - Diamond Drill Geologic Logs YDDH 1-4 1" = 10'

Plate 1 - Claim Map - Sections 14, 23 1" = 200'
Plate 2 - Geologic Map - SW 1/4 Sec. 14 1" = 100'
Plate 3 - Drill Hole Location Map with Assay Intervals 1" = 200'
Plate 4 - Proposed Exploration Drilling with Schematic Sections 4A-E 1" = 200'
Plate 5 - Geologic Sections Index
Plate 5A-N - Geologic Sections 1" = 100'
Plate 6 - Underground Workings Surveyed and Estimated 1" = 100'

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

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.

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 Payments not to exceed $175,000/yr	1% or Advance Royalty (Greater of the two)	None

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)

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

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

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° 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 not 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 approximate 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. ORE RESERVES

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:

JDS Reserve	ECS Reserve
(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

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.

Additional work is in progress. Twenty-four drill holes were selected and the assay intervals were composited into one sample per hole. A program of bottle rolls have been completed. Holes picked throughout the deposit are anticipated to give a representative average of the leachability of the ore zone. A report detailing the results was submitted by J.D. Sell (4-25-90).

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.

HEM Surveys - 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.

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JDS

ASARCO

Southwestern Exploration Division

September 27, 1990

W.L. Kurtz

Report on Yarnell Project
Yavapai County, Arizona

As requested by R.L. Brown, I submit my synopsis of the studies and results at the Yarnell Project.

The text has been double spaced to facilitate the corrections and additions of yourself, Graybeal, and Brown.

James D. Sell

James D. Sell

JDS:mek
Att.

cc: R.L. Brown
F.T. Graybeal

ASARCO

Southwestern Exploration Division

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Report on Yarnell Project
Yavapai County, Arizona

I submit my report on the Yarnell Project which was drilled in 1989 as a potential open-pit gold mine.

Seventy-three reverse-air circulation drill holes, on approximately 100-foot centers, were drilled to define the present configuration of the mineral zone. Four diamond drill core holes were also drilled adjacent to rotary holes to provide a complete geologic-structural-mineralization profile through the deposit and to serve as an assay check on the adjacent rotary holes.

Numerous studies have been undertaken such as bottle roll leach tests, large column percolation leach tests, a vat low-grade leach test and numerous computer runs involving various economic parameters.

At present a geologic inventory of a study pit outlines a potential of plus four million tons of plus 0.05 oz/ton gold. Several partially tested to untested areas remain which when drilled may add from one-half to one million or more tons at a similar grade and favorable stripping ratio. It is recommended to carry out the southwest extension drilling as the first phase of the expansion drilling to add more ounces gold to the inventory and be incorporated in a mining plan. Perhaps the majority of the waste dump could be restacked in the area of the southwestern extension and decrease mining costs. Should all three recommended drill expansion areas be successful in developing added tonnage and grade, the mining plans might be altered from the economic pit design as now suggested.

As developed in the report, I believe all initial assays within the main mineralized B Zone can be used uncut in any reserve calculation. Other high grade assays in the hanging wall area (A Zone) are likely to be associated with high-angled shears, which cannot be used in reserve calculations, but can and should be used in the day-to-day mining plan as the benches become subparallel to the strike of these structures.

Noted in the report is my heavy reliance upon the observations by the field project geologists, M.A. Miller and J.J. Malusa of the SWED Staff, and the numerous reports prepared on the various phases of the project, both in house and by outside consultants.

James D. Sell

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REPORT ON YARNELL PROJECT

YAVAPAI COUNTY, ARIZONA

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REPORT ON YARNELL PROJECT

Yavapai County, Arizona

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 is associated with iron oxides and secondary quartz veining manifested by 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 continues both northeast and southwest 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 gold 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.

RECOMMENDATIONS

Asarco has drilled off, on approximately one hundred foot centers, an inventory of +4 million tons at +.05 opt gold. 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, and recommended for further expansion of the mineral reserve (Plate 1).

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 (Sell 1990, Miller 1990).

AREA 2: NORTHEAST EXTENSION OF THE MINERALIZED ZONE

Mapping and sampling of the area (and particularly the small knob northeast 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 gold with a zone in the trench averaging thirty feet at .048 opt gold. 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. RDH-96 collared near the top of the hill had an interval of twenty feet which averaged .013 opt gold. 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 1990).

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 gold) and YM-33 (90' at .051 opt gold). A potential for 600,000 tons at >.05 opt gold exists with a waste to ore ratio above 3/1. A number of holes should be drilled along the entire downdip perimeter of the indicated ore zone to define the economic pit which may allow the increased pit depth to secure the downdip potential.

INTRODUCTION

The Asarco-Norgold Resources joint venture project, in north-central Arizona, is located 1-1/2 miles south of the town of Yarnell in Yavapai County. Yarnell is located 72 miles northwest of Phoenix, or 16 miles on Highway 89 northeast of Wickenburg, or 29 miles on Highway 89 southwest of Prescott (Figure 1).

The Yarnell project was named after the Yarnell Mine centered on the small hill named Yarnell.

Historical production from the Yarnell mine was from the early 1900's and was operated intermittently until the Gold Mine Closure Order L-208 of 1942. The underground workings exploited the higher grade gold values located along the major Yarnell Fault structure. The Yarnell Fault strikes N30°-45°E and dips 30°-45°NW. Minor production was also removed from an open cut along the surface trace of the fault at the top of Yarnell hill.

Asarco became interested in the property through a Norgold press release (George Cross News Letter, 1988), and a private report to Norgold by Philpot (1988). Philpot stated that the area contained a potential open pit tonnage of 4 million tons with an anticipated recoverable grade of 0.05 opt gold.

Asarco geologist, M.A. Miller, sampled the area and recommended further work (Miller, 1989 a,b).

After agreeing to a letter of intent Asarco drilled 96 reverse circulation rotary drill holes and four diamond core holes. Evaluation of the drill/assay data suggested an open-pit potential of 4.1 million tons at 0.051 opt gold with a 3/1 waste/ore ratio, using the triangular method of computation (Sell, 1989 b).

GEOLOGY

Biotite Granite. The Yarnell project is within the Yarnell granite immediately south of the town of Yarnell (Figure 2).

At the project area, the granite is a medium-grained phaneritic, equigranular biotite granite. The petrographic studies (Honea, 1990 a) indicate a compositional range of minerals as follows from fresh granite:

Plagioclase ($\pm An_7$) 25-35% with Carlsbad and Albite twinning

Microcline 40-65% with grid twinning and microperthitic texture

Quartz 12-16%

Biotite 5-10%

Anderson (1989) recently completed a PhD at the University of Arizona and describes the Yarnell granite mass as belonging to the "Group 4: Late (Late-Tectonic) Porphyritic Monzogranite-Granite Pluton and

Batholith" class.

To paraphrase Anderson (1989):

> "The Yarnell Granodiorite (new formal name), is a foliated, coarse-grained porphyritic granodiorite to monzogranite, ... The Yarnell Granodiorite follows the northwest edge of the Stanton-Octave metavolcanic-metasedimentary screen to as far north as Wilhoit, where dikes of unfoliated Yarnell Granodiorite intrude foliated granodiorite of the Wilhoit batholith ... The Yarnell Granodiorite is distinctly coarse-grained and weakly foliated, with large pinkish-tan K-feldspar phenocrysts in an equigranular matrix with biotite, plagioclase, uncommon hornblende, and abundant sphere ... Chemically the Yarnell body is metaluminous, high-K, calc-alkaline, high Fe-Ti and high-total alkali rock ..."

Anderson places the age of the Yarnell pluton in the 1730-1710 ma range.

DeWitt (1989) further states under the heading:

> "<u>Suite 4: Syn-to posttectonic biotite granodiorite to granite plutons:</u> ... The granodiorite of Yarnell is equigranular to slightly porphyritic, alkali-calcic biotite granodiorite and is the westernmost foliated pluton in this study area ... although the pluton is undated, it is assumed to be 1700-1750 ma because of its foliated nature. L.T. Silver (personal communication, 1986) suggested on the basis of unpublished U-Pb zircon data that the

granodiorite may be 1400 ma ... The pluton is the most magnetic rock in the region, averaging 8.0 percent magnetite ... Another distinguishing feature is the moderate iron-rich nature of the pluton, a characteristic restricted to this group of plutons ..."

Table 1 compares three samples of granodiorite of Yarnell (DeWitt, 1989, Table 2) with samples taken at the Yarnell Mine (Malusa, 1990 a). De Witt's sample 72 was collected about a mile north of the Yarnell Mine area, sample 73 about a mile to the west, and sample 74 at the base of the mountain on the west (Figure 2), all being collected near the highway 89.

Malusa's samples were collected in the freshest granite available in the hanging wall (HW) and footwall (FW) of the Yarnell Fault at Yarnell Hill.

As noted in Table 1, all five samples have the same major element chemistry, with the major difference being the 3% extra silica in the biotite granite at the Yarnell Mine area.

Dikes. The Yarnell pluton has few dikes within it. At the Yarnell mine area, four types of dikes/sills have been mapped (Miller and Rasmussen, 1990): aplite, andesite, felsic and diorite. The dike/sills are very minor in extent and volume.

a. Aplite. The aplite is yellow-white in color, fine to very fine grained, granular texture, quartz feldspar composition. It occurs as less than four inch wide streaks wandering through the Yarnell pluton in all directions and with all degrees of dip. The aplite is probably a syn-Yarnell granodiorite melt phase.

b. Andesite. Andesite is medium grey to dark grey, aphanitic with occasional biotite (?) grains, commonly weathers to green brown in clay developed zones. The andesite occurs as four to eight foot thick dikes widening to fifteen to twenty feet, in elongated lenses. They strike east-west to 70°-80° northeast and dip 25-40° northerly. The andesite dikes can be followed for one half-two thirds mile. They often have associated quartz veins on one or the other wall. The quartz is generally only three to five inches wide, but may become up to fifteen inches thick. Sericitic halos of six inches to two feet wide generally occur on either side of the dike with or without the associated quartz.

Malusa (1990 a) reports the andesite has 51% silica, high iron (6% Fe_2O_3 plus 6.7% FeO), and low alkali (1% Na_2O and 3.3% K_2O).

c. Felsic. The felsic dikes are yellow to orange-yellow to white, granular texture, quartz feldspar composition, with quartz eyes (elongated-stretched), often sheared appearance throughout. They strike east-west to 80° northeast, all nearly vertical in dip, are three to five feet thick and up to twenty feet thick, and can be followed up to half mile along strike.

c. Diorite. The diorite is dark grey to black, weathers to green-brown with clay development. The main diorite dike is a prominent photo linear in the west central part of Yarnell Hill. It is ten to twenty feet thick, strike N10°W, dips 80°W to vertical. The dike has a sheared appearance, and is magnetic. Malusa (1990 a) reports the diorite has 47% silica, high iron (8.6% Fe_2O_3 plus 2.7% FeO) and low alkali (3.3% Na_2O and 1.5% K_2O).

Comment. The andesite sills and felsic dikes do not appear in the hanging wall of the Yarnell Fault. The main diorite dike is found within the Yarnell Fault structure, as well as both in the hanging wall and foot wall of the structure, but does not appear to offset the Yarnell Fault nor be offset by the Yarnell Fault.

To the southeast of the project area, the Yarnell pluton is bordered by a sequence of mafic metavolcanics and metasediments of the Bradshaw Mountains group - Stage 1 (Anderson, 1989). This mafic volcanic screen

occurs between the Yarnell pluton and the Rich Hill pluton further to the southeast (Figure 2).

The only other rock unit sequence nearby is the mid-Tertiary ash and andesite-basalt units which cap the hills to the northeast.

Asarco mapping at a scale of 1" = 200' has been completed over sections 14 and 23 which covers the main claim block (Miller and Rasmussen, 1990).

STRUCTURE

The main structure in the Yarnell Project area is the Yarnell Fault (Plate 1, 1.A). The Yarnell Fault strikes N40°-50°E and dips 25°-30°NW in the mine area. The main gouge zone of the fault varies from inches to several feet in width and is within a larger five to twenty foot zone of a crushed and sheared zone within the granite (Miller, 1990 a).

The gold at the Yarnell deposit lies within the Yarnell Fault zone and within an associated alteration halo which contains quartz veining and quartz stockwork in and above the Yarnell Fault.

The Yarnell Fault can be traced to the northeast only fifteen hundred feet from the top of Yarnell Hill before it is concealed by debris from the basalt cap and valley fill with large unmineralized granite boulders.

The sheared and crushed zone of the Yarnell Fault varies from five to twenty feet within the drilled part of the deposit. As the structure is followed downward and laterally the Yarnell Fault zone becomes thinner and may be only two to five feet in thickness. As will be noted in later sections of this report, the alteration halos and mineralization zones also decrease in thickness with the associated thinning of the Yarnell Fault zone.

As previously discussed in the GEOLOGY Section, the andesite dikes occupy east-west to N70°-80°E, dipping 25°-40° northerly structures subparallel to the Yarnell Fault structure.

This system of northeasterly striking, shallow-dipping to the north structures are widely distributed in the greater Yarnell area. They often contain dikes, quartz, alteration halos and mineralization. Besides the half dozen structures of the Yarnell Fault trend found on the Yarnell claims, the shallow-dipping structures are found to the west both above and below the trace of the Yarnell Fault for several miles.

Similar trends are found at the gold mines at Congress, Octave, and Vulture.

A congregate system of structures trending northeasterly, dipping steeply (often occupied by felsic dikes) and trending north or slightly

northwesterly and also dipping steeply (often occupied by diorite dikes) is found throughout the Yarnell area.

At Yarnell, the field mapping (Miller and Rasmussen, 1990) suggests the two congregate dike sets do cut and offset one another in various exposures, but with no apparent systematic sequence.

Both the congregate sets appear to offset the shallow-dipping Yarnell Fault. In the open cut, several north-trending, steep dipping faults offset the Yarnell Fault with the east side being down-dropped four to eight feet.

The main diorite dike at Yarnell is north northwest trending and is readily followed on aerial photographs and can be traced from the footwall side into the Yarnell fault zone and continuing in the hanging wall. However, the diorite dike is found as an isolated block within the Yarnell Fault zone and is not observed to cut either the base nor the top of the Yarnell fault structure. Obviously, the diorite dike does cut the Yarnell fault as it is found in both the hanging wall and footwall (Miller & Rasmussen, 1990) in a line of disconnected outcrop.

The east-west striking set of fractures is not observed to cut the Yarnell Fault structure, but several drill holes intercepts are best resolved by placing an east-west structure within the sequence of events.

On the surface, several northeasterly striking, steep dipping narrow veins were mapped in the hanging wall of the Yarnell Fault (Miller, 1990 a). Underground, in the hanging wall, these mineralized structures dip steeply to the north and roll into structures which sub-parallel the Yarnell Fault, then re-steepen and disappear into the wall of the workings. It is probable that these structures are listric in nature and do sole into the main Yarnell Fault zone.

A number of drill holes have intercepted a single sample length of high-value gold in the hanging wall, and these are believed to belong to the easterly trend, steep dipping structure system.

In the footwall of the Yarnell Fault in the main drilled area, six drill holes have intercepted a five to ten foot assay of interesting values at depth. In three adjacent holes the intercept can be resolved to indicate being along a thin, subparallel zone to the Yarnell Fault, whereas the remaining three holes are isolated from other holes which do not have a lower intercept, and these may be indicating a steep dipping narrow structure(s).

The present drill spacing and the lack of many samples much beyond the base of the main mineralization preclude a rigorous analysis of these individual sample values, either in the hanging wall or the footwall, as to their associated fracture set or their relation to the mineralization system.

ALTERATION

Alteration at Yarnell follows a variation of the hydrothermal series from central to peripheral : potassic, phyllic (sericitic-argillic) and propylitic.

The three zones have been discussed by Honea (1990 a,b,e) and Miller (1990 g) as reviewed through the petrographic microscope, field mapping, and logging of the diamond drill core holes.

Alteration is strongest and central with the Yarnell Fault structure and decreases in intensity as alteration halo envelopes outward in both the hanging wall and footwall (Figure 2.A).

Within the Yarnell Fault zone the granite is highly crushed and sheared (Figure 3). Noted in thin-section and logging is abundant secondary quartz, chalcedony, secondary K-spar (adularia), secondary sericite, and secondary clay development.

Recent X-ray diffraction studies on the clay fraction suggests the material is mainly very fine sericite, variety illite (Malusa, 1990 b,c).

Outward from the crushed fault zone, the potassic zone is characterized by the pink feldspar (K-spar alteration) in the phenocrysts as well as along selvages to the quartz veins. Pinking (Figure 4) of feldspars

and K-spar selvages can be noted fifty to eighty feet above the fault gouge, and may extend twenty-five feet down into the footwall. This zone is also noticeable in the surface exposures.

The potassic zone grades outward into the phyllic zone where sericite is widely and pervasively developed. Complete replacement of the plagioclase and biotite by sericite characterizes the phyllic zone (Figure 5). Secondary iron oxide as hematite, geothite, and leucoxene (from altered sphere) is a by-product of this alteration phase.

The sericite zone extends as an intermediate envelope in thickness of thirty to one hundred fifty-five feet above the potassic zone, and extends only ten to forty-five feet into the footwall below the footwall potassic zone.

The argillic zone was not noticeable as a hanging wall envelope, but exists as a fine-grained dusting of the feldspars (Figure 6).

In the footwall, fine-grained clays were noted in the core holes. The two eastern holes had up to thirty feet of sericitic alteration (Miller 1989 d) with no noticeable clay-argillic alteration, whereas the two western holes had no noticeable sericitic alteration, but did have up to forty-five feet of the clay-argillic alteration. Subsequent studies have indicated that much of the clay is fine grained sericite and argillic alteration may again be restricted to dusting of feldspars.

The rotary hole distribution is more extensive than the core holes, but the rotary chips have not been studies in sufficient detail to separate out the difference between fine-grained sericite and fine-grained clays (which now are suggested to be more finely-grained sericite) in the footwall intercepts, nor to suggest any distribution trends to the two types logged during drilling (Malusa, 1989).

The propylitic zone is characterized by the occurrence of chlorite, epidote, minor calcite veining, with weak sericite alteration along biotite edges, and is the far outer alteration envelope (Figure 7).

In the hanging wall the propylitic envelope may extend up to one hundred feet beyond the phyllic envelope, but, in general, is a five to fifty foot transition zone between the phyllic and fresh granite. In the footwall it may be indicated by calcite filled gash veins in the lower part of the phyllic zone.

MINERALIZATION

General Statement. The mineralization events appear simple within the Yarnell system. Gangue minerals of silica, pyrite, and specularite; ore minerals of gold with trace amounts of silver, lead, zinc, and copper. However, the interplay of events with the alteration system appears much more complex.

Gangue Minerals.

a. Silica is found as banded chalcedonic quartz and opal within the Yarnell Fault zone, and as an early pervasive flooding-type overprint on all the alteration zones including propylitic. The silica is found as at least three stages of quartz with pyrite and specularite, and as two stages of late quartz, often with visible gold.

Miller (1990 g) states that the silica occurs as discrete quartz veins, as veins in quartz stockwork, and as the flooded quartz textures.

The field-core paragenesis indicates the Yarnell Fault and the sub-parallel structures system was the earliest event, with massive silica flooding out into both the hanging wall (further penetration) and footwall (lesser penetration). Continued movement along the shallow dipping fault structures crushed and sheared the quartz in the vicinity of the structures.

Within the developing silica system at least three quartz vein types have been noted by Miller (1990 g). These quartz veins developed in structures both subparallel to the shallow dipping Yarnell Fault structure and as high-angled veins cutting upward into the hanging wall. Very few quartz veins developed below the Yarnell Fault zone in comparison to the

volume in and above the fault zone.

The three types of quartz noted by Miller (1990 g) include:

1. Early, medium grey quartz, +/- associated with specularite in vugs aligned parallel to variously oriented quartz veins.

2. Dark grey quartz with some brecciated textures within the veins. The dark color is due to the fine specularite dusting within the quartz.

3. Lighter grey quartz with disseminated limonite pseudomorphs from pyrite, usually on the margins of the quartz veins.

These three generations of quartz development are generally noted as thin veins +/- one quarter inch in thickness, locally up to a half inch in thickness, and rarely up to a maximum of three inches thick.

Two later stages of white quartz cut one another and the three stages of grey quartz. The white quartz is found within the Yarnell Fault zone, the main mineralized zone, and up into the A zone mineralization and beyond into the hanging wall and peripheral to the deposit.

The white quartz veins range from six inches to two feet in

thickness and form discrete veins peripheral to the mineral system as masses up to twenty feet thick of limited extent. A gold assay is invariably obtained from these white quartz veins and often visible gold has been noted.

The major quartz development of flooded and vein quartz occurs as a domed shaped mass sub-concordant to the outer alteration halo envelopes, thinning on the lateral extremities and downdip, with a flattish bottom not far below the Yarnell Fault zone.

b. Pyrite is found throughout the drilled area. It is nearly totally oxidized to various iron oxides from the surface to the base of the Yarnell Fault, whereas within the footwall massive silica the pyrite is unoxidized.

Pyrite forms occur as discrete cubic shapes in the wall rock of the various veins as well as within the light grey quartz veins.

Bands of 30-50%, massive, granular, pyrite in thin lenticular zones are found both in the hanging wall (oxidized) and footwall (sulfide).

Within the drill indicated reserve the pyrite and its oxidized equivalents are 2-4% by volume.

c. Specularite is very noticeable within the Yarnell deposit and may average 2% throughout, both in the hanging wall and the footwall. Honea (1990 a) does not describe specularite as a separate mineral, but identifies magnetite and ilmenite as minor accessory minerals.

Native and Base Metal Sulfide Minerals

a. Gold, the primary economic mineral at Yarnell is found in the native state within quartz and various iron oxides.

Honea (1989, 1990 c, 1990 d) studied samples from the surface exposures, drill holes, and panned concentrate. Table 2 tabulates the size of the gold-silver particles found in the Honea photomicrographs. The size varies from very small dots 1/2 micron in size (Figure 8), up to the large elongate, 60 x 225 micron size (Figure 11). The figures are two-dimensional, with only limited expression of the depth factor. See Figure 11 for an example of three dimension aspect.

Even though Table 2 contains limited data, it does indicate the problem of having one of the large particles in a sample set. If it is assumed that the third dimension is equal to the short side of the exposed particle then the volumes of the particles can be calculated. In the example of Table 2, the total volume of all the forty gold particles from very small

through medium plus is 511,000 cubic microns, while the single large particle calculates to be 810,000 cubic microns. The problem of particle size and its influence on assay grades will be discussed further under the sampling and assaying sections.

b. Silver has been found in the native state (Figures 12, 13), and as electrum in the solid solution state with gold. Honea (1990 c) states "... the color of the gold suggests a low to moderate silver content to the mineral structure."

Fire assays for silver show only a trace of silver, with most of the values less than 0.01 opt silver, with a few values as high as 0.06 opt silver.

In the 24-hour bottle roll tests by Metcon (1990), they calculated a head assay and report values of silver from 0.013 up to 0.059 opt silver in the twenty four samples in the study.

In the larger column leach tests McClelland Labs found only a trace of silver (Crowell, 1990 b).

c. Base metals, copper, lead, and zinc are noted only in ppm amounts in both soil and rock within and around the Yarnell deposit.

Rasmussen (1990) conducted a 15-element geochemistry survey around and over the Yarnell deposit. The soil survey extended for fifteen hundred feet in the footwall of the Yarnell Fault and for fourteen hundred feet in the hanging wall of the deposit. Also collected were samples from rejects of three rotary drill holes, and along the adit in the hanging wall.

Table 3 compares the values in the drill hole rock geochemistry from that of the soil surveys values. Copper values (average) range from a low of 3.7 ppm in hole YM-6, to a high of 28.4 ppm from soil in the hanging wall. Lead and zinc also reflect low ppm values from the Yarnell system area.

Honea (1989) found a few pieces of galena (35 micron) and pyrite in drill hole YM-71 (Figures 14 and 15). In the logging of the rotary cuttings and the core, no lead or zinc sulfides were noted. The values reported by Rasmussen from the rock samples were mainly from the oxidized part of the mineral system.

DRILLING

Rotary. The bulk of the drilling at Yarnell was by truck mounted rotary, reverse air circulation, down-the-hole hammer, with cyclone discharge over a three-tiered Jones splitter. The drilling was dry through the mineralized section and became damp to wet below the

Yarnell Fault zone.

Drilling Service Company commenced drilling using a TH-100 drill with a 5 1/4 inch bit on March 20, 1989. After changing to a TH-60 drill, 5 1/4 inch bit, on drill hole YM-37, Drilling Services completed the drilling of 24,367 feet on October 3, 1989 (Table 4).

Mining of the main Yarnell Fault zone had begun in 1900 and continued intermittently until the Gold Mining Closure Order L-208 closed the mine down in 1942. A little pillar robbing and slabbing took place underground after that date when the gold mine closure was lifted, but the post-closure work was mainly concentrated in the open-cut at the top of the outcrop. The workings deteriorated from 1942 to 1989 and only a portion was available for inspection prior to the start of drilling. With no accurate map of the probable extent of the underground workings, it was not surprising that all five of the first holes drilled in the mined area intercepted stope openings.

From the drop in sample volume return, it soon became apparent that the down-the-hole hammer did not provide a good sample return after it penetrated the floor of the stope opening.

In viewing the action underground it was noted that the bit penetrated the floor and a cuttings pile cone was discharged onto the floor but as the sample intake ports on the hammer assembly are five feet above the

bit, no sample was returned to the surface. It was after the intake ports had gotten a foot or so below the floor and cuttings pile before sufficient sample entered the intake ports and was transmitted to the surface to be processed.

At this time of the drilling activity a change of technique was initiated for adequate sample control after entering an opening. Upon hitting an opening with a hammer drill bit, the top and bottom footages of the opening were recorded and the drill string was removed from the hole. The hammer assemblage was removed and a tricone bit was installed. The tricone assemblage has only a short, six inch difference between the face of the bit and the intake skirt which transferred the cuttings into the reverse air column, thus providing a reliable sample after entering solid rock below an opening.

Several holes were observed in the underground workings after initiation of the new technique and it was confirmed that the bulk of the cuttings were transferred into the skirt collection shortly after the skirt passed below the floor of the opening.

Thirteen additional holes were drilled through the mine openings using the modified procedure with excellent drilling results and sample recovery. Seven rotary holes had also been drilled in the mine working area which intercepted pillars within the stopes (Plate 1).

Core. Four core holes (Miller, 1989 d) were drilled as twins to the rotary holes, as follows:

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

The core holes were drilled by Boyles Brothers Drilling Company using aa Longyear 44 Hydraulic machine and coring NC size. In the four holes Boyles cored 1,295 feet (Table 4).

Core hole YDDH-3 intercepted a stope opening whereas its twin rotary hole YM-63 had hit a pillar and remained in rock all the way. When the opening was hit the hole was probed to bottom and the drill string pulled. The NC core barrel and bit was then replaced by a casing shoe and the NC drill string then was returned down the hole and set on "solid ground" at 187 feet. An NX drill string with core barrel and bit was made up and sent to bottom inside the NC string. The NX coring resumed at 187 feet, but recovered debris and muck with isolated blocks of rock down to 221 feet where solid core was obtained. Obviously a caved stope portion had been encountered to account for the thickness of debris and apparent large boulders cored through to the solid rock to the final depth at 325 feet.

Table 5 lists all the drill holes, both rotary and core, their coordinates and collar elevations and the total depths for the cumulative 25,662 feet of drilling.

SAMPLING

Rotary - General Statement

Samples were collected on five-foot intervals throughout the rotary reverse air circulation program. The drilling was momentarily stopped at the end of each five foot run to "blow" the hole clear and clean the sampling system.

From the drill pipe discharge, the cuttings passed into a cyclone which rapidly dropped the cuttings which cascaded through a three-tiered Jones splitter.

The third split collection pan of cuttings was again passed through a single Jones splitter and both sides, A and B, sacked into bags with the drill hole and footage marked on the bag.

A small sample was taken from the "A" pan side, washed, and placed in plastic trays. These samples were logged along with any comments noted during the drilling of the interval. The sample trays are stored in Tucson.

Rotary - Drilling thru Openings

As remarked under Drilling, the only problem encountered during the rotary drilling was the loss of some sample after penetrating an opening. As noted, after drill hole YM-5, the drilling sequence was changed by replacing the hammer with a tricone bit for drilling below the opening. As the same reverse air circulation drill pipe was used, the sample returned to the surface in the same manner as before.

A clean sample was secured by the time the tricone penetrated a foot below the new surface, whereas with the hammer, the sample was erratic for five to six feet before the collection ports were below the new surface.

see DSC's picture & description (attached)

When passing through an opening, the sample return was monitored at the surface to judge whether the return was from isolated blocks of mine rubble on the floor of the opening. The rubble material returned erratic volumes of material as the open spacing in the rock pile allowed sample and air to be dissipated into the rubble mass.

Sampling continued below the workings until sulfides appeared or the rock became very hard and dense suggesting a non-oxidized part of the system.

Assay results of samples below the main zone of mineralization show a

sharp drop between mineralized (0.0XX opt gold) and the weakly mineralized footwall (0.00X opt gold).

Rotary - Holes Encountering Water

The majority of the holes were drilled dry in the oxidized portion of the zone. In the sulfide footwall, in the down-dip holes, the bottom would often become moist and water was added to facilitate the removal of cuttings. As this moist condition was generally at or below the base of the mineralized zone, no sampling/assay problem is attributed to the collection of a wet sample in the area of the geological reserve.

Table 6 lists the "wet" drill holes and the relation of the water level to the main mineralized zone and a note on the relationship to the down-dip extent of the geologic pit edge. Figure 16 plots this same information and lists the depth to the main mineralization, its thickness and grade.

Review of this data indicates that water had little impact on sample collection inside the geologic pit outline as only one hole encountered water within the main mineral zone (YM-33). The deep, thin, intercepts of mineralization outside the present geologic pit edge, precludes the expansion of the pit into the area of wet holes except in an improved cost scenario.

Core - General Statement

In logging the core, the core was marked for splitting. Splitting was by use of a diamond saw blade cutting of the core longitudinally. One half of the core was sent for assay, the remaining half is in storage for review.

Sampling was integrated with the rotary footages as closely as possible. Often the five-foot runs were further broken down so as to separate out obvious high-grade stringers. The assay was then recombined into the equivalent five foot intervals for comparison with the adjacent rotary hole values (Miller, 1990 d).

ASSAYING

General Statement. The primary assay laboratory was Triad Minerals Company, Cory Eddington assayer, P.O. Box 2754, Wickenburg, Arizona 85358.

Assays were also performed by Skyline Labs, Inc., Charles E. Thompson, Chief Chemist, P.O. Box 50106, Tucson, Arizona 85703.

All assays were fire-assay, gravimetric and reported as ounces per ton gold/silver.

The assays are in bound volumes attached to the drill logs (Malusa

1989) and located in the Tucson Office files.

Assay Checks. Checking of assay results was handled in a variety of ways: a. insertion of an Asarco standard within the sample runs, generally two per hole; b. rerunning same standard reject, returned by the assayer, with several different holes; c. inserting reject rock samples material from previous holes; d. multiple assays from same pulp; and e. comparing Triad assays with Skyline assays of same pulps.

a-b. Standard Checks. Asarco standards were inserted with most of the rotary drill hole samples. The standards reflect an "interesting" value, "A" standard at 0.022 ±0.001 opt gold, and a low value, "B" standard, 0.006 ±0.0003 opt gold. The standards were incorporated in cement and supplied by the Rocky Mountain Exploration Division of Asarco.

Table 7 lists the number of sample sets, the high value, the low value, and the average of the "A" & "B" samples broken down by drilling break sequence.

As noted in the high and low variations, Triad Assays reported a value which at first glance might belong to the opposite set of standard; however, the average of all the samples in the set is generally within ±10% in the "A" standard, and with the first third of samples in the "B" standard. Such variation within labs was noted in the report by Fletcher (1989) on all samples reported from Asarco projects throughout

western US. The high and low "spikes" were generally attributed to 1. mismarked filed sample or 2. blotched sample analysis at assayer.

With the average of the samples being within the sample error of all the labs it would appear that Triad had only a small problem as noted in the drift during the several phases of the drilling.

In reviewing Table 7, the drift in the value reported for drilling holes YM-1 thru YM-64 was nominal and the averages were overall lower than the reported Standard "A." The Standard "B" drifted higher from the early drilling thru the later drilling and was overall higher than the reported standard.

The Standards "A" and "B" were used up at the end of drill hole YM-64. Thus from hole YM-65 to the end at YM-96, the reject from the previous standard samples were re-run through the assay procedure. As noted in Table 7, some of the samples were re-run the 2nd and 3rd time.

Again, the nominal drift was from a lower value in the early holes to a higher value in the later holes, but still below the reported value for Standard "A" and higher than in Standard "B." From this data it would indicate that the assayer was consistent in his reporting, and the variation is within the prepared standard. The one sample re-run the third time cannot be evaluated other than being a reported low value.

c. Rerunning previous rotary drill hole rejects as new hole sample.

Ten holes scattered across the deposit were used for this study. Only the main zone mineralized portion was used. The reject sample of the hole was renumbered and sent to the assayer where new pulps were processed and the sample assayed. On eight of the holes, the new pulps were again split and a "refire" assay produced.

In Miller's (1990 e) tabulation of the results (Table 8) it is noted that in the early holes (YM-3, -5) and the later holes (YM-40, -50,-56) the new reject assay was within 10% of the original assay, and generally lower in reported value, whereas in the remaining five holes the variation was in excess of 10% and generally reported a higher value. In the eight refires of new reject assays, all but two were within 10% of the original assay and all but one was lower than the new reject assay.

As the original assays were taken in sequence of drilling over a four-month period and the reject-refire assays were all taken within a few days, it would appear that the assayer variation is nominal.

d. Rerunning same pulp with multiple assays was undertaken to address the question of variability within the sample pulp. Kurtz (1989) reported on the results of five pulps of drill hole YM-55.

Table 9 lists all the multiple assays from the pulps and a standard deviation was calculated from this data. As shown only two sample values out of twenty fell outside the 95% confidence figure, suggesting

that the assay values are within 5% of the actual value based on the short sets used. The two outside samples may indicate a coarse gold variability but with the short set of values available for this study they probably do not change the validity of the sample value as being indicative of the value in the sample.

e. Comparison of Triad with Skyline Labs. Seventy-five samples were collected of various grades of mineralization previously assayed by Triad from holes YM-10 - 32. The pulps were sent to Skyline for reassay. Prior to the Skyline assay, they screened the pulp material and reported the +80 mesh, -80+200 mesh, and -200 mesh weight percent of sample. The sample was reground (-200 mesh), split and assayed (Miller, 1989 c).

The average of all samples for Triad is 0.053 opt gold vs. Skyline 0.055 opt gold (Table 10). The breakdown is also shown in various intervals of mineralization and these again show good correlation between Triad and Skyline. Although some five assays show Skyline appreciably lower than Triad, it is noted that these intervals had in general a +60% weight in the -80+2200 mesh size prior to Skyline repulverizing and reassaying and may reflect a non-homogeneous prepared sample and subject to a "nugget" problem when the assay ton was removed from the larger pulp.

Also, Table 10 indicates that few samples assayed by Triad and Skyline would have been placed in a different cut-off block if one or the other

had been chosen as the "correct" assay. The two notable exceptions are the Triad .078 vs. Skyline .165 and Triad .093 vs. Skyline .016. Based on the remaining samples it would appear that the sample values are an assayer's "bust" and not a variation in the sample pulp.

The remaining conclusion is that overall Triad assay values are slightly conservative compared to Skyline and can be used in all calculations.

CUTTING OF ASSAYS

From the previous discussion it is concluded that the Triad Lab assay values are nominally within ±10% of the value within the sample and that Triad Lab values are slightly conservative from those reported by Skyline Labs. The bulk of the assays are from Triad.

No sample values were cut because of the grade reported.

Sample values were cut within the computer program, however, to prevent the spreading of values where they probably do not belong. The case in point is isolated samples high in the hanging wall which probably reflect high angle, relatively narrow vein structures. These have been removed from the computer program even though it is recognized that the mining scheme may be able to take these zones should they lie along the strike of the bench in question.

It is believed that blast hole sample plotting will delineate these zones and contribute minor ounces to the overall zone of mineralization.

Also, for the rerun of the block model computer study, some blocks were eliminated or changed to reflect the structural and geologic-assay control on values where they were projected incorrectly into the footwall of the mineralization.

CONTINUITY OF VALUES

General Statement. Expressed in the drill hole assay data is a zone of lower grade values, 0.01 to 0.03 opt gold, overlying the main mineralized zone of higher grade, and amenable to open-pit calculations.

In the "Drill Indicated Reserve" report (Sell, 1989 b) these values were separated into the upper or A Zone and the lower main B Zone of mineralization.

The previous mining was from within the main B Zone and along the Yarnell Fault where the highest grade of mineralization is generally found.

The A Zone values generally continue into the B Zone values with a usual sharp change in gold values. Similarly the base of the B Zone is

also a sharp gold value cut-off.

Table 11 lists the drill holes and tabulates the top and bottom assay of the B Zone with the next assay above or below. The sharp grade change across the B Zone interval is evident from the inspection of Table 11.

Within the B Zone, the continuity of the intercept values appear to be excellent when viewed from hole to hole for the entire B Zone intercept. Within the B Zone, higher and lower grade values occupy various levels within the intercept. This is a natural function of a multiple injection quartz system with strong affinity to the regional northwest dipping Yarnell Fault structure. With stockwork quartz veining at high-angles as well as undulating and braided quartz veining in the plane of the Yarnell Fault, the lateral change in assay grade may vary within the overall intercept, but continuity of values for the overall intercept is considered very positive and can be projected from hole to hole.

Comparison of B Zone assays in DDH vs. RDH holes. Four diamond drill holes were twinned next to previously drilled rotary holes for visual examination of the structural and mineralogical features and to evaluate the continuity of sample values.

M.A. Miller (1990 d) discussed the rotary and diamond drill assays and check assay results obtained during this drilling program. Table 12

abstracts the comparative assays for the B Zone assays of the twinned pairs from Miller's memo. The respective collar elevations and coordinates of the four twin holes are listed in Table 5.

Miller noted the variability between actual depth values often exceeded 50%, but as noted in Table 12, the total B interval between the paired drill holes is around 10%. The actual depth values do not take into consideration the fact of the grade change due to high-angled veins which transpose their values to a different level in the adjacent hole.

Blast hole assays should be a part of the mining plan and mining along the strike of the mineralization will maximize the delineation of the northwest dipping mineralized zone.

METALLURGICAL STUDIES

General Statement. Four studies were undertaken for evaluation of the deposit:

1. Specific gravity determinations
2. Bottle Roll studies of leachability and check assays of intervals.
3. Large column leach tests of various ore types and grades.
4. Flotation/Fine Grind/Cyanide leach tests.

Specific Gravity. Twelve rock samples were collected and sent to McClelland Labs, Sparks, Nevada, for testing. The specific gravity

ranged from 2.36 gm/cm^3 to 2.62 gm/cm^3, with an average of 2.55 gm/cm^3. The average converts to a tonnage factor of 12.57 $ft.^3/ton$.

Three pieces of core from YDDH-1 was collected and sent to METCON Research, Tucson, for testing. They ran the three pieces by Torbal balance and by graduated cylinder methods. The Torbal balance is considered the most accurate and consistent and three values returned 2.67, 2.60, 2.70; average 2.66 gm/cm^3 converts to 12.05 $ft.^3/ton$. The graduated cylinder returned 2.64, 2.50 2.58; average 2.57 gm/cm^3, converts to 12.47 $ft.^3/ton$ (Crowell, 1989 b).

The tonnage factor of 12.0 cubic feet per ton has been selected for calculations.

Bottle-roll tests were initially completed by METCON Research, Tucson, in late April 1989 (Sell 1989 a). This 24-hour test involved material from holes YM-2, -5, & -8. Results of hole YM-2 were low (23%), whereas holes YM-5 and -8 were encouraging at 60% and 70%, respectfully, for the gold and around 50% for the silver values in the calculated head assay. The low value was with a sample where METCON and Triad head assays were widely different and interpretation of the low value recovery was not made.

METCON (1989) continued the bottle-roll leach from 24 hours to 72 hours and the percent recovery increased to 70%, 68%, and 83% for the gold values. Silver is again around 50%, but with the calculated head value

of less than 0.02 oz/ton silver, the effect on economics is minor. The late recovery increase of the low 23% test is encouraging that the values are determinable.

Four samples of rock from the open-cut were also submitted to McClelland Labs, Sparks, Nevada, for bottle-roll tests. The bottle-roll leach tests at 80% - 3/8 inch size for 96 hours obtained the following results (Crowell, 1989 a).

	Open-Cut Composite	Open-Cut High Grade	Open-Cut Low Grade	Clay Gouge
96-hr Extraction	63%	69%	70%	74%

The cyanide-lime consumption was low and the encouraging results from the bottle-roll leach tests led to expanded column tests and an expanded bottle-roll test from throughout the deposit.

A composite B Zone mineralization sample was collected from twenty-four holes throughout the deposit and within the drill indicated reserve. This 72-hour cyanide bottle roll test by METCON ranged from 60% to 89% recovery, with an overall average of 73% recovery (Sell, 1990 a).

No strong variation was noted across nor down the zone of mineralization, though two of the lowest values returned were from

holes near the downdip bottom of the drill indicated reserve.

Table 13 lists the twenty-four holes, their percent recovery, the METCON calculated head assay, Triad original assay and a Skyline head assay. As noted, the weighted average (based on feet- oz. divided by feet) of the METCON calculated head assay of 0.063 opt gold is 10% higher than the Triad original weighted assay of 0.057 opt gold. The Triad assay is a calculated value from the individual samples making up the composite. The Skyline head is an assay of a split from the pulp sent to METCON for the leach test. As noted, the Skyline head weighted average is slightly lower than Triad values, but with a variation on the individual assays.

Skyline was requested to assay as many splits as available in the pulps from six holes which indicated a Skyline variance with the other two assays. Eight repeat assays were secured by this method and the average is listed in Table 13 for the six holes. In all but one case, Skylines new composite average was within the ball-park of the original Triad and the METCON head assay.

At the start of the column leach tests, the core sample rejects of the B Zone composite was selected from the three diamond drill holes which cut the entire B Zone mineralization. McClelland Labs conducted a 96-hour leach test and these indicated recoveries of 67%, 65%, and 62% (Crowell, 1990 c).

The average of all the bottle-roll tests suggest a recovery of 71% of the gold values.

Large column perculation leach tests were conducted from material collected from the open-cut and from underground. The surface samples were from four locations and amounted to about twelve tons of freshly blasted material from the walls of the pit. This included several tons of gougy material in the vicinity of the crushed zone of the Yarnell Fault structure. Some two tons of material of low-grade values were removed from the underground main adit by blasting the sides of the adit. The material was separately contained in 55-gallon barrels and shipped to McClelland Labs, Sparks, Nevada, where a bulk sample composite was made with the high grade/low grade material.

As noted previously, a sample of the open cut high-grade, the low-grade, the composite sample, and the clay gouge sample was run with a 96-hour bottle roll test for preliminary values.

Column perculation leach tests were conducted on the high grade/low grade bulk ore composite at 80% minus 6", 2", and 3/8" feed sizes (Crowell, 1990 a).

The test data is as follows:

80% Passing Size	Column Size	Leach Time Days	Head Assay Opt	Tail Assay Opt	Extraction
6 inch	24" dia. x 18 ft.	111	0.046	0.022	52.2%
2 inch	15" dia. x 18 ft.	102	0.051	0.015	70.6%
3/8 inch	12" dia. x 18 ft.	79	0.055	0.013	76.4%

As noted the composite is amenable to heap leach cyanidation treatment in all three feed ranges with an increase in gold recovery with decrease in feed size. Gold recovery rates were fairly slow, but extraction was substantially complete in 60 days of leaching.

Cyanide consumptions were low and ranged from 0.56 to 0.79 pound per ton of ore. Consumption rates were fairly constant throughout the leaching cycles. The ten pounds of lime and cement (3/8 inch feed) per ton of ore added to the ore charges as the columns were filled was sufficient to maintain protective alkalinity at above pH 10.5 throughout the test period (Crowell, 1990 b).

A vat leach test on the underground low-grade composite at run-of-mine feed size, along with a parallel column test using 80% minus 3/8 inch feed was conducted. The respective gold recoveries were 40% (vat) and 70% (column) in about 40 days of leach contact. This suggests that the

low grade (0.010 opt gold) would be amenable for leaching if crushed to the smaller size. Cyanide and lime consumptions were within the previous column tests results.

Flotation/Fine Grind/cyanide leach tests were conducted on the Yarnell composite sent to Tucson from McClelland Labs. This head sample of 35 pounds assayed 0.031 opt Au and 2.35% Fe (Henderson, 1989).

In the two flotation tests, ground to -200 mesh, the recoveries were 75%-76% in the final concentrate and 79%-80% in the rougher concentrate.

In the two fine grind/cyanide leach tests, also ground to -200 mesh, the recoveries were 97% in 22 hours of agitated leach. The cyanide consumption was 0.21 pounds per ton of ore and the lime was 3.3 pounds per ton of ore.

The trade-off between high recovery by fine grinding agitated leach and lower recovery by coarse crush/heap leach is a matter of economics.

MINERAL INVENTORY - RESERVE

General Statement. The Yarnell Project contains ninety-six drill holes of the reverse circulation rotary type, four diamond drill holes which twinned adjacent rotary holes, and a comprehensive sampling of the open-cut along the outcropping upper edge of the mineral zone. The

rotary portion amounted to 24,367 feet of drilling with 1,295 feet of core drilled for a total of 25,662 feet of drilling (Plate 1 and Plate 2).

As noted in the drilling section, not all the footage contained assays, since some of the footage is through the open stopes while others were drilled in the footwall of the mineralization.

A packet of silicification, quartz veining, and quartz-sericite alteration sub-parallels the Yarnell Fault which strikes N40°E, and dips 30° northwesterly. The packet with the Yarnell Fault generally contains the highest grade of mineralization and varies in thickness and grade. This zone was designated the main or B Zone of mineralization.

Upward, a lower grade of mineralization is often found above the B Zone. Where it was of continuity and grade it was also inventoried as the A Zone mineralization.

Evaluation of the reserve potential was performed by two methods:

1. A drill indicated reserve using approximately a 0.010 opt gold cut-off for the A Zone and an 0.020 opt gold cut off for the B Zone mineralization. The hand calculation method using the triangular method discussed below and

2. The computer, cone miner, method using a modified polygon configuration, as discussed below.

Exploration Department triangular method. The triangular method was selected (Sell, 1989 b), and each drill hole leg assay values were scanned and the best interval of assays in the vicinity of the Yarnell Fault were selected for the B Zone calculation. Within this zone, some assay values were as low as 0.00X opt gold, but unless the grade and thickness was sufficient to be included within a proposed pit outline of the combined main B Zone, the inventory was not included in the drill indicated reserve. Also factored in was the parameter that any interval of twenty feet should average an 0.20 opt gold cut-off within the intercept used.

Through the first pass review it was determined that the average grade of the deposit might be 0.051 opt gold. This value was then placed in all the open stope areas for a total thickness computation of the B Zone. The tonnage and grade estimated as previously mined was then subtracted from the calculated tonnage-grade for the entire B Zone drill indicated reserve.

Calculation of the upper or A Zone mineralization was taken to be that which was within the suggested pit outline determined by the B Zone calculations. A 50° back-slope was suggested to be adequate for the B Zone and the pit plan was smoothed into what might be an acceptable outline, with a waste/ore ratio of around 3 tons of waste per ton of

ore. The value of the block within the A Zone needed to be within a minable plan with a 0.010 opt gold cut-off and a nominal thickness to be mined. Even though it was known that the material had to be moved to secure the B Zone mineralization, no economic parameters were placed in the calculation.

The previous Table 11 lists all the drill hole values broken down into A and B Zone intervals. Also noted are the holes not included in the drill indicated reserve as well as several other notes, such as, stope intercept, first and last value, and intervals projected from the areas.

Plate 2 plots the drill holes, the footwall outline of the mineralization, the downdip toe outline of the suggested pit, the crest outline of the proposed pit, the indicated outline of the underground workings and pillars, and the triangles used in the reserve study. Using a 12.0 tonnage factor, the following parameters were established:

Zone	Tonnage	Grade, opt Au	Waste/Ore
Waste*	12,670,000	--	--
B Total	4,360,000	0.051	--
Prev. Mined	250,000	0.051	--
B Remaining	4,110,000	0.051	3.08/1
Waste**	9,930,000	--	--
A Zone	2,740,000	0.017	--

B Zone (remaining)	4,110,000	0.051	--
A + B	6,850,000	0.038	1.45/1

*All material above B Zone inside pit parameters.

**Previous waste minus A Zone material.

Of the A Zone triangle blocks used, only two out of one hundred thirteen blocks averaged 0.010, all others were 0.011 or above, with a high of 0.025 opt gold.

In the B Zone the lowest grade block was 0.029, with a high of 0.114 opt gold.

Recalculation of previously removed stope tonnage/grade and recalculation of drilled mineral reserve.

Several questions had been raised as to the influence of the grade in the pillars, the near wall holes next to the stopes, and the configuration of the extracted stope perimeter, to the value of the remaining material in the B Zone.

The surveyed and estimated outline is plotted on Plate 2.

Miller (1990 c) compiled the drill hole intercepts from the holes which

intercepted pillars, 7 in number, and using the stope thickness calculations, separated out the equivalent stope interval. The average stope thickness was 21.4 feet with a grade of 0.090 opt gold. Miller also calculated the similar stope thickness on the holes outside the stope configuration, but within 50 feet of the stope wall. Fourteen holes with an average thickness of 19.6 feet contained an average of 0.076 opt gold.

Gay (1990) calculated the ore tonnage removed from the B Zone main mineralization by using all the drill holes which penetrated the openings, his survey of the working, and the estimate of the openings as suggested from an old file map. Gay also calculated the grade of the ore removed by using the ratio of the polygon readings.

Gay's calculations suggested a thickness of 20 feet of stope height with 230,000 tons of ore removed at a grade of 0.096 opt gold. The Gay data includes isopachs of the floor and back of the stopes and with the pillar and wall outlines, the data can be placed in the computer model for inclusion of the stope pillar while excluding the open stopes, if additional refinement is needed.

The values previously given for the waste and A Zone mineralization are not affected by the recalculation of values.

Miller (1990 b) recalculated the drill indicated reserve, using the new parameters developed. Table 14 is Table 4-A of Miller's report listing

the revised-main B Zone values. The bottom line indicates 4,130,000 tons at 0.055 opt gold remains in the B Zone area.

Computer evaluation with economic parameters has been undertaken by the ASARCO Engineering and Computer Service. Numerous scenarios of variable mining, milling, fixed and gold value costs have been used. L.J. Jansen's report (1990) using a 0.053 opt gold value for the open stope values, compared the inventory using the Exploration Department pit design and B Zone configuration vs. the economic pit using the computer derived pit with a $400 gold value, and costs of $7.34 per ton of ore mined (Model 4796).

The summary of the data for Model 4796 is as follows:

	Tons*	Grade, oz-ton
Exploration Dept. Inventory	4,797,000	0.052
Economic Computer Inventory	3,755,000	0.060

*No adjustment for previously mined material.

	Adj.Tons**	Adj.Grade, oz-ton
Exploration Department	4,567,000	0.052
Economic Computer	3,525,000	0.060

*Not adjusted for stope tonnage previously removed.

**Adjusted by subtracting 230,000 tons at 0.096 opt gold previously

mined as estimated.

The above figures compare favorably with the Exploration Department calculation reviewed in the previous section of the report.

A further computer revision is in progress based on the elimination of some values in blocks which were mis-projected beyond the footwall projection.

OTHER STUDIES - MAPS

A number of studies and map compilations have been conducted on the Yarnell Property.

The reports have been reviewed for facts listed in the foregoing report and are placed here for additional reference:

A. Studies

Bengson, S.A. 1990, Yarnell Project reclamation : Report to Asarco, July 23, 1990, 10 pages.

Crowell, D.E., 1989, McClelland proposal for metallurgical tests : Report to Asarco, June 9, 1989, 8 pages.

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B. Maps

Drilling progress, 1" = 200', Map 6734, 6773, 6781, 6841.

Structural contour top of B Zone, Map 6778.

Structural contour, base of B Zone, Map 6779.

Geology, 1" = 100', Map 6780.

Triangles & drill holes used in study pit, Map 6811.

Isopach, thickness, upper A Zone, Map 6812.

Isopach, foot-ounces gold, main B Zone, Map 6813.

Isopach, thickness, main B Zone, Map 6814.

Drilling program with proposed holes, 1" = 200', Map 6841.

Claims, 1" = 200', Map 6864.

Topography, Sec. 14, 1" = 100', no map number.

Topography, Sec. 14 & 23, 1" = 200', no map number.

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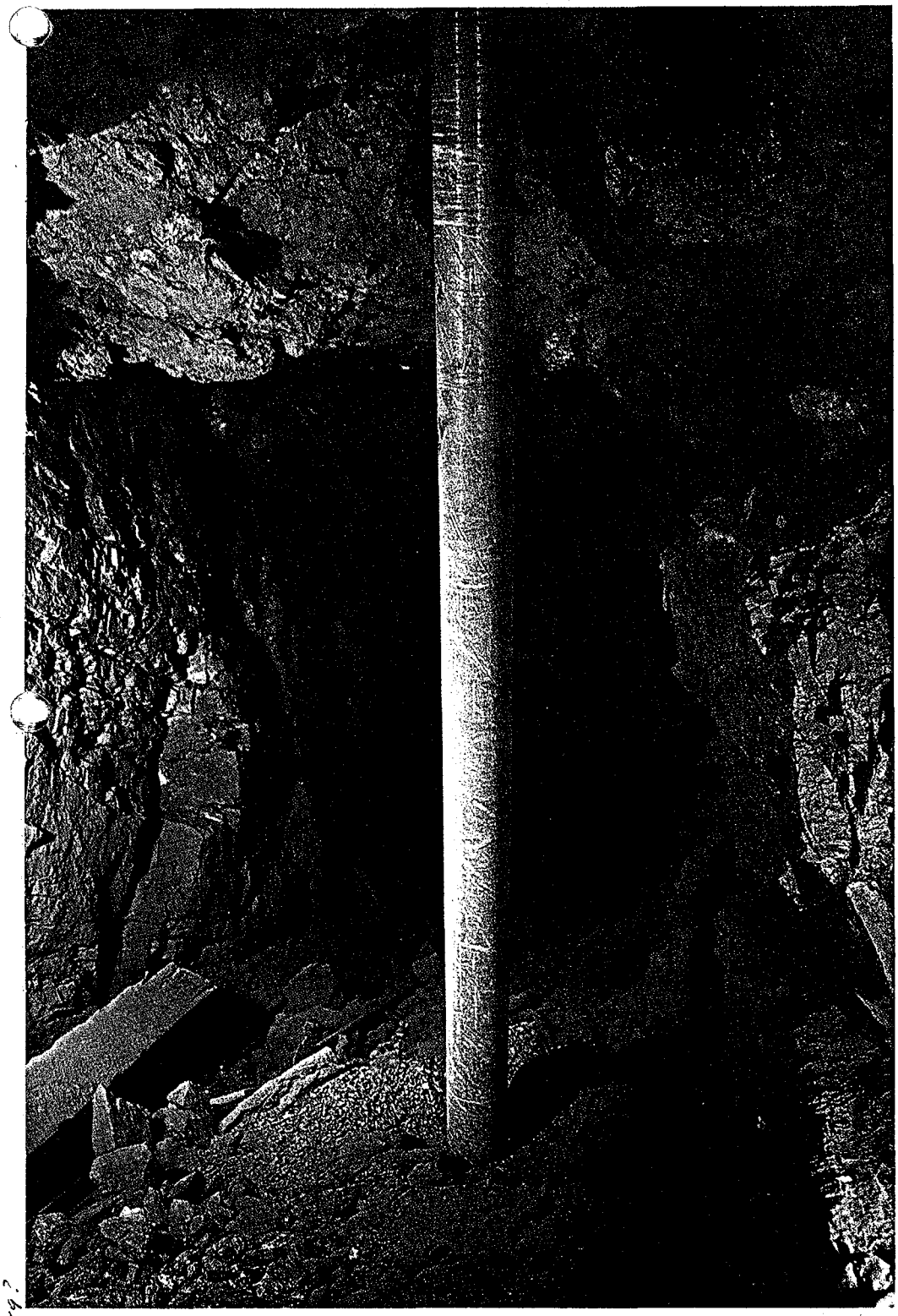


This photo shows the unique capability of the dual-wall reverse circulation drilling method.

Circulation was only momentarily lost as the drill pipe passed through this mine tunnel. As soon as the drill bit bore into the floor of the tunnel, circulation was quickly regained.

Had a conventional drilling method been used, all circulation would have been lost which would have necessitated setting casing, cementing or abandoning the hole. The additional materials and lost time would have been costly compared to using the dual-wall reverse circulation method.

It should be noted that in this case, as with other dual-wall reverse circulation applications, no drilling mud and/or additives were required for drilling operations to proceed.

DRILLING SERVICES CO.
A Division of Layne-Western Company, Inc.
12030 East Riggs Road
Chandler, Arizona 85249
(602) 895-9336

Valtec Mine 1989?

PLATE 1

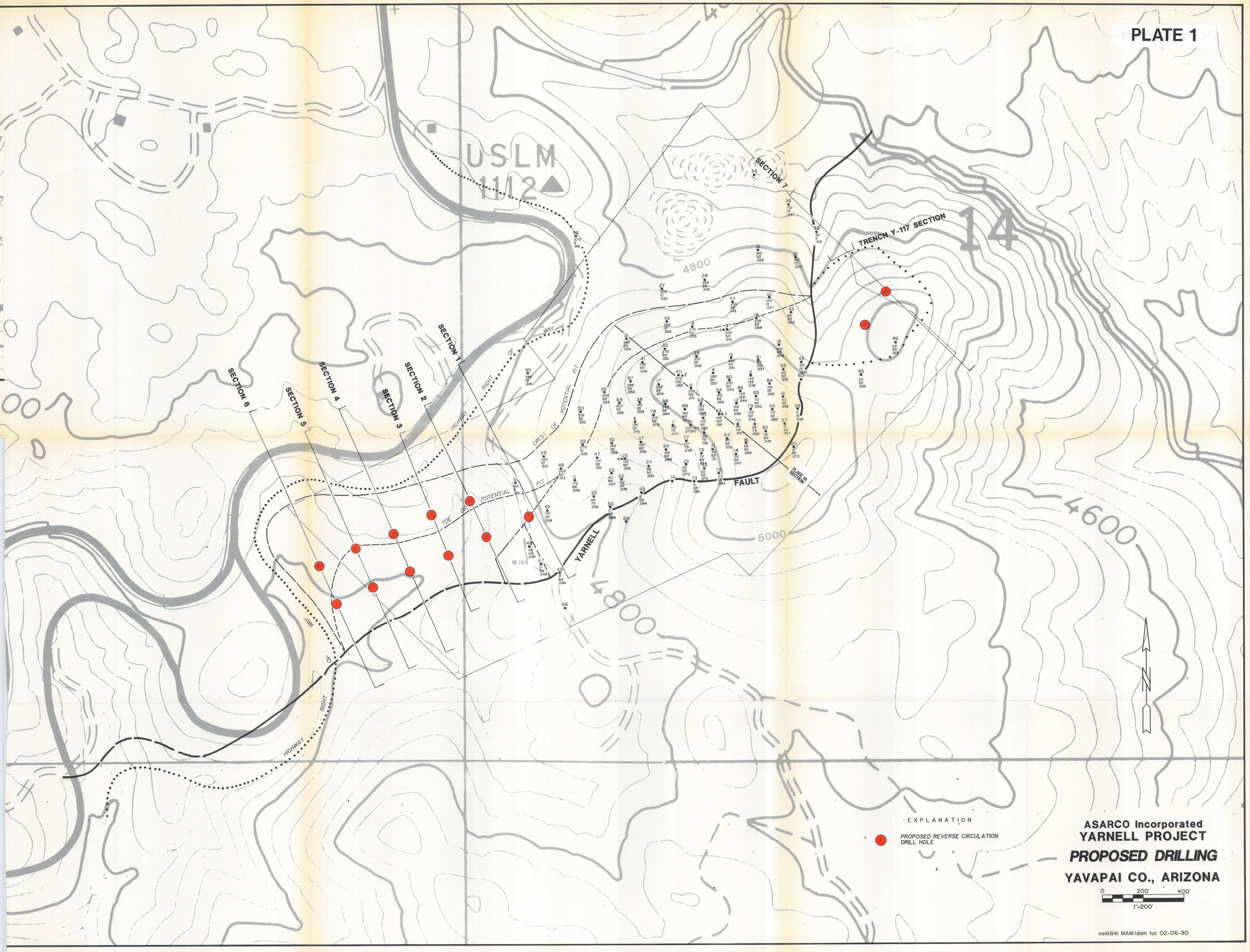
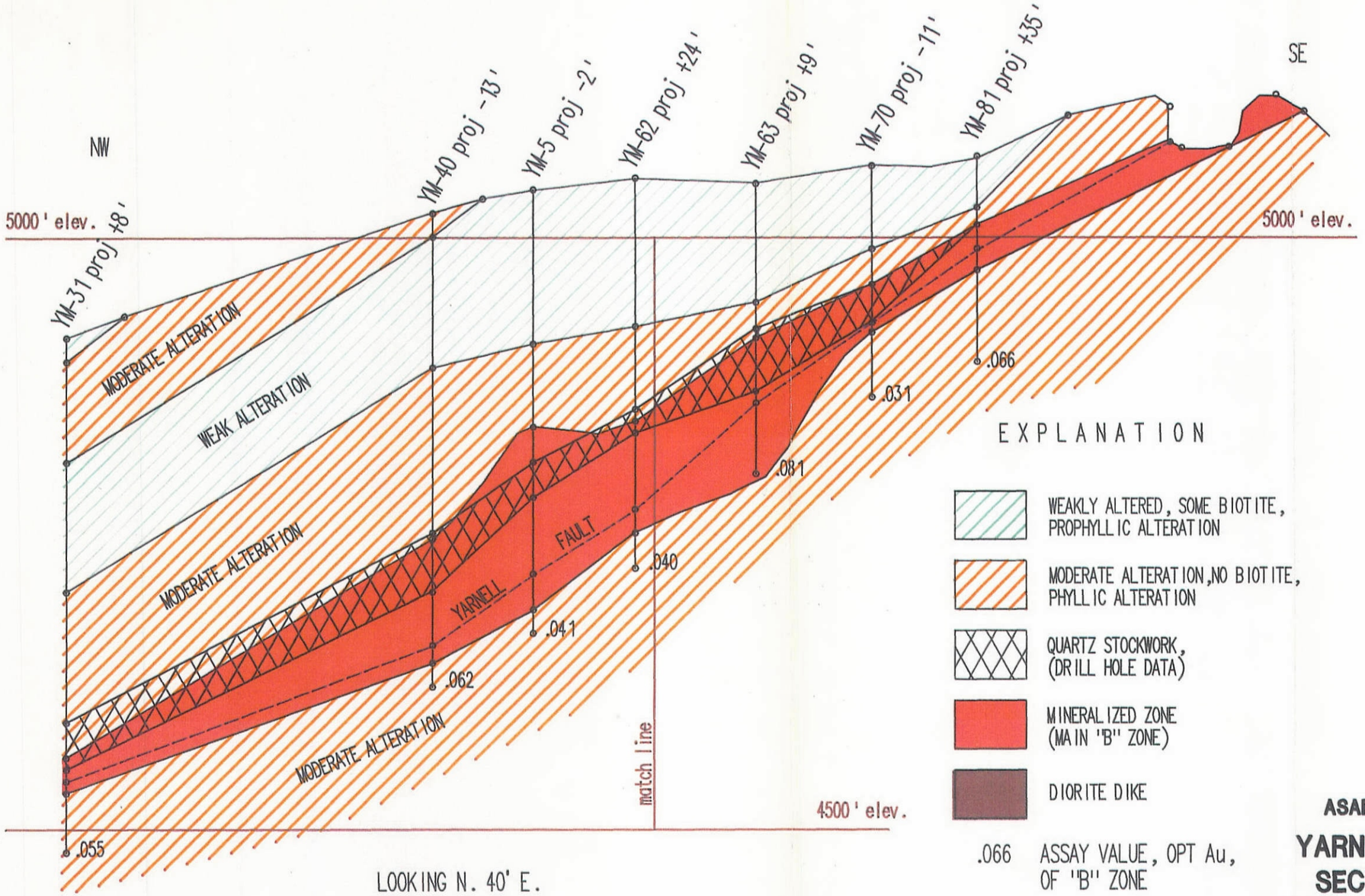

USLM
1112
14
4800'
5000
4600
4800
SECTION 1
SECTION 2
SECTION 3
SECTION 4
SECTION 5
SECTION 6
SECTION 7
TRENCH Y-117 SECTION
PLATE 1A SECTION
FAULT
YARNELL
CREST OF POTENTIAL PIT
TOE OF POTENTIAL PIT
HIGHWAY RIGHT OF WAY
M 169
EXPLANATION
PROPOSED REVERSE CIRCULATION DRILL HOLE
ASARCO Incorporated
YARNELL PROJECT
PROPOSED DRILLING
YAVAPAI CO., ARIZONA
0 200' 400'
1"=200'
mn6841 MAM/dam luc 02-06-90

PLATE 1A



EXPLANATION

- WEAKLY ALTERED, SOME BIOTITE, PROPHYLLIC ALTERATION
- MODERATE ALTERATION, NO BIOTITE, PHYLLIC ALTERATION
- QUARTZ STOCKWORK, (DRILL HOLE DATA)
- MINERALIZED ZONE (MAIN "B" ZONE)
- DIORITE DIKE

.066 ASSAY VALUE, OPT Au, OF "B" ZONE

ASARCO Incorporated

YARNELL PROJECT
SECTION 1400
YAVAPAI CO., ARIZONA

0 100' 200'

mn YR900922 MAM(JDS)/dam tuc 09-24-90

HORIZONTAL SECTION, Elevation 5200

PLATE 2

TRIANGLES & DRILL HOLES USED IN STUDY PIT YARNELL PROJECT YAVAPAI COUNTY, ARIZONA

J.D.SELL 11/10/89

ASARCO Engineering and Computer Services

YARNELL PROJECT COLLAR LOCATION MAP

SCALE In Feet	CHECKED BY	PLOT DATE	FILE
1:100.00		25-OCT-89	YARN-COLLAR

mn68II JDS/aam tuc 11-10-89

DRILL HOLE COLLAR LOCATION MAP50W

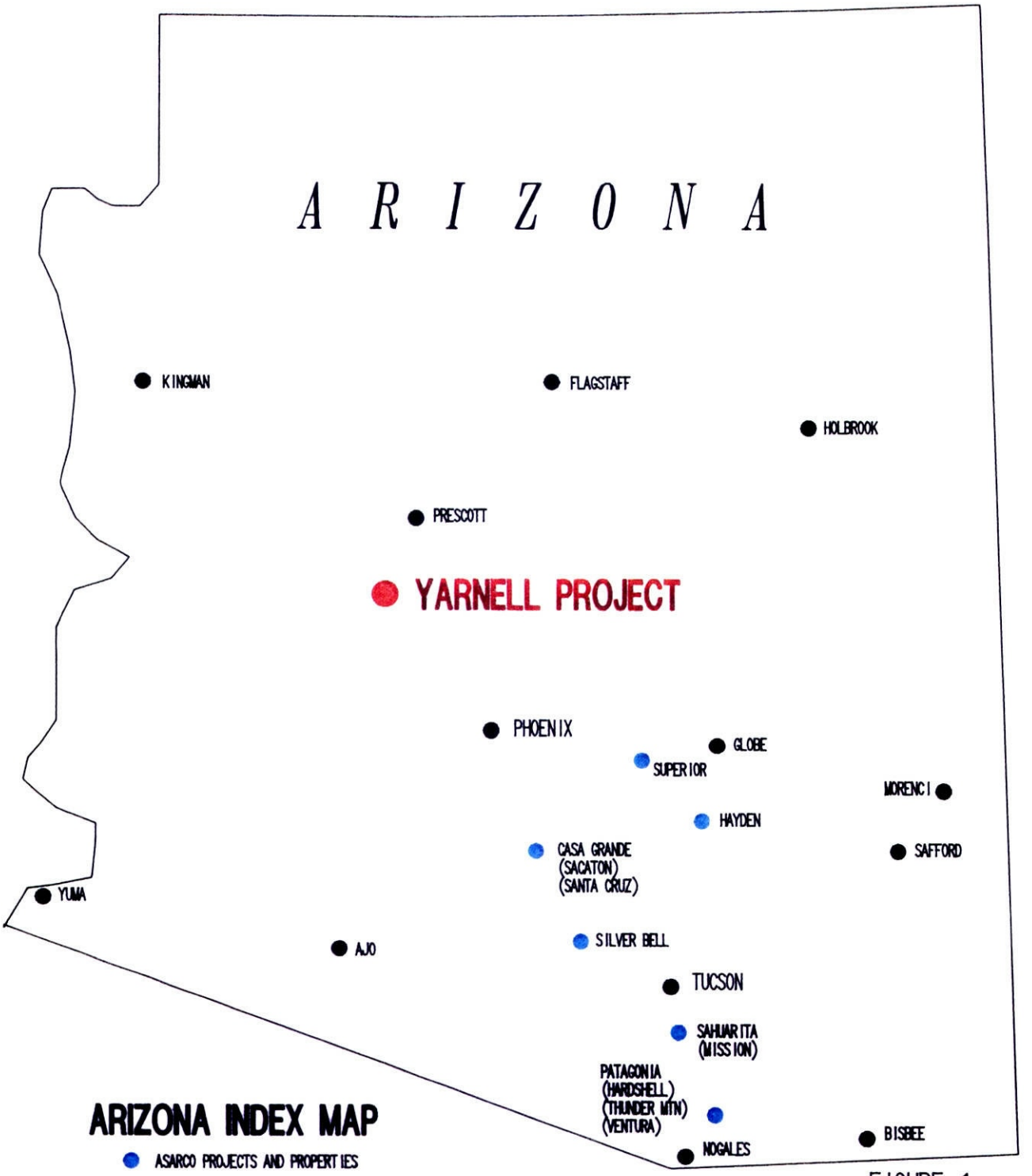


FIGURE 1

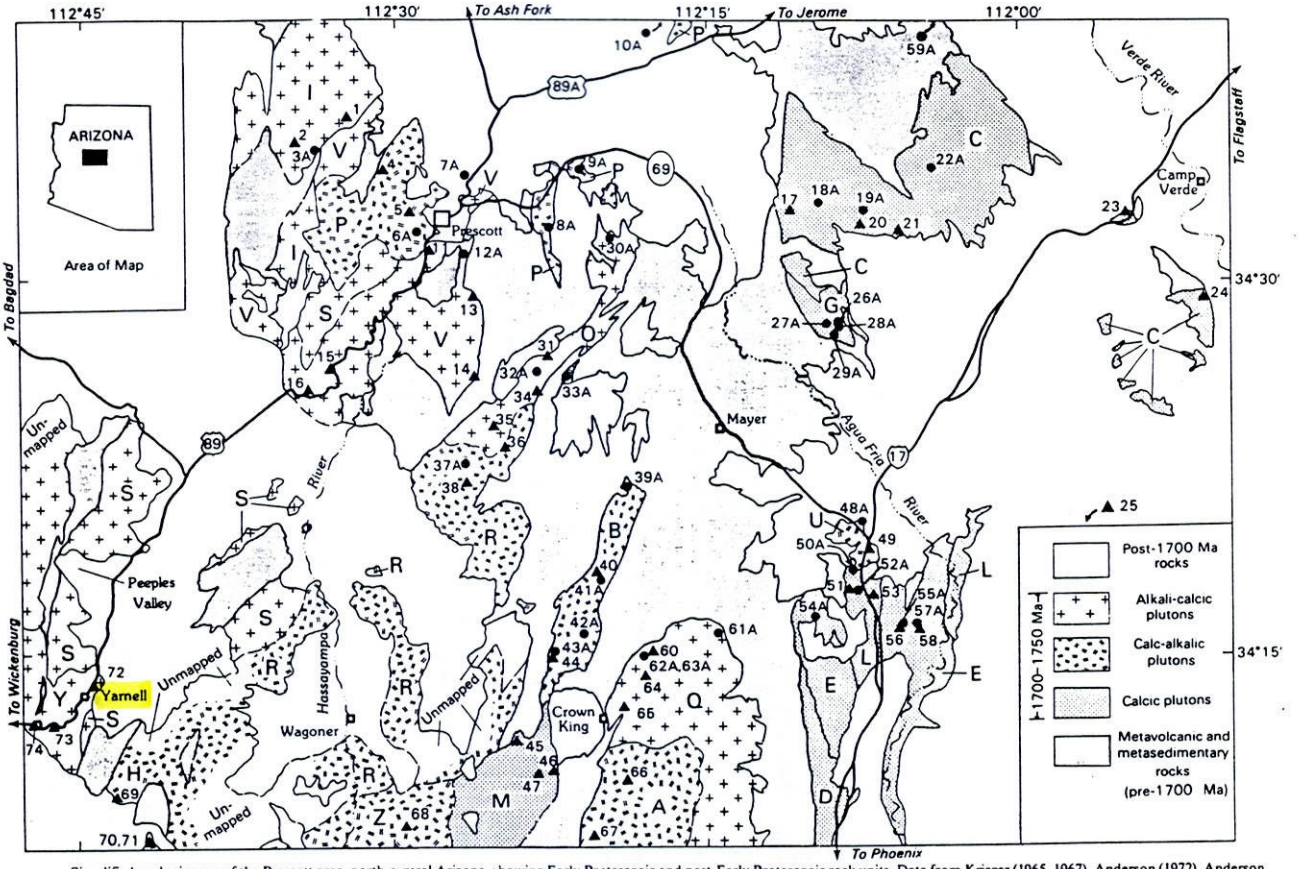
ASARCO Incorporated

YARNELL PROJECT

INDEX MAP

YAVAPAI CO., ARIZONA

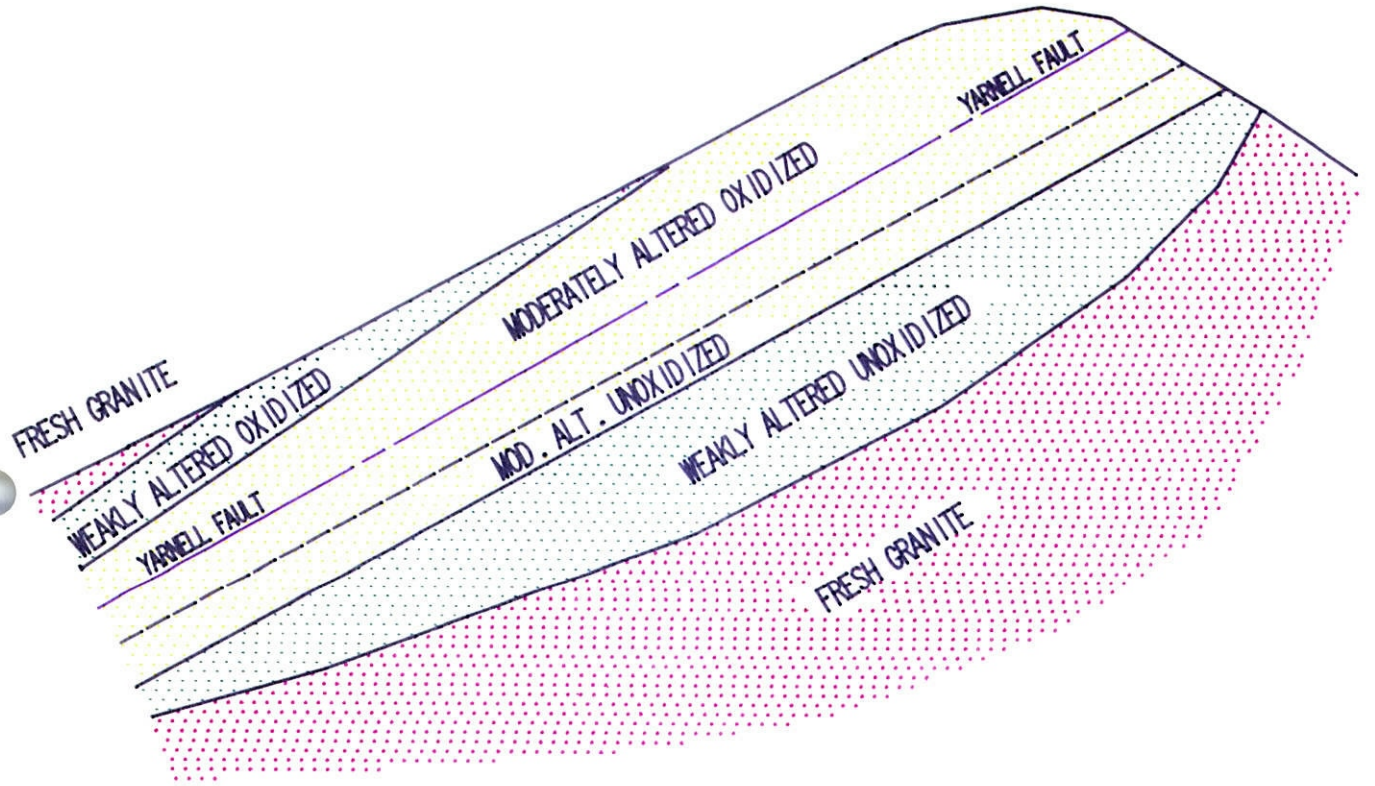
mn YR900701 MAM/dcm tuc 07/02/90



Simplified geologic map of the Prescott area, north-central Arizona, showing Early Proterozoic and post-Early Proterozoic rock units. Data from Krieger (1965, 1967), Anderson (1972), Anderson and Creasey (1958, 1967), Anderson and Blacet (1972a, 1972b, 1972c), DeWitt (1976, 1979), Jerome (1956), Light (1975), Hook (1956), Pflafker (1956), Wolfe (1983), and unpublished reconnaissance mapping by the author. All contacts, whether depositional, intrusive, or fault-related, are shown by the same kind of line. The Early Proterozoic metamorphic units (both pre- and postplutonic) consist of volcanic and sedimentary protoliths intruded by gabbroic masses. Sample numbers without an A are from this study. Sample numbers with an A are published and are from: Lee, 1984 (3A and 7A); Anderson and Blacet, 1972b (12A, 18A, 19A, 22A, 26A, 27A, 28A, 29A, 32A, 33A, and 37A); Anderson, 1972 (48A, 50A, 52A, 54A, 55A, and 57A); Krieger, 1965 (6A, 8A, 9A, 10A, and 30A); Anderson and Creasey, 1958 (59A); Blacet, 1968 (39A, 41A, 42A, 43A, and 62A), and Vrba, 1980 (61A and 63A). A, granodiorite of Lane Mountain; B, Brady Butte Granodiorite; C, tonalite of Cherry; D, quartz diorite of Bland; E, Badger Spring Granodiorite; G, granophyre of Cherry; H, granite of Rich Hill; I, granite of Iron Springs; L, Bumblebee Granodiorite; M, granodiorite of Minnehaha; O, Crooks Canyon Granodiorite [north]; P, Prescott Granodiorite; Q, Crazy Basin Quartz Monzonite; R, Crooks Canyon Granodiorite [south]; S, granodiorite of Wilhoit; U, granodiorite of Big Bug Creek; V, Government Canyon Granodiorite; Y, granodiorite of Yarnell; Z, granodiorite of Hozoni Ranch.

Figure 2. Regional geologic map of north-central Arizona (DeWitt, 1989, p.150).

FIGURE 2A

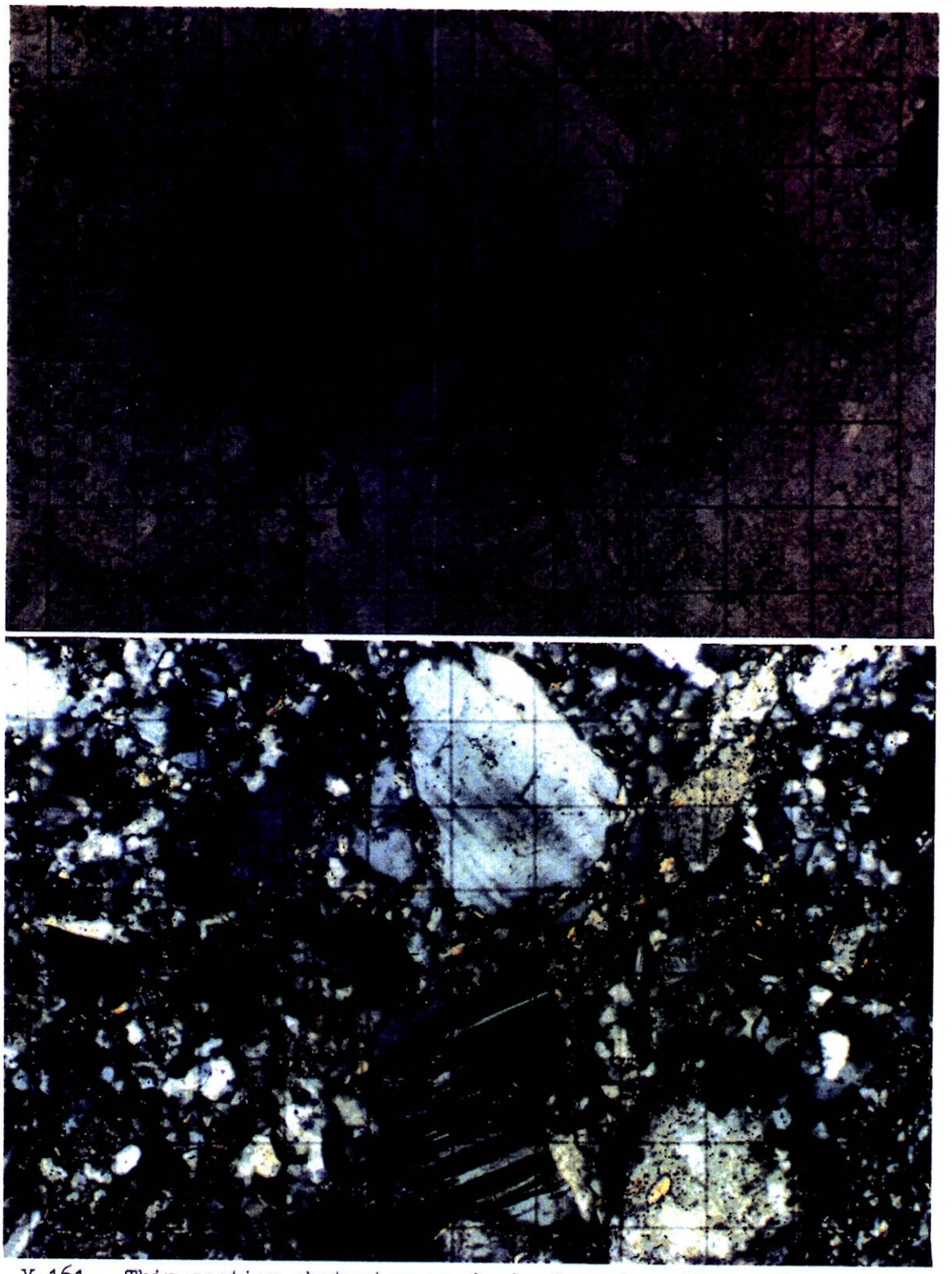


ASARCO Incorporated
YARNELL PROJECT

SCHEMATIC CROSS SECTION
ALTERATION ZONES

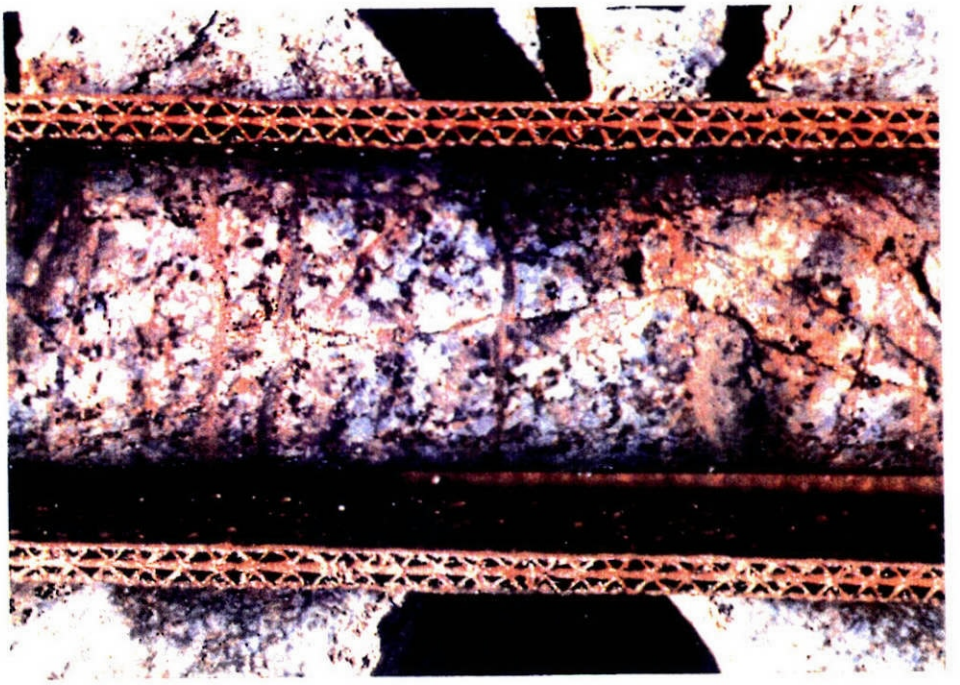
YAVAPAI CO,ARIZONA

mn YR900921 MAM(JDS)/dcm tuc 09-24-90



Y-161. Thin section photomicrograph showing microcline and opaque ilmenite fragments in rather finely crushed and recrystallized quartz-K-feldspar matrix. Plain light and crossed nicols, X110. Each square of grid is 130 microns on an edge.

FIGURE 3. Yarnell Fault zone. surface (R.M.Honea. 1-6-90)

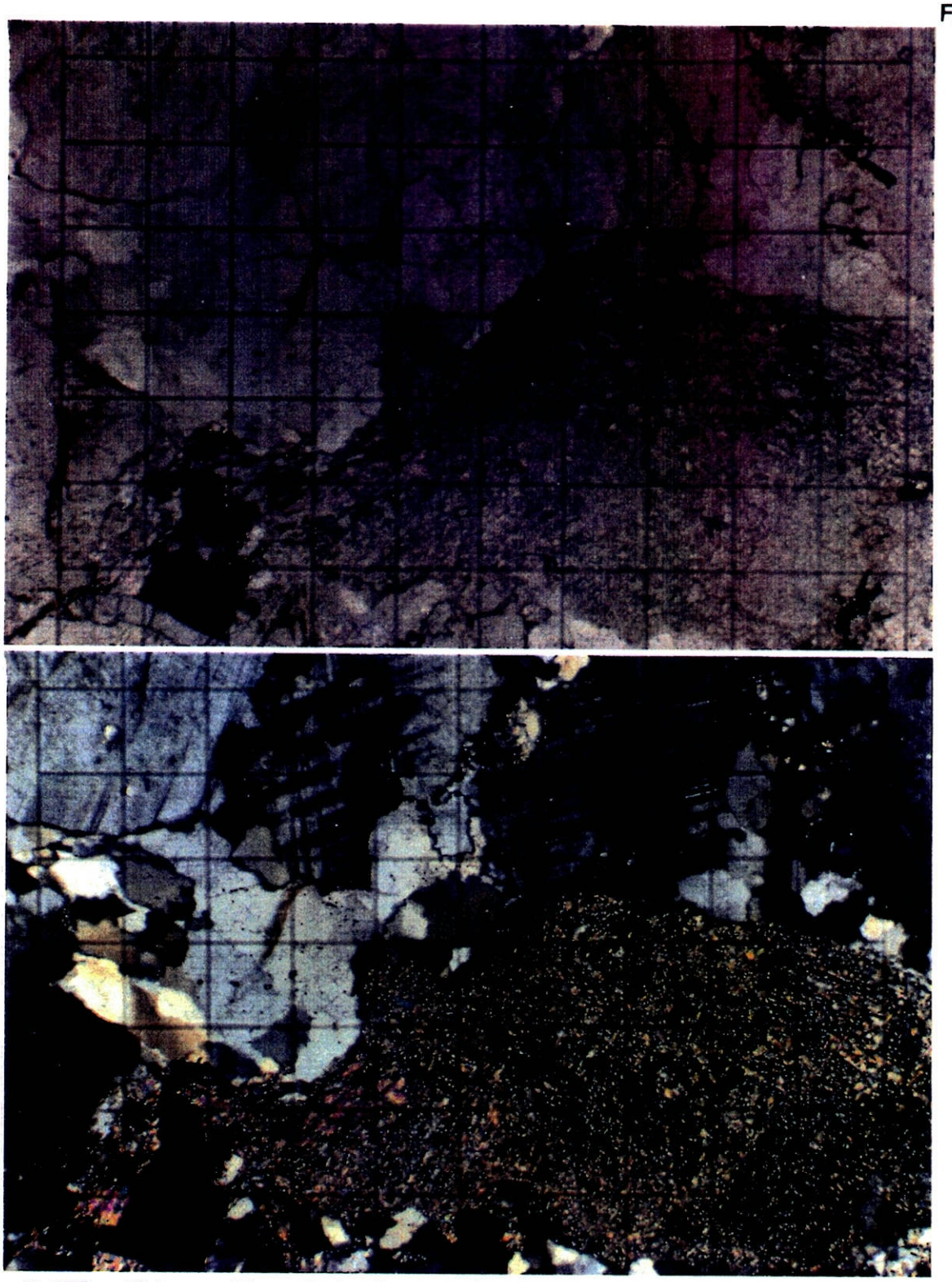


interval 142'-143'

interval 126'-127'

FIGURE 4. Core hole YDDH-3, potassic alteration associated with quartz veins.

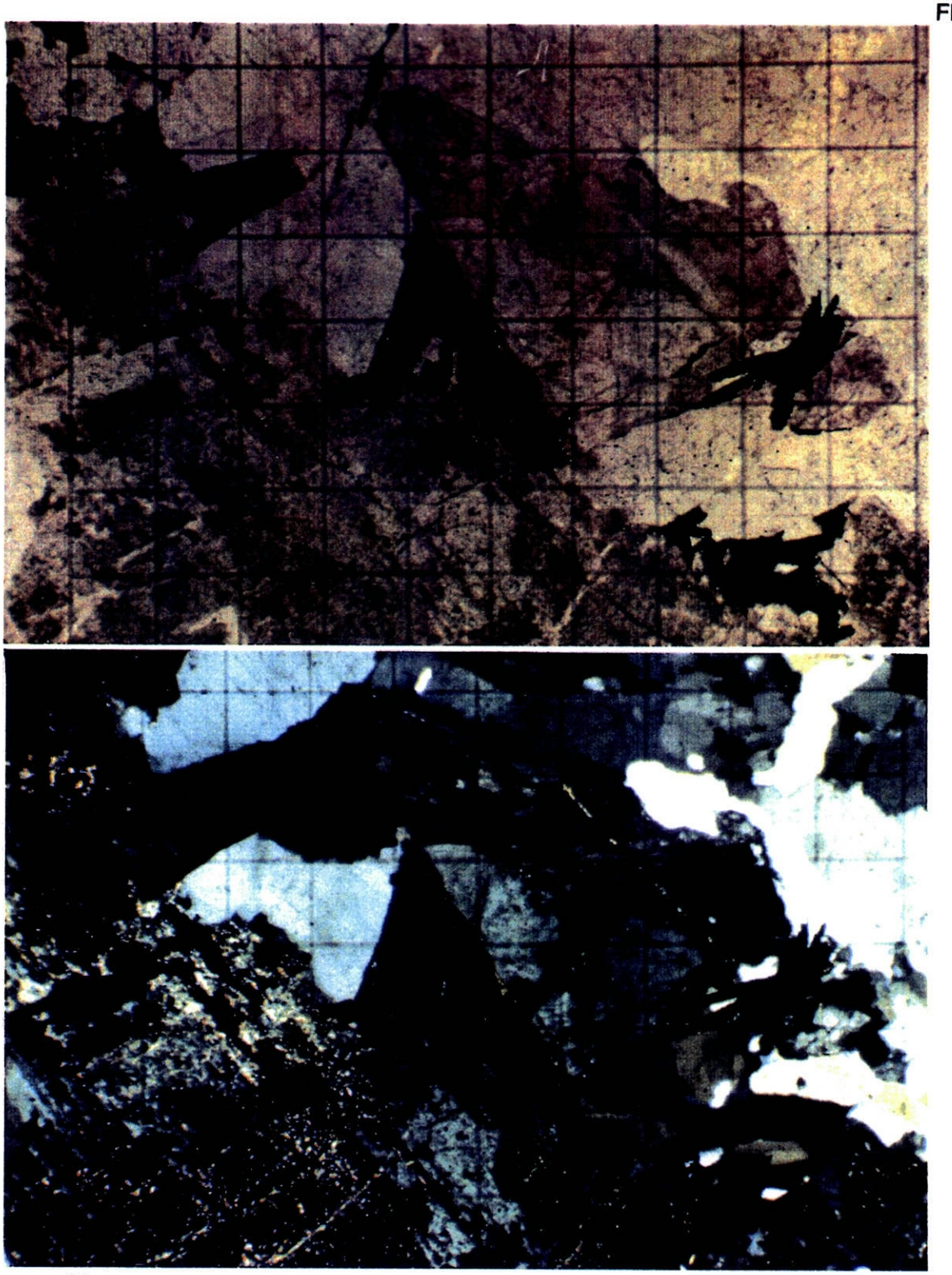
FIGURE 5



Y-155. Thin section photomicrograph of altered granite showing sericite replaced plagioclase with associated microcline, quartz, and sericite replace biotite. Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.

FIGURE 5. Phyllic. sericite. alteration (R.M.Honea. 1-6-90)

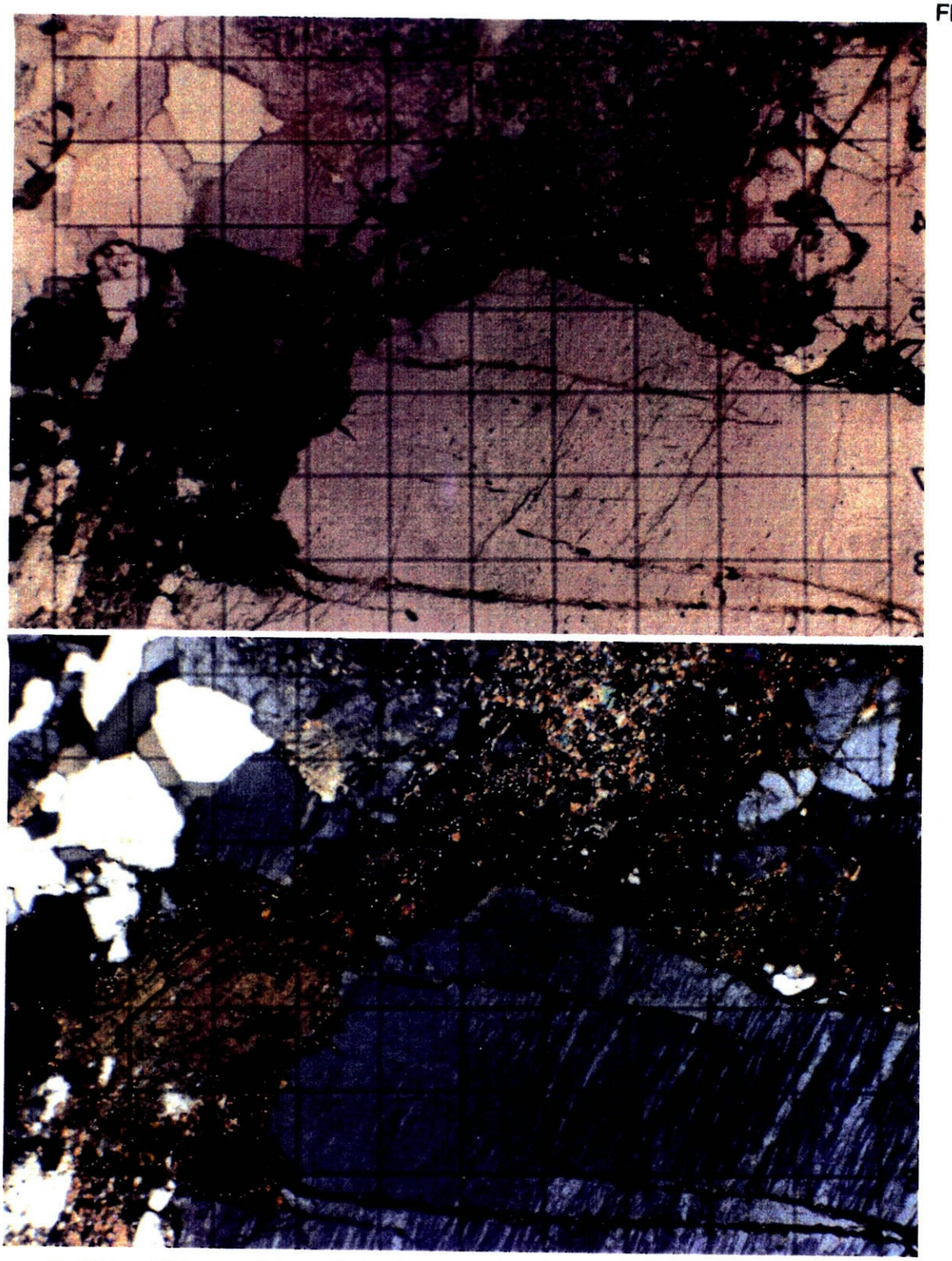
FIGURE 6



Y-166. Thin section photomicrograph of weakly argillized microcline (upper right) and weakly sericitized plagioclase (lower left) with quartz and hematite plates (opaque) in fractured and rehealed host granite. Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.

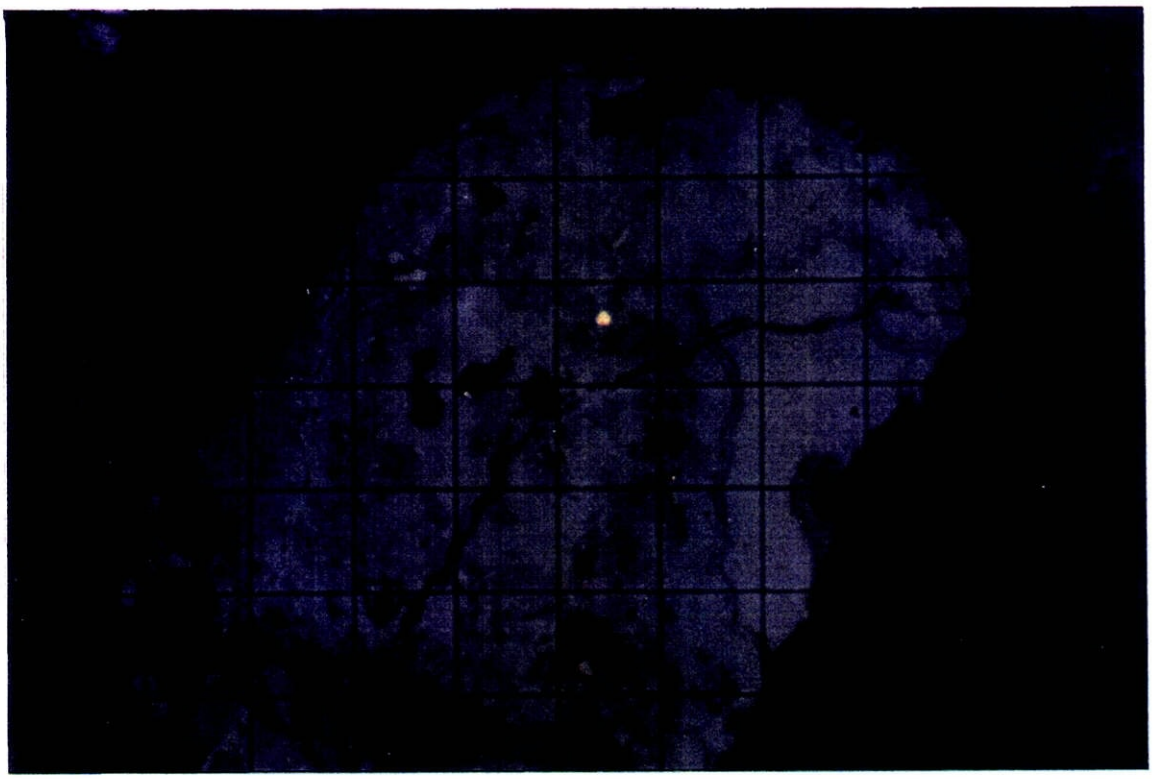
FIGURE 6. Outer. weak alieration (R.M.Honea. 1-27-90)

FIGURE 7



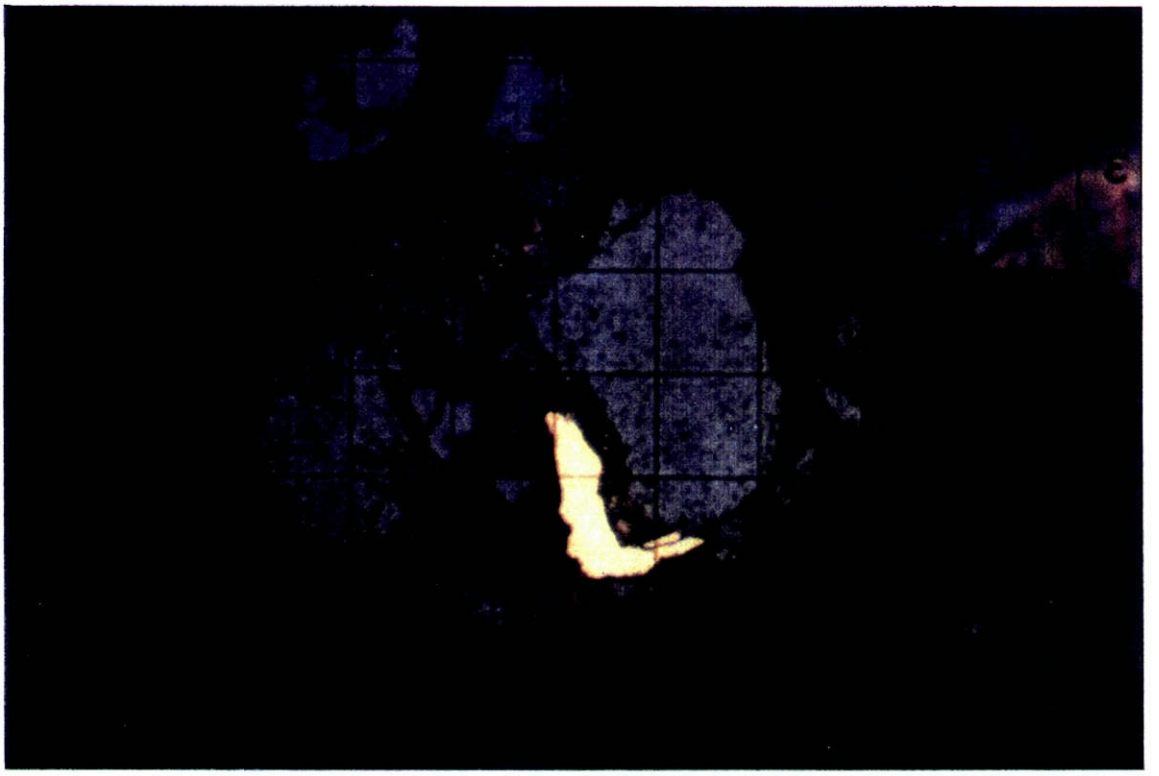
Y-150. Thin section photomicrograph of sheared granite showing sericitized plagioclase (upper center) and weak chlorite-epidote replacement of biotite (left and across center) along with unaltered microcline and quartz. Plain light and crossed nicols, X55. Each square of grid is 260 microns on an edge.

FIGURE 7. Weakly altered granite (R.M.Honae. 1-6-90)



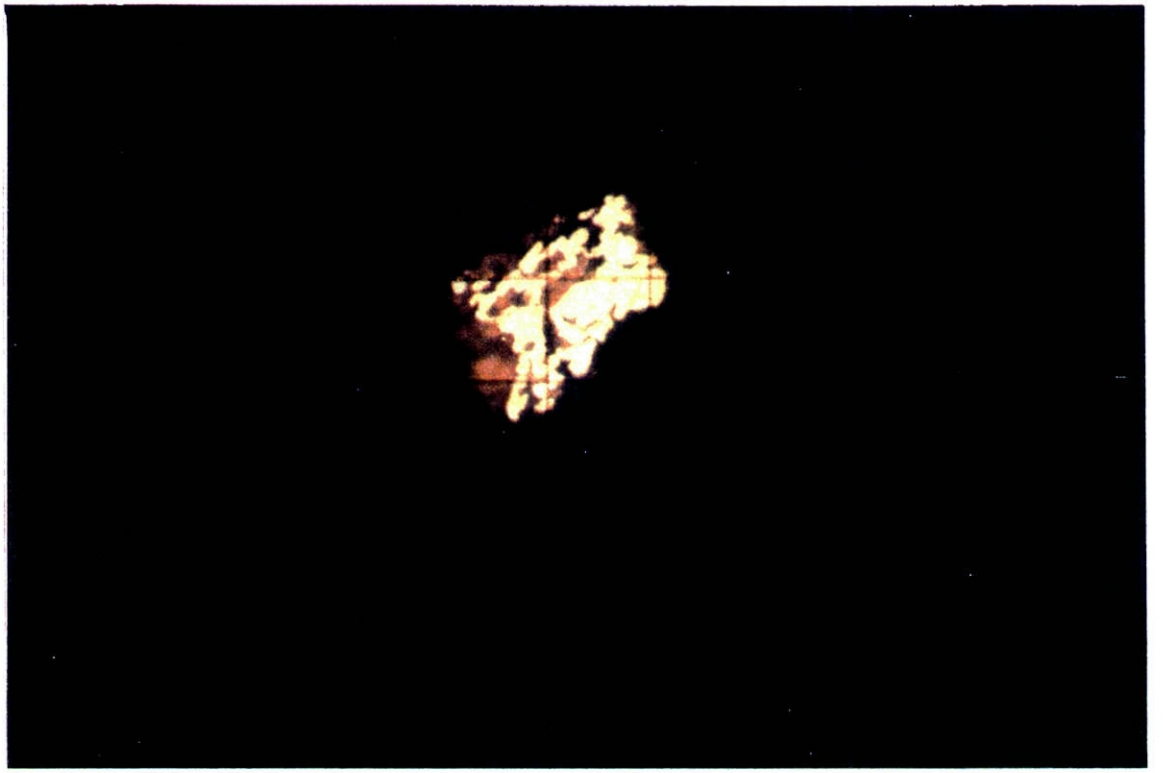
YM71 - 85-90'. Polished section photomicrograph of small native gold particle locked by goethite oxidation pseudomorph. Plain light, X435. Each square of grid is 32 microns on an edge.

FIGURE 8. Small 4x4 micron gold particles (R.M.Honea. 12-7-89)



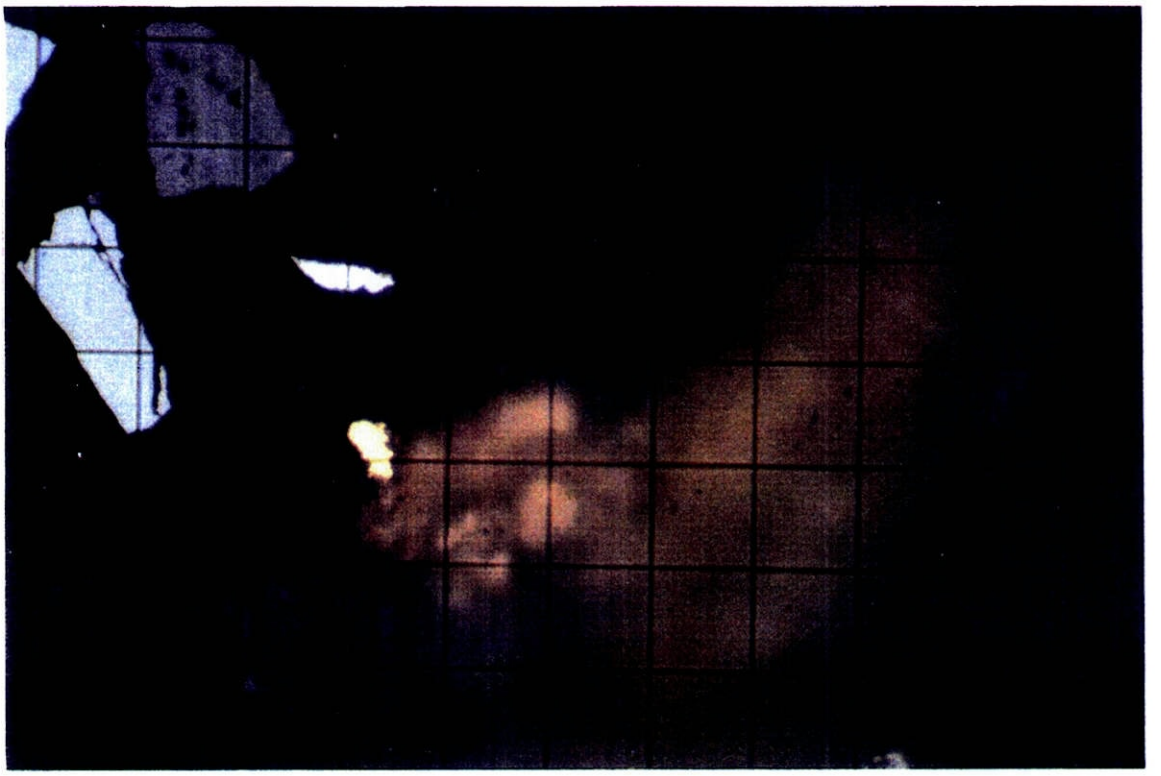
YM71 - 85-90'. Polished section photomicrograph showing composite grain with native gold and goethite. Plain light, X435. Each square of grid is 32 microns on an edge.

FIGURE 9. Medium. elongate. 12x87 micron gold (R.M.Honea. 12-7-90)



YM71 - 85-90'. Polished section photomicrograph of liberated dendritic aggregate of native gold. Plain light, X435. Each square of grid is 32 microns on an edge.

FIGURE 10. Medium+. 45x64 micron gold (R.M.Honea. 12-7-89)

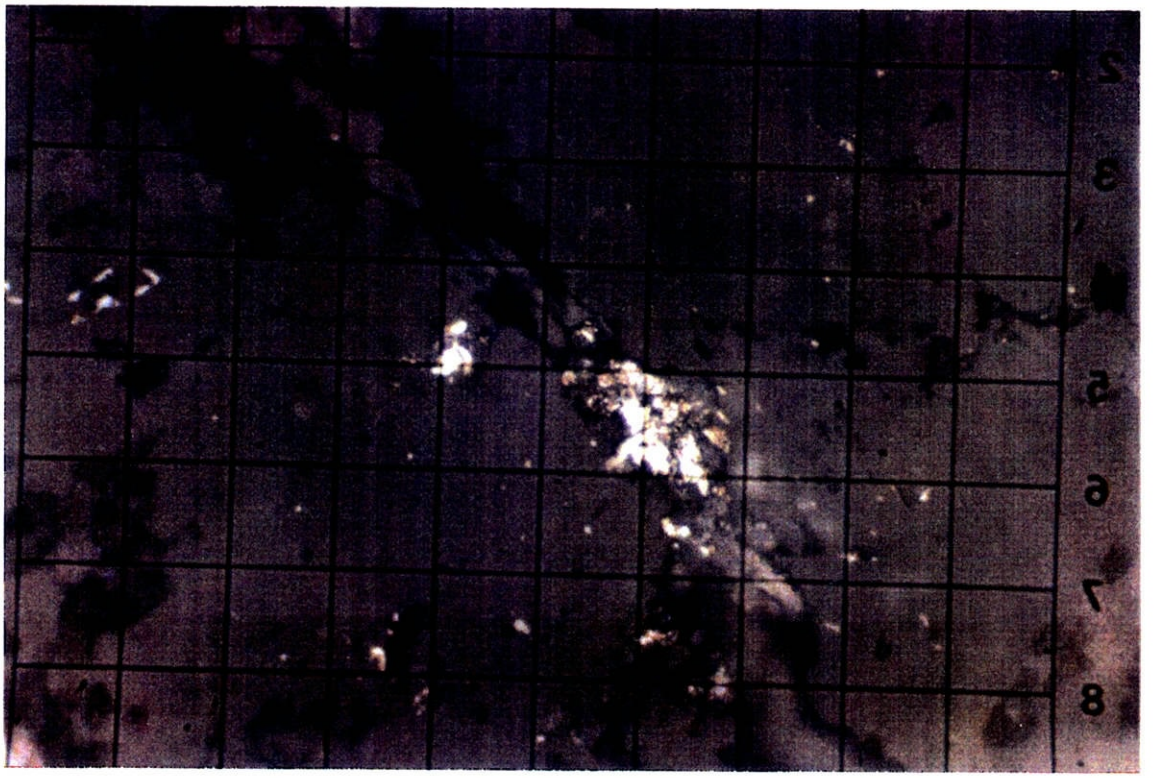


1G - 35-40'. Polished section photomicrograph showing liberated native gold particle in which only a small part of the grain is exposed in the polished surface. Associated at upper left are goethite, hematite, and trash iron. Plain light, X435. Each square of grid is 32 microns on an edge.

FIGURE 11. Large. elongate. 60x225 micron gold (R.M.Honea. 3-10-90)

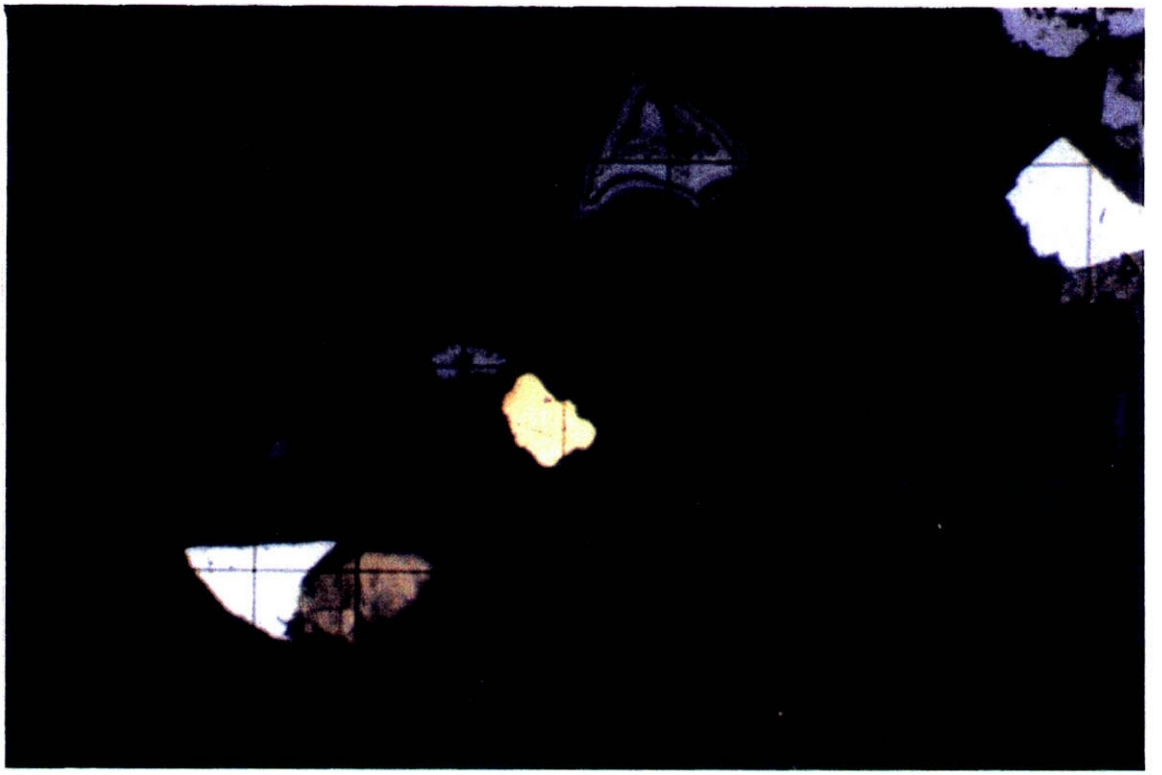
P.S. Y-158. Polished section photomicrograph of native silver particle in fracture filling cutting altered host. Associated with poorly polished goethite. Plain light, X435. Each square of grid is 32 microns on an edge.

FIGURE 12. Small elongate. 5x19 micron silver (R.M.Honea. 2-20-90)



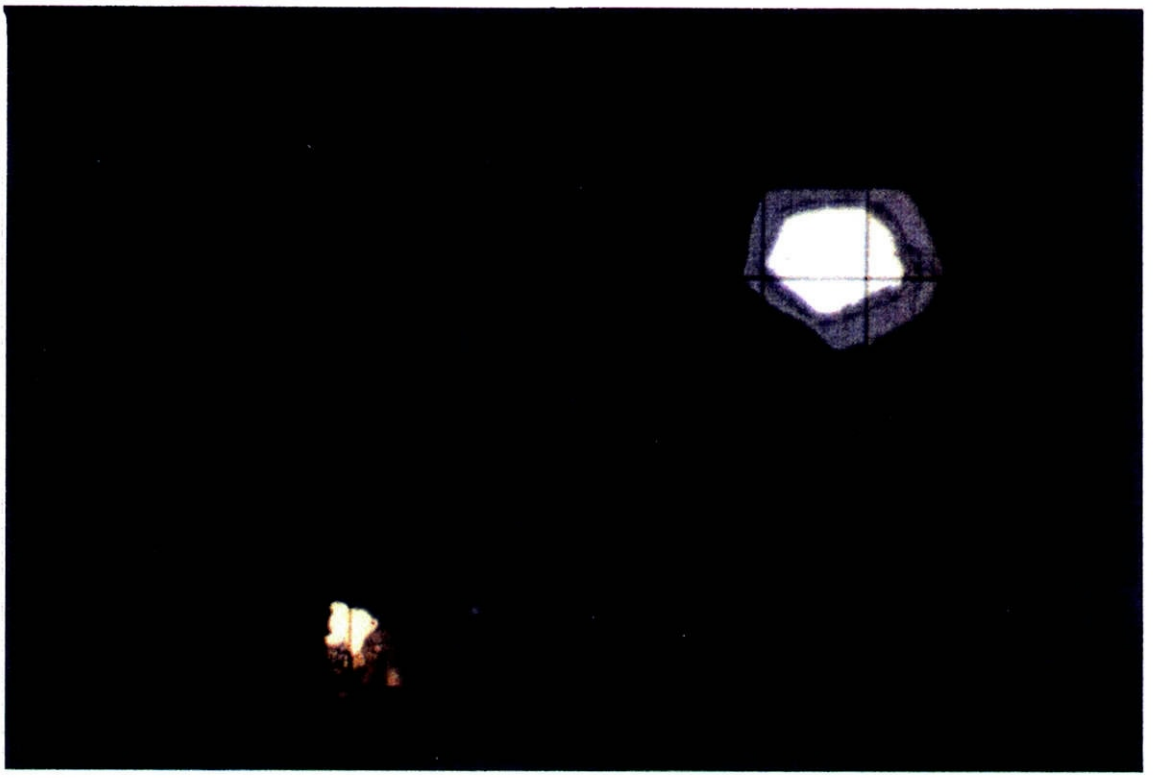
P.S. Y-158. Polished section photomicrograph of native silver in fracture filling cutting altered host. Plain light, X1090. Each square of grid is 13 microns on an edge.

FIGURE 13. Small. 2x4. 2x6. 3x5 micron silver particles (R.M.Honea. 2-20-90)



YM71 - 85-90'. Polished section photomicrograph of liberated native gold particle associated with separate fragments of goethite (upper center), galena (upper right), and pyrite (lower left). Plain light, X435. Each square of grid is 32 microns on an edge.

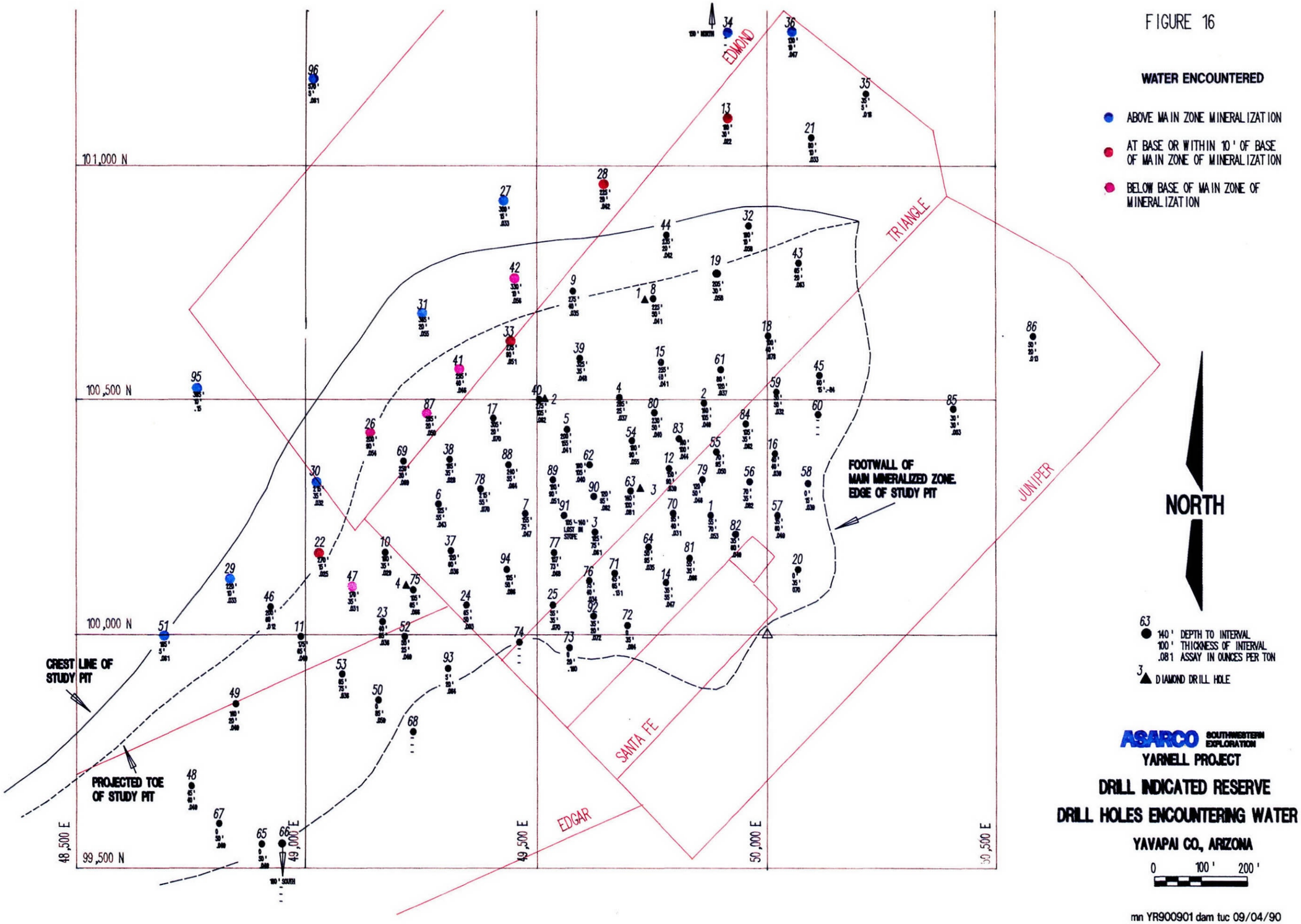
FIGURE 14. Galena and pyrite (R.M.Hones. 12-7-89)



YM71 - 85-90'. Polished section photomicrograph of native gold in liberated particle associated with pyrite remnant rimmed by goethite oxidation pseudomorph. Plain light, X435. Each square of grid is 32 microns on an edge.

FIGURE 15. Pyrite/geothite (R.M.Hones. 12-7-89)

FIGURE 16



ASARCO SOUTHWESTERN EXPLORATION

YARNELL PROJECT

DRILL INDICATED RESERVE

DRILL HOLES ENCOUNTERING WATER

YAVAPAI CO., ARIZONA

0 100' 200'

mn YR900901 dam tuc 09/04/90

YARNELL PROJECT

Yavapai County, Arizona

Table 1. Major Element Chemistry - Yarnell Pluton

	Granodiorite (De Witt)			Biotite Granite (Malusa)	
Sample #	72	73	74	HW	FW
SiO_2	67.4	66.3	65.1	70.0	69.8
Al_2O_3	14.5	14.1	14.3	14.3	14.4
Fe_tO_3*	4.98	5.45	6.65	4.76	5.02
MgO	1.17	1.22	1.52	1.00	1.10
CaO	2.57	2.84	3.43	2.60	2.30
Na_2O	3.08	3.10	3.14	3.20	3.10
K_2O	4.18	4.33	3.78	4.10	3.90
TiO_2	0.80	0.79	1.02	0.70	0.85
P_2O_5	0.27	0.34	0.39	0.45	0.55
MnO	0.12	0.11	0.13	0.11	0.13
TOTAL	99.07	98.58	99.72	101.22	101.15

*Fe_tO_2, total iron as Fe_2O_3

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Table 2. Size of Gold & Silver Particles

	Size	No.	Equidimensional in microns	No.	Elongate in microns
GOLD					
	v.small	7	"dot", 1/2	--	--
	small	9	1(1x2),2(2x2), 2(2x4),1(3x3), 1(3x6),1(4x4), 1(4x8)	6	1(2x8),3(2x12) 1(2x20),1(6x25)
	medium(-)	7	1(9x15),1(12x18), 2(13x19),1(15x30), 1(19x32),1(19x38)	4	1(10x35),1(10x45), 1(12x87),1(13x34)
	medium	3	1(25x33),1(25x38), 1(32x32)	1	1(26x70)
	medium(+)	3	1(35x60),1(45x60), 1(45x64)	--	--
	large	--	--	1	1(60x225)
		29	+	12	= 41 Subtotal
SILVER					
	v.small	--	--		--
	small	10	5(2x4),5(3x5)	2	1(2x6),1(5x19)
	medium(-)	--	--	--	--
	medium	--	--	--	--
	medium(+)	--	--	--	--
	large	--	--	--	--
		10	+	2	= 12 Subtotal
		39	+	14	= 53 TOTAL

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Table 3. Comparison of Trace Elements
(ppm values) in Main Ore Zone rotary cuttings
and Hanging Wall-Footwall soil samples.

	Ore Zone, Rotary Cuttings ppm			HW Soils ppm	FW Soils ppm
	YM-6	YM-26	YM-50		
No. of Samples	3	4	5	53	61
Cu, average	3.7	18.4	17.0	28.4	19.4
Cu, high	5.0	36.4	26.1	55.4	30.0
Cu, low	2.6	5.1	8.7	16.3	11.5
Pb, average	7.9	69.1	8.5	24.6	21.1
Pb, high	10.7	255.0	11.7	58.5	34.9
Pb, low	5.9	4.7	7.1	14.5	12.5
Zn, average	28.8	59.6	41.8	86.8	60.3
Zn, high	36.4	124.0	57.0	270.0	124.0
Zn, low	24.1	34.3	34.8	33.7	30.3

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Table 4. Drilling Contractors and Sequence

Contractor/ Equipment	Hole Numbers	Started	Completed	Footage*
Drilling Services Company, Reverse Air Circulation				
TH-100	YM-1 thru YM-9	3/20/89	4/1/89	3,022
TH-100	YM-10 thru YM-36	6/3/89	6/29/89	7,350
TH-60	YM-37 thru YM-96	7/19/89	10/3/89	13,995
			Subtotal	24,367
Boyles Bros., Core				
Longyear 44H	YDDH-1 thru -4	9/25/89	10/21/89	1,295
			Subtotal	1,295
			TOTAL	25,662

*Footage is to bottom of hole and includes footage in stopes where no samples were recovered.

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Table 5. Yarnell Drill Hole - Survey Data

ROTARY DRILL HOLE NUMBER	DEPTH FEET	COORDINATES NORTH	COORDINATES EAST	ELEVATION
YM-1	220	100,255.5	49,875.4	5,078.5
YM-2	350	100,490.7	49,860.6	5,063.0
YM-3	250	100,218.5	49,625.8	5,010.7
YM-4	440	100,505.3	49,675.8	5,052.3
YM-5	370	100,437.1	49,565.2	5,041.8
YM-6	400	100,278.7	49,286.7	4,949.0
YM-7	292	100,260.5	49,471.6	4,986.9
YM-8	350	100,717.9	49,749.2	4,957.9
YM-9	350	100,734.8	49,577.2	4,930.2
YM-10	300	100,177.0	49,171.1	4,893.9
YM-11	260	99,998.0	48,983.2	4,874.0
YM-12	240	100,356.5	49,788.4	5,073.6
YM-13	280	101,099.2	49,909.0	4,810.1
YM-14	160	100,110.1	49,780.1	5,050.5
YM-15	350	100,581.8	49,765.5	5,036.8
YM-16	150	100,383.9	50,017.0	5,057.1
YM-17	450	100,458.2	49,405.8	5,017.2
YM-18	250	100,637.8	50,002.4	4,990.8
YM-19	300	100,769.4	49,894.2	4,973.5
YM-20	200	100,136.5	50,065.9	5,074.7
YM-21	200	101,062.1	50,094.4	4,806.2
YM-22	380	100,172.6	49,027.2	4,884.0
YM-23	140	100,027.2	49,165.2	4,860.9
YM-24	150	100,062.9	49,349.4	4,893.5
YM-25	155	100,063.1	49,533.7	4,947.3
YM-26	450	100,427.5	49,139.4	4,911.0
YM-27	440	100,923.0	49,436.3	4,835.4
YM-28	350	100,959.3	49,648.0	4,817.0
YM-29	280	100,118.7	48,832.5	4,858.6
YM-30	315	100,331.8	49,022.5	4,894.1
YM-31	450	100,684.2	49,253.6	4,918.6
YM-32	260	100,873.5	49,960.0	4,920.2
YM-33	410	100,629.8	49,440.8	4,969.7
YM-34	150	101,468.1	49,898.0	4,671.9
YM-35	100	101,181.8	50,199.4	4,729.8

(Continued)

YARNELL PROJECT - Table 5. Yarnell Drill Hole - Survey Data (Continued)

ROTARY DRILL HOLE NUMBER	DEPTH FEET	COORDINATES NORTH	COORDINATES EAST	ELEVATION
YM-36	180	101,319.7	50,064.8	4,705.2
YM-37	240	100,178.0	49,314.9	4,925.1
YM-38	360	100,374.7	49,312.5	4,983.9
YM-39	360	100,587.8	49,594.9	5,010.7
YM-40	400	100,501.3	49,506.1	5,024.4
YM-41	460	100,564.3	49,330.1	4,978.4
YM-42	410	100,760.1	49,454.9	4,909.6
YM-43	140	100,793.2	50,066.0	4,907.9
YM-44	310	100,850.2	49,780.1	4,910.5
YM-45	120	100,551.4	50,110.8	4,980.4
YM-46	300	100,057.8	48,921.0	4,883.5
YM-47	320	100,104.5	49,097.3	4,873.4
YM-48	220	99,681.3	48,754.2	4,776.6
YM-49	220	99,853.3	48,847.1	4,827.6
YM-50	85	99,861.6	49,155.5	4,818.2
YM-51	240	99,994.7	48,694.1	4,789.0
YM-52	200	99,996.4	49,214.3	4,854.5
YM-53	150	99,916.2	49,077.7	4,844.7
YM-54	340	100,413.6	49,704.6	5,060.0
YM-55	220	100,391.2	49,885.2	5,073.8
YM-56	180	100,324.7	49,962.1	5,078.2
YM-57	120	100,254.5	50,021.2	5,090.1
YM-58	90	100,323.3	50,088.3	5,055.3
YM-59	180	100,517.2	50,020.0	5,019.0
YM-60	110	100,467.5	50,107.5	5,009.9
YM-61	250	100,564.3	49,899.7	5,036.1
YM-62	320	100,361.3	49,612.9	5,039.5
YM-63	240	100,306.6	49,701.4	5,045.0
YM-64	200	100,188.0	49,738.1	5,041.5
YM-65	135	99,551.4	48,903.2	4,765.6
YM-66	60	99,378.5	48,923.0	4,764.5
YM-67	90	99,597.7	48,811.0	4,776.5
YM-68	130	99,789.8	49,232.8	4,848.5
YM-69	400	100,371.2	49,213.1	4,951.2
YM-70	190	100,258.4	49,792.7	5,058.4
YM-71	160	100,129.8	49,664.8	5,010.7
YM-72	150	100,016.3	49,691.4	5,008.8
YM-73	90	99,972.5	49,569.8	4,947.4
YM-74	160	99,982.5	49,463.8	4,899.1
YM-75	220	100,096.1	49,233.7	4,880.3
YM-76	175	100,116.0	49,610.1	4,989.5
YM-77	215	100,175.7	49,536.7	4,982.1
YM-78	350	100,309.6	49,381.9	4,985.8
YM-79	220	100,327.0	49,857.7	5,076.2
YM-80	320	100,475.4	49,755.9	5,067.1
YM-81	170	100,165.3	49,829.4	5,067.4

YARNELL PROJECT - Table 5. Yarnell Drill Hole - Survey Data (Continued)

ROTARY DRILL HOLE NUMBER	DEPTH FEET	COORDINATES NORTH	COORDINATES EAST	ELEVATION
YM-82	140	100,217.1	49,927.8	5,091.9
YM-83	285	100,419.1	49,805.2	5,072.6
YM-84	200	100,449.6	49,950.0	5,051.8
YM-85	100	100,483.6	50,401.7	4,975.9
YM-86	155	100,636.9	50,574.2	5,010.2
YM-87	380	100,477.2	49,270.8	4,977.5
YM-88	400	100,365.6	49,438.8	5,012.3
YM-89	390	100,332.0	49,532.8	5.016.6
YM-90	320	100,292.0	49,620.8	5,027.0
YM-91	155	100,257.2	49,559.2	5,003.3
YM-92	160	100,040.8	49,620.6	4,984.9
YM-93	100	99,929.2	49,309.7	4,855.0
YM-94	195	100,137.6	49,436.6	4,939.9
YM-95	420	100,526.5	48,764.8	4,822.1
YM-96	575	101,187.1	49,017.0	4,846.3
Subtotal	24,367			

DIAMOND DRILL HOLES

DRILL HOLE NUMBER	DEPTH FEET	COORDINATES NORTH	COORDINATES EAST	ELEVATION
YDDH-1	350	100,715.1	49,740.7	4,956.8
YDDH-2	400	100,507.1	49,510.8	5,024.3
YDDH-3	325	100,316.1	49,723.0	5,045.4
YDDH-4	220	100,100.8	49,224.2	4,879.9
Subtotal	1,295			
GRAND TOTAL	25,662			

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Table 6. List of "Wet" Drill Holes

Hole No. YM-	Below Base of Main Zone	At or within 10' of Base of Main Zone	Above Base of Main Zone	Relation to downdip extent of geological pit reserve edge.
33		X		Inside pit
41	X			" "
87	X			" "
26	X			" "
47	X			" "
42	X			Near pit edge
31			X	" " "
30			X	" " "
22		X		" " "
29			X	" " "
51			X	" " "
34			X	Far outside pit edge
36			X	" " " "
13		X		" " " "
28		X		" " " "
27			X	" " " "
96			X	" " " "
95			X	" " " "

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Table 7. Triad Assay Values Returned on Asarco Standards

Standard *	Hole Sequence	Number of Samples	Assay Returned, opt Gold High	Low	Average
A	1-9	8	0.026	0.014	0.01825
A	10-36	33	0.035	0.004	0.02388
A	37-64	48	0.033	0.004	0.02156
A	65-96**	43**	0.025	0.004	0.01993
B	1-9	20	0.015	<0.001	0.00555
B	10-36	41	0.014	<0.001	0.00654
B	37-64	42	0.022	0.004	0.00779
B	65-96**	58**	0.020	0.005	0.00738

*Standard A, 0.022 ±0.001 opt gold
*Standard B, 0.006 ±0.0003 opt gold.
**Drill Hole 65 thru 96 used rejects of standards used for previous holes as listed below.

Standard *	Hole Sequence	Number of Samples	Assay Returned, opt Gold High	Low	Average
1st Rerun					
A	1-9	2	0.022	0.015	0.01850
A	10-36	13	0.022	0.004	0.01838
A	37-64	21	0.025	0.016	0.02195
2nd Rerun					
A	1-9	1	0.020	--	0.02000
A	10-36	--	--	--	--
A	37-64	5	0.023	0.019	0.02140
3rd Rerun					
A	1-9	--	--	--	--
A	10-36	--	--	--	--
A	37-64	1	--	0.014	0.014.00
		43**			

(Continued)

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Table 7. Triad Assay Values Returned on Asarco Standards (Continued)

Standard *	Hole Sequence	Number of Samples	Assay Returned, opt Gold High	Low	Average
1st Rerun					
B	1-9	1	0.008	--	0.00800
B	10-36	14	0.008	0.005	0.00693
B	37-64	19	0.020	0.005	0.00800
2nd Rerun					
B	1-9	1	0.006	--	0.00600
B	10-36	8	0.009	0.006	0.00713
B	37-64	12	0.009	0.006	0.00750
3rd Rerun					
B	1-9	--	--	--	--
B	10-36	1	0.007	--	0.00700
B	37-64	2	0.008	0.007	0.00750
		58**			

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Table 8. Original Assay vs. New Reject Assay and Refire Assay

Original Hole # (New Hole #)	Original Hole Assay	New Reject Assay	Refine New Reject Assay
YM-3 (1J)	.058	.058	.061
YM-5 (1A)	.033	.032	.032
YM-7 (1B)	.047	.055	.052
YM-8 (1C)	.041	.057	.055
YM-12 (1D)	.036	.045	.037
YM-20 (1E)	.070	.088	.076
YM-24 (1F)	.093	.121	.113
YM-40 (1G)	.062	.066	.059
YM-50	.064	.062	--
YM-56	.082	.077	--

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Table 9. Multiple Assays, Same Pulp, YM-55

Footage	Orig. Assay	Multiple Assay Splits Same Pulp				Avg.	Std. Dev.	95% of values should fall between high & low	
90-95	.015	.018	.016	.019	.022	.018	.003	.021	.015
95-100	.021	.023	--	--	--	.022	.001	.023	.021
110-115	.046	.063	.046	.044	--	.050	.010	.060	.040
125-130	.008	.011	.010	.012	.008	.010	.004	.014	.006
130-140	.142	.146	.131	.145	--	.141	.012	.153	.129

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Table 10. Assay Checks: Triad vs. Skyline
Values in oz/ton Gold

Triad	Skyline	Triad	Skyline	Triad	Skyline	Triad	Skyline
.000 to .020		.021 to .060		.061 to .080		.081 plus	
.004	<.002	.021	.028	.061	.065	.083	.070
.007	<.002	.023	.008	.061	.075	.093	.016
.007	<.002	.023	.012	.062	.070	.093	.095
.009	.010	.023	.030	.072	.075	.094	.105
.010	.020	.025	<.002	.076	.050	.095	.105
.011	.006	.025	.014	.078	.165	.099	.130
.011	.010	.026	.022			.101	.110
.011	.010	.027	.032			.111	.085
.012	.010	.027	.038			.114	.125
.012	.014	.031	.026			.116	.115
.013	.012	.031	.030			.121	.170
.013	.012	.032	.026			.132	.065
.013	.014	.032	.030			.149	.240
.014	.020	.032	.040			.229	.270
.015	.016	.033	.022			.297	.290
.015	.030	.033	.040			.331	.295
.017	.010	.034	.032				
.017	.020	.035	.036				
.018	.024	.036	.016				
.018	.046	.036	.030				
.019	<.002	.036	.040				
.019	.020	.038	.060				
.019	.020	.039	.042				
		.042	.034				
		.044	.044				
		.045	.055				
		.046	.050				
		.046	.055				
		.053	.055				
		.059	.060				
# of Samples 23	23	30	30	6	6	16	16
Average .013	.014	.034	.034	.068	.083*	.141	.143

Total Samples: 75
Triad Average: 0.053 opt Au
Skyline Average: 0.055 opt Au

*Dropping the high .165 value recalculates to .067 average.

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Table 11. Mineral Zone Interval Tabulation
With next assay above zone and next sample below zone.

Drill Hole YM-	Zone*	Last Assay Above	First Assay B Zone	Feet From	Feet To	Feet Footage	Last Assay B Zone	Head Assay Below	Grade (opt Au)
1	A			5	55	50			0.025
1	B	.014/.025		55	125	70	.062/.011		0.053, incl. 20' stope
2	A			45	140	95			0.017
2	B	.009/.076		140	245	105	.027/.002		0.049, incl. 40' stope
3	A			20	130	110			0.011
3	B	.013/.021		130	200	70	.129/.016		0.063, incl. 8' stope
4	A			15	230	175			0.013,40'low grade gap
4	B	.009/.016		285	310	25	.026/.007		0.037
5	A			150	200	50			0.005
5	B	.001/.029		200	355	155	.052/.006		0.041, incl. 35' stope
6	B	.012/.069		135	180	45	.155/.017		0.049
7	B	.007/.024		155	230	75	.022/.013		0.047 incl. 5' stope
8	A			30	225	195			0.022
8	B	.004/.047		225	275	50	.037/.004		0.041
9**	B	.006/.012		275	315	40	.020/.006		0.035
10	A			130	200	70			0.021
10	B	.015/.058		200	225	25	.041/.005		0.034
11	B	.015/.045		190	240	50	.103/.009		0.058
12	A			40	155	115			0.013
12	B	.013/.068		155	240	85	.030/***		0.041, incl. 15' stope

(Continued)

YARNELL PROJECT - Table 11. Mineral Zone Interval Tabulation (Continued)

Drill Hole YM-	Zone*	Last Assay Above	First Assay B Zone	Feet From	Feet To	Feet Footage	Last Assay B Zone	Next Assay Below	Grade (opt Au)
13**	B	.006/.021		180	210	30	.019/.004		0.022
14	B	.008/.038		15	90	75	.022/.010		0.040
15	A			25	140	115			0.015
15	B	.003/.132		140	295	155	.022/.008		0.034
16	A			0	40	40			0.017
16	B	.014/.036		40	80	40	.053/.007 after stope		0.039, incl. 5' stope
17	A			210	285	75			0.015
17	B	.007/.076		285	325	40	.020/.006		0.047
18	A			0	100	100			0.022
18	B	.013/.058		100	140	40	.028/.012		0.078
19	A			10	85	75			0.015
19	B	.005/.015		205	235	30	.083/.007		0.058
20	B	Surf./.044		0	35	35	.024/.004		0.070
21**	A			25	55	30			0.019
21**	B	.004/.034		80	90	10	.032/.001		0.033
22**	A			215	225	10			0.036
22**	B	.003/.032		270	285	15	.036/.005		0.025
23	B	.008/.116		40	125	85	.087/.006		0.047
24	B	.005/stope		65	115	50	.029/.006		0.093, incl. 10' stope
25	B	.002/.029		55	90	35	.058/.011		0.070
26	B	.003/.027		200	290	90	.051/.015		0.054
27**	A			35	265	90			0.015, 140' gap
27**	B	.007/.034		300	315	15	.028/.003		0.033
28**	A			95	225	130			0.022
28**	B	.006/.043		225	245	20	.049/.002		0.042
29**	B	.008/.046		220	230	10	.019/.008		0.033
30**	A			170	200	30			0.012
30**	B	.002/.030		215	250	35	.041/.009		0.032

YARNELL PROJECT - Table 11. Mineral Zone Interval Tabulation (Continued)

Drill Hole YM-	Zone*	Last Assay Above	First Assay B Zone	Feet From	Feet To	Feet Footage	Last Assay B Zone	Next Assay Below	Grade (opt Au)
31**	A			115	135	20			0.017
31**	B	.008/.093		365	385	20	.015/.005		0.055
32**	A			0	190	155			0.012, 35' gap
32**	B	.007/.027		190	200	10	.026/.001		0.027
33	A			15	55	40			0.015
33	B	.015/.074		280	365	85	.061/.008		0.053
34**	A			110	130	20			0.013
34**	B	Not reached -projected from other holes.							
34**	B			240	250	10			0.025
35	B	.004/.017		15	40	25	.016/.001		0.010
36**	A			35	55	20			0.023
36**	B	.013/.036		130	140	10	.059/.004		0.048
37	B	.007/.034		120	180	60	.030/.005		0.036
38	B	.009/.045		185	220	35	.024/.007		0.028
		Note: If no fault in area, then above may be "A" Zone.							
39	A			0	325	75			0.024, 250' gap
39	B	.004/.071		325	360	35	.062/***		0.048
40	A			20	80	60			0.014
40	B	.005/.023		275	380	105	.018/.005		0.062
41	B	.015/.054		300	335	35	.032/.004		0.050
42**	B	.003/.077		330	340	10	.035/.004		0.056
43	B	.001/.028		65	85	20	.032/.003		0.063
44**	A			115	235	120			0.024
44**	B	.009/.036		235	265	30	.191/.009		0.143
45	B	.001/.106		60	75	15	.041/.007		0.084
46**	B	.002/.010		200	260	60	.018/.008		0.012
47	A			120	170	50			0.014
47	B	.011/.041		170	205	35	.017/.010		0.031
48	B	.007/.045		45	85	40	.043/.004		0.049

YARNELL PROJECT - Table 11. Mineral Zone Interval Tabulation (Continued)

Drill Hole YM-	Zone*	Last Assay Above	First Assay B Zone	Feet From	Feet To	Feet Footage	Last Assay B Zone	Next Assay Below	Grade (opt Au)
49	B	.018/.048		140	160	20	.054/.013		0.049
50	B	Surf./.053		0	85	85	.173/***		0.059
51**	B	.001/.061		165	170	5	.061/.002		0.061
52	B	.003/.012		50	75	25	.015/.012		0.049
53	B	.007/.039		65	140	75	.031/.003		0.036
54	A			55	125	70			0.015
54	B	.012/.042		180	270	90	.021/.001		0.054
55	A			0	70	70			0.011
55	B	.013/.025		70	165	95	stope/.015		0.050, incl. 15' stope
56	A			0	45	45			0.012
56	B	.005/.083		70	105	35	.095/.015		0.082
57	A			0	15	15			0.011
57	B	.009/.027		15	60	45	Stope/.018		0.035, incl. 13' stope
58	B	Surf./.040		0	20	20	.018/.009		0.034
59	B	.004/.041		50	100	50	.025/.003		0.032
60**	In Footwall			-	-	-	-		-
61	B	.011/.087		80	200	120	.021/.002		0.037, incl. 15' stope
62	A			115	190	75			0.015
62	B	.003/.056		190	295	105	.043/.003		0.040, incl. 40' stope
63	A			10	140	120			0.011
63	B	.011/.073		140	240	100	.071/***		0.081
64	A			50	110	60			0.025
64	B	.014/.159		110	140	30	.038/.016		0.059
65	B	Surf./.091		0	50	50	.057/.005		0.049
66**	In Footwall			-	-	-	-		-

YARNELL PROJECT - Table 11. Mineral Zone Interval Tabulation (Continued)

Drill Hole YM-	Zone*	Last Assay Above	First Assay B Zone	Feet From	Feet To	Feet Footage	Last Assay B Zone	Next Assay Below	Grade (opt Au)
67	B	.013/.062		5	50	45	.044/.008		0.052
68**	In Footwall			-	-	-	-		-
69	A			185	250	65			0.011
69	B	.044/.077		250	280	30	.032/.012		0.069
70	A			60	95	35			0.011
70	B	.006/.041		95	135	40	.045/.007		0.031
71	B	.011/.085		45	110	65	.052/.011		0.131
72	B	Surf./.029		0	35	35	.143/.007		0.084
73	B	Surf./.087		0	20	20	.048/.008		0.190
74	In Footwall			-	-	-	-		-
75	A			65	85	20			0.016
75	B	.010/.026		85	170	85	.045/.010		0.058
76	A			0	75	75			0.012
76	B	.012/stope		75	110	35	.022/.015		0.039, incl. 15' stope
77	A			70	95	25			0.016
77	B	.016/.038		95	180	85	.117/.007		0.045, incl. 13' stope
78	A			130	215	85			0.011
78	B	.004/.125		215	270	55	.068/.011		0.070
79	A			10	120	110			0.019
79	B	.011/.027		120	170	50	.041/.008		0.046
80	A			140	230	90			0.023
80	B	.014/.028		230	280	50	.023/.014		0.040
81	A			5	55	50			0.015
81	B	.002/.119		55	90	35	.019/.013		0.066
82	A			0	35	35			0.015
82	B	.013/.029		35	95	60	.028/.009		0.049
83	A			0	140	140			0.014
83	B	.006/.088		140	240	100	.028/.004		0.044, incl 20' stope

YARNELL PROJECT - Table 11. Mineral Zone Interval Tabulation (Continued)

Drill Hole YM-	Zone*	Last Assay Above	First Assay B Zone	Feet From	Feet To	Feet Footage	Last Assay B Zone	Next Assay Below	Grade (opt Au)
84	A			10	105	95			0.017
84	B	.010/.019		105	140	35	.059/.011		0.062
85**	In Footwall			-	-	-	-		-
86**	B ?	.007/.016		50	70	20	.012/.006		0.013
87	A			245	285	40			0.010
87	B	.003/.086		285	305	20	.034/.010		0.050
88	A			180	240	60			0.020
88	B	.004/.023		240	295	55	.041/.008		0.064
89	A			40	180	140			0.010
89	B	.007/.032		180	270	90	.089/.017		0.051
89	Subzone			270	340	70			0.016
90	A			10	120	110			0.012
90	B	.009/.022		120	215	95	.077/.001		0.062
90	Subzone			215	235	20			0.019
91	A			10	95	85			0.010
91	B	Hole lost in Stope - projected from other holes.							
91	B	.007/.030		95	180	85	-		0.051
92	B	.003/.031		35	55	20	.032/.009		0.072
93	B	.013/.036		5	25	20	.051/.018		0.064
94	B	.006/.028		105	155	50	.023/.005		0.086, incl. 30' stope
95**	B	.006/.018		385	395	10	.011/.002		0.015
96**	B	.005/.061		570	575	5	.061/***		0.061

* Zone A - Upper low-grade Zone.
* Zone B - Main Yarnell Fault Zone and envelope.
** Hole not in drill indicated reserve.
*** Hole terminated in "ore" grade assay.

YARNELL PROJECT

Yavapai County, Arizona

Table 12, B Zone Assay Comparison, DDH vs. RDH

Drill Hole Pair	Thickness Feet	Composite Assay, opt Au	Recheck of Rotary Pulps, opt Au
YDDH-1	50	0.041	
YM-8	50	0.041	0.045
YDDH-2	105	0.070	
YM-40	105	0.062	0.066/0.080
	54		
YDDH-3*	27/stope/19	.036/stope/.047	
YM-63**	25/55/20	.054/.098/.045	.047/.112/.027
YDDH-4	85	0.066	
YM-75	85	0.058	0.068

*YDDH-3 intercepted stope from 167 to 221 feet.

**YM-63 intercepted the stope pillar, and later terminated in ore grade values.

YARNELL PROJECT

Yavapai County, Arizona

Table 13. Comparison of CN Results based on Assay of Interval

Hole Number	Triad Orig. Assay	Skyline Head	Skyline Check	Metcon Calculated Head Assay	CN %Recovery, Au	
47	.031	.020		.036	72	
15	.034	.028		.037	78	
53	.036	.034		.044	77	
					Sub-average	76
14	.040	.036		.051	81	
6	.042	.075	.042	.060	66	
8	.042	.055		.074	76	
79	.046	.032	.050	.056	61	
48	.049	.036		.045	78	
49	.049	.034		.039	69	
82	.049	.040		.052	65	
					Sub-average	71
87	.050	.036		.068	65	
33	.051	.050		.055	60	
54	.054	.055		.068	68	
					Sub-average	64
40	.062	.060		.074	67	
84	.062	.120	.067	.073	70	
90	.062	.055		.053	66	
43	.063	.055	.047	.066	88	
88	.064	.085		.086	74	
93	.064	.065		.075	79	
75	.066	.055		.065	81	
					Sub-average	75
25	.070	.065		.067	64	
18	.078	.080		.071	89	
63	.081	.046	.070	.077	71	
71	.131	.120	.127	.141	83	
					Sub-average	77
Weighted Average	.057	.054		.063		
					Overall average	73

YARNELL PROJECT

Yavapai County, Arizona

Table 14 - M.A. Miller's Revised "B" Zone Values

Using 12.0 ft.^{3}/ton factor

Triangle No.	Volume ft.^{3}	Thickness ft.	Tons	Grade oz/ton	Recalc. Grade	Recalc. Ton-oz.
1	87,375	23.3	7,281	0.037	--	269.397
2	208,250	35.0	17,354	0.057	--	989.178
3	382,500	30.0	31,875	0.068	--	2167.500
4	117,600	20.0	9,800	0.037	.043	421.400
5	182,250	30.0	15,188	0.035	.039	592.332
6	189,810	33.3	15,818	0.047	.056	885.808
7	149,184	33.3	12,432	0.051	.065	808.080
8	119,699	31.7	9,975	0.054	.057	568.575
9	232,187	56.7	19,349	0.054	.060	1160.940
10	221,130	56.7	18,428	0.050	.056	1031.968
11	191,403	41.7	15,950	0.043	.045	717.750
12	280,292	63.3	23,358	0.047	.051	1191.258
13	308,424	78.3	25,702	0.051	.057	1465.014
14	505,084	91.7	42,090	0.041	.046	1936.140
15	486,850	70.0	40,571	0.044	.048	1947.408
16	681,298	63.3	56,775	0.049	.053	3009.075
17	989,495	66.7	82,458	0.041	.045	3710.610
18	298,880	46.7	24,907	0.050	.053	1320.071
19	169,070	58.3	14,089	0.047	.055	774.895
20	255,500	50.0	21,292	0.054	.062	1320.104
21	190,515	51.7	15,876	0.057	.061	968.436
22	205,920	60.0	17,160	0.055	.062	1063.920
23	211,723	78.3	17,644	0.045	--	917.488
24	256,880	95.0	21,407	0.044	--	1134.571
25	373,700	100.0	31,142	0.048	--	1712.810
26	290,105	85.0	24,175	0.045	--	1257.100
27	280,740	93.3	23,395	0.046	--	1216.540
28	232,000	80.0	19,333	0.047	--	985.983
29	667,076	126.7	55,590	0.039	.043	2390.370
30	994,194	108.3	82,850	0.036	.039	3231.150
31	557,304	103.3	46,442	0.040	.042	1950.564
32	339,398	76.7	28,283	0.036	--	1018.188
33	180,290	55.0	15,024	0.047	--	706.128
34	490,428	71.7	40,869	0.037	--	1512.153

(Continued)

YARNELL PROJECT - Table 14 M.A. Miller's Revised "B" Zone Values (Continued)

Triangle No.	Volume ft.^{3}	Thickness ft.	Tons	Grade oz/ton	Recalc. Grade	Recalc. Ton-oz.
35	856,800	80.0	71,400	0.038	--	2713.200
36	188,100	55.0	15,675	0.054	.059	924.825
37	188,370	48.3	15,698	0.050	.055	863.390
38	154,837	53.3	12,903	0.045	.050	645.150
39	205,800	60.0	17,150	0.039	.044	754.600
40	331,840	76.7	27,650	0.056	.060	1659.000
41	438,510	93.3	36,543	0.059	.062	2265.666
42	474,789	98.3	39,566	0.058	.062	2453.092
43	551,291	116.7	45,941	0.044	.049	2251.109
44	535,500	90.0	44,625	0.045	.049	2186.625
45	532,950	95.0	44,413	0.048	.052	2309.476
46	402,050	55.0	33,504	0.055	--	1842.720
47	674,960	76.7	56,247	0.056	--	3149.832
48	728,660	78.3	60,722	0.055	--	3339.710
49	144,417	48.3	12,035	0.049	--	589.715
50	137,625	36.7	11,469	0.049	--	561.981
51	238,000	50.0	19,833	0.051	.053	1051.149
52	414,426	71.7	34,536	0.064	.065	2244.840
53	258,750	90.0	21,563	0.068	.070	1509.410
54	278,30	100.0	23,192	0.061	.064	1482.288
55	211,565	85.0	17,630	0.058	.063	110.690
56	233,700	95.0	19,475	0.051	.056	1090.600
57	324,684	93.3	27,057	0.047	.050	1352.850
58	436,458	116.7	36,372	0.043	.049	1782.228
59	547,500	100.0	45,625	0.048	.052	2372.500
60	639,450	105.0	53,288	0.052	.055	2930.840
61	350,175	66.7	298,181	0.060	--	17890.860
62	434,985	61.7	36,249	0.055	--	1993.695
63	371,371	58.3	30,948	0.083	--	2568.684
64	242,820	58.3	20,235	0.076	--	1537.860
65	153,643	46.7	12,804	0.092	.098	1254.792
66	263,749	58.3	21,979	0.085	.087	1912.173
67	340,303	71.0	28,359	0.078	.082	2325.438
68	124,115	59.3	10,343	0.075	.084	868.812
69	245,532	77.7	20,461	0.053	.060	1227.660
70	272,727	77.7	22,727	0.049	.053	1204.531
71	265,560	83.3	21,130	0.050	.051	1077.630
72	352,207	73.3	29,351	0.054	.055	1614.305
73	237,786	66.7	19,815	0.060	--	1188.900
74	181,125	48.3	15,094	0.058	--	875.452
75	243,563	43.3	20,297	0.049	--	994.553
76	213,553	33.3	17,796	0.047	--	836.412
77	205,416	31.7	17,118	0.041	--	701.838
78	145,745	28.3	12,145	0.048	--	582.960
79A	93,375	25.0	7,781	0.103	--	801.443
79B	81,250	25.0	6,771	0.109	--	738.039
80A	95,924	31.7	7,994	0.055	.065	519.610
80B	79,123	31.7	6,594	0.060	.071	468.174

YARNELL PROJECT - Table 14 M.A. Miller's Revised "B" Zone Values (Continued)

Triangle No.	Volume ft.^{3}	Thickness ft.	Tons	Grade oz/ton	Recalc. Grade	Recalc. Ton-oz.
81	85,973	18.3	7,164	0.114	--	816.696
82	206,123	49.3	17,177	0.049	.061	1047.797
83M.	311,355	45.0	25,946	0.084	.085	2205.410
84	209,420	28.3	17,452	0.084	.084	1465.968
86M.	319,800	53.3	26,650	0.069	.070	1865.500
87M.	294,962	52.7	24,580	0.065	.069	1696.020
88	643,243	69.3	53,604	0.044	.049	2626.596
90M.	277,611	61.0	23,134	0.054	.059	1364.906
91	478,865	63.3	39,905	0.048	.052	2075.060
92	297,675	56.7	24,806	0.049	--	1215.494
93	200,445	48.3	16,704	0.049	--	818.496
94	192,000	40.0	16,000	0.045	--	720.000
95	349,800	58.3	29,150	0.063	.064	1865.600
96	313,031	53.3	26,086	0.047	--	1226.042
97	362,500	50.0	30,208	0.037	--	1117.696
98	360,000	40.0	30,000	0.045	--	1350.000
99	366,751	26.7	30,563	0.043	--	1314.209
100M.	39,000	30.0	3,250	0.069	--	224.250
101	215,129	23.3	17,927	0.085	--	1523.795
102	247,260	31.7	20,605	0.075	.076	1545.375
103	280,200	46.7	23,350	0.073	--	1704.550
104	157,643	58.3	13,137	0.054	--	709.398
105	315,040	61.7	26,253	0.051	--	1338.903
106	235,980	45.0	19,665	0.047	--	924.255
107	143,623	28.3	11,969	0.029	--	347.101
108M.	181,125	22.5	15,094	0.054	--	815.076
109	363,720	43.3	30,310	0.058	--	1757.980
110	431,653	61.7	35,971	0.048	--	1726.608
111	245,258	61.7	20,438	0.043	--	878.834
112	672,975	75.0	56,081	0.044	--	2467.564
113	502,238	61.7	41,853	0.045	--	1883.385
114M.	210,000	50.0	17,500	0.043	--	752.500
118	1,188,594	66.7	99,050	0.048	--	4754.400
119	765,000	45.0	63,750	0.042	--	2677.500
120	665,184	53.3	55,432	0.043	--	2383.576
121	415,911	48.3	34,659	0.034	--	1178.406
122M.	91,000	20.0	7,583	0.049	--	371.567
124	1,282,600	58.3	106,883	0.054	--	5771.682
127M.	388,890	30.0	32,408	0.049	--	1587.992
128	279,000	25.0	23,250	0.075	--	1743.750
129M.	125,000	25.0	10,417	0.060	--	625.020
135M.	77,520	40.0	6,460	0.057	--	368.220
136	468,000	40.0	39,000	0.065	--	2535.000
137	513,827	41.7	42,819	0.041	--	1755.579
138	607,200	55.0	50,600	0.046	--	2327.600
144	507,400	40.0	42,283	0.052	--	2198.716
145M.	118,300	65.0	9,858	0.049	--	483.042
146M.	89,250	30.0	7,438	0.050	--	371.900

YARNELL PROJECT - Table 14 M.A. Miller's Revised "B" Zone Values (Continued)

Triangle No.	Volume ft.^{3}	Thickness ft.	Tons	Grade oz/ton	Recalc. Grade	Recalc. Ton-oz.
147M.	54,000	20.0	4,500	0.050	--	225.000
148	258,251	46.7	21,521	0.057	--	1226.697
149	92,364	56.7	7,697	0.049	--	377.153
150	751,162	56.7	62,597	0.049	--	3067.253
151M.	92,000	20.0	7,667	0.064	--	490.688
152M.	321,563	52.5	26,797	0.060	--	1607.820
153M.	813,484	68.0	67,790	0.055	--	3728.450
154M.	580,000	50.0	48,333	0.049	--	2368.317
156M.	172,500	50.0	14,375	0.049	--	704.375
162M.	389,034	18.0	32,420	0.072	--	2334.240
163M.	97,650	17.5	8,139	0.063	--	512.757
165M.	36,000	8.0	3,000	0.084	--	252.000
166M.	852,600	42.0	71,050	0.049	--	3481.450
167M.	693,000	42.0	57,750	0.053	--	3060.750
168M.	362,250	23.0	30,188	0.059	--	1781.092
169M.	2,835,000	45.0	236,250	0.048	--	11340.000
170M.	400,125	27.5	33,344	0.057	--	1900.608

	Original 12/20/89	Recalculated 2/19/90
Tons	4,361,005	4,361,005
Grade, opt Au	.051	.057
Total Oz	223,912	247,960
Mined		**Mined**
Previously Mined	250,000	229,500
Grade, opt Au	.051	.096
Total Oz	12,750	22,032
Totals	**Remaining**	**Remaining**
Tons	4,111,005	4,131,505
Grade, opt Au	.051	.055
Oz	211,162	225,928

10/4/90

FROM: W. L. KURTZ

TO: J. D SELL

YARNELL REPORT

RE: YOUR COVER dated Sep 27, 1990 to Yarnell report.

Unless directed by Mr. Brown I am not going to comment on your report since it is an after-the-fact report that we had requested to be completed last March.

cc: R. L. Brown

1st Draft 11/15/90

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AGS Field Trip Guide

ABSTRACT

THE YARNELL DEPOSIT LOCATED IN THE WEAVER DISTRICT OF YAVAPAI CO, AZ IS A STRUCTURALLY CONTROLLED HYDROTHERMALLY ALTERED ZONE THAT HOSTS ECONOMIC GOLD MINERALIZATION. THE DEPOSIT IS HOSTED BY A PE GRANITE 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 IS ASSOC. W/ IRON OXIDES AND THE DEVELOPMENT OF QUARTZ VEINS AND QZ VEIN STOCKWORK. THE FOOTWALL OF THE YARNELL FAULT IS PHYLLICLY ALTERED BUT UNMINERALIZED WITH RESPECT TO GOLD. THE YARNELL FAULT ZONE (YFZ) CONTINUES BOTH NE & SW FROM THE MAIN DEPOSIT AND WHERE EXPOSED CONTAINS GOLD MINERALIZATION. HOWEVER, THE THICKNESS OF THE ZONE AND ASSOC. ALTERATION ENVELOPE DIMINISH AWAY FROM THE ORE BODY. NINTY-SIX R.C HOLES AND FOUR DDH OUTLINE A MINERAL INVENTORY OF 4.1 MT @ .055 opt Au. ESTIMATED RECOVERY BY COLUMN LEACHING EXCEEDS 70% IN ADDITION, T 2.7 MT @ .017 opt Au OCCUR IN A LOW GRADE ZONE ABOVE THE MAIN MINERALIZED ZONE.

LOCATION & HISTORY

THE YARNELL GOLD DEPOSIT IS LOCATED IN THE WEAVER MINING DISTRICT ON THE S.W SIDE of THE WEAVER MTNS, YAVAPAI Co, AZ. IT IS SITUATED VERY CLOSE TO THE DRAINAGE DIVIDE BETWEEN THE YARNELL PEOPLES VALLEY WATERSHED & THE CONGRESS VALLEY WATERSHED. U.S. HIGHWAY 89 IS WITHIN 300' FROM THE DOWN DIP EXTENT OF THE KNOWN ECONOMIC DEPOSIT. AND ACCESS IS YEAR ROUND. ELEVATIONS w/in THE DEPOSIT RANGE FROM 4650 to 5100 AND THE WEATHER IS CONDUCIVE FOR YEAR ROUND OPERATION.

HISTORICAL PRODUCTION FROM YARNELL WAS DERIVED FROM UNDERGROUND & LIMITED PRODUCTION FROM THE OPEN cut. WINSLOW MINING COMPANY OPERATED THE PROPERTY FROM 1939-1941 AND MINED THE MAJORITY of THE ESTIMATED 200,000T WHICH WAS THE TOTAL ESTIMATED PRODUCTION FROM THE PROPERTY. AVERAGE GRADE of THE ORE WAS REPORTED TO BE .2-.3 oz/T MINED EXCLUSIVELY FROM THE YARNELL FAULT ZONE. THE MINE CLOSED IN 1941 DUE TO L-208; THE FEDERAL GOLD MINE CLOSURE ORDER.

ASARCO'S INTEREST IN THE PROPERTY WAS INITIATED WHEN NORGOLD RESOURCES, A ~~[illegible]~~ R CANADIAN MINING COMPANY PUBLISHED THE RESULTS of ROCK CHIP SAMPLING THE IMPLIED WIDTH OF THE MINERALIZATION & RESULTANT GRADE SUGGESTED A BULK TONNAGE ~~TARGET~~ OPEN PIT TARGET. ASARCO EXAMINED & SAMPLED THE PROPERTY CONFIRMING NORGOLDS RESULTS. A LETTER AGREEMENT WAS SIGNED

w/ NORGOLD IN LATE JANUARY 1989. FOR AN EXPLORATION OPTION ON THE PROPERTY A MAPPING & DETAILED ROCK CHIP SAMPLING PROGRAM WAS completed @ WHICH TIME A NINE HOLE DRILL PROGRAM BEGAN. DRILLING RESULTS CONFIRMED THE BULK TONNAGE OPEN PIT POTENTIAL. THREE PHASES OF DRILLING WERE completed TOTALLING 96 R.C HOLES + 4 DIAMOND DRILL HOLES (TWINS TO THE R.C HOLES) WHICH completed THE DRILLING PROGRAM.

GEOLOGY

THE YARNELL GOLD DEPOSIT OCCURS w/IN A GRANITE/GRANODIORITE INTRUSIVE BODY INFORMALLY NAMED THE YARNELL GRANITE BY ANDERSON (1989) THE GRANITE INTRUDES A SEQUENCE OF META VOLCANICS AND META SEDIMENTARY ROCKS OF THE BRADSHAW MTNS GROUP. XENOLITHS & ROOF PENDANTS OF COUNTRY ROCK ARE COMMON w/IN THE GRANITE AND ~~are~~ PROBABLY ~~are~~ RESULTED ~~of~~ from "STOPING" and RAFTING AS THE GRANITE INTRUDED. A RECENTLY completed PHD DISSERTATION BY ANDERSON 1989 DESCRIBES THE YARNELL GRANITE AS FOLLOWS.

~~Batholith class.~~

~~To paraphrase~~ Anderson (1989):

"The Yarnell Granodiorite (new formal name), is a foliated, coarse-grained porphyritic granodiorite to monzogranite, ... The Yarnell Granodiorite follows the northwest edge of the Stanton-Octave metavolcanic-metasedimentary screen to as far north as Wilhoit, where dikes of unfoliated Yarnell Granodiorite intrude foliated granodiorite of the Wilhoit batholith ... The Yarnell Granodiorite is distinctly coarse-grained and weakly foliated, with large pinkish-tan K-feldspar phenocrysts in an equigranular matrix with biotite, plagioclase, uncommon hornblende, and abundant sphere ... Chemically the Yarnell body is metaluminous, high-K, calc-alkaline, high Fe-Ti and high-total alkali rock ..."

Anderson places the age of the Yarnell pluton in the 1730-1710 ma range.

DeWitt (1989) further states under the heading:

"Suite 4: Syn-to posttectonic biotite granodiorite to granite plutons: ... The granodiorite of Yarnell is equigranular to slightly porphyritic, alkali-calcic biotite granodiorite and is the westernmost foliated pluton in this study area ... although the pluton is undated, it is assumed to be 1700-1750 ma because of its foliated nature. L.T. Silver (personal communication, 1986) suggested on the basis of unpublished U-Pb zircon data that the

TABLE I COMPARES THREE SAMPLES of GRANODIORITE (DEWITT 1989) WITH SAMPLES TAKEN @ THE YARNELL MINE (MALUSA 1990) DEWITTS SAMPLE 72 WAS COLLECTED ABOUT ONE MILE NORTH of THE YARNELL MINE AREA; SAMPLE 73 ABOUT ONE MILE WEST AND SAMPLE 74 AT THE BASE of WEAVER MTN. MALUSA'S SAMPLES WERE COLLECTED IN THE FRESHEST GRANITE IN THE HANGING WALL AND FOOTWALL of THE YARNELL [redacted]

Table 1. Major Element Chemistry - Yarnell Pluton

Sample #	Granodiorite (De Witt) 72	73	74	Biotite Granite (Malusa) HW	FW
SiO_2	67.4	66.3	65.1	70.0	69.8
Al_2O_3	14.5	14.1	14.3	14.3	14.4
Fe_tO_3*	4.98	5.45	6.65	4.76	5.02
MgO	1.17	1.22	1.52	1.00	1.10
CaO	2.57	2.84	3.43	2.60	2.30
Na_2O	3.08	3.10	3.14	3.20	3.10
K_2O	4.18	4.33	3.78	4.10	3.90
TiO_2	0.80	0.79	1.02	0.70	0.85
P_2O_5	0.27	0.34	0.39	0.45	0.55
MnO	0.12	0.11	0.13	0.11	0.13
TOTAL	99.07	98.58	99.72	101.22	101.15

*Fe_tO_2, total iron as Fe_2O_3

STRUCTURE

THE PRINCIPAL FEATURE THAT LOCALIZES & CONTROLS ALTERATION & GOLD MINERALIZATION IS THE YARNELL FAULT ZONE (YFZ) A NE N30-50°E 30-50° NW DIPPING STRUCTURE WHOLLY CONTAINED IN THE YARNELL GRANITE WHICH IS COMPOSED OF STRONG GOUGE, MYLONITE, MICROBRECCIAS (TECTONICALLY DERIVED) QUARTZ VEINS (AND CHALCEDONIC REPLACEMENT) WITHIN A 1' → 6'+ ZONE.

There is ABUNDANT CLAY IN THE ZONE PROBABLY AS A RESULT OF THE FAULT GOUGE. A SAMPLE OF ILLITE FROM THE FAULT (CHAFEY 1990) GAVE AN AGE OF 65 my ± 10 my. THIS DATE SUGGESTS LARAMIDE STYLE TECTONICS (WHICH IMPLIES TO A COMPRESSIONAL EVENT (THRUSTING) AS OPPOSED TO A MIO TERTIARY EXTENSION (DETACHMENT)

THE FAULT HAS BEEN TRACED ~2 MILES → SW WHERE IT DISAPPEARS UNDER THE VALLEY ALLUVIUM. ~~THE NE EXTENSION IS LESS CERTAIN AS IT TRENDS INTO A THICK ALLUVIAL FILL CAPPED BY VOLCANIC FLOWS.~~

THE Y.F. CAN BE TRACED → NE 1500' FROM THE TOP OF YARNELL HILL BEFORE IT IS CONCEALED BY DEBRIS FROM THE VOLCANIC CAP AND VALLEY FILL w/ LARGE UNMINERALIZED GRANITE BOULDERS.

DIKES

THE YARNELL FAULT IS CUT BY AND PROXIMAL TO SEVERAL TYPES OF DIKES THAT ARE DIORITIC, ANDESITIC AND FELSIC IN COMPOSITION. DIORITE DIKES ARE FOUND IN BOTH THE HANGING WALL & FOOTWALL OF THE YARNELL FAULT. w/ THE MOST PROMINENT ~~AND~~ TREND N-NW. THE MOST PROMINENT DIKE TRENDS N10°W DIPPING 80°SW AND CUTS THE YARNELL FAULT. THIS DIKE DOES NOT OFFSET NOR IS IT OFFSET BY THE YARNELL FAULT. THE ANDESITIC + FELSIC DIKES ARE PROXIMAL TO THE YARNELL DEPOSIT AND APPEAR TO SUB PARALLEL THE YARNELL FAULT. THIS DIKES HAVE BEEN FOUND IN THE F-W OF THE STRUCTURE.

THE YARNELL PLUTON IS BORDERED ON THE SOUTHEAST BY A SEQUENCE OF MAFIC METAVOLCANICS AND META SEDIMENTARY ROCKS. MIO TERTIARY BASALTS & ANDESITES CAP THE HILLS + RIDGES NORTH & NORTHEAST OF THE DEPOSIT.

~~DRILLING RESULTS INDICATE THAT~~ THE SHEARED & CRUSHED ZONE OF THE YARNELL FAULT VARIES FROM 5 → 20' WITHIN THE DRILLED PART OF THE DEPOSIT. AS THE STRUCTURE IS FOLLOWED DOWNDIP + LATERALLY THE YARNELL FAULT THINS ~~TO~~ 2-5'. THE ALTERATION HALOS AND MINERALIZATION ALSO DIMINISH w/ THE ASSOCIATED THINNING OF THE YARNELL FAULT.

SUB PARALLEL TO THE YARNELL FAULT ARE NUMEROUS FRACTURES & SMALL FAULTS. THIS APPEAR TO "MIMIC" THE FAULT. THERE ARE ALSO SEVERAL NE TRENDING STRUCTURES THAT HAVE BEEN MAPPED ON THE SURFACE IN THE

HANGING WALL OF THE YARNELL STRUCTURE. THESE STRUCTURES APPEAR TO FLATTEN & "ROLL" IN THE UNDERGROUND EXPOSURES & MAY SOLE INTO THE YARNELL FAULT @ DEPTH. WHICH SUGGESTS A LISTRIC NATURE TO THESE STRUCTURES. THE FELSIC DIKES SUBPARALLEL THE YARNELL FAULT IN BOTH STRIKE & DIP AND SHOW SIMILAR BUT RESTRICTED ALTERATION & MINERALIZATION. WHICH MAY BE REFLECTING A "HALO" TO THE MAIN YARNELL DEPOSIT.

ALTERATION

ALTERATION AT THE YARNELL GOLD DEPOSIT VARIES FROM PROPYLITIC → POTASSIC. THE STRONGEST ALTERATION IS CENTERED ON THE YARNELL FAULT ZONE AND DECREASES OUTWARD IN INTENSITY INTO THE FOOTWALL + HANGING WALL.

THE PROPYLITIC ZONE IS CHARACTERIZED BY CHLORITE, EPIDOTE, MINOR CALCITE VEINING (IN THE UNOXIDIZED FW) w/ WEAK SERICITIC DUSTING & REPLACEMENT ALONG BIOTITE EDGES & ON FELDSPARS. IN THE HANGING WALL THE ~~THE PROPYLITIC~~ ZONE MAY EXTEND UP TO 100' BEYOND THE PHYLLIC ENVELOPE. IN THE FOOTWALL, THE PROPYLITIC ZONE IS THINNER AND IS USUALLY MARKED BY CALCITE GASH VEINS.

PHYLLIC ZONE - SERICITE IS WIDELY & PERVASIVELY DEVELOPED W/IN THIS ZONE. BIOTITE and PLAGIOCLASE IS COMPLETELY REPLACED BY SERICITE (HYMER, MILLS) TABLE: SECONDARY IRON OXIDES AS LIMONITE, GOETHITE, HEMATITE AND LEUCOXENE CHARACTERIZE THE OXIDIZED PORTION OF THIS ZONE. THE UNOXIDIZED PORTION IS CHARACTERIZED BY EXTENSIVE

SILICA FLOODING + SERICITE REPLACEMENT, WHICH GIVES THE ROCK A DISTINCTLY "GREEN" COLOR. THE PHYLLIC ZONE EXTENDS THIRTY TO ONE HUNDRED, 50+ FEET INTO THE H.W ABOVE THE POTASSIC ZONE & 10-95' ~~BELOW~~ INTO THE FOOTWALL.

POTASSIC ZONE - ALTERATION IS STRONGEST W/IN THE ~~FARNHOLL~~ FAULT ZONE. ABUNDANT SECONDARY QUARTZ, CHALCEDONY, ADULARIA AND CLAY IS OCCURS W/IN A HIGHLY CRUSHED YFZ (HANDY, MILLER) ~~RECENT~~ X-RAY DIFFRACTION STUDIES BY WALLUSA (1990) ON THE CLAY SIZE FRACTION IMPLY THE MATERIAL IS ~~[illegible]~~ FINE GRAINED ~~SERIC~~ SERICITE (ILLITE). A POTASSIC ZONE OUTWARD FROM THE CRUSHED FAULT ZONE IS DEFINED BY ADULARIA, OCCURING AS PHENOCRYSTS AND SELVEGES to THE QUARTZ VEINS. POTASSIC ALTERATION ~~[illegible]~~ IS NOTED 50-80' ABOVE THE FAULT ~~[illegible]~~ AND 25 FEET BELOW.

Mineralization & Occurrence

Gold mineralization is associated with several stages of quartz, iron sulfides and oxides. (Pyrite, specularite) Base metal sulfides have been seen in polished section and implied from trace element geochemistry. Copper minerals (azurite, malachite) is associated w/ quartz/~~veins~~ hematite veins in the underground workings

Gangue Minerals:

Quartz- Quartz occurs associated w/ the Yarrell Fault as discrete veins and quartz stockwork. Quartz veins also occur in sub-parallel veins to the Yarrell Fault. Quartz paragenesis suggests that the Yarrell Fault & subsidiary structures were the earliest event with silica flooding from these structures into the surrounding rocks. Successive movements along the fault and fault related structures crushed & sheared the quartz. There has also been some remobilization of silica into the YFZ as banded chalcedonic quartz. At least 4 generations of quartz veins have been identified:

(1) Early grey quartz associated w/ specularite in vugs parallel to quartz veins.

(2) Dark grey quartz with some brecciation in the vein; dark color due to fine specularite

(3) Lighter grey quartz w/ disseminated limonite pseudomorphs after pyrite usually on the margin of the vein.

THESE THREE GENERATIONS OF QUARTZ ARE USUALLY SEEN AS SMALL VEINS up to 1/4" THICK, commonly up to 1/2" and HAVE BEEN NOTED up to 3" THICK IN DRILL CORE.

(4) WHITE QUARTZ HAS BEEN RECOGNIZED IN AT LEAST TWO STAGES. THESE VEINS APPEAR TO CROSS CUT ALL OF THE OTHER STAGES. THE WHITE QUARTZ VEINS HAVE BEEN MEASURED FROM 6". TO 1' IN DRILL CORE UP TO 20' IN THE FIELD. ASSAYS OF THESE VEINS CONSISTENTLY ASSAY FROM .01 TO 0.8 opt Au (AVERAGE .05-.07 opt Au) VISIBLE GOLD OCCURS IN SIMILAR LOOKING VEINS IN DIAMOND DRILL HOLES (YDDH-4).

IRON OXIDES- SEVERAL OCCURANCES OF IRON OXIDES ARE FOUND WITHIN THIS DEPOSIT AND ALL ARE INTIMATELY ASSOCIATED WITH GOLD MINERALIZATION.

LIMONITE- LIMONITE PSEUDOMORPHIC AFTER PYRITE IS VERY COMMON IN THE OXIDIZED PHYLLIC ZONE. IT OCCURS AS DISCRETE CRYSTALS OR AS INTERGROWTHS ASSOCIATED WITH QUARTZ VEINS. POLISHED SECTIONS SHOW THE RELATIONSHIP OF NATIVE GOLD TO LIMONITE PSEUDOMORPHS.

GOETHITE GOETHITE OCCURS AS FRACTURE/VEIN FILLING/ ~~COATING AND~~ FRACTURE COATINGS. GOETHITE ALSO OCCURS AS DISCRETE PATCHES. ASSOCIATED W/ PSEUDOMORPHS (PRINCIPALLY LIMONITE & GOETHITE)
THE TOTAL AMOUNT OF IRON OXIDES DRAMATICALLY INCREASE W/IN THE ORE ZONE up to 4-5%.

HEMATITE - HEMATITE IS VERY COMMON WITHIN THE YARNELL FAULT AND WHEN INTERSECTED IN DRILL HOLES TURNS THE CUTTINGS BRICK RED. HEMATITE IS ASSOC. WITH THE HIGHEST GOLD GRADE AND VISIBLE GOLD OCCURANCES. HEMATITE IS ALSO ASSOCIATED w/ PYRITE CUBES. ESPECIALLY CLOSE TO THE YARNELL FAULT. THE OCCURANCE OF HEMATITE USUALLY INDICATES INCREASED GRADE; >.03 opt Au.

PRECIOUS METAL ~~Mineralogy~~
~~GOLD MINERALOGY~~: NATURE & OCCURANCE

GOLD -

GOLD APPEARS TO HAVE SEVERAL MODES OF OCCURANCE AS FREE GOLD AND ASSOCIATED w/ IRON OXIDES. HONGA ~~DRAW~~ PREPARED A PAN CONCENTRATE FROM A 1.02 opt Au ZONE IN A R.C HOLE AND COUNTED 38 GOLD PARTICLES. 14 WERE LIBERATED (FREE GOLD) AND 24 SHOWED SOME DEGREE OF LOCKING WITH GOETHITE (18) AND QUARTZ (6) (HMEA 12-7-90) SIZE RANGES OF THE FREE GOLD PARTICLES IS. < 1 ~~MM~~ MICRONS → 110 μ MICRONS. (1 MICRON = .001 MM = .0025" INCHES) SIZE RANGES OF THE "LOCKED" PARTICLES RANGE FROM <1 TO 26 MICRONS. HMEA'S STUDY SHOWS THAT ~~THAT~~ THE SIZE OF FREE GOLD IS SMALL (18.3 MICRONS AVERAGE) AND FOR LOCKED PARTICLES EVEN SMALLER (5.4 MICRONS AVERAGE)

~~FREE~~ VISIBLE GOLD IS ASSOCIATED WITH THE QUARTZ STOCKWORK (YDDH-4) IN ASSOCIATION WITH GREY QUARTZ AND QUARTZ/SPECULARITE VEINS. THE HIGHER GOLD ASSAYS ARE RELATED TO QUARTZ STOCKWORK

WITH ARDUCARIA. HIGHER grade ASSAYS ARE ALSO RELATED TO THE OCCURANCE of limonite pseudomorphic AFTER py AND HEMATITE. THE HIGHEST GRADE ASSAYS ARE DIRECTLY RELATED TO THE YARRGU FAULT AND ABUNDANT >10% RED HEMATITE AND QUARTZ. THIS WAS THE ZONE THAT THE OLD TIME MINERS WERE FOLLOWING & ranged in GRADE FROM .1 TO 1.0 opt Au.

SILVER: SILVER OCCURS IN BOTH THE NATIVE STATE AND AS ELECTRUM (Hansen. 1990)
~~In the beginning of the program Silver was reading assayed w/ gold. However, silver is insignificant as an economic material and was assays of Fire assays show silver ranges from .01—.06 opt Silver.~~

BASE METALS- COPPER, LEAD & ZINC OCCUR IN THE GEOCHEMICAL REGIME IN ROCK SOIL WITHIN ~~RIMED~~ AROUND THE TARGU DEPOSIT. SECONDARY COPPER AS MALACHITE & AZURITE IS ASSOCIATED w/ LATE STAGE QUARTZ/HEMATITE VEINS.

RASMUSSEN (1990) COMPLETED A 15 ELEMENT GEOCHEMISTRY SURVEY OVER AND AROUND THE DEPOSIT. THE SURVEY WAS DESIGNED TO CONTINUOUSLY SAMPLE ROCK SOILS FROM THE HARRY WALL ZONE THRU THE FOOTWALL INTO FRESH GRANITE. SAMPLES WERE ~~ALSO~~ COLLECTED FROM REJECTS OF THREE R.C HOLES. THAT TESTED THROUGH THE ~~FW~~ HW & FW ZONE AND FROM THE MAIN HAULAGE ADIT THAT WAS DRIVEN IN THE HARRY WALL.

YARNELL PROJECT

Yavapai County, Arizona

TABLE 3

Table 3. Comparison of Trace Elements (ppm values) in Main Ore Zone rotary cuttings and Hanging Wall-Footwall soil samples.

	Ore Zone, Rotary Cuttings ppm			HW Soils ppm	FW Soils ppm
	YM-6	YM-26	YM-50		
No. of Samples	3	4	5	53	61
Cu, average	3.7	18.4	17.0	28.4	19.4
Cu, high	5.0	36.4	26.1	55.4	30.0
Cu, low	2.6	5.1	8.7	16.3	11.5
Pb, average	7.9	69.1	8.5	24.6	21.1
Pb, high	10.7	255.0	11.7	58.5	34.9
Pb, low	5.9	4.7	7.1	14.5	12.5
Zn, average	28.8	59.6	41.8	86.8	60.3
Zn, high	36.4	124.0	57.0	270.0	124.0
Zn, low	24.1	34.3	34.8	33.7	30.3

Table 3 compares the values in the drill hole rock geochemistry from that of the soil surveys values. Copper values (average) range from a low of 3.7 ppm in hole YM-6, to a high of 28.4 ppm from soil in the hanging wall. Lead and zinc also reflect low ppm values from the Yarnell system area..

MINERAL INVENTORY

THE RESULT OF NINTY SIX R.C. HOLES HAS DEFINED A MINERAL INVENTORY OF 4.3 MT @ .051 opt Au w/ A LOWER GRADE ZONE

NINTY SIX R.C HOLES HAVE DEFINED A MINERAL INVENTORY WHICH OCCURS IN TWO ZONES. THE MAIN ZONE OR "B" IS CONTAINED IN A 20-155' + ZONE OF MINERALIZATION WHICH IS CLOSELY COENCIDENT W/ THE YARNOW FAULT. USING A .02 opt CUTOFF THE MINERAL INVENTORY FOR THIS ZONE IS 4.1 MT @ .051 opt Au THE "A" ZONE IS A LOWER GRADE ZONE WHICH OCCURS ABOVE THE "B" AND IS LOCATED IN THE N-E PORTION OF THE DEPOSIT. THIS ZONE CONTAINS AN INVENTORY OF 2.7 MT @ .017 opt Au USING A .01 opt CUTOFF. THE STRIPPING RATIO VARIES FROM 1.5-3.0 W/O DEPENDING UPON THE ECONOMIC CUTOFFS USED.

METALLURGY

NUMEROUS BOTTLE ROLLS & COLUMN LEACH TESTS WERE COMPLETED ON THE DEPOSIT. A SMALL 15 TON SAMPLE WAS MINED FROM THE OPEN CUT TO PROVIDE ROM ORE FOR LEACH TESTING. ~~THIS SAMPLE WAS~~ AND WAS SENT TO MCCELLAND LABS IN RENO NV FOR THE TEST PROGRAM. THE RESULTS OF THE COLUMN LEACH TESTING IS SUMMARIZED BELOW

80% Passing Size	Column Size	Leach Time Days	Head Assay Opt	Tail Assay Opt	Extraction
6 inch	24" dia. x 18 ft.	111	0.046	0.022	52.2%
2 inch	15" dia. x 18 ft.	102	0.051	0.015	70.6%
3/8 inch	12" dia. x 18 ft.	79	0.055	0.013	76.4%

TWO MAY WITH

~~As noted~~ The composite is amenable to heap leach cyanidation treatment in all three feed ranges. GOLD RECOVERY INCREASES AS FEED SIZE DECREASES. ~~with an increase in gold recovery with decrease in feed size.~~ Recovery rates were fairly slow, but extraction was substantially complete in 60 days of leaching.

Cyanide consumptions ~~were low and~~ RANGED. ~~ranged~~ from 0.56 to 0.79 pound per ton of ore. Consumption rates were fairly constant throughout the leaching cycles. The ten pounds of lime and cement (3/8 inch feed) per ton of ore added to the ore charges as the columns were filled was sufficient to maintain protective alkalinity at above pH 10.5 throughout the test period (Crowell, 1990 b).

Flotation/Fine Grind/cyanide leach tests were conducted on the Yarnell composite sent to Tucson from McClelland Labs. This head sample of 35 pounds assayed 0.031 opt Au and 2.35% Fe (Henderson, 1989).

In the two flotation tests, ground to -200 mesh, the recoveries were 75%-76% in the final concentrate and 79%-80% in the rougher concentrate.

In the two fine grind/cyanide leach tests, also ground to -200 mesh, the recoveries were 97% in 22 hours of agitated leach. The cyanide consumption was 0.21 pounds per ton of ore and the lime was 3.3 pounds per ton of ore.

The trade-off between high recovery by fine grinding agitated leach and lower recovery by coarse crush/heap leach is a matter of economics.

MINERAL INVENTORY - RESERVE

General Statement. The Yarnell Project contains ninety-six drill holes of the reverse circulation rotary type, four diamond drill holes which twinned adjacent rotary holes, and a comprehensive sampling of the open-cut along the outcropping upper edge of the mineral zone. The

JDS

ASARCO

Southwestern Exploration Division

November 13, 1990

W.L. Kurtz

M.A. Miller's
Final Geological Report
Yarnell Project
Yavapai County, Arizona

I am pleased to submit M.A. Miller's final Geological Report on the Yarnell Project, Yavapai County, Arizona. This should essentially wrap up the project from the SWED work load and allow us to get on with the business at hand.

The report has gone through a number of revisions and reviews, and some glitches still exist, but do not distract from the intent of the report.

James D. Sell

James D. Sell

JDS:mek
Att.

cc: R.L. Brown
M.A. Miller

JD Sell

ASARCO

Southwestern Exploration Division

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.

Mark A. Miller
Project Geologist

MAM:mek
Att.

cc: W.L. Kurtz

YARNELL FINAL REPORT

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YARNELL FINAL REPORT

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Attachment A - Diamond Drill Geologic Logs YDDH 1-4 1" = 10'

Plate 1 - Claim Map - Sections 14, 23 1" = 200'
Plate 2 - Geologic Map - SW 1/4 Sec. 14 1" = 100'
Plate 3 - Drill Hole Location Map with Assay Intervals 1" = 200'
Plate 4 - Proposed Exploration Drilling with Schematic Sections 4A-E 1" = 200'
Plate 5 - Geologic Sections Index
Plate 5A-N - Geologic Sections 1" = 100'
Plate 6 - Underground Workings Surveyed and Estimated 1" = 100'

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

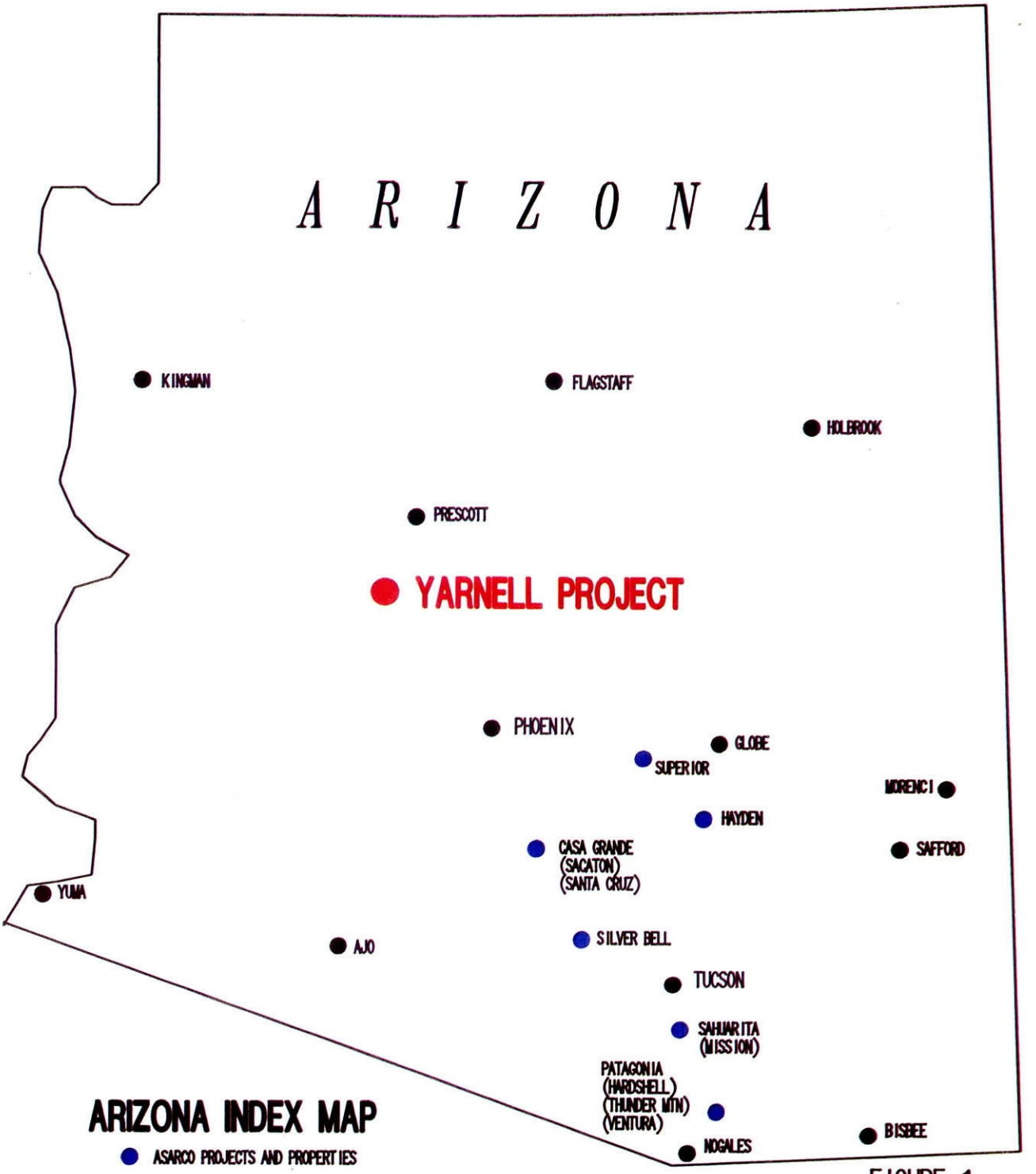

FIGURE 1
ASARCO Incorporated
YARNELL PROJECT
INDEX MAP
YAVAPAI CO., ARIZONA

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.

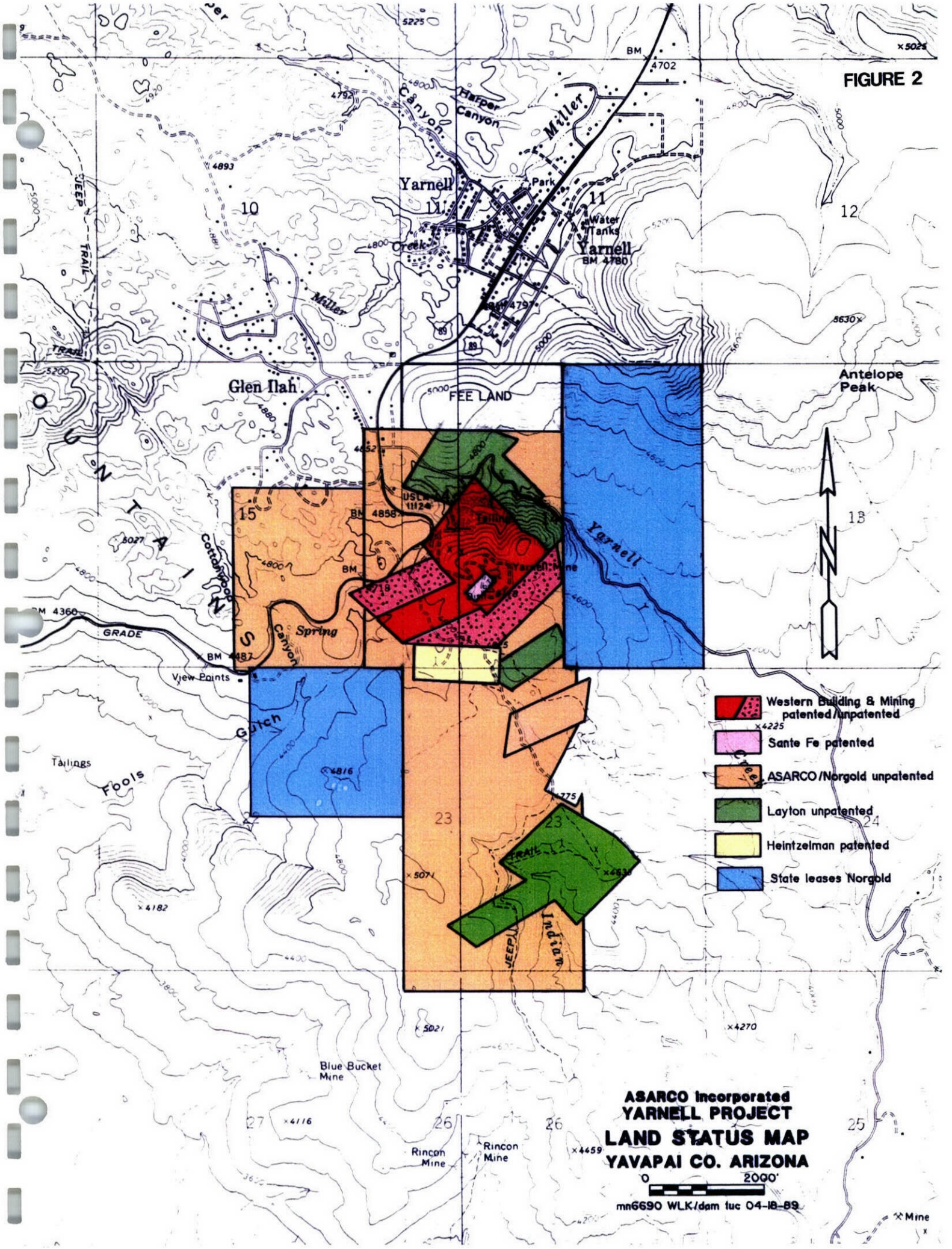
FIGURE 2
Western Building & Mining patented/unpatented
Sante Fe patented
ASARCO/Norgold unpatented
Layton unpatented
Heintzelman patented
State leases Norgold
FEE LAND
Yarnell
Glen Ilah
Antelope Peak
Harper Canyon
Miller
Yarnell Creek
Water Tanks
Park
Cottonwood Canyon
Spring
Gulch
Fools
Indian
Tailings
View Points
GRADE
JEEP TRAIL
Blue Bucket Mine
Rincon Mine
ASARCO Incorporated
YARNELL PROJECT
LAND STATUS MAP
YAVAPAI CO. ARIZONA
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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 Payments not to exceed $175,000/yr	1% or Advance Royalty (Greater of the two)	None

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.

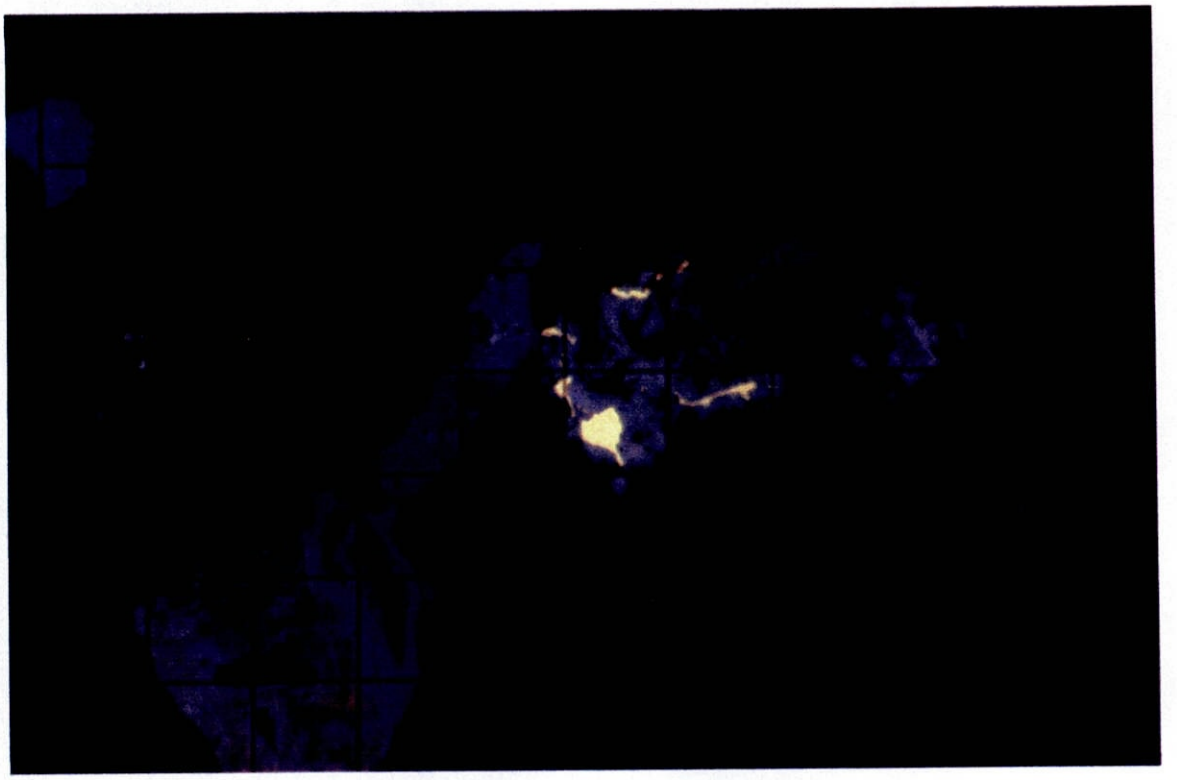
Aplite Dikes (not shown on map) - These dikes are very minor in occurrence and are found in the unaltered granite. They do not appear to be related to alteration/mineralization. The aplite dikes are probably a late feature of granite crystallization as they have the same mineralogy as the intrusive;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

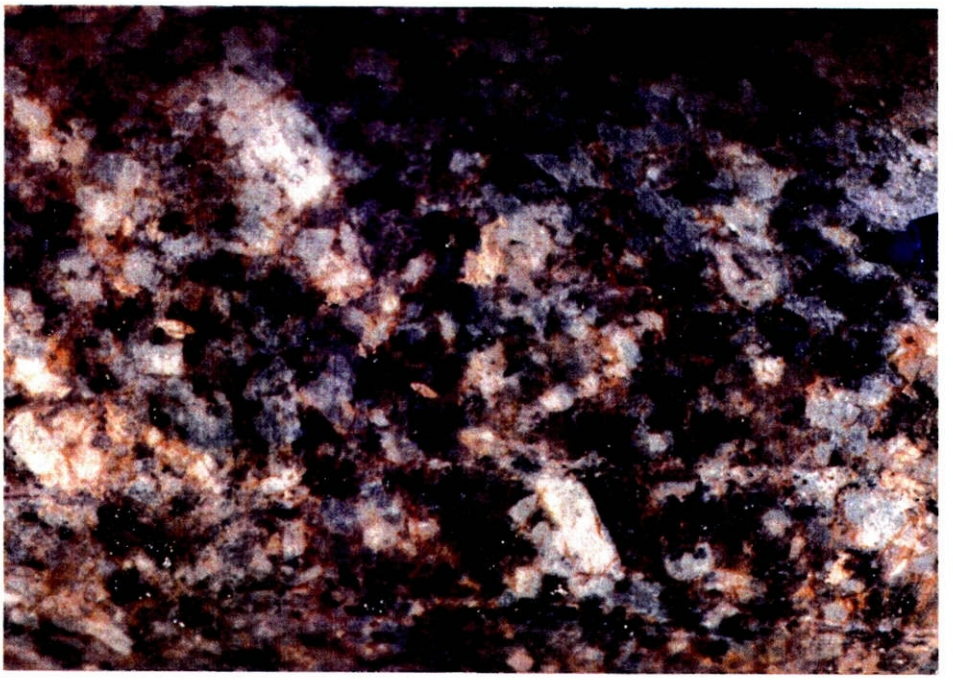
Moderate Alteration (Phyllic) Unoxidized

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

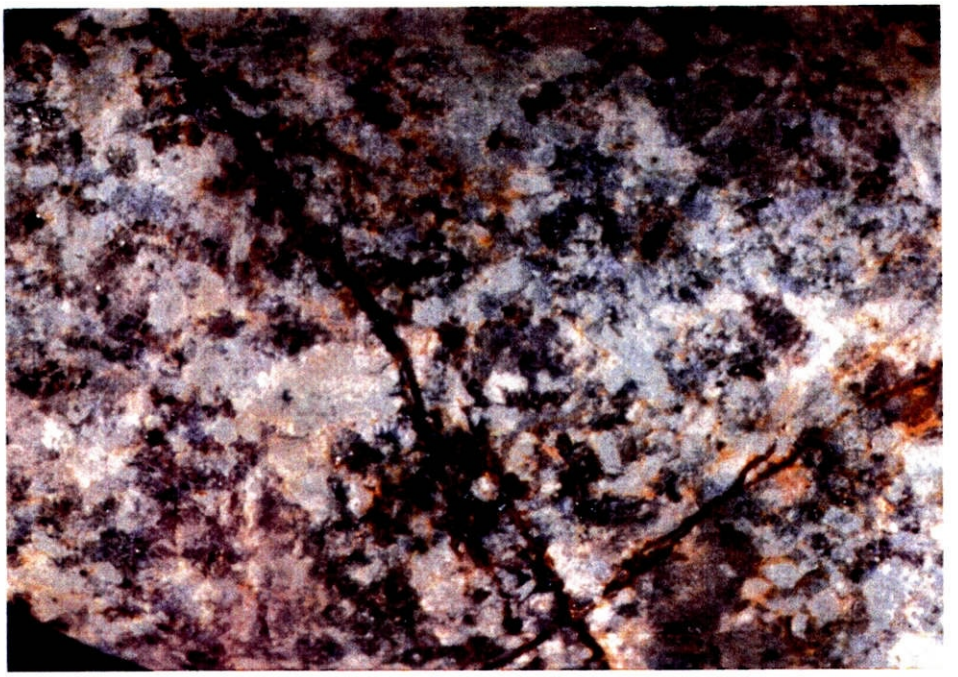
The mineralogy of the hanging wall and footwall moderately altered zones are very similar (attached chart) with up to >20% sericite as secondary minerals and almost complete replacement of primary plagioclase minerals to sericite. A minor difference between the mineralogy of the unoxidized vs. oxidized 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



4A

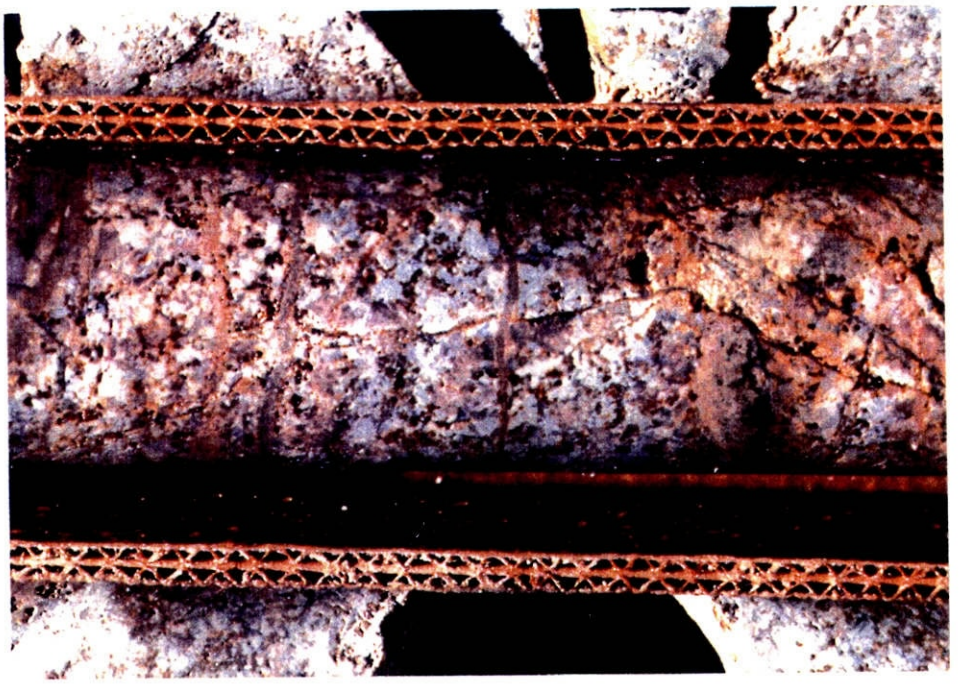
8A - DDH - 3 @ 18-19 feet - Weak Zone
host rock (plagioclase - biotite - alkali feldspar - quartz; granodiorite or quartz-monzonite?) showing weak alteration including formation of specularite (slightly magnetic) ± pyrite at biotite sites, and greenish hue in feldspars. (Page, 10-24-89)



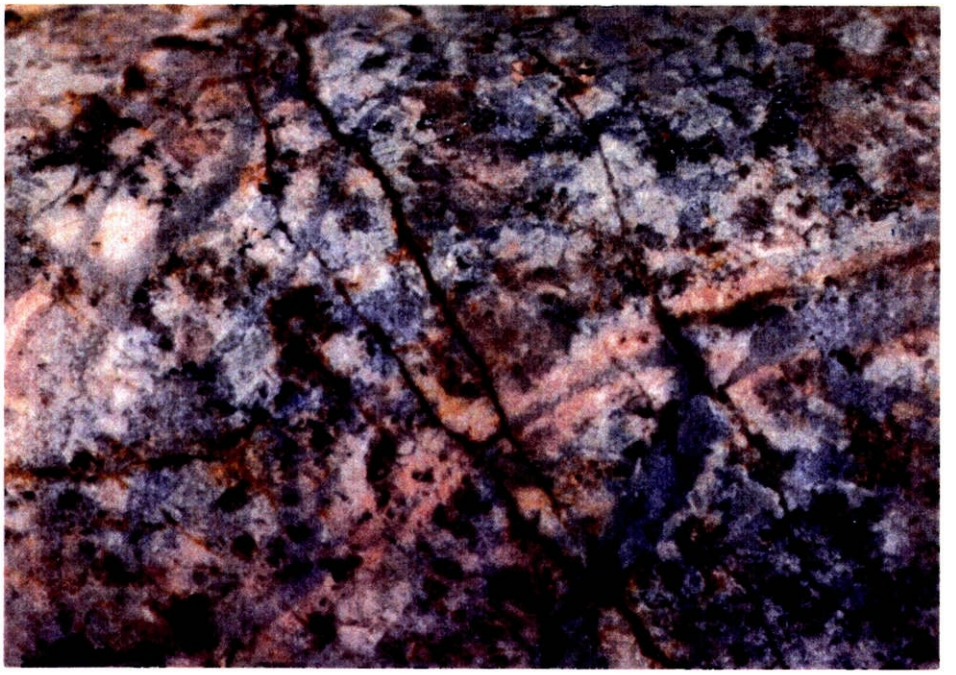
4B

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



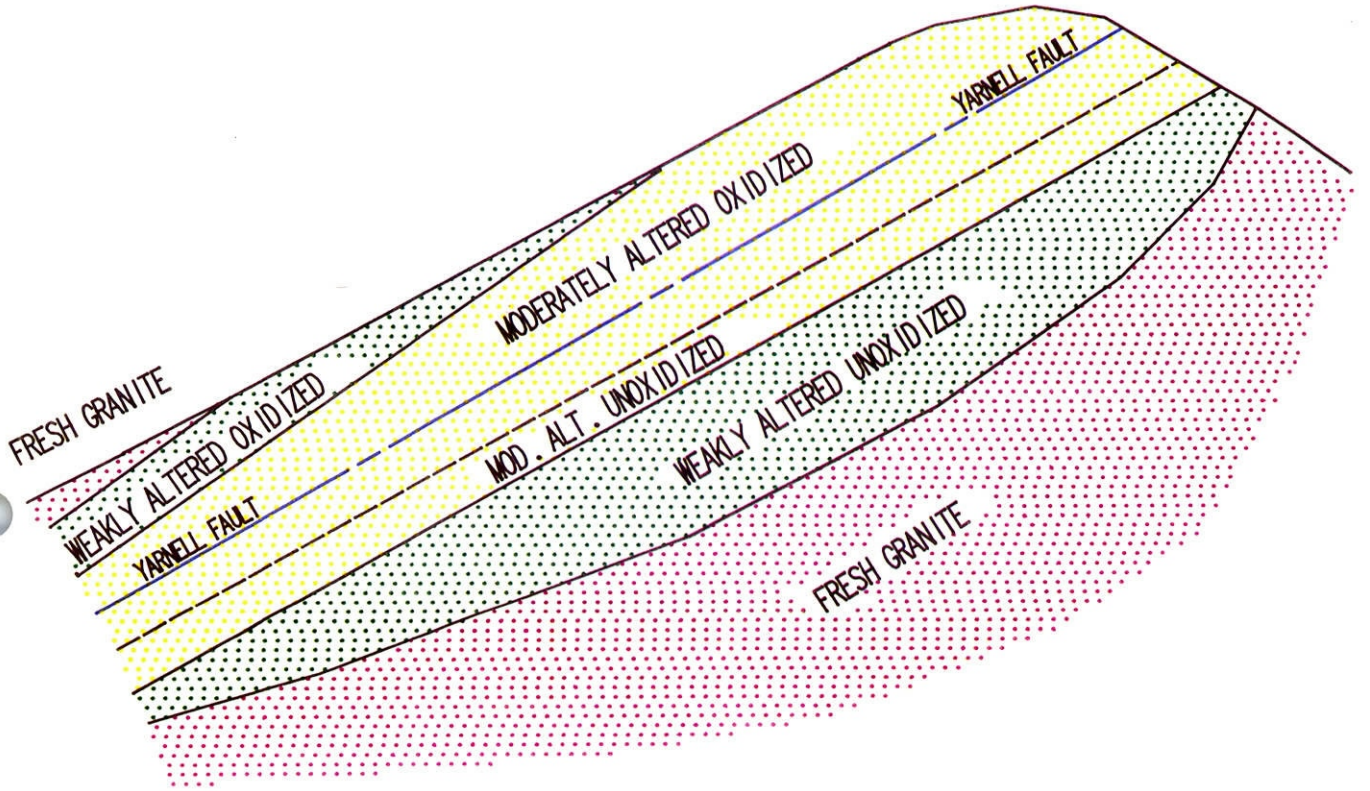
14A - DDH - 3 @ 142 feet - Moderate Zone
stockwork mineralization showing quartz stringers subparallel to main Yarnell structure; later finer fractures contain mixed specularite and Mn-ox; minor pseudomorphs of limonite after pyrite occur locally. Note potassic hue adjacent to both quartz stringers and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

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Yarnell Project

Petrographic Descriptions - Russ Honea

Table 2

Sample No.	Alteration Zone	Primary Minerals %				Secondary Minerals %						Silica %		Iron Oxides %			
		Plagio-clase	Micro-cline	Quartz	Biotite	Sericite	Clay	Chlorite	Calcite	Epidote	Leuco-xene	Quartz/ Adularia	Chalce-dony/Opal	Hematite/ Magnetite	Limonite/ Pyrite(Fresh)	Goethite	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° 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 not 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 approximate 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. ORE RESERVES

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:

JDS Reserve	ECS Reserve
(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

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.

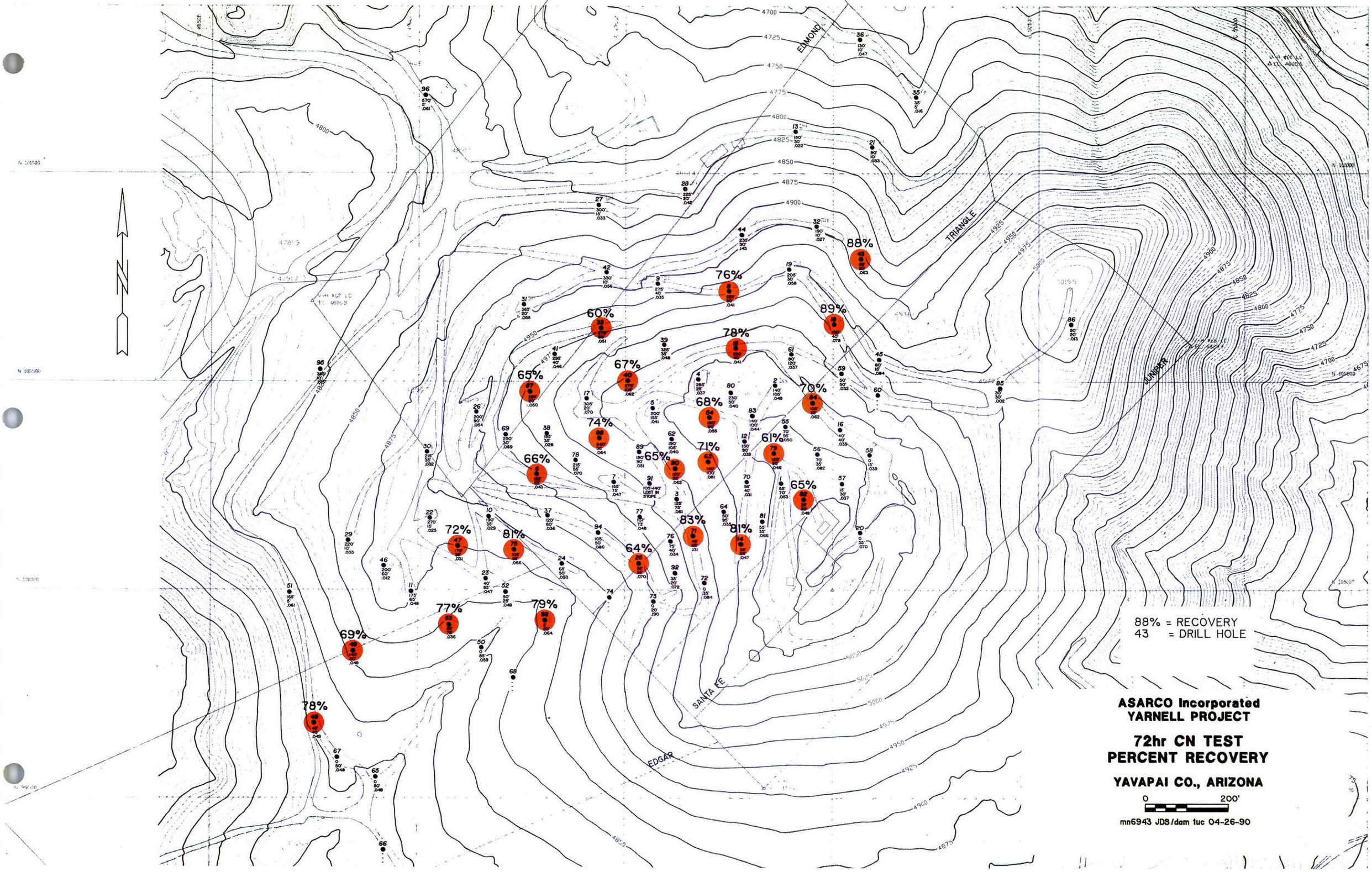
In addition to the column leaching, twenty-four RC holes were picked and the "B" zone interval was composited into one sample per hole. Holes picked throughout the deposit were anticipated to give a representative average of the leachability of the ore zone. A 72 hour cyanide leach program was completed 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.

FIGURE 8


EDMOND
TRIANGLE
JUNIPER
SANTA FE
EDGAR
88% = RECOVERY
43 = DRILL HOLE
ASARCO Incorporated
YARNELL PROJECT
72hr CN TEST
PERCENT RECOVERY
YAVAPAI CO., ARIZONA
0 200'
mn6943 JDS/dam tuc 04-26-90

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.

YARNELL FINAL REPORT

List of Figures, Tables, Attachment, and Plates

Figure 1 - Index Map - Yarnell Project
Figure 2 - Land Status Map
Figure 3 - Photomicrograph YM-71, 85-90
Figure 4 - Photographs - DDH-3 Alteration
Figure 5 - Photographs - Potassic Alteration Associated with quartz veins
Figure 6 - Schematic Cross Section of Alteration Zones
Figure 7 - Photographs - DDH-3 Showing Quartz Vein Relationships
Figure 8 - 72 Hour CN Test; Percent Recovery

Table 1 - Payment and Royalty Schedule
Table 2 - Petrographic Descriptions - Russel Honea

Attachment A - Diamond Drill Geologic Logs YDDH 1-4 1" = 10'

Plate 1 - Claim Map - Sections 14, 23 1" = 200'
Plate 2 - Geologic Map - SW 1/4 Sec. 14 1" = 100'
Plate 3 - Drill Hole Location Map with Assay Intervals 1" = 200'
Plate 4 - Proposed Exploration Drilling with Schematic Sections 4A-E 1" = 200'
Plate 5 - Geologic Sections Index
Plate 5A-N - Geologic Sections 1" = 100'
Plate 6 - Underground Workings Surveyed and Estimated 1" = 100'

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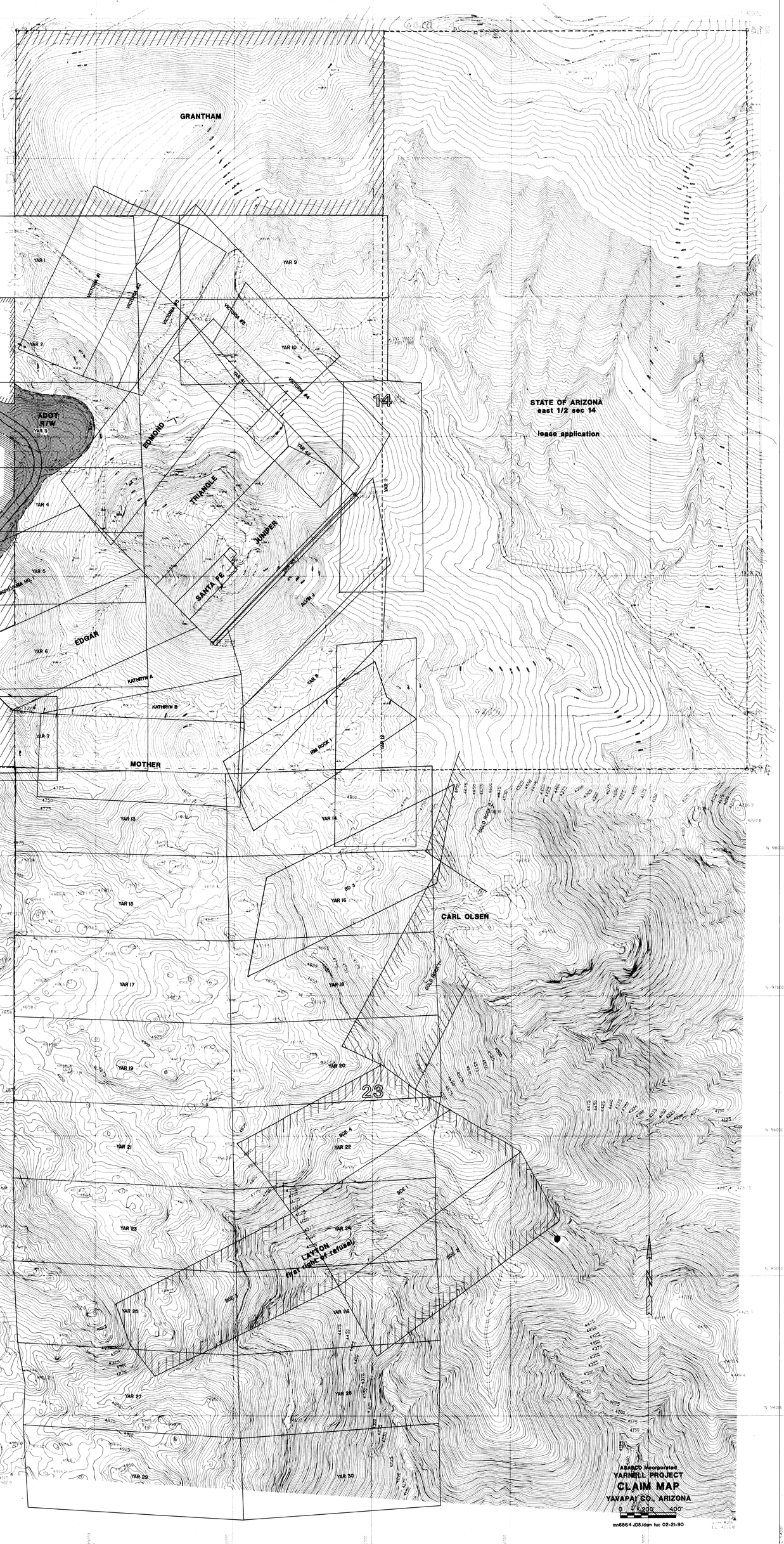
PLATES 1-6

To Accompany

Yarnell Final Report


GRANTHAM
YAR 1
YAR 2
YAR 9
YAR 10
YAR 11
YAR 4
YAR 6
YAR 7
YAR 8
YAR 12
YAR 13
YAR 14
YAR 15
YAR 16
YAR 17
YAR 18
YAR 19
YAR 20
YAR 21
YAR 22
YAR 23
YAR 24
YAR 25
YAR 26
YAR 27
YAR 28
YAR 29
YAR 30
VICTORIA #1
VICTORIA #2
VICTORIA #3
VICTORIA #4
VICTORIA #5
VICTORIA #6
ADOT R/W
EDMOND
TRIANGLE
JUNIPER
SANTA FE
EDGAR
KATHRYN A
KATHRYN B
MOTHER
RIM ROCK 1
RIM ROCK 2
GOLD ROCK 1
GOLD ROCK 2
RD 3
RDE 1
RDE 2
RDE 3
RDE 4
CARL OLSEN
LAYTON
not done at refusal
14
23
STATE OF ARIZONA
east 1/2 sec 14
lease application
ASARCO Incorporated
YARNELL PROJECT
CLAIM MAP
YAVAPAI CO., ARIZONA
0 200 400'
mn6864 JDS/dam fuc 02-21-90

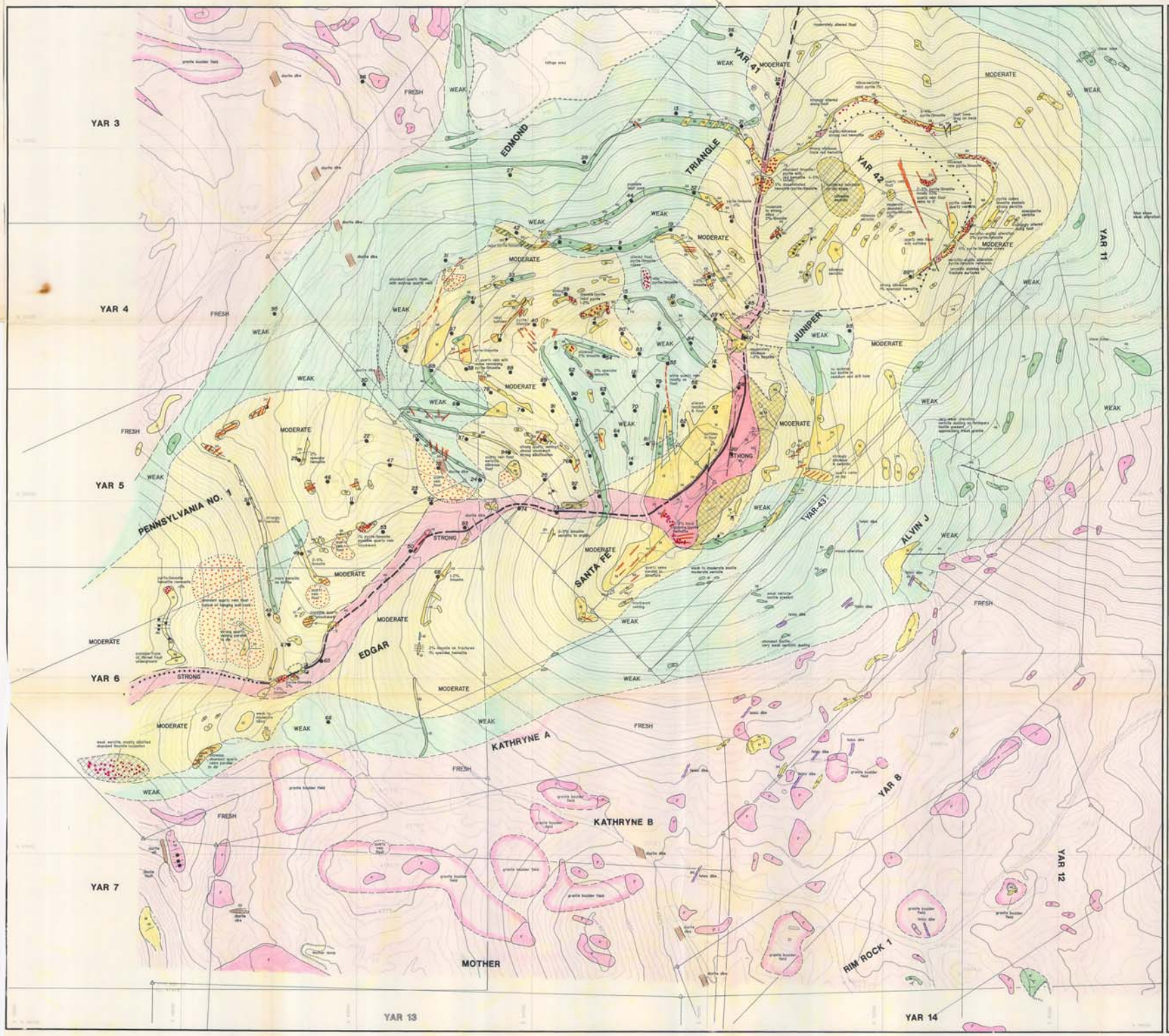


PLATE 2

DIORITE DIKE

FELSIC DIKE

GRANITE

FRESH

WEAKLY ALTERED
biotite fresh to weakly altered
slight specularite pseudomorphs after biotite
weak sericite replacement of feldspar
rutilus veinlets

MODERATELY ALTERED
biotite absent
specularite pseudomorphs after biotite
moderate/strong sericite replacement of feldspar
rutilus veinlets

STRONGLY ALTERED
argillic, kaolinite, clay alteration
specularite altered to hematite

AS ABOVE
overprint of interstitial to pervasive
silica with minor quartz veining

LIMONITE PSEUDOMORPHS
limonite pseudomorphs of pyrite and red/orange
hematite of oxidized specularite/pyrite

MAJOR QUARTZ VEINS, with strike and dip

YARNELL FAULT, as mapped with strike and dip

YARNELL FAULT, as projected

YARNELL FAULT, as inferred

MAJOR STRUCTURES, with strike and dip

JOINTING, with strike and dip

SURVEYED CLAIM CORNERS

DUMP

N

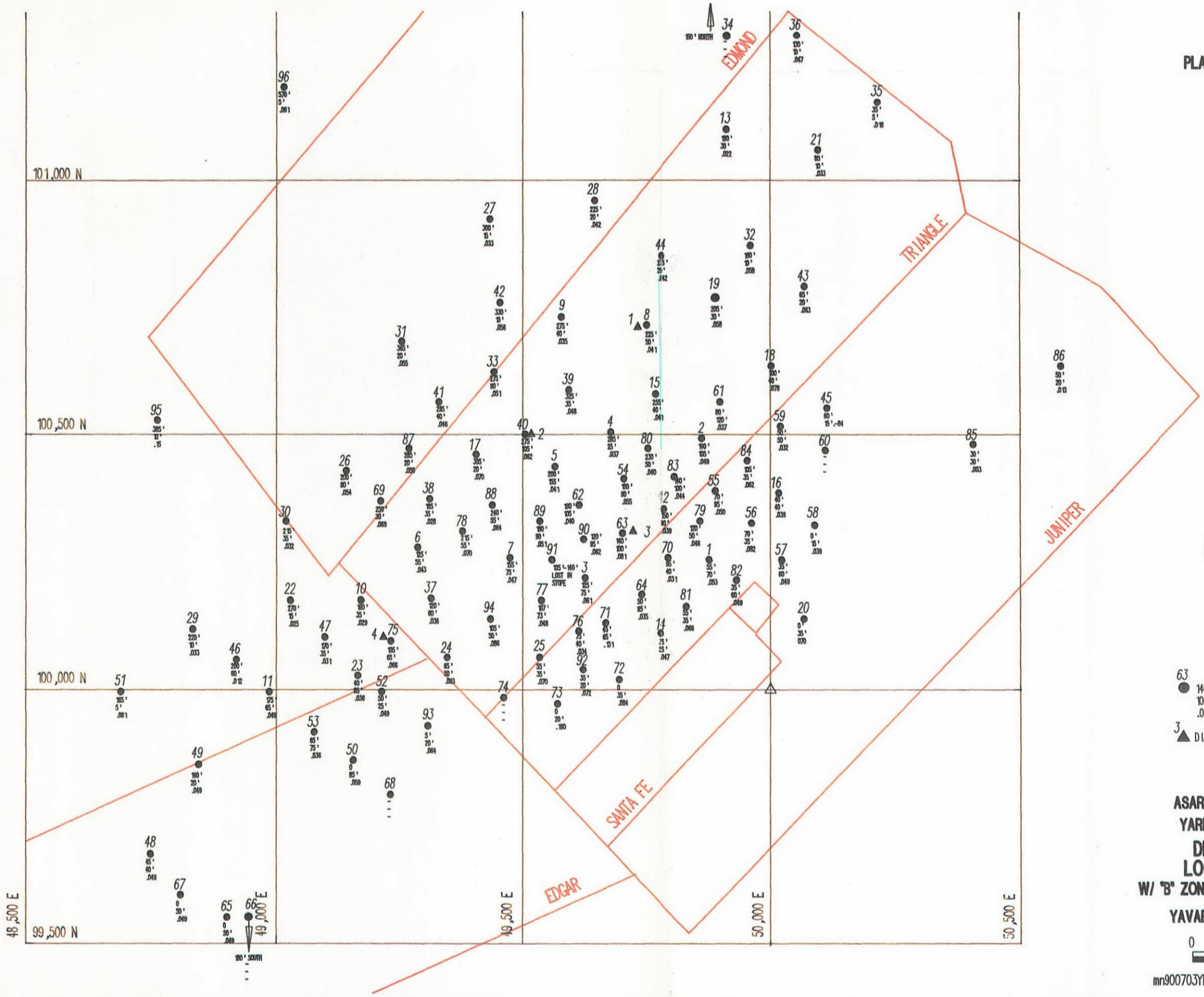
0 100' 200'

ASARCO Incorporated
YARNELL PROJECT
GEOLOGY MAP
YAVAPAI CO., ARIZONA

m6780 MAM/dam bui 11-08-89

GEOLOGIST COPY (MAM)

PLATE 3



NORTH

63 ● 140' DEPTH TO INTERVAL
100' THICKNESS OF INTERVAL
.081 ASSAY IN OUNCES PER TON

3 ▲ DIAMOND DRILL HOLE

ASARCO Incorporated
YARNELL PROJECT

DRILL HOLE LOCATION MAP W/ "B" ZONE ASSAY INTERVALS

YAVAPAI CO., ARIZONA

0 100' 200'

mn900703YR dam tuc 07/06/90

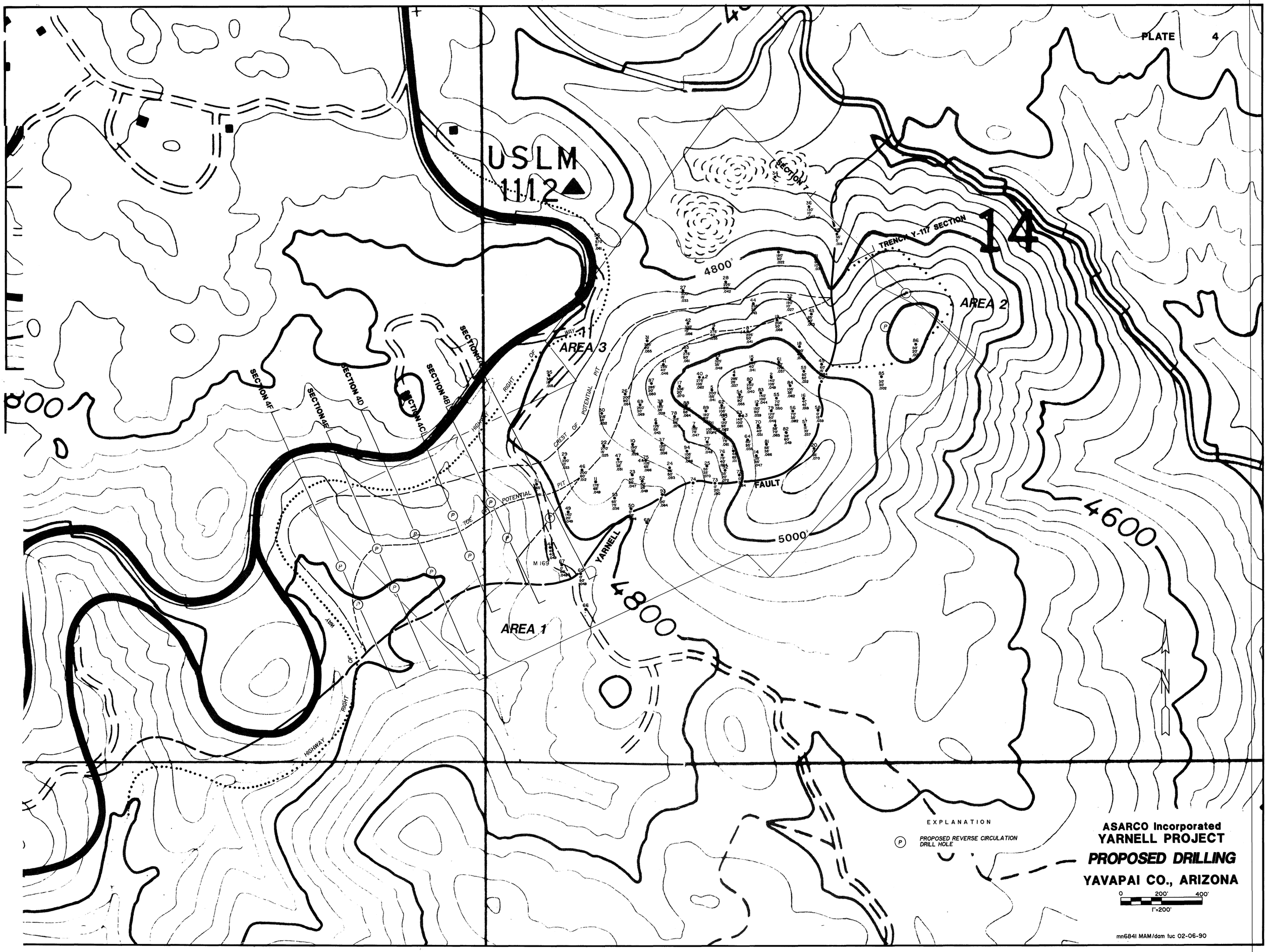
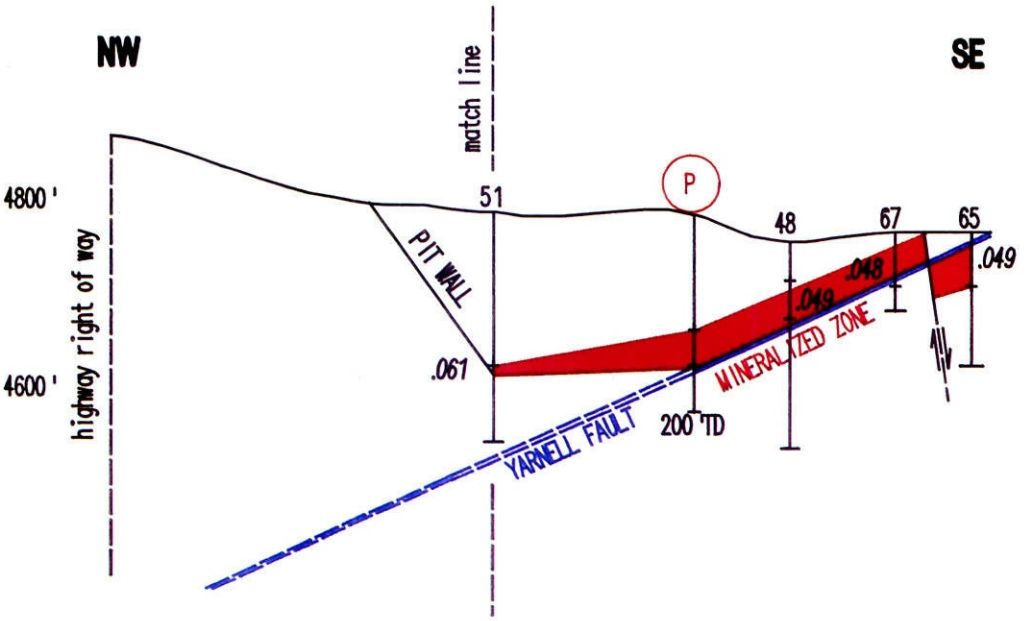


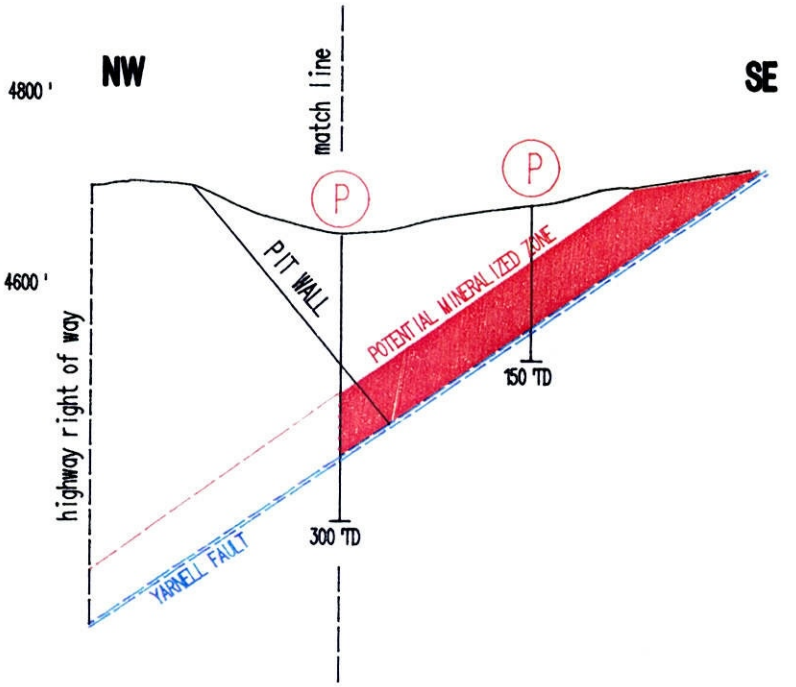
PLATE 4
USLM
1112
14
4800'
5000'
4600
4800
AREA 1
AREA 2
AREA 3
SECTION 4F
SECTION 4E
SECTION 4D
SECTION 4C
SECTION 4B
SECTION 4A
SECTION 7
TRENCH Y-117 SECTION
HIGHWAY RIGHT OF WAY
TOE POTENTIAL PIT
CREST OF POTENTIAL PIT
YARNELL FAULT
M 169
EXPLANATION
PROPOSED REVERSE CIRCULATION DRILL HOLE
ASARCO Incorporated
YARNELL PROJECT
PROPOSED DRILLING
YAVAPAI CO., ARIZONA
0 200' 400'
1"=200'
mn6841 MAM/dam fuc 02-06-90

PLATE 4A



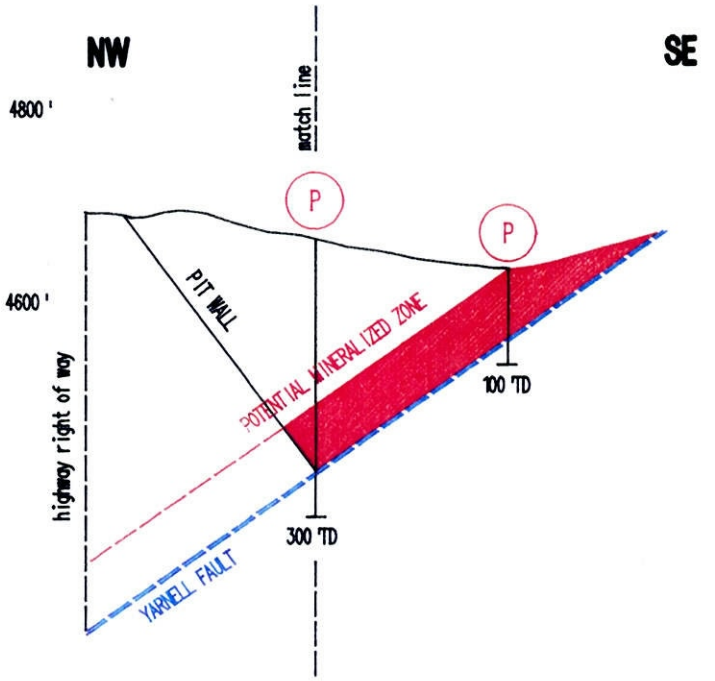
ASARCO Incorporated
YARNELL PROJECT
PROPOSED DRILLING
SECTION 1
YAVAPAI CO., ARIZONA
1"-200'

mn 6836 mam/dam tuc 2-2-90
file YPD-SEC1.DWG



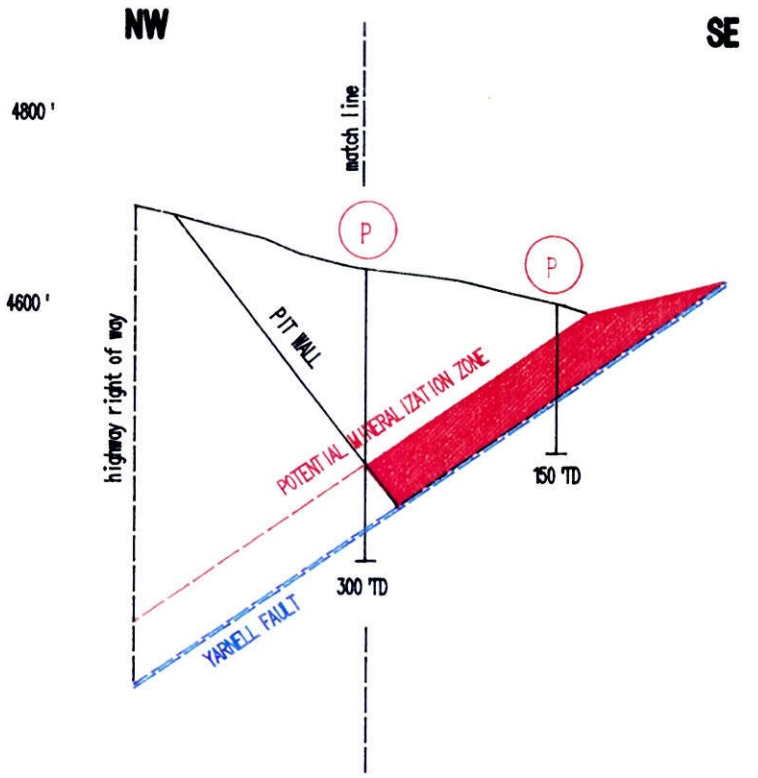
ASARCO Incorporated
YARNELL PROJECT
PROPOSED DRILLING
SECTION 2
YAVAPAI CO., ARIZONA
1"-200'

mn 6837 mam/dam tuc 2-2-90
file YPD-SEC2.DWG



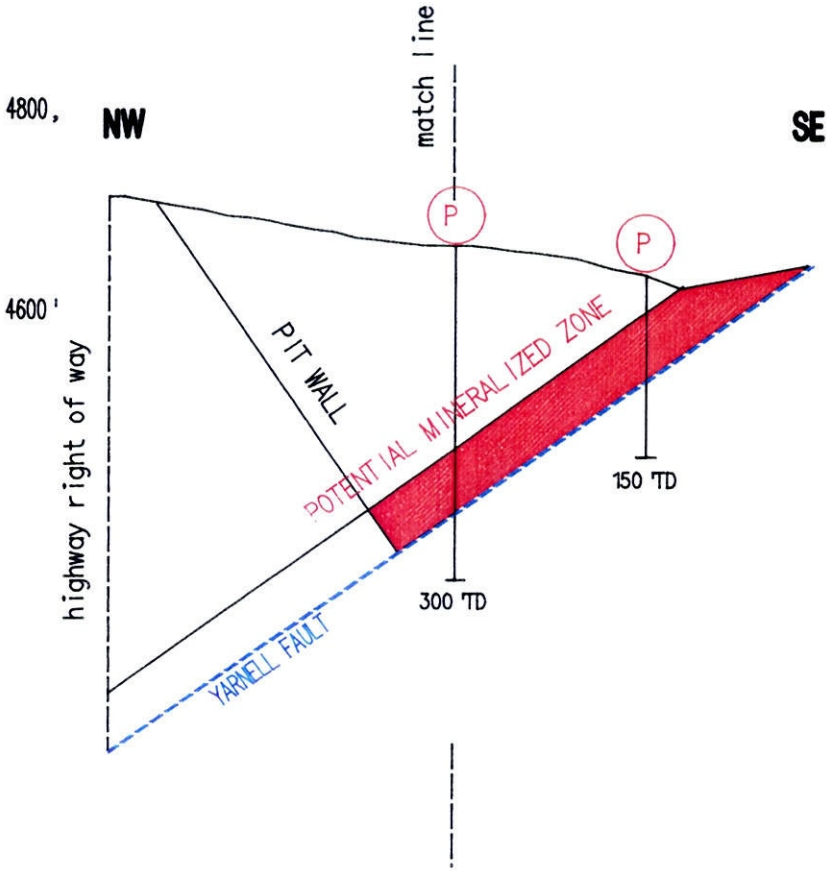
ASARCO Incorporated
YARNELL PROJECT
PROPOSED DRILLING
SECTION 3
YAVAPAI CO., ARIZONA
1"-200'

mn 6838 mam/dam tuc 2-29-90
file YPD-SEC4.DWG



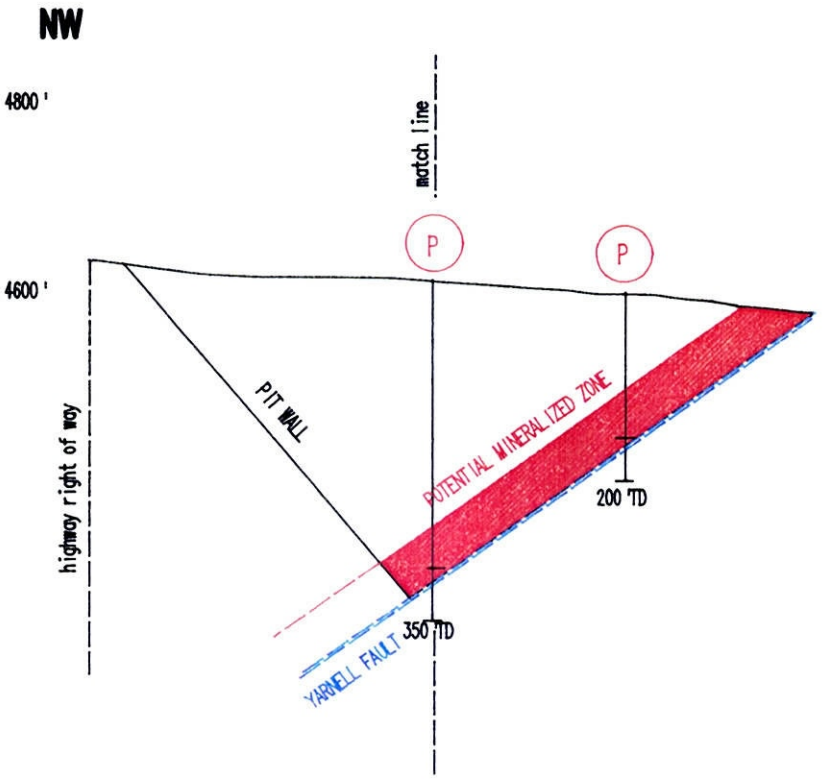
ASARCO Incorporated
YARNELL PROJECT
PROPOSED DRILLING
SECTION 4
YAVAPAI CO., ARIZONA
1"-200'

mn 6839 mam/dam tuc 2-2-90
file YPD-SEC4.DWG



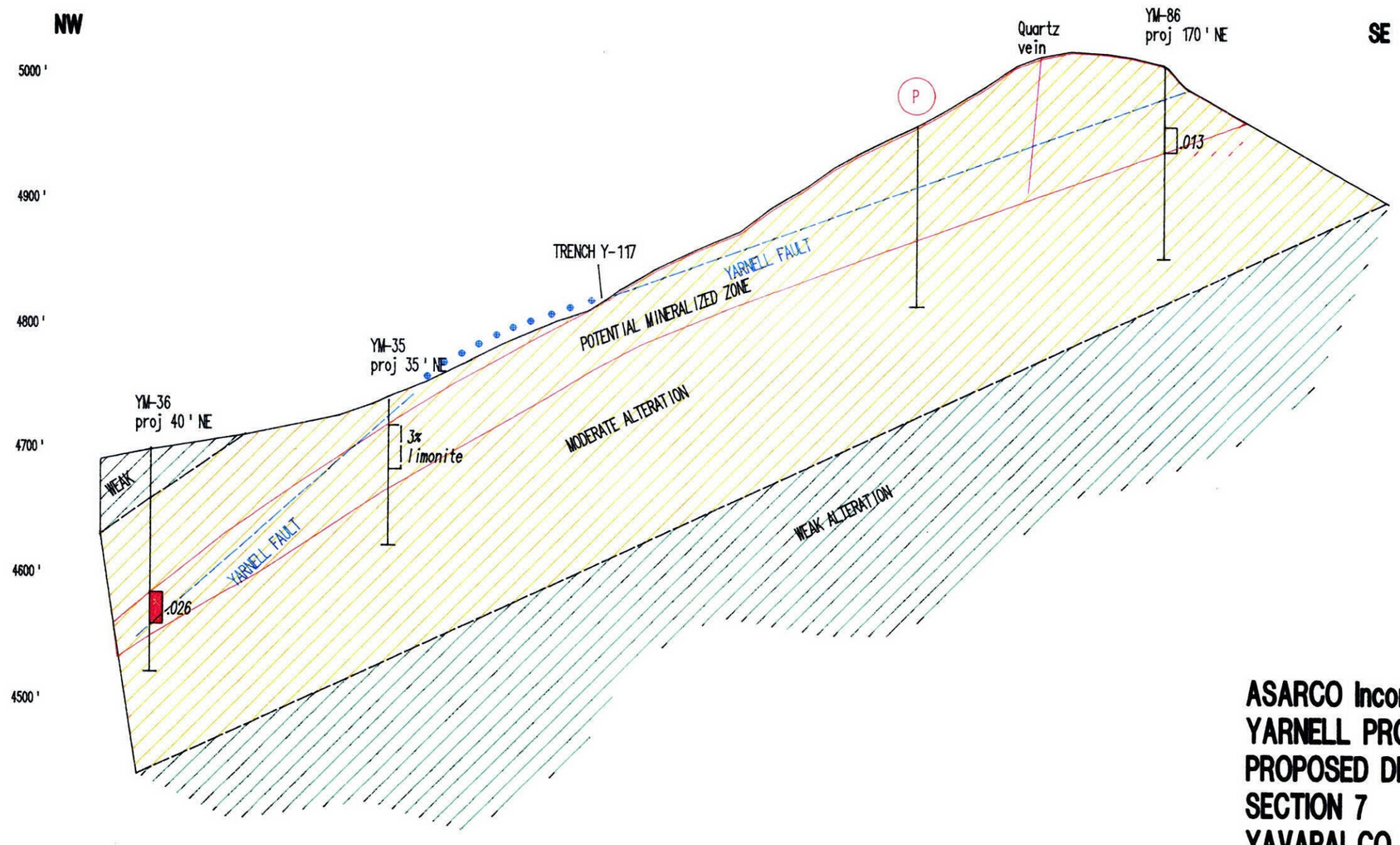
ASARCO Incorporated
YARNELL PROJECT
PROPOSED DRILLING
SECTION 5
YAVAPAI CO.,ARIZONA
1"-200'

mn 6835 mam/dam tuc 2-2-90
file YPD-SEC5.DWG



ASARCO Incorporated
YARNELL PROJECT
PROPOSED DRILLING
SECTION 6
YAVAPAI CO., ARIZONA
1"-200'

mn 6840 mam/dam tuc 2-5-90
file YPD-SEC6.DWG

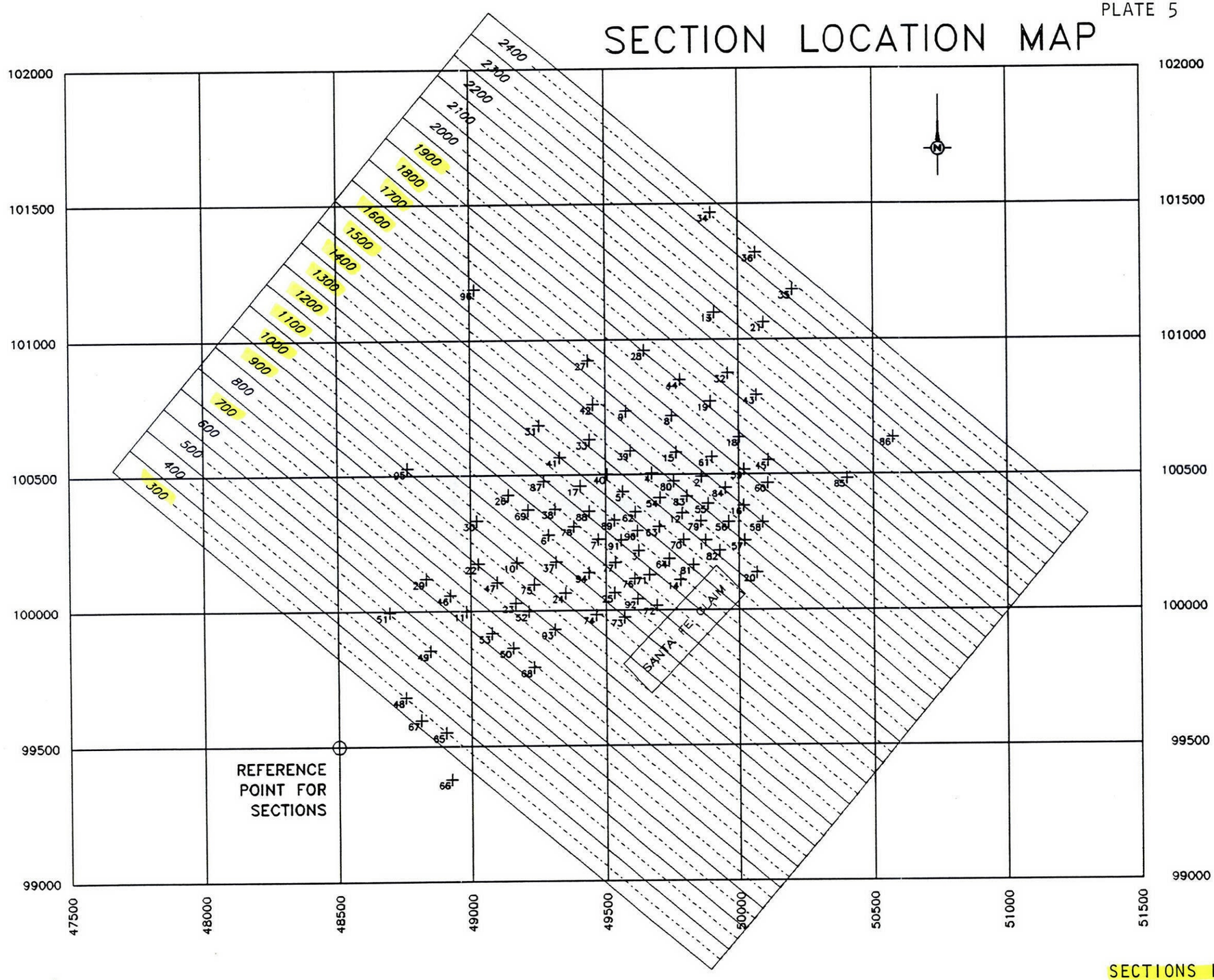


ASARCO Incorporated
YARNELL PROJECT
PROPOSED DRILLING
SECTION 7
YAVAPAI CO., ARIZONA
1"-100'

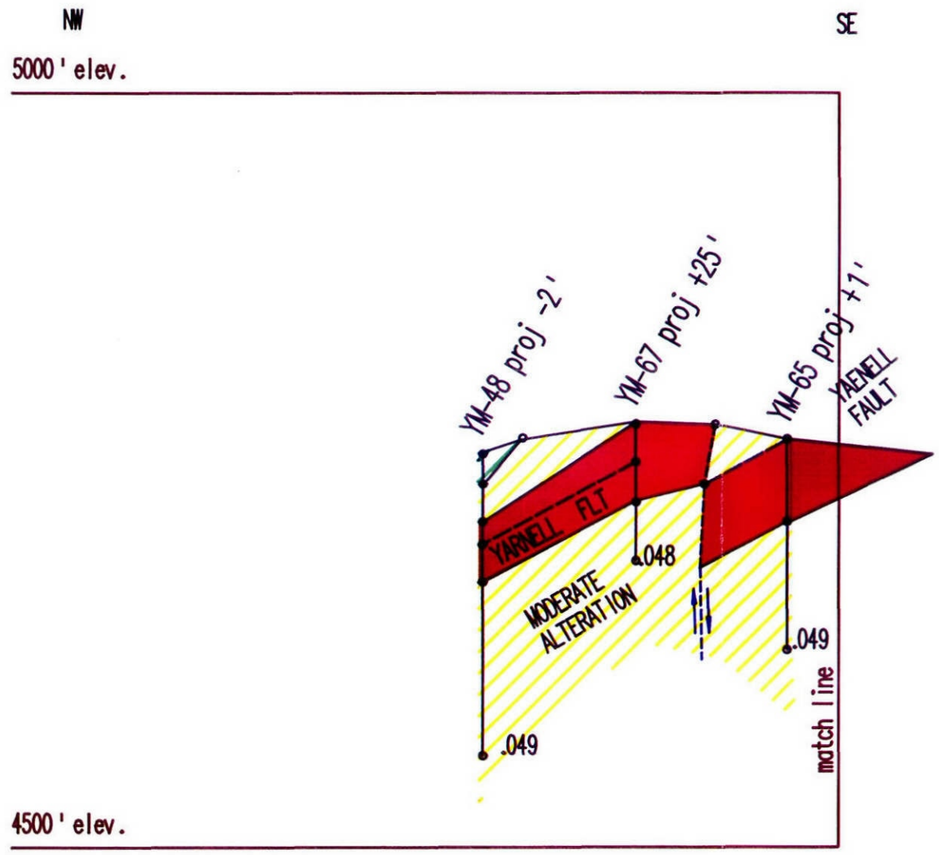
mn 6843 mcm/dcm tuc 2-6-90
file YPD-SEC7.DWG

PLATE 5

SECTION LOCATION MAP



SECTIONS INDEX



LOOKING N. 40° E.

EXPLANATION

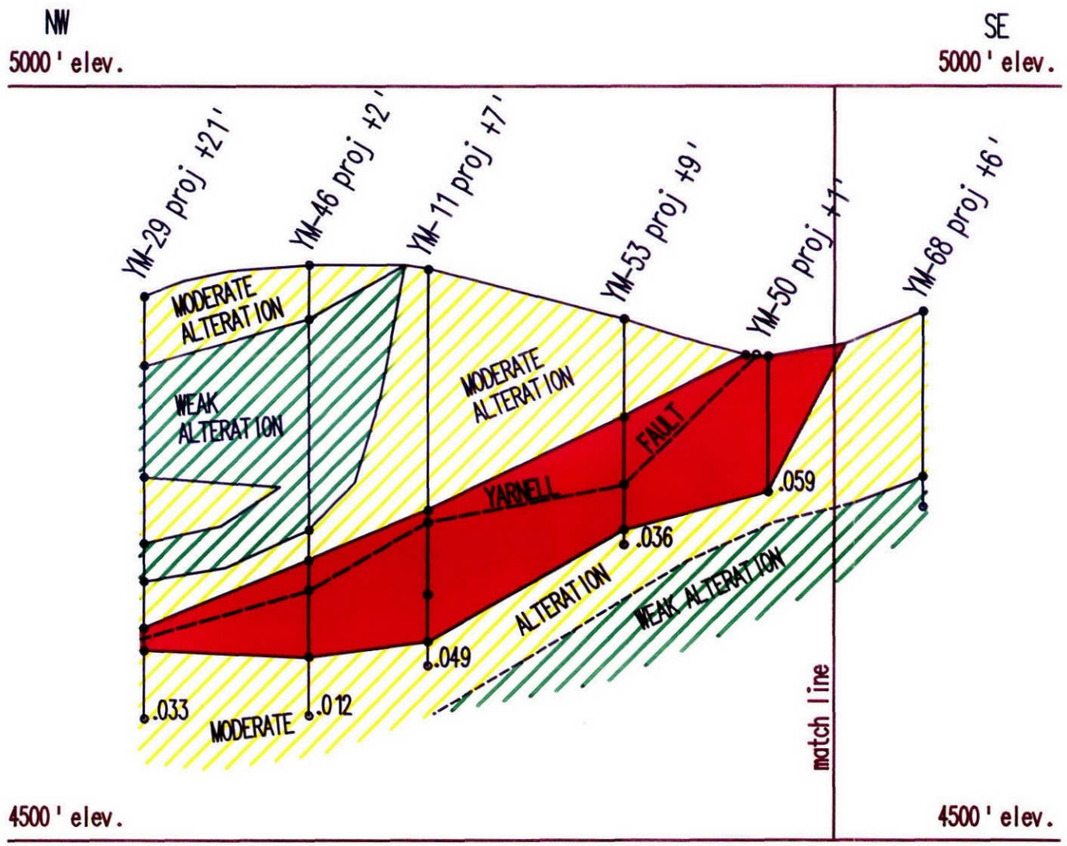
- WEAKLY ALTERED, SOME BIOTITE, PROPYLITIC ALTERATION
- MODERATE ALTERATION, NO BIOTITE, PHYLLIC ALTERATION
- QUARTZ STOCKWORK, (DRILL HOLE DATA)
- MINERALIZED ZONE (MAIN "B" ZONE)
- DIORITE DIKE

ASARCO Incorporated

YARNELL PROJECT
SECTION 300
YAVAPAI CO., ARIZONA

0 100' 200'

mn 6912 MAM/dam tuc 3-20-90
file YAR-6912.DWG



LOOKING N. 40° E.

EXPLANATION

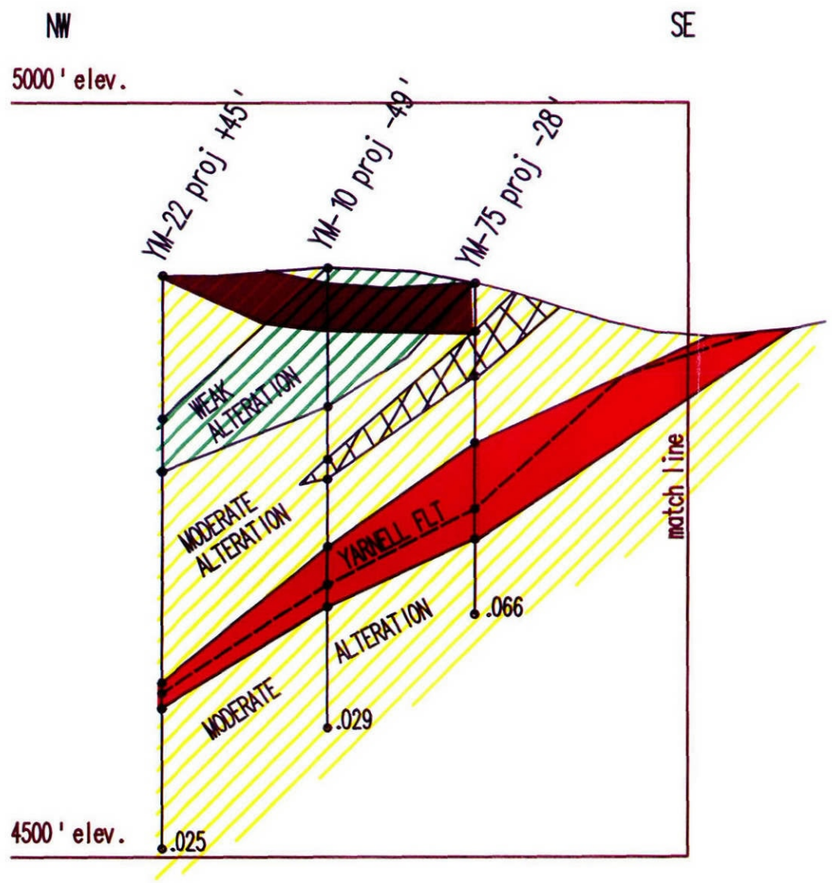
- WEAKLY ALTERED, SOME BIOTITE, PROPYLITIC ALTERATION
- MODERATE ALTERATION, NO BIOTITE, PHYLLIC ALTERATION
- QUARTZ STOCKWORK, (DRILL HOLE DATA)
- MINERALIZED ZONE (MAIN "B" ZONE)
- DIORITE DIKE

ASARCO Incorporated

YARNELL PROJECT
SECTION 700
YAVAPAI CO., ARIZONA

0 100' 200'

mn 6913 MAW/dam tuc 3-20-90
file YAR-6913.DWG



LOOKING N. 40' E.

EXPLANATION

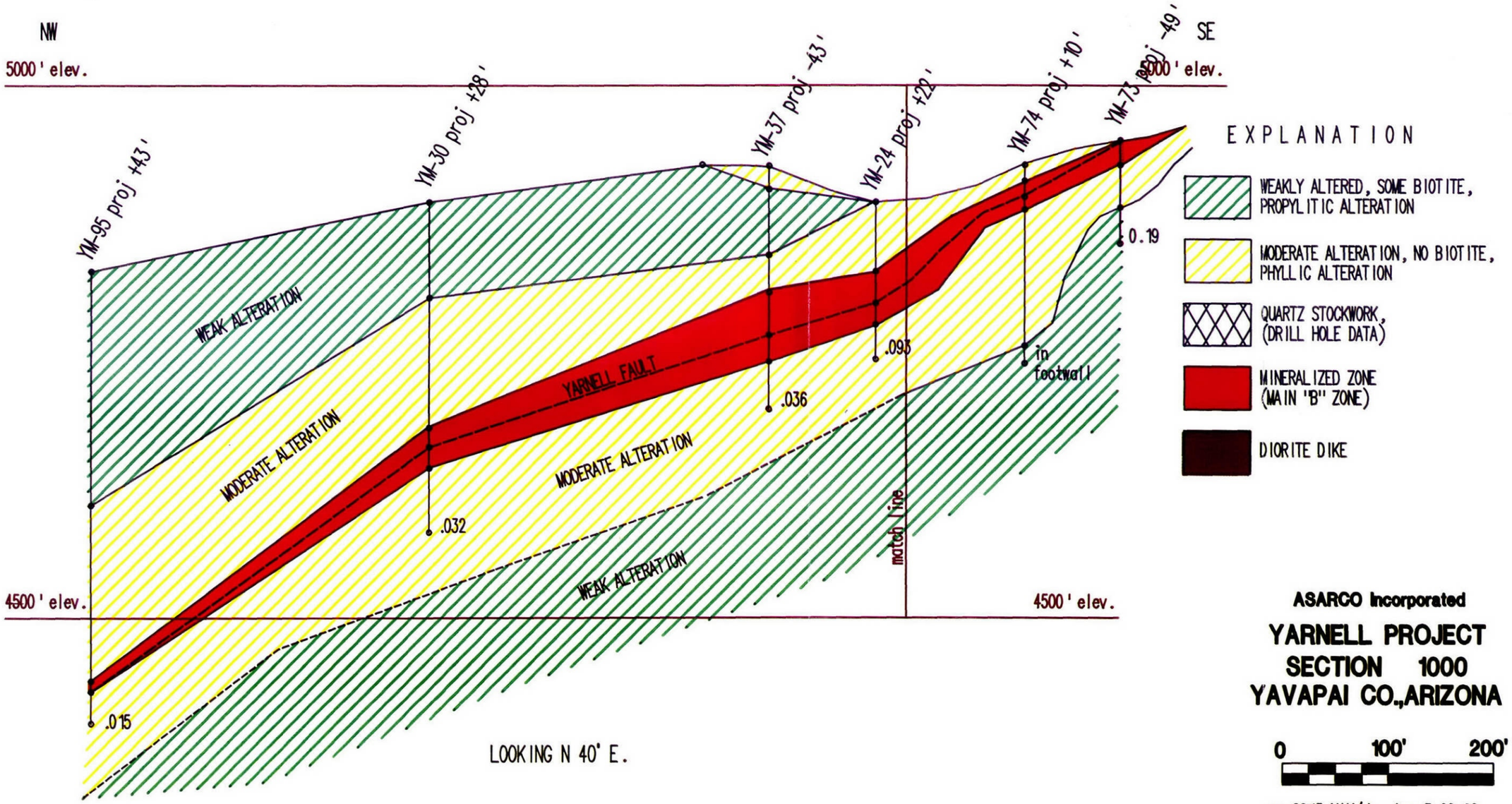
- WEAKLY ALTERED, SOME BIOTITE, PROPYLITIC ALTERATION
- MODERATE ALTERATION, NO BIOTITE, PHYLLIC ALTERATION
- QUARTZ STOCKWORK, (DRILL HOLE DATA)
- MINERALIZED ZONE (MAIN "B" ZONE)
- DIORITE DIKE

ASARCO Incorporated

YARNELL PROJECT
SECTION 900
YAVAPAI CO.,ARIZONA

0 100' 200'

mn 6914 MAM/dam tuc 3-20-90
file YAR-6914.DWG

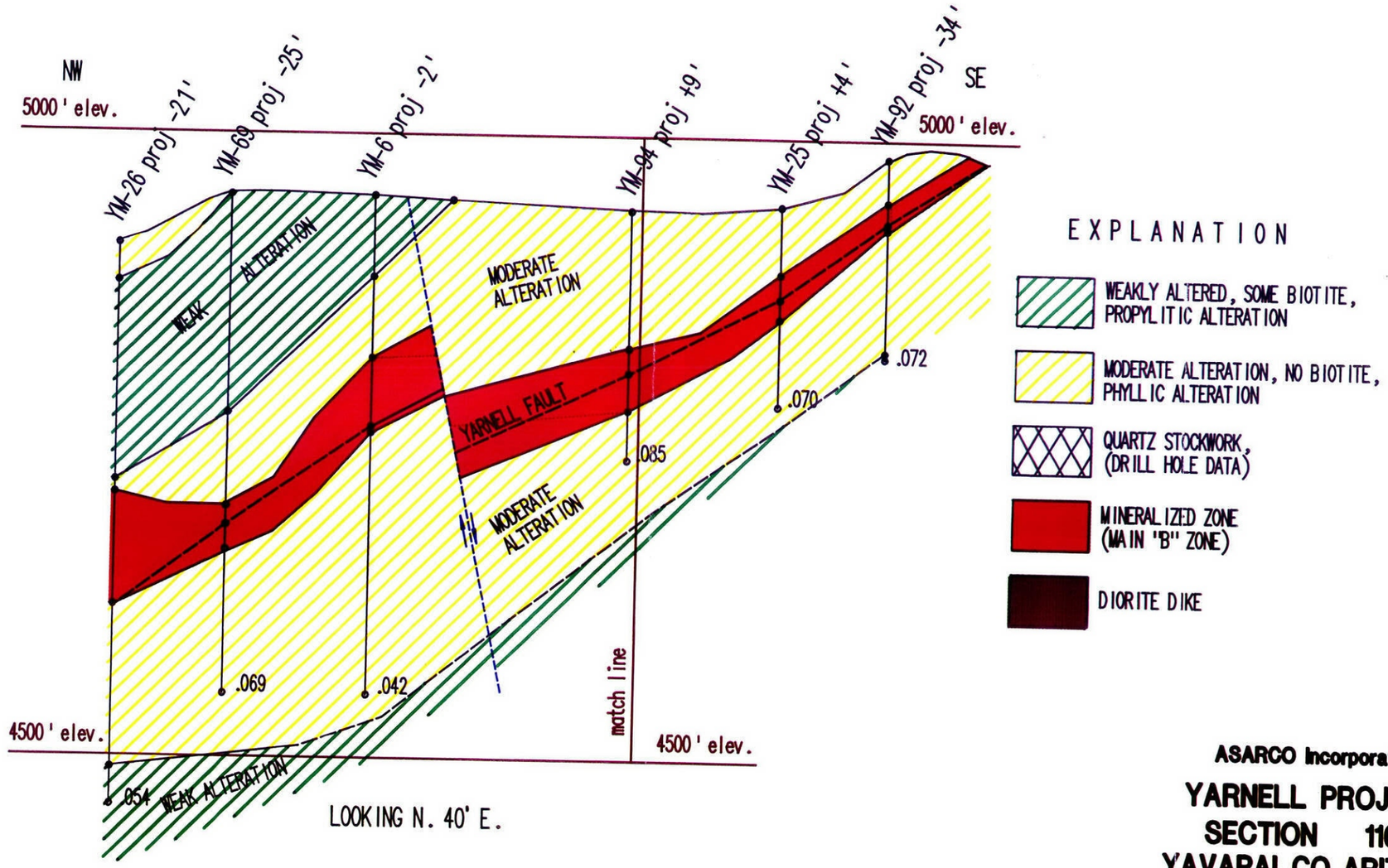


ASARCO Incorporated

YARNELL PROJECT
SECTION 1000
YAVAPAI CO.,ARIZONA

0 100' 200'

mn 6915 MAM/dam tuc 3-20-90
file YAR-6915.DWG



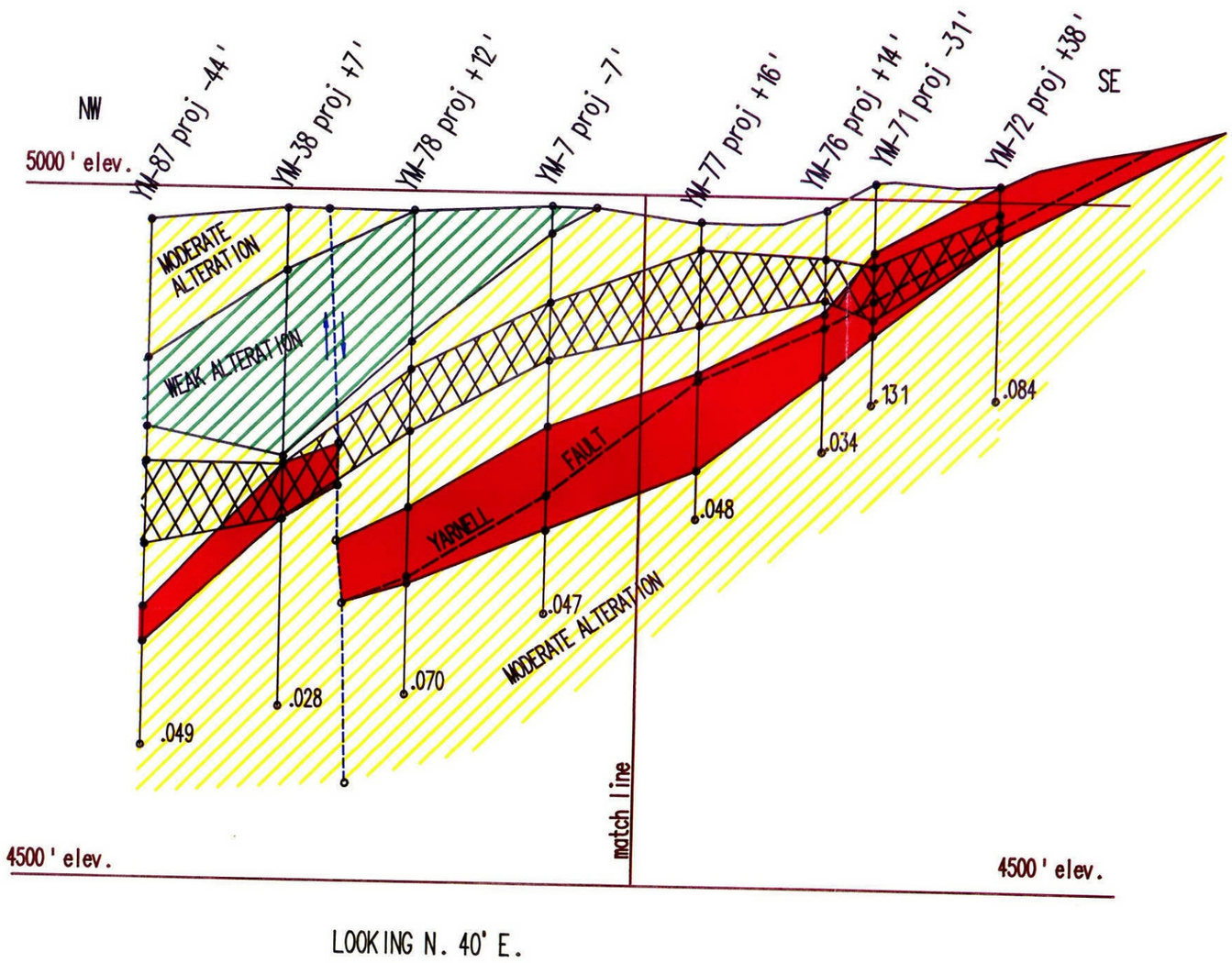
ASARCO Incorporated

YARNELL PROJECT
SECTION 1100
YAVAPAI CO.,ARIZONA

0 100' 200'

mn 6916 MAM/dam tuc 3-20-90
file YAR-6916.DWG

PLATE 5F



LOOKING N. 40° E.

EXPLANATION

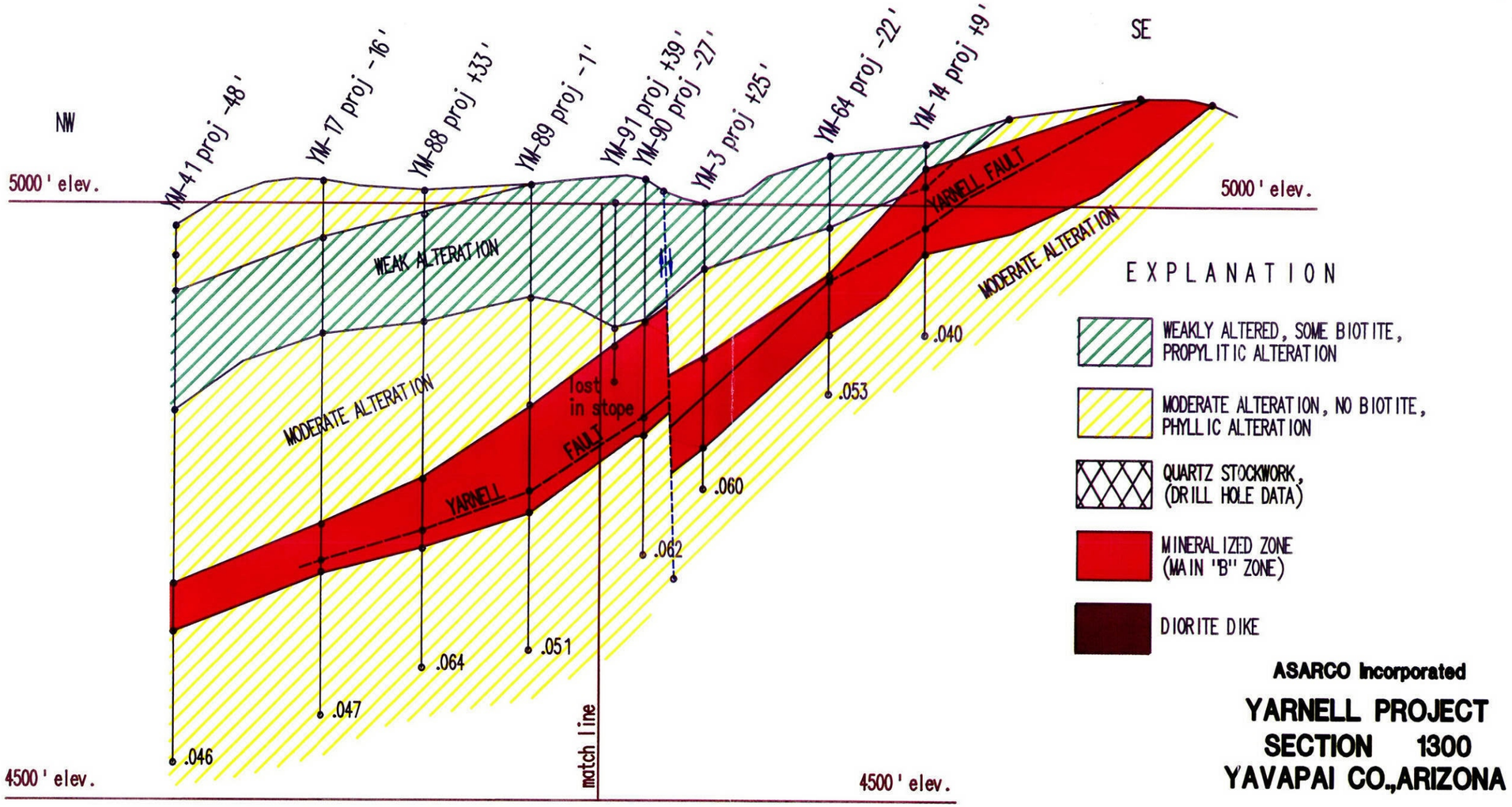
- WEAKLY ALTERED, SOME BIOTITE, PROPYLITIC ALTERATION
- MODERATE ALTERATION, NO BIOTITE, PHYLLIC ALTERATION
- QUARTZ STOCKWORK, (DRILL HOLE DATA)
- MINERALIZED ZONE (MAIN "B" ZONE)
- DIORITE DIKE

ASARCO Incorporated

YARNELL PROJECT
SECTION 1200
YAVAPAI CO., ARIZONA

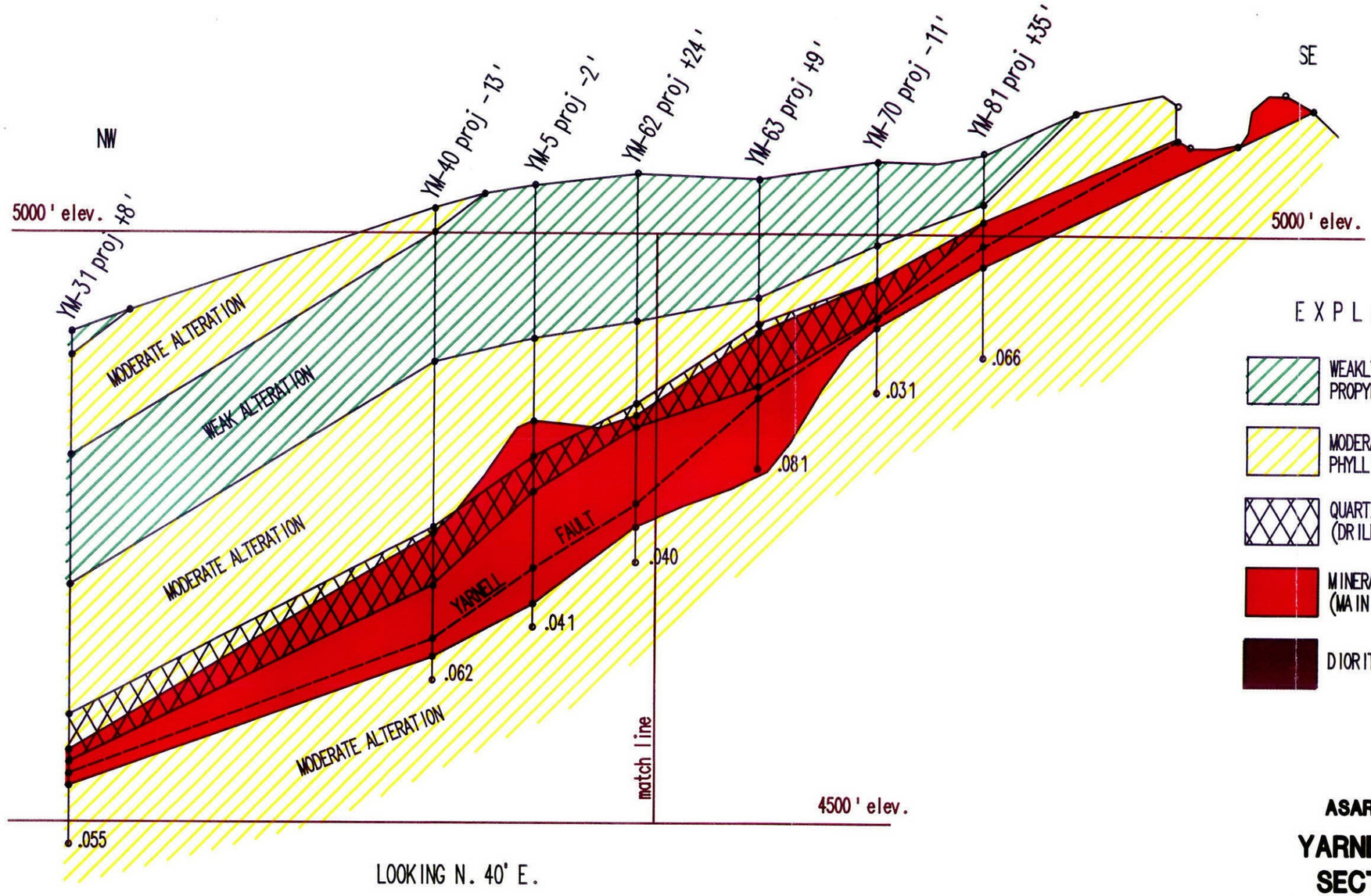
0 100' 200'

mn 6917 MAM/dam tuc 3-20-90
file YAR-6917.DWG



LOOKING N. 40° E.

PLATE 5H



LOOKING N. 40' E.

EXPLANATION

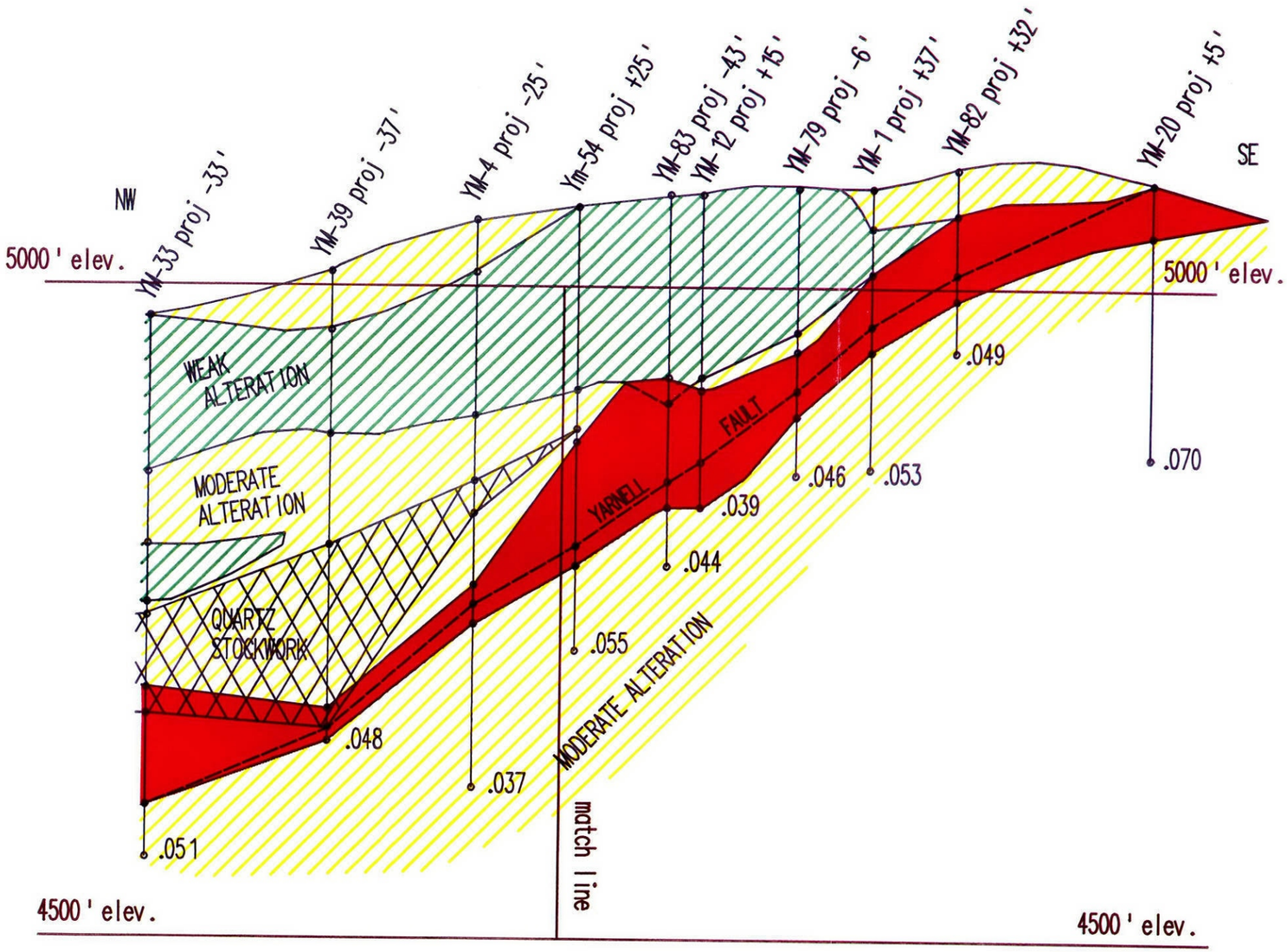
- WEAKLY ALTERED, SOME BIOTITE, PROPYLITIC ALTERATION
- MODERATE ALTERATION, NO BIOTITE, PHYLLIC ALTERATION
- QUARTZ STOCKWORK, (DRILL HOLE DATA)
- MINERALIZED ZONE (MAIN "B" ZONE)
- DIORITE DIKE

ASARCO Incorporated

YARNELL PROJECT
SECTION 1400
YAVAPAI CO.,ARIZONA

0 100' 200'

mn 6919 MAM/dam tuc 3-20-90
file YAR-6919.DWG



EXPLANATION

- WEAKLY ALTERED, SOME BIOTITE, PROPYLITIC ALTERATION
- MODERATE ALTERATION, NO BIOTITE, PHYLLIC ALTERATION
- QUARTZ STOCKWORK, (DRILL HOLE DATA)
- MINERALIZED ZONE (MAIN "B" ZONE)
- DIORITE DIKE

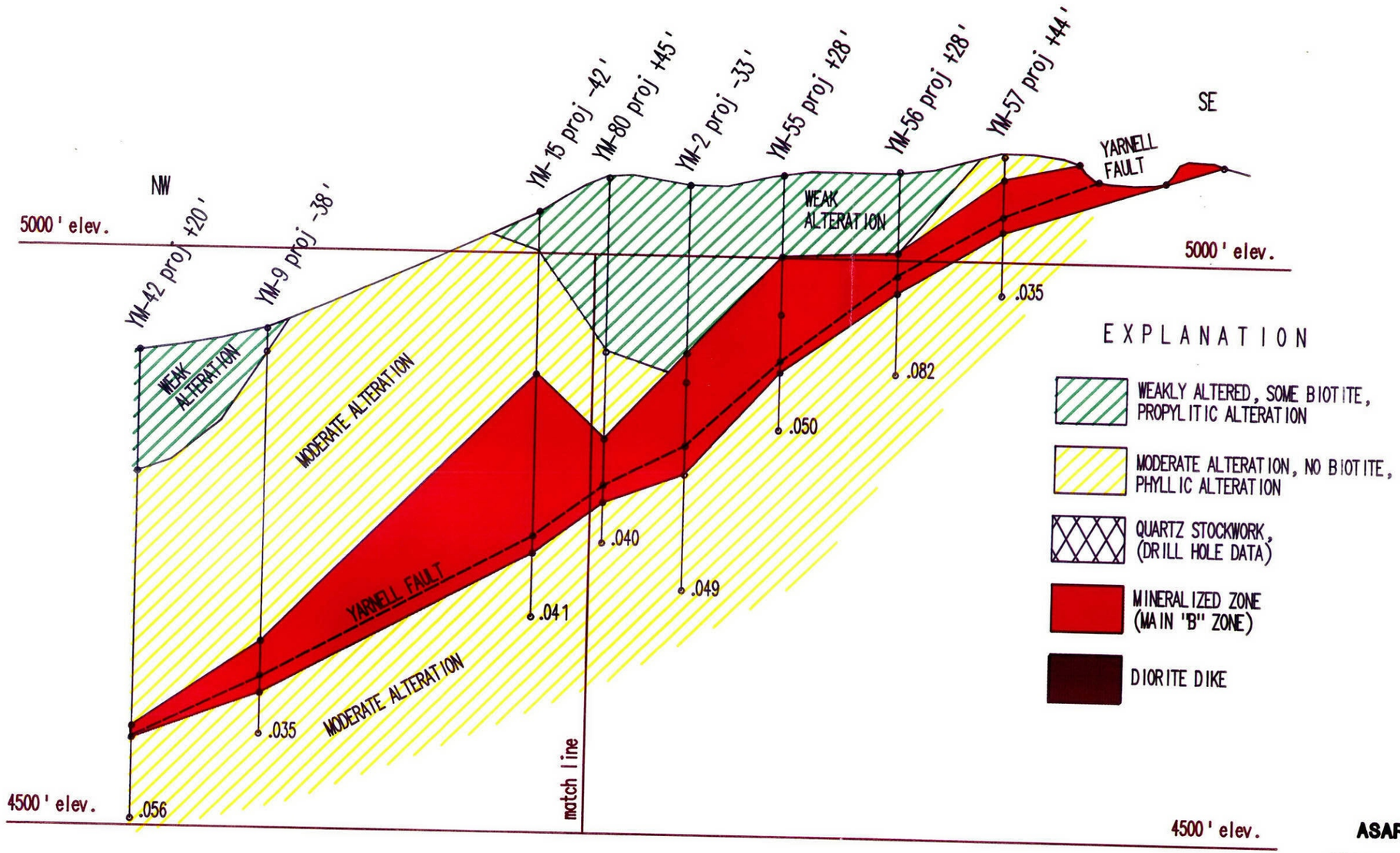
ASARCO Incorporated

YARNELL PROJECT
SECTION 1500
YAVAPAI CO.,ARIZONA

0 100' 200'

mn 6920 MAM/dam tuc 3-20-90
file YAR-6920.DWG

PLATE 5J



LOOKING N. 40' E.

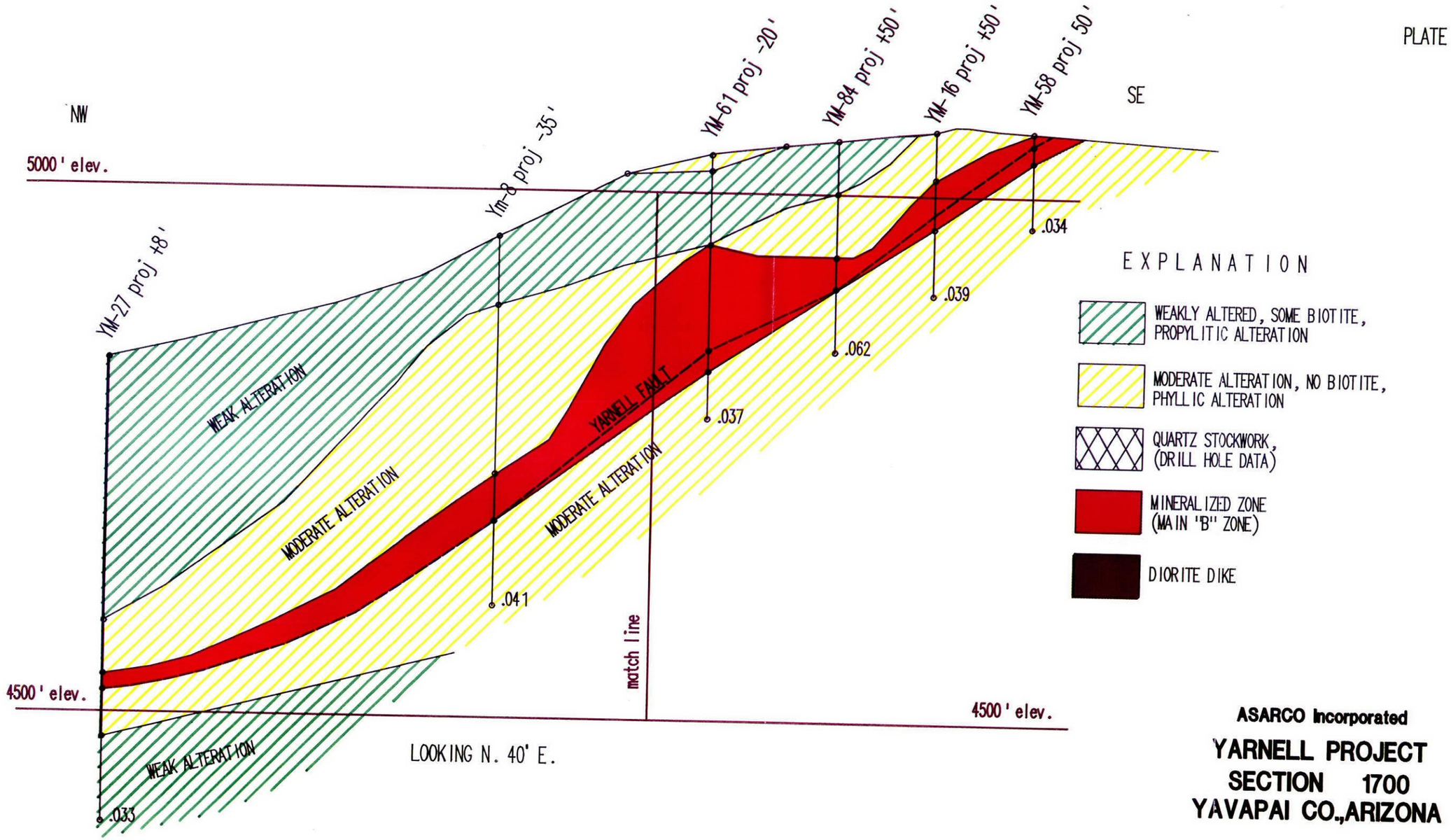
ASARCO Incorporated

YARNELL PROJECT
SECTION 1600
YAVAPAI CO., ARIZONA

0 100' 200'

mn 6921 MAM/dam tuc 3-20-90
file YAR-6921.DWG

PLATE 5K



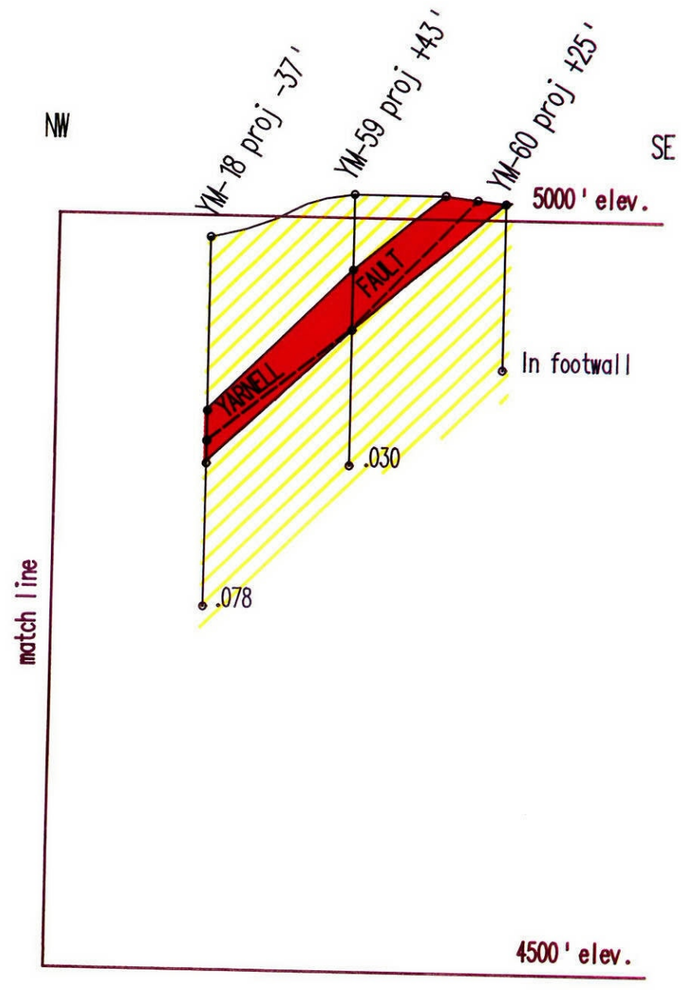
ASARCO Incorporated

YARNELL PROJECT
SECTION 1700
YAVAPAI CO.,ARIZONA

0 100' 200'

mn 6922 MAM/dam tuc 3-20-90
file YAR-6922.DWG

PLATE 5L



LOOKING N. 40° E.

EXPLANATION

- WEAKLY ALTERED, SOME BIOTITE, PROPYLITIC ALTERATION
- MODERATE ALTERATION, NO BIOTITE, PHYLLIC ALTERATION
- QUARTZ STOCKWORK, (DRILL HOLE DATA)
- MINERALIZED ZONE (MAIN "B" ZONE)
- DIORITE DIKE

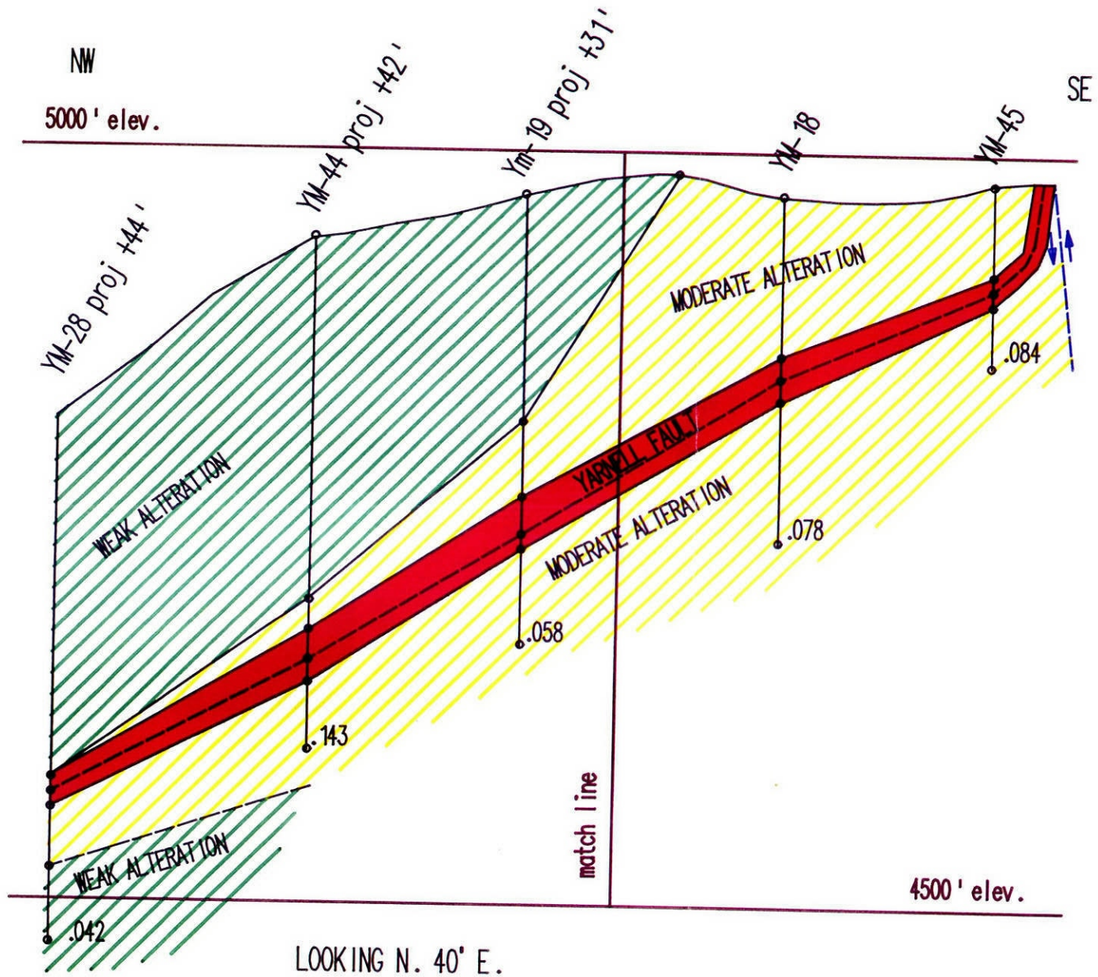
ASARCO Incorporated

YARNELL PROJECT
SECTION 1800
YAVAPAI CO.,ARIZONA

0 100' 200'

mn 6923 MAM/dam, tuc 3-20-90
file YAR-6923.DWG

PLATE 5M



LOOKING N. 40° E.

EXPLANATION

- WEAKLY ALTERED, SOME BIOTITE, PROPYLITIC ALTERATION
- MODERATE ALTERATION, NO BIOTITE, PHYLLIC ALTERATION
- QUARTZ STOCKWORK, (DRILL HOLE DATA)
- MINERALIZED ZONE (MAIN "B" ZONE)
- DIORITE DIKE

ASARCO Incorporated

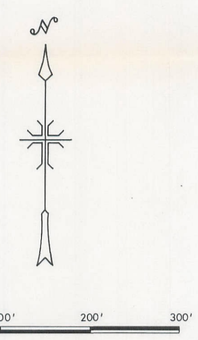
YARNELL PROJECT
SECTION 1900
YAVAPAI CO.,ARIZONA

0 100' 200'

mn 6924 MAM/dam tuc 3-20-90
file YAR-6924.DWG

HORIZONTAL SECTION, Elevation 5200

PLATE 6



TRIANGLES & DRILL HOLES USED IN STUDY PIT YARNELL PROJECT YAVAPAI COUNTY, ARIZONA

J.D.SELL 11/10/89

ASARCO Engineering and Computer Services

YARNELL PROJECT
COLLAR LOCATION MAP

SCALE in Feet	CHECKED BY	PLOT DATE	FILE
1:100.00		25-OCT-89	YARN-COLLAR

mn6811 JDS/aam tuc 11-10-89

DRILL HOLE COLLAR LOCATION MAP50W

DIAMOND DRILL RECORD

HOLE NO. _____

Coord. _____ N _____ E Elev. _____ PROPERTY YARNELL - LOGGING EXPLANATION SHEET.

Bearing _____ Inclination _____ Depth _____ LOCATION _____

Started _____ Completed _____ Notes by M.A. MILLER Scale 1" = 10' Sheet _____ of _____

DEPTH	% REC	A	ROCK TYPE	ALTERATION	B	C	D	E	MINERALIZATION	Graphic Col.	CORE ASSAYS
			WEAKLY ALTERED GRANITE BIOTITE PRESENT WEAK SERICITE	POTASSIC ALTERATION RIMS					FRACTURES / VEINING QUARTZ VEIN(S) IRON OXIDE ON VNLTS + FRACTURES OXIDIZED SULFIDES HEMATITE ON FRACTURES.		
				TEXTURAL DESTRUCTION RELATIVE INTENSITY EQUALS AMOUNT OF CROSS HATCHING							
			TRANSITION ZONE	BIOTITE					DISSEMINATED MINERALIZATION SPECULARITE		
			MODERATELY ALTERED, NO BIOTITE SERICITE PRESENT	TRANSITION - BIOTITE w/ HEMATITE RIMS					HEMATITE		
				CHLORITE					OXIDIZED SULFIDES. LIM AFTER PY / (LIM / PY)		
			UNALTERED GRANITE	SERICITIZATION DOTTED → SOLID SHOWS INCREASE IN AMOUNT OF ALTERATION					FRESH PYRITE		
			FAULTS / FAULT ZONE → FAULT BRECCIA	INTENSE PERVASIVE POTASSIC ADDITION							
				SILICA FLOODING AMOUNT OF CROSS-HATCHING = RELATIVE AMOUNT OF QUARTZ FLOODING							
				ARGILLIZATION							

COLUMN

B = BIOTITE, CHLORITE ETC.

C = AMOUNT OF SERICITE, POTASSIC ALTERATION

D : SILICA FLOODING

E : DISSEMINATED MINERALIZATION

DIAMOND DRILL RECORD

HOLE NO. Y-DD11-1

Coord. 101/315 N 49740 E Elev. 4957 PROPERTY YARNELL PROJECT

Bearing – Inclination VERTICAL Depth 350' LOCATION YM-8 REVERSE CIRCULATION LOCATION

Started 9/25/89 Completed 9/27/89 Notes by M. MILLER Scale 1" = 10' Sheet 1 of 4

DEPTH	% REC	A	ROCK TYPE	ALTERATION	B Biotite	C Sericite	D Silicic	E	MINERALIZATION	Graphic Col.	CORE ASSAYS Au (opt)	YM-8
			CASING-	NO RECOVERY								.004
75°			GRANITE-M/CRS GRND MOD EQUI-GRANULAR TYPICAL ASSEMBLAGE Qz, FPAR, BIOTITE	CORE V. FRIABLE DUE TO WEATHERING. BIOTITE + SERICITIC FPARS.					LOW % FRACTS TO CORE (75°) W/ MINR LIM/OXIDATION. (MOSTLY AS MUD) AND ALONG CORE BREAKS		.006	.003
10			LT PALE BLUE Qz "EYES" SLT OPALESCENT.	AS ABOVE BUT MORE COMPETENT CORE "CREAM COLORED" ALT. PRODUCT 1-2% USU ASS W/ BIO. ALSO PINKISH RED ALT PROD. ASS W/ BIOTITE							.003	.027
			- BROKEN ZONE						BROKEN ZONE W/ LIM FRACTS - (WK) + OXIDATION (WK)		.008	.002
20			- BROKEN ZONE						H.L WK OXIDIZED FRACTS.			
									OXIDATION + WK LIM ON FRACTS		.001	.008
							X		Qz VEINING W/ SILICIFICATION SELVEGE			
			- SLT BLEACHED? BIOT. - GRANITE WEAKER BIOT. THAN ABOVE								.004	.004
30									HIGH % WK OXIDIZED FRACTS 20° ⊥ TO CORE			
				- LT GREEN CLAY FILM ON FRACTS - WEAK IN APP. 2-3% ALONG FRACTS - DEC BIOTITE					WKLY OXIDIZED BUT SILIC FRACTURES. SOME LIMONITE IN FRACT FILLINGS. POSS WK STOCKWORK FRACTS -		.001	.037
			- POSS FAULT ZONE W/ Qz VEINING + GOUGE?								.012 .034	.212
60°			SAME AS ABOVE BUT MUCH MORE ALTERED. STILL LT PALE BLUE Qz INCLUSIONS - BUT ALT HAS DESTROYED TEXTURE	STRONG SERICITIC + SILIC ALT - V. WK BIO - POSS SEC??					Py REPS (LIM/Py) W/IN SILICIFIED ZONE 1-2% SOME OFF SETTING FRACTS WK MN STAINING ON FRACTS QUARTZ VNS (WHT) W/IN VNS 1/4" IN THICKNESS.		.134 .108 .195 .108	.235 RT
40				RED ALT ASS W/ BIOTITE V.V. WK BIOTITE					X-CUTTING LIMONITIC FRACTS + DISS LIM/Py 1-2% FROM 2 60-70° 1/4" Qz VN 55			.015
65			- BROKEN/GOUGY ZONE POSS FA? POSS SILIC GOUGE	BEG of STRONG ALT ZONE					MN FRACT SETTING 1/4 - 1/2" RED HM W/ REPS Py/LIM STRONGLY BROKEN ZONE 2" SILIC - Py/LIM REPS -		.125	.012
50			CRS GRN'D GRANITE WKLY ALT - BIOTITE PRES - 6-8%	MOD SERICITIC K-SPARS - SLT PINK PLAG. W/ MOD SILIC		X			MOST LOW % FRACTS W/ MINOR LIM/OXIDATION - 6" ZONE W/ NEARLY FLAT Qz VNS - 1-2" IN THICKNESS SPEC HM ON BOTTOM Qz VN 1/4 - 1/2" Py/LIM		.015	.014
						X			LIMONITIC "GRUNGE" ON CORE BREAKS 1/4" Qz VN. 65			
				DEC SILICA?		X			LIMONITIC FRACTS ESP ON CORE BREAKS. 1/16" CRUST 1/8" RUSTY BAND SPEC HM W/ LIM.		.003	.010
60	35					X			LIMONITIC FAULT 1/4" TIC. 55			
			- BROKEN - POSS FA. CEMENTED? GOUGE?	WK/MOD SERICITIC FPARS		X			HIGH LIM FRACT 1/4" Qz VNS → 60		.002	.004
			- BROKEN ZONE	BIOTITE BECOMING MORE ALT - POSS CHLORITIC?		X			BROKEN ZONE - LIMONITIC FRACTS. MOSTLY HI % - LIM "PAINT" 1/2" Qz VN - W/ ASS II H.L VNLTS. 50		.015	.013
70			AS ABOVE BUT LESS BIOTITE - STILL PINK PLAG SPARS -									
	80		CRS GRN'D GRANITE >10% BIOTITE - MOD/STRONG SER. FPARS -	ABU. BIOTITE - AB SERICITIC FELDSPARS.					1' RED HEM, Py/LIM + SILIC ZONE 60 PROB A VEIN TO Qz VNS W/IN. 50		.010	.01
						?			FAMILY OF 50-60° H.L FRACTS - WKLY LIMONITIC. 50-60°		.019	.037
80	50		AS ABOVE BUT MORE ALT - LESS BIOTITE BASE	DEC BIOTITE BECOMING MORE ALT?					LIMONITIC FRACTS - RARE "GREASY" GRN CLAY ON FRACT SURFACES		.008	.008
									SPEC HM/LIM FRACTS - ASS. Qz VNS - 30 60			
			- BROKEN ZONE						BROKEN ZONE Qz VNS W/IN		.012	.011
90				APPEARS TO BE SILICA FLOODING →					V. HIGH % Qz VN ASSOC Py/LIM CUBES DISS 1-2%			.012
	60		INC IN BIOTITE CHANGE ASSOC W/ Qz VEIN. 6-8%	THIN SILIC SELVEGES SOME Qz VNS -					MINOR OR/YELL LIM "PAINT"		.013	
									Qz VEINS - LIMONITIC - 70			
100				MORE ALT AROUND Qz VNS -					DISS Py/LIM CUBES - 1% 20° X-CUT LIM FRACT		.002	.015

DIAMOND DRILL RECORD

HOLE NO. Y-DDH-1

Coord. _____ N _____ E Elev. _____ PROPERTY _____

Bearing _____ Inclination _____ Depth _____ LOCATION _____

Started _____ Completed _____ Notes by _____ Scale _____ Sheet 2 of 4

DEPTH	% REC	ROCK TYPE (A)	ALTERATION	B	C	D	E	MINERALIZATION	Graphic Col.	CORE ASSAYS Au (opt)	
100	50	← CONTACT ON QZ VN 8-10% BIOTITE	BIOTITE STILL PRESENT - FELDSPARS SERICITIC SOFT (SCHIST) SILICA FLOODING →					H.C QZ VNLTS ASS w/ LIMONITE AS FILL.	100	.001	.004
	50	LESS BIOTITE - MORE CHLORITIC/ALT 3% - XENOLITH @ 109'	SILICA FLOODING GRP AROUND QZ VNS SELVEGE. SILICA FLOODING ASSN/ QZ VN.					Py/LIM ASS w/ SILIC TUF + QZ VEINING - SULFIDES MAINLY RESTRICTED TO QZ VNS - TN 1/8" QZ VNS →		.006	.01
110		MORE BIOTITE THEN PREV INTERVAL 4-5%	MOD/STRONG SERICITE ON FELDSPARS.					EARTHY YELLOW BRN LIM ON FRACTS. w/ SPEC HM - INCREASING SPEC HM ASS w/ EARTH YELL BRNT BRN LIM	110	.001	.01
								X-CUTTING 35-70° FRACTS LOCALLY SPEC HM w/ MINOR LIM			
120			POSS QZ FLOODING BUT WK					2" LIM FILLED FRACTURE SPEC HM VNLTS W/IN. ‖ QZ VNS → 1/4" TUF - LIM + Py VOIDS ASS w/ QZ VNS - SOME MINOR X-CUTTING VNS. 7/FT - X-CUTTING SPEC HM VNLT OPEN LIM FRACT	120	.039	.033
								LOW % QZ VNS CUTTING LIMONITIC FRACTS (OPEN) + OFFSETTING LIMONITIC FRACTS 1/4" OPEN LIMONITIC FRACT →		.050	.005
	60							Py/LIM AT CONTACT →		.004	.011
130		AS ABOVE - WEAKER BIOTITE 2% BIOTITE MORE CHLORITIC - 6" GOUGE ZONE FAULT?	STRONG SILICA FLOODING - ASS w/ QZ VNS - BIOTITE → PARTIALLY TO CHLORITE					ABU QZ VNING + SILIFICATION → POSS 2' QZ VN - Py/LIM 2-3% DISS IN. SOME X-CUTTING QZ VEINING ‖ QZ VNS 8/FT → WK LIMONITIC STOCKWORK → FAULT ZONE 6" GOUGE →	130	.016	.047
	60	- BROKEN TALC - PROB MYLONITIC FABRIC						LIMONITIC FRACTS/ THROUGH MICROFRACTS WK LIMONITIC STOCKWORK - PRINCIPAL DIP IS 7/-70° BRECCIATED QZ VN		.013	.017
140	60	1" MYLONITE ZONE	V.V.FG BIOTITE →						140	.020	.004
		1" XENOLITH - V.FG. SCHIST??	SILICA FLOODING PATCHY BIOTITE ENRICHMENT OF					LIMONITIC FRACTS - X-CUTTING 2-4 QZ VNS/FT.		.011	.004
150	60	CONTACT ON QZ VEIN. ABUND. BIOTITE CONTACT ON TN QZ VN.	REMNANT OF SLT. ALT BIOTITE GRAIN - SCRE FDSP.						150		
	60	MOD/STRONG ALT - TEXTURE IS MOSTLY DESTROYED. FEW REMNANTS OF UNALT ROCK w/ BIOTITE INCLUDED w/IN.	PINKISH ALT ASS w/ BIOTITE BIOTITE PATCH SILICA FLOODING - WK BIOTITE w/in INTERVAL					QZ VNS w/ 1% Py/LIM REPLACE SULFIDES. X-CUTTING FRACT'S - 6" QZ VN w/ SULFIDES (OXID) 2-3% Py/LIM CUBES DISS SULFIDES. ASS w/ QZ VNS. 2-3 QZ VNS/FT DISS OX SULFIDES 1-2%	160	.010	.02
160			BIOTITE ↓ CHLORITIC FEW PATCHES OF REM FRESH BIOTITE					SPEC HM FRACT. LIMONITIC + QZ VNS + FRACTS		.021	.043
								1/2" GOUGE ZONE 2 QZ VEINING → w/ SULFIDES ASS. w/ QZ VEINING		.058	.008
170			PROB CHLORITIC TIE REM V.F.G. BIOTITE					EARTHY BROWN LIMONITE → SPECULAR HEMATITE ON FRACTS LIM. FRACTS →	170	.016	.047
								X-CUTTING + CUT OFF QZ VNS - POSS 2 STAGES OF QZ? OFFSETTING MOUSHANITE ON FRACTS BOTH ON QZ VNS + LIM. FRACTS.		.017	.014
180								LIMONITIC QZ VNS - + LIM IN FRACTS V. MINOR OX SULFIDES. ALONG QZ VNS.	180	.021	.016
	70	- GOUGY ZONE 6-8"						2" QZ VN V.V FINE DISS OX SULFIDES - EST 1% OX SULFIDES (Py (ASTS)) LIMONITIC VNLTS -		.023	.029
		- BROKEN GOUGY ZONE SLICKENSIDES w/in ZONE						FAULT BRECCIA + ? GOUGE MINOR SPEC HM VNLTS w/ MOD LIMONITE - QZ VN FRAGS w/ DISS SULF (OX)	190	.019	.004
			W/K BIOTITE PATCHES REST CHLORITIC -					SPEC HM DISS ALONG FRACTS/ SOME w/ QZ FRESH Py DISS. ON FRACTURE RED HEMATITIC STAINING		.017	.009
200								PRIMARY Py (FRESH) ASS w/ QZ VNS. TIE MALACHITE w/ QZ VNS. 7/8 VNS/FT AS Py w/ QZ VNS	200	.067	.019

DIAMOND DRILL RECORD

HOLE NO. Y-DDH-1

Coord. _____ N _____ E Elev. _____ PROPERTY _____

Bearing _____ Inclination _____ Depth _____ LOCATION _____

Started _____ Completed _____ Notes by M. MILLER Scale 1" = [illegible] Sheet 3 of 4

DEPTH	% REC	A	ROCK TYPE	ALTERATION	B	C	D	E	MINERALIZATION	Graphic Col.	CORE ASSAYS Au (opt)	VM-8 RC Au
200			Broken Zone - wk Gouge Granite m/crscomp - Strongly Alt - Sericitic w/ Fpars -	Little Rem Biotite Rest Alt → Chlorite? Feldspars Strongly Sericitic. Silica Flooding - Some Textural Destruction					Probable Fault Zone Gouge - Spec Hm on Lim Fract ox Sul Ass w Qz Vns 2-3 Qz Vns/Ft. Abu. Hi & Lim. Vnlts 70		.013	.012
									50		.029	.005
210									Diss Ox Sulfides in Silic Zone Silica Zone Hi & Limonitic Fracts 75		.061	.019
			Broken, Gouge Zone						Qz Veining w/m Slickensides on Fractures Broken Zone Prob Fault Slt/Mod Gouge 70		.020	.01
220	5		Broken Chip Type Fracturing.	Strong Silica Flooding					F.G Hi & Shears? w/ ox Py casts est 1% Py. Gouge Zone on Top. Lim Fracture/Qz @ Bs		.017	.004
	70		1" Gouge Zone. Broken Thru → 228' Poss Fault?						Abu. Lim Filled Fracts w/ Minor Spec Hm - wk Diss Py (Ox) Cubes ½-1% Prob Fa Zone Broken 70		.043	.047
230			¼-½" Gouge Zone.	Strong Silica Flooding Flooding Bays out Phenk-spars-wat.					10 Qz Vns/Ft 1/16" Py Voids. → L" Gouge @ 228.5' Diss Ox Py Cubes - 3% 4		.013	.044
									Limonitic - +/- Qz on Hi & Fracts w/ Minor Spec Hm Diss Ox Sulfides 1% 5-7 Qz Vns/Ft 40°		.003	.029
240			0.5' Core Loss - Grano.	Granitic Texture Still Present But Var. Flooded.								
			Var Broken + Gouge - Abu Fracts → Gouge + Mud Zone 70						Broken + Fractured Limonitic "Paint" on Fractures Also Limonitic Muds. wk Ox Sulfides w/in < ½% 70		.016	.019
250			1" Gouge Zone 7°						Limonitic Fractures w/k Diss Ox Sulfides		.009	.013
											.065	.048
			Textural Destroyed Dict to Morg Intense Silic + Sericitic Alt.	Abu Silica Flooding Prominent Feldspars (wht) Bleached out By Si Flooding w/k Chloritic Rem →					Mod Abu Gy - Irr Silica Flooded Fault. Diss Ox Sulfides (Py) Cubes. 2-3% Sulfides 70		.079	.057
260			Bottom 3' Not As Silic But Still Strong Textural Destr.						Slt Red Hm Staining Either Assy Gy Qz Vn or Total Silica Flooded Zone Diss Py (Ox) 2% Total Limonitic Fracts Thruout O.C. Limonitic Paint on Fractures 70		.153	.063
			Contact @ Fault	Thob Yarnell Fault. Top.					Lim Zone Top 1" of Fault 70		.012	.023
270			- Gouge Zone @ Top Yarnell Fault Zone - Gouge @ Top. Argillic Alt/ 1" Gouge @ Bs. 70	Argillic Alt → Red Hematite As Shown.					Red Hematite + Oxidized. Zone. w/Abu Clay/Gouge Strongly Lim. Muds? → 70		.019	.037
			Sericitic - Still Cubby Gouge Zone.	Argillic Alt Textural Destruction					Abu Lim Fracts 41 to Structural Direction. ¼" wht Qz Vn.		.002	.004
280			- Poss Alt "Basic Dike" - Broken Zone	Sericitic. Becoming Less Intense					Broken Zone But wk Limonitic Coating + Float Fill		.004	.003
			- Broken Zone - Gouge - 2" Gouge Zone	Biotite Alt (Red) Reduces Pos Y. Wk Biotite Also.					Few Limonitic Fracts		.002	.002
			Becoming Weakly Alt But Not Biotite						Principle ∡ is 70° w/k Limonitic "Paint"		.002	.003
300									Minor Healed Fractures - Some Weakly Limonitic		TR	.004

DIAMOND DRILL RECORD

HOLE NO. Y-DDH-1

Coord. _____ N _____ E Elev. _____ PROPERTY YARNELL

Bearing – Inclination VERT Depth 350' LOCATION YM-8 R.C LOCATION

Started _____ Completed _____ Notes by M. MILLER Scale 1" = 100' Sheet 4 of 4

DEPTH	% REC	A	ROCK TYPE	ALTERATION	B	C	D	E	MINERALIZATION	Graphic Col.	CORE ASSAYS Au (opt)
			GRAY TH LOOKING BUT POSS MORE CHLORITIC	W/MOD SER - TR BIOTITE					OXIDATION OCCURS ONLY AROUND FRACTS/VALLS - FRESH PY ON FRACTS - GU PIP / PROM. DIRECTION		300 .001 .004
			APPROX 35 OXIDIZ ZONE								
310			POSS DIFF ROCK TYPE MORE CHLORITIC LESS OVERALL SILICA BUT STILL HEAVILY ALTERED. GREENISH TINT to ROCK.	LITTLE SILICA FLOODING DEC ALT.					1/16" QZ VEIN RARE OX PY - W/IN OX ZONE SE FRACT		310 .001 .003 TR .005
			CHLORITIC - GREENISH TINT -						W/R DISS PY (FRESH) FROM OXID FRACT.		TR .003
320			± TR OPALESCENT QZ -	4 - 6% - BIOTITE							320
			BIOTITE REAPPEARS -								NIL .005
									HEALED CLEAN/WELL OXIDIZED FRACTS -		TR .004
330											330
									TR DISS PY - V.V. FINE CUBES USUALLY ASS W/ BIOTITE SITES TO TR	70	TR .003
									TR LIMONITIC FRACT	70	
340									OXIDIZED FRACTS - NO LIMONITE		NIL .005 340
				LIMEG TO Red MAROON BIOTITE ALT PRODUCT POSS EDGE of LOWER ALT. ZONE TO TR					OVERALL INC IN OXIDATION + FRACTURING - NOTABLE INC.		.001 .002
									SPEC HM FRACT TR DISS SPEC HM		TR .002
350											350

TD @ 350'

DIAMOND DRILL RECORD

HOLE NO. YDDH-2

Coord. 100,507 N 49510 E Elev. 5024 PROPERTY YARNELL

Bearing _____ Inclination _____ Depth 400 LOCATION TWIN TO YM-40

Started 9/29/89 Completed 10/8/90 Notes by M. MILLER Scale 1"=10' Sheet 1 of 4

DEPTH	% REC	A	ROCK TYPE	ALTERATION	B	C	D	E	MINERALIZATION	Graphic Col.	CORE ASSAYS
0			0-3' CASING- BIOTITE GRANITE M/CRS GRN'D. 5-8% BIOTITE LOC AS CLOTS → 2-3mm IN SIZE.	NO RECOVERY. WK → MOD (W DEPTH) GREENISH FELDSPARS- SERICITIC?					ABU OXIDIZED FRACTS + CORE BREAKS- PROB SURFACE OXIDATION. DIPS RANGE FROM 50-70° ON CORE BREAKS.		.002
											.004
									20 60		.040
10			- BREAKER ZONE. - BROKEN ZONE	INCREASING RED ALT ASS W/ BIOTITE					BROKEN ZONE W/ WK OXIDATION ALONG FRACTS		.002
											.033
									TR < 1/16" QZ VEINS → 60 70 30		.003
									SLT LIMONITIC FRACTURES W/ TR.		.025
20									40 BROKEN + FRACT- MINOR LIM-		.002
	60			< 1/2% OVERALL					TR QZ FRACT W/ MINOR QZ - 40		.003
									TR GOUGE ZONE? 60		.01
									1/16" LIMONITIC MUD ZONE? POSS. FAULT?		.003
30									35 FRACTURED- TR LIMONITE		.009
			AS ABOVE BUT INC IN BIOTITE 10%+	INC IN RED ALT- (HEMATITE REPLACEMENT)					TR Py/LIM CUBES- 60-70°		.003
									CORE BREAKS- V. MINOR LIMONITE		.001
40			- BREAKER ZONE.	K SPAR XLS- SERICITIC ON RIMS BECOMING LESS ALT → INTERIOR.							TR
									LIMONITIC FRACTURE 50		.002
											.001
									MUDY LIMONITE AS GLAZED ON FRACT		.013
									Py/LIM CUBES - LITTLE RED HEMAT FRACT.		.009
50			DEC IN BIOTITE < 3%. TRANSITION ZONE	INC IN HM REPLACEMENT @ BIOTITES; INC IN SERICITE							.002
				HM REPLACEMENT ~3% SILICA FLOODING POSS. POTASSIC ALT- W/IN SILC ZONE			B		1" QZ VN- M GY IN COLOR 70		.004
									4-5 FRACTS/FT. SLT/MOD LIMONITIC		.002
	50		1' GOUGE ZONE PROB FAULT.	POSS MOD SILICA FLOODING					1" QZ VEIN- M.GY 50° 80		.007
60									POSS GOUGE ZONE →		.002
			HI BIOTITE ZONE 10%+ BIOTITE						70		.006
				GRADUAL CHANGE FROM BIOTITE → CHLORITE					RED HM SPOTTING ON FRACTURE SURFACES. 1" GY QZ VEIN → 70		.021
			MOD BROKEN ZONE						SPEC HM BEGINNING TO REP BIOTITE. 1/4" GY QZ VEIN → 70		.002
70											.004
									6-8 FRACTS/FT- LITTLE LIM. 50°		.003
			MOD/STRONG FRACTURING.						1/2" GY QZ VEIN 70 3" GY QZ VEIN 70		.003
			3" "GOUGE ZONE"								.012 .022 .005 .001 .010
									FAULT W/ GY QZ VEIN AS SHOWN ~ 3" QZ VEIN. 70 50		.058
80			PROB FA ZONE GOUGY- GRANULAR RECOVERY.								
									QZ VN PSEUDO STOCKWORK		.005
				POTASSIC RIMS AROUND QZ VEINS					PINK POTASSIC RIMS AROUND QZ VEINS ASS. FRACTS W/ LIMONITE 60-70°		.005
											TR
											.003
											.002
				POTASSIC RIMS AS ABOVE					// TO SUB // QZ VEINS (GY IN COLOR) ASS LIM W/ QZ VEINS SMA X-CUTTING. 60°		.003
100											.013
											.002

DIAMOND DRILL RECORD

HOLE NO. Y-001-2

Coord. _____ N _____ E Elev. _____ PROPERTY _____

Bearing _____ Inclination _____ Depth _____ LOCATION _____

Started _____ Completed _____ Notes by _____ Scale _____ Sheet 2 of 4

DEPTH	% REC	A	ROCK TYPE	ALTERATION	B	C	D	E	MINERALIZATION	Graphic Col.	CORE	ASSAYS	
			ALTERED GRANITE w/ BIOTITE PROB ALT → CHLORITE → SPEC HM. SAME GRAIN SIZE PERSISTS.	CHLORITE → SPEC HM @ FORMER BIO SITES. SERICITE FELDSPARS - SILICA FLOODING					ABUNDANT FRACTURES w/ MINOR LIM. MAD GOUGE ZONE 1' ZONE 60 60		160	.003	.001
									TN GY QZ VEIN' BROKEN ZONE H & SLY LIM FRACTS			.002	.002
110				TR POTASSIC ALT ASS w/ GY QZ VNS/VNLTS.					PARALLEL → SUB // QZ VEIN (GY IN COLOR) SOME OK GY QZ VEINING. w/ DISS PY/LIM < ½ % 50		110	.002	.003
									QZ VEINING AS ABOVE w/ POTASSIC? RIMS 6" QZ VEIN GY IN COLOR →				
									DISS SPEC HM @ FORMER BIO SITES 2% +			.098	.002
120			SLY LIM IN BIO/CHL.	PROB QZ (SILICA) FLOODING					40		120	.002	.003
									¼" QZ VEINING (GY) 40				
									40			.002	.005
130									20		130		
									MOSTLY HI % FRACTURES LITTLE OXIDATION ON FRACTURES - + LIMONITE.			.002	.003
									½" GY QZ VNLT →			.004	.004
140				SILICA FLOODING.					¼" GY QZ VEIN. 20 60 ½" QZ VN (GY) 60 ½ GY QZ VN - w/ SPEC HM INCLUDED IN QZ 60 50		140	.005	.028
									MORE OXIDIZED ZONE BROWN STAINING				
				LOC POTASSIC RIMS AROUND QZ VNS -					X-CUTTING QZ VNS/VNLTS - QZ VNS w/ INCLUDED SPECULARITE 60 70 50			.003	.006
150			MOD/STRONG BROKEN ZONE						BROKEN ZONE - LITTLE LIM FRACTS —		150		
									1" QZ VEIN → HI GY IN COLOR			.011	.009
												.005	.008
160			BROKEN ZONE								160		
				POTASSIC RIMS (SELVEDGES) AROUND QZ VNS.					1" QZ VEIN 50			.001	.016
									AREA of HI % GY QZ VEINS → 1" THICK. W/ STOCKWORK? 40 1" WHT QZ VEIN ← MINOR PY/LIM - DISS SPEC HM 2% + 20-50° DIPS SEEN			.017	.004
170									2' QZ VEIN SPECULARITE ON FRACTS - TRACE CuOx IN SMALL VNS - ALSO TR BY IN QZ BOTH WHT + GY QZ IN VEIN. 50		170	.002	.003
									SHATTERED QZ VEINS → ½" IN THICKNESS. (GY QZ) SOME LIM FRACTS W/ DISS PY/LIM < ½% 60-70°			.002	.002
180			BROKEN ZONE PROB FA w/ GOUGE	SI FLOODING					½" QZ VEIN GY IN COLOR ½ LIMT PY/LIM ASSOC/QZ VEINS. ALSO SPECULARITE VEINS/LETS -		180	.008	.003
50									70			.004	.002
			BROKEN ZONE BROKEN CORE						60		190		
				POTASSIC SELVEDGES AROUND QZ VEINS					QZ VEINS. 9-5/FT COL. 1-2 AVE → ½" TK LIM FILLED ½ MICROFRACTS X-CUTTING QZ VNLT SUB PARA. OCC PY/LIM CUBES OVERALL < ½%			.001	.002
200			BROKEN ZONE - PT. GOUGE. FA??						BROKEN - BUT LIM / SPEC FRACTURES 5-7 MAIN FRACTS/FT. AND MINOR FRACTS		200	.002	.004

DIAMOND DRILL RECORD

HOLE NO. YDDH-2

Coord. _____ N _____ E Elev. _____ PROPERTY YARNELL

Bearing _____ Inclination _____ Depth _____ LOCATION _____

Started _____ Completed _____ Notes by _____ Scale _____ Sheet 3 of 4

DEPTH	% REC	ROCK TYPE	ALTERATION	MINERALIZATION	CORE ASSAYS
200		Broken Zone Broken Core	Mod Abu Potassic Alt - Seems to be More Than Selvegs -	Predom. Fract's 70° - However Abu X-cutting Micro Fracts - Some Micro Qz Vn/ts - 8-10 70° Fract's/ft - Spec on Fracs. Specularite @ Biotite Sites	.004
		Broken Zone	Silica Flooding	Broken Zone - Some Gouge Some Qz Vns (Gy) w/ "Earthy" Brn Lim.	.032 .015
210	70 75 70 60	6-8" Gouge + Fault Zone 1/4" Gouge Zone w/ Lim Mud in Pt		1/4" Qz Vn 4 (Gy) Fault Zone As Shown in Rock Type Sec. 3" Gouge Zone As Shown	.040 .003
				Qz Veining - Poss Stockwork 4/ft Microqz Vn/ts - Also Abu. Lim Vns/Micro Vn/ts - 8-10/ft Py/Lim Cubes < 1% Open Fract's w/ Lim Fill Some Lim/Qz Veining on Micro Vn/ts	.014 .003
220		Mod/Strongly Broken Core Gouge Zones, Lim Fract's		"Earthy" Brn Limonite on Fract. Pt Open Qz Vein Limonitic Lim/Mud Filling Fract	.001 .013
	65	6" Gouge Zone 228		Hi % Fracts + Cu-70° Fracts - All Limonitic - Some Lim. Muds - Few Qz Vns 1-3 cm/Lim. Mostly Broken Core on Fracts.	.002 .003
230				Gy Qz Veins/Vn/ts - Diss Py/Lim < 1/2%	.022 .007
			Abundant Qz (Silica) Flooding Potassic Selvegs? Also Alt of Discrete Feldspars (Pinkish Selvegs)	2" Gy Qz Vein. Diss Py/Lim, Cubes → 1/4" Est 2%	.023 .011
240			Silica Flooding Prob Due to Amt + Size of Qz Veining.	Pt Open/Limonitic Qz Vein - Specularite/Qz Vn/t Stockwork? Qz Veining. Prom. Potassic? Rims - 1-1 1/2% Py/Lim Cubes Qz/Limonite Vein. Earthy Lim. w/ Py/Lim	.003 .006
				"Bleached" Fragment - Poss Breccia → Specularite Vn/ts. X-cutting	.003 .003
250				Hi % + Low % Qz Vn'ng Some X-cutting Qz Vns. Mod Lim Ass. w/ Qz Vns.	.002 .003
			Silica Flooding Related to Qz Veins - Some Potassic Selvegs.	Qz Veining Stockwork Specularite/Qz Vns -	.004 .009
260			Mod Abu. Silica Flooding	1% Py/Lim. Qz/Lim Veins/Vn/ts.	.003 .009
		Broken Zone Hi % Bits on Core	Potassic Selvegs - Around Qz Vns.	< 1% Py/Lim Cubes - Qz/Lim Vns/Lets - X-cutting Qz Vns -	.003 .003
270	30	1/2" Clay/Gouge Zone	Chlorotic Alt - Bleaches Sericite?	Loc Large → 1/2" Py/Lim Cube in Qz Vn.	.003 .005
	60	Broken Zone Poss Fa Zone		Stockwork Qz Veining Both Wht + Gy Qz Vns Strong Wht Postdates Gy - 1% Py/Lim w/ Qz. Potassic Alt Lot spec Hm Broken But Qz Vns -	.015 .023
280				Qz/Lim Vns - Stockwork - Near Vert Specularite/Qz Vn/t. 2% + Py/Lim Cubes Lim Lines Fract Then Qz - Lim Vns -	.011 .018
			Potassic Rims.	6" Wht Qz Vn - Gy Qz Vn Terminates Against This: Specularite Vn/ts - 2% Py/Lim Cubes 6" Wht Qz Vn Some 1/4" in Size - Usually Gy Qz Vns -	.011 .012
		Observed Contact			
290	50 40 30	Appears to be Sinic Myl Zone? Frags of Qz Vn Wall Rock Gal-Lato Wht Qz Vns X-cut. Clay Zone 295' Fault Gouge Dip Estimated	Strong Silica Flooding Poss w/ Potassic Rims.	289-91 - Poss Qz Vn - w/ Inclusions of Wall Rock. 291 - Mostly Wht Qz Vns. Overall 10% Oxidation Gouge < 1% Py/Lim Cubes Large Cubes → 1/4" Assu/ 6" Qz Zone → Wht Qz Vns - Myl/Gouge	.067 .129 .031 .036
300					

DIAMOND DRILL RECORD

HOLE NO. YDDH-2

Coord. _____ N _____ E Elev. _____ PROPERTY _____

Bearing _____ Inclination _____ Depth _____ LOCATION _____

Started _____ Completed _____ Notes by _____ Scale _____ Sheet 4 of 4

DEPTH	% REC	ROCK TYPE (A)	ALTERATION	MINERALIZATION (D, E)	CORE ASSAYS
300		Contactation of Silic + Gouge Fault Zone	Silica flooding	Minor Qz Vns - Lim on Fract. Surfaces - Lim/Py Cubes - Gouge/Fractured Zone.	.122 / .041
	30	Major Silicification	Strong Sec - Sma -	Wht Qz Vein - 70	
		↓ Varnell Fault Zone Contact.		2-3% Py/Lim Cubes -	.077 / .027
310	70	Varnell Fa. Zone Strong Bxd Hm Zone 2 Brecc 1-4	Silicified Mylonite	Varnell Fault Zone - Visible Au on Fractures 100% Red Hematite in Mylonite	.320 / .177
		Silic Qz Bx @ Top Strong Gouge Zone Related to YFZ	Poss/Prob Argillic Alt. w/in Gouge	Mylonite/Gouge Zone - Mod Red Hm Lim/Py + Lim Fracts + Muds - 70	
	70		Silicified → Textural Destruction Argillic Alt?	Qz Veining/Vnlts w/in Silicification	.091 / .038
320		- Strong Mud/Gouge @ Bs		Py/Lim Along & Accn/Qz Vns. 1+% Py/Lim + Red Hm Ass. w/ Py/Lim.	
	60	- Gouge Zone	Argillic Alt -	Shattered Wht Qz Vein 60	.015 / .013
		Broken Zone - Broken + Shattered Qz Vein. 2' in thickness. Many Gouge + Clay Zones.	Mod Silification	Strong Lim in Gouge → Gouge →	
330		Broken Zone	Initial Silica Flooding - w/ Strong Argillic Alt.	Py/Lim Cubes Shattered Wht Qz Vns Py/Lim Cubes w/in Argillic Gouge Zone. 2% to 10% overall Lim/Oxidation	.079 / .021
		Intensely Broken Prob Gouge Zone.	Potassic Alt - Ass. w/ → Qz Vns		.174 / .162
		Gouge Zone	Silica Flooding	Shattered Qz Veins Mostly Wht, Abu Fracts w/ Limonite, Diss Py/Lim - 60	.099 / .043
340		6" Gouge Zone			
		Gouge/Mud + Clay Zone		Abu Py/Lim Cubes 2% overall - Red Hematite on Fracts + as Stains -	.029 / .034
		320-353 Intensely Broken + Gouge Zones - Prob Fault Zone Contact Obscured	Continued Argillic Alteration w/ Silic Overprint	Broken + Gouge Zone Silification Mod Abu Red Hm Stain on Microfracts	.029 / .108
350				Gouge/Fault Zone Minor Lim.	
		Silic Fault Zone. Brecc in Fragments	Qz Flooding	Strong Qz Veinlets. Gouge Mostly Lt Gy Vnlts -	.082 / .081
	70	Red Hematite Fault Zone → Gouge Contact Obscured.		Red Hematite Fault Zone w/ Gouge / Abu Red Hem Mud. Qz Vn Fracs w/in Fault Zone + 3% Diss Py/Lim. Broken Lim Zone	.152 / .131
360	70	Gouge	Alt Changes to More Sericitic → Chloritic? @ Bs -		
		- Broken + Gouge Zones		Wht + Gy Qz Vns - Py/Lim Ass. w/ Qz Vns - 1-2% Hi & Lim Fracts Wk Stockwk.	.036 / .043
		- Red Hm Mud Gouge Zone -		Shattered + Bx'd Qz Vns involved in Fault	.013 / .079
370		Varnell FZ Complex Prob 310-380+/- Companion Faults. Contact is Estimated.		N-12/F4 + Gouge Hi & Qz Vnlts - Ass Py Lim w/Qz Vns - Numerous Gouge Zones - 1-2% X-cutting Lim Fracts w/+w/o Qz wk Red Hm on Fracts + Diss -	.046 / .033
				Lim +/- Qz Fracts - 20-30°	.008 / .018
380		Porphyritic Rock - Large K-spars - Gouge Rock Unalt - Rock has a Greenish Tint - Poss Chlorite?? Broken Zone	Poss Chloritic Alt?	Gouge Zone. Mod Abu. X-cutting. wk Lim Fracts - Few Py Cubes/Lim	.004 / .005
		Porphyritic Granite in T.W. of YFZ?? - Broken Gouge Zone	Poss wk Qz Flooding?	Hi % Limonitic Fracts -	.003 / .003
390			Unoxid m. Alt	Few Lim Fract's -	.004 / .009
		- Broken Gouge Zone -		Broken Gouge Zone - Lim in Py w/o Diss Py	.007 / .004
400			TD @ 400'		

DIAMOND DRILL RECORD

HOLE NO. Y-DDH-3

Coord. 100,316 N 49723 E Elev. 5045 PROPERTY YARNELL

Bearing — Inclination -90 Depth 325 LOCATION TWIN TO YM-63 25' N65°E

Started 10/9/89 Completed 10/13/89 Notes by M. MILLER Scale 1"=10' Sheet 1 of 4

DEPTH	% REC	A	ROCK TYPE	ALTERATION	B	C	D	E	MINERALIZATION	Graphic Col.	CORE ASSAYS	R.C. YM-63
			0-6' CASING	NO RECOVERY-							Au (opt)	.002
10			BIOTITE GRANITE, M/CRS QZ'O, EQUIGRANULAR. 10-13% BIOTITE	W/K SERICITIC SHEEN ON FELDSPARS-					H.L LIMONITIC FRACTS		.004	.001
			BROKEN DECOMPOSED ZONE	SOFT PROB SUB OXID. RED ALT RIMS ARound BIOTITE 1-2% (HM REPLACEMENT?) POSS IAC ↓					4-5 FRACTS/FT w/ w/k LIM	40° 80°	.001 .002 .001 .016 .004	.057
20				MOD SERICITE ON FELDSPARS. → MORE COMPETENT CORE POSS V. W/K SILICA FLOODING					½" QZ VN GY IN COLOR 70		.005	.003
											.007	.004
30	50°		PROB FAULT/ QZ VEIN ZONE - BIOTITE ARGILLIC → GOUGE + BROKEN ZONE	POSS SILICA FLOODING -					Py/LIM LOCALIZED IN QZ & SOME IN GROUNDMASS. 50 6" QZ VEIN - 80 FROM Py/LIM CLASTS		.070	.038
	70		BIOTITE GRANITE AS ABOVE w/ 25-30% BIOTITE & STRONG BIOTITE ROCK IS WEAKLY DECOMPOSED PAST 36' ↓ BIOTITE INC → 25-30%	W/K SERICITE ON FELDSPARS-					W/K LIMONITIC FRACTS 8+/FT		.007	.002
40									~70°		TR	.005
				TR RED ALT w/ BIOTITE LESS BIOTITE AROUND QZ VEINS							.001	.004
50	70		AS ABOVE BUT CONTACT PICKED ON INC? IN SILICA (i.e. MORE COMPETENT CORE)	RE APPEARANCE OF RED ALT PROD. w/ BIOTITE INC IN AMT OF SERICITE IN FELDSPARS BECOMING MORE PROMINENT. WEAK BIOTITE, PROB BECOMING CHLORITIC					THIN MUD FILLED FRACT. LIM MUD?? - 50		TR	.005
	70		SIGNIFICANT INC. IN QZ VNS - ½" FAULT.						50 ↗ ½" QZ VN → ½" FAULT w/ GOUGE SUB LIM. 70 40		.008	.002
			(DESCRIPTION INDICATES W/K ALTERATION TYPE TRANSITION ZONE)	15-20% BIOT? / CHLORITE TRANSITION ZONE POSS SILICA FLOODING MODERATE					FAMILY OF M/GY QZ VNS - LOC WKLY LIMONITIC 3-4 VNS/FT. QZ VN w/ SPEC HM → 70		.006	.015
60			XENOLITH						TR SPEC HM w/ QZ 1" QZ VN WHT VN → 70		.036	.011
				SER INC ↓							TR	.042
70			BROKEN, MUDDY ZONE						ZONE OF HI % FRACTURES MOSTLY MUD FILLED HOWEVER SOME LIM. FILL. 4-6 FRACT/FT		.001	.005
			BROKEN ZONE						20-30°		.001	.002
80			BROKEN ZONE									
			MOD - HIGH FRACT ZONE w/ INTERVAL AREAS of "CRUMBLED" CORE MANY HI % FRACTURES w/ MUD + LIM MUD FILL.						TN QZ VN TR JAROSITE? ON LIM FRACT. N		.001	.014
95			BROKEN OX ZONE POSS FAULT	SLI INC IN BIOTITE RED ALT ASS w/ BIOTITE ↓					BROKEN / 1" QZ VNS - M GY IN OX ZONE / COLOR SOME BX'D VNS 75 75		.001	.004
									AS ABOVE - W/K SPEC HM		TR	.005
			LARGE → 1" QZ PHENOCRYSTS						½" QZ VN - M GY → 60		.004	.003
100												

DIAMOND DRILL RECORD

HOLE NO. YDDH-3

Coord. _____ N _____ E Elev. _____ PROPERTY YARNELL

Bearing _____ Inclination _____ Depth _____ LOCATION TWIN TO YM-C3

Started _____ Completed _____ Notes by M. MILLER Scale 1" = 10' Sheet 2 of 4

DEPTH	% REC	A	ROCK TYPE	ALTERATION	B	C	D	E	MINERALIZATION	Graphic Col.	CORE ASSAYS Au (OPT)	RC
100												
			ABU. QZ VNS IN ALT CHLORITIC GRANITE	6-8% CHLOR/BIO? (REG) STRONG SGR W/ FELDSPARS					Ox LIM. FRACTS →		.003	.01
				INC SER, INC CHL/BIO CHL REPL. BIOTITE GOT 8-10% CHL					QUARTZ VEINING - POSS STOCKWORK M GRY IN COLOR SOME LIM FILL 50		.003	.004
110				INCREASINGLY STRONGER CHLORITIC ALT-					QZ VEINING W/ LIM + SPEC HM - 1/4-1/2" QZ VNS 2/FT 50 70		.001	.007
									OX LIM FRACT TR SPEC HM 30			
									SPEC HM INC W/IN FRAGS BIOTITE/CHL SITES 1-2% 2" QZ VN W/ LIM FRACTS + SPEC HM 50		.009	.009
120			- OVERALL HI & FRACT - PARTIALLY BROKEN	POSS INC IN SILICA AS SHOWN					HI & FRACTS W/ LIMONITE + SPEC HM			
			- BROKEN/GOUGY ZONE POSS FAULT??								.005	.009
			INC IN QZ VEINING BROKEN ZONE.						BROKEN LIM ZONE			
				POSS POTASSIC ALT? RIMMING QZ VNS PINKISH K-SPAR					1/4" QZ VEIN - POSS K-ALT		.003	.015
130				STRONG SERICITIC ALT GSP IN FELDSPARS					DISS PY/LIM 1/2 - 3/4" QZ SOME LIM ZONE THROUGH 1% 70 20 MOD ABU SPEC HM ALONG FRACTS + W/C DISS - 1-2% IN BIOSITES. 8-10 FRACTS/FT		.045	.010
				RESTRICTED TO SELVEDGES AROUND QZ VNS.					6" QZ VN - 1" QZ VN 40 50			
									LARGE PIECE OF BR'D QZ VEIN 6-8" IN SIZE TERMINATES AGAINST 70° QZ VN ABU SPEC HM. LIM/PY CUBES		.024	.011
140									POTASSIC VALT W/ QZ -			
									DISS SPEC HM + 2-3% 70 DISS LIM/PY CUBES - 1% 70		.020	.073
									6-8 QZ VNS/FT -			
									STOCKWORK QZ VEINING SOME VNS → 6" TK.		.029	.016
150				POTASSIC ALT INC W/IN GROUNDMASS + STRONG SILICA FLOODING PROB DUE TO INTENSITY OF QZ VEINING AS IS K-ALT					PY/LIM DISS THRU STOCKWORK LIM + SPEC HM ON FRACTS WITH →		.080	.118
											.018	.042
160											.016	.024
											.013	.033
170			NO CORE RECOVERY 162-209. OPEN STOPES -									.048
			NC CASING SET 184-187'									.018
180			VOIDS 162-184 184-209 217-221									.137
			CORE BETWEEN 209-221. SUSPECT, POSS BOULDER AND/OR MELT.?									.106
												.203
200												.116

DIAMOND DRILL RECORD

HOLE NO. V-DDH-3

Coord. _____ N _____ E Elev. _____ PROPERTY _____

Bearing _____ Inclination _____ Depth _____ LOCATION _____

Started _____ Completed _____ Notes by _____ Scale 1"=10' Sheet 3 of 4

DEPTH	% REC	A	ROCK TYPE	ALTERATION	B	C	D	E	MINERALIZATION	Graphic Col.	CORE ASSAYS	YM
200											200	CB
												.116
												.093
210			ABU FALL IN + CAVE W/IN OPEN STOPING AREA.						FALL IN (CAVE)		210 .092	
											.037	.191
220											.072	.03
			BS of OPEN STOPES								220	
	CALC		STRONGLY ALT - STRONGLY SERICITIC	POTASSIC RIMS ABOUT CLEAR QZ VEINS - LT GY VEINS MAY CUT CLEAR QZ - W/K OCCASL TOURT DESTRUCTION					2-3% DISS SULF (OX) LOC DISS Py/Lim THROUGHOUT EST ~ 1% TOTAL. / ABU - LOW % OXID FRACS - FRACT - STOCKWORK		.075	.078
			- 1" STRONGLY OXID ZONE W/ SULFIDES CLIM/Py						1/4" QZ VEIN W/ OXID RIMS - 4 LT GY IN COLOR - SPECULARITE W/IN QZ - W.L QZ VEINING @ 227 THIN SILC. MICRO BX K	AQ 30	.095	.016
230	CALC		GRAYISH GY. ALTERED + SILC GRANITE SOME TEXTURAL DESTRUCTION	STILL POTASSIC ALT? ASSM VEINING STRONG SERICITIC FELDSPARS.					ABUNDANT Hi & H.L @ 228 LIMONITE FRACTURES - ALMOST STOCKWORK TYPE		230 .019	.015
									DISS Py/LIM CUBES EST < 1% OVERAL - / DISS ALONG QZ VEINS	50 30	.008	.071
240			LT GY - STRONGLY ALT - D - PREMINERAL LARGE K-SPAR PHENOS - SEC? ALT.	SILICA FLOODING. REM SERICITE K-ALT?? SEEMS PERVASIVE					Limo/Spec Hem/Qz Vnlt →	50	240	T.D
									DISS Py/Lim 2%	60	.038	
									DISS Py (FRESH) + Vnlts of Py. 2% Py - Limonitic →	40 60		
			BS of OXIDATION. SULFIDES								.110	
250	50		UNALTERED GRANITE? GREENISH GY - F/M GRAIN. NO BIOTITE - WEAK FELDSPARS - POSS DIFF ROCK TYPE??	POTASSIC FLOODING →						70	250	
			BS SULFIDES -	POTASSIC FLOODING AROUND QZ VEIN. POSS CHLORITIC?					DISS Py + (SPEC HEMATITE EST 1% Py 3% Spec Hm.	65	.012	
			OXIDIZED EQUIVALENT OF ABOVE	POSS MOD SILICA FLOODING					OXID BUT TR FRESH Py			
			OXIDATION INCREASES + BECOMES PERVASIVE LOW CORE SHOWS WEAKLY CORRODED ZONES.						TIN QUARTZ VEIN →	80	.004	
260				POSS WK SERICITE					OX/LIM QZ VEIN	40	260	
									SCATTERED WEAKLY LIMONITIC FRACTS - W/IN PERVASIVE OXIDATION → ≥ 10% OXIDIZED 3% + DISS SPEC HM		.004	
			OXIDIZED →								.008	
270			1.5' STRONG OXID ZN						FRESH Py @ 269.1 OXIDIZED ZONE W/ Py CUBES 1" @ 5% Py/Lim		270	
											.004	
											.015	
280			AS ABOVE BUT TEXTURAL MORE CORRODED.	STRONG SILICA DESTRUCTION FLOODING.					Hi & LIM FRACS		280	
			ST DICBER LIMONITE	STRONGLY CORRODED. + LEACHED.					5-6% DISS Py/LIM - PATCHES of FRESH Py AT @ 281.5		.038	
			LAMINATED TO BOUL - POSS VOLCANIC BED !						6" RED/YELLOW HEM ZONE. 2-3% SPEC HM W/IN CORRODED ZONE			
			AS ABOVE	POSS WK SER/OR CHL? BUT NOT AS SEEN IN CORE CAN'D GRANITE					TIN QZ VNLT LIMONITE VNLTS -	60	.007	
									DISS SPEC HM. W/ LT BRN "FLUFFY" LIMONITE OVERALL 2-3%	60 60 60	290 .002	
	70								VERTICAL BREAKS THRU CORE - SLT LIMONITIC			
			SOME TEXTURAL DESTRUCTION, STRONG PERVASIVE OXIDATION.	SILICA FLOODING GOP 297-299					JAROSITIC STAIN ON FRACT			
300									DISS Py/LIM EST < 3% TOTAL SULFIDES		.013	
											300	

DIAMOND DRILL RECORD

HOLE NO. 4-DDH-3

Coord. _____ N _____ E Elev. _____ PROPERTY _____

Bearing _____ Inclination _____ Depth _____ LOCATION _____

Started _____ Completed _____ Notes by M. MILLER Scale 1" = 10' Sheet 4 of 4

DEPTH	% REC	A	ROCK TYPE	ALTERATION	B	C	D	E	MINERALIZATION	Graphic Col.	CORE ASSAYS
			Scattering Alt- Pervasive Oxidation Both on Fracts + Interstitial						Family of 40° Lim/Spec Hm Fractures- + Diss Spec Hm.		300 .002
310	70		Greenish Gy- Poss Diff Rock Type From Granite Top of Hole - Chloritic?	Chloritic ↓ Pervasive					Diss Spec Hm Trace to 1-2% Moderate Limonitic Fractures Some X-cut Hm- Pseudo Stockwork: 6-8/Ft	40	.001 310 TR
320											Tr 326 .003
			TD @ 325'								

DIAMOND DRILL RECORD

HOLE NO. YDDH-4

Coord 100,100 N 49224 E Elev. 4880 PROPERTY YARNELL

Bearing — Inclination -90° Depth 220' LOCATION TWIN TO YM-75

Started 10/16/89 Completed 10/20/89 Notes by M. MILLER Scale 1"=10' Sheet 1 of 3

DEPTH	% REC	ROCK TYPE (A)	ALTERATION	B	C	D	E	MINERALIZATION	Graphic Col.	CORE ASSAYS Au (opt)	R.Q
		PROB DIORITIC SILL? ABU MAFICS BUT STRONGLY WX'D	NONE SEEN - STRONG WEATHERING					0-6' CASING: NO RECOVERY			.003
		INTENSELY LEACHED/ WEATHERED - ROCK IS VERY SOFT -	CARBONATE MATRIX 38' PROB DUE TO WEATHERING/ LEACHING OF FELDSPARS?							.002	.001
10		ABU PLAGIOCLASE SPARS	ABU BIOTITE - SOME SHOWN RED ALT - & PROB HM RIMS BUT RELATED TO WEATHERING					CALCITE VEINING →		.001	.001
								SLATE(?) FRACTS - MUSTY ON CORE BREAKS - BUT NO SIGNIFICANT MINERALIZATION OR QZ VEINING		.001	.002
20		1. BROKEN MUDDY ZONE						BROKEN ZONE -		.001	.003
										.001	.002
30								"GASH" VEIN W/ CALCITE		.001	.002
		- BROKEN ZONE - BROKEN + DISAGG. ZONE						STRONG LIM ZONE 36-37' 50%		.001	.002
40		ALTERED GRANITE TYPICAL OF MUD ALT ZONE - NO BIOTITE	SERICITIC FELDSPARS -					STAINED LIM OXIDIZED/LIM FRACT'S			
	70	MUD + GOUGE ZONE						MUD + GOUGE ZONE - PY LIMONITIC	70	.002	.005
50		MUDDY/GOUGY - SOFT ZONE - POSS FAULT?						GOUGY / FAULT ZONE? FGW FRACT BX'D QZ VNS W/IN - OVERALL WEAKLY LIMONITIC.		.001	.004
	80		POSS SEC BIOTITE VFG. DIOSAGGREGATED →					DISS PY/LIM CUBES - L/H USU. ASS. W/ QZ VEIN	80	.001	.004
								WHT QZ VN - CUTS LIM QZ FRACT'D VNS -	50 60 40%		
			MOD SILICA FLOODING							.011	.003
60	50	1" GOUGE ZONE						WHT QZ VEIN CUT BY SILICA - STEPPING MICRO FRACTS	25		
			INC IN SILICA FLOODING					QZ/LIM VNLTS - 3-4/FT; W/L LIM/PY CUBES CC & L/H FGW LIMONITIC FRACTURES + LIM ON CORE BREAKS	60+/-	.006	.004
			INC IN SERICITE W/C POTASSIC ALT PROB ASS. W/ QZ VNLTS.					DISS PY/LIM CUBES - 1-2% + OVERALL V. ABU. MICRO VNLTS OF LIMONITE 10-12/FT		.004	.016
70	70	6" GOUGE ZONE						PY/LIM CUBES	60 40-50	.016	.028
			POTASSIC ALT. ASS W/ QZ VEINS - AND IN INTERVENE OUT SILICA QZ VEIN					1" QZ VEIN (WHT) 6" WHT/GY QZ VN. H.L FAULT, VERT	50 70		
								VISIBLE AU ASS W/ QZ/SPEC VNLT -		.012	.011
80								LATER LIM VNLT CUTS FAULT DISS PY/LIM CUBES - 1-2% 1" QZ VEIN	20-30 70 40		
								X-CUTTING QZ VNS - ½" T/K STOCKWORK?	60	.009	.01
								STOCKWORK QZ VNS W/ ASS. SPEC HM.			
			POTASSIC ALTERATION ASS W/ QZ VEINING AS PINKISH R-SPAR SOME DISS.					PY/LIM CUBES → W/L	60		
		BROKEN ZONE						VISIBLE AU ASS W/ 1" WHT/GY QZ VEIN - SPEC HM SEEMS TO OCCUR @ THE "ROOF" OF THE VEIN		.020	.026
		LT TAN - ARGILLIC ZONE	ARGILLIC ZONE 89-90					EARTHY LIMONITE			
			STRONG QZ FLOODING PROBABLY W/ STOCKWORK VEINING					1" BRECCIATED QZ VEINS → V.TN "MYLONITIC FISSURES (GY QZ) QZ/SPECULARITE VNS W/ SPEC ON ROOF OF FRACTURE.		.025	.021
			NOTICEABLY INC IN					8" WHT QZ VEIN → MORE STOCKWORK PY/LIM CUBES DISS THROUGH 2%+/- DISS SPEC HM - 1-2%	60	.009	.035
100											

DIAMOND DRILL RECORD

HOLE NO. YDDH-4

Coord. _____ N _____ E Elev. _____ PROPERTY YARNELL PROJECT

Bearing _____ Inclination _____ Depth _____ LOCATION _____

Started _____ Completed _____ Notes by M. MILLER Scale 1" = 10' Sheet 2 of 3

DEPTH	% REC	ROCK TYPE	ALTERATION	MINERALIZATION	CORE ASSAYS Au (opt)	YM-75
100			CONTINUED SERICITIC ALT " SILICA FLOODING " POTASSIC ALT EVENLY in DISCRETE FELDSPARS.	Py/Lim CUBES - DISS THRUOUT MOD ABU Qz VEINS / Lim + Lim VEINS - DISS SPECULARITE/Lim w/ Specin 2%+ CENTER. 2-3% Py/Lim @ 102-103 CUBES → ½" WHT/Gy ½" Qz VN → 50 FRR BOULDERS		.071	.037
		Hi & BROKEN ZONE		STOCKWORK Gy Qz VEINING 2% Py Lim ASSOC w/ Qz Vns DISS SPECULARITE (BLACK MINERAL) X-CUTTING LIMONITIC VNLTS - 60	- MINOR DOLOMITE .095	.062
110			DISCRETE K-SPAR AS FELDSPAR x/s ¼" PINK RIMS AROUND Qz VNLTS -	DISS Py/Lim CUBES - Hi & FRACTS - LIMONITIC Qz FRAGS w/in Hi & LIMONITIC ZONE	.076	.064
			Qz VEINING DEL BUT SILICA FLOODING SAME	FRACTS AS SHOWN - LIMONITIC ALSO DESS. Py/Lim - AMT of DISCRETE Qz VEINING DECREASES.	.067	.026
120		- SLIGHTLY LESS ALT'D Qz VEINING - MGY in COLOR. 50 60 THE GOUGE ZONE M/Brn	SILICA FLOODING	DISS Py/Lim AGAIN 50-60 20 ALONG Qz VEINS - LIMONITIC VNLTS + FRACTURES 40 1' Gy VUGGY Qz VEIN →	.021 MINOR MIX - DISS + FGW	.047
				Lim VNLT - 50 FGW Py/Lim 1" Hi & Qz VEIN LOOKS LIKE BX ZONE - VN BX ? 20 GY Qz VEIN	.190	.067
130				LIMONITE / +/- Qz LT BROWN LIM.		
	40	- BROKEN GOUGY ZONE PROB FAULT	SILICA FLOODING		.021	.088
		LOOKS LIKE A SILIC. BX. SILICIFICATION SEEMS TO HAVE TIED ALL FRAGMENTS TOGETHER. BRECCIATION IS STRUCTURE RELATED -	POTASSIC ALTERATION AROUND Qz VNS/VNLTS - POSS REL? TO Qz FLOODING	BROKEN - MOD/LIMONITIC FRACT'S 40 SPOTTY - SPEC HM - L/Y. Py/Lim ON FRACTURE CUBES - 1%+	- MINOR	.006
140		GOUGE ZONE 140-140.5 LIMONITIC GOUGE	SERICITIC ALT PERSIST.	BRECCIA CONSISTS of Qz VEINS WHICH HAVE BEEN BROKEN + FRACTURED MOD LT BRN LIMONITIC LATER LIMONITIC VNLTS THAT CUT BRECCIA. PERVASIVE THROUGHOUT. BRECCIA ZONE IS CUT BY LATER FAULTS SHOWN AS GOUGE ZONES.	.024	.043
	60-70	CONTACT OBSCURED			.022	
150		YARNELL FAULT ZONE STRONG LT YELLOW GOUGE CLAY ZONE TOP 2.0' 1' STRONG RED HM w/ 2" SILICA (Qz) "CAP" HM AS MOD/CLAY	DIOPSIDE 70-80% CONT	40-50° Lim/Red HM MOD./CLAY ZONE AS DESCRIBED.	.045	.138
	65	CONTINUATION of BX BUT MORE INTENSLY ALT.	WEAK ALT - PROB ARGILLIC	Qz VN/LT FRAGS - w/in BX	.155	.118
	50	GOOD SUR/FR CONTACT		SHATTERED Qz VN		
160		157 STRONGLY ALTERED TEXTURAL DESTRUCTION VERY EVIDENT POSS BRECCIATION	STRONG ARGILLIC ALT ↓ TEXTURE DESTRUCTION	- BOTTOM of OBVIOUS Lim/Py CUBES BRECCIA CONTINUES ? MOD → STRONG LIMONITIC - FRACTURING / VEINING + VNLTS - 12-15/FT MOSTLY AS LONG FRACTURES/VNLTS FEOX SEEMS TO "TRAVEL" AWAY FROM FRACTURES - CREATING A SELVEDGE AROUND FRACTURE.	.125	.110
	30-60	- TEXTURAL DESTRUCTION BROKEN, CLAY / GOUGY ZONE			.020	.051
170		- STRONG GOUGE CLAY ZONE - PROB FAULT.		- TR MN DENDRITES ON FRACTURE SURFACE.	.018	.045
	30	174	POTASSIC RIM? SEEMINGLY AROUND Qz VNLTS and LIM VNLTS	STRONG GOUGE ZONE w/ ABU. CLAY / MUD GOUGE BROKEN FRAG - POSS BX ?	.111	.01
		- MORE SILIC PROBABLY ARGILLIC CONTACT OBSCURED.		BROKEN / GOUGY ZONE - MOD LIMONITIC ALTD FRACTS - ABU H.L LIM VNLTS +/- Qz FEW V. SMALL Py/Lim CUBES LL L Y. SPECULARITE VN - POSS ½ w/ MINOR AS DENDRITES -	.047	.01
180		CHANGE in ROCK or ALT -	POSS. PROPYLITIC ALT -	Hi. CALCITE VNLT → Qz/SPEC VN 50		
		PINKISH FELDSPARS - ROCK MORE PORPHYRITIC 10-12% Pink K-SPARS	GREENISH TINT - CHLORITIC ? LOOKS LIKE BLEACHING in INTERVALS	POSS SPECULARITE IN GREENISH MINOR - ON FRACTS -	.002	.027
				ABU. GASH VEINS MOSTLY WELL HEALED VNS 3-6/FT OF CALCITE	TR	.018
190				VERY AS SPECULARITE AS DISS + ASSOC/ VNLTS - 5-6% TOTAL 25 2% Py.		
			CHLORITIC ZONES AROUND VNLTS -	1-3% Py AS RIMS + DISS. 30 40	.007	.02
				10%+ SPECULARITE AS MICROVNLTS THROUT 70 CALCITE VNLTS →		
			CARBONATE MTX - GOOD FIZZ		.004	
200				Py X/S IN 1" BAND 10% SPECULARITE / HM →		

DIAMOND DRILL RECORD

HOLE NO. YDDH-4

Coord. _____ N _____ E Elev. _____ PROPERTY YARNELL PROJECT

Bearing _____ Inclination _____ Depth 220' LOCATION _____

Started _____ Completed _____ Notes by M. MILLER Scale 1" = 10' Sheet 3 of 3

DEPTH	% REC	Δ	ROCK TYPE	ALTERATION	B	C	D	E	MINERALIZATION	Graphic Col.	CORE ASSAYS (Au opt)
			DEFINITE FABRIC IS EVIDENT BY LINEATION of FELDSPARS +/- @ 30° DIPS SEEN	- BLEACHED ZONE w/ Lim/ Spec Hm.					CALCITE VNLTS GASH VEINS 1/4" WHT Qz VEIN	200	Tr
									Lim/ Spec Hm. X-CUTTING FRACT'S	45	
210			FABRIC	CALCITE/ GYPSUM GASH VEINING					SILK ZONE 6" TK. 1/8" Lim Vnlt @ 15° →	30	Tr 210
	40%								VN - w/ Lim	35	Tr
										20	
220									Lim/ CALCITE VNLT	20	.002 220

TD @ 220'

FRACTURES SEEM TO STEEPEN BELOW YFZ. FROM 50-70° → 30-40°/-

11/28/90
P 1/5

YARNELL TALK

- Acknowledgments -

1 THE YARNELL DEPOSIT IS LOCATED IN
SLDG1 YAVAPAI CO ~ 75 MILES NW OF PHOENIX AND
2 ABOUT HALFWAY BETWEEN ~~THE~~ WICKENBURG +
PRESCOTT ON THE WEST PRESCOTT HIGHWAY.
THE ELEVATION OF THE DEPOSIT IS BETWEEN 4650-5100'
~~[illegible]~~ THE CLIMATE IS CONDUCIVE
FOR YEAR ROUND OPERATION.

1 A LITTLE BIT OF THE HISTORY OF THE DEPOSIT
THE DEPOSIT WAS DISCOVERED DURING THE TEENS OF
THE CENTURY AND WAS THE SITE OF SEVERAL
3 MINING VENTURES PRIMARILY EXPLOITING THE HIGH
GRADE YARNELL FAULT ZONE. THE WINSLOW MINING COMPANY
BEGAN OPERATIONS IN 1939 & CONTINUED TO 1942
4 ~~WHERE~~ WHEN THE PROPERTY WAS ~~CLOSED~~ SHUT DOWN DUE TO
L-208 FEDERAL GOLD ~~the~~ CLOSURE ORDER. BEFORE
ASARCO'S ENTRY INTO THE PROPERTY SEVERAL SMALL OPERATORS
HAD ATTEMPTED TO MINE SELECTED PORTIONS OF THE
DEPOSIT.

Asarco's interest in the property was initiated in 1988 when Norgold Resources, a Canadian company, published the results of rock chip sampling from the implied width of the mineralized zone. The resultant grade suggested a bulk tonnage open pit target. Asarco examined and sampled the property confirming Norgold's results. A letter of agreement was signed with Norgold in late January 1989 for an exploration option on the property. A mapping and detailed rock chip

sampling program was completed at which time a nine hole drill program began. Drilling results confirmed the bulk tonnage open pit potential of the deposit. Three phases of drilling were completed totalling 25,662 feet. This consisted of 96 reverse circulation and four diamond drill holes (twins to the reverse circulation holes) which completed the drilling program.

ice (4) THE DEPOSIT OCCURS W/IN A CRANO / GRANODIORITE COMPLEX INFORMALLY CALLED THE TARAU GRANITE BY ANDERSON. THE GRANITE INTRUDES A SEQUENCE OF INTERMEDIATE & METAVOLCANICS OF THE BRADSHAW INTRUSIVE GROUP. ANDERSON PLACES THE AGE OF THE PLUTON @ 1730-1710 MYR.

SLIDES 5 TABLE 2 ANDERSON DESCRIBES THE ~~GRAN~~ INTRUSIVE AS A FOLIATED COARSE GRAINED PORPHYRITIC GRANODIORITE ~~FOT~~ W/ LARGE ~~[illegible]~~ PINKISH-TAN K-FELDSPAR PHENOCRYSTS IN AN EQUIGRANULAR MATRIX W/ BIOTITE, PLAGIO, RARE HBLNDE + SPHENE.

SLIDE 5 PHOTO - COARSE GRANODIORITE DIKE

DIKES - THE DEPOSIT IS CUT BY & PROXIMAL TO SEVERAL TYPES OF DIKES. FELSIC AND ANDESITIC DIKES ARE FOUND PROXIMAL TO THE DEPOSIT & ARE SUB PARALLEL TO THE ATTITUDE OF THE TF. MINERALIZATION & MINERALIZATION OCCUR W/ THESE DIKES. A LONG PROMINENT DIKE CROSSES THE TARAU FAULT AS SHOWN ON THE NEXT SLIDE. THIS DIKE TRENDS N10-20°W & DIPS 80° SW. THIS APPEARS TO BE A POST ~~[illegible]~~ FAULTING, POST MINERALIZATION FEATURE. AS IT CUTS THE TF ZONE MINERALIZATION (SLIDE CORE 5)

Slide Notes

Alteration -

Propylitic Alteration -

ALTERATION (Figures 2 & 3)

Alteration at the Yarnell Gold Deposit varies from propylitic to potassic. The strongest alteration is centered within the Yarnell Fault Zone and decreases outward in intensity into the footwall and hanging wall.

Propylitic Zone - This zone is characterized by chlorite, epidote, minor calcite veining (in the unoxidized footwall) with weak sericitic dusting and replacement by sericite along biotite edges and/or on plagioclase feldspars. In the hanging wall, the propylitic zone may extend up to 100' beyond the phyllic envelope. In the footwall, the propylitic zone is thinner and is usually marked by calcite gash veins.

Propylitic

Slide 8 outcrop

In outcrop this zone appears to weather much more strongly. Feldspars have a light greenish sericitic tinge

Slide 9 Core

In Drill Core it is easier to see the transition from propylitic → phyllic zone. However the rock has a similar look as in outcrop

Slide 10 photomicrograph PM-152 or 162

The photomicrograph mineral constituents are similar to unaltered rock except there is an increase in secondary quartz & sericite Table 1

Phyllic Zone - Biotite and plagioclase have been completely altered to sericite (Table 4, Honea 1990). Secondary iron oxides as limonite, goethite, hematite and leucoxene characterize the oxidized portion of this zone. The unoxidized portion (which occurs in the footwall of the structure) is characterized by extensive silica flooding and sericite which gives the rock a distinctly green color. The phyllic zone extends 30-100' into the hanging wall above the potassic zone and 10-45' into the footwall.

Slide 9 outcrop

SLIDE ~~X~~ 11 — In outcrop THE PHYLLIC ZONE SHOWS A MUCH ~~more~~ BLOCKY outcrop IS ~~more~~ due to increased resistance. BULGED outcrop. SILICIFICATION IS STRONGER & BECOMES MORE PERVASIVE CLOSER TO THE YAKAL FAULT. ~~Feldspars~~ AND BIOTITE IS ALTERED TO FELDSPAR AND IRON OXIDES SLASSHANING INCREASE. NOTE THE SQUUGGS or fractures

SLIDE 12 CORE — DRILL CORE SHOWS THE ~~increase~~ ABSENCE of BIOTITE, & THE INCREASE of SERICITE. ALSO NOTE THE CIMONITE PSEUDOMORPHIC AFTER PY.

SLIDE 11 CORE — THE UNOXIDIZED PHYLLIC ZONE IS USUALLY CHARACTERIZED BY DISTINCTLY GREEN COLOR AND IS STRONGLY QUARTZ FLOODED. PYRITE IS DISTINCT and SOMETIMES up to 10% IN BANDS & PATCHES

~~Slide 12~~

SLIDE 13 TSS OXIDIZED — PHOTOMICROGRAPHS - NOTE THE INCREASE IN SERICITE FROM THE PREVIOUS SAMPLE. ALSO NOTE THE CIMONITE/PY REM.

POTASSIC ZONE - YAKAL FAULT ZONE.

Potassic Zone - Alteration is strongest within the YFZ. Abundant secondary quartz, chalcedony, adularia and clays occur within this highly crushed and tectonized zone. X-ray diffraction studies by Malusa on the clay size fraction of the fault zone suggest the material is fine grained sericite (illite) and adularia. The potassic zone outward from the YFZ is defined by adularia occurring as phenocrysts and selveges to the quartz veins. The altered zone is noted 50-80' above the fault and up to 25' below.

SLIDE 14 E OUTCROP

In outcrop this zone is well granulated & sheared (this is an after effect of the YFZ - however, potassic alt (adularia) rims Qz veins also significant increase in quartz veins.

SLIDE 15 ✓ CORE

- Note the potassic rims around quartz veins - typical ~~to~~ to this zone.

Y-161 SLIDE 16

The photomicrograph shows alteration as replacement Qz & K-spar (adularia) in a crushed matrix. Note the amount of ~~sericite~~ plagioclase now to sericite

SLIDE 17 GEOLOGIC MAP

STRUCTURE

SLIDE 17 FAULT ZONE surface PHOTOS -

The principal feature that localizes and controls alteration and gold mineralization is the Yarnell Fault Zone (YFZ): a N30-50°E, 30-50°NW dipping structure wholly contained in the Yarnell Granite. This zone is composed of strong gouge, mylonite, micro-breccia (tectonically derived), quartz veins and chalcedonic replacement within a 3 - 7+ foot zone. There is abundant clay in the zone probably as a result of the fault gouge. A sample of illite from the fault (Shafiqullah, 1990) gave an age of 69 million years; +/- 1.6 million years. This date is probably indicative of regional cooling and uplift and suggests that the mineralization is no younger than the illite date. Tertiary extension (detachment style faulting) is not related to this deposit.

SLIDE 18 FZ PHOTO

The fault has been traced two miles to the southwest where it disappears under the valley alluvium. The fault can be traced to the northeast 1500' from the top of Yarnell hill before it is concealed by debris from the volcanic cap and valley fill which consists of large unmineralized Yarnell granite boulders.

- NOTE THE CLAY GOUGE ZONE IN SURFACE EXPOSURES - THERE IS ALSO ZONES OF CHALCEDONIC REPLACEMENT W/IN THE FAULT ZONE

- NOTE THE AMOUNT OF HEMATITE SEEN IN THE FAULT ZONE.

The sheared and crushed zone of the Yarnell Fault complex varies from five to eighty feet in thickness within the drilled part of the deposit. As the structure is followed downdip and along strike the entire zone thins to less than ten feet. The alteration envelope and mineralization also diminish in thickness with the associated thinning of the Yarnell Fault.

There are numerous sub-parallel fractures in the hanging wall that appear to mimic the fault. There are also several northeast trending quartz veins that have been mapped on the surface in the hanging wall of the Yarnell structure. These structures appear to flatten and "roll" in the underground exposures and may merge with the Yarnell Fault at depth. This orientation suggests a listric nature to these structures. The felsic dikes as mapped on the surface sub-parallel to the Yarnell Fault in both strike and dip and show similar but much restricted alteration and mineralization. This may represent a "halo" to the main Yarnell deposit.

SILICIFICATION - GOLD

MINERALIZATION AND OCCURRENCE

Gold mineralization is associated with several stages of quartz, iron sulfides and oxides (pyrite, specularite). Base metal sulfides have been seen in polished section and implied from trace element geochemistry. Copper minerals (azurite and malachite) are associated with quartz/hematite veins in the underground workings.

QUARTZ

Quartz occurs associated with the Yarnell Fault as discrete veins and stockwork. Quartz veins also occur subparallel to the fault.

Slide 22, Qz Veins

22, 23

Paragenesis of the quartz suggests that the Yarnell Fault and subsidiary structures were the earliest event with silica flooding from these structures into the surrounding rocks. Successive movement along the fault and fault-related structures crushed and sheared the quartz. There has also been some remobilization of silica into the YFZ as banded chalcedonic quartz. At least four generations of quartz veining have been identified.

1. Early grey quartz associated with specularite in vugs parallel to quartz veins.

2. Dark grey quartz with some brecciation in the vein; dark color is probably due to fine grained specularite.

3. Lighter grey quartz with disseminated limonite pseudomorphic after pyrite; usually on the margins of the vein.

These three generations of quartz are usually seen as small veins up to 1/4" thick, commonly up to a half inch and have been noted up to three inches thick in drill core.

4. White quartz has been recognized in at least two stages. These veins appear to cross cut all of the other stages. The white quartz veins have been measured from six inches to one foot in drill core and up to twenty feet thick in the field. These veins will consistently assay from 0.01 to 0.8 opt gold. Visible gold occurs in similar looking veins in diamond drill holes.

IRON OXIDES

Iron oxides occur within this deposit and all are intimately associated with gold mineralization.

Slide 21 core limonite w/ Slide 24

Limonite pseudomorphic after pyrite is very common in the oxidized phyllic zone. It occurs as discrete crystals or as intergrowths associated with quartz veins. Polished sections show native gold locked within and at the edges of limonite pseudomorphs.

Goethite occurs as fracture/vein filling and fracture coatings. Goethite also occurs as discrete patches associated with pseudomorphs. The total amount of iron oxides (principally limonite and goethite) dramatically increase within the zone up to 4-5%.

Hematite is very common within the Yarnell Fault and when intersected in drill holes turns the cuttings brick red. Hematite is associated with the highest gold grade and visible gold occurrences. Hematite is also associated with pyrite cubes especially close to the Yarnell fault. The occurrence of hematite usually indicates increased grade; greater than 0.03 opt gold.

Slide 25 Note Au assoc w/ limonite cubes.

Slide 26-29 Various Gold Pictures

Visible gold is associated with quartz stockwork in association with grey quartz and quartz/specularite veins. The higher gold assays are related to quartz stockwork with adularia. Higher gold assays are also related to the occurrence of hematite and limonite pseudomorphic after pyrite. The highest grade assays are directly related to the Yarnell Fault and abundant (+10%) red hematite and quartz. This was the zone that the old time miners were following and ranged from .01-1.0 opt gold.

Base metals-copper, lead and zinc occur in the geochemical regime in recent soil within and around Yarnell deposit. Secondary copper as malachite and azurite is associated with late stage quartz/hematite veins.

SLNE 30

Rasmussen completed a 15 element geochemistry survey over and around the deposit. The survey was designed to continuously sample rock and soils from the hanging wall zone through the footwall into fresh granite. Samples were collected from rejects of these reverse circulation holes that tested through the hanging wall and footwall zone and from the main haulage adit that was driven in the hanging wall.

Table 2 compares the values in the drill hole rock geochemistry from that of the soil surveys. Copper values (average) range from a low of 3.7 ppm in hole YM-6, to a high of 28.4 ppm from soil in the hanging wall. Lead and zinc also reflect low ppm values.

Table 2. Comparison of Trace Elements (ppm values) in Main Ore Zone rotary cuttings and Hanging Wall-Footwall soil samples.

	Ore Zone, Rotary Cuttings ppm			HW Soils ppm	FW Soils ppm
	YM-6	YM-26	YM-50		
No. of Samples	3	4	5	53	61
Cu, average	3.7	18.4	17.0	28.4	19.4
Cu, high	5.0	36.4	26.1	55.4	30.0
Cu, low	2.6	5.1	8.7	16.3	11.5
Pb, average	7.9	69.1	8.5	24.6	21.1
Pb, high	10.7	255.0	11.7	58.5	34.9
Pb, low	5.9	4.7	7.1	14.5	12.5
Zn, average	28.8	59.6	41.8	86.8	60.3
Zn, high	36.4	124.0	57.0	270.0	124.0
Zn, low	24.1	34.3	34.8	33.7	30.3

SLIDE 30 ~~29~~ TABLE of Trace Elements

TRACE ELEMENTS ARE MORE OFTEN MORE SIGNIFICANT. TABLE TWO SLIDE SHOWS THE RELATIONSHIP BETWEEN ELEMENT INCLUDING & ELEMENTS IN THE HANGING FROM SOLID. NOTE THE SLIGHT INC IN H.W VS F.W RATIO w/ RESPECT TO Cu Pb Zn.

SLIDE 31 ~~30~~ Geology Map Showing Mineral Inventory.

MINING SIX DRILL HOLES HAVE DEFINED A RESERVE OF 9.1 mt @ .05 opt Au (.02 c.o.) THERE IS AN ADDITIONAL 2.7 mt @ .07 opt Au (.01 c.o.). OVERALL STRIPPING VARIES FROM 1.7 — > 3.0 w/o DEPENDING ON ECONOMICS.

METALLURGY

SLIDE 32 Numerous bottle roll tests and column leach tests were completed on the deposit. A fifteen ton sample was mined from the ore zone exposed in the open cut to provide run of mine ore for column leach testing. Results of the column testing are summarized on Table 3.

Table 3. Column Leach Data

80% Passing Size	Column Size	Leach Time Days	Head Assay Opt	Tail Assay Opt	Extraction
6 inch	24" dia. x 18 ft.	111	0.046	0.022	52.2%
2 inch	15" dia. x 18 ft.	102	0.051	0.015	70.6%
3/8 inch	12" dia. x 18 ft.	79	0.055	0.013	76.4%

Cyanide consumptions ranged from 0.56 to 0.79 pound per ton or ore. Consumption rates were fairly constant throughout the leaching cycles. The ten pounds of lime and cement (3/8 inch feed) per ton or ore added to the ore charges as the columns were filled was sufficient to maintain protective alkalinity at above pH 10.5 throughout the test period.

Flotation/Fine Grind/cyanide leach tests were conducted on the Yarnell composite sent to Tucson from McClelland Labs. This head sample of 35 pounds assayed 0.031 opt Au and 2.35% Fe.

In the two flotation tests, ground to -200 mesh, the recoveries were 75%-76% in the final concentrate and 79%-80% in the rougher concentrate.

In the two fine grind/cyanide leach tests, also ground to -200 mesh, the recoveries were 97% in 22 hours of agitated leach. The cyanide consumption was 0.21 pounds per ton or ore and the lime was 3.3 pounds per ton or ore.

The trade-off between high recovery by fine grinding agitated leach and lower recovery by coarse crush/heap leach is a matter of economics.

Misc - Location of Fan Slides w/ orig Drill Rig.

Geochemistry Rankama & Sahama

Copper	–	igneous rocks	60-70 ppm
		intermed igneous rocks	38
		acidic igneous rocks	16

Zinc	igneous rocks	132
	granodiorite gly segeits (Sweden)	200
	Plagioclase granite (")	150
	Plagioclase - microcline granite (")	30

Lead	igneous rocks	16
	Granitic rocks	30
	Granites of Skagland	9-27
	Acid igneous rocks, one	19