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J. H. Courtright

A.I.M.E. - ARIZONA CONFERENCE

MINING GEOLOGY DIVISION
SPRING MEETING 1978
APRIL 22, 1978

P R O G R A M

8:00 a.m. - 9:00 a.m.	REGISTRATION	
9:00 a.m. - 12:00 Noon	TECHNICAL SESSION	
	Welcome Address	Robert J. Bonnis
	1. Bruce Mine - A Case for Metamorphic Remobilization of Precambrian Massive Sulfide	Robert L. Clayton
	2. Geology of Cyprus Bagdad Mine	P. K. Medhi James Sterling Frank Nelson
	3. Ore Estimation at Cyprus Bagdad Mine	John E. Nelson George Rudy
	4. Engineering Geology at Cyprus Bagdad Mine	Wayne L. Jacobsen
	5. Cyprus Bagdad Mine Today	Mark Gillo
12:00 Noon - 1:30 p.m.	LUNCH AT THE COPPER KETTLE	
1:30 p.m. - 4:30 p.m.	TOUR OF CYPRUS BAGDAD OPEN-PIT MINE	
5:30 p.m. - 6:30 p.m.	HAPPY HOUR AT THE COPPER KETTLE	
6:30 p.m. - 7:30 p.m.	DINNER	
7:30 p.m. - 7:45 p.m.	GUEST SPEAKER R. C. Bogart General Manager Cyprus Bagdad	
7:45 p.m. - 8:00 p.m.	AMATEUR MAGICIAN Armando Gonzales	

principal veining NE

N 60° E trend of more intrusions

deepest hole 3600'

3-4% total sulphides

middle of ore body cpy:py 1:1

1100' — 300' capping .1 — .3 %
400 cc coat — .7
400 primary .5

Hole — Giroux adit area —
Depth to sulphides — grade of capping

~~500'~~ of .7 Cu primary 2
~~500'~~ .55 " drilling problem
1st bio —

current w/o — 1.5/1
over all w/o 1.1/1

~~Cum~~
Head grade last Q — .57 —

9 16 Ton 36 40,000 leach per day

.025 mo

Aa-25.8.2

Sept. 30, 1

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

DIGEST OF FILE: BAGDAD COPPER COMPANY

OCT 17 R

L. K. W.

10/27/13 Option agreement between stockholders of Bagdad and Gen. Dev. Co.
" " " Bagdad Copper Co. and " " "

9/25/17 J. K. to H. A. G. transmitting reports on Dist. property by Stockder. Bagdad best of the lot.

11/8/17 J. K. to H. A. G. Suggested getting and equipping prop. on participation basis.

11/15/17 H. A. G. to K. E. B. Bronson in Ariz. Will look him up on his return.

11/30/17 Letter H. A. G. to E. B. Bronson, pres. Bagdad. Suggesting supplying dev. to be returned at 6% and then division of profit 65 - 35.

11/30/17 H. A. G.-J. K.

Ore blocked	6,031,000 tons	1.77 Cu
Prob. ore	7,246,000 "	1.60 "
Total	13,277,000 "	1.68 "

Ore 58' thick. Over-burden 254'.

12/7/17 Letter H. A. G. to J. K. Sending Allen H. Roger's report.

12/26/17 H. A. G. to J. K.. Doubted if installment purchase plan offered by Bagdad would interest A. S. & R.

1/17/18 H. A. G. to J. K. Will see Bronson on his return. If agreeable to 35-65 split.

9/15/19 Letter T. J. Sparks to J. K. Thought he could round up Bagdad outside properties.

4/16/20 H. A. G. to J. K. Will wait Thornton's report on Bagdad before again contacting Bronson.

5/20/20 Thornton's report. Churn drilling showed 15,000,000 tons . 1.68% Cu. Chance for more ore in undev. ground. Attractive for large deposit.

5/27/20 J. K. to H. A. G. Thought Hillside country attractive for disseminated dep.

11/23/27 H. A. G. to Simon Guggenheim. Gives history review.

12/2/27 H. A. G. to " " On basis of 35-65 would send engineers to see what recent drilling accomplished.

12/6/27 J. K. to H. A. G. Worth serious investment on 35-65 basis.

9/12/29 Roland Blanchard to J. K. Thought productive area pretty outlined. Little hope of extensions of consequence.

/36 A. F. Goodwin to B. R. H. Market reports Bagdad stockholders getting $3-$4 per share for their stock. Please make inquiry.

/27/36 R. R. H. to R. F. G. Milling limited tonnage of selected 5% ore. Probably operation not very profitable.

4/1/36 B. N. R. to R. F. G. Company invested $2,000,000 in purchase of property, dev., C drilling, equipment, etc. Geo. A. Schroder reports 40,000,000 tons 1.25% copper. Mining high grade streaks. 100 tons per day. Heads 5%. R/C 7:1. Conts. 40% Cu.

4/27/36 B. N. R. to H. A. Kursell - Mine recently examined by Vincent D. Perry, geologist from Cananea, Mex. presumably for Anaconda. Also by Walter Harvey Weed for Bagdad Copper. Now claimed 48,000,000 tons of 1.28% Cu. Thomas admits present operation not success.

5/3/37 B. N. R. to Roger W. Straus - Thomas says 20,000,000 tons 2%. Now milling 300 tons of 1.65%. R/C 35:1. Block caving.

Mining	.88
Milling	.72
Camp & O.H.	.26
	$1.86

Recommended looking into if A. S. & R. wants a Cu property.

5/13/37 H. A. G. file memorandum: 'Phoned Bronson who came over. When Bronson gets more data he will come again. At present he does not want to discuss terms.

5/20/37 H. A. G. to B. R. H. Arrange a visit to prop. with Ring.

6/21/37 Hatcher reported on findings. Confidential on S. E. C. hearings. Bronson manipulating stock and had made $275,000. S. E. C. asked Bronson to resign but he refused. He may go to penitentiary.
Reports in Bagdad file by:

M. W. Hayward of American Metal
Geo. A. Schroder for International
Blanchard & Locke
Dr. Harvey Walter Weed
J. W. Hutchison
L. C. Penhold

7/15/37 H. A. G. Confidential file memo. Saw Bronson and offered partnership proposition. A. S. & R. to equip and develop, then get back invest. at 5% interest and divide profits 50-50. Bronson in tangle with S. E. C. Uncertain if he had authority to deal.

5/11/38 Letter H. A. Kursell to H. A. G. Visit with Geo. A. Thomas. Bronson out. Milliken and associates in control. Thomas thought something might be done with prop. now.

5/24/38 B. N. R. to H. A. G. Asked if he could have Thomas call on him in N. Y.

5/3/39 R. D. Bradford to B. N. R. C. W. Schlereth in and said plans under way for 1000-ton mill. Apparently they are not negotiating with A. S. & R.

5/22/39 B. N. R. File Memo. Schlereth & Whittaker hired to report on prop. by Milliken. Schlereth estimates 6,000,000 tons 1.47%. He would like to discuss financing with A. S. & R. in N. Y.

25/39 H. A. G. File Memo: Little doubt but there are 6,000,000 tons 1.47% Cu. Figure cost of production on this grade of 9½¢ per pound. $1,000,000 cost of equipping. On basis 360,000 tons per year, profit would be $216,000 on 12¢ copper. Amort. at 5% over ten years would be $125,000, leaving $91,000 profit or $45,000 A. S. & R. share. 11¢ makes operation about break even so A. S. & R. would not lose even at 11¢ and if larger tonnage dev., say 20,000,000 tons of somewhat lower grade but a higher price level, it would still be commercial ore.

12/1/39 J. F. J. to H. A. G.: Property visited Nov. 22-24. Reports on operating conditions.

12/22/39 H. A. Kursell Memo to H. A. G.: Regarding experiments on leaching in place.

1/10/40 H. A. G. to W. H. Loerpabel: Highly probable will make agreement with Bagdad Copper Co. All money back with 5% interest over period of 10 years. Bal. of profits split 50-50, with same split after amortization completed. Estimated cost of placing in production $700,000 but H. A. G. thought probably $1,000,000.

1/29/40 W. H. L. to H. A. G. Regarding having Cooper & Bickel design mill rather than Sweeney. Also about grade of ore, dilution in mining and operating costs, etc.

Feb., 1940 File contains draft of proposed agreement between A. S. & R. and Bagdad Copper Corporation. Asarco to have 50-year lease plus year to year extension option. Asarco to have four months' trial operation of property with any profits for Bagdad acct. and any losses for Asarco acct. After which, if Asarco proceeds, it will equip prop. for 1,000 per day operation. Equipment to become property of Bagdad. Asarco to advance working capital not to exceed $300,000 for which it shall be reimbursed with 5% interest out of first profits. Net profits thereafter divided 50-50 between Bagdad and Asarco. Other regular mining lease clauses with right to terminate agreement on 30 days' notice.

2/5/40 Wires H. A. G. to W. H. L. Proceed to Bagdad. Kursell arrives. 2/8/40 to accompany him.

2/27/40 H. A. G. to W. H. L. On 2,250,000 tons of 1.47% Cu would take 8 years to get back investment of $1,000,000. $800,000 with 5% interest.) Leaving only $282,500 to be divided 50-50 if copper market 12¢. Copper market 11¢ would result in loss.

Larger tonnage of 20,000,000 tons of 1.0% with increased capital outlay a 15¢ market necessary. Outlook for 15¢ copper over 20-year period not bright and enterprise risky.

2/28/40 W. H. L. report to H. A. G.: On basis of 1200 tons per day 11.5¢ copper market would repay investment and a 12¢ market on 800 tons per day.

3/4/40 H. A. G. to W. H. L. Slight profit to be expected from Bagdad on 12¢ copper is insufficient to justify time and expense and risk that outlay might not be returned if copper below 12¢. Will advise Milliken our decision not to proceed further.

F. M. STEPHENS

FMS:ar

BY FILE REVIEWER: (Classify as "A"—Active interest; "B"—Moderate interest; "C"—Not ... "D"—Of no interest. Give reasons and sign name. Leave space for later reviews.)

NAME BAGDAD COPPER CORPORATION

LOCATION 25 miles N. W. of Hillside
Yavapai County, Ariz.

SHEET #2

FILE NO. Aa-25.3.2

CONCLUSIONS BY EXAMINING ENGINEERS:

SUMMARY OF DATA IN FILE ON WHICH CONCLUSIONS ARE BASED

PROPERTY: (Claims, acreage, etc.)

NEARBY PROPERTIES:

OWNER: (Last known name and address)

HISTORY: (First exploration, periods of operation and extent thereof) CONTINUED FROM SHEET #1

Feb., 1940 - Draft of Option Agreement with Bagdad Copper Corp. drawn up. Asarco to supply capital to equip prop. Capital to be refunded at 5% interest over ten-year period, and profits to be divided 50-50 during this time and for the life of the operation. Lease for 50 years.
Feb. 9-17, 1940 - Examined by W. H. Loerpabel, H. A. Kursell, J. Fred Johnson and Messrs. Cooper and Bickel. Mr. Guess could see no profitable outcome on a 12¢ copper market and informed Mr. Milliken A. S. & R. not interested.
9/1/44 - Property acquired by J. C. Lincoln, pres. of the Lincoln Elec. Co., Phoenix, Ariz. Open pit mining employed. in 1947

PRODUCTION:

MINE DEVELOPMENT: (Shafts, inclines, adits, etc., with lateral development)

Au oz.	Ag oz.	Pb %	Cu %	Zn %

DISTRICT GEOLOGY: (Predominant rocks, faults, dikes, ore controls, etc.)

Yavapai schist intruded by monzonite porphyry. Area in part cover basalt flow.

MINE GEOLOGY: (Type orebody, oxidation, features which may limit or cut off ore occurrence, probable depth, etc.)

Yavapai schist intruded by granatoid monzonite. Northeast area covered by bas flow. Ore occurs in monzonite. Ore zone from 50' to 125' thick and overlain by oxi zone of variable thickness estimated to average .5% ox. copper. Chalcocite zone und by primary of .5% ore. Monzonite faulted and shattered. High grade (6% to 30%) chr cite concentrated in N-S trending veins from 1 inch to 2 feet wide. 4 mineralized c indicated.

ORE RESERVES: (Positive, probable, possible. If formal estimate not made, give best guess, with suitable comment as to degree of certainty.) Estimates from time to time show various tonnages and grade.

Hayward of American Metals	27,000,000	tons	1.48%	copper
" " " " add'l.	23,000,000	"	1.10%	"
Schroder	40,000,000	"	1.25%	"
1929 Blanchard & Locke	14,000,000	"	1.62%	"
1937 W. H. Weed	23,100,000	"	1.20%	"
" W. H. Weed	27,500,000	"	1.00%	"
1938 Geo. G. Thomas (Poss. add'l. blocked)	7,000,000	"	1.62%	"
1940 H. A. Kursell assured ore	2,250,000	"	1.45%	"
" " " possible add'l.	20,000,000	"	1.0%	" (100' thick

EXPLORATION POSSIBILITIES: (State objectives, method and approximate cost of work.)

Adjoining areas as yet little explored might have added possibilities for low-grade bodies.

NOTE by L. K. W. 11/5/46: "U. S. G. S. report of 10/29/46 at A I M E meet, Tucson, stated no other orebodies foreseeable."

PROPERTY SUBMITTED BY: (Names and dates)

Geo. G. Thomas 5/11/38
C. Q. Schlereth 5/22/39

REPORTS IN FILE: (With date of last examination by Company Engineer)

Allen H. Rogers 5/20/11
Edward Thornton 5/20/20
B. R. Hatcher 6/21/37
W. H. Loerpabel 2/28/40

MISCELLANEOUS: (Other comment where above space not sufficient)

1937 Hatcher and King figured following milling outcome on ore of 1.6% heads:

NS BY FILE REVIEWER: (Classify as "A"—Active interest; "B"—Moderate interest; "C"—Not roved; "D"—Of no interest. Give reasons and sign name. Leave space for later reviews.)

"D"? Now owned by Lincoln and probably not available.
A break-even proposition on a 12¢ copper market. At a copper price of 15-17¢ would have made a nice profit.
F. M. STEPHENS 10/1/46

t.'s recent study of district as reported by Anderson at A I M E 10/29/46 ws no other orebodies foreseeable. Any new interest would have to be determined from study of new developments and ore reserves since 1940 for recomputation of outcome. No indication that owners wish to sell during current successes without prior overture from us. CLASS "C". L. Kenneth Wilson, 11/5/46.

CONCLUSIONS BY EXAMINING ENGINEERS:

J. Kruttschnitt 9/25/17 - Thought A. S. & R. should try to acquire property.
Edw. Thornton 5/20/20 - Churn drilling had shown 15,000,000 tons of 1.68% copper ore. Attractive for large disseminated deposit.
B. R. Hatcher 6/21/37 - Visited property with A. E. Ring and reported on existing conditions. Made no recommendations.
W. H. Loerpabel 2/28/40 - About break even on 12¢ copper market.

NAME BAGDAD COPPER CORPORATION
LOCATION 25 miles N. W. of Hillside
Yavapai County, Arizona

SHEET #1

FILE NO. Aa-25.8.2

SUMMARY OF DATA IN FILE ON WHICH CONCLUSIONS ARE BASED

PROPERTY: (Claims, acreage, etc.)

A group of patented claims in the Eureka Mining District. No file information as to exact number.

NEARBY PROPERTIES:

Hillside Mine.

OWNER: (Last known name and address)

Lincoln Electric Company, 315 N. Central Ave., Phoenix, Ariz. J. C. Lincoln, President.

HISTORY: (First exploration, periods of operation and extent thereof)

Prior to 1907 - Eight claims patented by John Lawler.
1907 - 1910 - Group obtained by Copper Creek Dev. Co. Later by various successions - Arizona-Nevada Copper Co.; Bagdad Copper Co.; Arizona-Bagdad Copper Co.; and in March, 1927, by Bagdad Copper Corp.
1917 - H. A. Guess conferred with E. B. Bronson, Pres. of Bagdad regarding A. S. & R. becoming interested. Could not get together on terms.
1918 - 1937- Looked at by Ed. Thornton, 1920; B. R. Hatcher and A. E. Ring 1937. Guess unable to do anything with E. B. Bronson.
1938 - After investigation of stock manipulation by S. E. C. Bronson was put out and S. A. Millikin became president of Co.
Nov., 1939 - Property visited by J. Fred Johnson and Zelenkov.

(CONTINUED ON SHEET #2)

PRODUCTION:

Total production figures not available.

Production	1939	14,196 tons
"	1941	88,209 "
"	1942	56,392 "
"	1943	375,715 "
"	1944	668,887 "

D. J. P.
NOV -

MINE DEVELOPMENT: (Shafts, inclines, adits, etc., with lateral development)

Mine developed for block caving mining.

Au oz.	Ag oz.	Pb %	Cu %	Zn %	Mc
			1.0		

OCT -3 REC'D

cc:WHLoerpabel

From Field Trip Report by Reed Welch

April-May 1956

5. Bagdad Copper Corporation. The Bagdad mine is currently stripping in excess of one million tons per month. The mill is treating 100,000 tons per month of ore coming from the lowest level in the pit assaying .4 to .6% Cu. For the past month the mill has produced a little less than 1 million pounds of copper and this production will continue for the next few months.

The fluo-solid electrolytic pilot plant is in operation after overcoming innumerable mechanical problems, managed by Dorr Oliver personnel paid for by Bagdad. Lack of trained personnel now appears to be one of the principal drawbacks. The pilot plant has capacity of approximately 4 tons of concentrate per day. A few copper sheets have been made and the tanks are charged with pregnant solution.

Mr. Lincoln has moved to Cleveland where he will reside for the remainder of the summer. His address is Wade Park Manor, Cleveland, Ohio, telephone Cedar 1-3300.

Bagdad Copper Corp. Production for the first quarter - 6718 tons, average grade about 27% Cu, 1.8 oz Ag. Mill feed, about 4,000 tons per day is coming from the bottom of the pit assaying 0.4% to 0.6% Cu. The fluo-solids electrolytic pilot plant, capacity 4 tons concentrate per day, is now operating and has produced a few copper sheets.

FROM A REPORT BY REED F. WELCH

July 31, 1956

figures about 0.52 oz received per ton ore milled — av. grade ± .60 oz

Bagdad Copper Corp. Receipts at El Paso during the first half of 1956 total 12,352 tons, average grade about 26.2% Cu, 2 oz Ag. Production will be maintained at about the same rate for the balance of the year.

BAGDAD COPPER CORPORATION
SUMMARY OF OPERATIONS 1951 THROUGH NOV. 1955

	1951	Per ton ore	1952	Per ton ore	1953	Per ton ore	1954	Per ton ore	Jan. thru Nov. 1955	Per ton ore
Stripping Tons	4,032,690		4,078,579		5,480,108		6,139,612		8,341,594	
Ore Production, Tons	1,230,560		1,221,220		1,232,591		1,300,454		1,243,220	
Stripping Ratio	3.28		3.34		4.45		4.72		6.7	
Grade of Prod. Total Cu %	0.84		0.91		1.02		0.82		1.00	
" " " Oxide Cu %	0.09		0.15		0.16		0.13		0.13	
Cu Conc. Production/Tons	31,455 (1)		27,121		27,710		31,788		29,791	
Concentrate Grade %	28.98 (1)		33.28		36.22		28.08		34.68	
Cu Production (lbs. in conct.)	18,376,483		18,053,521		20,070,811		17,852,309		20,667,422	
Metallurgical Recovery %	86.6 (1)		80.91		79.79		84.00		83.28	
Molybdenum Conct. Prod. Tons									194 (1)	
Income										
Copper Concentrate	$3,390,747	$2.755	$3,307,903	$2.708	$4,685,575	$3.801	$4,048,614	$3.113	$6,543,133*	$5.263
Molybdenum Concentrate	85,550	.069	163,223	.134	138,777	.113	120,315	.092	169,557	.136
Miscellaneous	33,408	.027	2,494	.002	8,724	.007	62,225	.048	39,548	.032
Total	3,442,889	2.797	3,468,632	2.840	4,815,628	3.907	4,231,154	3.253	6,752,238	5.431
Expenses										
Exploration Drilling	23,214	.019	23,305	.019	6,343	.005	69,045	.053	35,086	.028
Stripping	785,507	.638	800,552	.656	1,119,159	.908	1,333,554	1.025	1,234,075	.992
Mining	348,447	.283	439,683	.360	419,799	.341	403,874	.311	441,229	.355
Milling	910,162	.740	993,013	.813	1,041,469	.845	970,485	.746	917,281	.738
Trucking Concentrates	95,561	.077	90,551	.074	91,643	.074	107,431	.083	100,645	.081
Indirect	410,960	.334	376,574	.308	510,339	.414	528,433	.406	586,602	.472
Total	2,573,851	2.091	2,723,678	2.230	3,188,752	2.587	3,412,822	2.624	3,314,918	2.666
Operating Profit before Depr., Depl. & Income Tax	869,038	.706	744,954	.610	1,626,876	1.320	818,332	.629	3,437,320	2.765
Equip. Rental & Interest not incl. in costs	40,966	.033	39,434	.032	122,528	.099	128,096	.099	141,363	.114
Direct Material Moving Costs										
Stripping, per ton	785,507	.195	800,552	.196	1,119,159	.204	1,333,554	.217	1,234,075	.148
Ore, per ton	348,447	.283	439,683	.360	419,799	.340	403,874	.311	441,229	.355
Total ore and waste, per ton	1,133,954	21.5	1,240,235	.234	1,538,958	.229	1,737,428	.232	1,675,304	.175

Note: All figures from accounting reports except where noted.
(1) Mill figures

* Includes $13,861 received from crude ore shipments.

(February 13, 1956)

BAGDAD COPPER CORPORATION
SUMMARY OF OPERATIONS 1951 THROUGH NOV. 1955

	1951	Per ton ore	1952	Per ton ore	1953	Per ton ore	1954	Per ton ore	Jan. thru Nov. 1955	Per ton ore
Stripping Tons	4,032,690		4,078,579		5,480,108		6,139,612		8,341,594	
Ore Production, Tons	1,230,560		1,221,220		1,232,591		1,300,454		1,243,220	
Stripping Ratio	3.28		3.34		4.45		4.72		6.7	
Grade of Prod. Total Cu %	0.84		0.91		1.02		0.82		1.00	
" " " Oxide Cu %	0.09		0.15		0.16		0.13		0.13	
Cu Conc. Production/Tons	31,455 (1)		27,121		27,710		31,788		29,791	
Concentrate Grade %	28.98 (1)		33.28		36.22		28.08		34.68	
Cu Production (lbs. in conct.)	18,376,483		18,053,521		20,070,811		17,852,309		20,667,422	
Metallurgical Recovery %	86.6 (1)		80.91		79.79		84.00		83.28	
Molybdenum Conct. Prod. Tons									194 (1)	
Income										
Copper Concentrate	$3,390,747	$2.755	$3,307,903	$2.708	$4,685,575	$3.801	$4,048,614	$3.113	$6,543,133*	$5.263
Molybdenum Concentrate	85,550	.069	163,223	.134	138,777	.113	120,315	.092	169,557	.136
Miscellaneous	33,408	.027	2,494	.002	8,724	.007	62,225	.048	39,548	.032
Total	3,442,889	2.797	3,468,632	2.840	4,815,628	3.907	4,231,154	3.253	6,752,238	5.431
Expenses										
Exploration Drilling	23,214	.019	23,305	.019	6,343	.005	69,045	.053	35,086	.028
Stripping	785,507	.638	800,552	.656	1,119,159	.908	1,333,554	1.025	1,234,075	.992
Mining	348,447	.283	439,683	.360	419,799	.341	403,874	.311	441,229	.355
Milling	910,162	.740	993,013	.813	1,041,469	.845	970,485	.746	917,281	.738
Trucking Concentrates	95,561	.077	90,551	.074	91,643	.074	107,431	.083	100,645	.081
Indirect	410,960	.334	376,574	.308	510,339	.414	528,433	.406	586,602	.472
Total	2,573,851	2.091	2,723,678	2.230	3,188,752	2.587	3,412,822	2.624	3,314,918	2.666
Operating Profit before Depr., Depl. & Income Tax	869,038	.706	744,954	.610	1,626,876	1.320	818,332	.629	3,437,320	2.765
Equip. Rental & Interest not incl. in costs	40,966	.033	39,434	.032	122,528	.099	128,096	.099	141,363	.114
Direct Material Moving Costs										
Stripping, per ton	785,507	.195	800,552	.196	1,119,159	.204	1,333,554	.217	1,234,075	.148
Ore, per ton	348,447	.283	439,683	.360	419,799	.340	403,874	.311	441,229	.355
Total ore and waste, per ton	1,133,954	21.5	1,240,235	.234	1,538,958	.229	1,737,428	.232	1,675,304	.175

Note: All figures from accounting reports except where noted.
(1) Mill figures

* Includes $13,861 received from crude ore shipments.

ASARCO

Exploration Department

Tucson, May 3, 1978

FILE MEMORANDUM

Cyprus Bagdad

Attached is a copy of data provided at the Bagdad "77" meeting 4-22-78. The following notes contain some additional information obtained during the tour.

The open pit reserve is given as 300 million tons of .49% Cu, .03% Mo; however, the last quarter's production (40,000 tpd) averaged .57% Cu and .025% Mo. Some chalcocite enriched ore remains and as much of this as possible is being mined to hold up the grade (.30% Cu cutoff).

While the overall W/O ratio is 1.1/1, they are currently stripping 4 to 1. On the pit tour it appeared that stripping was still far behind.

Mill recovery: Copper -- 89%, Moly -- 60%.

It was stated that ore estimation based on polygons has checked within 2% of production, both tons and grade.

Two diamond drills are running in the pit to aid in development planning and two are on exploration, one on the NE and one on the NW. Core recovery: 92% average. Recently, a hole on the NW, well beyond the established pit perimeter, cut (1) 300' of capping running .1% to .3% oxide copper, (2) 400' of .70% Cu as chalcopyrite with minor chalcocite and (3) 400' of .5% Cu as primary. The hole was abandoned due to drilling problems. The deepest hole drilled so far is 3600'.

It was stated that the principal veining trends northeasterly as does the monzonite intrusives. Total sulphides were estimated at 4% with the chalcopyrite to pyrite ratio being one-to-one in the zones of stronger primary mineralization.

Potassic alteration -- biotite with lesser amounts of K-spar -- is generally associated with the stronger primary copper at Bagdad. The limits of this potassic zone, both in depth and laterally, apparently have yet to be defined. Thus, the "ore" potential (based in part on Asarco's 1956 examination) is very likely far greater than the current reserve estimate.

J. H. Courtright

J. H. Courtright

JHC:lb
Att.

cc: TCOsborne - w/att.
WLKurtz - w/o att.
FTGraybeal - w/o att.
JDSell - w/o att.

notes on back of last page

April 22 78

J. H. Cowbright

BAGDAD "77"

PREPARED FOR THE ARIZONA CONFERENCE A.I.M.E. DECEMBER 1977 MEETING
TUCSON, ARIZONA

BY: R. J. BONNIS — mine Supt ?
J. E. NELSON

CYPRUS BAGDAD COPPER COMPANY
BAGDAD, ARIZONA

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BAGDAD "77"

PREPARED FOR THE ARIZONA CONFERENCE A.I.M.E. DECEMBER 1977 MEETING
TUCSON, ARIZONA

1.0 INTRODUCTION

THIS PROGRAM IS TO INTRODUCE THOSE WHO ARE NOT FAMILIAR WITH BAGDAD TO THE ACTIVITIES CARRIED ON BY THE CYPRUS BAGDAD COPPER COMPANY AT BAGDAD, ARIZONA. THIS TEXT IS A BRIEF DESCRIPTION OF THE OPEN PIT OPERATION OF THE CYPRUS BAGDAD COPPER COMPANY.

2.0 LOCATION

THE CYPRUS BAGDAD COPPER COMPANY'S OPEN PIT COPPER MINING OPERATION IS LOCATED IN THE EUREKA MINING DISTRICT IN THE WEST CENTRAL SECTION OF THE STATE OF ARIZONA, YAVAPAI COUNTY. NEARBY COMMUNITIES ARE PRESCOTT, ARIZONA, TO THE EAST APPROXIMATELY 70 MILES BY ROAD, AND WICKENBURG, ARIZONA, ABOUT THE SAME DISTANCE TO THE SOUTHEAST. IT IS SERVED BY A HARD-SURFACED ROAD FROM BOTH OF THESE COMMUNITIES. A RAILROAD SIDING IS LOCATED 23 MILES TO THE EAST AT THE TOWN OF HILLSIDE, ARIZONA. BAGDAD HAS A POPULATION OF ABOUT 3,500.

3.0 CLIMATOLOGY

BAGDAD IS LOCATED IN THE SEMI-DESERT AREA OF ARIZONA, AT AN AVERAGE ELEVATION OF APPROXIMATELY 3,300 FEET. THE ELEVATION OF THE AIRPORT IS APPROXIMATELY 4,000 FEET AND THE BOTTOM OF THE PIT 2,800 FEET. THE ANNUAL RAINFALL AVERAGE IS 13.83 INCHES. THE AVERAGE AMBIENT TEMPERATURE IS 62 DEGREES, WITH HIGHS OF 105 DEGREES TO LOWS OF 10 DEGREES ABOVE ZERO. THE PREVAILING WINDS ARE FROM THE SOUTHWEST. THE GENERAL FLORA AND FAUNA OF THE AREA ARE TYPICAL OF THE BASIN REGION OF ARIZONA, CONSISTING OF MANY SPECIES OF CACTI, CEDAR, MESQUITE AND OAK BRUSH. A VARIETY OF WILDLIFE ABOUNDS IN THE SURROUNDING HILLS.

4.0 BRIEF HISTORY

THE BAGDAD MINING CLAIMS WERE DISCOVERED IN 1882 AND PATENTED IN 1889 BY MR. JOHN LAWLER. SUCCESSOR OWNERS AND COMPANIES WERE: GIROUX SYNDICATE, COPPER CREEK DEVELOPMENT COMPANY, ARIZONA NEVADA COPPER COMPANY, BAGDAD COPPER COMPANY, ARIZONA BAGDAD COPPER COMPANY, AND FINALLY IN 1927, BAGDAD COPPER CORPORATION.

5.0 MERGER

IN JUNE, 1973, CYPRUS MINES CORPORATION AND BAGDAD COPPER CORPORATION MERGED. IN JANUARY, 1974, IT BECAME THE CYPRUS BAGDAD COPPER COMPANY.

EXPLORATORY DRILLING TO PROVE THE BAGDAD ORE BODY WAS STARTED AS EARLY AS 1919. THE FIRST METALLURGICAL TESTING WAS BY A 50-TON PILOT PLANT IN THE LATE 20's. THIS WAS FOLLOWED BY A 200-TON MILL IN THE EARLY 30's. AS PART OF THE WORLD WAR II WAR EFFORT, A 2,500 TON PER DAY MILL WAS CONSTRUCTED UNDER AN RFC LOAN.

IN 1944, MR. JOHN C. LINCOLN, OF LINCOLN ELECTRIC COMPANY, ACQUIRED CONTROLLING INTEREST OF BAGDAD COPPER CORPORATION. SHORTLY AFTER THIS DATE, IN 1945, UNDER THE DIRECTION OF MR. LINCOLN, THE MINE WAS CONVERTED FROM AN UNDERGROUND BLOCK CAVING TO AN OPEN PIT OPERATION.

UPON BECOMING AN OPEN PIT OPERATION, THE MILL CAPACITY WAS INCREASED TO 4,000 TONS IN 1949, 5,000 TONS IN 1957, AND TO 6,000 TONS IN 1963.

IN MAY 1974, THE DECISION WAS MADE TO EXPAND BAGDAD'S PRODUCTION AGAIN, BUT THIS TIME FROM THE 6,000 TON PER DAY CONCENTRATOR TO A NEW ONE WITH A CAPACITY OF 40,000 TONS PER DAY.

THE OLD CONCENTRATOR WAS SHUT DOWN IN JULY OF 1977, AND THE SHAKEDOWN OF THE NEW CONCENTRATOR BEGAN. IT IS EXPECTED TO REACH ITS 40,000 TON PER DAY DESIGN CAPACITY SOME TIME BEFORE THE END OF 1977.

A LEACH-PRECIPITATION SYSTEM, TOGETHER WITH A CONTACT SULPHURIC ACID PLANT, WAS INSTALLED IN 1961. THIS PROCESSING WAS INITIATED TO TAKE ADVANTAGE OF THE COPPER IN THE OXIDE ORE STOCKPILED IN THE ADJACENT CANYONS WHILE STRIPPING THE SULPHIDE ORE BODY. IN 1970, A SOLVENT EXTRACTION- ELECTROWINNING PROCESS WAS BUILT AND COMMISSIONED TO REPLACE THE FORMER IRON CEMENTATION SYSTEM. ALL COPPER RECOVERED FROM THE OXIDE DUMPS IS NOW PRODUCED IN THE FORM OF CATHODE COPPER.

IN 1966, A JOINT VENTURE BETWEEN BAGDAD COPPER CORPORATION AND CHEMETALS COMPANY, CALLED ARIZONA CHEMCOPPER COMPANY, WAS FORMED AND A PLANT WAS CONSTRUCTED TO REFINE PRECIPITATE COPPER PRODUCED BY THE LEACHING SYSTEM INTO FRICTION AND MOULDING GRADE COPPER POWDER. THIS PLANT USED HYDROGEN-REDUCTION IN AN ACID CIRCUIT AS THE PROCESS, AND WAS THE ONLY ONE OF ITS KIND.

THE JOINT VENTURE OPERATED THIS PLANT FOR A PERIOD OF TIME, AND IT WAS FINALLY PURCHASED BY BAGDAD.

THE OPERATION'S PRODUCTION WAS FROM PURCHASED COPPER PRECIPITATES AND, DUE TO THE SCARCITY OF PRECIPS, IT WAS CLOSED.

6.0 PIT GEOLOGY

ALONG A CROSS SECTION TAKEN IN THE PIT, THE FOLLOWING GEOLOGICAL UNITS CAN BE OBSERVED:

THE MESA CAPPINGS ARE COMPOSED OF BLACK COLORED BASALT FLOWS WHICH HAVE ERUPTED FROM VENTS SEEN N-W OF THE PIT (NEXT TO BOULDER CREEK). BELOW THE BASALT, IT IS EASY TO RECOGNIZE A WHITE UNIT OF TUFFACEOUS ASH DEPOSITED IN RIVER CHANNELS AND LAKES.

UNDER THE WHITE TUFF LIES A LAYER OF BEIGE COLORED CONGLOMERATE (10,000 - 100,000 YEARS OLD) DEPOSITED IN OLD RIVER CHANNELS AND COMPOSED OF BASALT BOULDERS AND CEMENTED FRAGMENTS.

ALL THE ROCKS MENTIONED ABOVE MUST BE REMOVED BEFORE THE ROCK CONTAINING THE COPPER CAN BE REACHED. THIS ROCK IS CALLED QUARTZ MONZONITE, WHICH IS VERY SIMILAR IN CHARACTER TO A GRANITE AND IS APPROXIMATELY 72 MILLION YEARS OLD.

COPPER SULFIDE ($CuFeS_2$) AND MOLYBDENUM SULFIDE (MoS_2) MINERALIZATION WAS INTRODUCED INTO THIS ROCK BY HOT WATERS ORIGINATING IN THE INTERIOR OF THE EARTH.

THE COPPER OXIDES FORMED AT A LATER DATE BY LEACHING AND OXIDATION OF THE $CuFeS_2$. THE LEACHING WAS DONE BY GROUND WATER, RIVERS, AND RAIN. THE MAJOR OXIDE MINERALS IN THE PIT ARE CHRYSOCOLLA, COMMONLY ASSOCIATED WITH QUARTZ CRYSTALS, MALACHITE, AND AZURITE. NO TURQUOISE EXISTS IN THE MINE, DUE TO A LACK OF PHOSPHOR AND ALUMINUM.

THE ORE BODY (303,000,000 TONS AT .49% TOTAL Cu AND .03% OXIDE Cu - FEBRUARY, 1973) CONTAINS ABOUT HALF A PER CENT COPPER, 0.03 PER CENT MOLYBDENUM, 30 ppm LEAD, 60 ppm ZINC, ONE OUNCE PER TON OF CONCENTRATE SILVER AND 5 ppm URANIUM. THIS MINE IS NOT CREDITED FOR ANY GOLD RECOVERY.

7.0 PLANNING AND ENGINEERING

THE BAGDAD GEOLOGY DEPARTMENT HAD PROVEN A RESERVE OF 303 MILLION TONS, AND THIS WAS THEN TURNED OVER TO THE ENGINEERS TO SEE IF A FEASIBLE MINING PLAN COULD BE DEVELOPED. AN IN-HOUSE STUDY REVEALED THAT THIS 303 MILLION TONS COULD BE MINED WITH A PROFIT; AND WITH THIS IN HAND, BAGDAD WENT OUT TO LOOK FOR SOME CAPITAL TO EXPAND.

AFTER THE MERGER, IN JUNE OF 1973, FORMAL STUDIES COMMENCED; AND IN MAY OF 1974, THE CAPITAL EXPENDITURE REQUIRED FOR THE EXPANSION WAS AUTHORIZED.

DURING OCTOBER 1974, A JOINT VENTURE COMPOSED OF FLUOR UTAH INC. OF SAN MATEO, CALIFORNIA AND HOLMES & NARVER INC. OF ANAHEIM, CALIFORNIA WAS SELECTED TO PERFORM THE DESIGN, ENGINEERING AND PROCUREMENT OF PERMANENT FACILITIES. A CONTRACT WAS ISSUED TO BROWN & ROOT OF HOUSTON, TEXAS AND CONSTRUCTION OF THE NEW 40,000 TON PER DAY CONCENTRATOR COMMENCED SEPTEMBER 1, 1975. THE MINE SITE FACILITIES AND PRE-PRODUCTION STRIPPING WERE UNDERTAKEN BY BAGDAD PERSONNEL.

8.0 EXPANSION

8.1 TOWNSITE

WITH THE INCREASED TONNAGE, A CORRESPONDING INCREASE IN EMPLOYMENT HAS TAKEN PLACE. BAGDAD AT 6,000 TONS PER DAY EMPLOYED 525 PEOPLE; BUT AT 40,000 TONS PER DAY, THE COMPANY EMPLOYS 750 PEOPLE.

CYPRUS BAGDAD OWNS AND OPERATES THE TOWNSITE. IN OTHER WORDS, IT IS A COMPANY TOWN. RENTS ARE NOMINAL. TOP RENT IS $35.00 PER MONTH, WITH ELECTRICITY AND WATER FURNISHED. DURING THE PAST SEVERAL YEARS, THE COMPANY HAS INSTITUTED AN UPGRADING PROGRAM TO IMPROVE THE QUALITY OF HOUSING. AS PART OF THE EXPANSION PROJECT, 354 MODERN BLOCK CONDOMINIUMS WERE CONSTRUCTED. A NEW MODERN 259 UNIT MOBILE HOME PARK WAS CONSTRUCTED FOR EMPLOYEES WHO OWN THEIR OWN TRAILERS; ALSO, IT IS UTILIZED BY RETIRED EMPLOYEES.

COMPANY OWNED AND MAINTAINED FACILITIES INCLUDE A CENTRAL SEWAGE TREATMENT PLANT, AN ELECTRIC POWER DISTRIBUTION SYSTEM, AND ALL STREETS, MOST OF WHICH WILL BE PAVED BY THE END OF THE YEAR. THE TOWN IS PIPED FOR BUTANE AND THERE IS A NATURAL GAS LINE TO THE MINE PLANT SITES.

BAGDAD OWNS AND OPERATES A STORE ON A NON-PROFIT BASIS AS AN EMPLOYEE FRINGE BENEFIT.

CYPRUS BAGDAD COPPER COMPANY OWNS AND OPERATES AN 11-BED HOSPITAL, WHICH IS STAFFED BY THREE DOCTORS AND A 24-HOUR NURSING STAFF. IT IS WELL MAINTAINED AND EQUIPPED. THERE IS AN EMERGENCY OPERATING ROOM, DELIVERY ROOM, AN OPERATING ROOM, X-RAY LABORATORY, CHEMICAL LABORATORY, VARIOUS TREATMENT ROOMS, OFFICE, KITCHEN, WARDS, AND PRIVATE ROOMS.

USES HAVE BEEN FOR MAJOR OPERATIONS, EMERGENCY TREATMENT AND CONVALESCENCE.

AMBULANCE SERVICE IS ALSO PROVIDED BY A WELL MAINTAINED AMBULANCE. WHEN NECESSARY, THE COMPANY AIRCRAFT IS AVAILABLE TO TRANSPORT PATIENTS TO PHOENIX FOR SPECIALIZED SERVICES.

THIS COMMUNITY OF BAGDAD HAS TWO MODERN AND ATTRACTIVE SCHOOL PLANTS. GRADES KINDERGARTEN THROUGH EIGHTH ARE HOUSED IN THE DAVID C. LINCOLN ELEMENTARY SCHOOL, COMPLETED IN 1976. GRADES NINE THROUGH TWELVE ARE HOUSED IN TWO ATTRACTIVE RED BRICK BUILDINGS, SCHEDULED FOR RENOVATION DURING 1977. A LARGE GYMNASIUM, A MULTI-PURPOSE BUILDING, AN AUDITORIUM, ATHLETIC FIELDS, AND A COMMUNITY SWIMMING POOL ENHANCE THE EXTRACURRICULAR PROGRAMS.

THE FOLLOWING SERVICES ARE PROVIDED BY OUTSIDE INDIVIDUALS: SERVICE STATION, GARBAGE COLLECTION, BANK, BEAUTY SALON, BARBER SHOP, HOBBY SHOP, LAUNDRAMAT, MOTION PICTURE THEATRES (BOTH DRIVE-IN AND INDOOR). THERE ARE ALSO A POST OFFICE, LIBRARY, MOUNTAIN BELL TELEPHONE SERVICES, A JAIL, TWO FULL TIME DEPUTIES. AN AUTO SUPPLY STORE IS OWNED AND MAINTAINED BY THE COMPANY. BAGDAD ALSO BOASTS A WEEKLY NEWSPAPER, THREE RESTAURANTS, TWO BARS AND ELEVEN CHURCHES.

8.2 MINING AND THE PIT

THE MINING METHOD USED IN THE CYPRUS BAGDAD MINE IS THE MULTIPLE BENCH, OPEN PIT SYSTEM.

THE BENCH HEIGHT IS 40 FEET, AND THE MINIMUM MINING WIDTH IS 100 FEET. MINING STARTS BY DRILLING MULTIPLE ROWS OF 9-INCH ROTARY DRILL HOLES, 47 FEET DEEP. THESE ARE ON A 20-FOOT BY 20-FOOT SPACING, BOTH IN GILA AND QUARTZ MONZONITE.

THESE HOLES ARE THEN LOADED WITH AMMONIUM NITRATE FUEL OIL BLASTING AGENT TIED TOGETHER WITH DETONATING CORD. IN WET GROUND, A PUMP TRUCK AND PLASTIC LINERS ARE USED; OR IF THE HOLE CAN'T BE PUMPED OUT, A SLURRY OR TRITEX BOMBS ARE USED. A MINIMUM OF 30 FEET OF BACKBREAK CAN BE EXPECTED WHEN MULTIPLE ROWS ARE SHOT SIMULTANEOUSLY. BAGDAD'S EXPERIENCE HAS BEEN THAT IF DELAYS ARE USED, ONLY 10 TO 15 FEET OF BACKBREAK CAN BE EXPECTED. SOMETIMES AS MUCH AS 60 FEET BACKBREAK WILL APPEAR ON A SIMULTANEOUS SHOT; SO BY NOT USING DELAYS, 20 TO 50 FEET OF "FREE" MUCK ARE OBTAINED WITH THE SAME NUMBER OF HOLES AND SAME AMOUNT OF POWDER. IN SPECIAL CASES, DELAYS ARE PLACED BETWEEN THE ROWS (SEE FIGURE #1) TO REDUCE VIBRATION AND POSSIBLE SUBSEQUENT DAMAGE TO THE PIT SLOPES.

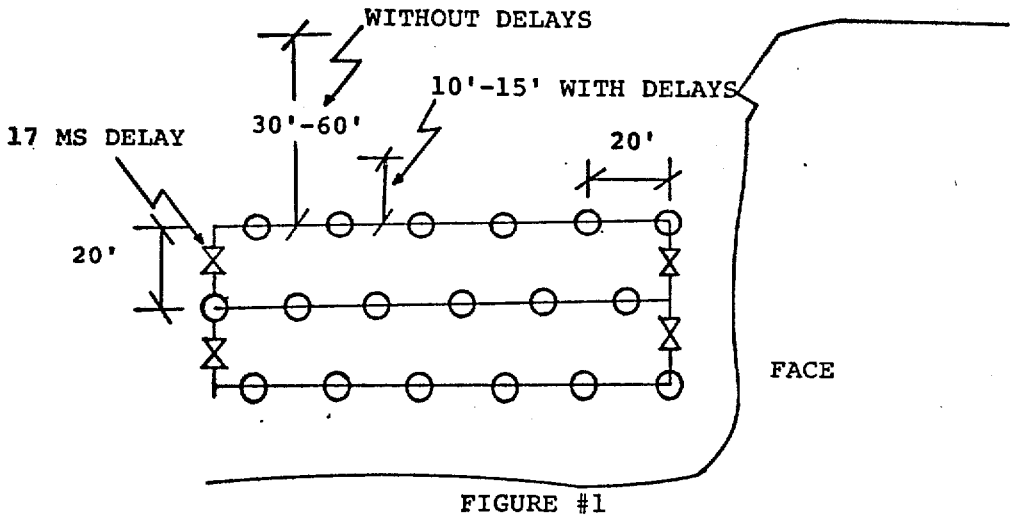


FIGURE #1

SECONDARY BLASTING IS RARE, BUT IF A BOULDER DOES APPEAR, IT IS DRILLED WITH AN AIR TRACK DRILL OR A JACKHAMMER, LOADED WITH STICK POWDER, AND SHOT. THIS OPERATION TAKES PLACE AT THE WORKING FACE.

MUCH CARE IS TAKEN WITH THE BLASTING AS IT IS BAGDAD'S PHILOSOPHY TO USE THE SHOVELS TO LOAD AND NOT TO DIG. HARD TOES OR EXCESSIVELY COARSE MUCK NOT ONLY TEAR UP THE EQUIPMENT, BUT ALSO SLOW THE LOADING CYCLE.

AFTER THE MUCK HAS BEEN BROKEN, IT IS LOADED INTO 170-TON TRUCKS BY A 20-YARD SHOVEL. DOUBLE SET UPS ARE MAINTAINED AS OFTEN AS POSSIBLE. TRUCKS THAT ARE BACKING UNDER THE SHOVEL ARE SPOTTED BY THE SHOVEL OPERATOR WITH THE DIPPER WHEN THE TRUCK IS BACKING BLIND, WHILE THE TRUCKS ON THE OTHER SIDE CAN SPOT THEMSELVES. BAGDAD USES THE CABLE BRIDGE SYSTEM RATHER THAN THE DRIVE-OVER SYSTEM BECAUSE IT FACILITATES BETTER ROAD MAINTENANCE AND A FASTER CYCLE TIME, AND THE TRUCKS DON'T HAVE TO SLOW DOWN FOR THE "BUMP".

THE ROAD MAINTENANCE PROGRAM IS AN INTEGRAL PART OF BAGDAD'S MINING OPERATION. IT NOT ONLY REDUCES TIRE COSTS (BAGDAD'S TIRE LOSS DUE TO ROCK CUTS IS LESS THAN 5%, AND THE PROJECTED RUNOUT TIRE LIFE IS IN EXCESS OF 5,000 HOURS FOR OUR 36.00 x 51 TIRE SIZE), BUT IT ALSO DECREASES THE CYCLE TIME BY ALLOWING FASTER SPEEDS. SMOOTH ROADS ALSO DECREASE MAINTENANCE ON THE HAULAGE FLEET BY REDUCING PROBLEMS INHERENT IN ROUGH ROAD DRIVING, i.e. FRAME, SUSPENSION, AND TIRE OVERLOADING PROBLEMS. THE ROADS ARE MAINTAINED WITH A FLEET OF FOUR SCRAPERS, FOUR CAT 16 BLADES, ONE CAT 12 BLADE, AND ONE CHAMPION 80-T BLADE. THE CHAMPION 80-T IS THE WORLD'S LARGEST MOTOR GRADER WITH 700 BPH AND A WORKING WEIGHT OF 180,000 POUNDS. THIS IS A PROTOTYPE, AND BAGDAD IS RENTING IT.

GRADES ARE MAINTAINED AT THE SHOVELS BY THE USE OF A LASER. THIS ELIMINATES HARD TOES AND WATER PROBLEMS, AS CORRECT GRADES ARE MAINTAINED, EVEN AT NIGHT. THE LASER ALLOWS A SHOVEL OPERATOR TO

HOLD GRADE BECAUSE IT IS ALWAYS ON THE JOB, AND AT NIGHT THE OPERATOR CAN SEE A RED LINE ON THE WORKING FACE. IT ALSO ALLOWS THE ENGINEERING CREW MORE TIME TO DO OTHER JOBS.

HAULING IS DONE WITH TWENTY-TWO 170-TON TRUCKS AND THREE 60-TON TRUCKS. THE 60-TON TRUCKS ARE USED ONLY FOR BACKUP OR WHEN A LEVEL IS TOO SMALL TO ACCOMMODATE A LARGE SHOVEL OR TURCK, i.e. WHEN STARTING A LEVEL OR BUILDING A ROAD.

8.3 MUCK MOVING

THE NAME OF THE GAME IS "MUCK MOVING". BAGDAD FEELS ITS MOST IMPORTANT ASSET IS ITS PERSONNEL, AND BAGDAD IS VERY MUCH PEOPLE ORIENTED.

THE EXPANSION PROGRAM HAS INCREASED THE TOTAL EMPLOYMENT AT BAGDAD FROM ABOUT 500 TO 750 EMPLOYEES, AND THE PIT DEPARTMENT HAS ONLY INCREASED FROM 210 TO 297. THE MINIMUM WORK FORCE FOR THE EXPANDED OPERATION WAS BUILT UP AT A RATE WHICH PERMITTED STRIPPING TO PROGRESS WITHOUT PEAKING AND A CONSEQUENT DECLINE IN MANPOWER OR EQUIPMENT REQUIREMENTS.

THE ORE REQUIREMENTS HAVE JUMPED 700%, BUT OUR EMPLOYMENT HAS ONLY INCREASED 50%. THE INCREASED PRODUCTIVITY PER MAN HAS BEEN ACCOMPLISHED BY INTRODUCING NEW AND LARGER EQUIPMENT. THE FIGURES IN THE FOLLOWING GRAPHS INDICATE A LARGE INCREASE IN PRODUCTIVITY WITH THE INTRODUCTION OF 170-TON TRUCKS, i.e. TONS/DRIVER SHIFT.

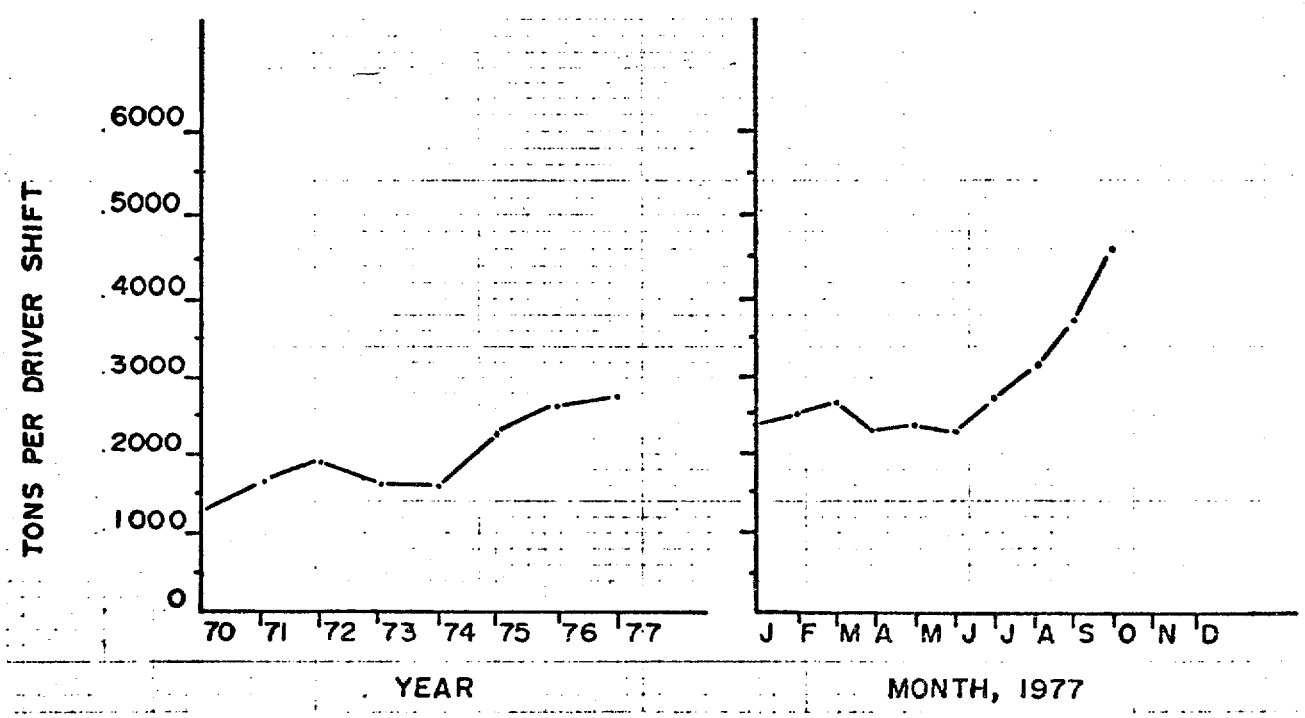


FIGURE #2

BAGDAD PLANS ITS HAUL ROADS 120 FEET WIDE WITH A STRADDLE BERM IN THE CENTER OF THE ROAD. THIS BERM NOT ONLY GIVES A RUNAWAY TRUCK AN OUT, BUT SEPARATES THE TWO LANES OF TRAFFIC IN WET WEATHER. THE MAXIMUM GRADE PLANNED ON THE HAUL ROADS IS 8%.

IN ORDER TO MAXIMIZE EQUIPMENT AVAILABILITY AND MANPOWER UTILIZATION, BAGDAD ONLY OPERATES TWO SHIFTS PER DAY, WITH ONE HOUR BETWEEN SHIFTS. THIS SYSTEM ALLOWS MAINTENANCE OF ANY PIECE OF EQUIPMENT ON THE THIRD SHIFT AND ALLOWS THE BACK UP FLEET TO BE VERY SMALL, AS ROUTINE MAINTENANCE IS DONE ON THE THIRD SHIFT OR BETWEEN SHIFTS. THIS SYSTEM ALSO ELIMINATES THE NEED FOR A SHUTDOWN TO BLAST, AS ALL BLASTING CAN BE DONE BETWEEN, BEFORE, OR AFTER SHIFT. THIS TWO SHIFT PER DAY SYSTEM ENHANCES OUR ROAD MAINTENANCE PROGRAM, AS HAUL ROADS CAN BE BLADED WITHOUT INTERRUPTING TRAFFIC. IT ALSO ELIMINATES THIRD SHIFT SUPERVISION AND THE ACCIDENT PRONE GRAVEYARD SHIFT.

ANOTHER FEATURE BAGDAD HAS ADOPTED IS THE USE OF "PIT STOPS". A PIT STOP IS A PORTABLE SLED WITH FUEL, AIR, HOIST OIL, TREATED WATER, AND LUBRICANTS ON BOARD. THESE ARE NORMALLY PLACED ON THE DUMPS AND AT THE CRUSHER. THESE ARE RELATIVELY INEXPENSIVE TO BUILD ($40,000) AND SAVE MANY HOURS IN TRANSPORT TIME AND FUEL TIME. THESE PIT STOPS ARE EQUIPPED WITH QUICK CONNECT FITTINGS AND CAN PUMP 300 GALLONS PER MINUTE OF FUEL. THE LOCATION OF THESE STOPS ALSO ALLOWS THE TRUCKS TO CYCLE FASTER AND GIVES THEM MORE TIME TO HAUL, AS SOME TRUCKS ARE LEFT LOADED ON THE ONE HOUR SHIFT CHANGE AND WILL GO TO DUMP UPON SHIFT START AS THE REST OF THE FLEET WILL GO TO A SHOVEL TO BE LOADED. THE PIT STOPS BEING AT THE DUMP POINT, THERE IS NO LOST TRANSPORT TIME.

THE CONFIGURATION OF THE BAGDAD PIT NORMALLY DICTATES THAT TRUCKS HAUL TO ONE DUMP FROM A PARTICULAR SHOVEL. IN RARE CASES, ONE DUMP IS ADEQUATE FOR TWO SHOVELS; BUT THE USUAL CASE IS ONE SHOVEL, ONE DUMP. THIS SITUATION LENDS ITSELF TO THE USE OF A SCHEDULE BOARD, A BOARD THAT IS PUT UP AT THE START OF A SHIFT AND TELLS EACH DRIVER WHICH SHOVEL HE IS TO HAUL FROM THAT SHIFT. THE DRIVERS THEN OPERATE ON AN HONOR SYSTEM AS THEY KEEP THE SHOVEL COVERED.

SPOTTERS ARE USED AT BAGDAD FOR THREE REASONS: ON HIGH DUMPS THE OUTSIDE EDGE OF A DUMP TENDS TO SETTLE, AND THE SPOTTER WILL NOT ALLOW A TRUCK TO BACK INTO ONE OF THESE LOW SPOTS, EXPECIALLY AT NIGHT. THE SECOND REASON IS TO KEEP TRACK OF THE LOADS AND TYPE OF MATERIAL EACH SHOVEL PRODUCES, AS WELL AS THE NUMBER OF LOADS EACH TRUCK HAULS PER SHIFT. THE THIRD REASON IS TO KEEP ROCKS FROM UNDER THE TRUCKS, BOTH BY BACKING THEM INTO CLEAN SPOTS AND REMOVING FALLEN ROCKS FROM THE DUMPING PROCESS.

THE MAINTENANCE PROGRAM ON THE EQUIPMENT IS VERY EXTENSIVE. THE 20 YARD SHOVELS ARE EQUIPPED WITH AN AUTOMATIC LUBE SYSTEM, BUT BAGDAD STILL MAINTAINS AN OILER. THIS OILER WILL CLEAN AND CHECK THE SHOVEL DAILY. HE ALSO RELIEVES THE OPERATOR, THUS ALLOWING THE OPERATOR A BREATHER WHILE HE LEARNS THE CORRECT TECHNIQUES TO OPERATE A SHOVEL. THE TRUCKS ARE ALSO SERVICED REGULARLY - OIL AND LUBRICANTS ARE CHANGED ACCORDING TO TACH HOURS AND THE OIL IS ANALYZED FOR METALS. WE ARE CURRENTLY CHANGING THE CRANKCASE OIL EVERY 200 TACH HOURS ON THE 170 TON TRUCKS.

9.0 SLOPE STABILITY AND MONITORING

THE SLOPE ANGLE IS VERY CRITICAL IN OPEN PIT MINING. CURRENTLY BAGDAD EMPLOYS A SLOPE STABILITY MAN TO ANALYZE THE VARIOUS AREAS OF THE PIT AND TO MAKE RECOMMENDATIONS.

CURRENTLY IN ONE AREA WE ARE EXPERIMENTING WITH A 57° SLOPE BETWEEN HAUL ROADS. THIS AREA IS IN A GILA CONGLOMERATE, IS PRE-SPLIT AND HAS BEEN STANDING FOR TWO YEARS WITH NO INSTABILITY. WHEN WE REACH ROCK WE WILL FLATTEN THE SLOPE TO 45°.

EACH AREA OF THE PIT HAS TO BE LOOKED AT INDIVIDUALLY, AS TO ROCK TYPE, WATER LEVEL, AND MOST IMPORTANTLY FAULTING AND FRACTURING. IT APPEARS NOW THAT IN SOME AREAS OF THE PIT WE WILL BE LIMITED TO A 50° SLOPE AS SOME STRUCTURE IS DAYLIGHTED AT THIS ANGLE.

SLOPE STABILITY IS AN ONGOING JOB AS THERE ARE OVER 35 MONITORING DEVICES WITHIN THE PIT. SLOPE MOVEMENT IS DETECTED BY A INFRA-RED DISTANCE METER LOCATED 3000-4000 FEET AWAY FROM THE SLOPE. THE DISTANCE METER CAN DETECT MOVEMENTS IN THE ORDER OF .001 FEET AT 10,000 FEET. THE RATE AT WHICH A SLOPE INSTABILITY MOVES DICTATES THE FREQUENCY OF THE MEASUREMENTS. SLOPE STABILITY MONITORING HELPS ESTABLISH SAFE WORKING CONDITIONS BY PROVIDING OPERATING PERSONNEL WITH AN EARLY WARNING OF SLOPE INSTABILITY.

10.0 THE CONCENTRATOR

DESIGN CONCEPTS - PROCESS TECHNIQUES AND GENERAL CONCENTRATOR LAYOUT ARE SIMILAR TO OTHER WELL ESTABLISHED PLANTS IN ARIZONA HANDLING HIGH TONNAGE, LOW-GRADE PORPHYRY ORES. AN EFFORT HAS BEEN MADE TO USE LARGE CAPACITY PROCESSING UNITS WHICH HAVE ALREADY PROVEN THEIR RELIABILITY IN OTHER OPERATIONS. THE USE OF LARGE WELL PROVEN EQUIPMENT WITH ADEQUATE INSTRUMENTATION FOR MONITORING AND CONTROL WILL ALLOW A HIGH TONNAGE OPERATION WITH A MINIMUM OF OPERATING PERSONNEL.

THE CONCENTRATOR IS DESIGNED TO PROCESS 40,000 TONS OF ORE PER DAY, CONTAINING .55% TOTAL COPPER. PRODUCTION IS ESTIMATED TO BE 650 TONS PER DAY OF 28-30% COPPER CONCENTRATE AND 12,500 POUNDS PER DAY OF 55% MOLYBDENUM CONCENTRATE.

THE PRIMARY CRUSHER IS PLANNED TO OPERATE TWO SHIFTS PER DAY, SEVEN DAYS PER WEEK. THE CRUSHER IS A 60 x 89 ALLIS CHALMERS GYRATORY CRUSHER WITH THE OPEN SIDE SET AT 8.5 INCHES. THE CRUSHER IS DRIVEN BY A 500 HP INDUCTION MOTOR. MAXIMUM CRUSHER CAPACITY IS 3595 TPH.

THE CRUSHED ORE DROPS INTO A 450-T SURGE BIN AND IS THEN DRAWN OUT BY A FLUID-POWERED 84" x 20'-LONG APRON FEEDER.

THE ORE IS THEN CONVEYED AND ELEVATED ABOUT 6400 FT. AND 1020 FT. RESPECTIVELY ON A SERIES OF FIVE 54" AND 60" WIDE STEEL CHORD CONVEYOR BELTS, THE FINAL OF WHICH IS A RADIAL STACKER DELIVERING TO A 55,000 T (LIVE) ORE STOCKPILE AT THE CONCENTRATOR. THE MAXIMUM BELT SLOPE IS 14 DEGREES AND THE TOTAL CONNECTED POWER ON THE CONVEYING SYSTEM IS 6500 HP.

THE MILL IS COMPRISED OF THREE PARALLEL AND SEPARATELY OPERABLE LINES. THE NOMINAL DESIGN THROUGHPUT IS 600 TPH PER LINE.

THE 8.5 INCH ORE IS RECLAIMED AND FEEDS DIRECTLY INTO A 32'Ø x 13'-LONG KOPPERS CASCADE MILL ALONG WITH RECLAIM WATER AND MILK OF LIME.

THIS MILL IS DESIGNED TO OPERATE AUTOGENOUSLY, TURNING AT 73% OF CRITICAL SPEED AND DRIVEN BY TWO 4000 HP WOUND ROTOR MOTORS.

THE AUTOGENOUS MILL DISCHARGES INTO A DOUBLE-DECK SCREEN AND THE PLUS HALF-INCH OVERSIZE IS RETURNED TO A SHORTHEAD CRUSHER AND ITS 3/8-INCH PRODUCT RETURNS TO THE COARSE ORE FEED OF THE AUTOGENOUS MILL. THE MATERIAL PASSING THE SCREEN IS CYCLONED AND THE OVERFLOW WITH 50% PASSING 200-MESH CONSTITUTES FEED TO FLOTATION. THE UNDERFLOW IS THE FEED TO THE SECONDARY GRINDING CIRCUIT (A 15.5'Ø x 22'-LONG KOPPERS OVERFLOW BALL MILL OPERATING AT 66.5% OF CRITICAL SPEED.

CYCLONE OVERFLOW IS THEN COMBINED AND GRAVITATES VIA A FEED SAMPLER TO A 4-POINT DISTRIBUTOR AND INTO 4 @ 15-CELL LINES OF 500 CU. FT. FLOTATION CELLS. CELLS ARE COMPARTMENTED IN FIVE 3-CELL UNITS PER LINE.

THE ROUGHER TAILS ARE THEN SAMPLED AND FLOW BY GRAVITY TO THE TAILINGS POND.

THE ROUGHER FROTH IS CYCLONED AND THE UNDERFLOW IS REGROUND IN A 10'Ø x 15' BALL MILL AND THE OVERFLOW IS CLEANER FEED. THIS IS CLEANED TWICE AND SENT TO THE MOLY CIRCUIT. THE CLEANER TAILS ARE SCAVENGED

AND THE FROTH IS REGROUND AND THE TAILS GO TO THE TAILINGS POND.

THE COPPER-MOLY CONCENTRATE IS THICKENED, CONDITIONED AND SENT TO THE MOLY ROUGHER CELLS. THE ROUGHER FROTH IS THEN CYCLONED AND REGROUND IF NECESSARY, THEN IT IS SENT TO THE CLEANERS. THE FINAL CONCENTRATE IS THEN FILTERED AND DRIED.

THE COPPER CONCENTRATE IS FILTERED, DRIED AND LOADED INTO TRUCKS FOR A 25 MILE TRIP TO THE NEAREST RAILROAD SIDING AT HILLSIDE, ARIZONA.

THE CONCENTRATOR IS SERVED BY A 5300-GPM, 12-WELL SYSTEM LOCATED IN THE BIG SANDY VALLEY NORTH OF WIKIEUP.

SINGLE POINT MAINLINE PUMPING THROUGH A 24"Ø x 31 MILE LONG PIPELINE UTILIZES (5) 6 x 4 - 5 STAGE BINGHAM PUMPS DRIVEN BY 1000 HP RELIANCE MOTORS.

11.0 CONCLUSION

THE FOUR PRIMARY REASONS FOR BAGDAD'S SUCCESS IN MEETING ITS GOAL OF "MOVING MUCK" ARE:

1. PERSONAL RELATIONS "OPEN DOOR POLICY".
2. EXCELLENT PREVENTIVE MAINTENANCE PROGRAM.
3. EXCELLENT HAUL ROAD MAINTENANCE.
4. USING SHOVELS TO LOAD, NOT TO DIG.

Ore estimation on polygons – check with production
98%, (tons + grade)

dd – 250' square grade – test on 150' checked
core + sludge assayed – total 400 holes

40,000 tpd –
blast holes 15' spacing –

Core rec cov – 92% – Use mud
– and "lo-loss" system to recover sludges
semi internal waste
sample blast holes top + bott (20') separately
– use 12½ cu ft per ton – av 2% moisture

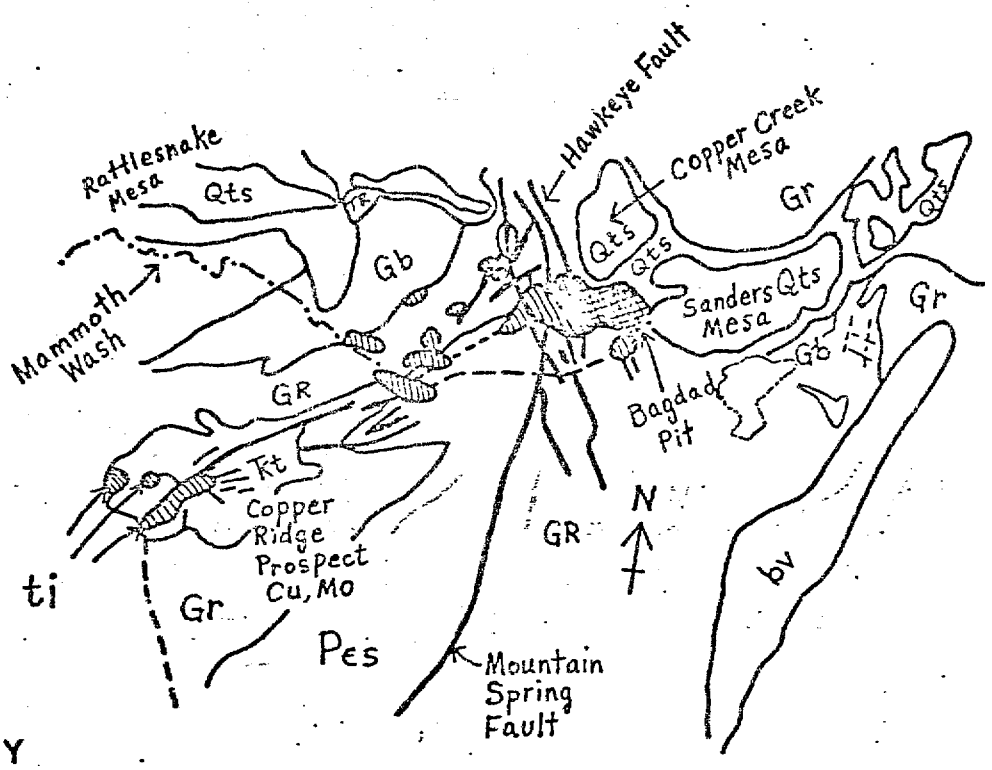
.3 Cu cutoff – in pit

Rec. 89% Cu – 60 to 70 mo

Eng. Geol mapping – map rock types –
and fractures, faults – determine
potential strength of rock – design shape
and slope of benches

pit slope designed on degree of probability of failure
vs. cost of strip – and cost of cleaning up

GENERALIZED GEOLOGIC MAP OF THE BAGDAD AREA



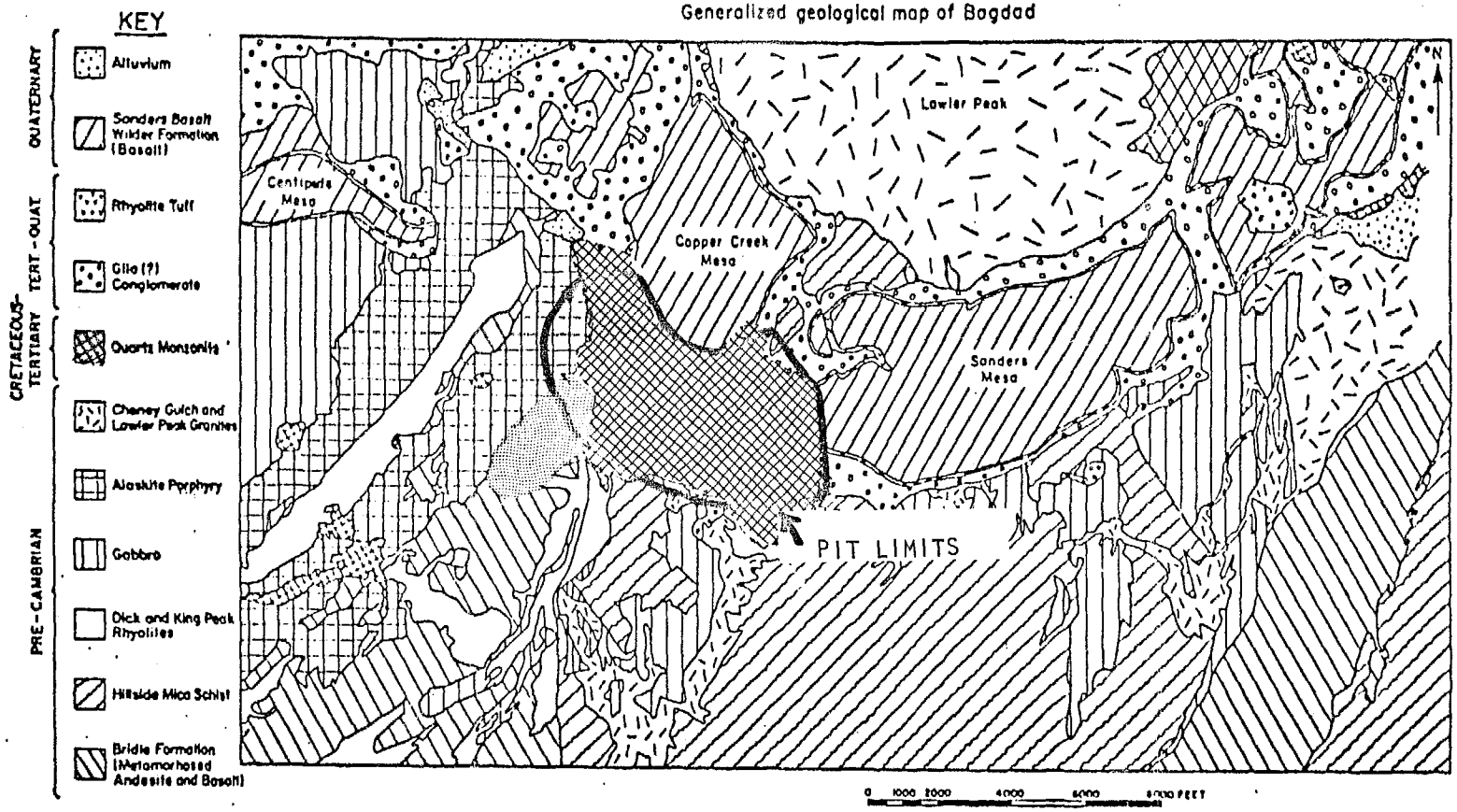
KEY

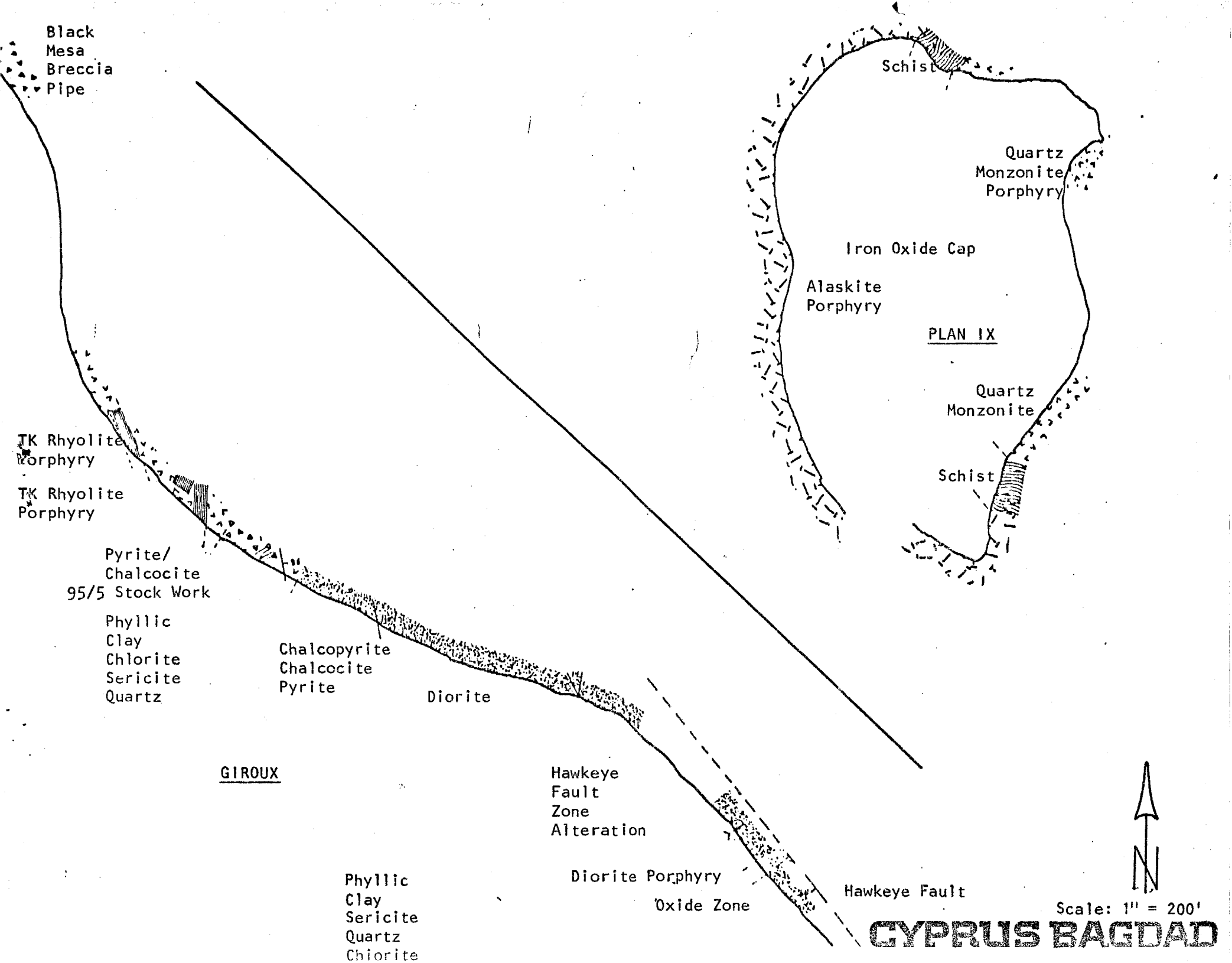
Qts — Quaternary-Tertiary Alluvium and Basalt	Gb — Precambrian Gabbro-Anorthosite
Ti — Tertiary-Cretaceous Intrusives, Dikes, Stocks of Monzonite, Diorite or Rhyolite	Gr — Precambrian Granites
Tt — Tertiary-Cretaceous Welded Tuff	br — Bridle Formation Precambrian Meta-Andesites and Basalts
Pes — Precambrian Shists	

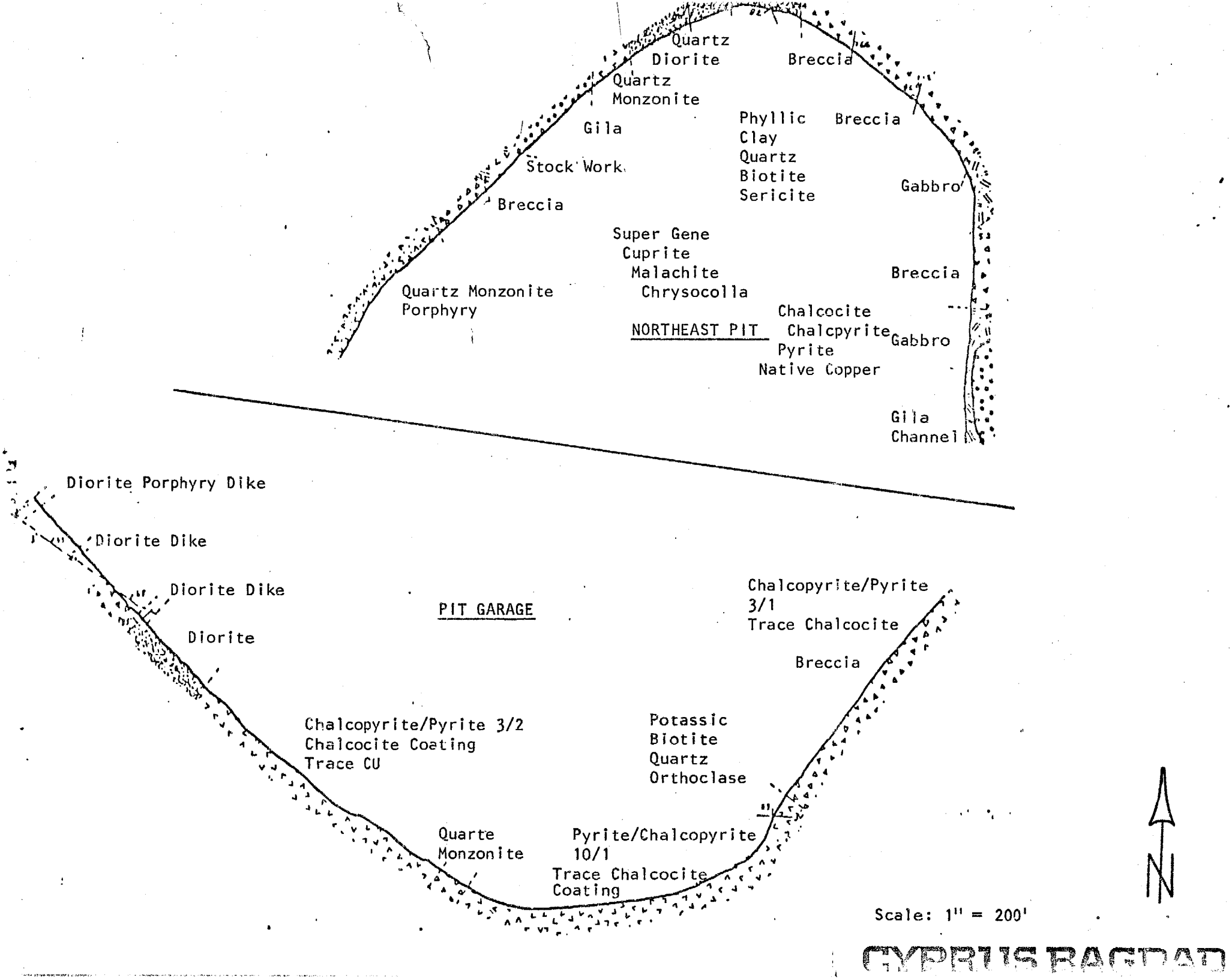
SCALE 1:120,000

PKM

Generalized geological map of Bagdad




Black
Mesa
Breccia
Pipe
Schist
Quartz
Monzonite
Porphyry
Iron Oxide Cap
Alaskite
Porphyry
PLAN IX
Quartz
Monzonite
Schist
TK Rhyolite
Porphyry
TK Rhyolite
Porphyry
Pyrite/
Chalcocite
95/5 Stock Work
Phyllic
Clay
Chlorite
Sericite
Quartz
Chalcopyrite
Chalcocite
Pyrite
Diorite
GIROUX
Hawkeye
Fault
Zone
Alteration
Phyllic
Clay
Sericite
Quartz
Chlorite
Diorite Porphyry
Oxide Zone
Hawkeye Fault
N
Scale: 1" = 200'
CYPRUS BAGDAD



CYPRUS BAGDAD

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

December 29, 1956

Mr. T. A. Snedden, Manager
Southwestern Mining Department
Tucson Office

BAGDAD MINE
Yavapai County
Arizona

Dear Sir:

Herewith is a report on the Bagdad Mine. This is based on information accumulated during several visits to the Mine beginning last January and including, in various groups, yourself, F. V. Richard, Norman Weiss, J. D. Vincent, L. H. Hart, A. H. Haworth, R. B. Meen, B. S. Hardie, and ourselves.

Because Bagdad was known as a marginal proposition, and because some of their engineering data were in rather incomplete form, certain aspects of the evaluation program, such as drill hole sample accuracy and ore reserve estimates, were more complicated than anticipated and were analyzed with more care than is customarily used in mine evaluation.

This has required considerable time and personnel. Certain parts of the study had to be completed before other parts could be started, and work on these various phases was interrupted frequently because of work on other projects. The point is, the job has taken much longer than expected, but we have recognized no legitimate short-cuts.

Although we of course are responsible for the essential data in the report, and its form, others have contributed substantially, as follows:

Vincent, Weiss --- The metallurgy has been entirely handled by these men. We have expressed no independent opinions on this important subject.

Meen, Haworth, Barlow, Kendall --- The detailed analysis of mining systems and costs was worked out by these men. Also, Meen collected much of the engineering and financial data on Bagdad's operations, Haworth assisted in ore reserve and other calculations, and Kendall derived water supply system costs and some of the power costs.

Hardie --- The data on history and production were compiled by Hardie, who also assisted on ore reserve and other calculations.

Hayes --- Liquidation and other calculations in connection with outcome estimates were made by Hayes.

SUMMARY AND CONCLUSIONS

Bagdad is a small open pit mine in northwestern Arizona, producing 3600 tons of porphyry copper ore per day. Although its operational history dates back to 1928 when experimental cave mining was attempted, substantially all of its production, totalling over 13 million tons of 0.98% copper, has come during the past 12 years. This grade compares favorably with that of other porphyry copper mines. However, due principally to under-capitalization and the small size of the plant, the operation has been marginal. On several occasions, financial collapse seemingly was averted only by fortuitous copper price rises. As the matter now stands, most of the shallow, high grade chalcocite ore has been mined out and, while the ore reserve now is large, the grade and stripping ratio both are less favorable than in the past.

Due to the rather wide spacing and erratic distribution of many of the drill holes, and to the lack of certain sample data, only a part (around 35%) of the total reserve can be considered as "measured" ore. The balance is classed as "indicated", or "inferred". Based on two pit designs and two grade cutoffs, our estimate is:

	Cutoff	Tons (Millions)	% Cu Total	Waste/Ore Ratio
Small Pit	.50% Cu	37.8	.84	2.53/1
Small Pit	.40% Cu	59.1	.72	1.36/1
Large Pit	.50% Cu	68.8	.77	2.73/1
Large Pit	.40% Cu	101.4	.68	1.63/1

To place this reserve on an acceptably firm basis, we estimate that at least 27,000 feet of interspaced drilling would be required.

No exploration opportunities are recognized for finding consequential tonnages of shallow chalcocite ore of good grade -- say, 1.0% or better -- which would provide fast capital return for a new, larger plant. However, possibilities are good for finding additional large tonnages of low grade chalcopyrite ore. Some of this possible low grade ore would be shallow but most of it would be deep. Rather large tonnages of this deeper ore at a grade of .6 or .7% Cu would be accessible to open pit mining at waste/ore ratios somewhat higher than those of present reserves.

Considering the possibility of eventual commercial interest in deposits averaging around .5% Cu, it should be emphasized, we believe, that Bagdad has a huge tonnage potential in material of that grade.

The estimated financial outcome for Bagdad cannot be adequately expressed in a single figure because there are several variables, the principal of which are the amount of capital needed and the degree of technological certainty. From the several possible combinations we have selected four alternatives as those best representing the range in outcome.

These are in two categories: (A) standard process -- i.e., concentrates

smelted, and (B) cement copper produced by fluosolid roasting of concentrates with resulting acid used for calcine leaching and heap leaching, as proposed by Mr. Vincent. These are summarized as follows:

Constants:

Copper Price	--	29¢ CV
Production Rate	--	10,000 tpd

Variables:

	A		B	
Ore Grade Cutoff	.5% Cu	.4% Cu	.5% Cu	.5% Cu
Ore Reserve.... tons....millions...	37.8	101.4	37.8	68.8
Ore Reserve.... grade...% Cu	.84	.68	.84	.77
Life	10 yrs.	28 yrs.	10 yrs.	19 yrs.
Gross Income... $ per ton ore.....	3.15	2.61	4.44	4.32
Operating Cost..$ per ton ore.....	2.12	1.90	2.74	2.79
Operating Profit $ per ton ore.....	1.03	.71	1.29 ~~1.70~~	1.03 ~~1.53~~
@ 31¢ lb	1.29	[illegible]	1.65	1.39
Capital .....$ millions	13.1	14.4	10.6	11.1
Net before interest and income tax ($ per ton ore.....	.68	.57	1.42	1.37
Net before interest and income tax ($ millions.....	25.68	57.38	53.64	94.57
Variation in Net per 1¢ change Cu price $ per ton ore.....	.13	.11	.18	.18
Production (concentrates..tons per yr.	93,000	84,200		
Production (cement Cu ....tons per yr.			42,568	39,687
Production (Total Cu.....tons per yr.	25,300	20,200	34,054	31,749

The price for Mr. J. C. Lincoln's 56% stock interest in Bagdad Copper Corporation was $20 per share, or $6 million, in 1952. He would probably place a higher value on the stock now. The market for the remaining stock is reported at about $19 per share. 100% ownership of Bagdad would probably cost $10 million or more.

The outcomes under category A are unfavorable even if the purchase price were appreciably less than anticipated. However, under category B, the fluosolid-heap leaching system, outcomes are attractive -- capital would be returned rapidly and profits would be large. The difference between the A and B outcomes is dependent essentially on the feasibility of the metallurgical system proposed by Mr. Vincent.

LOCATION - GEOGRAPHY

Bagdad is in west-central Arizona (See Index map, Att. A) at an altitude of about 3200 feet. Moderately rugged hills and broad, flat-topped mesas characterize the topography of the region. The mine is situated near the head of Copper Creek, which drains westerly into Boulder Creek, a tributary of the drainage system leading to the Colorado River on the west.

An oil-surfaced road 26 miles in length connects Bagdad with Hillside, a station on the AT&SF Railroad. Congress Junction on U. S. Highway 89 (see road map, Att. B) is 22 miles by gravel road from Hillside. The driving distance from Tucson to Bagdad is 245 miles.

HISTORY - PRODUCTION

Like the majority of porphyry copper deposits in the west, the development of Bagdad was initiated some 50 years ago by the discovery of disseminated chalcocite ore in underground workings. Around 1910, drilling demonstrated the existence of widespread ore of sub-marginal grade as well as a small but high grade porphyry ore body which eventually was mined --- first by block-caving and later by open pit methods. Production to January, 1956 is tabulated below:

Year	Tons	Grade
Pre-1935	8,000	5.00% Cu
	59,000	1.01% Cu
Block-Cave 1935 - 1945	2,085,049	1.05% Cu
Open Pit 1945 - 1955 (incl.)	11,581,637	.96% Cu
Total	13,733,686	.98% Cu

From an economic standpoint, operation of the mine has been a marginal proposition from the beginning. During recent years, continuity of production has been possible only through benefit of rising copper prices. The year 1955 is the only interval during which the operation could be described as a commercial success. As might be expected under such conditions, the property has been considered at various times by a large number of prospective buyers. ASARCO's interest dates back to 1917. The following brief outline of Bagdad's history is a digest of ASARCO's files. (The historic details are complex, and a review of these has been compiled as Appendix 1.)

1880 - 1890	Discovery of the District.
1905	Exploration by adits (recognition of disseminated copper mineralization).

1909	Churn drilling started.
1911	Bagdad Copper Company capitalized --- 1.3 million shares at $5.00 par.
1917	Report to ASARCO by Stockder. Ore reserves (Kruttschnitt) --- 13 million tons @ 1.68% Cu.
1920	Thornton's report --- 15 million tons @ 1.68% Cu. "Good exploration possibilities."
1928	50-ton mill constructed.
1929	First production of copper.
1930	Experimental block caving. Mill capacity increased to 200 tpd.
1931 - 1934	Property inactive.
1935	Work in two block cave stopes resumed. Mill capacity increased to 300 tpd.
1937	(Brent Rickard) milling 300 tons 1.65% Cu at operating cost of $1.86 per ton.
1939	(H. A. Guess) reserve of 6 million tons of 1.47% Cu fairly certain. Figured cost of copper production at 9-1/2¢ per lb. on 1000 tpd basis.
1940	Another study conducted by ASARCO. Outcome based (surprisingly) on only 3.0 million tons at 1.44% Cu showed insufficient profit to justify capital investment. (Exploration and operation possibilities of larger tonnage-lower grade material not reported on.)
1941	$2.5 million RFC loan granted to Bagdad.
1943	2500 tpd mill put into operation.
1944	Block cave mine produced average of 57,000 tons per month of .93% Cu (wide spacing of draw points --- 25 feet --- and improper draw control probably responsible for wide difference between reserve grade and mine grade.)
1946	Block caving abandoned and open pit mining started. (Motivated by Ernest Dickie, backed by J. C. Lincoln.)
1948	Report to ASARCO by W. R. Landwehr. Recommended thorough examination and serious attempt to acquire property.

1952	Comprehensive report to ASARCO by J. G. Pearcey. Estimated 16.5 million tons at .77% Cu and an $8.2 million operating profit (at 24.5¢ Cu) before taxes over a life of 13 years. Price asked for controlling interest by J. C. Lincoln (6 million dollars) considered much too high. Report included section by K. E. Richard on exploration possibilities.
1954	Kennecott option dropped after 6 months examination.

Except for a short period during the first year or two of open pit mining, Bagdad concentrates have been treated by Company smelters. The Hayden plant has handled some, but currently the total output is shipped to El Paso.

Bagdad never has been adequately capitalized or explored, and the plant has been too small for the grade and tonnage of ore available. The fact that the operation has been maintained since 1946 is largely due to the unusual capabilities of the late E. R. Dickie.

In retrospect, and from the viewpoint only of technical engineering, the potentiality of the deposit could have been recognized and its optimum development approached in a better manner if about 100,000 feet of additional exploration drilling had been done in the early 1940's before mining was begun.

OWNERSHIP - FACILITIES

There are 540,000 shares outstanding of Bagdad Copper Corporation stock, of which Mr. J. C. Lincoln holds 56%, or 300,000 shares. Total dividends paid amount to $1.25 per share (50¢ in 1954 and 75¢ in February, 1956).

Appendix 3 is the Corporation's balance sheet for December 31, 1955. The significant data thereon is compared with similar data in Mr. Pearcey's report in the following tabulation:

	Pearcey Report Jan. 30, 1952	Bagdad Balance Sheet Dec. 31,1955
Current Assets plus Prepaid Expenses and Deferred Charges	$ .93 Mil.	$ 3.64 Mil.
Depreciated Net Book Value	2.57	6.18
	$ 3.50	$ 9.82
Total Liabilities	1.56	2.73
Net Assets	$ 1.94	$ 6.09

The details of facilities and equipment at the property are to be found in Appendices 2A, 2B and 2C.

GEOLOGY

An appropriate resume of the regional geologic picture is found in the following quotation from the very good USGS professional paper 278 by C. A. Anderson and associates, just published:

"Most of the rocks exposed in the area make up a metamorphosed pre-Cambrian complex of volcanic, tuffaceous and sedimentary rocks and associated intruded igneous rocks of diverse composition. After considerable erosion, this pre-Cambrian complex was covered by rhyolite tuff and intruded by rhyolite dikes of Cretaceous or early Tertiary age. Later, stocks of quartz monzonite and associated dikes were emplaced. After erosion carved a surface of considerable relief upon these rocks, lava flows and volcanic cones dammed the principal streams, causing deposition of gravels and sands (Gila Formation) in the main and tributary canyons. This stage in the geologic history culminated in the outpouring of widespread basalt flows, which were carved into lava mesas by the latest interval of erosion."

The general geologic environment of the district is shown on the accompanying, small-scale map (Att. F). The quartz monzonite stocks are of principal interest.

Intrusives and Breccias:

The monzonite stocks are irregularly distributed along a belt at least 7 miles long with an approximate trend of N70E. Although slightly divergent, this trend approximates regional trends of dikes and older structures in pre-Cambrian rocks. The largest monzonite stock has apophyses elongated NW-SE, as well as NE-SW; and it occupies a position about at the intersection of two prominent dike systems of somewhat younger age but aligned about NW-SE and NE-SW. The principal zone of alteration carries disseminated pyrite and chalcopyrite throughout and is confined mostly to this large stock. The known ore body occurs entirely within the stock.

Although nearly contemporaneous, the following intrusive rocks are identified, from oldest to youngest, as follows:

Rhyolite	-	dikes and pods
Quartz monzonite	-	stocks
Diorite porphyry	-	dikes and plugs
Quartz monzonite porphyry	-	dikes

These rocks can be dated positively only as younger than pre-Cambrian. However, they are lithologically and structurally typical of the Laramide intrusive types which are spatially and genetically related to all porphyry copper deposits. Therefore, with little doubt they are early Tertiary in age.

A group of irregularly shaped breccia pipes and dikes is distributed through the district in a NE-trending belt in close relation to the Laramide intrusives. These pipes have various ages within the Laramide intrusive sequence. Several of the stocks, plugs and dikes and most of the breccia pipes outside the main monzonite stock are centers of small, satellitic zones of alteration

with outcrop evidence of minor copper sulphides. The distribution of the Laramide intrusives, breccia pipes and zones of mineralization demonstrates that all three are genetically related -- a fact of considerable importance to exploration.

Mineralization:

It can be hypothesized that the occurrence of intrusives, breccias and mineralization of the Bagdad district as a unit may be controlled by intersection of regional structures, but there is little if any visible structural control of the main primary disseminated ore body. This ore body consists predominantly of discreetly disseminated sulphide (chalcopyrite with some pyrite) grains and veinlets of random orientation and distribution. The upper part of this sulphide ore body contains a layer enriched by chalcocite and erratically overlain (and locally intermixed) with oxide Cu minerals (chrysocolla, cuprite, malachite, native Cu).

Chalcocite was accumulated as the result of leaching and downward migration of copper bearing solutions which took place during an early erosion cycle --- one which culminated in the deposition of the Gila conglomerate. This enriched blanket now has a gentle northerly dip, locally paralleling the base of the conglomerate. Copper Creek Canyon, which contains exposures both of the chalcocite and the underlying primary mineralization, was formed during the modern cycle of erosion. Apparently, formation of the non-sulphide copper minerals was due to oxidation of the chalcocite during this modern erosion cycle.

The leached zone, overlying the chalcocite zone, varies in thickness from about 350 feet beneath the gravels of Copper Creek Mesa on the north to zero in Copper Creek Canyon on the south.

Alteration

Anderson recognized two distinct types of alteration in the monzonite at Bagdad: one represented by a finely granular quartz-sericite rock, and the other by a coarse-textured biotite-feldspar-quartz assemblage. The latter has a rather fresh appearance and is difficult to distinguish from unaltered monzonite. Anderson believes that the quartz-sericite may represent a more advanced stage of alteration, but considers the biotite-feldspar-quartz type to have been a little more favorable to copper mineralization. Our field observations indicate that the two types are often intermingled and that, for practical purposes, they can be considered equally favorable.

The quartz-sericite occurs most frequently as a stock work of narrow stringers, cutting the biotite-feldspar-quartz rock; but in some areas it forms massive ribs several hundred feet in length, such as those which strike northwesterly along the edge of the gravel cover, a short distance east of the Giroux area.

The principal zone of alteration occupies an area of at least 1.0 by 1.5 miles. Its approximate shape, and that of the zone of stronger copper mineralization within it, are indicated on the accompanying Alteration-Mineralization map (Att. E). The known ore body (7th level outline) and the pit perimeter as of January 1, 1956 are also shown on this map.

Alteration is not confined to the monzonite stock, but extends some distance into the surrounding pre-Cambrian rocks, particularly on the west. Its extent to the north and east beneath the post-ore cover is largely conjectural, except in the vicinity of Copper Creek Canyon about 2000 feet north of the pit. Here, bedrock exposures show small irregular patches of alteration which represent the fringe of the main zone of alteration. Some limonite-after-chalcocite is present in this fringe.

Leached Outcrops:

Bagdad outcrops were investigated as early as 1924. A map prepared by Roland Blanchard at that time shows that the location of the comparatively rich chalcocite ore body (the cave-mine block) was indicated approximately by concentrations of limonite-after-chalcocite in the outcrops. Anderson concluded, after extensive field work in 1944 (U.S.G.S. pp. 278), that leached pyrite-chalcopyrite-bearing rock and leached chalcocite-bearing rock could be differentiated on the basis of outcrop studies; and pointed out that the south boundary of the chalcocite zone could be located in the outcrops approximately on the basis of color alone --- the oxidized primary mineralization having a generally pale brown tone in contrast to the dark reddish-brown tones over the chalcocite mineralization.

Although the outcrops over the better part of the chalcocite ore have been removed by open pit mining, there is still sufficient evidence remaining to demonstrate that the capping at Bagdad is in many respects similar to that of other enriched porphyry copper deposits.

DRILLING AND SAMPLING PRACTICE

As of June 1 of this year about 120,000' of drill hole had been completed. Of this, approximately 40,000' was by churn drill and the remainder by diamond drill, as follows:

	Years	Number of Holes	Hole Numbers	Footages	Totals
Churn	1909-1928	123	1 to 123	39,604'	39,604'
Diamond	1929-1930	10	124 to 133 (#129 no data)	5,343	
	? ?	23	301 to 323	8,840	
	1946-1955	158	46-1 to 55-?	63,585	77,768
	to 6/1/1956	3	56-1 to 56-3	2,140	2,140
Total Number of Holes		317			
Total Diamond and Churn Drilling to June 1, 1956					119,512

Churn Drill:

As in the case of most early work of this type, records are quite scanty. About all that is known for certain is that the holes were sampled on five-foot intervals and the samples assayed for total copper. The holes were no doubt drilled open, except where caving conditions made casing necessary.

Diamond Drill:

Diamond drilling, started in 1929, included a number of underground holes. Since 1945, all drilling has been done from the surface with most of the holes being vertical.

The records of the diamond drilling are somewhat better than those of the churn drilling. They indicate hole size (principally AX), cementing, casing and core recovery. Sludge Recovery was not recorded. Obviously, lack of such information hampers the analysis of sample accuracy. As we have observed in the field during past examinations and recently (Holes No. 1-56 and 2-56), sludge handling practice has been, and is, very poor. The sludges are discharged from the drill into 82-gallon capacity settling tanks. At the end of each 5' coring run, the sludge residue is washed into a 1-gallon tomato can where it is allowed to settle. After decanting, the sample, weighing one to three pounds, is sent to the assay laboratory. Drill cores are split and an assay sample made up of the one-half portion.

ACCURACY OF DRILL HOLE SAMPLES

The questionable reliability of Bagdad drill information has been a factor of concern to many in past examinations. In most cases the matter was dealt with by application of an overall, flat, arbitrary reduction in assay value. This arbitrary use of a "safety factor" (unsupported by analysis of data) in deposits of near-marginal grade, can, we believe, result in serious error in evaluation. In fact, in this case, the difference between an "arbitrary" and an "analyzed" adjustment amounts to about $.50 per ton of ore -- or the difference between an unprofitable and a profitable outcome calculation.

Accordingly, we have considered it necessary to make a careful analysis of the available data. The details of this analysis and our conclusions are contained in Appendices 12, 13, 14 and 15. The matter may be summarized as follows:

(1) The greatest error present is in the diamond drill sludge samples, the assay values of these being approximately 10% too high. However, Bagdad's method of combining core and sludge assays has to a large extent compensated for this error; therefore, their combined assays were taken at face value, except in certain instances where reductions appeared warranted.

(2) The majority of the churn drill samples are considered to be within an acceptable range of accuracy. And due to the fact that the churn drill samples represent less than 30% of the total samples, the possible error from this source is of very small proportions, probably less than .02% copper, if applied to the 100 million ton ore reserve. Due to the small size of the possible error, and lacking a firm basis for estimating a reduction factor, the churn drill samples were accepted at face value.

The foregoing conclusions were supported by the results of a comparison of ore extraction to ore reserves calculated on the drill samples. This comparison showed that the ore milled (11,581,637 tons @ .96% Cu) amounted to only 4% less in tonnage and grade than indicated by the ore reserve calculation.

ORE RESERVES

Calculation Method and Results:

Due principally to the high proportion of low grade, or near-marginal, ore in the deposit, evaluation of reserves required something more than a single pit design and a single cutoff in grade in order to indicate minimum and maximum potential in both grade and tonnage. Accordingly, two open pits were designed: one, a relatively small pit (Att. J) which would show the best average grade obtainable, and the other, a large pit (Att. K) showing the maximum potential (within the present limits of exploration). The principal factors taken into account in setting up the calculation were:

(1) Accuracy of sample data (discussed under "Drilling and Sampling")

(2) Spacing of drill holes. Only a small proportion of the drilling is on sufficiently close-spaced intervals to consider the ore measured; therefore, the ore was segregated in the calculation into three categories representing three degrees of probability: (a) "measured", (b) "indicated" and (c) "inferred." Considerable drilling eventually will be required in areas where much of the ore is classed as inferred, as in the northeast portion of the large pit, for example.

(3) Grade Cutoff. A study of copper distribution indicated that cutoffs of .40% Cu and .50% Cu represented the limits which, in the ore calculation, would best define the deposit's range in commercial potential.

(4) Non-sulphide values. All material containing non-sulphide copper amounting to 30% or more of the total copper content (see section on Metallurgy) was classed as "Mixed Ore" and calculated separately. In cases where only total copper assays were available, non-sulphide values were assigned by study of surrounding information.

The calculation procedure involved the following steps:

(1) 50' interval level maps with 25' rectangular grids were prepared at elevations midway between bench levels, and average bench assays were plotted for each drill hole (see example, Att.N).

(2) "Areas of influence" were drawn around each hole on each level map, and the average bench assay of each hole was applied to each area. Where hole spacing was relatively wide, additional areas were plotted in between holes; and assays were assigned on the basis of surrounding information, including that on levels immediately above and below.

(3) Each area of influence was classified, depending principally on hole spacing, as "measured", "indicated", or "inferred", and further classified, depending on the assay, as "sulphide ore", "mixed ore", "leach", or "bedrock waste".

(4) Tonnage and grade were calculated (a) by counting the 25-ft. squares, each representing a rectangular prism 50 feet high, in each area of influence, (b) by tabulating the sum of the prisms with corresponding copper values, and (c) by deriving weighted averages, using 12.5 cu.ft. per ton as a gravity factor for all material except gravel capping which was calculated at 16 cu.ft. per ton.

One full set of north-south sections (Att. M) accompanies this report. These show bench assays used in the ore calculation and the profiles of the proposed large and small pits. To illustrate the distribution of the three classes of ore, and of the leach material and waste, two special sections (Att. G and H) and a single ore calculation plan map (the 7th level, Att.N) have been included as "examples". The large amount of supporting calculation detail and maps are on file in the Tucson office.

As may be noted in the results of the calculation (see tabulated summary, Appendix 5), the tonnage of sulphide ore varies from 37.8 million to 101.4 million, and the grade from .84% Cu to .68% Cu, with waste-ore stripping ratios from 2.73/1 to 1.36/1.

Our results show a wider range of tonnage and grade possibilities than those obtained recently by another company (presumably Kennecott; reserve figures in memo of December, 1955 from Mr. Pope to Mr. Goodwin); however, fairly close agreement in tons and grade is present in the comparison below, particularly numbers (3)-(6) and (4)-(7). It is to be noted that their stripping ratios are considerably lower than ours; also, it is believed evident that Kennecott accepted Bagdad's drill results without appreciable reduction, as we did.

			Tons (Millions)	% Cu Total	% Cu Sulphide	W/O Stripping	
ASARCO Cutoff	.50% Cu	(1)	37.8	.84		2.53/1	Small
	.40% Cu	(2)	59.1	.72		1.36/1	Pit
	.50% Cu	(3)	68.8	.77		2.73/1	Large
	.40% Cu	(4)	101.4	.68		1.63/1	Pit
Kennecott		(5)	50.0	.81	.64	2.12/1	
		(6)	67.0	.77	.61	1.84/1	
		(7)	90.0	.68	.54	1.37/1	

We did not calculate a precise value for non-sulphide copper, due to the incompleteness of non-sulphide assay data; however, we did exclude material known, or inferred, to be over 30% non-sulphide and estimate that the remaining sulphide ore averages not more than 15%, or 0.10% Cu, as non-sulphide (in the 100-million ton reserve at .68 total copper). Actually, a substantial portion of this ore assays less than .05% non-sulphide copper. Since Kennecott's 90-million ton reserve shows 21% of the total copper as non-sulphide (.14% Cu), it is believed evident that their figure includes the "mixed ore" which we calculated separately. This is also suggested by their lower stripping ratio (1.37/1 compared to 1.63/1).

The greater volume of ore in our estimate (100 million tons), as compared to Kennecott's (90 million tons) is probably due to the fact that after their estimate was completed, additional ore was encountered in the exploratory drilling.

Measurement Drilling:

As pointed out in the foregoing, considerable drilling will be required to satisfactorily establish, or "measure", the grade and tonnage of the reserve in the large pit design. We have estimated that such a program would involve a minimum of 62 holes varying from 300 to 800 feet in depth and totalling 27,000

feet. The proposed location for these holes are shown on the 400 scale geologic plan map (Att. L). Much more drilling than this might be required, depending to what degree the results of these 62 holes substantiate assumptions of ore continuity in our estimate of reserves.

Although satisfactory samples could likely be obtained in diamond drilling, providing proper procedures were employed, it is our opinion that churn drilling, with sufficient casing to produce results of acceptable reliability, would be the best method.

EXPLORATION POSSIBILITIES

The principal exploration potential of Bagdad is the reasonable possibility of finding additional large tonnages of primary ore. This ore would be low to moderate in grade. Some of it would be shallow, but much of it would be deep (though still accessible to open pit mining at waste/ore ratios somewhat higher than those of present reserves).

In general, Bagdad's exploration possibilities are classed as not very attractive because there is no recognized opportunity to find consequential tonnages of shallow sulphide ore of at least 1.0% grade.

The possibilities of finding more enriched chalcocite ore have not been entirely eliminated, but the zone is relatively deep. The alteration-mineralization map (Att. E) shows a small-scale picture of the spatial relationships of the more important features bearing on exploration -- that is, the known ore body, the zone of better copper mineralization, the zone of alteration, and the extent of post-ore cover rocks. As may be noted by referring to the geologic map (Att. L), the largest unexplored areas within the zone of better copper mineralization are the possible extension in depth of the known primary ore body and the possible projections of the zone to the north and northeast beneath the post-ore gravel and lava cap. These areas, of course, involve the disadvantage of probably high stripping ratios. Beyond the limits of the cover only one area of appreciable size is considered of interest. It lies west of Copper Creek and southerly from the Giroux adit. This west area and those at depth and to the north are discussed below.

West Area

The approximate limits of the zone of stronger copper mineralization were determined in our study of the outcrops. As may be seen on the map (Att. L), the western limit is an irregular boundary running north-south at distances up to 1000 feet west of the known ore body. The few widely scattered holes drilled in this area showed only .40 to .50% copper with little or no chalcocite. According to Anderson (USGS Prof. paper 278), this area was eroded down below the bottom of the chalcocite zone during the formation of Copper Creek Canyon. This appears to be a plausible explanation in view of the fact that portions of the main chalcocite blanket are now exposed by erosion along the northeast side of the canyon. Considering the apparent northeast dip, the blanket would project above the present ground surface to the southwest across Copper Creek.

However, the outcrops in this area show some evidence of limonite-after-chalcocite and several zones of strong sericite alteration are present. It is our opinion that the area merits some further exploration, in view of the strong character of the primary copper mineralization which, along with only a minor

amount of secondary enrichment, could constitute ore of commercial grade. An important factor is the particularly low stripping ratio that might be obtained. Locations of the eight holes proposed are shown on the map (Att. L).

The narrow zone running northerly through the Black Mesa breccia pipe has not been thoroughly explored, but sufficient drilling has been done to indicate a very small possible potential.

Primary Ore in Depth:

The chalcopyrite mineralization is believed to have generally vertical continuity and extent to unknown depth probably well below the deepest drill holes. There is no apparent overall tendency toward a diminishing of values in depth, although the assays in any individual drill hole will range back and forth within .2 and .8% Cu as depth is gained.

The areal limit of this zone of deep, low grade primary mineralization is gradational and very incompletely defined by present drill holes, but it roughly corresponds to the ore body outline shown on Attachment E. There may be a huge tonnage of material (say, 50 million tons per 100 feet of depth beneath the "large" pit) which should average something like .5% Cu. A large number of deep drill holes would be required for measurement of shape and grade of this body. The possibility that this material will have commercial value, either as open pit or underground ore, sometime in the future is so uncertain that no recommendations for specific, close-spaced deep drilling are made. However, it certainly is worth noting that Bagdad has one of the larger potentials of low grade copper "ore" in the United States.

Northwest Area

Drill holes put down through the post-ore lava cap cut considerable oxide copper, but only minor values in sulphide copper; also, these holes showed that a deep gravel-filled channel exists beneath the lava flows in this area. This channel has the effect of increasing the overburden and thinning the chalcocite ore possibilities. Although a fairly large unexplored area within the projected zone of better copper mineralization exists here, the high stripping ratio plus the oxidized character of the known mineralization are features which offer little encouragement to further exploration.

Northeast Area

Drilling during the past two years north and northeast of the open pit encountered some ore grade primary mineralization (around .80% Cu) in the monzonite. This ore is of substantial thickness, particularly in holes 13-55 and 1-56. Little is known so far of its possible size and extent; two holes drilled to the north (1-54 and 12-55) cut long columns of mostly sub-marginal values in pre-Cambrian rocks, which tends to limit the zone. At any rate, this primary ore is probably the most important discovery made at Bagdad for some time. Although the cover over possible projections of this ore is quite thick, the stripping ratio might not exceed 3 to 1, providing it is assumed that the proposed large pit is to be mined. And, although only minor amounts of chalcocite were reportedly encountered in the area, high grade chalcocite ore resulting from the enrichment of .7% or .8% primary could exist. Accordingly, further exploration here is believed warranted. The locations of the 14 proposed holes are spotted on the map (Att. L).

Summary of Proposed Exploration Drilling:

			Footage
West Area	-	8 holes	4,000
Northeast Area	-	14 holes	18,000
		Total	22,000

OPEN PIT MINING

Bagdad's Equipment and Costs:

Various detail on Bagdad's mining operation is given in Mr. Meen's letters of April 3 and March 3, 1956 to Mr. Snedden (App. 2B and 2C). Included are such items as drill performance, powder factors for various rock types, loading and hauling cycles, equipment lists, labor classification and rates, etc.

For 1955, Bagdad's direct mining cost was $0.19 per ton, or $1.49 per ton of ore mined at a stripping ratio of 6.78 to 1.0.

Cost Estimate for 10,000 tpd Rate:

A cost estimate for mining the "Large Pit", 0.4% Cu cutoff, was made on a basis of all truck haul and other general operational procedures similar to Silver Bell Mine. Derivation of cost figures, Forms A-5 and Forms A-1, and descriptive detail are included under Appendix 6. Pit plans and dump positions are shown on Attachment "O". Work sheets of the estimate are retained in the Tucson office.

Assumptions:

Ore Reserves: 101.44 million tons of ore,
167.1 million tons of waste.
Milling rate: 10,000 Tpd.
Shovels now at the property are utilized.
Pre-Mine stripping: --- 2 years.
Life of operation : --- 30.178 years

Progress at the property during 1956 is not considered. All leach and mixed ore is treated as waste but is dumped separately.

An escalated wage scale as estimated for 1958 was used throughout.

Summary of Estimated Cost:

	Ore Per Ton	Waste Per Ton	Per Ton Ore
Drilling	$ .0253	$ .0253	
Blasting	.0402*	.0402*	
Loading	.0309	.0309	
Trucking	.0723	.1092	
Roads	.0165	.0165	

Summary of Estimated Cost (continued)

	Ore Per Ton	Waste Per Ton	Per Ton Ore
Waste Dump	$	$ .0143	$
Supervision	.0089	.0089	
Total Direct	.1941	.2453	.5981
Indirect Costs			.2658
Total Cost			$0.8639
N. Y. Office Expense			.045

*Cost based on Bagdad powder factors for bedrock and for gravel. Figure shown is average for total tonnage -- ore plus waste.

Loading shovels at the property were used as a base for production rates. Drilling, blasting, hauling and all functions of the operation were estimated by work shifts to determine costs and equipment needs. Orderly mining was planned from pit bench tracings showing position of ore and waste. Dump areas were laid out for optimum economy of haul.

Major changes from present operating practices at this property to effect increased production were: More favorable haulage roads, addition of new trucks, rotary drills to replace churn drills, the addition of secondary drilling, and more serviceable water and electric installations.

Labor requirements were estimated for all phases of the operation at an estimated 1958 pay scale. To this wage was added regular Saturday overtime, call out overtime, and shift differential.

Operating supplies and maintenance costs were increased in the same ratio as the wages.

Indirect mining costs were determined as a direct ratio of above direct costs to the indirect costs in the 9300 tpd Silver Bell estimate of July, 1956.

METALLURGY

From the standpoint of milling, Bagdad ore is comparable to that of other porphyry copper deposits, with the exception that it has a slightly higher than average non-sulphide content. The non-sulphide copper (principally copper silicate) is most abundant in the upper part of the chalcocite zone. Passing downward into the lower grade primary chalcopyrite mineralization, the non-sulphide content drops off to almost nil, except along certain faults and fractures where oxidation has penetrated unusually deep.

Monthly mill production figures for 1955 (see Appendix 7, Norman Weiss, memo to F. V. Richard, February 9, 1956) serve to illustrate grade range in total and non-sulphide copper mined from the open pit, and the corresponding

range in mill recovery. The two months showing the widest variation, and the average for the year are as follows:

Period	Tons Milled	% Copper Total	% Copper Non-Sulphide	% Recovery Copper
April, 1955	106,797	.702	.037	89.48
September, 1955	108,328	1.356	.272	74.93
12 mo. 1955	1,352,513	.997	.130	83.13

Production for the month of April, above, with the lowest non-sulphide content and the highest recovery, came mainly from the 9th, or bottom level of the pit.

Mr. Vincent visited Bagdad in November of this year and has reported on past results and future possibilities, including fluosolids roasting and dump leaching (Appendix 8). His conclusions have a very important bearing on the evaluation of Bagdad. Following are his principal points:

(1) Based on current Bagdad methods, recoveries would vary between 80.0% and 84.9%, and concentrate grades between 23.2% Cu and 27.3% Cu.

(2) A finer primary grind and a regrind of the rougher concentrate might increase overall recovery of copper as much as 2%, and the concentrate grade as much as 4%.

(3) The large volume of leach material is a potentially important source of copper. Dump leaching with acid produced from fluosolids roasting of concentrates could substantially increase the net income per ton of ore milled.

(4) Production of cement copper, rather than electrolytic copper, which is being produced in Bagdad's pilot plant, would eliminate the large capital investment necessary for an electrolytic plant.

Costs:

In his letter of December 10 (Appendix 8) Mr. Vincent gives preliminary estimates of capital and operating costs for milling, fluosolids and leaching. He does not intend that these figures represent a detailed analysis because in asking him to make the study we specified that only a general idea of metallurgical possibilities would be appropriate at the present time. Test work and other studies which he would probably require to support a careful cost estimate would be in order only if the Company were taking the property over.

Milling costs, both direct and indirect, used in calculating outcomes at a rate of 10,000 tpd are essentially the same as Silver Bell costs. The capital cost of a new 10,000-ton mill, $10,000,000, and for expansion of the old mill, $5,000,000, were estimated by Mr. Vincent.

Fluosolids and leaching costs were estimated by Mr. Vincent as totalling $2,243,118 per year, equivalent to $.64 per ton of ore milled at a rate of 10,000 tpd.

POWER

Bagdad's power is transmitted at 69,000 volts over a 70 mile transmission line, from Parker Dam. The 20 year contract with the Bureau of Reclamation (terminating in 1963) calls for a maximum demand of 4000 KW at the following rates:

Demand charge	-	$0.75 per KW of max. demand x 102%
Energy charge	-	102% of KW reading
		1st 50,000 KWH @ 4.0 mills
		Next 100,000 KWH @ 3.0 mills
		Balance 2.25 mills

The average cost of power has been around 3.6 mills per KWH; consumption, 2,200,000 KWH per month; maximum demand, 3800 KW.

Bagdad advanced $295,000 for construction of the power line, which amount is being refunded through deductions of 25% of the monthly power bills.

In connection with 1951 expansion planning Bagdad engineers investigated possible sources of additional power. According to our copy of the plans, an agreement was made with Central Arizona Light and Power Company whereby Bagdad would advance the $450,000 cost of a 48-mile line from Prescott, and recover this sum at the rate of 10% of their monthly power bill.

The rate was to be $3.00 per KW demand plus 2 1/2 mills per KWH energy charge. They expected to maintain a lead factor of 94% and obtain power at an average cost of 6.9 mills per KWH consumed.

Our estimates of mining and milling costs are based on Tucson Gas, Electric Light and Power Company rates for Silver Bell, which involve an average cost of around 10 mills per KWH consumed.

OUTCOME

On the customary treatment basis of smelting concentrates, Bagdad has always been considered a marginal proposition at best. Other treatment processes, particularly heap leaching withacid derived from roasting concentrates at the property, have been seriously considered in the past, but largely on a theoretical basis. By contrast, a certain amount of pilot plant data on the technical feasibility of this process now has been obtained. This opens a new avenue for determining profitable outcome, although there still are many engineering uncertainties involved. As a consequence, outcome cannot be expressed in a single figure. Risk involves two main variables: amount of capital and degree of technological certainty. Within these are minor variables; so, the possible outcome combinations are numerous. We have selected four as providing the most useful alternative data. These are in two categories: (A) standard process --- i.e., concentrates smelted, and (B) cement copper produced by fluosolid roasting

of concentrates with resultent acid used for calcine leaching and for heap leaching. These outcomes are tabulated, with notes referring to source material, as Appendix 10.

Category A involves low rates of capital return and profit, but engineering estimates are relatively firm and conservative. This plant would be suited to expansion and long life in the event the long-term copper market outlook improves and the exploration possibilities for very large additional tonnages of low grade ore materialize as expected. No allowance was made in this category for the estimated 2% improvement in mill recovery and ½% increase in concentrate grade (Att. 8). This would amount to approximately $.14 of additional net profit per ton.

Category B represents attractive rates of capital return and profit, but metallurgical technology is less well-assured than under Category A, and the plant would not be suited to expansion or long life. In calculating these outcomes, the additional 2% in mill recovery (Att. 8) has been included.

KENYON RICHARD

J. H. COURTRIGHT

27 Oct 83 (Anaely Property

28 DDH to 200' / cores
8 DDH to 500' / + some
(Forgot to ask Diameter core) pulps still available

Au .119 / Not same
Ag .70 / area as
Hi Be, Mo + W
3.5 mt.?? #'s

Au oxidized in hematite
- some pyrite

Sounds alot like the buy
@ Spring Valley (1982)

Check BLM Microfiche + Bagdad P.P.

(Anaely is really ANXious for
people to look @ his property
∴ will not send any
HARD data out first "to be Fair to everyone"

27 Oct

cg This property sounds
too good to be true. I
think it might be worth
HAK &/or GJS taking a look
to see if there is any thing @
the time on their way BAK to
CALIF. (any time time)
otherwise I will try to visit
AREA ON 6-7 NOV on way
BAK from AZ & FIND OUT.
- If the like these sheets please
leave them for me.
should be BAK in office 4 NOV
TAK

BT will leave time
for NEBORD

JDS –

10/28

I returned orig. to FRK saying that neither GJS nor HGK could look at property because they are flying to & from Mother Lode.

J

HAYES MINING & MACHINERY
BAGDAD, ARIZONA 86321

T.E. H
M M

SEP 12 1983

THE CROSBY MINE
PAST PRODUCER 1906-38

RE: MINING PROPERTY

STATE: ARIZONA

COUNTY: YAVAPAI

AREA: 10 MILES FROM BAGDAD, ARIZONA

MINING DISTRICT: EUREKA

MINERAL RIGHTS: LODE AND PLACER

WATER RIGHTS: SANTA MARIA RIVER, TWO WELLS

MINING ACREAGE: 2500 ACRES

PROVEN RESERVES: 3,500,000 TONNES D. D.

ORE GRADES: .119 AU. .70 AG. .173 BE. .161 MO. .134 W.

OBJECTIVE: TO SELL ORE TO SMELTER OR SELL PROPERTY OUTRIGHT

RAIL DEPOT: HILLSIDE AZ. 12 MILES TO RAIL DEPOT

AMOCO SHIPS ORE TO SMELTER FROM OPEN PIT KROM HERE

OWNER: W.C. CANADY WILL NEGOTIATE PRICE AND TERMS WITH SUBSTANTIAL FIRM

MR. CANADY MAY BE REACHED AT 445-2054 AREA CODE 602. AN APPOINTMENT CAN BE ARRANGED TO EXAMINE THE MINING PROPERTY, ANY ADDITIONAL INFORMATION PLEASE WRITE TO THE ABOVE ADDRESS.

YOURE TRULY,

R.W. RHODES
V.P. EXPLORATION

TUCSON

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 332
January 20, 1984
SHIPMENT NO. 2-CMA

ASARCO INCORPORATED
Attn: Mr. Fleetwood R. Koutz
Southwestern Exploration
P.O. Box 5747
Tucson, Arizona 85703

CROSBY MINE AREA
Bagdad

Analysis of 8 Rock Chip Samples

ITEM	SAMPLE NO. *	Au (ppm)
1	CMA-15	8.20
2	CMA-16	1.30
3	CMA-17	.70
4	CMA-18	4.20
5	CMA-19	1.40
6	CMA-20	3.60
7	CMA-21	1.10
8	CMA-22	7.00

*NOTE: Sample numbers start with CMA-15 and not CMA-16 as on the advice.

cc: Asarco Incorporated
Southwestern Exploration
P.O. Box 5747
Tucson, Arizona 85703
Attn.: Mr. James D. Sell

REGISTERED ASSAYER
CERTIFICATE NO. 9425
WILLIAM L. LEHMBECK
FILE SIGNED
Arizona

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF SPECTROGRAPHIC ANALYSIS

JOB NO. TAJ 332
January 20, 1984
SHIPMENT NO. 2-CMA

ASARCO INCORPORATED
Attn: Mr. Fleetwood R. Koutz
Southwestern Exploration
P.O. Box 5747
Tucson, Arizona 85703

Analysis of 8 Rock Chip Samples

The attached pages comprise this report of analysis. Values are reported in parts per million (ppm), except where otherwise noted, to the nearest number in the series 1, 1.5, 2, 3, 5, 7, 10, etc. within each order of magnitude. These numbers represent the approximate boundaries and midpoints of arbitrary ranges of concentration differing by the reciprocal of the cube root of ten. The 'accepted' value is considered to be within + or - 1 step of the range reported at the 68 % confidence level and within + or - 2 steps at the 95 % confidence level.

REGISTERED ASSAYER
CERTIFICATE NO. 9425
WILLIAM L. LEHMBECK
DATE SIGNED 1-23-84
Arizona U.S.A.

William L. Lehmbeck
Manager

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NO. TAJ 332
PAGE 2

ITEM NO.		SAMPLE NO.
1	=	CMA-15
2	=	CMA-16
3	=	CMA-17
4	=	CMA-18
5	=	CMA-19
6	=	CMA-20
7	=	CMA-21
8	=	CMA-22

ITEM	1	2	3	4	5	6	7	8
ELEMENT								
Fe	3%	2%	3%	3%	2%	2%	3%	2%
Ca	.1%	.07%	.15%	.02%	.15%	.07%	.1%	.07%
Mg	.3%	.3%	.3%	.2%	.3%	.3%	.3%	.3%
Ag	3	<1	2	5	<1	2	3	5
As	<500	<500	<500	<500	<500	<500	<500	<500
B	10	<10	<10	<10	10	20	50	<10
Ba	500	300	700	500	500	500	700	500
Be	3	2	2	3	3	<2	3	<2
Bi	<10	<10	<10	<10	<10	<10	<10	<10
Cd	<50	<50	<50	<50	<50	<50	<50	<50
Co	<5	<5	<5	<5	<5	<5	<5	<5
Cr	100	70	100	500	100	20	70	50
Cu	300	30	200	700	200	150	300	300
Ga	10	<10	10	10	10	10	15	10
Ge	<20	<20	<20	<20	<20	<20	<20	<20
La	50	30	30	20	30	<20	20	50
Mn	200	200	300	200	300	300	500	200
Mo	10	<2	<2	20	2	<2	2	<2
Nb	20	<20	<20	20	<20	<20	<20	<20
Ni	7	5	<5	7	5	<5	7	<5
Pb	700	30	300	5000	300	200	1000	1500
Sb	<100	<100	<100	<100	<100	<100	<100	<100
Sc	10	<10	10	10	10	<10	10	<10
Sn	<10	<10	<10	<10	<10	<10	<10	<10
Sr	<100	<100	<100	<100	<100	<100	<100	<100
Ti	3000	2000	2000	2000	2000	2000	3000	3000
V	70	20	50	150	20	30	70	20
W	<50	<50	<50	<50	<50	<50	<50	<50
Y	30	15	20	15	20	15	30	20
Zn	500	<200	200	700	200	200	500	300
Zr	150	100	150	100	100	70	150	150

ASARCO

Exploration Department

Tucson, May 3, 1978

FILE MEMORANDUM

Cyprus Bagdad

Attached is a copy of data provided at the Bagdad "77" meeting 4-22-78. The following notes contain some additional information obtained during the tour.

The open pit reserve is given as 300 million tons of .49% Cu, .03% Mo; however, the last quarter's production (40,000 tpd) averaged .57% Cu and .025% Mo. Some chalcocite enriched ore remains and as much of this as possible is being mined to hold up the grade (.30% Cu cutoff).

While the overall W/O ratio is 1.1/1, they are currently stripping 4 to 1. On the pit tour it appeared that stripping was still far behind.

Mill recovery: Copper -- 89%, Moly -- 60%.

It was stated that ore estimation based on polygons has checked within 2% of production, both tons and grade.

Two diamond drills are running in the pit to aid in development planning and two are on exploration, one on the NE and one on the NW. Core recovery: 92% average. Recently, a hole on the NW, well beyond the established pit perimeter, cut (1) 300' of capping running .1% to .3% oxide copper, (2) 400' of .70% Cu as chalcopyrite with minor chalcocite and (3) 400' of .5% Cu as primary. The hole was abandoned due to drilling problems. The deepest hole drilled so far is 3600'.

It was stated that the principal veining trends northeasterly as does the monzonite intrusives. Total sulphides were estimated at 4% with the chalcopyrite to pyrite ratio being one-to-one in the zones of stronger primary mineralization.

Potassic alteration -- biotite with lesser amounts of K-spar -- is generally associated with the stronger primary copper at Bagdad. The limits of this potassic zone, both in depth and laterally, apparently have yet to be defined. Thus, the "ore" potential (based in part on Asarco's 1956 examination) is very likely far greater than the current reserve estimate.

J. H. Courtright

J. H. Courtright

JHC:lb
Att.

cc: TCOsborne - w/att.
WLKurtz - w/o att.
FTGraybeal - w/o att.
JDSell - w/o att.

JDS

ASARCO

Southwestern Exploration Division

May 17, 1990

FILE NOTE

AZ AIME Open-Pit Meeting
Cyprus Bagdad Copper Corp.
Bagdad, Arizona

Attached is the handout at the meeting in Bagdad, Arizona.

Of interest are the Geology paper and plans where they have now drilled off, and intend to mine, about three-fourths of the ellipse ore-shell mineralization.

The other quarter is for under the basalt cap and has only a few holes in it, but Blacet was optimistic that they would drill the rest out and be ready to mine it prior to the exhausting of the present (Table 4) ore reserves of 922 million tons at 0.39% Cu and 0.021% Mo at a strip ratio of 0.80 w/o, to be mined in the next 33 years.

Only a few exploration geologists (from PD and Cyprus) were at this meeting, plus a few consultants.

James D. Sell

James D. Sell

JDS:mek
Attachment

cc: W.L. Kurtz
F.T. Graybeal (w/Geology paper)

JDS

GEOLOGY AND MINE PLANNING AT THE CYPRUS BAGDAD MINE

A.I.M.E. PRESENTATION

MAY 12, 1990

PREPARED BY

JOHN W. HAWLEY AND PHIL M. BLACET

CYPRUS

CYPRUS BAGDAD MINE AND REGIONAL GEOLOGY

Section 1 Bagdad's Regional and District Setting

The Bagdad porphyry copper mine is located near the center of a 1,200-mile-long belt of Late Mesozoic through Early Tertiary intrusive-related hydrothermal ore deposits. This belt extends from northern Mexico to Light's Creek in northern California. Like many other Arizona porphyry copper occurrences, Bagdad is within the Central Arizona Mountain or Transitional Province which separates the undeformed Colorado Plateau from the structurally complex Basin and Range Province. The Bagdad ore body is located in the Eureka District at the boundary of a complex succession of older Precambrian metavolcanic and metasedimentary rocks (Yavapai Series) dated at 1,730 to 1,740 million years (my) with a younger Precambrian granitic stock (Lawler Peak Granite) dated at 1,411 my. Other Laramide porphyry systems exhibit a similar relationship suggesting a deeply rooted Precambrian basement anisotropy which controls porphyry emplacement.

Figure 1.1 presents the macro rock constituents of the Eureka District. The unshaded portion of the Figure is undifferentiated Precambrian rocks and the Tertiary volcanic and sedimentary rocks are hatched. The cross hatched pattern highlights a 12-mile-long belt of N70°E trending, compositionally and texturally similar Laramide intrusive stocks and plugs. Recent U. of A. Potassium-Argon (K-Ar) dates from two stocks in the district average 77± my. Paralleling this belt are Diorite Porphyry (DP) dikes considered cogenetic with the stocks and K-Ar dated at 75± my (all dates courtesy of University of Arizona, Isotope Geochemistry Lab, 1990). Cutting the stocks and DP dikes are N20°W trending Quartz Monzonite Porphyry (QMP) dikes which are recognized within the mine area. From within the mine a secondary biotite K-Ar date of 72± my is considered a main stage mineralization age.

The District Laramide intrusive structural trends are repeated in fault, vein and dike trends within the mine area. Comparing Bagdad to other porphyry copper Districts in Arizona implies that the timing and structural controls of the mineralizing events were remarkably similar throughout central and western Arizona. Within 80 miles of Bagdad, the Mineral Park, Copper Basin, Diamond Joe Peak and the Big Bug Districts are all dated at 70-72 my, the same age as Bagdad.

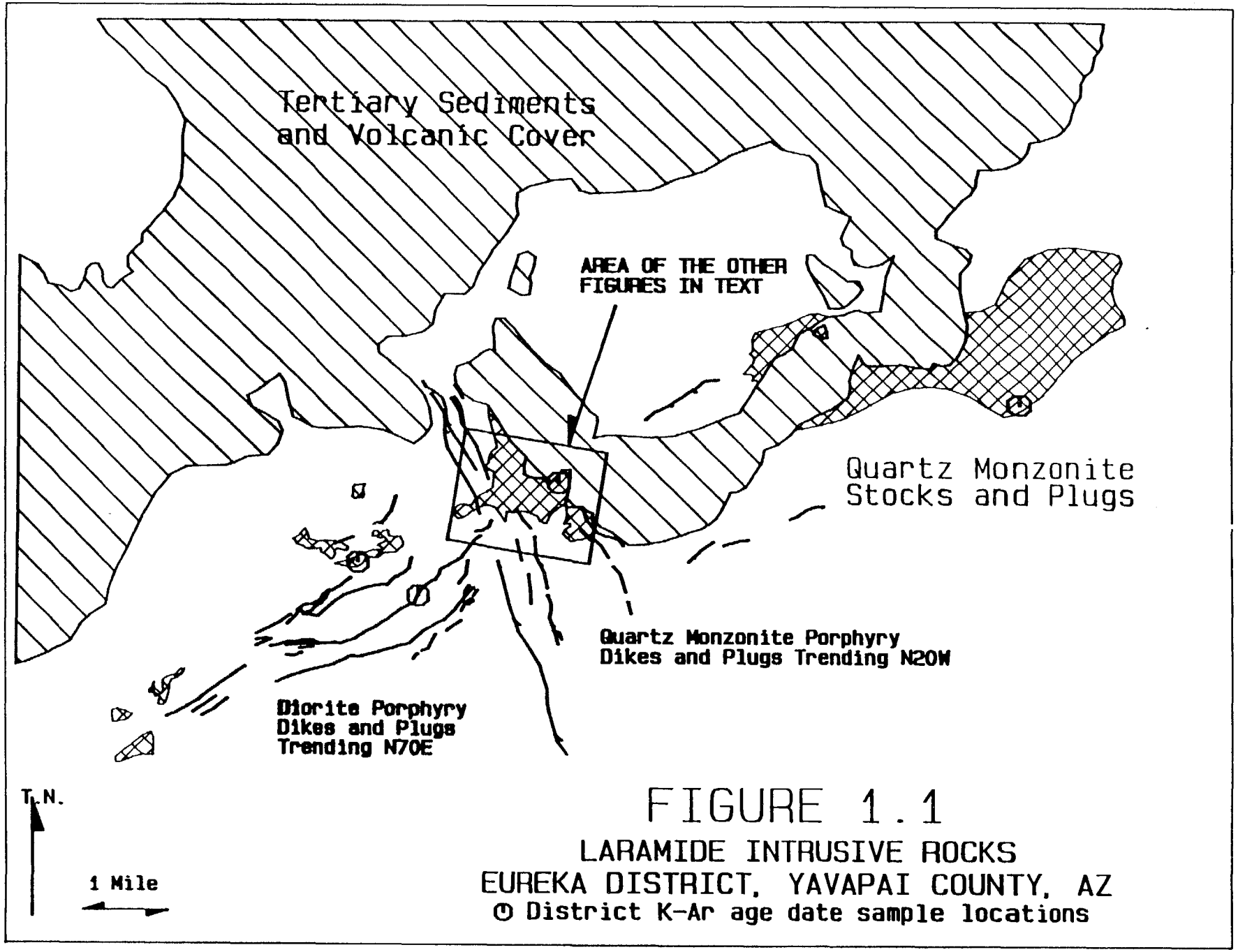


FIGURE 1.1

LARAMIDE INTRUSIVE ROCKS
EUREKA DISTRICT, YAVAPAI COUNTY, AZ
District K-Ar age date sample locations

Furthermore, from the available literature on the structural character of Arizona porphyry systems, these same occurrences most closely resemble Bagdad. Other Laramide stocks in the District have been prospected, and at least moderate Cu-Mo mineralization has been discovered.

Several lines of evidence suggest that Tertiary age tectonic activity may have affected the Eureka District. When moving across the area from northeast to southwest;

1) The surface area of the stocks decreases,
2) the abundance of diking is increasing,
3) the abundance of complex intrusive breccias increases and
4) at the southwest terminus of the belt the Grayback Mountain Tuff is preserved which probably represents the extrusive equivalent of Laramide intrusive activity.

Circumstantially, these observations indicate that higher levels of the Laramide intrusive belt are exposed towards the west-southwest.

Section 2 Mine Geology

Figure 2.1 is a January 1, 1990, pit geologic and topographic map. The following paragraphs describe the geologic units on the Figure.

Dump

Mine rock waste material, except for active oxide leach dumps along the western margin of the map. Most of the dumps are pre-1975 dump locations.

Tailings

Pre-1978 mill tailings. This material is scheduled to be relocated beginning in 1991, to allow for pit expansion.

Tb - Tertiary Sanders Basalt

Basalt flows of inferred Late Miocene age (8-10± my) forming mesa caps up to 120 feet thick to the east and

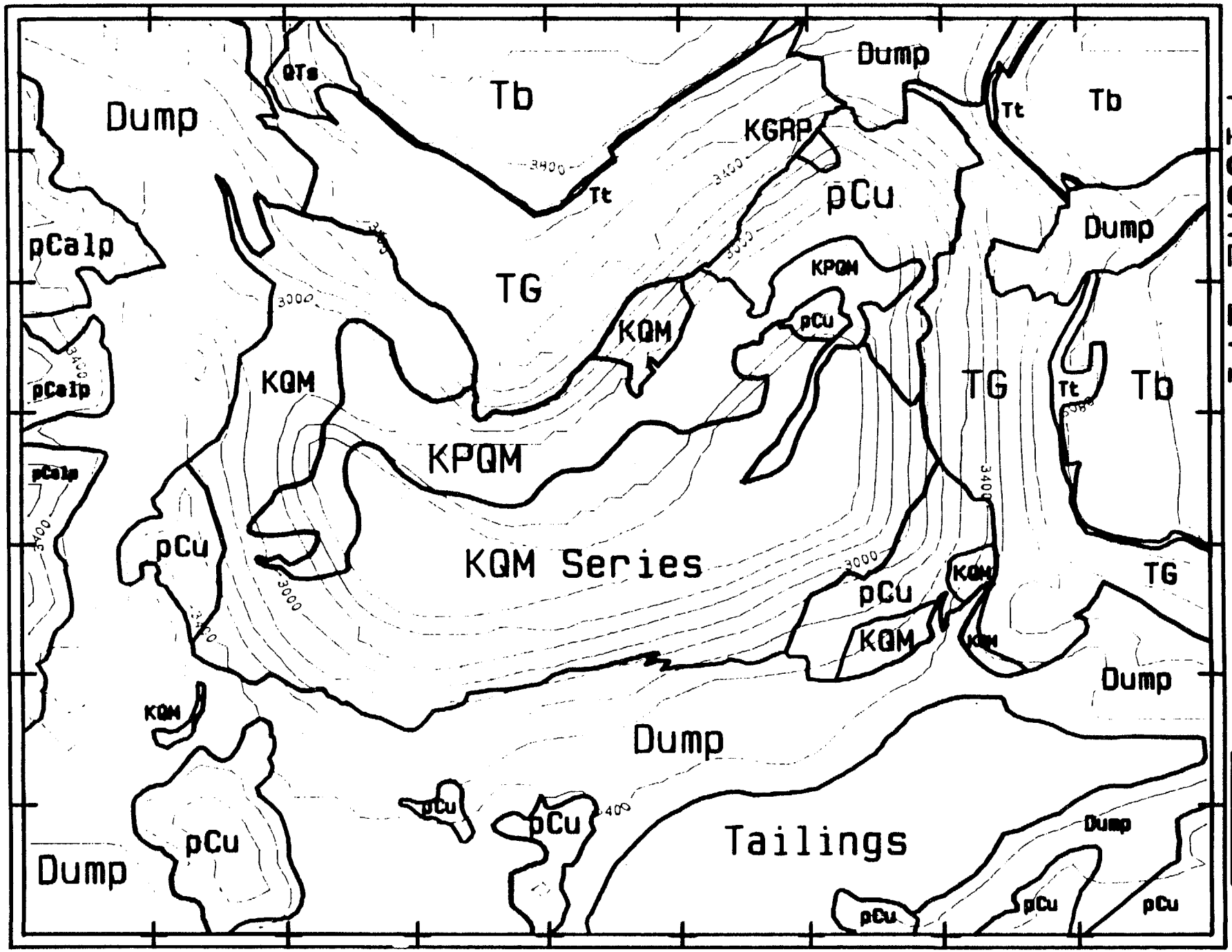

Dump
QTs
Tb
Dump
Tt
Tb
KGRP
3400
Tt
pCu
Dump
pCalp
3000
TG
KPQM
KQM
pCu
pCalp
KQM
TG
Tt
Tb
KPQM
pCalp
3400
pCu
KQM Series
3000
pCu
KQM
TG
KQM
KQM
Dump
KQM
Dump
pCu
pCu
Tailings
Dump
pCu
Dump
pCu
pCu
pCu
Grid North
1" = 1,000'

FIGURE 2.1

north of the pit area. Includes interbeds of Gila Conglomerate.

Tt - Tertiary tuff

Rhyolitic tuff, typically 30 feet thick and immediately beneath the mesa capping basalt (Tb).

QTs - Quaternary-Tertiary landslide debris

Landslide material consisting of basalt, rhyolite tuff and Gila Conglomerate.

TG - Tertiary Gila Conglomerate

Conglomerate, fanglomerate, sandstone and tuffaceous interbeds forming a typical basin fill section from 0 to 1,000 feet thick.

--- Unconformity

Early Mid-Tertiary erosional episode which removed about one mile of cover overlying the recent exposures of the Laramide intrusive rocks. This conclusion is based upon fluid inclusion work for quartz ± chalcopyrite ± molybdenite bearing veins (Nash and Cunningham, 1974). This episode appears responsible for mine area supergene enrichment.

KGRP - Laramide(?) Granite Porphyry

Typically a highly clay and sericite altered intrusive and breccia dike of late to post main-stage mineralization age. The unit is comprised of two distinct facies: of rhyolite porphyry with euhedral orthoclase and quartz phenocrysts (to 3cm and 1 cm, respectively), and a clast-rich intrusive breccia featuring mineralized clasts and nearly pure clay + sericite matrix (GRP breccia).

KPQM - Laramide Porphyritic Quartz Monzonite

Distinctly porphyritic rock with 2-10%, 5-15mm euhedral orthoclase phenocrysts, 5-20%, 2-6mm rounded quartz eyes and 3-8%, 1-4mm book biotite in a fine to medium grained groundmass of quartz and feldspar. The host

KQM had cooled sufficiently at the time of the PQM emplacement to result in a 5-10 foot chilled contact zone.

Comparing Figures 3.2 and 3.3, it is apparent that the PQM is coincident with the low grade core and symmetrically enveloped by the >0.30% total copper (TCu) contours. Although the PQM is the only rock unit containing truly disseminated sulfides, the average Cu content is significantly less than the KQM average. Within the narrow north-northeasterly trending offshoot off the main PQM mass, "blinded" cupolas grade 2-3 times the overall average as a result of sulfide filled miarolitic cavities.

Alteration silicate mineral assemblages in general follow a concentric zonation of potassic-phyllic-argillic, moving outward from the central PQM rock mass. The common association of secondary biotite and orthoclase (potassic alteration) with the PQM and cogenetic intrusive breccias suggest that the secondary biotite age of 72± my dates the PQM intrusion and the hydrothermal mineralizing event.

KQM (Series) - Laramide Quartz Monzonite undifferentiated

A combination of intrusive events of granodioritic to quartz monzonitic composition. All of the QM facies textures are fine to medium grained hypidiomorphic equigranular to seriate porphyritic. The earlier granodioritic facies contains accessory hornblende and 8-20% mossy biotite aggregates, possibly the result of early selectively pervasive biotitization, all normally altered to chlorite. In the late QM facies, biotite is less abundant and occurs as subhedral books; Kf is more abundant and intergrown with quartz in a fine to medium grained matrix.

The KQM series rocks are the principle ore host in the mine comprising 74% of the total material over 0.3% TCu. Within these rocks mineralization is entirely stockwork in character with the exception of minor sulfide grains nucleated at biotite sites.

--- Unconformity

pCalp - Late Precambrian alaskite porphyry

Distinctive leucocratic rock featuring conspicuous quartz eyes and albite phenocrysts set in a very fine grained myrmekitic groundmass of quartz and feldspar.

pCu - Precambrian undifferentiated

Structurally complex mix of younger Precambrian plutonic rocks ranging from granite to gabbro and older metavolcanic and metasedimentary rocks (Yavapai Series). Within the ore shell, while the Precambrian rocks of higher original iron/magnesium content are better hosts of copper mineralization the reverse is true for molybdenum mineralization.

Section 3 Geologic Block Modeling

The geologic block modeling discussion is divided into rock modeling and assay modeling subsections. The modeling process begins with a thorough understanding of the lithologic and mineral zonation controls on grade. The goal of the block modeling process is to create an accurate three-dimensional representation of the ore deposit, prior to mining, so accurate planning and economic forecasts are possible.

Section 3.1 Lithologic and Zone Modeling

At Bagdad 465,000 feet (ft) of drilling from nearly 560 drill holes has been added to the rock type/assay database since 1946. The Bagdad geologic block model is 11,000 ft wide (east-west), 10,000 ft long (north-south) and 3,200 ft in elevation (64 benches), for a total of over 700,000 individual 100' X 100' X 50'-high (bench height) blocks. Each block of rock contains 40,000 tons of material for a total days production of about four blocks, half in ore and half in waste material.

Within the drill hole database, twenty-three rock types are recognized. Three rock types are Tertiary in age and unmineralized (Tb,Tt and TG). The twenty rock types which host ore mineralization range from minor dike types comprising less than 1% of the drill hole file to the KQM series rocks which are nearly a quarter. The ROCK code

is identified by logging the core or rotary cuttings, with each assay interval (normally five feet) identified by the predominant lithology.

A second geologic code distinguishes the mineral ZONE. Five separate zone codes are used in the assay file to identify the mineralogic character of the interval. The primary hypogene ore mineralogy is chalcopyrite and molybdenite which is distinguished within the assay file and the block model from the supergene copper oxides, carbonates and chalcocite. Regression analysis between copper and molybdenum within the ore shell provides a correlation coefficient of 0.236, indicating a poor correlation. A possible explanation for this observation is that several ionic species carried both copper and molybdenum, each with slightly different stability fields. Molybdenite mineralization is found as two distinctive types within the pit, a fine grained high silica gangue variety with little associated chalcopyrite and a later coarse grained open quartz + molybdenite ± chalcopyrite variety.

An additional zone code is used to distinguish the hypogene ore shell from pyrite shell which eliminates the tendency of "drawing" the ore shell grades outward into the pyrite shell. A value of 0.2% TCu, which corresponds well with a 10:1, iron to copper ratio, was selected since it represents a relatively abrupt "assay wall" boundary at the margins of the orebody. Once this information is coded into the file the geologist prepares maps and/or cross-sections for interpretation between drill hole locations. Beyond this point the volumetrically insignificant rock types are ignored in the modeling process and the corresponding assay values are not used.

At the present time, the twenty mineralized rock types have been grouped into five statistically meaningful families for the assay modeling. **Table 3.1** presents the drill hole assay file averages for the five hypogene ore shell rock modeling units and the five zone modeling units used at Bagdad.

TABLE 3.1

Block Modeling Units

Rock Type	Average Grade % TCu	% ACu	% Mo	% Fe	o/t Ag	ppm Pb	ppm Zn
Ore Shell Rock Modeling Units:							
GRP	0.05	0.01	0.001	1.16	0.014	26.4	53.9
GRP breccia	0.10	0.02	0.008	2.24	N/A	N/A	N/A
PQM	0.33	0.02	0.020	1.25	0.036	12.2	33.2
QM Series	0.38	0.01	0.020	1.71	0.041	12.4	41.5
pC undiff.	0.39	0.02	0.017	2.53	0.047	18.1	48.0
Zone Modeling Units:							
Leach cap	0.13	0.03	0.007	1.88	0.014	14.9	43.8
Oxide zone	0.48	0.31	0.007	1.47	0.033	14.3	47.9
Chalcocite	0.83	0.08	0.015	1.90	0.054	12.6	55.0
Pyrite shell	0.12	0.01	0.006	2.42	0.021	17.6	50.6
Ore Shell*	0.37	0.02	0.020	1.72	0.040	13.0	41.2

* The ore shell zone is an average of all the hypogene rock modeling units listed in the Table.

Within the block model five other non-mineralized rock material types are identified for planning and design purposes. They are:

1) Dump
2) Tailings
3) Basalt
4) Tuff
5) Gila Conglomerate

These material types are treated separately so that proper tonnage factors, pit wall slope angles and mining costs can be applied.

The next step in the modeling procedure is the compositing of the drill hole assay file into 50-foot intervals corresponding to the working levels in the mine. Simple statistics are performed on the composited file so inconsistent rock and zone code assignments can be found and corrected. **Figure 3.1** is a typical cross-section through the northwest pit. The illustration highlights the significance of the rock and zone designations. The left half of the Figure presents the drill hole locations, the composited TCu and ACu assay

FIGURE 3.1
CROSS SECTION

1": 200'
No Vertical exaggeration

Gila Conglomerate

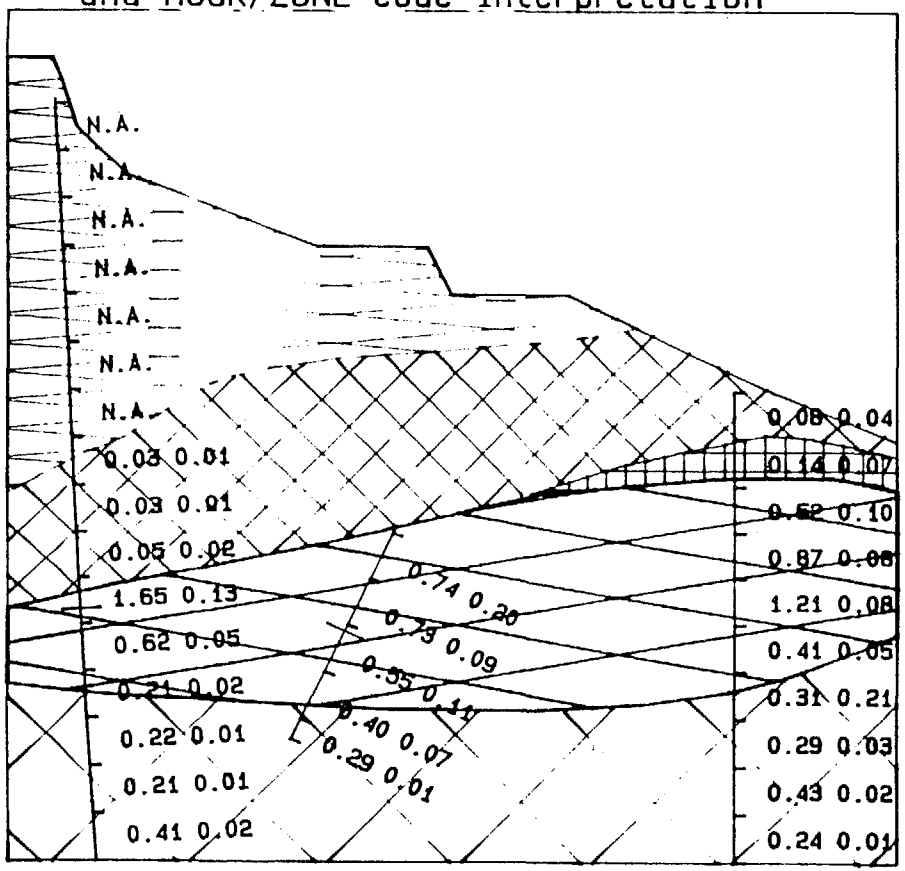
Leached Capping

Oxide Copper Mineralogy

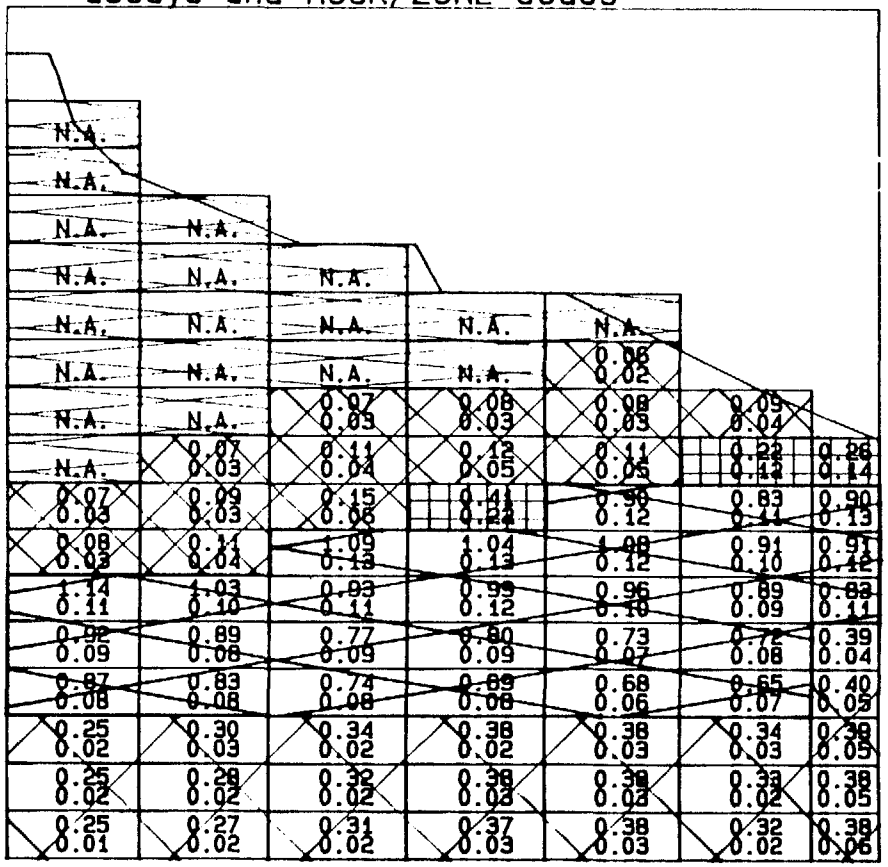
Chalcocite Blanket

Hypogene (Primary Sulfide) Material

Drill holes with composite assays and ROCK/ZONE code interpretation



Block model with interpolated assays and ROCK/ZONE codes



intervals and the rock and zone boundaries interpreted from the drill hole intersections. The right half of the Figure presents the equivalent code assignments present in the block model. The block codes are loaded on the basis of the block center rule, where the entire block is coded by the rock and zone type identified at the block center. Some of the code assignments shown on the Figure are complicated by the third-dimension, which is difficult to illustrate on a page.

Section 3.2 Assay Modeling

At this point in the modeling procedure both the drill hole composite file and the block model contain rock and zone code identifiers. This technique limits the assay selection for interpolation of any block to only the composites with compatible rock and zone codes.

Since 1985, a kriging technique has been used at Bagdad for block model interpolation. **Table 3.2** presents the kriging parameters and the point validation results for each modeling unit.

TABLE 3.2

Variogram Modeling Parameters

Modeling Unit:	C_0*	C	R	Z	E_K	E_I
Total Copper (TCu) variogram parameters:						
GRP/GRPbrx	0.000	0.006	800	1.00	0.008	0.007
PQM	0.002	0.007	1,200	0.75	-0.000	-0.000
QM Series: TZ2**	0.002	0.010	850	0.71	-0.001	-0.002
TZ3***	0.002	0.007	1,900	0.63	0.000	-0.000
TZ4	0.003	0.006	1,200	0.67	-0.001	0.001
TZ5	0.003	0.006	850	0.76	-0.002	-0.002
pC undiff.	0.004	0.021	1,100	0.68	0.000	0.003
Leach cap	0.002	0.004	1,500	0.20	-0.003	0.000
Oxide zone	0.011	0.045	650	0.35	-0.005	0.000
Chalcocite	0.039	0.039	1,000	0.25	-0.012	-0.035
Pyrite shell	0.001	0.002	700	1.00	0.001	0.001
Molybdenum variogram parameters:						
GRP/GRPbrx	0.00000	0.00001	800	1.00	0.000	0.000
PQM	0.00004	0.00009	750	1.00	-0.000	0.000
QM Series: TZ2	0.00008	0.00009	1,100	0.55	0.000	-0.000
TZ3	0.00006	0.00011	1,200	1.00	-0.001	-0.002
TZ4	0.00005	0.00007	1,400	1.00	-0.000	0.000
TZ5	0.00004	0.00007	1,100	1.00	0.000	0.000
pC undiff.	0.00005	0.00005	750	1.00	-0.000	-0.000
Leach cap and Oxide zone***:						
	0.00000	0.00003	700	1.00	0.000	0.000
Chalcocite	0.00007	0.00006	1,125	1.00	0.000	-0.000
Pyrite shell	0.00000	0.00002	700	1.00	-0.000	-0.000

C_0* Nugget Gamma Value
C Gamma Component of Structure
R Range of Structure
Z Z Axis Anisotropy
E_K Point kriging error mean
E_I Point IDC error mean
** The hypogene QM series rocks are divided into four separate trend zones (TZ) to better depict the ore shell geometry.
*** Maximum gamma and range values of nested structures.

The point validation results presented in the last two columns of **Table 3.2**, in general, show that the kriging

estimates are slightly better than the Inverse Distance Cubed (IDC) interpolation technique.

Figure 3.2 presents a plan view of the 2000 elevation through the block model. The four hypogene modeling units in addition to the drill hole composite locations are shown in relation to the 2000 elevation outline of the current reserve pit. **Figures 3.3 and 3.4** present the total copper and molybdenum contours for the same elevation, respectively. The symmetry of the grade contours around the PQM is noteworthy, and the general lack of correlation between copper and molybdenum is evident.

Section 4 Bagdad Ore Reserves

The updated geologic-assay block model was used to calculate Cyprus Bagdad's 1990 estimated ore reserves, summarized in **Table 4**.

Table 4

Cyprus Bagdad Ore Reserves
for January, 1990

	Ore Tons (MM)	Ore %TCu	Ore %Mo	Waste Tons (MM)	Strip Ratio
Proven Ore	708	0.42	0.022	680	0.96
Proven & Probable	922	0.39	0.021	741	0.80

4.1 Proven Ore Reserves -- represent sulfide ore within the current 33-year mine plan with a total copper content above 0.29%, and with interpolated block model grades having a confidence level of at least 95%, estimated by kriging variance. Proven reserves total about 700 million short tons at a mean grade of 0.42% total copper, 0.02% acid soluble copper, and 0.022% molybdenum.

The overall strip ratio, waste tons divided by ore tons, for combined proven and probable ore reserves is approximately 0.8 to 1. That is, averaged over the mine life, about 80 tons of mineralized and unmineralized waste rock will be mined to produce 100 tons of sulfide ore. More than 50 million tons of oxide copper leach material is included within the waste category.

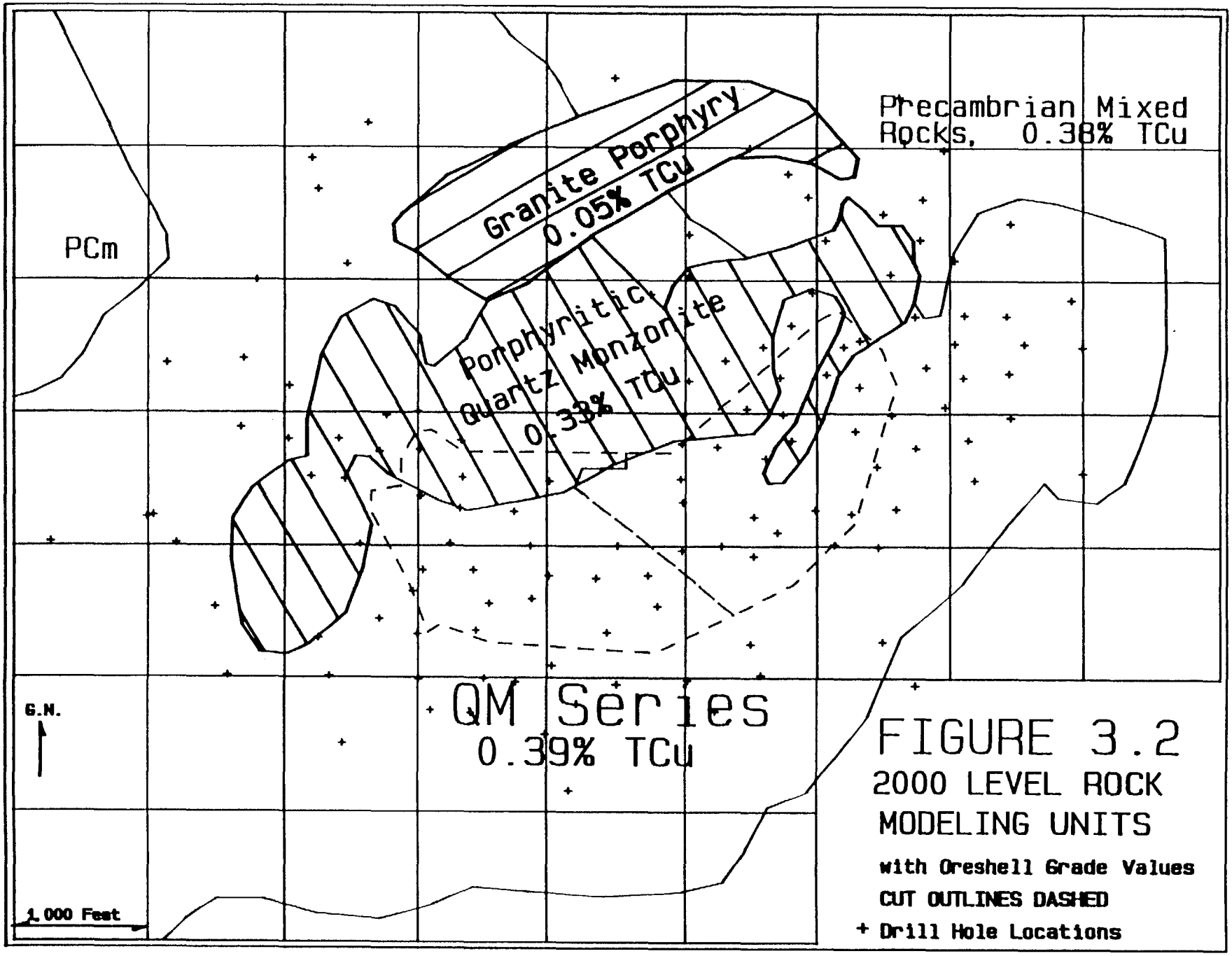


FIGURE 3.2
2000 LEVEL ROCK
MODELING UNITS

with Oreshell Grade Values
CUT OUTLINES DASHED
+ Drill Hole Locations

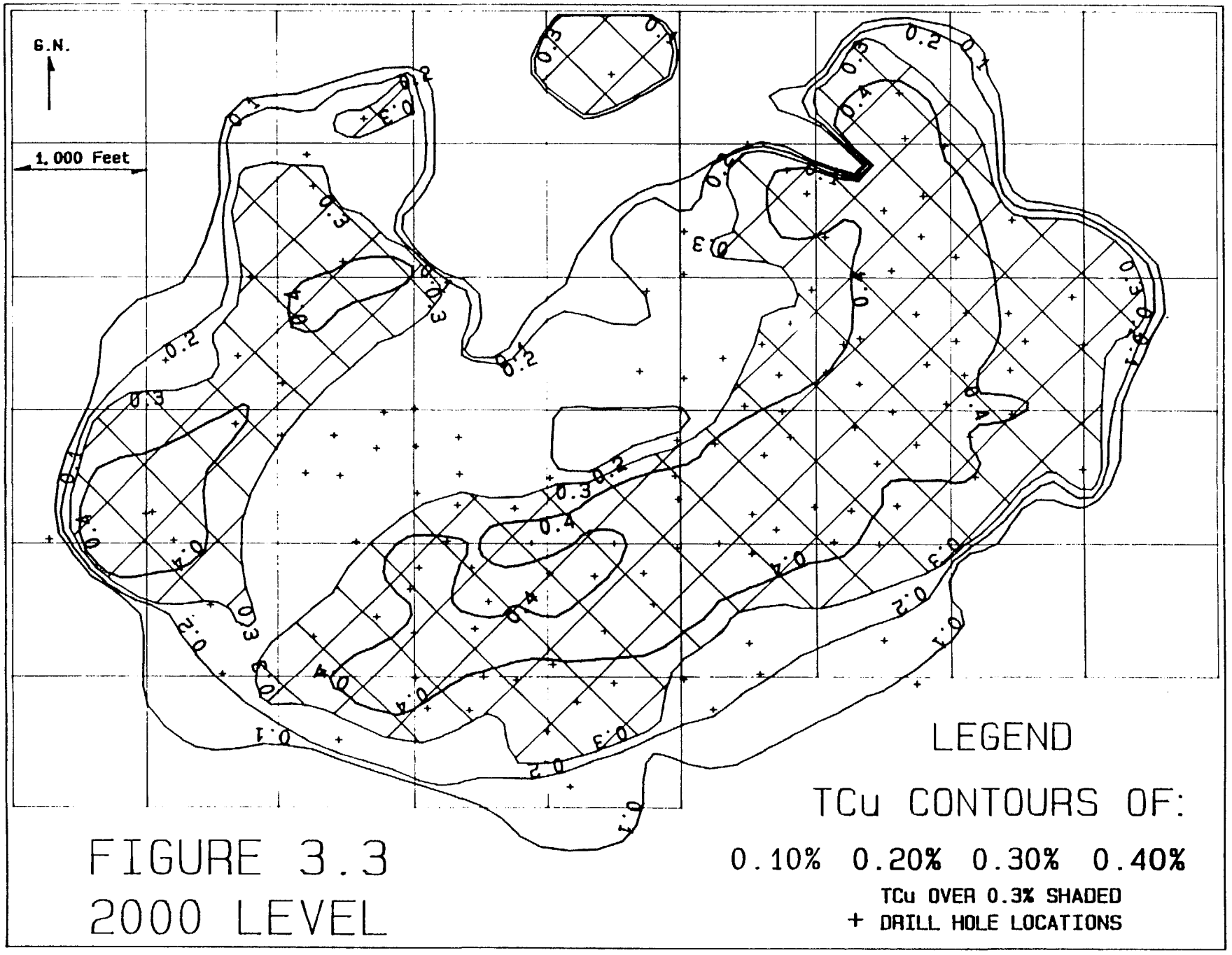
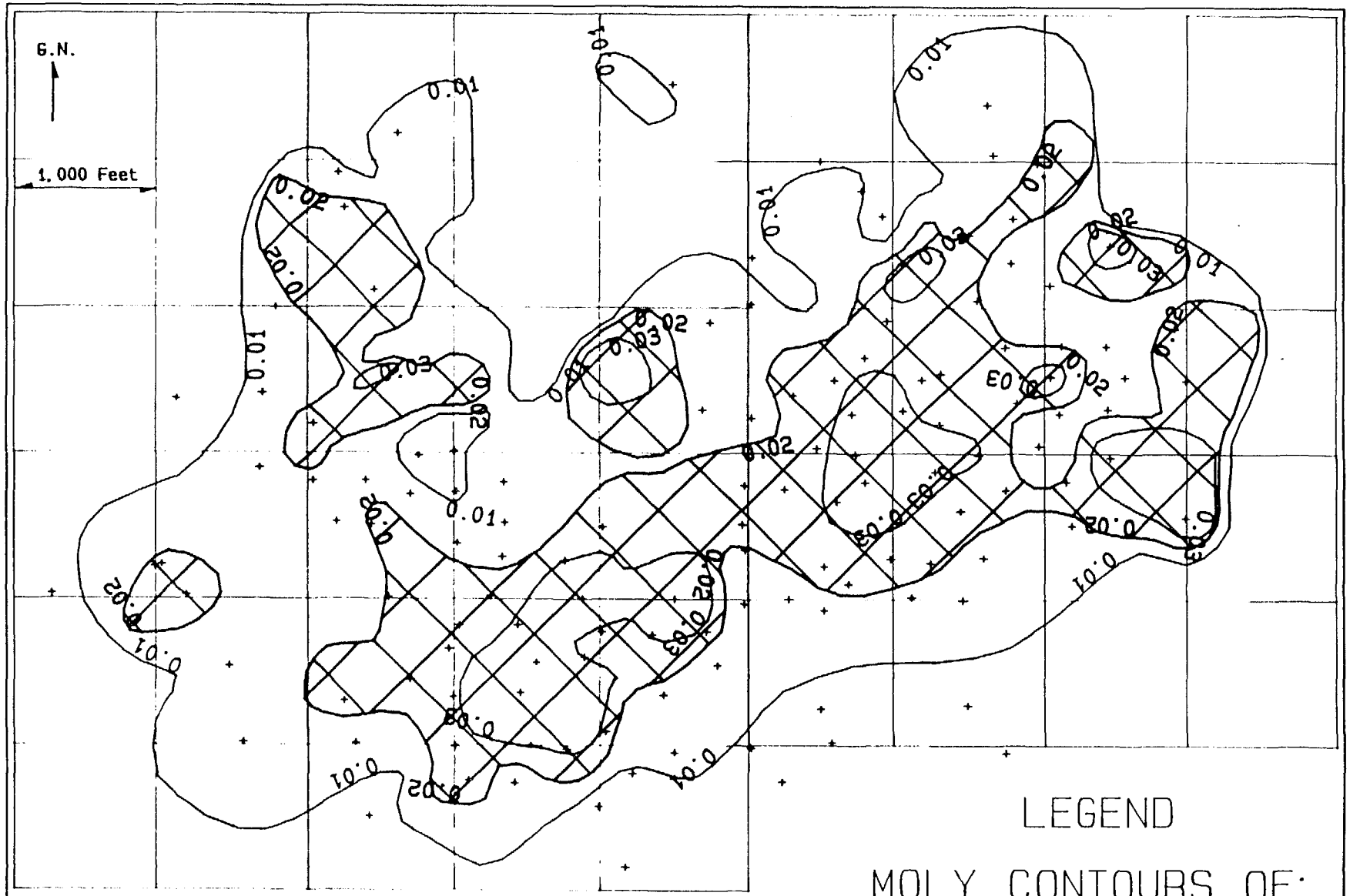


FIGURE 3.3
2000 LEVEL



LEGEND

MOLY CONTOURS OF:

0.01% 0.02% 0.03%

MOLY OVER 0.02% SHADED

+ DRILL HOLE LOCATIONS

FIGURE 3.4

2000 LEVEL

4.2 Proven and Probable Ore Reserves -- represent mineable ore within the current 75¢ copper design pit, totaling more than 900 million tons. At a 75,000-ton-per-day milling rate, anticipated by late 1990, these reserves represent a conservatively estimated mine life of nearly 33 years.

Projected metals recoveries from proven and probable sulfide ore are expected to exceed 6.2 billion pounds copper, 290 million pounds of molybdenum, and approximately 30 million troy ounces of silver. In addition, more than 250 million pounds of premium grade cathode copper will be produced by leaching oxide waste material. At current metals prices, Bagdad's mineable reserves would have a "street value" of about $9 billion.

4.3 Geologic Resources -- although largely unmineable, "geologic resources" provide a limiting value by which to judge the magnitude of the copper-molybdenum deposit. The fundamental responsibility of the mine geologists and engineers is to determine the configuration of the deposit and to devise a practical mine plan to safely extract as much of these geologic resources as is feasible under changing economics and technology.

Using a 0.3% total copper cutoff grade, geologic resources estimated to the 1,000 foot elevation average 0.40% total copper, 0.03% acid soluble copper and 0.021% molybdenum; these values simply express the overall character of the Bagdad deposit.

Section 5 Mine Planning

Mine Planning is a never-ending, reiterative process that requires close coordination between the Planning and Development team, the analytical lab, and Mine Production personnel. Diamond drilling is an on-going data-collection program at Bagdad, utilizing an in-house Longyear 44 drill and a two-man crew. Outside diamond drill contractors are used to supplement core drilling as required. The Planning and Development Department consists of 17 people: geologists, engineers, surveyors, ore control technicians and diamond drillers.

Mine planning can be categorized as short range (day-to-day/week-to-week), intermediate range (month-to-month/year-to-year), and long range (life-of-mine).

5.1 Short-Range Mine Planning -- depends to a large extent on timely and accurate delineation of relatively small scale variations in copper and molybdenum contents, mineralogy, and milling characteristics of the ore. The diverse material types within the mine are classified as "ore" or "waste", depending on their metal content and mineralogy. By definition, ore must have a recoverable sulfide copper and molybdenum content sufficient to pay all production costs, and provide a reasonable profit. All other rock within the mine plan is classified as waste, even though leaching of "oxide waste" contributes substantially to overall copper production.

"Ore Control" is a fundamental aspect of short-range mine planning, the purpose of which is to physically delineate ore and waste boundaries needed to guide the day-to-day mine operation. **Table 5.1** outlines the ore and waste categories flagged separately at Bagdad.

Table 5.1

Ore and Waste Flagging Categories

Material Type	Dominant Character	Flagging Color	Destination
Sulfide Ore	Cu-Mo Sulfide	Red	Concentrator
Oxide Material	>0.06% ACu	Yellow	SX Leach Dump
Mineral Waste	>0.06% TCu	Blue	Min. Waste Dump
Unmin. Waste	<0.07% TCu	White	Unmin. Waste Dump

Consistent, accurate sampling and assaying of blasthole cuttings provides the basis for ore control. Throughout most of the mine, blastholes are drilled on a 28-foot grid. Total copper (TCu) and acid soluble copper (ACu) contents are determined for every blasthole in mineralized rock, with every-other hole assayed for molybdenum. Atomic absorption assays are done in the state-of-the-art Bagdad analytical lab, usually within 24 hours of sampling. The blasthole assays are used to interpolate (three-dimensional IDC) grade values for 25-foot blocks within the blast rounds. Another computer program performs an economic evaluation to determine

material type designations for each blasthole (e.g. ore, oxide, waste). The ore control engineer then maps out mineable ore-waste splits using colored pin flags and ribbon to delineate boundaries within the shot blast rounds. The flagging and plastic ribbons guide the shovel operators, who direct the loaded trucks to the primary crusher, or appropriate dump location.

An important objective of short-range mine planning is to blend ore from different shovel faces to achieve a relatively consistent mill feed, both in terms of copper-molybdenum grade and grinding characteristics. Rock hardness and fragmentation are important factors to be considered in blending.

5.2 Intermediate-Range Planning -- depends heavily on both the geologic assay block model and blasthole assay trends to schedule mining areas and production rates months or years in advance. Careful planning is required to provide long-range production forecasts, and to prevent radical fluctuations in concentrator head grades and mill throughput.

Design and scheduling of waste and copper leach dumps is an important objective in intermediate-range planning. Haulage distances must be minimized, with careful planning of oxide leach and mineralized waste dump locations to protect environmentally sensitive areas.

5.3 Long-Range Planning -- is dependent almost exclusively on the geological assay block model, and therefore, on the interpretation of data from nearly 90 miles of deep drilling used to create this model.

Figure 5.0 is a computer designed, ideal pit that serves as the starting point for life-of-mine planning at Bagdad. The "floating cone" pit optimization provides a first approximation of a practical, economically mineable pit. Although overall slope angles ranging from 38° to 47° have been designed into this optimal pit, it lacks haul roads and was constructed without consideration of ore scheduling and economic cut sequencing. It represents a design target that includes all the theoretically mineable ore reserves at an assumed copper price ($.75/lb).

Using the optimized pit as a goal, the next step in the planning process is the creation of a mineable pit design incorporating an efficient haul road system and maximum slope angles designed to approximate stability limits.

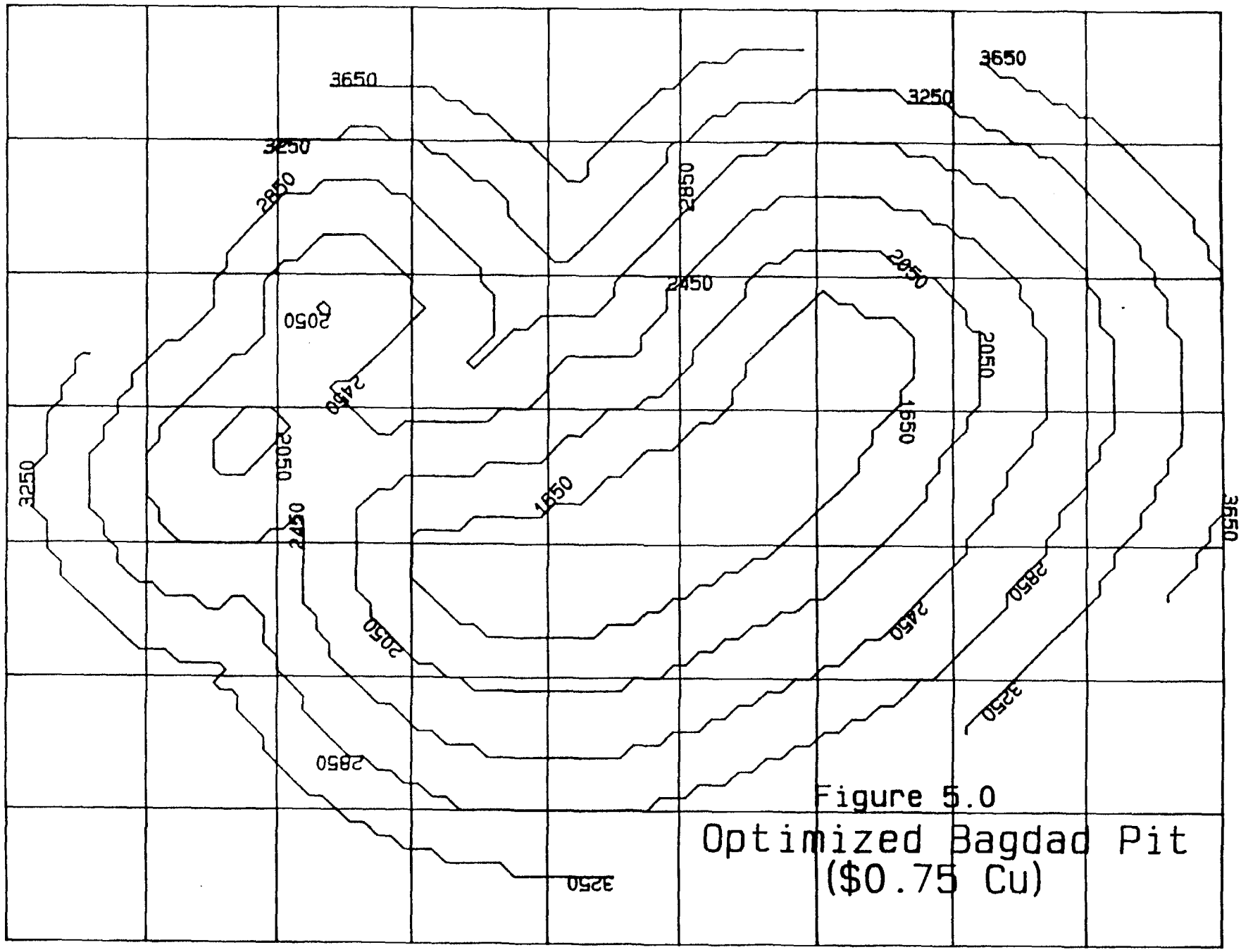


Figure 5.0
Optimized Bagdad Pit
($0.75 Cu)

Detailed geology, pit wall stability analysis, and historic monitoring of slope failures provide the basis for determining design slope angles. Consideration of pit wall stability is fundamental to long-range planning, and efforts to minimize slope failure are an on-going responsibility for both Planning and Development and Mine Operations personnel.

Figure 5.1 outlines the design pushbacks or cuts within the 33-year mine plan at the 2,950′ elevation. All current mining is within the Giroux and Northeast Cuts. The East Cut will be mined in three phases starting in 1992. Stripping of West Cut waste will begin about the year 2000 when Phase I of the East Cut becomes the primary ore production area, with the termination of the Giroux Cut at the 2,050′ elevation.

Figure 5.2 is an idealized northwest-southwest cross section of the Bagdad pit expansions, with the West Cut projected to the section as a dashed outline. The final central pit will be almost exclusively in ore, terminating the 1,500′ elevation about the year 2023. This generalized long-range plan will be refined as detailed ore scheduling dictates.

Section 6 Kimberly Tailings Relocation

As indicated on **Figure 5.2**, the East Cut will intersect mill tailings in the old Kimberly Pond area south of the present pit. Phase I stripping in the East Cut will be down to the 3,450 ft tailings elevation in 1996, by which time approximately 40 million tons of tailings will have to be relocated to an area south of the concentrator road.

6.1 Bucket Wheel Excavator and Conveyor System -- After evaluating several tailings relocation methods, it became evident that a bucket wheel excavator and conveyor system was the lowest cost mechanical method. Mining and relocation costs for this system were less than half that of shovel or scraper methods. Hydraulic removal was rejected because of water requirements and concerns about introduced water adversely impacting the stability of the south pit wall.

Figure 6.0 is a schematic diagram of a typical bucket wheel excavator and conveyor system. The 36 ft Kimberly conveyor system will include a 2,850 ft track-shiftable

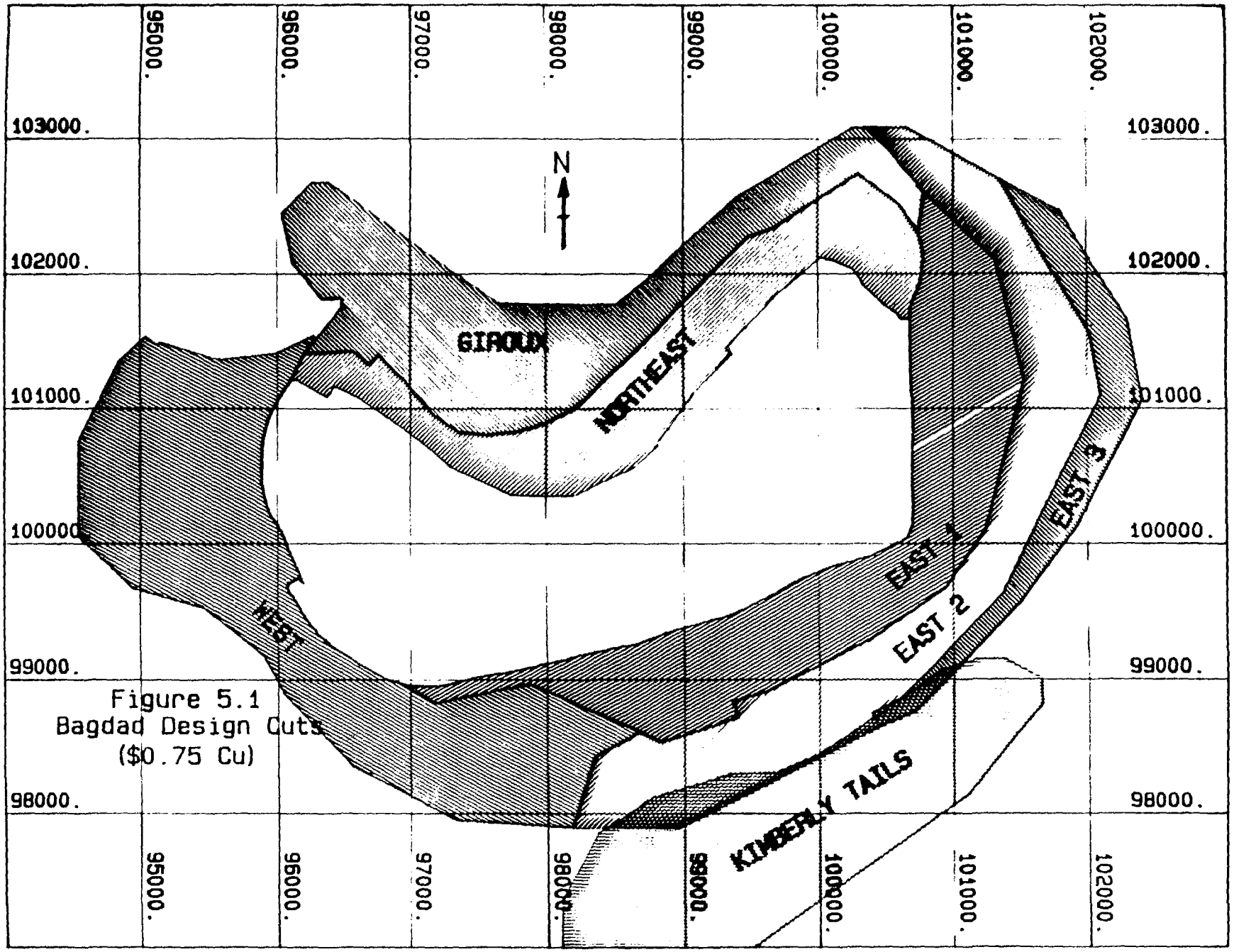


Figure 5.1
Bagdad Design Cuts
($0.75 Cu)

Figure 5.2
IDEALIZED X-SECTION OF PIT EXPANSIONS

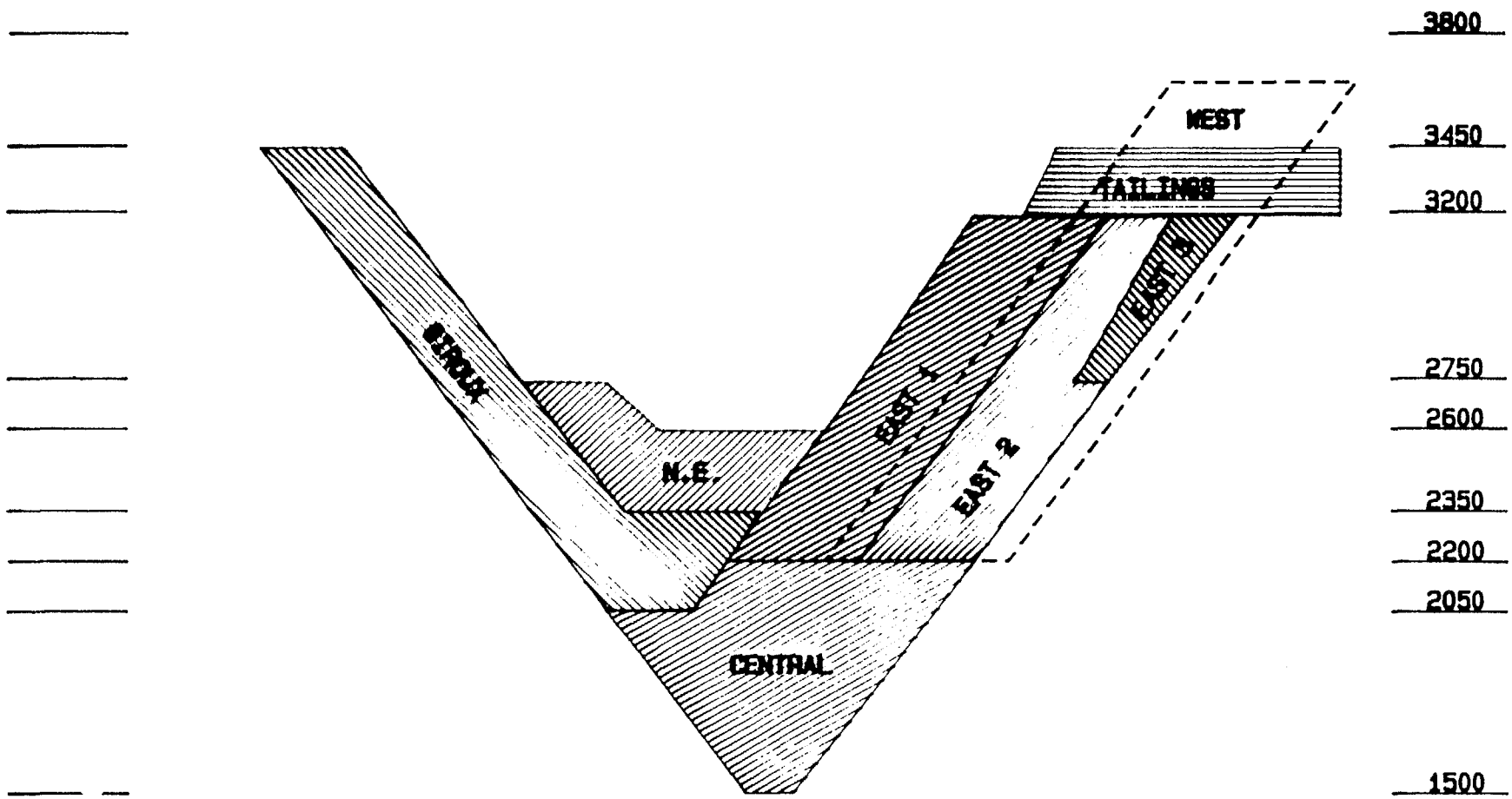
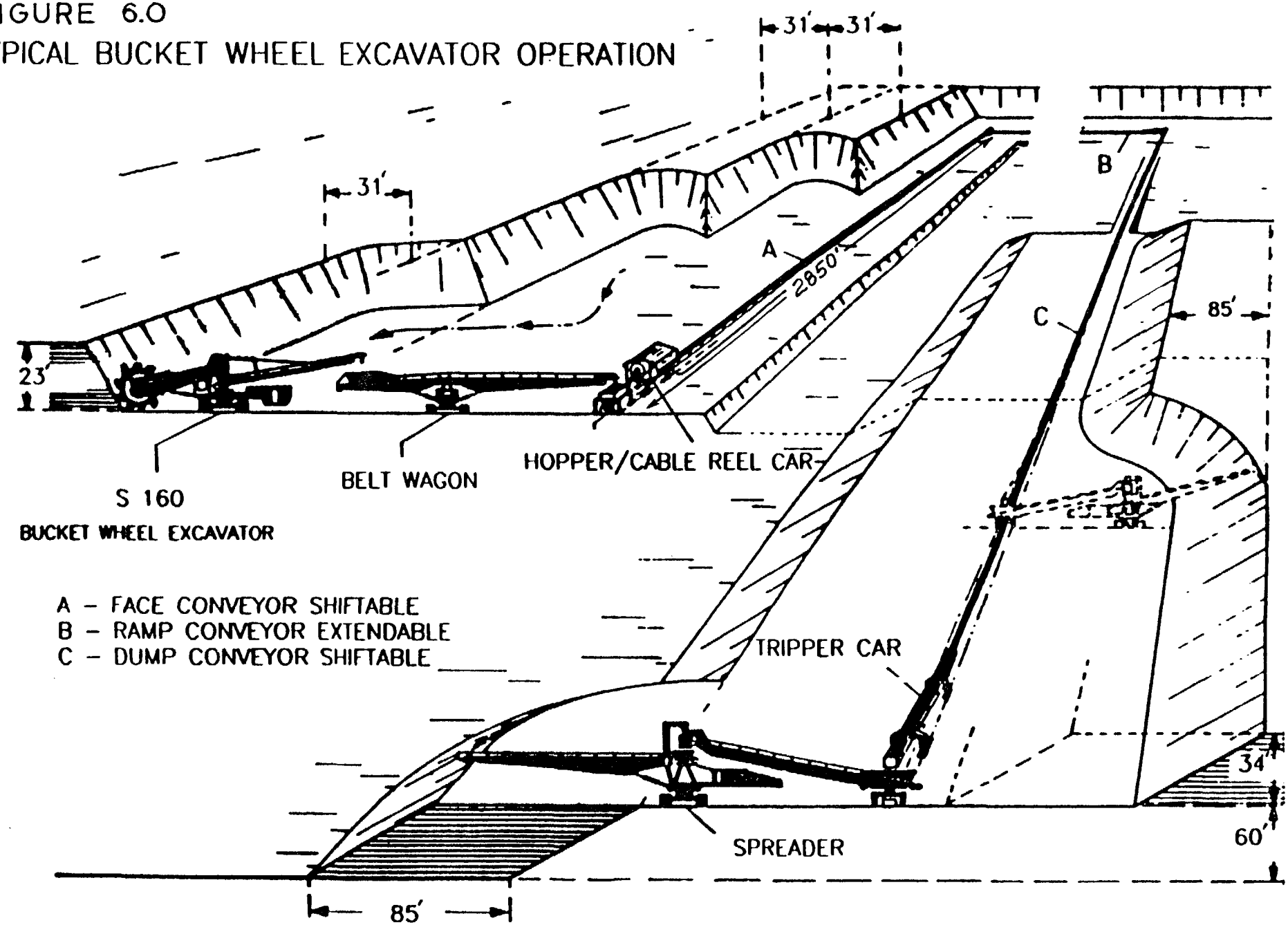


FIGURE 6.0
TYPICAL BUCKET WHEEL EXCAVATOR OPERATION



face conveyor, an extendable stationary ramp conveyor, and a 1,600 ft shiftable dump conveyor. Three track-mounted pieces of equipment constitute the heart of the system: 1) An O & K 600-bcyd/hour bucket wheel excavator equipped with 200-liter buckets and wide tracks; 2) a 130 ft mobile conveyor belt wagon; and 3) a 100 ft mobile spreader at the discharge end of the conveyor system. Operating ground pressures for the three track-mounted pieces of equipment will be less that 14 psi. Use of the belt wagon will permit three 31-ft-wide, 23-ft-high cuts to be made along the length of the tailings excavation before the face conveyor needs to be shifted.

Section 7 Summary and Conclusions

Due in large part to dedication and teamwork by its workforce, Cyprus Bagdad ranks among the Nation's lowest cost copper and molybdenum producers. The geology of the Bagdad mine has been deciphered using more than forty years of diamond drilling information, and has recently been integrated into a comprehensive geology assay block model. Although the interpolated block model terminates at the 1,000 ft elevation, 1,600 ft below the present pit floor, deep drilling indicates copper-molybdenum mineralization at least to sea level.

Although many refinements will no doubt be made in the block model and mine plan, and problems will need to be overcome, the future of the Bagdad mine appears bright. The Bagdad deposit is truly a world class resource worthy of recognition and protection. If not closed prematurely by unrealistic environmental regulations, very possibly imposed because of inappropriate designation of adjacent Burro Creek Wilderness, the Cyprus Bagdad mine will continue to be a major contributor to the State and National economy well into the 21st century.