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May 12, 1971

TO: Paul Eimon

FROM: Ken Jones

SUBJECT: ARGENTA MINING DISTRICT
Beaverhead County, Montana

The Cyprus report and maps were reviewed briefly and discussed with Dick Thomssen on May 4. While potential exists on this property for a large copper deposit, evidence to date indicates that this potential lies at least 2,000 feet below the surface. This seems a bit too speculative as far as economics are concerned to be of immediate interest to Essex.

Thomssen was not impressed by surface exposures of the intrusive, but did comment on very attractive molybdenite encountered near the bottom of one of the deep holes in quartz monzonite.

If we undertake reconnaissance examinations in Montana and Idaho this summer, a look at the surface and especially the core, would be worthwhile for background, if nothing else. However, I do not feel that an expenditure of $75,000 to $100,000 this year to obtain an interest in the property is justified.

JKJ:td

cc: H. Lanier

COUNTY:	COUNTRY:	STATE:	NAME OF PROPERTY:
BEAVERHEAD	USA	MONTANA	ARGENTA MINE

DISTRICT OR AREA:	METALS:	ACCOUNT NUMBER:	NUMBER:
ARGENTA	Cu, Pb, Zu, Ag, Au		

GENERAL DESCRIPTION:

Base metal veins with possible deep porphyry copper target

EXAMINED BY:

DATE:

BRIEFED BY: P.I. Eimon & J.K. Jones

DATE:

STATUS:

TYPE OF DEPOSIT:

GEOLOGY

Moderately dipping sedimentary rocks intruded by quartz monzonite

LOCATION: Northwest of Dillon, Mont. about 15 miles by good road.

ELEVATION:

LAT: 45° 15' ± **LONG:** 112° 50' ±

ACCESS:

DEVELOPMENT: 8,000 to 10,000 feet of drilling, numerous underground workings.

MINERALIZATION:

Shallow Pb, Zu, Ag mineralization in veins in sedimentary rocks. At depth in quartz monzonite is several percent disseminated pyrite, traces of copper and molybdenite.

PROPERTY & OWNERSHIP:

Owned by Hand family, Dillon, Mont.

GEOPHYSICS:

Magnetics & IP by Copper Range

AERIAL PHOTOGRAPHS:

GEOCHEMISTRY:

See Cyprus report

TOPOGRAPHIC MAPS:

7½ minute Argenta Quadrangle

MAPS & REPORTS:

Cyprus report – see Dick Thomssen in Tucson, Joe Worthington in Spokane

MINERAL PROSPECT DEPOSIT DATA SHEET

ESSEX INTERNATIONAL, INC.
1704 WEST GRANT RD., TUCSON, ARIZONA 85705
PHONE (602) 624-7421

BY: J.K. Jones

DATE: May 12, 1971

NAME OF PROPERTY:	NUMBER:
ARGENTA MINE	

REFERENCES:

USGS Bull. 574
Montana Bureau of Mines & Geology Bull. No. 6
Also see Joe Worthington, Cyprus Mines, Spokane

PRODUCTION & RESERVES	SAMPLES:
$5 to $10 million in base & precious metals. Has been continuously mined for 40 years.	
METALLURGY:	**ENGINEERING:**
FACILITIES:	**EXPLORATION POSSIBILITIES:**
	Speculative deep porphyry copper or molybdenum target.

ADDITIONAL INFORMATION OR SKETCH MAP:

Cyprus seeking joint venture partner for 1971, must spend $20,000 for assessment work, about $50,000 in July & August for work committment - probably would be a deep drill hole.

Cyprus has spent $180,000, Essex would have to spend $200,000 over 2 year period to gain 50% interest.

Agreement was for three free years, annual payments of $87,500 starting in fourth year with buy-out price of $2.5 million.

ii) **Data:**

A. 1. Winchell, A. N.; 1914; Mining Districts of the Dillon Quadrangle; U. S. G. S., Bull. 574

2. Shenon, P. J.; 1931; Geology and Ore Deposits of Bannack and Argenta, Montana; Montana Bur. of Mines and Geol., Bull. No. 6

3. Myers, W. B.; 1952; Geology and Mineral Deposits of the Northwest Quarter Willis Quadrangle and Adjacent Brown's Lake Area, Beaverhead County, Montana; U. S. G. S., Minerals Branch Open File Report; with accompanying preliminary geologic map

4. Lowell, W. R.; 1965; Geologic Map of the Bannack-Grayling Area, Beaverhead County, Montana; U. S. G. S. Misc. Geologic Investigations Map. I-433, with text

5. Copper Range Exploration Co.; 1968; Maps, Drill logs, geophysical data, per list in paragraph I-D of this report.

B. 6. Meyer, C., and Hemley, J. J.; 1967; Wall Rock Alteration; Chapt. 6 in Barnes, H. L. (Ed.), Geochemistry of Hydrothermal Ore Deposits; Holt, Rinehart, and Winston, Inc., publishers

7. Meyer, C.; Shea, E. P.; Goddard, C. C., Jr.; 1968; Ore Deposits at Butte, Montana; Sect. 65, Vol. II. Ore Deposits in the United States; A.I.M.E., Graton-Sales Volume pps. 1373 - 1416

8. Lowell, J. D.; and Guilbert, J. M.; 1970; Lateral and Vertical Alteration-Mineralization Zoning in Porphyry Ore Deposits; Econ. Geol. V. 65, No. 4 pps. 373 - 408

9. Cyprus; 1970; Drill core graphic logs, with assay returns; Cyprus Spokane files

COUNTY:	COUNTRY:	STATE:	NAME OF PROPERTY:
BEAVERHEAD	USA	MONT.	ARGENTA MINE

DISTRICT OR AREA:	METALS:	ACCOUNT NUMBER:	NUMBER:
ARGENTA	Cu, Pb, Zn, Ag, Au		

GENERAL DESCRIPTION:
Base metal veins with possible deep porphyry copper target

EXAMINED BY:
DATE:
BRIEFED BY: P.E. & JKJ
DATE:
STATUS:

TYPE OF DEPOSIT:

GEOLOGY
moderately dipping sedimentary rocks intruded by quartz monzonite

LOCATION: northwest of Dillon, Mont. about 15 miles by good road.
ELEVATION:
LAT: 45°N' ± LONG: 112°50' ±
ACCESS:

DEVELOPMENT: 8,000 to 10,000 feet of drilling, numerous underground workings.

MINERALIZATION:
Shallow Pb, Zn, Ag mineralization in veins in sedimentary rocks. At depth in quartz monzonite is several percent disseminated pyrite, traces of copper and molybdenite.

PROPERTY & OWNERSHIP:
Owned by Hand family, Dillon, Montana.

GEOPHYSICS:
Magnetics & IP. by Copper Range

AERIAL PHOTOGRAPHS:

GEOCHEMISTRY:
see Cyprus report

TOPOGRAPHIC MAPS:
7½ minute Argenta Quadrangle

MAPS & REPORTS:
Cyprus report - See Dick Thomssen in Tucson, Joe Worthington in Spokane

MINERAL PROSPECT DEPOSIT DATA SHEET

ESSEX INTERNATIONAL, INC.
1704 WEST GRANT RD., TUCSON, ARIZONA 85705
PHONE (602) 624-7421

BY: J. K. Jones
DATE: May 12, 1971

NAME OF PROPERTY: ARGENTA MINE

NUMBER:

REFERENCES:

USGS Bull. 574

Montana Bureau of Mines & Geology Bull. No. 6

also see Joe Worthington, Cyprus Mines, Spokane

PRODUCTION & RESERVES

$5 to 10 million in base & precious metals. Has been continuously mined for 40 years.

SAMPLES:

METALLURGY:

ENGINEERING:

FACILITIES:

EXPLORATION POSSIBILITIES:

Speculative deep porphyry copper or molybdenum target.

ADDITIONAL INFORMATION OR SKETCH MAP:

Cyprus seeking joint venture partner for 1971, must spend $20,000 for assessment work, about $50,000 in July & August for work committment — probably would be a deep drill hole.

Cyprus has spent $180,000, Essex would have to spend $200,000 over 2 year period to gain 50% interest.

Agreement was for three free years, annual payments of $87,500 starting in fourth year with buy out price of $2.5 million

COUNTY:	COUNTRY:	STATE:	NAME OF PROPERTY:
Beaverhead	USA	Montana	Argenta

DISTRICT OR AREA:	METALS:	ACCOUNT NUMBER:	NUMBER:
Argenta	Cu, Pb, Zn, Ag, Au		

GENERAL DESCRIPTION:
Deep Porphyry Cu target in old Pb-Zn district

EXAMINED BY:
DATE:
BRIEFED BY:
DATE:
STATUS: under option to Cyprus, Cyprus seeking join venture partner

TYPE OF DEPOSIT:

GEOLOGY
Moderately dipping sedimentary rocks intruded by large sill-like mass of quartz monzonite.

LOCATION: near Dillon
ELEVATION:
LAT: **LONG:**
ACCESS: easy
DEVELOPMENT: old district

MINERALIZATION:
Shallow Pb-Ag mineralization, several percent FeS_2, traces Cu & MoS_2 at depth in 2000 foot deep drill hole

PROPERTY & OWNERSHIP:
Hand Family, Dillon Montana

GEOPHYSICS: Copper Range IP and Magnetics

AERIAL PHOTOGRAPHS: exist.

GEOCHEMISTRY: started & ½ completed

TOPOGRAPHIC MAPS: 7½ minute quad Argenta

MAPS & REPORTS: Cyprus - in hands of Thomason for inspection, Tucson, May 1971

MINERAL PROSPECT DEPOSIT DATA SHEET

ESSEX INTERNATIONAL, INC.
1704 WEST GRANT RD., TUCSON, ARIZONA 85705
PHONE (602) 624-7421

BY: Paul Eimon
DATE: April 26, 1971

NAME OF PROPERTY:	NUMBER:

REFERENCES: Joe Worthington - Cyprus
See attached sheet for list of publications

PRODUCTION & RESERVES	SAMPLES:
$5 - $10 in base & precious metals Hand family has shipped for fourty years.	Core at Property 4-5,000' Copper Range 4-5,000' Cyprus
METALLURGY: sulphides	**ENGINEERING:**
FACILITIES: 15 miles to Dillion	**EXPLORATION POSSIBILITIES:** Porphyry Deep hole.

ADDITIONAL INFORMATION OR SKETCH MAP:

Seeking joint venture partner 1971

Assessment work $20,000.00

Deep drilling ~~[illegible]~~ $ 50,000.00
(1 hole)
July - August

cost $75 - $100,000.00

Cyprus has spent $180,000.00

∴ Essex $200,000.00 over two years to gain ½ interest to Sept. 1972

---

3 free years
1 Cyprus
2 "
3 joint - $175,000.00

4th year on annual payments $87,500.00

By out 2½ million

RUSSELL CHADWICK - ECONOMIC GEOLOGIST

2407 S. GARFIELD RD. • SPOKANE, WASH. 99203 • 509-RI 7-2595

ARGENTA PROJECT

Beaverhead County, Montana

REPORT FOR 1970 FIELD SEASON

to

Cyprus Mines Corporation

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ILLUSTRATIONS

Topographic Map	In Pocket
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Figure 1; Alteration-Mineralization Zoning in Porphyry Ore Deposits	Page 35

I) Introduction:

As proposed in 1969, the exploration program for the 1970 field season at Argenta was designed to evaluate the possibility that sufficient reserves could be found in the Hand Mine area to permit early production of silver-lead-zinc ore. The program contemplated a second phase aimed at evaluating the potential of the district for a porphyry copper deposit. Work on the project began in February, 1970 with a review of the data and drill core available from the mine operators and from previous exploration. Following mapping and sampling of the Hand Mine, a drill hole testing that area was begun on June 30th. Results from two holes and other work in the mine area did not point out an attractive silver-lead target and the project effort was shifted in August toward exploration of the copper potential. Two drill holes and other work on the "porphyry" bet were proceeding when instructions to close down the project were received in late September.

Since our findings from the season's work suggest a continued interest in the porphyry copper potential of the district but not in the lead-silver veins, the evidence for the "porphyry" bet is discussed in a separate section of this report.

ii) Data:

1. Winchell, A. N.; 1914; Mining Districts of the Dillon Quadrangle; U. S. G. S., Bull. 574

2. Shenon, P. J.; 1931; Geology and Ore Deposits of Bannack and Argenta, Montana; Montana Bur. of Mines and Geol., Bull. No. 6

3. Myers, W. B.; 1952; Geology and Mineral Deposits of the Northwest Quarter Willis Quadrangle and Adjacent Brown's Lake Area, Beaverhead County, Montana; U. S. G. S., Minerals Branch Open File Report; with accompanying preliminary geologic map

4. Lowell, W. R.; 1965; Geologic Map of the Bannack-Grayling Area, Beaverhead County, Montana; U. S. G. S. Misc. Geologic Investigations Map. I-433, with text

5. Copper Range Exploration Co.; 1968; Maps, Drill logs, geophysical data, per list in paragraph I-D of this report.

6. Meyer, C., and Hemley, J. J.; 1967; Wall Rock Alteration; Chapt. 6 in Barnes, H. L. (Ed.), Geochemistry of Hydrothermal Ore Deposits; Holt, Rinehart, and Winston, Inc., publishers

7. Meyer, C.; Shea, E. P.; Goddard, C. C., Jr.; 1968; Ore Deposits at Butte, Montana; Sect. 65, Vol. II. Ore Deposits in the United States; A.I.M.E., Graton-Sales Volume pps. 1373 - 1416

8. Lowell, J. D.; and Guilbert, J. M.; 1970; Lateral and Vertical Alteration-Mineralization Zoning in Porphyry Ore Deposits; Econ. Geol. V. 65, No. 4 pps. 373 - 408

9. Cyprus; 1970; Drill core graphic logs, with assay returns; Cyprus Spokane files

I. The Argenta District

A. Location, Access:

The Argenta District is within T. 6 S., R. 10 W. in Beaverhead County, Montana (45° 17' N. Lat., 112° 52' W. Long.). It is about twenty miles west-northwest of Dillon, Montana, county seat of Beaverhead county. The road from Dillon is flat, paved except for the last few miles. Dillon is served by the Union Pacific R. R.

Argenta consists of about a dozen small homes; it does have electric power but not telephone service. Rattlesnake Creek, which runs through Argenta, provides plenty of water year-round for domestic purposes and irrigation.

B. Topography, Climate:

The area mapped around the Hand Mine consists of a gentle south-facing slope ranging between 6100 ft. on the Argenta Flats along Rattlesnake Creek and 6500 ft. The slope has a shallow soil cover with grass, sage, and a few junipers. The climate is semi-arid, with from 15 - 20 inches of rain per year. The area is generally free of snow cover after April and until December; winter temperatures can reach 30 degrees below zero.

C. Area, Title:

Cyprus holds most of the claims in the Argenta Mining District and the real property in Argenta Townsite. A land status map and list of owners is in Cyprus Los Angeles and Spokane files. Some 194 unpatented claims, 19 patented claims and most of the other real property around Argenta are held under a Mining Lease (and Option-to-Purchase) from the Hand family of Argenta and Dillon dated

17 September, 1969. Four patented claims in the Bella - Ferdinand area, four upatented claims, and some Argenta property are held under an Option Agreement from Rudy Nygren of Argenta dated 9 February, 1970. The Hand agreement contains the following provisions:

a) 20 year term, plus 10 year extensions upon 60 days notice
b) Exploration expenditures: (with carry-forward provision)
   1st year - $75,000 (to October 17, 1970)
   2nd year - $125,000
   3rd year - $175,000
   4th year and subsequently $87,000 - 1 year
c) Royalties:
   Starting 4th year: Advance minimum $87,000/year
d) Assessment Work:
   Cyprus notifies prior to September 1 of any year, or does assessment work for subsequent year
e) Taxes: Cyprus shall pay pro-rata
f) Upset Price: $2,500,000
g) Any locations by either party subject to agreement

The Nygren agreement contains the following provisions:

a) Cash Consideration: $1,000
   1st Anniversary $2,000
   2nd Anniversary $3,000
   3rd Anniversary $4,000
   4th Anniversary $5,000
   5th Anniversary Balance of $125,000 purchase price in four equal annual installments
b) Taxes: Cyprus shall pay
c) Assessment Work: Cyprus shall do for any assessment year in which option runs 90 days
d) Minimum Expenditures: None

Assessment work on the unpatented Hand and Nygren claims was filed for the year ended 1 September, 1970 and copies of the affidavits furnished to Cyprus' Spokane office. The amount spent in 1970 applicable to the Hand agreement minimum work requirement was approximately $165,000, leaving a requirement for 1971 of approximately $35,000.

The area held covers almost all of the area of interest, that is: the Hand Mine area and the triangular altered portion of the quartz monzonite. To completely cover the latter would require picking up the following (with reference to the claim map and the "Appendix A" list which accompanies it):

No. 9	Patented Jack Rabbit claim; Mr. Graeter of Deer Lodge
No. 14	Big Jumbo, Big Paymaster, East End patented claims; the Anaconda Company
No. 16	Goldsmith patented claim; Anaconda one-half
No. 31	Noname unpatented claim; Carl Shafer of Dillon
No. 32	Cold Day patented claim; Leonard Christie of Dillon

Those parcels in Argenta Townsite not owned by Hand or Nygren.

D. History, Production:

Mining in Argenta began in 1865; the first smelter in Montana was built there the same year. Some thirty mines and prospects operating intermittently by 1929 produced some $1,500,000 in lead and silver, or gold, or copper ores either for local smelters or for shipment elsewhere. Nearly all of this early production came from enriched oxide silver-lead ores in shallow workings. The Tuscarora, Governor Tilden, and Florida claims of the Argenta Springs area together produced about 10,000 tons from pipe-like shoots in the Devonian Jefferson Formation. In the same area several modest operations each produced a few hundreds or thousands of tons from bedded runs in the Jefferson. A half-dozen more similarly-sized mines produced from fissures in the Cambrian Flathead Quartzite or in the Precambrian Spokane Shale.

At the south end of the district in and around the present Hand Mine, the early production was chiefly from either the irregular deposits at the contact of the early Tertiary Argenta quartz-monzonite stock with the U. Miss.-L. Penn.

Amsden Limestone or from fissure veins in the Amsden close above the stock. The Iron Mt., Anaconda, Brownell, and Mauldin Mines were the leading producers. Nearby, to the east and southeast, the Copper Belle, Jack Rabbit, and Bella mines operated on secondary chalcocite ores from pyritic veins in the quartz monzonite; these ores carried substantial silver or gold. The Ferdinand Mine at the southeast corner of the district produced lead-zinc-silver-copper ore from a fault-vein between quartz monzonite and Madison Limestone.

In contrast to the sporadic high-grading of the early years, and to the occasional small leasing operation, the Hands, John and his son Bill, have operated continuously for the last thirty-five years. In this time they have produced about 100,000 tons with a gross value of $3,000,000 from the Hand Mine (Mauldin - Anaconda - Brownell - Iron Mt. Group of claims). Production is currently about 60 tons of shipping ore per week; it averages about 12% Pb, 2 - 3% Zn, 2 - 5 oz. Ag, and .01 - .05 oz. Au.

In 1967 the Copper Range Company optioned the Hand and other properties in the district, staked the open ground, and conducted an exploration program aimed at the porphyry copper potential. Their program resulted in the following coverage (copies of their maps and data are in the Los Angeles and Spokane Cyprus files).

1. Geologic Map, 1" = 500' - covering from the altered sediments north of the Hand Mine to the ditch south of Rattlesnake Creek
2. Geochemical Map, 1" = 500' - two east-west sample lines, one in quartz monzonite just south of the contact, the other in the long ditch south of Rattlesnake Creek
3. Alteration Overlay, 1" = 500'
4. Aeromagnetic Map, 2" = 1 mile - covers an area about 6 miles by

7 miles centered on the Hand Mine

5. Geological - Geochemical Section, 1" = 50' - ditch south of creek
6. Geological - Geochemical Sections, 1" = 50' - one for each of four Copper Range diamond drill holes
7. IP - seven east-west lines each four miles long shown on (4.) above, and on profiles
8. Magnetic Profiles, ground survey, for 4 east-west lines.

It is understood that the Copper Range drill holes were sited principally to test their I.P. anomalies. When three of their four holes (CRX-1, CRS-3, CRX-4) found pyritization and alteration but not commercial mineralization they terminated their work on the area in May, 1969.

E. General Geologic Setting:

The Argenta District occupies low piedmont slopes on the north-south-trending eastern flank of the Pioneer Range. The trend incorporates the eastern margin of the granitic core of the range; a belt of folded and faulted sediments of Precambrian, Paleozoic, and Mesozoic age; Tertiary sediments, intrusives, and volcanics. It also includes a twenty-mile-long zone of mining districts, i.e., the Bannack gold district, Blue Wing silver district, Ermont Silver mine, Argenta lead-silver district, and the Argenta Springs silver-lead district. In the project area, sediments from late Precambrian through Pennsylvanian in age trend north-northeast; they are cut by north-to-northwest-trending, high-angle, normal faults and intruded by Tertiary stocks and dikes.

The stratigraphy and structure of the region has been mapped and described by Myers (1952). His findings are generalized in the following stratigraphic column.

Stratigraphic Section, NW 1/4 Willis Quadrangle

Thickness		
	Pleistocene	Terrace gravels
		Angular Unconformity
300 - 900'	Upper Tertiary	Weakly consolidated gravels, Paleozoic and later materials
		Angular Unconformity
to 2000'	Oligocene	Rhyolitic flows and tuffs, basalt and scoria
		Angular Unconformity
	Eocene ?	Dikes (andesite, dacite); mineralization
		Quartz Monzonite
		Folding, Faulting, Thrusting
2000 - 3000'	Paleocene ?	Andesite and trachyte flows, tuffs
		Angular Unconformity
to 7800'	Cretaceous	Continental clastic sediments, intercalated tuffs, limestone
200'	U. Jurassic	Morrison tuffaceous mudstone, flows, limestone
		Angular Unconformity
to 1000'	L. Triassic	Mudstone, limestone, shale
to 500'	Permian	Phosphoria Formation quartzite, phosphatic mudstone, dolomite
650'	Pennsylvanian	Quadrant Quartzite
115 - 285'		Amsden - Upper - variable argillaceous limestone, limey sandstone
110 - 280'	Mississippian	Amsden - Lower - argillaceous dolomite and grey limestone
525 - 650'		Mission Canyon Limestone - light to dark grey bedded limestone
650 - 725'		- white to grey coarse, massive limestone
750 - 950'		Lodgepole Limestone - thin-bedded, fine-grained, blue-grey limestone
175'	U. Devonian	Three Forks Shale - light brown fissile shale, thin dolomite
550 - 600'		Jefferson Dolomite - black, fetid, thick-bedded
100'		- grey dolomite
	-Disconformity-	
300'	U. Cambrian	Pilgrim Dolomite - thick-bedded, light grey, local chert
		Block Faulting, Angular Unconformity
200'	M. Cambrian	Wolsey Shale - Grey-green soft, fissile
500'		Flathead Quartzite - pink, cross-bedded, thick-bedded
		Angular Unconformity, Faulting?
5000 - 6000'	Belt	Upper Quartzite - white, pale pink or grey, feldspathic
3000 - 5500'		Lower Red - shale, argillaceous quartzite, arkosic; some green
?	Pre-Belt	Biotite gneiss - not mapped, 160' in CRX-4

Stratigraphy:

The sedimentary units encountered in the work to date in the project area are the Lodgepole Limestone, Mission Canyon Limestone, Amsden Formation, and Quadrant Quartzite. Based on the mapping and core logging the following descriptions apply:

Quadrant Quartzite - blocky, tan-weathering vitreous quartzite forming resistant capping of hills; only about 80 feet exposed in the mapped area.

Upper Amsden - poorly exposed on slopes below the Quadrant; the float indicates thin-bedded fine-grained tan-weathering, light grey to buff, argillaceous to sandy limestone and dolomite; grades laterally to dolomitic argillite or argillaceous siltstone

Lower Amsden - similar to upper unit, but greater percentage of dolomitic argillite and siltstone beds

Mission Canyon Limestone - Upper unit greyish white to grey; fine-grained except where re-crystallized, indistinctly-bedded, impure dolomitic limestone, locally cherty

- Lower unit white to dark grey, fine to medium-grained, thick-bedded, in good part now white coarsely recrystallized marble; locally crinoidal

Lodgepole Limestone - dark blue-grey to grey (white where re-crystallized), thin bedded to well-bedded, fine-grained except where re-crystallized Limestone, fossil fragments common.

As seen in the Band workings and in core, all of the limey formations have developed water courses and caverns above the water table. In and around the areas of strong fracturing and mineralization, collapse caverns filled with rock fragments, limonite and manganese oxide jasperoid, and clays are common. Some of these have been mixed suggesting that some of the cavernous development started with oxidation of sulphides in a mineralized fissure.

F. Igneous Rocks:

The quartz monzonite of the Argenta Stock is exposed over an area about 8000' East-West and 3000' North-South around the town of Argenta. Its aeromagnetic expression suggests that a much larger area, about three miles by two miles is underlain by granitic rock. Several miles north and northeast of Argenta, two small stocks of quartz monzonite are exposed. Again the magnetic data suggests a) that at shallow depth these stocks are also much larger than in outcrop, and b) that they and the Argenta Stock are probably continuous at depth.

The Argenta quartz monzonite when fresh, as in the outcrops southwest of town, is a relatively fine-grained, equigranular biotite quartz monzonite; its average composition is about 40 - 50% plagioclase, 20 - 25% orthoclase, 20 - 25% quartz, 10 - 15% biotite, with hornblende and magnetite as accessories. In the area south and east from the Hand Mine to the ditch south of Rattlesnake Creek and in all of the drill intercepts to date, the quartz monzonite is hydrothermally altered. The alteration varies from propylitic (chloritic) alteration of outcropping quartz monzonite, to a weak argillic variety in much of the drill intercepts, to complete replacement locally by pyrophyllite and to feldspathic alteration at depth; alteration is most intense in the areas of close-spaced fracturing and of sulphide introduction. The subject is covered in some detail in the discussion of the "Porphyry Copper Potential".

The quartz monzonite is cut by an occasional late dike. These are narrow (1 - 6 ft.), and follow the prevalent steeply-dipping north or northwest fracture pattern of the area. Several were mapped along the ditch south of Rattlesnake

Creek and elsewhere in the southeast portion of the mapped area; a few were noted in and around the Hand workings and in the drill intercepts below the workings. In the field they were mapped as quartz latite or even quartz porphyry. Petrographic work indicates that they are highly altered, and that the original composition was probably andesite or dacite. Since they are pre-alteration and mineralization, they must have been emplaced somewhat later than the quartz monzonite.

G. Alteration:

As stated under Igneous Rocks above, all of the exposed northern portion of the Argenta Stock is hydrothermally altered. Hydrothermal alteration of the sediments appears to extend outward from the northern contact of the stock for about 1500 feet. In that zone the Amsden Formation is bleached and discolored to an extent considered to be beyond its normal tan-weathering characteristic and beyond the iron-staining attributable to weathering of introduced pyrite. The apparent effects of alteration on the sediments are the removal of carbonaceous coloring matter in areas of fracturing and mineralization, along with the recrystallization of some of the clay minerals. In the fracture zones and at the contact, the limey rocks are recrystallized (marble).

Whereas the formation of skarn seems to be a common phenomenon at granitic-limestone contacts in the region, there was very little calc-silicate development in the mine area. Just northeast of the Hand Mine, some of the Amsden Formation argillites have been mapped as hornfels, but the hornfelsic-appearing rock may be merely a dense, siliceous facies. Some scarce diopside and wollastonite, and rare epidote was noted in the core of our holes in the same area.

In hole CHX-3, located a mile southeast of the Hand Mine, and drilled southwest at minus 45°, five hundred feet of fine-grained (2 - 6 mm) quartz monzonite was cut between two sections of altered recrystallized limestone. Whether the quartz monzonite of that area is sill-like or a vertical protuberance is not known from the one hole. At the upper (or easternmost) granite-limestone contact, the limestone unit locally contains diopside, grossularite, and chert, and the quartz monzonite exhibits epidote along some veinlets. At the lower (westernmost) contact, the limestone is re-crystallized, and locally silicified, with the development of some wollastonite and of garnet which locally amounts to 75% of the rock. This alteration appears to be more intense toward the bottom (west end) of the hole, suggesting that with further depth the hole might have again been in quartz monzonite.

H. Structure:

In general the Paleozoic host rocks for the intrusive are striking north-northeastward with the regional pattern and dipping eastward at less than 30°. Locally, at the margins of the intrusive, however, the more argillaceous, thin-bedded units are moderately folded, and faulting has tilted the strata of some small blocks.

Within the mapped area the structures of most significance are the steep, north or north-northwest-trending mineralized faults cutting the quartz monzonite and the overlying sediments with small displacement. A few faults of possible major displacement are suggested by indirect evidence. Some jointing in the QM near Rattlesnake Creek striking along the creek, combined with a parallel pattern of aeromagnetic data suggests a northwest-trending fault separating the fresh

QM southwest of Argenta from the altered northern block. Another fault with a substantial indicated displacement is the mineralized fault of the Ferdinand Mine bringing quartz monzonite on the west into near-vertical contact with a block of Amsden-Quadrant on the east.

There is some indirect evidence that all or part of the Quartz Monzonite may be sill-like in form, emplaced along a thrust zone parallel to the known thrusts west of the district. The quartz monzonite at its upper contact is much sheared (Holes CRX-1, AH-1, AH-3). In CRX-3, the Q.M. is fine-grained (2 - 6 mm), with an hypabyssal aspect. All of the Q.M. at Argenta is relatively fine-grained, and non-porphyritic.

Although the bulk of the structural activity affecting the mapped area was pre-mineral, some late, post-oxidation, faulting is evidenced. In hole AH-2 1800 feet north of the mine area there are iron and manganese oxides to about 1200 feet vertical depth whereas the water table of the district in general is at about 300 feet. In the mine some of the veins have been offset slightly, others an unknown amount, by post-mineral faulting. There is also evidence in slickensided limonite of some very late, post-oxidation movement in the north-trending fault-veins themselves.

I. Geophysics:

The Copper Range aeromagnetic data covers an area of about 45 square miles, centered on Argenta. Most significantly the outcropping portion of the Argenta Stock north of Rattlesnake Creek which is known to be altered occurles a distinct magnetic low. This V-shaped low extends southward between two

prominent highs; for about a mile beyond the quartz monzonite outcrops. The High southwest of the V apparently reflects the fresh quartz monzonite visible in outcrop. In the area of the magnetic high southeast of the V, the surface is gravel-covered. Hole CRX-3 was collared in the high, however, and the magnetite-bearing skarn encountered in the hole may explain the anomalism. North of the V, in the area north of the Hand Mine, the magnetic response flattens out to a broad low suggesting either a) that the northern margin of the stock is a steeply-dipping east-west trending surface, or b) that the stock continues at moderate depth below the sediments but is magnetite-poor due to alteration. Our hole AB-2 in the low to the north of the mine area encountered only sediments to a depth of 1772 feet, indicating that a) is the best assumption on present evidence. The dimensions, then, of the triangular altered portion of the Argenta Stock appear to be about 6000 feet along the northern border, 6500 feet along the eastern side, and 8500 feet along the southwestern side.

The magnetic picture of the altered triangle is supported by the Induced Potential data. The four-mile long, east-west Line IV crossing just north of the Hand Mine returned low resistivities and good P. F. E.s over the area north of the CM outcrop. On Lines III and VI across the southern point of the magnetic triangle, the magnetic low coincides in each case with the most anomalous portion of a broad weak IP anomaly. The IP used was a dual frequency (3.0 and 0.1 cps) method, with 1000 foot dipoles. In general it was only at the greater dipole separations that frequency effects showed up (n = 3 to 5). This would indicate either a cover of sulfide-barren rocks where the granitics do not outcrop, or increasing sulfide with

depth where they do outcrop. These indications conform to the geological evidence. In CRX-1 oxidized sediments extended down to about 500 feet vertical depth, the contact with pyritic QM. The percentage of pyrite in the QM increased gradually downward from the contact toward the bottom of the hole at 1950 feet vertical depth.

There is a noticeable northwest lineal trend of the most favorable IP data which coincides with the boundary between the altered QM to the northeast and the unaltered QM to the southwest, suggesting a zone of higher sulfide concentration along the southwestern leg of the altered triangle.

The 200-foot grid around the Hand Mine was run with a ground magnetic survey in 1970, using Cyprus' McPhar Fluxgate Magnetometer. The data is shown on the attached Magnetic Survey Map. Maximum relief is about 250 gammas; in general the relief is less than 100 gammas. The upper East-West contact of the quartz monzonite is clearly shown by a drop off of values on the limestone side. Further extension of the magnetic coverage over the quartz monzonite was in progress when the project was shut down. The coincidence of a sharp magnetic low with the most altered area observed in the stock, the pyrophyllite zone south of the mine, suggests that some very useful patterns might be developed by grid coverage of all of the altered portion of the stock along with its margins.

J. Geochemistry:

One hundred two rock samples and 130 soil samples were collected on the 200-foot grid of the Hand Mine area. These were run by the atomic absorption method for lead and copper by the Frontier Laboratory at Melrose, Montana.

The results are shown on the attached two geochemical survey maps. The anomalism of the Ferdinand area in the southeastern corner of the area covered to date is perhaps due to the samples having been collected selectively at plane table survey points which coincided with workings. Again, the coverage of the quartz monzonite area is insufficient as yet to give a useful geochemical picture.

K. Diamond Drilling:

Four holes were drilled during the 1970 season. The work was done under contract with Boyles Bros. Drilling Company using one truck mounted Joy 22 drill and one skid mounted Joy 22 drill. Overall costs were $13.43 per foot. Water was pumped from Rattlesnake Creek. There was no water return.

Cores were brought daily to the Dillon office for logging, splitting, and sampling. Splitting was done on a large diamond saw. Samples were crushed and split by Cyprus personnel using the facilities of the Montana Laboratory at Philipsburg. Core, coarse rejects and pulps are stored on the property at Argenta. Skeleton (representative) core from each hole is stored at Cyprus' Philipsburg warehouse.

Drilling of inclined holes in the fractured and oxidized sediments, particularly around the QM contacts, was difficult and expensive. Considerable cementing was required. Unfortunately, vertical holes are unsatisfactory geologically because of the vertical fracturing and mineralization.

Hole AH-1 was collared at an elevation of 6432.10 feet on N. 104,789.44, E. 95,400.37, coordinates on June 30th and was inclined 50° from the horizontal on a S. 47° 15' 12" W. bearing. It was oriented in this position to, (1) explore

the projected northerly extensions of Hand Mine veins, (2) test the area immediately east of the mine for parallel structures, (3) intersect the Hand veins at various vertical intervals to determine the oxide, secondarily enriched sulfide and primary sulfide grades and (4) expand a near surface oxide lead and zinc potential in a bedding replacement deposit that was found as a result of mapping and sampling in the Hand Mine.

From the collar to 636 feet AH-1 intersected numerous 0.5 to 3.0 foot wide veins in Amsden sedimentary rocks all of which at various depths contained trace to submarginal lead, zinc, copper, gold and silver assays (see drill logs). The hole proved continuity in Hand veins and the existence of parallel veins in the neighboring area east of the mine but none were well mineralized. It did not intersect the bedding replacement deposit and thus limited its projectability and the possibility of finding an adequate tonnage for an open pit lead-zinc oxide operation.

At a depth of 636 feet AH-1 intersected argillized Argenta quartz monzonite containing quartz-calcite-pyrite veinlets. It continued in argillized quartz monzonite to a depth of 868 feet where it was stopped on the 8th of August in broken and caving ground. A two hundred foot interval between 636 and 835 feet contained supergene chalcocite as thin films on the pyrite in veinlets. Most of the five to ten foot intervals within this intercept did not assay more than 0.39% copper and 0.38 oz. silver per ton with less values in gold, lead and zinc.

The chalcocite probably was derived by the leaching of copper from the minor quantities of chalcopyrite and tetrahedrite in the Hand lead-zinc veins during the oxidation cycle. This copper was then carried in solution presumably to a

water table in the quartz monzonite where it replaced the surface areas of pyrite in the 1.0 to 2.0 millimeter wide veinlets.

On June 30th, AH-2 was collared as a vertical hole at an elevation of 6462.57 feet on the N.105,984.73, E.55,259.47 coordinates. This site was selected to extend mineralization in the Argents quartz monzonite northward under the sedimentary rocks and thus increase the size of the porphyry potential. The site also was selected to complete the annual assessment obligations on the 204 unpatented mining claims in the Hand claim group.

AH-2 did not intersect the quartz monzonite nor any significant mineralization. Before it was terminated on the 26th of August at a depth of 1772 feet the hole had drilled almost all of the Mississippian section of the Amsden, Mission Canyon and Lodgepole Formations. A total oxidation of the sparse original sulfide in some of these rocks persisted to an 1100 foot depth.

Holes AH-3 and AH-4 were collared in the Amsden Formation on the 10th and 31st of August at elevations of 6352.48 and 6349.51 feet, respectively. AH-3 was inclined at 55° to the horizontal on a bearing of N30°53'20" E from the site at N.103,729.05, E.55,498.53 coordinates. AH-4 was collared vertically from a site at N.103,759.15, E.56,076.75 coordinates.

Both holes were drilled for copper mineralization in an area containing the best copper showings on surface near the Copper Belle Mine. Open prospect pits and caved mine workings in this area show copper oxides for several hundred feet along the quartz monzonite-sedimentary contact.

About sixty feet of barren sediments were drilled before AH-4 intersected

quartz monzonite. It remained in quartz monzonite to its total depth of 780 and it was stopped at that depth on the 26th of September. Traces of chalcocite or pyrite veinlets assaying less than 0.2% copper were obtained in two intervals between 240 to 250 feet and 500 to 570 feet. Two chalcopyrite and quartz veinlets one to two inches wide also were intersected in AP-4 at the 548 and 566 foot depths. A ten foot interval with chalcopyrite veinlets between 1162 and 1172 feet assayed 0.30% copper and 0.10 oz. of silver per ton.

L. Costs, Personnel, Housekeeping:

The entire cost of the Argenta Project was $164,057 as of 11/12/70. The principal item was 4,725 feet of diamond drilling. The total cost was $63,470 or $13.43 per foot. Other items as reported by Cyprus' Spokane Office are as follows:

Acquisition Costs	$ 2,227	
Salaries and Wages	13,555	(Cyprus Personnel)
Surveying and Mapping	35,231	
Outside Contract Services	44,926	
Excavation	1,565	
Assaying and Sampling	7,242	
Travel	5,837	
Equipment	1,045	
Miscellaneous	1,159	

The project was undertaken by R. Chadwick, consulting geologist, by contract with Cyprus. In the field the work was actively managed by Senior Geologist, C. C. Goddard, III. Keith Jones, geologist for Cyprus, spent the latter part of the season on the project. Vern Wallace, field assistant for Cyprus, put in most of the season with the project, as did Doug Chadwick and Tate Johnson, student field assistants. Ed Kahoe, field assistant for Cyprus, was on the job

during the early part of the season. A portion of the surveying was done by Cyprus engineering personnel from Los Angeles; the bulk of the underground surveying was done under contract by Larry Hoffman, of Butte.

An office, drafting room and space for core logging, sample splitting, and storage was maintained during the season in a former automobile showroom at 19 East Sebree Street in Dillon. The chief reason for a Dillon office was the convenience of a telephone, not available at Argenta. Housing was found to be very scarce in Dillon. The geologist-in-charge used a rental trailer, the other men motels or their own pickup-campers.

II Hand Mine

A. Summary:

The deposits mined to date are narrow vertical veins of oxidized lead-silver-zinc-gold ore in a Paleozoic dolomite-argillite sequence. The wall rock between veins does not carry sufficient values to permit non-selective mining. Other irregular deposits at the contact of the sediments with the underlying quartz monzonite or above the contact as "mantos" are known, but the two penetrations of the contact below the mine did not develop any new showings of that sort. The drilling also indicates that all the ore minerals above the quartz monzonite in the mine area are oxidized, and that dramatic or even substantial silver enrichment cannot be expected in the veins at depth. The oxide ore minerals are not efficiently recovered from the iron oxide gangue by conventional separation and concentration methods. Considerable quantities of ground water are dammed in the sediment behind the north-sloping upper surface of the underlying stock.

B. Conclusions:

The Hand Mine potential consists of a good probability that the known productive veins continue in depth to the contact with the quartz monzonite. It also includes a good probability that manto-type deposits would be found during development down to the contact. It seems likely that there is at least as much potential tonnage as has been mined over the life of the property. The principal problem in winning the potential ore would be the need to drain the large area upland (north) from the mine.

It appears that it would be difficult to increase the tonnage by lowering

the mine cutoff grade. In the absence of an effective milling method it remains necessary to maintain a grade which will stand the high costs of transportation and smelting of raw ore.

It seems probable that the water problem might be solved with some large diameter drilled wells. It is also possible that a reasonable research effort would result in finding a suitable milling process. In the face of a limited tonnage potential, e.g. 500,000 T., and an acquisition cost of $2,500,000, it becomes difficult to justify the necessary capital costs for water and process development in addition to the cost of exploring for and developing the 500,000 T. (150 T/day for 10 years.)

Assuming any reasonable tonnage potential, the Hand Mine is concluded to be too small to be of interest to Cyprus.

C. Recommendations:

As stated earlier, work aimed at the Hand Mine itself was terminated in August. No further effort by Cyprus is called for.

D. Development, Production:

The Hand Mine workings consist of some 6000 feet of drifts and 2000 feet of crosscuts on the main haulage level, as shown on the attached Geologic and Assay Maps. Most of the stoping has been from within 75 feet above or below that level, but a few stopes extend up 150 feet or more to the surface, and a few extend downward 130 feet or more, which is below the water table. In recent years the Hands rehabilitated the bottom of the Mauldin Shaft at the southeast corner of the workings. Its bottom is 130 feet below the Haulage Level; the only

lateral working from the shaft is a 30 foot crosscut east. Workings and assay data along seven of the veins worked prior to 1966 are shown on longitudinal sections from the Hand records (copies are in your files).

In general the production at any given time has come from one active stope, with one two-man crew working one shift, six days a week. The stopes are open; a slusher is used where feasible. Mining proceeds in whatever pattern is indicated by the width and grade of the faces exposed. The grade of doubtful faces is checked by sampling and lead analysis run at the mine. The attempt is made to cut off at 10 percent Pb over a 3 foot mining width. Mined ore is stockpiled at the surface until a carload lot is accumulated. The mine cars making up the lot are sampled individually; a composite sample is prepared for the carload lot and run at the mine. Low-grade, which will not bring an adequate return after transportation costs and smelter charges (about $11 per ton combined) is stockpiled. It seems that occasionally the smelter, because of a shortage of supply, will offer to take a large lot (3,000 T. usually) of low-grade for which the smelter charge will be greatly reduced.

At present the Hands operate under the following smelter schedule:

(East Helena, Montana, Smelter)

Pb:	Assay, less one percent (1%)
	Pay 80% of balance
	Weekly market price, less 1-1/2¢ lb. metal freight
Zn:	No pay
Ag:	Assay, less 1 ounce
	Market
Au:	Assay, less $2
Cu:	Assay, less three percent (3%)

Freight to Helena: $5.00
Base Treatment Charge: $6.00 (no deducts, no premiums)

The Iron Mt. (Drainage) Tunnel is the only other major underground working in the sediments in the Hand Mine area. The Iron Mt. stopes are about 600 - 700 feet southwest of the southwesterly workings of the Hand. Production started in the early days of the camp. The ores which are at the contact of the QM with limestone were developed by two inclined shafts and two tunnels. According to Shenon (1931) the old stopes indicate that considerable ore was produced. In 1958 the Hands re-opened the lower 700 foot-long Drainage Tunnel by driving around a caved area. They operated for about six months, producing about 5400 T. of lead-zinc ore (26 - 36% combined, low Ag, low Au) and about 400 T of 5 - 8% oxide Cu ore. The tunnel is caved at about 400 feet from the portal and the old stopes inaccessible.

As described the Iron Mt. ore occurs in irregular masses of oxides, with minor residual sulfides, on the limestone side of the contact.

The Hands hoped that the re-opened tunnel would lower the water table in the Hand Mine, however the re-caving has prevented the hoped-for drainage.

Some production from the Hand Mine area has come from shallow surface workings. Recently some 500 T. of ore running 10 oz. to 60 oz. Ag was shipped from a small pit about 250 feet southwest of the collar of Hole AH-1.

E. Hand Mine Geology:

The ore of the Hand Mine occurs within the Amsden Formation just above its contact with the underlying intrusive Argenta quartz monzonite. While nearly all of the production has come from near-vertical, north-trending fault veins, minor tonnages have come from northwest-trending veins, from flat "bedded"

deposits, or from irregular solution-collapse cavern fillings. Except for occasional relict sulphides, the ore is "oxide", i.e.: lead, zinc and minor copper carbonates in a gangue of limonite, cryptocrystalline silica, and carbonates. The existence of an ore shoot of commercial grade is dependent upon a combination of favorable factors - stratigraphy, structure, proximity to the igneous contact, and the effects of oxidation.

1) Stratigraphy: The Amsden strata of the mine area are impure-largely fairly thick-bedded silty or argillaceous dolomites, but with substantial sections of thin-bedded dolomitic argillites or siltstones. As exposed on the Haulage Level, the folded strata are cut by faulting into a mosaic of small blocks of varied strike and dip. Thin-bedded argillites are more common in the southeastern portion of the workings.

The only igneous rock exposed in the mine is a north-trending, vertical, quartz-porphyry (altered dacite) dike, 10 to 20 feet wide, located between Vein 7 and Vein 8 and known over a strike length of 900 feet. The dike, with a vein on each wall, is itself mineralized and altered; as a result it is difficult to attribute wall-rock alteration in that area specifically to the dike.

2) Structure: As suggested above, the structure of the host rocks in the mine is complex, in detail, as would be expected just above a granitic intrusive. In general, however, the strata are dipping gently to the east, with Mississippian limestones in the area west of the mine and the post-Amsden formations northeast of it. So also the mine area is cut by innumerable minor steep normal faults, but in general the important mineralized faults may be described as uniform,

regular and persistent. A typical vein-fault strikes N. 5° W., dips from 80° W. to 80° E., is slickensided on both walls, locally splits into several strands which rejoin along strike. Typically, where the fault traverses the more massive carbonate units, the vein is distinct, with sharp walls little affected by hydrothermal alteration or mineralization. Within such units the development of watercourses and caverns along the structure may be pronounced. In contrast, where a vein-fault traverses thin-bedded argillaceous strata, the walls are shattered and show the effects of some lateral dispersal of both hydrothermal and secondary solutions.

Within the 600 foot east-west extent of the Haulage Level workings, some twenty prominent north-south faults are present. None of them appear to have effected a large displacement between the walls; in places horizontal strale suggest that the horizontal component may be as great or greater than the vertical one. The faulting and veining in the sediments continues down into the underlying intrusive. Since the intrusive-sediment contact is well exposed and not noticeably displaced by vertical faulting, the vein-faults are viewed as relatively minor post-intrusive structures possibly sympathetic to larger regional faulting.

In the western portion of the mine, around Vein 6, a number of northwest-trending veins or veinlets are exposed, one of which, Vein B, supported a 4100 T. stope. These veins appear to be slightly displaced by the north-south system and were therefore slightly earlier.

Throughout the mine, notably in the central and southwestern portions, solution-collapse breccias have formed along watercourses. Some of these are chaotic accumulations of very large blocks of country rock with open voids between

and some cementation by secondary carbonates. Where a mineralized fault served to guide the downward-percolating meteoric waters, the oxidizing sulphides apparently provided acid for accelerated dissolution of the carbonate wall rocks. As a result caverns formed along the veins and were wholly or partially filled with wall-rock fragments, limonite, jasperoid and the "oxide" ore minerals. Some of these very irregular cavern fillings were of ore grade and were mined.

In the southeastern portion of the mine the sediments exposed are not far, vertically, from the top of the stock. It seems likely that several flat faults present in that area parallel the flat shears at the contact evidenced in the drill core. Also in the southeast portion of the mine, several steep faults of unusual east-west strike are present. These are thought of as possible evidence of east-west faulting of the stock; such faulting is suspected between the altered northern and unaltered southern portions of the stock.

3) Mineralization: Geologically-speaking, the mineralization within the Hand Mine may be said to be, like the enclosing faults, very uniform and persistent. Some vein material, however narrow, is present almost continuously along the drifts throughout the mine. And wherever there is vein material there are respectable, if not commercial, values in all of the ore metals (Pb, Zn, Ag, Au, Cu). Commercially-speaking, the high cutoff grade (10% plus Pb) demanded for direct-shipping ore puts much of the vein material out of the "ore" category. Furthermore, the width of the veins varies between 0 and 10 feet, but in the developed strike length of structures, most of it carries widths below the 3 feet required. After eliminating vein which is unprofitable on the basis of grade or mining width or both, about 25% can be classed as ore.

There does not appear to be any reliable guide to "ore" in the dimensions of a particular vein-fault, nor its attitude. The effects of secondary activity on both the primary material and on the enclosing structures may have eliminated any primary pattern of deposition that once existed, and which may exist below the water table.

The principal ore mineral is cerussite; minor amounts of residual galena and anglesite are generally present. A substantial percentage of the lead is present as plumbojarosite. The only zinc mineral noted has been the carbonate smithsonite. Silver occurs both as argentojarosite or as the chloride cyrargyrite; the gold is free. Copper is found as the oxides neodysite and tenorite, or as malachite. The ore runs over 45% Fe; it averages from two-thirds to three-fourths iron oxide - goethite, jarosite, hematite, and jasperoid. The balance of the gangue is secondary carbonate, usually calcite, and manganese oxide.

Judging from the relict sulphides, and the appearance of the mineralization in unoxidized veins cut by drill holes, the veins in the mine were originally pyrite-galena with minor tetrahedrite and/or minor sphalerite containing some exsolution chalcopyrite, all in a gangue of ankerite-siderite-rhodochrosite. No barite or fluorite has yet been identified. As to the silica now present in the jasperoid of the oxidized ore in sediments this may have been derived from siliceous sediments during hydrothermal alteration or weathering, or may have been introduced with the sulphides.

Whether the ores are enriched at the water table has not been established to date by development work since the openings have been almost entirely in the

zone of oxidation. It is known from the Iron Mt. Tunnel and from the Jack Rabbit and Copper Belle Mines that there has been secondary enrichment in copper, but evidence on gold or silver enrichment is lacking. Within the Hand Mine the deepest development reached just below the water table on Vein No. 6. The vein material was still oxidized at that level and was not notably enriched.

In considering the direction other than depth that might best be taken by future exploration for veins of the Hand Mine type, surface or drill indications of additional structures are good both east and west of the mine workings. The few development openings at the north end of the workings are an insufficient test of the continuation of the known structures in that direction. On the basis of what is known, then, it cannot now be said that the character or the strength of the Hand Mine-type of mineralization varies laterally in a predictable way. Commercial values (Pb-Ag-Au) do not appear to continue down into the quartz monzonite nor to extend very far above the contact. The vein-bearing structures continue into the intrusive, but they apparently contain only very small percentages of the ore minerals other than pyrite. In the two holes (CPX-1, AH-1) penetrating the section below the mine, a few of the stronger pyritic veins in quartz monzonite did contain narrow bands with minor quantities of galena, sphalerite, and tetrahedrite. In the exposed quartz monzonite immediately south of the mine, despite the presence of a number of steep, north-trending fault-veins with shallow diggings on them none were developed. To the north of the mine where, judging from AH-2 and the aeromagnetic data, the thickness of older rocks between the top of the intrusive and the surface increases rapidly, evidence of mineralized structures also fades out abruptly.

As to the possible existence of deposits other than the fault-vein type, evidence is meager. As stated previously, the southeast corner of the Hand workings contains some bedded mineralization in thin-bedded dolomitic argillites, and in the Iron Mountain workings, the ore was in irregular bodies parallel to the quartz monzonite-sedimentary contact. There is thus some possibility that as the upper surface of the stock is approached, below the area in and near the Hand Mine, bedded, contact, or irregular "replacement" (manto) orebodies may be found. This possibility was one of the objects of our hole AH-1 which probed the northeast corner of the mine area but did not encounter any such orebody. Nor did CRX-1 encounter any such in penetrating the contact in the area just west of the mine.

F. Geologic Mapping; Surveying:

The geology of the area around the Hand Mine is shown on the attached Geologic Map (1" = 200'). The area was mapped on a scale of 1" = 100', using a previously-laid-out transit and chain survey grid with stations every 200 feet. The grid also served for subsequent geochemical sampling and for the magnetic survey. Earlier mapping by the U.S.G.S. or by Copper Range was on too small a scale to serve as a base for evaluation of the mine area.

It was shown by the mapping that the productive Amsden units of the area were argillaceous in varying degree; it was also found that the Amsden did not have any distinctive marker units that would serve to provide a more exact structural picture. The Amsden - GM contact and the relative lack of contact pyrometasomatic effects were established in detail. As a whole, the mapping added detail to the existing picture of the mine area and improved our understanding of the Hand Mine

potential but did not point out the new prospective areas or exploration guides that had been hoped for.

G. Underground Mapping and Sampling:

The accessible Hand Mine workings were surveyed with transit and tape to carry the close control underground. Mapping was done by C. Goddard on a scale of 50 feet equals one inch; the results are shown on the attached Geology Map, Hand Mine Haulage Level. Prior mapping by W. Hand and some by K. Herness is available in the mine records at Argenta. An illustrative east-west cross-section of the mine is shown on the Copper Range drill hole section for CRX-1. Our mapping was partly an evaluation of the existing data and of unmapped areas. Much of the northern and western portions of the workings were found to be inaccessible or in unsafe condition. The old mapping was fortunately found to be complete and accurate.

One goal of our underground work was to check the possibility that the ground between productive veins might be sufficiently fractured and mineralized to permit non-selective mining of a large block of ground in the developed area. Careful examination and later sampling showed that the possibility did not exist. As to trends which might guide exploration the work showed most of the mineralization to be uniform, without a recognizeable zoning from north to south, east to west, or from the highest to the lowest working within the boundaries of the existing underground development. It was found that where one of the fault-veins intersected thin-bedded argillites some mineralization followed the bedding. This did suggest the possibility that the mine area may contain mineralized blocks of greater tonnage potential than might be available in the narrow veins.

The results of underground sampling are shown on the attached Assay Map, Hand Mine Haulage Level. Three hundred forty five continuous chip samples were cut, using five-foot, or ten-foot sample widths; assays for five elements (Au-Ag-Cu-Pb-Zn) were run by Degenhart at Philipsburg. Previous sampling by the Hands and by Gunnar Mines is shown on an assay plan from the Hand data, a copy of which is in your files.

As stated above, the sampling of crosscuts in effect ruled out the ability of the ground between veins to carry itself in non-selective mining. The sampling of the bedded mineralization at the southeast corner of the mine workings returned values of 2 - 4 percent combined lead-zinc, lessening the possibility of a block of open-pit material in that area, at least above the Haulage Level. Some 26 samples were cut from workings along Vein 6, at the west side of the mine, below the Haulage Level, just above the water level. The object of this sampling was to see whether detectable enrichment was present at the lowest accessible working. The result was that our assays, particularly Pb and Ag, were lower than those shown in the Hand data (Longitudinal Section, No. 6 Vein) for the back of the stopes above the Haulage Level. It is possible that our assays are more conservative than Hand's, but no reasonable correction would improve the results enough to demonstrate enrichment.

III The Porphyry Copper Potential

A. Summary:

The Porphyry Copper Potential at Argenta was recognized before the start of the project in the area, but it was also recognized that its evaluation would probably take several seasons and substantial drilling funds. The decision was made prior to the 1970 field season to evaluate the Hand Mine potential first, since it might result in a reserve that might be developed quickly into a producer. As the 1970 work progressed, evidences bearing on the "porphyry bet" developed about as follows:

1. Re-logging in detail of the Copper Range drill core, specifically CRX-1, demonstrated the pervasiveness of argillic alteration and an increase in intensity of both alteration and mineralization (veining, pyrite) with depth (or west to east).

2. Review of the existing magnetic and I. P. data indicated the extent of alteration throughout the northeast half of the exposed QM stock. A discussion of Geophysics is presented under I - I. above.

3. Geologic Mapping indicated pervasive propylitic alteration at the margins of the altered portion of the stock, pervasive argillic alteration in the more fractured portions of the stock and overlying sediments, as well as local high-intensity kaolinitic (pyrophyllite) alteration.

4. Microscopic and laboratory studies of rock samples from outcrops and drill cores confirmed the megascopic observations as to alteration zoning of the clay minerals. A summary by C. Goddard of the findings from this work is included in Sections D, E, and F below.

The picture resulting from these evidences is of a triangular body of altered quartz monzonite, over a mile long on its northern and eastern sides and a mile-and-a-half long on its southwestern leg along the south margin of the Argenta Townsite flats. Penetrations and exposures of QM in this area are insufficient for a three-dimensional picture of lateral and vertical alteration and mineral zoning. Geophysical data suggests that alteration and sulfide mineralization are strongest along the southwestern leg of the triangle. The strongest outcropping alteration is the pyrophyllite concentration just south of the mine. Data from the core suggests that if a copper orebody is present it may well be at a depth greater than the 1050 feet reached by CRX-1. Theoretical considerations of the typical pattern (Ref. 6, 8) of hydrothermal alteration of a porphyry copper suggest that the alteration zone most likely to be copper-bearing has not yet been penetrated.

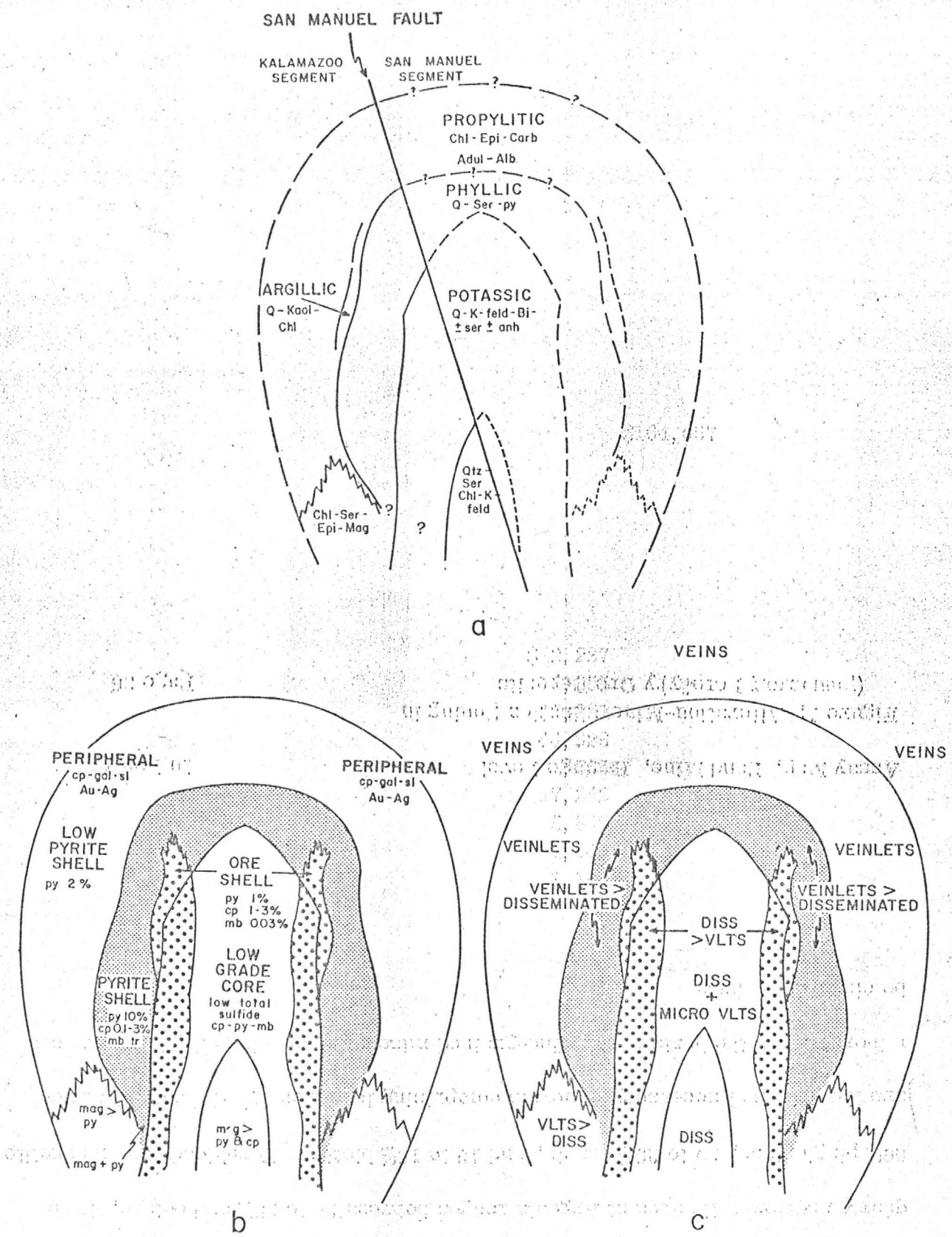

FIG. 3. Concentric alteration-mineralization zones at San Manuel–Kalamazoo. (a) schematic drawing of alteration zones. Broken lines on Kalamazoo side indicate uncertain continuity or location and on San Manuel side extrapolation from Kalamazoo. (b) schematic drawing of mineralization zones. (c) schematic drawing of the occurrence of sulfides.

B. Conclusions:

The potential for finding a large body of low-grade, disseminated copper mineralization is considered to be good. The alteration-mineralization pattern indicated by the evidence developed to date has much in common with that found among the outer zones of a number of districts containing disseminated copper ore deposits in quartz monzonite intrusives, e.g., San Manuel, Arizona (8), Butte (7).

With reference to the model illustrated in Figure 1 (Ref. 8, p. 379), the section of the District explored to date is viewed as the propylitic alteration zone which, in the case of Argenta, is more complex than the sample model in having been cut by linear fracture zones which exhibit more intensive types (argillic or phyllic) of alteration. Conforming to the model, the sulfides above the quartz monzonite at Argenta occur as veins, in the Argillic-Phyllic zone as veinlets. The penetrations to date can be said to be still in the low-pyrite mineralization zone. One is, then, justified in looking, with increasing depth, for a high-pyrite shell giving way in turn to chalcopyrite-pyrite ore coinciding roughly with the boundary between the quartz-sericite-pyrite (Phyllic) and the quartz-orthoclase (Potassic) types of alteration.

Adequately-sized altered stocks of the Argenta type are scarce and considered to merit a thorough evaluation. Admittedly, all of the information on Argenta is not positive; from the drilling to date it would seem likely that if a large body of ore is present, it is probably below open-pit depth, possibly at over the 2,000 foot vertical depth penetrated by CBX-1. Apparently there has

been no secondary blanket enrichment in the stock. It is recognized that in all cases of exploration for disseminated ores, there is no assurance that if primary copper mineralization is found in the predicted position in the zoning pattern that it will be of ore grade. To date the molybdenite and precious metal content of the observed mineralization in the QM has been very meager. None of these factors are debilitating, however; further exploration aimed at the zoning pattern and ultimately at the locus of copper deposition is well justified in my opinion by the positive evidences in hand and the magnitude of the potential.

To date the available evidence does not clearly point in one specific direction. The apex of the stock was apparently at or south of the Argenta Townsite flats. As stated in the Summary above, other evidences suggest other sectors as the best place to put in the next exploratory probe; all evidences point to depth. In this situation it seems desirable to obtain full coverage of all the prospective sectors with the exploration tools which seem to be effective before committing the funds needed for the next round of drilling.

Mention should be made of the similarity of the magnetic patterns over and around the stocks north of Argenta to those around the project area. In effect the district as a whole has some wildcat "porphyry" possibilities in addition to the best-known target south of the Hand Mine.

In summary, Argenta constitutes the typical "porphyry copper" bet that is sought after and explored by nearly all the major exploration groups today. Typically, the basis for effort is the analogy between a theoretical picture of alteration-mineralization zoning and the incomplete picture made by the partial

and scattered evidence available at the moment. Until the actual picture has been completed the permissibility for a major deposit is inescapable, and the indicated course for work is clear.

C. Recommendations:

The required expenditure at Argenta for the year ending October 17, 1971 under existing contracts and the mining laws will be about $40,000 after deducting the carry-forward from 1970. Although geological-geochemical-geophysical studies could be used for the assessment work, it would seem that the total required to be spent presupposes some drilling. As suggested under Conclusions above, completion of the geochemical and geophysical coverage of the target "altered triangle" and its immediate environs will provide a tangible basis for judging among the possible drill sites. Accordingly, I have the following recommendations:

1. The Hand and Nygren properties should be retained by your company during 1971.

2. The exploration of the "altered triangle" should proceed in two stages during 1971, i.e.:

a) Surface work including (1) completion of the copper-in-soil geochemical survey, (2) several northeast-southwest IP lines across the center of the triangle (using 1000 foot dipole spacing and a longer spacing if feasible), (3) completion of the 200 foot grid coverage with a ground magnetometer survey, and (4) review of our petrographic data and samples by a leading expert, and further laboratory work on existing materials, if desireable.

b) Drill two deep (3000 foot) holes, (in succession, not concurrently) at the best widely-spaced locations indicated by the results of the surface work.

It is estimated that Stage a) will cost less than $20,000 and can be completed by June 30, 1971. Six thousand feet of drilling at $13 per foot would be $78,000, and would require, judging from CRX-1, six months. In that period only one logger-sampler would be needed; with assays, new core-storage facilities and year-end reporting, the overhead for Stage b) should be about $12,000. The total for the year would then be $110,000.

The above program is considered to be the minimum effort which would permit a "No Go" decision in 1971. Deferring the decision until 1972 will involve both the 1971 expenditure of $35,000-$40,000 and the 1972 commitment maturing 17 October, 1971 for $175,000. If the 1971 budget for the project is limited to the legally-required $35,000-$40,000 rather than the recommended $110,000, my recommendation would continue to be that the "Stage a)" surface work be done, with the balance of authorized funds above Stage a) requirements going into drilling the first 1500 feet or so of the first hole of Stage b). If the entire amount ($35,000-$40,000) were allocated only to drilling in 1971, then the hole would have to be spotted on the basis of our present incomplete picture, with the risk that it might not provide any definitive data ultimately needed for a decision on the property. Therefore, if the minimum program is elected it would be essential to include the "Stage a)" program.

D. Petrography:

This and the following two sections of this report on Alteration and Mineralogy were written by C. C. Goddard, III, Consulting Geologist, who was in charge of the field work at Argenta during the 1970 season.

The intrusive stock, alteration and mineralization, at Argenta was studied by Dr. H. F. Fisk and Dr. F. N. Earll of the Montana Technical College, Butte, Montana. Results of these studies are summarized below. Copies of the original reports are in Cyprus' Spokane files. In addition to forty thin section and ten polished section examinations their efforts included: a) supporting oil immersion studies of individual minerals separated electro-magnetically from complex clay aggregates, b) both conventional and experimental clay and feldspar staining processes for mineral identification, and c) a number of investigations of the more complex rock alteration patterns with x-ray diffraction.

These comprehensive studies of representative samples of drill core, outcrop, and mine material are of such quality that the results may be applied to any or all parts of the Argenta district without reservation.

Argenta Quartz Monzonite

The mineral composition of the igneous stock that outcrops over a three quarter square mile area at Argenta ranges between 20 to 25% orthoclase, 40 to 50% plagioclase, 20 to 25% quartz, and 10 to 15% biotite. Hornblende and magnetite are the principal accessory minerals comprising less than 5% of the original rock minerals. On the basis of this fine-grained mineral assemblage the intrusive can be classified a hypabyssal quartz monzonite.

A maximum refractive index for the plagioclase is 1.56 suggesting that it is a high calcic (Ab_6-An_4) andesine. All of the andesine and some orthoclase are twinned and zoned. In mapped areas pleochroic brown biotite in the quartz monzonite has been partly, or totally, replaced by chlorite giving the rock a distinct dark gray-green color.

A facies of the quartz monzonite formed slightly earlier than the main mass exhibits a sub-ophitic hypidiomorphic fabric. In this facies subhedral to euhedral plagioclase crystals are lath-shaped and vary from 0.2 to 2.0 millimeters in length and 0.5 to 1.0 millimeters in cross section. The later facies shows the same sub-ophitic fabric and crystallization sequence differing only in grain size. Feldspars in this facies range between 1.5 and 3.5 millimeters in length and 1.0 to 2.0 millimeters in cross section. Euhedral orthoclase and biotite with crystal dimensions similar to the plagioclase in the two facies apparently formed after the plagioclase and anhedral quartz filled the interstices between the crystallized feldspars and biotite. Evidence for the later phase of quartz monzonite other than grain size difference consists of deuteric alteration at the gradational contact, sub-

angular inclusions of the earlier phase in the later phase, and the presence of epidote and andradite in the contact zone of the earlier facies.

Intergranular movement, or microfracturing, shredded the biotite in both facies and intact hexagonal biotite crystals are rare. The interstitial quartz is similarly fractured and the feldspars to a lesser degree. In altered portions of the stock, microfractures are filled with calcite, ankerite, quartz, and pyrite. Microfracturing is almost totally obliterated in zones of intense alteration.

Andesite and Dacite Porphyries

A number of dikes outcrop in quartz monzonite on the south bank of Rattlesnake Creek at Argenta and transect the quartz monzonite north of the creek and extend into the metasediments along its northern margins.

Lath shaped plagioclase crystals in these dikes range in length from 0.5 to 1.0 millimeters and from 0.2 to 0.5 millimeters in cross section. The plagioclase, which is andesine, comprises between 60 and 70% of the mineral composition in the andesite and dacite dikes. Both rocks also contain between 10 and 20% euhedral orthoclase with the approximate dimensions of the andesine. The feldspars in the andesite and dacite dikes occur in microcrystalline groundmasses of quartz and minutely fragmented feldspar.

The most distinguishing characteristic of the andesite dikes is their content of 2 to 5% magnetite and 15 to 25% augite as phenocrysts measuring 1.5 to 2.5 millimeters in length and 0.5 to 1.5 millimeters in cross section. Dacite can be identified, megascopically, by its 20 to 30% content of quartz in subhedral phenocrysts measuring 2.0 to 2.5 millimeters in maximum dimension.

Amsden Formation

The Upper Mississippian Amsden Formation is in contact to the Argenta stock along its northern margins. Most of the productive mines in the district are located in this formation within several hundred feet of the igneous contact.

The Amsden Formation at Argenta consists of interbedded limey argillites, hornfels, and argillaceous limestone. Bedding thicknesses range between one and twenty-five feet in these units with limestones generally forming the thicker beds. All of the units are extremely fine grained with particle sizes in the clastic limey argillites rarely exceeding 0.5 millimeters in largest dimension.

Petrographic and x-ray diffraction studies of some units in the Amsden Formation indicate an original 35% to 65% clay mineral content in the hornfels and limey argillites and between 10% and 25% clay in the argillaceous limestones. Kaolinite, halloysite, endillite, montmorillonite, saponite (?), palygorskite, and pyrophyllite were identified in many of the examined samples. Apparently most of the kaolinite and montmorillonite is of hydrothermal origin as these minerals often occur in crystalline habit with structurally controlled accumulations of pyrophyllite.

E. Alteration:

Quartz Monzonite

In exposures southwest of Argenta, the quartz monzonite appears to be fresh with resilient biotite crystals exhibiting vitreous luster and no chloritic replacement. North of Argenta, the stock appears superficially to be only slightly altered in most of the prominent outcrops. Biotite crystals and fragments,

however, have lost their luster and resiliency and are partly, or totally, replaced by chlorite. Locally, where strong tectonic jointing is evident in the stock, biotite is totally replaced by pennine and sericite. In these areas, feldspars also are replaced by either pyrophyllite, sericite, kaolinite, or montmorillonite.

Pyrophyllitic alteration is restricted to several structurally-controlled zones immediately north of Rattlesnake Creek. A pyrophyllite and sericite alteration of feldspar forms a halo pattern around the margins of the pyrophyllitic alteration zones. Sericite and a sericite-kaolinite alteration of feldspars is associated with some of the larger northwest trending fractures that extend from Rattlesnake Creek to beyond the northern margins of the intrusive. Montmorillonite also replaces some feldspars in the zones described and partially replaces feldspars many hundreds of feet into the adjacent wall rock.

Alteration in the Argenta stock suggests a horizontal, or lateral, zoning pattern. The most intense mesothermal alteration is manifested in one three-hundred foot wide and six-hundred foot long pyrophyllite zone and two smaller zones shown on the Geology Map on the north bank of Rattlesnake Creek near the Ferdinand and Bella mines. The amount of feldspar replacement by pyrophyllite apparently diminishes toward the northern margins of the intrusive.

An alteration of intermediate, or epithermal, intensity is restricted to larger structures in the extensive fracture system. The epithermal alteration extends through the stock within the confines of closely spaced parallel fracture planes and into the metasediments along its contacts.

The outlines of these alteration zones are obvious although locally where

intense alteration has been superimposed on less intense patterns the outlines are more obscure. The superimposed intense alteration on weaker patterns probably occurred during the repeated fracturing of the Argenta stock.

At least three stages of fracturing have been recognized in core samples by the displacement of one veinlet by another containing entirely different suites of sulfide and gangue minerals. Some veinlets in the core, ranging between 10.0 and 50.0 millimeters in width, also exhibit classic ribboned structure of quartz-sulfide, quartz-calcite-sulfide, and calcite-ankerite-sulfide within the same veinlet. Where evidence of multi-stages of mineralization is observed, an incipient alteration of higher intensity usually has been superimposed on a more extensive alteration of lower intensity.

Alteration of the stock in the third dimension of depth, as interpreted from drill core data, suggests a vertical alteration zoning similar to the lateral, or horizontal, alteration zoning patterns previously described. Vertical sections A-A' and B-B' show that CRX-1 attained the greatest depth and contained the longest intercepts of intensely altered quartz monzonite in the mesothermal range. Holes AH-1 and AH-4 contain epithermal argillic alteration over significant intervals on these sections and Hole AH-3 clearly illustrates an epithermal argillic alteration associated with narrow structures and restricted to these widely spaced fracture zones. Most of the quartz monzonite in AH-3 and AH-4 is the later facies described in a preceeding section on petrography.

The argillic alteration logged in drill holes and shown on the vertical sections is comprised predominantly of kaolinite and lesser quantities of montmorillonite

and sericite. Orthoclase, plagioclase, and some chlorite are totally replaced by these minerals in the indicated intervals. However, montmorillonite with minor quantities of kaolinite partially replaces orthoclase and plagioclase beyond the boundaries of the more intense alteration shown on the vertical sections. In these montmorillonite envelopes the amount of feldspar replacement gradually diminishes as the distance from the core of total replacement increases. This decrease in the degree of feldspar alteration undoubtedly is related to proximity of fractures in the hydrothermal conduit system and could not be distinguished megascopically or with simple optical aids in the field.

Within zones containing both types of argillic alteration (kaolinite, montmorillonite) calcite and ankerite are the predominant gangue minerals in the multitude of 0.05 to 10.0 millimeter wide veinlets. The few quartz veinlets observed in argillic alteration zones seemed to be associated with a later superimposed higher intensity sericite and kaolinite alteration.

The mesothermal silicification logged in the deepest intervals of CRX-1 and AH-1 contrasts sharply with the argillic alteration present in the upper portions of the holes. Well defined quartz veinlets are predominant over relatively scarce carbonate veinlets and many of the quartz veinlets exhibit ragged indistinct margins where vein silica has invaded and replaced the wall rock. Orthoclase, plagioclase, and chlorite, are entirely replaced by sericite and kaolinite and trace quantities of pyrophyllite.

From the narrow silicic alteration near the bottom of AH-1 to much wider zones of intense alteration toward the bottom of CRX-1 there is but a vertical

difference of 350 feet. Perhaps with additional depth this type of alteration might become pervasive and as silicic alteration is almost always associated with classic "porphyry copper deposits", this possibility should be further investigated.

Andesite and Dacite Porphyries

North and northwest trending dikes appear on the geologic map as latite, quartz latite, and quartz porphyry dikes. Field classifications appearing on the geology map are incorrect. Laboratory examinations show these rocks originally were andesite and quartz dacite. The steeply dipping dikes, range between one foot and four feet in width and occupy a number of the prime set of closely spaced fracture cleavages in the stock and metasediments. These structures apparently are the principal conduits in the hydrothermal system.

The pre-mineral dikes are intensely altered and mineralized. Locally, they contain both quartz and carbonate veinlets and are pockmarked with fine limonite-filled casts after pyrite. Quartz and sericite totally replace the groundmass and feldspars. In some of the dikes partly resorbed quartz phenocrysts measuring 2.0 to 2.5 millimeters in diameter are the only recognizable original rock forming mineral. A low temperature, iron-rich orthoclase (adularia) one to two millimeters in length occurs as fresh euhedral crystals in extremely well altered portions of the dikes.

Amsden Formation

Contact metamorphism along the north margins of the Argenta intrusive resulted in the conversion of limey argillites to hornfels, the recrystallization of purer limestones to fine and coarse-grained marbles, and the formation of

minor quantities of wollastonite and forsterite. A similar metamorphism of the same formation was indicated by drilling in a portion of the south contact which as overlain by Tertiary gravel. A coarsely crystalline marble intersected by the drilling, however, contained significant quantities of grossularite and magnetite. These minerals are not present in the metasediments along the north contacts of the intrusive.

The Amsden sediments along the north contact have been hydrothermally altered. Hornfels with high clay content have been sericitized and indigenous clays in the impure limestones have been converted to crystalline montmorillonite, kaolinite, and sericite. Moderate to intense argillization may extend at least 1500 feet into the sediments north of the contact as suggested by the number of well altered quartz porphyry dikes and the abundance of iron-manganese stained veins and veinlets within this distance of the contact.

Cyrptocrystalline silica and very fine crystalline quartz particles were introduced, or remobilized and concentrated, in veins and vein wall rocks by hydrothermal activity. Weathering and the oxidation of vein sulfides has converted some of this silica to blood red jasperoid veins which are most plentiful in the vicinity of the Hand, Jack Rabbit, and Copper Belle mines.

F. Mineralogy:

Polished section studies and supporting microchemical analyses and x-ray diffraction investigations were made of CRX-1 drill core samples and sulfide ore minerals from the Copper Belle, Jack Rabbit, Cold Day, and Ferdinand mines. Although no single sulfide depositional sequence applies to all of the examined specimens, a general pattern of paragenesis was developed.

Quartz appeared first in established fractures and displaced previously formed clay and calcite. Pyrite and sphalerite were deposited almost contemporaneously with the quartz but somewhat later. A period of shattering followed and was accompanied by the introduction of quartz and chalcopyrite or calcite and tetrahedrite. A third period of fracturing occurred during which minor amounts of quartz and large quantities of galena were deposited and replaced earlier formed sulfides. A final stage of fracturing was accompanied by the deposition of calcite with minor amounts of pyrite.

The mine ores contained all of the primary sulfide minerals described in the paragenesis although pyrite was the most plentiful sulfide in all of the examined specimens. No clear pattern could be seen in the ratios of one ore sulfide to another from the various parts of the district. However, more chalcopyrite was identified in ore from the centrally located Copper Belle mine than was present in ore from mines along the east contact. The Copper Belle ore also contained more tetrahedrite than chalcopyrite. Galena was the most abundant ore sulfide in samples from mines along the eastern contact. Chalcopyrite in the mine samples was predominantly in exosolution blebs within sphalerite.

Supergene minerals in the mine samples consisted of chalcocite and covellite. These minerals replaced exosolution chalcopyrite and tetrahedrite. No supergene minerals were present in the core specimens studied. Cerussite and anglesite were the principal oxide ore minerals forming shells around nodules of galena, sphalerite, and pyrite. Malachite, cuprite, and tenorite also were observed in samples from the Copper Belle mine.

Although efforts to date have failed to intersect substantial mineralization of ore grade, the ore mineralogy of the drill holes indicates a porphyry copper possibility in the district. For example; quartz veinlets containing chalcopyrite in the drill holes rarely contained tetrahedrite and calcite-tetrahedrite veinlets contained only trace quantities of chalcopyrite as exosolution beads in sphalerite. These facts point to either a) a separate genesis for these two sulfides or b) a vertical sulfide zoning distribution paralleling the previously-described increase in alteration intensity with depth. Chalcopyrite in the deeper parts of CRX-1 and AH-1 is associated with veinlet quartz that replaces wall rocks. This is the criterion for classifying the silicic alteration pattern shown on the vertical sections and outlined in the preceeding descriptions of alteration.

The vertical zoning of sulfides is evident in the amount of tetrahedrite over chalcopyrite in ores from the mines that probe only the thin layer of overlying sediments and the first few hundred feet of the intrusive. Drilling results also support the sulfide zoning concept by showing more tetrahedrite-calcite veinlets in the sediments and in the upper portions of the intrusive.

The chalcocite enrichment shown on vertical sections in holes AH-1, AH-3, and AH-4 obviously was derived by the leaching of copper from minor quantities of tetrahedrite and exosolution chalcopyrite in the original lead-zinc sulfide veins in the overlying Amsden limestones. The copper in solution was then deposited as chalcocite replacements of unoxidized pyrite veinlets in the first two hundred feet of the quartz monzonite intrusive. Much of the leached copper in solution was depleted by reaction with carbonate host rocks and as a consequence, malachite formed at the expense of the chalcocite enrichment.

A H 1

From	To	Int	Ag	Au	Cu	Pb	Zn
9	19	10			Tr	.01	
19	28.5	9.5			Tr	.01	
28.5	30	1.5			.06	.25	
30	40	10			Tr	.05	
40	45	5			Tr	.05	
45	49	4			Tr	.10	
49	54	5			Tr	.10	
54	60	6			Tr	.10	
60	70	10			Tr	.10	
70	75	5			Tr	.10	
75	80	5			Tr	.10	
80	86	6			Tr	.05	
86	106	20			Tr	.15	
106	116	10			Tr	.05	
116	126	10			Tr	.10	
126	136	10			.02	.35	
136	146	10			Tr	.05	
146	148	2			Tr	.10	
148	151	3			Tr	.10	
151	154	3			Tr	.10	
154	164	10			Tr	.30	
164	168	4			Tr	.05	
168	178	10			Tr	.05	
178	188	10			Tr	.05	
188	198	10			Tr	.05	
198	208	10			.04	.10	

AH 1

From	To	Int	Ag	Au	Cu	Pb	Zn
208	218	10			Tr	.30	
218	223	5			.04	.20	
223	233	10			Tr	.05	
233	243	10			Tr	.05	
243	248	5			Tr	.10	
248	258	10			Tr	.05	
258	268	10			Tr	.10	
268	278	10			.02	.05	
278	288	10			Tr	.05	
288	298	10			Tr	.05	
298	308	10			Tr	.05	
308	318	10			Tr	.05	
318	328	10			Tr	.15	
328	338	10			Tr	.25	
338	343	5			Tr	.15	
343	348	5			Tr	.30	
348	358	10			Tr	.05	
358	368	10			Tr	.05	
368	373	5			.02	.05	
373	383	10			Tr	.15	
383	393	10			Tr	.20	
393	403	10			.02	.30	
403	413	10			Tr	Tr	
413	423	10			Tr	Tr	
423	433	10			Tr	Tr	
433	443	10			Tr	Tr	

AH 1

		Ag	Au	Cu	Pb
443 - 448	5			Tr	Tr
448 - 456	8			Tr	.05
456 - 466	10			Tr	Tr
466 - 476	10			Tr	Tr
476 - 486	10			Tr	.05
486 - 496	10			Tr	.85
496 - 506	10			Tr	.10
506 - 516	10			Tr	.05
516 - 526	10			Tr	.10
526 - 536	10			Tr	.20
536 - 546	10			Tr	.05
546 - 553	7			.04	.30
553 - 563	10			Tr	.20
563 - 573	10			Tr	.05
573 - 583	10			Tr	.05
583 - 593	10			Tr	.05
593 - 603	10			Tr	.10
603 - 613	10			Tr	.05
613 - 623	10			Tr	.05
623 - 635	12	.06	Tr	.02	.04
635 - 639	4	.24	Tr	.02	.14
639 - 645	6	.32	Tr	.03	.25
645 - 654	9	1.20	Tr	.21	.51
654 - 660	6	.28	Tr	.28	.05
660 - 665	5	.88	Tr	.39	.21
665 - 670	5	Tr	nil	.03	.13
670 - 675	5	Tr	nil	.03	.11

20

carbonate

↑

↓ stock

THIS ENRICHED

AH 1

		Ag	Au	Cu	Pb
675 - 680	5	Tr	nil	.02	.03
680 - 685	5	Tr	nil	.04	.04
685 - 690	5	Tr	nil	.02	.03
690 - 695	5	Tr	nil	.04	.04
695 - 700	5	Tr	nil	.01	.03
700 - 705	5	Tr	nil	.005	.03
705 - 710	5	Tr	nil	.005	.04
710 - 715	5	Tr	nil	.005	.05
715 - 720	5	.14	Tr	.02	.02
720 - 725	5	Tr	nil	.01	.01
725 - 730	5	Tr	nil	.01	.02
730 - 735	5	.01	nil	.34	.04
735 - 740	5	.01	nil	.05	.03
740 - 745	5	.01	nil	.11	.05
745 - 750	5	.03	nil	.06	.07
750 - 755	5	Tr	nil	.02	.01
755 - 765	10	nil	Tr	Tr	Tr
765 - 775	10	nil	Tr	Tr	.05
775 - 785	10	nil	Tr	Tr	.05
785 - 795	10	nil	Tr	Tr	.15
795 - 805	10	.30	.003	.15	.20
805 - 815	10	nil	Tr	Tr	.20
815 - 820	5	nil	Tr	Tr	.05
820 - 825	5	.10	Tr	.46	.05
825 - 830	5	nil	Tr	Tr	.05
830 - 835	5	nil	Tr	Tr	.05
835 - 840	5	nil	Tr	Tr	.20

A H 1

		Ag	Au	Cu	Pb
840 - 845	5	nil	Tr	Tr	.32
845 - 850	5	nil	.01	.04	.05
850 - 855	5	nil	Tr	Tr	.05
855 - 860	5	.10	.02	.15	.05
860 - 868	8	nil	Tr	Tr	.63

ARGENTA AH - 3

from - to	Interval	Ag	Au	Cu	Pb	Zn
39 - 440	5'			.011	.019	
85 - 94	9'	Tr	Nil	.044	.24	
117 - 125	8'			.006	.028	
209 - 215	6'			.004	.018	
302 - 307	5'	.10	.015	.04	1.69	Tr
307 - 317	10'	.46	.002	.02	.05	ND
317 - 327	10'	.30	.002	.01	.20	ND
327 - 337	10'	.20	.025	.02	.63	Tr
337 - 342	5'	.05	.005	.04	.05	.15
342 - 347	5'	.25	.040	.27	1.16	1.70
347 - 352	5'	.25	.010	.05	.32	1.00
352 - 357	5'	1.70	.015	.05	.74	Tr
357 - 362	5'	ND	.002	Tr	.05	ND
362 - 368	6'	ND	.002	Tr	.05	ND
368 - 373	5	ND	Tr	Tr	Tr	ND
373 - 383	10'	.05	.002	Tr	.05	ND
383 - 388	5'	.05	.002	.04	.42	ND
388 - 398	10'	Tr	Tr	.02	.05	ND
398 - 408	10'	Tr	Tr	.02	.05	ND
408 - 418	10'	.05	.010	.34	1.59	2.40
418 - 423	5' ~~.05~~	.05 ~~.010~~	.010 ~~.34~~	.34 ~~1.59~~	1.59	4.50
423 - 433	10'	Tr	nil	.13	1.36	3.18
433 - 443	10'	.06	nil	.01	.05	.02
443 - 448	5'	.06	.01	.08	.66	1.71
448 - 458	10'	.05	tr	.01	.05	ND
458 - 468	10' ~~ND~~	ND ~~tr~~	tr	tr ~~.05~~	.05	ND
468 - 478	10'	ND	tr	.02	.05	tr

SUPERGENE ZONE 251 0.26 %

From - To	Interval	Ag	Au	Cu	Pb	Zn
478 - 488	10'	.05	tr	tr	.05	tr
488 - 493	5'	ND	tr	.12	.32	.80
493 - 503	10'	ND	tr	tr	tr	tr
503 - 513	10	ND	tr	tr	.15	.35
513 - 518	5'	.80	tr	.05	.32	4.10
518 - 528	10'	.05	tr	.17	.53	1.70
528 - 538	10'	.05	tr	.07	.05	.60
538 - 548	10	ND	tr	tr	.05	ND
548 - 553	5	ND	tr	tr	.10	.18
553 - 558	5	.05	tr	.07	.42	1.30
558 - 568	10	ND	tr	tr	.10	tr
568 - 578	10	.05	tr	tr	.10	tr
578 - 588	10	ND	tr	tr	.10	ND
588 - 593	5	ND	tr	tr	.21	ND
593 - 603	10	.30	tr	.17	.21	.80
603 - 613	10	ND	tr.	.05	.32	tr
613 - 623	10	ND	tr	.02	.21	.40
623 - 633	10	.10	tr	.05	.05	.75
633 - 643	10	ND	tr	.07	.05	.65
643 - 653	10	tr	nil	.03	.29	.77
653 - 663	10	.10	.01	.05	.09	.43
663 - 673	10	.16	nil	.09	.04	.27
673 - 683	10'	.34	.01	.17	.13	.49
683 - 693	10'	.05	tr	.02	.15	ND
693 - 703	10'	ND	tr	tr	.15	ND
703 - 713	10'	.05	tr	.05	.30	.95

AH 4

From	To	Int	Ag	Au	Cu	Pb	Zn
0 -	61		Amsden				
61 -			Stock				
268	273	5	.05	.002	.05	.05	.50
273 -	278	5	nil	Tr	Tr	.05	nil
278 -	283	5	nil	Tr	Tr	.05	nil
283 -	293	10	nil	Tr	Tr	.05	nil
293 -	303	10	nil	Tr	Tr	.05	nil
303 -	313	10	nil	Tr	Tr	.05	nil
313 -	323	10	nil	Tr	Tr	.05	Tr
323 -	333	10	nil	Tr	.02	.05	.05
333 -	343	10	.05	Tr	.05	.10	1.35
343 -	353	10	.05	Tr	Tr	.25	nil
353 -	363	10	nil	Tr	Tr	.10	nil
363 -	373	10	nil	Tr	Tr	.15	nil
373 -	374	lost					
374 -	384	10	nil	Tr	.02	.10	nil
384 -	394	10	tr	nil	.02	.03	.04
394 -	404	10	tr	nil	.01	.04	.03
404 -	414	10	.28	.01	.04	.42	1.18
414 -	424	no assay					
424 -	434	10	nil	tr	tr	.30	nil
484 -	494	10	nil	tr	.02	.05	nil
494 -	499	5	nil	tr	.02	.10	nil
499 -	504	5	.34	.04	.21	.19	.30
504 -	514	10	nil	tr	.02	.10	nil
564 -	574	10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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ARGENTA PROJECT

Beaverhead County, Montana

REPORT FOR 1970 FIELD SEASON

to

Cyprus Mines Corporation

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1) Introduction:

As proposed in 1969, the exploration program for the 1970 field season at Argenta was designed to evaluate the possibility that sufficient reserves could be found in the Hand Mine area to permit early production of silver-lead-zinc ore. The program contemplated a second phase aimed at evaluating the potential of the district for a porphyry copper deposit. Work on the project began in February, 1970 with a review of the data and drill core available from the mine operators and from previous exploration. Following mapping and sampling of the Hand Mine, a drill hole testing that area was begun on June 30th. Results from two holes and other work in the mine area did not point out an attractive silver-lead target and the project effort was shifted in August toward exploration of the copper potential. Two drill holes and other work on the "porphyry" bet were proceeding when instructions to close down the project were received in late September.

Since our findings from the season's work suggest a continued interest in the porphyry copper potential of the district but not in the lead-silver veins, the evidence for the "porphyry" bet is discussed in a separate section of this report.

ii) Data:

1. Winchell, A. N.; 1914; Mining Districts of the Dillon Quadrangle; U. S. G. S., Bull. 574

2. Shenon, P. J.; 1931; Geology and Ore Deposits of Bannack and Argenta, Montana; Montana Bur. of Mines and Geol., Bull. No. 6

3. Myers, W. B.; 1952; Geology and Mineral Deposits of the Northwest Quarter Willis Quadrangle and Adjacent Brown's Lake Area, Beaverhead County, Montana; U.S.G.S., Minerals Branch Open File Report; with accompanying preliminary geologic map

4. Lowell, W. R.; 1965; Geologic Map of the Bannack-Grayling Area, Beaverhead County, Montana; U.S.G.S. Misc. Geologic Investigations Map. I-433, with text

5. Copper Range Exploration Co.; 1968; Maps, Drill logs, geophysical data, per list in paragraph I-D of this report.

6. Meyer, C., and Hemley, J. J.; 1967; Wall Rock Alteration; Chapt. 6 in Barnes, H. L. (Ed.), Geochemistry of Hydrothermal Ore Deposits; Holt, Rinehart, and Winston, Inc., publishers

7. Meyer, C.; Shea, E. P.; Goddard, C. C., Jr.; 1968; Ore Deposits at Butte, Montana; Sect. 65, Vol. II. Ore Deposits in the United States; A.I.M.E., Graton-Sales Volume pps. 1373 - 1416

8. Lowell, J. D.; and Guilbert, J. M.; 1970; Lateral and Vertical Alteration-Mineralization Zoning in Porphyry Ore Deposits; Econ. Geol. V. 65, No. 4 pps. 373 - 408

9. Cyprus; 1970; Drill core graphic logs, with assay returns; Cyprus Spokane files

I. The Argenta District

A. Location, Access:

The Argenta District is within T. 6 S., R. 10 W. in Beaverhead County, Montana (45° 17' N. Lat., 112° 52' W. Long.). It is about twenty miles west-northwest of Dillon, Montana, county seat of Beaverhead county. The road from Dillon is flat, paved except for the last few miles. Dillon is served by the Union Pacific R. R.

Argenta consists of about a dozen small homes; it does have electric power but not telephone service. Rattlesnake Creek, which runs through Argenta, provides plenty of water year-round for domestic purposes and irrigation.

B. Topography, Climate:

The area mapped around the Hand Mine consists of a gentle south-facing slope ranging between 6100 ft. on the Argenta Flats along Rattlesnake Creek and 6500 ft. The slope has a shallow soil cover with grass, sage, and a few junipers. The climate is semi-arid, with from 15 - 20 inches of rain per year. The area is generally free of snow cover after April and until December; winter temperatures can reach 30 degrees below zero.

C. Area, Title:

Cyprus holds most of the claims in the Argenta Mining District and the real property in Argenta Townsite. A land status map and list of owners is in Cyprus Los Angeles and Spokane files. Some 194 unpatented claims, 19 patented claims and most of the other real property around Argenta are held under a Mining Lease (and Option-to-Purchase) from the Hand family of Argenta and Dillon dated

17 September, 1969. Four patented claims in the Bella - Ferdinand area, four upatented claims, and some Argenta property are held under an Option Agreement from Rudy Nygren of Argenta dated 9 February, 1970. The Hand agreement contains the following provisions:

a) 20 year term, plus 10 year extensions upon 60 days notice
b) Exploration expenditures: (with carry-forward provision)
   1st year - $75,000 (to October 17, 1970)
   2nd year - $125,000
   3rd year - $175,000
   4th year and subsequently $87,000 - 1 year
c) Royalties:
   Starting 4th year: Advance minimum $87,000/year
d) Assessment Work:
   Cyprus notifies prior to September 1 of any year, or does assessment work for subsequent year
e) Taxes: Cyprus shall pay pro-rata
f) Upset Price: $2,500,000
g) Any locations by either party subject to agreement

The Nygren agreement contains the following provisions:

a) Cash Consideration: $1,000
   1st Anniversary $2,000
   2nd Anniversary $3,000
   3rd Anniversary $4,000
   4th Anniversary $5,000
   5th Anniversary Balance of $125,000 purchase price in four equal annual installments
b) Taxes: Cyprus shall pay
c) Assessment Work: Cyprus shall do for any assessment year in which option runs 90 days
d) Minimum Expenditures: None

Assessment work on the unpatented Hand and Nygren claims was filed for the year ended 1 September, 1970 and copies of the affidavits furnished to Cyprus' Spokane office. The amount spent in 1970 applicable to the Hand agreement minimum work requirement was approximately $165,000, leaving a requirement for 1971 of approximately $35,000.

The area held covers almost all of the area of interest, that is: the Hand Mine area and the triangular altered portion of the quartz monzonite. To completely cover the latter would require picking up the following (with reference to the claim map and the "Appendix A" list which accompanies it):

No. 9	Patented Jack Rabbit claim; Mr. Graeter of Deer Lodge
No. 14	Big Jumbo, Big Paymaster, East End patented claims; the Anaconda Company
No. 16	Goldsmith patented claim; Anaconda one-half
No. 31	Noname unpatented claim; Carl Shafer of Dillon
No. 32	Cold Day patented claim; Leonard Christie of Dillon

Those parcels in Argenta Townsite not owned by Hand or Nygren.

D. History, Production:

Mining in Argenta began in 1865; the first smelter in Montana was built there the same year. Some thirty mines and prospects operating intermittently by 1929 produced some $1,500,000 in lead and silver, or gold, or copper ores either for local smelters or for shipment elsewhere. Nearly all of this early production came from enriched oxide silver-lead ores in shallow workings. The Tuscarora, Governor Tilden, and Florida claims of the Argenta Springs area together produced about 10,000 tons from pipe-like shoots in the Devonian Jefferson Formation. In the same area several modest operations each produced a few hundreds or thousands of tons from bedded runs in the Jefferson. A half-dozen more similarly-sized mines produced from fissures in the Cambrian Flathead Quartzite or in the Precambrian Spokane Shale.

At the south end of the district in and around the present Hand Mine, the early production was chiefly from either the irregular deposits at the contact of the early Tertiary Argenta quartz-monzonite stock with the U. Miss.-L. Penn.

Amsden Limestone or from fissure veins in the Amsden close above the stock. The Iron Mt., Anaconda, Brownell, and Mauldin Mines were the leading producers. Nearby, to the east and southeast, the Copper Belle, Jack Rabbit, and Bella mines operated on secondary chalcocite ores from pyritic veins in the quartz monzonite; these ores carried substantial silver or gold. The Ferdinand Mine at the southeast corner of the district produced lead-zinc-silver-copper ore from a fault-vein between quartz monzonite and Madison Limestone.

In contrast to the sporadic high-grading of the early years, and to the occasional small leasing operation, the Hands, John and his son Bill, have operated continuously for the last thirty-five years. In this time they have produced about 100,000 tons with a gross value of $3,000,000 from the Hand Mine (Mauldin - Anaconda - Brownell - Iron Mt. Group of claims). Production is currently about 60 tons of shipping ore per week; it averages about 12% Pb, 2 - 3% Zn, 2 - 5 oz. Ag, and .01 - .05 oz. Au.

In 1967 the Copper Range Company optioned the Hand and other properties in the district, staked the open ground, and conducted an exploration program aimed at the porphyry copper potential. Their program resulted in the following coverage (copies of their maps and data are in the Los Angeles and Spokane Cyprus files).

1. Geologic Map, 1" = 500' - covering from the altered sediments north of the Hand Mine to the ditch south of Rattlesnake Creek
2. Geochemical Map, 1" = 500' - two east-west sample lines, one in quartz monzonite just south of the contact, the other in the long ditch south of Rattlesnake Creek
3. Alteration Overlay, 1" = 500'
4. Aeromagnetic Map, 2" = 1 mile - covers an area about 6 miles by

7 miles centered on the Hand Mine

5. Geological - Geochemical Section, 1" = 50' - ditch south of creek
6. Geological - Geochemical Sections, 1" = 50' - one for each of four Copper Range diamond drill holes
7. IP - seven east-west lines each four miles long shown on (4.) above, and on profiles
8. Magnetic Profiles, ground survey, for 4 east-west lines.

It is understood that the Copper Range drill holes were sited principally to test their I. P. anomalies. When three of their four holes (CRX-1, CRS-3, CRX-4) found pyritization and alteration but not commercial mineralization they terminated their work on the area in May, 1969.

E. General Geologic Setting:

The Argenta District occupies low piedmont slopes on the north-south-trending eastern flank of the Pioneer Range. The trend incorporates the eastern margin of the granitic core of the range; a belt of folded and faulted sediments of Precambrian, Paleozoic, and Mesozoic age; Tertiary sediments, intrusives, and volcanics. It also includes a twenty-mile-long zone of mining districts, i.e., the Bannack gold district, Blue Wing silver district, Ermont Silver mine, Argenta lead-silver district, and the Argenta Springs silver-lead district. In the project area, sediments from late Precambrian through Pennsylvanian in age trend north-northeast; they are cut by north-to-northwest-trending, high-angle, normal faults and intruded by Tertiary stocks and dikes.

The stratigraphy and structure of the region has been mapped and described by Myers (1952). His findings are generalized in the following stratigraphic column.

Stratigraphic Section, NW 1/4 Willis Quadrangle

Thickness		
	Pleistocene	Terrace gravels
		Angular Unconformity
300 - 800'	Upper Tertiary	Weakly consolidated gravels, Paleozoic and later materials
		Angular Unconformity
to 2000'	Oligocene	Rhyolitic flows and tuffs, basalt and scoria
		Angular Unconformity
	Eocene ?	Dikes (andesite, dacite); mineralization
		Quartz Monzonite
		Folding, Faulting, Thrusting
2000 - 3000'	Paleocene ?	Andesite and trachyte flows, tuffs
		Angular Unconformity
to 7800'	Cretaceous	Continental clastic sediments, intercalated tuffs, limestone
200'	U. Jurassic	Morrison tuffaceous mudstone, flows, limestone
		Angular Unconformity
to 1000'	L. Triassic	Mudstone, limestone, shale
to 500'	Permian	Phosphoria Formation quartzite, phosphatic mudstone, dolomite
650'	Pennsylvanian	Quadrant Quartzite
115 - 285'		Amsden - Upper - variable argillaceous limestone, limey sandstone
110 - 280'	Mississippian	Amsden - Lower - argillaceous dolomite and grey limestone
525 - 650'		Mission Canyon Limestone - light to dark grey bedded limestone
650 - 725'		- white to grey coarse, massive limestone
750 - 950'		Lodgepole Limestone - thin-bedded, fine-grained, blue-grey limestone
175'	U. Devonian	Three Forks Shale - light brown fissile shale, thin dolomite
550 - 600'		Jefferson Dolomite - black, fetid, thick-bedded
100'		- grey dolomite
	-Disconformity-	
300'	U. Cambrian	Pilgrim Dolomite - thick-bedded, light grey, local chert
		Block Faulting, Angular Unconformity
200'	M. Cambrian	Wolsey Shale - Grey-green soft, fissile
500'		Flathead Quartzite - pink, cross-bedded, thick-bedded
		Angular Unconformity, Faulting?
5000 - 6000'	Belt	Upper Quartzite - white, pale pink or grey, feldspathic
3000 - 6500'		Lower Red - shale, argillaceous quartzite, arkosic; some green
?	Pre-Belt	Biotite gneiss - not mapped, 160' in CRX-4

Stratigraphy:

The sedimentary units encountered in the work to date in the project area are the Lodgepole Limestone, Mission Canyon Limestone, Amsden Formation, and Quadrant Quartzite. Based on the mapping and core logging the following descriptions apply:

Quadrant Quartzite - blocky, tan-weathering vitreous quartzite forming resistant capping of hills; only about 30 feet exposed in the mapped area.

Upper Amsden - poorly exposed on slopes below the Quadrant; the float indicates thin-bedded fine-grained tan-weathering, light grey to buff, argillaceous to sandy limestone and dolomite; grades laterally to dolomitic argillite or argillaceous siltstone

Lower Amsden - similar to upper unit, but greater percentage of dolomitic argillite and siltstone beds

Mission Canyon Limestone - Upper unit greyish white to grey; fine-grained except where re-crystallized, indistinctly-bedded, impure dolomitic limestone, locally cherty

- Lower unit white to dark grey; fine to medium-grained, thick-bedded, in good part now white coarsely recrystallized marble; locally crinoidal

Lodgepole Limestone - dark blue-grey to grey (white where re-crystallized), thin bedded to well-bedded, fine-grained except where re-crystallized Limestone, fossil fragments common.

As seen in the Hand workings and in core, all of the limey formations have developed water courses and caverns above the water table. In and around the areas of strong fracturing and mineralization, collapse caverns filled with rock fragments, limonite and manganese oxide jasperoid, and clays are common. Some of these have been mixed suggesting that some of the cavernous development started with oxidation of sulphides in a mineralized fissure.

F. Igneous Rocks:

The quartz monzonite of the Argenta Stock is exposed over an area about 8000' East-West and 3000' North-South around the town of Argenta. Its aeromagnetic expression suggests that a much larger area, about three miles by two miles is underlain by granitic rock. Several miles north and northeast of Argenta, two small stocks of quartz monzonite are exposed. Again the magnetic data suggests a) that at shallow depth these stocks are also much larger than in outcrop, and b) that they and the Argenta Stock are probably continuous at depth.

The Argenta quartz monzonite when fresh, as in the outcrops southwest of town, is a relatively fine-grained, equigranular biotite quartz monzonite; its average composition is about 40 - 50% plagioclase, 20 - 25% orthoclase, 20 - 25% quartz, 10 - 15% biotite, with hornblende and magnetite as accessories. In the area south and east from the Hand Mine to the ditch south of Rattlesnake Creek and in all of the drill intercepts to date, the quartz monzonite is hydrothermally altered. The alteration varies from propylitic (chloritic) alteration of outcropping quartz monzonite, to a weak argillic variety in much of the drill intercepts, to complete replacement locally by pyrophyllite and to feldspathic alteration at depth; alteration is most intense in the areas of close-spaced fracturing and of sulphide introduction. The subject is covered in some detail in the discussion of the "Porphyry Copper Potential".

The quartz monzonite is cut by an occasional late dike. These are narrow (1 - 6 ft.), and follow the prevalent steeply-dipping north or northwest fracture pattern of the area. Several were mapped along the ditch south of Rattlesnake

Creek and elsewhere in the southeast portion of the mapped area; a few were noted in and around the Hand workings and in the drill intercepts below the workings. In the field they were mapped as quartz latite or even quartz porphyry. Petrographic work indicates that they are highly altered, and that the original composition was probably andesite or dacite. Since they are pre-alteration and mineralization, they must have been emplaced somewhat later than the quartz monzonite.

G. Alteration:

As stated under Igneous Rocks above, all of the exposed northern portion of the Argenta Stock is hydrothermally altered. Hydrothermal alteration of the sediments appears to extend outward from the northern contact of the stock for about 1500 feet. In that zone the Amsden Formation is bleached and discolored to an extent considered to be beyond its normal tan-weathering characteristic and beyond the iron-staining attributable to weathering of introduced pyrite. The apparent effects of alteration on the sediments are the removal of carbonaceous coloring matter in areas of fracturing and mineralization, along with the recrystallization of some of the clay minerals. In the fracture zones and at the contact, the limey rocks are recrystallized (marble).

Whereas the formation of skarn seems to be a common phenomenon at granitic-limestone contacts in the region, there was very little calc-silicate development in the mine area. Just northeast of the Hand Mine, some of the Amsden Formation argillites have been mapped as hornfels, but the hornfelsic-appearing rock may be merely a dense, siliceous facies. Some scarce diopside and wollastonite, and rare epidote was noted in the core of our holes in the same area.

In hole CRX-3, located a mile southeast of the Hand Mine, and drilled southwest at minus 45°, five hundred feet of fine-grained (2 - 6 mm) quartz monzonite was cut between two sections of altered recrystallized limestone. Whether the quartz monzonite of that area is sill-like or a vertical protuberance is not known from the one hole. At the upper (or easternmost) granite-limestone contact, the limestone unit locally contains diopside, grossularite, and chert, and the quartz monzonite exhibits epidote along some veinlets. At the lower (westernmost) contact, the limestone is re-crystallized, and locally silicified, with the development of some wollastonite and of garnet which locally amounts to 75% of the rock. This alteration appears to be more intense toward the bottom (west end) of the hole, suggesting that with further depth the hole might have again been in quartz monzonite.

H. Structure:

In general the Paleozoic host rocks for the intrusive are striking north-northeastward with the regional pattern and dipping eastward at less than 30°. Locally, at the margins of the intrusive, however, the more argillaceous, thin-bedded units are moderately folded, and faulting has tilted the strata of some small blocks.

Within the mapped area the structures of most significance are the steep, north or north-northwest-trending mineralized faults cutting the quartz monzonite and the overlying sediments with small displacement. A few faults of possible major displacement are suggested by indirect evidence. Some jointing in the QM near Rattlesnake Creek striking along the creek, combined with a parallel pattern of aeromagnetic data suggests a northwest-trending fault separating the fresh

QM southwest of Argenta from the altered northern block. Another fault with a substantial indicated displacement is the mineralized fault of the Ferdinand Mine bringing quartz monzonite on the west into near-vertical contact with a block of Amsden-Quadrant on the east.

There is some indirect evidence that all or part of the Quartz Monzonite may be sill-like in form, emplaced along a thrust zone parallel to the known thrusts west of the district. The quartz monzonite at its upper contact is much sheared (Holes CRX-1, AH-1, AH-3). In CRX-3, the Q.M. is fine-grained (2 - 6 mm), with an hypabyssal aspect. All of the Q.M. at Argenta is relatively fine-grained, and non-porphyritic.

Although the bulk of the structural activity affecting the mapped area was pre-mineral, some late, post-oxidation, faulting is evidenced. In hole AH-2 1800 feet north of the mine area there are iron and manganese oxides to about 1200 feet vertical depth whereas the water table of the district in general is at about 300 feet. In the mine some of the veins have been offset slightly, others an unknown amount, by post-mineral faulting. There is also evidence in slickensided limonite of some very late, post-oxidation movement in the north-trending fault-veins themselves.

I. Geophysics:

The Copper Range aeromagnetic data covers an area of about 45 square miles, centered on Argenta. Most significantly the outcropping portion of the Argenta Stock north of Rattlesnake Creek which is known to be altered occupies a distinct magnetic low. This V-shaped low extends southward between two

prominent highs; for about a mile beyond the quartz monzonite outcrops. The high southwest of the V apparently reflects the fresh quartz monzonite visible in outcrop. In the area of the magnetic high southeast of the V, the surface is gravel-covered. Hole CRX-3 was collared in the high, however, and the magnetite-bearing skarn encountered in the hole may explain the anomalism. North of the V, in the area north of the Hand Mine, the magnetic response flattens out to a broad low suggesting either a) that the northern margin of the stock is a steeply-dipping east-west trending surface, or b) that the stock continues at moderate depth below the sediments but is magnetite-poor due to alteration. Our hole AH-2 in the low to the north of the mine area encountered only sediments to a depth of 1772 feet, indicating that a) is the best assumption on present evidence. The dimensions, then, of the triangular altered portion of the Argenta Stock appear to be about 6000 feet along the northern border, 6500 feet along the eastern side, and 8500 feet along the southwestern side.

The magnetic picture of the altered triangle is supported by the Induced Potential data. The four-mile long, east-west Line IV crossing just north of the Hand Mine returned low resistivities and good P. F. E.s over the area north of the QM outcrop. On Lines III and VI across the southern point of the magnetic triangle, the magnetic low coincides in each case with the most anomalous portion of a broad weak IP anomaly. The IP used was a dual frequency (3.0 and 0.1 cps) method, with 1000 foot dipoles. In general it was only at the greater dipole separations that frequency effects showed up (n = 3 to 5). This would indicate either a cover of sulfide-barren rocks where the granitics do not outcrop, or increasing sulfide with

depth where they do outcrop. These indications conform to the geological evidence. In CRX-1 oxidized sediments extended down to about 500 feet vertical depth, the contact with pyritic QM. The percentage of pyrite in the QM increased gradually downward from the contact toward the bottom of the hole at 1950 feet vertical depth.

There is a noticeable northwest lineal trend of the most favorable IP data which coincides with the boundary between the altered QM to the northeast and the unaltered QM to the southwest, suggesting a zone of higher sulfide concentration along the southwestern leg of the altered triangle.

The 200-foot grid around the Hand Mine was run with a ground magnetic survey in 1970, using Cyprus' McPhar Fluxgate Magnetometer. The data is shown on the attached Magnetic Survey Map. Maximum relief is about 250 gammas; in general the relief is less than 100 gammas. The upper East-West contact of the quartz monzonite is clearly shown by a drop off of values on the limestone side. Further extension of the magnetic coverage over the quartz monzonite was in progress when the project was shut down. The coincidence of a sharp magnetic low with the most altered area observed in the stock, the pyrophyllite zone south of the mine, suggests that some very useful patterns might be developed by grid coverage of all of the altered portion of the stock along with its margins.

J. Geochemistry:

One hundred two rock samples and 130 soil samples were collected on the 200-foot grid of the Hand Mine area. These were run by the atomic absorption method for lead and copper by the Frontier Laboratory at Melrose, Montana.

The results are shown on the attached two geochemical survey maps. The anomalism of the Ferdinand area in the southeastern corner of the area covered to date is perhaps due to the samples having been collected selectively at plane table survey points which coincided with workings. Again, the coverage of the quartz monzonite area is insufficient as yet to give a useful geochemical picture.

K. Diamond Drilling:

Four holes were drilled during the 1970 season. The work was done under contract with Boyles Bros. Drilling Company using one truck mounted Joy 22 drill and one skid mounted Joy 22 drill. Overall costs were $13.43 per foot. Water was pumped from Rattlesnake Creek. There was no water return.

Cores were brought daily to the Dillon office for logging, splitting, and sampling. Splitting was done on a large diamond saw. Samples were crushed and split by Cyprus personnel using the facilities of the Montana Laboratory at Philipsburg. Core, coarse rejects and pulps are stored on the property at Argenta. Skeleton (representative) core from each hole is stored at Cyprus' Philipsburg warehouse.

Drilling of inclined holes in the fractured and oxidized sediments, particularly around the QM contacts, was difficult and expensive. Considerable cementing was required. Unfortunately, vertical holes are unsatisfactory geologically because of the vertical fracturing and mineralization.

Hole AH-1 was collared at an elevation of 6432.10 feet on N. 104,789.44, E. 95,400.37, coordinates on June 30th and was inclined 50° from the horizontal on a S. 47° 15' 12" W. bearing. It was oriented in this position to, (1) explore

the projected northerly extensions of Hand Mine veins, (2) test the area immediately east of the mine for parallel structures, (3) intersect the Hand veins at various vertical intervals to determine the oxide, secondarily enriched sulfide and primary sulfide grades and (4) expand a near surface oxide lead and zinc potential in a bedding replacement deposit that was found as a result of mapping and sampling in the Hand Mine.

From the collar to 636 feet AH-1 intersected numerous 0.5 to 3.0 foot wide veins in Amsden sedimentary rocks all of which at various depths contained trace to submarginal lead, zinc, copper, gold and silver assays (see drill logs). The hole proved continuity in Hand veins and the existence of parallel veins in the neighboring area east of the mine but none were well mineralized. It did not intersect the bedding replacement deposit and thus limited its projectability and the possibility of finding an adequate tonnage for an open pit lead-zinc oxide operation.

At a depth of 636 feet AH-1 intersected argillized Argenta quartz monzonite containing quartz-calcite-pyrite veinlets. It continued in argillized quartz monzonite to a depth of 868 feet where it was stopped on the 8th of August in broken and caving ground. A two hundred foot interval between 636 and 835 feet contained supergene chalcocite as thin films on the pyrite in veinlets. Most of the five to ten foot intervals within this intercept did not assay more than 0.39% copper and 0.88 oz. silver per ton with less values in gold, lead and zinc.

The chalcocite probably was derived by the leaching of copper from the minor quantities of chalcopyrite and tetrahedrite in the Hand lead-zinc veins during the oxidation cycle. This copper was then carried in solution presumably to a

water table in the quartz monzonite where it replaced the surface areas of pyrite in the 1.0 to 2.0 millimeter wide veinlets.

On June 30th, AH-2 was collared as a vertical hole at an elevation of 6462.57 feet on the N.105,984.78, E.95,259.47 coordinates. This site was selected to extend mineralization in the Argenta quartz monzonite northward under the sedimentary rocks and thus increase the size of the porphyry potential. The site also was selected to complete the annual assessment obligations on the 204 unpatented mining claims in the Hand claim group.

AH-2 did not intersect the quartz monzonite nor any significant mineralization. Before it was terminated on the 26th of August at a depth of 1772 feet the hole had drilled almost all of the Mississippian section of the Amsden, Mission Canyon and Lodgepole Formations. A total oxidation of the sparse original sulfide in some of these rocks persisted to an 1100 foot depth.

Holes AH-3 and AH-4 were collared in the Amsden Formation on the 10th and 31st of August at elevations of 6352.49 and 6349.51 feet, respectively. AH-3 was inclined at 55° to the horizontal on a bearing of N30°53'20"E from the site at N.103,729.05, E.95,498.53 coordinates. AH-4 was collared vertically from a site at N.103,758.15, E.96,076.75 coordinates.

Both holes were drilled for copper mineralization in an area containing the best copper showings on surface near the Copper Belle Mine. Open prospect pits and caved mine workings in this area show copper oxides for several hundred feet along the quartz monzonite-sedimentary contact.

About sixty feet of barren sediments were drilled before AH-4 intersected

quartz monzonite. It remained in quartz monzonite to its total depth of 789 and it was stopped at that depth on the 26th of September. Traces of chalcocite on pyrite veinlets assaying less than 0.2% copper were obtained in two intervals between 240 to 250 feet and 500 to 570 feet. Two chalcopyrite and quartz veinlets one to two inches wide also were intersected in AH-4 at the 548 and 566 foot depths. A ten foot interval with chalcopyrite veinlets between 1162 and 1172 feet assayed 0.80% copper and 0.10 oz. of silver per ton.

L. Costs, Personnel, Housekeeping:

The entire cost of the Argenta Project was $164,057 as of 11/12/70. The principal item was 4,725 feet of diamond drilling. The total cost was $63,470 or $13.43 per foot. Other items as reported by Cyprus' Spokane Office are as follows:

Acquisition Costs	$ 2,227	
Salaries and Wages	13,555	(Cyprus Personnel)
Surveying and Mapping	35,231	
Outside Contract Services	44,926	
Excavation	1,565	
Assaying and Sampling	7,242	
Travel	5,837	
Equipment	1,045	
Miscellaneous	1,159	

The project was undertaken by R. Chadwick, consulting geologist, by contract with Cyprus. In the field the work was actively managed by Senior Geologist, C. C. Goddard, III. Keith Jones, geologist for Cyprus, spent the latter part of the season on the project. Vern Wallace, field assistant for Cyprus, put in most of the season with the project, as did Doug Chadwick and Tate Johnson, student field assistants. Ed Kahoe, field assistant for Cyprus, was on the job

during the early part of the season. A portion of the surveying was done by Cyprus engineering personnel from Los Angeles; the bulk of the underground surveying was done under contract by Larry Hoffman, of Butte.

An office, drafting room and space for core logging, sample splitting, and storage was maintained during the season in a former automobile showroom at 19 East Sebree Street in Dillon. The chief reason for a Dillon office was the convenience of a telephone, not available at Argenta. Housing was found to be very scarce in Dillon. The geologist-in-charge used a rental trailer, the other men motels or their own pickup-campers.

II Hand Mine

A. Summary:

The deposits mined to date are narrow vertical veins of oxidized lead-silver-zinc-gold ore in a Paleozoic dolomite-argillite sequence. The wall rock between veins does not carry sufficient values to permit non-selective mining. Other irregular deposits at the contact of the sediments with the underlying quartz monzonite or above the contact as "mantos" are known, but the two penetrations of the contact below the mine did not develop any new showings of that sort. The drilling also indicates that all the ore minerals above the quartz monzonite in the mine area are oxidized, and that dramatic or even substantial silver enrichment cannot be expected in the veins at depth. The oxide ore minerals are not efficiently recovered from the iron oxide gangue by conventional separation and concentration methods. Considerable quantities of ground water are dammed in the sediment behind the north-sloping upper surface of the underlying stock.

B. Conclusions:

The Hand Mine potential consists of a good probability that the known productive veins continue in depth to the contact with the quartz monzonite. It also includes a good probability that manto-type deposits would be found during development down to the contact. It seems likely that there is at least as much potential tonnage as has been mined over the life of the property. The principal problem in winning the potential ore would be the need to drain the large area upland (north) from the mine.

It appears that it would be difficult to increase the tonnage by lowering

the mine cutoff grade. In the absence of an effective milling method it remains necessary to maintain a grade which will stand the high costs of transportation and smelting of raw ore.

It seems probable that the water problem might be solved with some large diameter drilled wells. It is also possible that a reasonable research effort would result in finding a suitable milling process. In the face of a limited tonnage potential, e.g. 500,000 T., and an acquisition cost of $2,500,000, it becomes difficult to justify the necessary capital costs for water and process development in addition to the cost of exploring for and developing the 500,000 T. (150 T/day for 10 years.)

Assuming any reasonable tonnage potential, the Hand Mine is concluded to be too small to be of interest to Cyprus.

C. Recommendations:

As stated earlier, work aimed at the Hand Mine itself was terminated in August. No further effort by Cyprus is called for.

D. Development, Production:

The Hand Mine workings consist of some 6000 feet of drifts and 3000 feet of crosscuts on the main haulage level, as shown on the attached Geologic and Assay Maps. Most of the stoping has been from within 75 feet above or below that level, but a few stopes extend up 150 feet or more to the surface, and a few extend downward 130 feet or more, which is below the water table. In recent years the Hands rehabilitated the bottom of the Mauldin Shaft at the southeast corner of the workings. Its bottom is 130 feet below the Haulage Level; the only

lateral working from the shaft is a 30 foot crosscut east. Workings and assay data along seven of the veins worked prior to 1966 are shown on longitudinal sections from the Hand records (copies are in your files).

In general the production at any given time has come from one active stope, with one two-man crew working one shift, six days a week. The stopes are open; a slusher is used where feasible. Mining proceeds in whatever pattern is indicated by the width and grade of the faces exposed. The grade of doubtful faces is checked by sampling and lead analysis run at the mine. The attempt is made to cut off at 10 percent Pb over a 3 foot mining width. Mined ore is stockpiled at the surface until a carload lot is accumulated. The mine cars making up the lot are sampled individually; a composite sample is prepared for the carload lot and run at the mine. Low-grade, which will not bring an adequate return after transportation costs and smelter charges (about $11 per ton combined) is stockpiled. It seems that occasionally the smelter, because of a shortage of supply, will offer to take a large lot (3,000 T. usually) of low-grade for which the smelter charge will be greatly reduced.

At present the Hands operate under the following smelter schedule:

(East Helena, Montana, Smelter)

Pb:	Assay, less one percent (1%)
	Pay 90% of balance
	Weekly market price, less 1-1/2¢ lb. metal freight
Zn:	No pay
Ag:	Assay, less 1 ounce
	Market
Au:	Assay, less $2
Cu:	Assay, less three percent (3%)

Freight to Helena: $5.00
Base Treatment Charge: $6.00 (no deducts, no premiums)

The Iron Mt. (Drainage) Tunnel is the only other major underground working in the sediments in the Hand Mine area. The Iron Mt. stopes are about 600 - 700 feet southwest of the southwesterly workings of the Hand. Production started in the early days of the camp. The ores which are at the contact of the QM with limestone were developed by two inclined shafts and two tunnels. According to Shenon (1931) the old stopes indicate that considerable ore was produced. In 1958 the Hands re-opened the lower 700 foot-long Drainage Tunnel by driving around a caved area. They operated for about six months, producing about 5400 T. of lead-zinc ore (26 - 36% combined, low Ag, low Au) and about 400 T of 5 - 8% oxide Cu ore. The tunnel is caved at about 400 feet from the portal and the old stopes inaccessible.

As described the Iron Mt. ore occurs in irregular masses of oxides, with minor residual sulfides, on the limestone side of the contact.

The Hands hoped that the re-opened tunnel would lower the water table in the Hand Mine, however the re-caving has prevented the hoped-for drainage.

Some production from the Hand Mine area has come from shallow surface workings. Recently some 500 T. of ore running 10 oz. to 60 oz. Ag was shipped from a small pit about 250 feet southwest of the collar of Hole AH-1.

E. Hand Mine Geology:

The ore of the Hand Mine occurs within the Amsden Formation just above its contact with the underlying intrusive Argenta quartz monzonite. While nearly all of the production has come from near-vertical, north-trending fault veins, minor tonnages have come from northwest-trending veins, from flat "bedded"

deposits, or from irregular solution-collapse cavern fillings. Except for occasional relict sulphides, the ore is "oxide", i.e.: lead, zinc and minor copper carbonates in a gangue of limonite, cryptocrystalline silica, and carbonates. The existence of an ore shoot of commercial grade is dependent upon a combination of favorable factors - stratigraphy, structure, proximity to the igneous contact, and the effects of oxidation.

1) Stratigraphy: The Amsden strata of the mine area are impure-largely fairly thick-bedded silty or argillaceous dolomites, but with substantial sections of thin-bedded dolomitic argillites or siltstones. As exposed on the Haulage Level, the folded strata are cut by faulting into a mosaic of small blocks of varied strike and dip. Thin-bedded argillites are more common in the southeastern portion of the workings.

The only igneous rock exposed in the mine is a north-trending, vertical, quartz-porphyry (altered dacite) dike, 10 to 20 feet wide, located between Vein 7 and Vein 8 and known over a strike length of 900 feet. The dike, with a vein on each wall, is itself mineralized and altered; as a result it is difficult to attribute wall-rock alteration in that area specifically to the dike.

2) Structure: As suggested above, the structure of the host rocks in the mine is complex, in detail, as would be expected just above a granitic intrusive. In general, however, the strata are dipping gently to the east, with Mississippian limestones in the area west of the mine and the post-Amsden formations northeast of it. So also the mine area is cut by innumerable minor steep normal faults, but in general the important mineralized faults may be described as uniform,

regular and persistent. A typical vein-fault strikes N. 5° W., dips from 80° W. to 80° E., is slickensided on both walls, locally splits into several strands which rejoin along strike. Typically, where the fault traverses the more massive carbonate units, the vein is distinct, with sharp walls little affected by hydrothermal alteration or mineralization. Within such units the development of watercourses and caverns along the structure may be pronounced. In contrast, where a vein-fault traverses thin-bedded argillaceous strata, the walls are shattered and show the effects of some lateral dispersal of both hydrothermal and secondary solutions.

Within the 600 foot east-west extent of the Haulage Level workings, some twenty prominent north-south faults are present. None of them appear to have effected a large displacement between the walls; in places horizontal straie suggest that the horizontal component may be as great or greater than the vertical one. The faulting and veining in the sediments continues down into the underlying intrusive. Since the intrusive-sediment contact is well exposed and not noticeably displaced by vertical faulting, the vein-faults are viewed as relatively minor post-intrusive structures possibly sympathetic to larger regional faulting.

In the western portion of the mine, around Vein 6, a number of northwest-trending veins or veinlets are exposed, one of which, Vein B, supported a 4100 T. stope. These veins appear to be slightly displaced by the north-south system and were therefore slightly earlier.

Throughout the mine, notably in the central and southwestern portions, solution-collapse breccias have formed along watercourses. Some of these are chaotic accumulations of very large blocks of country rock with open voids between

and some cementation by secondary carbonates. Where a mineralized fault served to guide the downward-percolating meteoric waters, the oxidizing sulphides apparently provided acid for accelerated dissolution of the carbonate wall rocks. As a result caverns formed along the veins and were wholly or partially filled with wall-rock fragments, limonite, jasperoid and the "oxide" ore minerals. Some of these very irregular cavern fillings were of ore grade and were mined.

In the southeastern portion of the mine the sediments exposed are not far, vertically, from the top of the stock. It seems likely that several flat faults present in that area parallel the flat shears at the contact evidenced in the drill core. Also in the southeast portion of the mine, several steep faults of unusual east-west strike are present. These are thought of as possible evidence of east-west faulting of the stock; such faulting is suspected between the altered northern and unaltered southern portions of the stock.

3) Mineralization: Geologically-speaking, the mineralization within the Hand Mine may be said to be, like the enclosing faults, very uniform and persistent. Some vein material, however narrow, is present almost continuously along the drifts throughout the mine. And wherever there is vein material there are respectable, if not commercial, values in all of the ore metals (Pb, Zn, Ag, Au, Cu). Commercially-speaking, the high cutoff grade (10% plus Pb) demanded for direct-shipping ore puts much of the vein material out of the "ore" category. Furthermore, the width of the veins varies between 0 and 10 feet, but in the developed strike length of structures, most of it carries widths below the 3 feet required. After eliminating vein which is unprofitable on the basis of grade or mining width or both, about 25% can be classed as ore.

There does not appear to be any reliable guide to "ore" in the dimensions of a particular vein-fault, nor its attitude. The effects of secondary activity on both the primary material and on the enclosing structures may have eliminated any primary pattern of deposition that once existed, and which may exist below the water table.

The principal ore mineral is cerussite; minor amounts of residual galena and anglesite are generally present. A substantial percentage of the lead is present as plumbojarosite. The only zinc mineral noted has been the carbonate smithsonite. Silver occurs both as argentojarosite or as the chloride cyrargyrite; the gold is free. Copper is found as the oxides neodysite and tenorite, or as malachite. The ore runs over 45% Fe; it averages from two-thirds to three-fourths iron oxide - goethite, jarosite, hematite, and jasperoid. The balance of the gangue is secondary carbonate, usually calcite, and manganese oxide.

Judging from the relict sulphides, and the appearance of the mineralization in unoxidized veins cut by drill holes, the veins in the mine were originally pyrite-galena with minor tetrahedrite and/or minor sphalerite containing some exsolution chalcopyrite, all in a gangue of ankerite-siderite-rhodochrosite. No barite or fluorite has yet been identified. As to the silica now present in the jasperoid of the oxidized ore in sediments this may have been derived from siliceous sediments during hydrothermal alteration or weathering, or may have been introduced with the sulphides.

Whether the ores are enriched at the water table has not been established to date by development work since the openings have been almost entirely in the

zone of oxidation. It is known from the Iron Mt. Tunnel and from the Jack Rabbit and Copper Belle Mines that there has been secondary enrichment in copper, but evidence on gold or silver enrichment is lacking. Within the Hand Mine the deepest development reached just below the water table on Vein No. 6. The vein material was still oxidized at that level and was not notably enriched.

In considering the direction other than depth that might best be taken by future exploration for veins of the Hand Mine type, surface or drill indications of additional structures are good both east and west of the mine workings. The few development openings at the north end of the workings are an insufficient test of the continuation of the known structures in that direction. On the basis of what is known, then, it cannot now be said that the character or the strength of the Hand Mine-type of mineralization varies laterally in a predictable way. Commercial values (Pb-Ag-Au) do not appear to continue down into the quartz monzonite nor to extend very far above the contact. The vein-bearing structures continue into the intrusive, but they apparently contain only very small percentages of the ore minerals other than pyrite. In the two holes (CRX-1, AH-1) penetrating the section below the mine, a few of the stronger pyritic veins in quartz monzonite did contain narrow bands with minor quantities of galena, sphalerite, and tetrahedrite. In the exposed quartz monzonite immediately south of the mine, despite the presence of a number of steep, north-trending fault-veins with shallow diggings on them none were developed. To the north of the mine where, judging from AH-2 and the aeromagnetic data, the thickness of older rocks between the top of the intrusive and the surface increases rapidly, evidence of mineralized structures also fades out abruptly.

As to the possible existence of deposits other than the fault-vein type, evidence is meager. As stated previously, the southeast corner of the Hand workings contains some bedded mineralization in thin-bedded dolomitic argillites, and in the Iron Mountain workings, the ore was in irregular bodies parallel to the quartz monzonite-sedimentary contact. There is thus some possibility that as the upper surface of the stock is approached, below the area in and near the Hand Mine, bedded, contact, or irregular "replacement" (manto) orebodies may be found. This possibility was one of the objects of our hole AH-1 which probed the northeast corner of the mine area but did not encounter any such orebody. Nor did CRX-1 encounter any such in penetrating the contact in the area just west of the mine.

F. Geologic Mapping; Surveying:

The geology of the area around the Hand Mine is shown on the attached Geologic Map (1" = 200'). The area was mapped on a scale of 1" = 100', using a previously-laid-out transit and chain survey grid with stations every 200 feet. The grid also served for subsequent geochemical sampling and for the magnetic survey. Earlier mapping by the U.S.G.S. or by Copper Range was on too small a scale to serve as a base for evaluation of the mine area.

It was shown by the mapping that the productive Amsden units of the area were argillaceous in varying degree; it was also found that the Amsden did not have any distinctive marker units that would serve to provide a more exact structural picture. The Amsden - QM contact and the relative lack of contact pyrometasomatic effects were established in detail. As a whole, the mapping added detail to the existing picture of the mine area and improved our understanding of the Hand Mine

potential but did not point out the new prospective areas or exploration guides that had been hoped for.

G. Underground Mapping and Sampling:

The accessible Hand Mine workings were surveyed with transit and tape to carry the close control underground. Mapping was done by C. Goddard on a scale of 50 feet equals one inch; the results are shown on the attached Geology Map, Hand Mine Haulage Level. Prior mapping by W. Hand and some by K. Herness is available in the mine records at Argenta. An illustrative east-west cross-section of the mine is shown on the Copper Range drill hole section for CRX-1. Our mapping was partly an evaluation of the existing data and of unmapped areas. Much of the northern and western portions of the workings were found to be inaccessible or in unsafe condition. The old mapping was fortunately found to be complete and accurate.

One goal of our underground work was to check the possibility that the ground between productive veins might be sufficiently fractured and mineralized to permit non-selective mining of a large block of ground in the developed area. Careful examination and later sampling showed that the possibility did not exist. As to trends which might guide exploration the work showed most of the mineralization to be uniform, without a recognizeable zoning from north to south, east to west, or from the highest to the lowest working within the boundaries of the existing underground development. It was found that where one of the fault-veins intersected thin-bedded argillites some mineralization followed the bedding. This did suggest the possibility that the mine area may contain mineralized blocks of greater tonnage potential than might be available in the narrow veins.

The results of underground sampling are shown on the attached Assay Map, Hand Mine Haulage Level. Three hundred forty five continuous chip samples were cut, using five-foot, or ten-foot sample widths; assays for five elements (Au-Ag-Cu-Pb-Zn) were run by Degenhart at Philipsburg. Previous sampling by the Hands and by Gunnar Mines is shown on an assay plan from the Hand data, a copy of which is in your files.

As stated above, the sampling of crosscuts in effect ruled out the ability of the ground between veins to carry itself in non-selective mining. The sampling of the bedded mineralization at the southeast corner of the mine workings returned values of 2 - 4 percent combined lead-zinc, lessening the possibility of a block of open-pit material in that area, at least above the Haulage Level. Some 26 samples were cut from workings along Vein 6, at the west side of the mine, below the Haulage Level, just above the water level. The object of this sampling was to see whether detectable enrichment was present at the lowest accessible working. The result was that our assays, particularly Pb and Ag, were lower than those shown in the Hand data (Longitudinal Section, No. 6 Vein) for the back of the stopes above the Haulage Level. It is possible that our assays are more conservative than Hand's, but no reasonable correction would improve the results enough to demonstrate enrichment.

III The Porphyry Copper Potential

A. Summary:

The Porphyry Copper Potential at Argenta was recognized before the start of the project in the area, but it was also recognized that its evaluation would probably take several seasons and substantial drilling funds. The decision was made prior to the 1970 field season to evaluate the Hand Mine potential first, since it might result in a reserve that might be developed quickly into a producer. As the 1970 work progressed, evidences bearing on the "porphyry bet" developed about as follows:

1. Re-logging in detail of the Copper Range drill core, specifically CRX-1, demonstrated the pervasiveness of argillic alteration and an increase in intensity of both alteration and mineralization (veining, pyrite) with depth (or west to east).

2. Review of the existing magnetic and I. P. data indicated the extent of alteration throughout the northeast half of the exposed QM stock. A discussion of Geophysics is presented under I - I. above.

3. Geologic Mapping indicated pervasive propylitic alteration at the margins of the altered portion of the stock, pervasive argillic alteration in the more fractured portions of the stock and overlying sediments, as well as local high-intensity kaolinitic (pyrophyllite) alteration.

4. Microscopic and laboratory studies of rock samples from outcrops and drill cores confirmed the megascopic observations as to alteration zoning of the clay minerals. A summary by C. Goddard of the findings from this work is included in Sections D, E, and F below.

The picture resulting from these evidences is of a triangular body of altered quartz monzonite, over a mile long on its northern and eastern sides and a mile-and-a-half long on its southwestern leg along the south margin of the Argenta Townsite flats. Penetrations and exposures of QM in this area are insufficient for a three-dimensional picture of lateral and vertical alteration and mineral zoning. Geophysical data suggests that alteration and sulfide mineralization are strongest along the southwestern leg of the triangle. The strongest outcropping alteration is the pyrophyllite concentration just south of the mine. Data from the core suggests that if a copper orebody is present it may well be at a depth greater than the 1050 feet reached by CRX-1. Theoretical considerations of the typical pattern (Ref. 6, 8) of hydrothermal alteration of a porphyry copper suggest that the alteration zone most likely to be copper-bearing has not yet been penetrated.

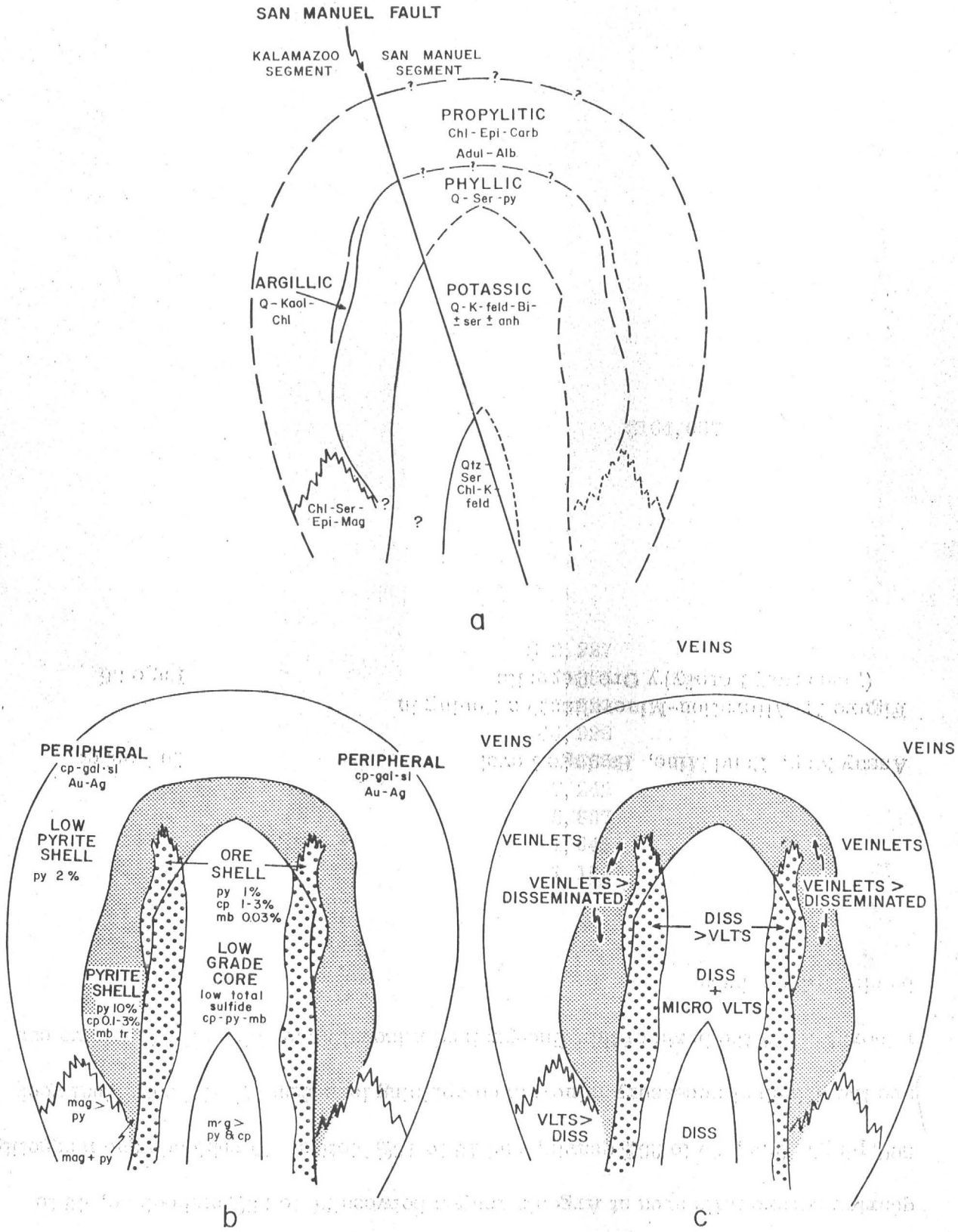

FIG. 3. Concentric alteration-mineralization zones at San Manuel-Kalamazoo. (a) schematic drawing of alteration zones. Broken lines on Kalamazoo side indicate uncertain continuity or location and on San Manuel side extrapolation from Kalamazoo. (b) schematic drawing of mineralization zones. (c) schematic drawing of the occurrence of sulfides.

B. Conclusions:

The potential for finding a large body of low-grade, disseminated copper mineralization is considered to be good. The alteration-mineralization pattern indicated by the evidence developed to date has much in common with that found among the outer zones of a number of districts containing disseminated copper ore deposits in quartz monzonite intrusives, e.g., San Manuel, Arizona (8), Butte (7).

With reference to the model illustrated in Figure 1 (Ref. 8, p. 379), the section of the District explored to date is viewed as the propylitic alteration zone which, in the case of Argenta, is more complex than the sample model in having been cut by linear fracture zones which exhibit more intensive types (argillic or phyllic) of alteration. Conforming to the model, the sulfides above the quartz monzonite at Argenta occur as veins, in the Argillic-Phyllic zone as veinlets. The penetrations to date can be said to be still in the low-pyrite mineralization zone. One is, then, justified in looking, with increasing depth, for a high-pyrite shell giving way in turn to chalcopyrite-pyrite ore coinciding roughly with the boundary between the quartz-sericite-pyrite (Phyllic) and the quartz-orthoclase (Potassic) types of alteration.

Adequately-sized altered stocks of the Argenta type are scarce and considered to merit a thorough evaluation. Admittedly, all of the information on Argenta is not positive; from the drilling to date it would seem likely that if a large body of ore is present, it is probably below open-pit depth, possibly at over the 2,000 foot vertical depth penetrated by CRX-1. Apparently there has

been no secondary blanket enrichment in the stock. It is recognized that in all cases of exploration for disseminated ores, there is no assurance that if primary copper mineralization is found in the predicted position in the zoning pattern that it will be of ore grade. To date the molybdenite and precious metal content of the observed mineralization in the QM has been very meager. None of these factors are debilitating, however; further exploration aimed at the zoning pattern and ultimately at the locus of copper deposition is well justified in my opinion by the positive evidences in hand and the magnitude of the potential.

To date the available evidence does not clearly point in one specific direction. The apex of the stock was apparently at or south of the Argenta Townsite flats. As stated in the Summary above, other evidences suggest other sectors as the best place to put in the next exploratory probe; all evidences point to depth. In this situation it seems desirable to obtain full coverage of all the prospective sectors with the exploration tools which seem to be effective before committing the funds needed for the next round of drilling.

Mention should be made of the similarity of the magnetic patterns over and around the stocks north of Argenta to those around the project area. In effect the district as a whole has some wildcat "porphyry" possibilities in addition to the best-known target south of the Hand Mine.

In summary, Argenta constitutes the typical "porphyry copper" bet that is sought after and explored by nearly all the major exploration groups today. Typically, the basis for effort is the analogy between a theoretical picture of alteration-mineralization zoning and the incomplete picture made by the partial

and scattered evidence available at the moment. Until the actual picture has been completed the permissibility for a major deposit is inescapable, and the indicated course for work is clear.

C. Recommendations:

The required expenditure at Argenta for the year ending October 17, 1971 under existing contracts and the mining laws will be about $40,000 after deducting the carry-forward from 1970. Although geological-geochemical-geophysical studies could be used for the assessment work, it would seem that the total required to be spent presupposes some drilling. As suggested under Conclusions above, completion of the geochemical and geophysical coverage of the target "altered triangle" and its immediate environs will provide a tangible basis for judging among the possible drill sites. Accordingly, I have the following recommendations:

1. The Hand and Nygren properties should be retained by your company during 1971.

2. The exploration of the "altered triangle" should proceed in two stages during 1971, i.e.:

a) Surface work including (1) completion of the copper-in-soil geochemical survey, (2) several northeast-southwest IP lines across the center of the triangle (using 1000 foot dipole spacing and a longer spacing if feasible), (3) completion of the 200 foot grid coverage with a ground magnetometer survey, and (4) review of our petrographic data and samples by a leading expert, and further laboratory work on existing materials, if desireable.

b) Drill two deep (3000 foot) holes, (in succession, not concurrently) at the best widely-spaced locations indicated by the results of the surface work.

It is estimated that Stage a) will cost less than $20,000 and can be completed by June 30, 1971. Six thousand feet of drilling at $13 per foot would be $78,000, and would require, judging from CRX-1, six months. In that period only one logger-sampler would be needed; with assays, new core-storage facilities and year-end reporting, the overhead for Stage b) should be about $12,000. The total for the year would then be $110,000.

The above program is considered to be the minimum effort which would permit a "No Go" decision in 1971. Deferring the decision until 1972 will involve both the 1971 expenditure of $35,000-$40,000 and the 1972 commitment maturing 17 October, 1971 for $175,000. If the 1971 budget for the project is limited to the legally-required $35,000-$40,000 rather than the recommended $110,000, my recommendation would continue to be that the "Stage a)" surface work be done, with the balance of authorized funds above Stage a) requirements going into drilling the first 1500 feet or so of the first hole of Stage b). If the entire amount ($35,000-$40,000) were allocated only to drilling in 1971, then the hole would have to be spotted on the basis of our present incomplete picture, with the risk that it might not provide any definitive data ultimately needed for a decision on the property. Therefore, if the minimum program is elected it would be essential to include the "Stage a)" program.

D. Petrography:

This and the following two sections of this report on Alteration and Mineralogy were written by C. C. Goddard, III, Consulting Geologist, who was in charge of the field work at Argenta during the 1970 season.

The intrusive stock, alteration and mineralization, at Argenta was studied by Dr. H. F. Fisk and Dr. F. N. Earll of the Montana Technical College, Butte, Montana. Results of these studies are summarized below. Copies of the original reports are in Cyprus' Spokane files. In addition to forty thin section and ten polished section examinations their efforts included: a) supporting oil immersion studies of individual minerals separated electro-magnetically from complex clay aggregates, b) both conventional and experimental clay and feldspar staining processes for mineral identification, and c) a number of investigations of the more complex rock alteration patterns with x-ray diffraction.

These comprehensive studies of representative samples of drill core, outcrop, and mine material are of such quality that the results may be applied to any or all parts of the Argenta district without reservation.

Argenta Quartz Monzonite

The mineral composition of the igneous stock that outcrops over a three quarter square mile area at Argenta ranges between 20 to 25% orthoclase, 40 to 50% plagioclase, 20 to 25% quartz, and 10 to 15% biotite. Hornblende and magnetite are the principal accessory minerals comprising less than 5% of the original rock minerals. On the basis of this fine-grained mineral assemblage the intrusive can be classified a hypabyssal quartz monzonite.

A maximum refractive index for the plagioclase is 1.56 suggesting that it is a high calcic (Ab_6-An_4) andesine. All of the andesine and some orthoclase are twinned and zoned. In mapped areas pleochroic brown biotite in the quartz monzonite has been partly, or totally, replaced by chlorite giving the rock a distinct dark gray-green color.

A facies of the quartz monzonite formed slightly earlier than the main mass exhibits a sub-ophitic hypidiomorphic fabric. In this facies subhedral to euhedral plagioclase crystals are lath-shaped and vary from 0.2 to 2.0 millimeters in length and 0.5 to 1.0 millimeters in cross section. The later facies shows the same sub-ophitic fabric and crystallization sequence differing only in grain size. Feldspars in this facies range between 1.5 and 3.5 millimeters in length and 1.0 to 2.0 millimeters in cross section. Euhedral orthoclase and biotite with crystal dimensions similar to the plagioclase in the two facies apparently formed after the plagioclase and anhedral quartz filled the interstices between the crystallized feldspars and biotite. Evidence for the later phase of quartz monzonite other than grain size difference consists of deuteric alteration at the gradational contact, sub-

angular inclusions of the earlier phase in the later phase, and the presence of epidote and andradite in the contact zone of the earlier facies.

Intergranular movement, or microfracturing, shredded the biotite in both facies and intact hexagonal biotite crystals are rare. The interstitial quartz is similarly fractured and the feldspars to a lesser degree. In altered portions of the stock, microfractures are filled with calcite, ankerite, quartz, and pyrite. Microfracturing is almost totally obliterated in zones of intense alteration.

Andesite and Dacite Porphyries

A number of dikes outcrop in quartz monzonite on the south bank of Rattlesnake Creek at Argenta and transect the quartz monzonite north of the creek and extend into the metasediments along its northern margins.

Lath shaped plagioclase crystals in these dikes range in length from 0.5 to 1.0 millimeters and from 0.2 to 0.5 millimeters in cross section. The plagioclase, which is andesine, comprises between 60 and 70% of the mineral composition in the andesite and dacite dikes. Both rocks also contain between 10 and 20% euhedral orthoclase with the approximate dimensions of the andesine. The feldspars in the andesite and dacite dikes occur in microcrystalline groundmasses of quartz and minutely fragmented feldspar.

The most distinguishing characteristic of the andesite dikes is their content of 2 to 5% magnetite and 15 to 25% augite as phenocrysts measuring 1.5 to 2.5 millimeters in length and 0.5 to 1.5 millimeters in cross section. Dacite can be identified, megascopically, by its 20 to 30% content of quartz in subhedral phenocrysts measuring 2.0 to 2.5 millimeters in maximum dimension.

Amsden Formation

The Upper Mississippian Amsden Formation is in contact to the Argenta stock along its northern margins. Most of the productive mines in the district are located in this formation within several hundred feet of the igneous contact.

The Amsden Formation at Argenta consists of interbedded limey argillites, hornfels, and argillaceous limestone. Bedding thicknesses range between one and twenty-five feet in these units with limestones generally forming the thicker beds. All of the units are extremely fine grained with particle sizes in the clastic limey argillites rarely exceeding 0.5 millimeters in largest dimension.

Petrographic and x-ray diffraction studies of some units in the Amsden Formation indicate an original 35% to 65% clay mineral content in the hornfels and limey argillites and between 10% and 25% clay in the argillaceous limestones. Kaolinite, halloysite, endillite, montmorillonite, saponite (?), palygorskite, and pyrophyllite were identified in many of the examined samples. Apparently most of the kaolinite and montmorillonite is of hydrothermal origin as these minerals often occur in crystalline habit with structurally controlled accumulations of pyrophyllite.

E. Alteration:

Quartz Monzonite

In exposures southwest of Argenta, the quartz monzonite appears to be fresh with resilient biotite crystals exhibiting vitreous luster and no chloritic replacement. North of Argenta, the stock appears superficially to be only slightly altered in most of the prominent outcrops. Biotite crystals and fragments,

however, have lost their luster and resiliency and are partly, or totally, replaced by chlorite. Locally, where strong tectonic jointing is evident in the stock, biotite is totally replaced by pennine and sericite. In these areas, feldspars also are replaced by either pyrophyllite, sericite, kaolinite, or montmorillonite.

Pyrophyllitic alteration is restricted to several structurally-controlled zones immediately north of Rattlesnake Creek. A pyrophyllite and sericite alteration of feldspar forms a halo pattern around the margins of the pyrophyllitic alteration zones. Sericite and a sericite-kaolinite alteration of feldspars is associated with some of the larger northwest trending fractures that extend from Rattlesnake Creek to beyond the northern margins of the intrusive. Montmorillonite also replaces some feldspars in the zones described and partially replaces feldspars many hundreds of feet into the adjacent wall rock.

Alteration in the Argenta stock suggests a horizontal, or lateral, zoning pattern. The most intense mesothermal alteration is manifested in one three-hundred foot wide and six-hundred foot long pyrophyllite zone and two smaller zones shown on the Geology Map on the north bank of Rattlesnake Creek near the Ferdinand and Bella mines. The amount of feldspar replacement by pyrophyllite apparently diminishes toward the northern margins of the intrusive.

An alteration of intermediate, or epithermal, intensity is restricted to larger structures in the extensive fracture system. The epithermal alteration extends through the stock within the confines of closely spaced parallel fracture planes and into the metasediments along its contacts.

The outlines of these alteration zones are obvious although locally where

intense alteration has been superimposed on less intense patterns the outlines are more obscure. The superimposed intense alteration on weaker patterns probably occurred during the repeated fracturing of the Argenta stock.

At least three stages of fracturing have been recognized in core samples by the displacement of one veinlet by another containing entirely different suites of sulfide and gangue minerals. Some veinlets in the core, ranging between 10.0 and 50.0 millimeters in width, also exhibit classic ribboned structure of quartz-sulfide, quartz-calcite-sulfide, and calcite-ankerite-sulfide within the same veinlet. Where evidence of multi-stages of mineralization is observed, an incipient alteration of higher intensity usually has been superimposed on a more extensive alteration of lower intensity.

Alteration of the stock in the third dimension of depth, as interpreted from drill core data, suggests a vertical alteration zoning similar to the lateral, or horizontal, alteration zoning patterns previously described. Vertical sections A-A' and B-B' show that CRX-1 attained the greatest depth and contained the longest intercepts of intensely altered quartz monzonite in the mesothermal range. Holes AH-1 and AH-4 contain epithermal argillic alteration over significant intervals on these sections and Hole AH-3 clearly illustrates an epithermal argillic alteration associated with narrow structures and restricted to these widely spaced fracture zones. Most of the quartz monzonite in AH-3 and AH-4 is the later facies described in a preceeding section on petrography.

The argillic alteration logged in drill holes and shown on the vertical sections is comprised predominantly of kaolinite and lesser quantities of montmorillonite

and sericite. Orthoclase, plagioclase, and some chlorite are totally replaced by these minerals in the indicated intervals. However, montmorillonite with minor quantities of kaolinite partially replaces orthoclase and plagioclase beyond the boundaries of the more intense alteration shown on the vertical sections. In these montmorillonite envelopes the amount of feldspar replacement gradually diminishes as the distance from the core of total replacement increases. This decrease in the degree of feldspar alteration undoubtedly is related to proximity of fractures in the hydrothermal conduit system and could not be distinguished megascopically or with simple optical aids in the field.

Within zones containing both types of argillic alteration (kaolinite, montmorillonite) calcite and ankerite are the predominant gangue minerals in the multitude of 0.05 to 10.0 millimeter wide veinlets. The few quartz veinlets observed in argillic alteration zones seemed to be associated with a later superimposed higher intensity sericite and kaolinite alteration.

The mesothermal silicification logged in the deepest intervals of CRX-1 and AH-1 contrasts sharply with the argillic alteration present in the upper portions of the holes. Well defined quartz veinlets are predominant over relatively scarce carbonate veinlets and many of the quartz veinlets exhibit ragged indistinct margins where vein silica has invaded and replaced the wall rock. Orthoclase, plagioclase, and chlorite, are entirely replaced by sericite and kaolinite and trace quantities of pyrophyllite.

From the narrow silicic alteration near the bottom of AH-1 to much wider zones of intense alteration toward the bottom of CRX-1 there is but a vertical

difference of 350 feet. Perhaps with additional depth this type of alteration might become pervasive and as silicic alteration is almost always associated with classic "porphyry copper deposits", this possibility should be further investigated.

Andesite and Dacite Porphyries

North and northwest trending dikes appear on the geologic map as latite, quartz latite, and quartz porphyry dikes. Field classifications appearing on the geology map are incorrect. Laboratory examinations show these rocks originally were andesite and quartz dacite. The steeply dipping dikes, range between one foot and four feet in width and occupy a number of the prime set of closely spaced fracture cleavages in the stock and metasediments. These structures apparently are the principal conduits in the hydrothermal system.

The pre-mineral dikes are intensely altered and mineralized. Locally, they contain both quartz and carbonate veinlets and are pockmarked with fine limonite-filled casts after pyrite. Quartz and sericite totally replace the groundmass and feldspars. In some of the dikes partly resorbed quartz phenocrysts measuring 2.0 to 2.5 millimeters in diameter are the only recognizable original rock forming mineral. A low temperature, iron-rich orthoclase (adularia) one to two millimeters in length occurs as fresh euhedral crystals in extremely well altered portions of the dikes.

Amsden Formation

Contact metamorphism along the north margins of the Argenta intrusive resulted in the conversion of limey argillites to hornfels, the recrystallization of purer limestones to fine and coarse-grained marbles, and the formation of

minor quantities of wollastonite and forsterite. A similar metamorphism of the same formation was indicated by drilling in a portion of the south contact which os overlain by Tertiary gravel. A coarsely crystalline marble intersected by the drilling, however, contained significant quantities of grossularite and magnetite. These minerals are not present in the metasediments along the north contacts of the intrusive.

The Amsden sediments along the north contact have been hydrothermally altered. Hornfels with high clay content have been sericitized and indigenous clays in the impure limestones have been converted to crystalline montmorillonite, kaolinite, and sericite. Moderate to intense argillization may extend at least 1500 feet into the sediments north of the contact as suggested by the number of well altered quartz porphyry dikes and the abundance of iron-manganese stained veins and veinlets within this distance of the contact.

Cyrptocrystalline silica and very fine crystalline quartz particles were introduced, or remobilized and concentrated, in veins and vein wall rocks by hydrothermal activity. Weathering and the oxidation of vein sulfides has converted some of this silica to blood red jasperoid veins which are most plentiful in the vicinity of the Hand, Jack Rabbit, and Copper Belle mines.

F. Mineralogy:

Polished section studies and supporting microchemical analyses and x-ray diffraction investigations were made of CRX-1 drill core samples and sulfide ore minerals from the Copper Belle, Jack Rabbit, Cold Day, and Ferdinand mines. Although no single sulfide depositional sequence applies to all of the examined specimens, a general pattern of paragenesis was developed.

Quartz appeared first in established fractures and displaced previously formed clay and calcite. Pyrite and sphalerite were deposited almost contemporaneously with the quartz but somewhat later. A period of shattering followed and was accompanied by the introduction of quartz and chalcopyrite or calcite and tetrahedrite. A third period of fracturing occurred during which minor amounts of quartz and large quantities of galena were deposited and replaced earlier formed sulfides. A final stage of fracturing was accompanied by the deposition of calcite with minor amounts of pyrite.

The mine ores contained all of the primary sulfide minerals described in the paragenesis although pyrite was the most plentiful sulfide in all of the examined specimens. No clear pattern could be seen in the ratios of one ore sulfide to another from the various parts of the district. However, more chalcopyrite was identified in ore from the centrally located Copper Belle mine than was present in ore from mines along the east contact. The Copper Belle ore also contained more tetrahedrite than chalcopyrite. Galena was the most abundant ore sulfide in samples from mines along the eastern contact. Chalcopyrite in the mine samples was predominantly in exosolution blebs within sphalerite.

Supergene minerals in the mine samples consisted of chalcocite and covellite. These minerals replaced exosolution chalcopyrite and tetrahedrite. No supergene minerals were present in the core specimens studied. Cerussite and anglesite were the principal oxide ore minerals forming shells around nodules of galena, sphalerite, and pyrite. Malachite, cuprite, and tenorite also were observed in samples from the Copper Belle mine.

Although efforts to date have failed to intersect substantial mineralization of ore grade, the ore mineralogy of the drill holes indicates a porphyry copper possibility in the district. For example; quartz veinlets containing chalcopyrite in the drill holes rarely contained tetrahedrite and calcite-tetrahedrite veinlets contained only trace quantities of chalcopyrite as exosolution beads in sphalerite. These facts point to either a) a separate genesis for these two sulfides or b) a vertical sulfide zoning distribution paralleling the previously-described increase in alteration intensity with depth. Chalcopyrite in the deeper parts of CRX-1 and AH-1 is associated with veinlet quartz that replaces wall rocks. This is the criterion for classifying the silicic alteration pattern shown on the vertical sections and outlined in the preceeding descriptions of alteration.

The vertical zoning of sulfides is evident in the amount of tetrahedrite over chalcopyrite in ores from the mines that probe only the thin layer of overlying sediments and the first few hundred feet of the intrusive. Drilling results also support the sulfide zoning concept by showing more tetrahedrite-calcite veinlets in the sediments and in the upper portions of the intrusive.

The chalcocite enrichment shown on vertical sections in holes AH-1, AH-3, and AH-4 obviously was derived by the leaching of copper from minor quantities of tetrahedrite and exosolution chalcopyrite in the original lead-zinc sulfide veins in the overlying Amsden limestones. The copper in solution was then deposited as chalcocite replacements of unoxidized pyrite veinlets in the first two hundred feet of the quartz monzonite intrusive. Much of the leached copper in solution was depleted by reaction with carbonate host rocks and as a consequence, malachite formed at the expense of the chalcocite enrichment.

A H 1

From	To	Int	Ag	Au	Cu	Pb	Zn
9	19	10			Tr	.01	
19°	28.5	9.5			Tr	.01	
28.5	30	1.5			.06	.25	
30	40	10			Tr	.05	
40	45	5			Tr	.05	
45	49	4			Tr	.10	
49	54	5			Tr	.10	
54	60	6			Tr	.10	
60	70	10			Tr	.10	
70	75	5			Tr	.10	
75	80	5			Tr	.10	
80	86	6			Tr	.05	
86	106	20			Tr	.15	
106	116	10			Tr	.05	
116	126	10			Tr	.10	
126	136	10			.02	.35	
136	146	10			Tr	.05	
146	148	2			Tr	.10	
148	151	3			Tr	.10	
151	154	3			Tr	.10	
154	164	10			Tr	.30	
164	168	4			Tr	.05	
168	178	10			Tr	.05	
178	188	10			Tr	.05	
188	198	10			Tr	.05	
198	208	10			.04	.10	

AH 1

From	To	Int	Ag	Au	Cu	Pb	Zn
208	218	10			Tr	.30	
218	223	5			.04	.20	
223	233	10			Tr	.05	
233	243	10			Tr	.05	
243	248	5			Tr	.10	
248	258	10			Tr	.05	
258	268	10			Tr	.10	
268	278	10			.02	.05	
278	288	10			Tr	.05	
288	298	10			Tr	.05	
298	308	10			Tr	.05	
308	318	10			Tr	.05	
318	328	10			Tr	.15	
328	338	10			Tr	.25	
338	343	5			Tr	.15	
343	348	5			Tr	.30	
348	358	10			Tr	.05	
358	368	10			Tr	.05	
368	373	5			.02	.05	
373	383	10			Tr	.15	
383	393	10			Tr	.20	
393	403	10			.02	.30	
403	413	10			Tr	Tr	
413	423	10			Tr	Tr	
423	433	10			Tr	Tr	
433	443	10			Tr	Tr	

AH 1

		Ag	Au	Cu	Pb
443 - 448	5			Tr	Tr
448 - 456	8			Tr	.05
456 - 466	10			Tr	Tr
466 - 476	10			Tr	Tr
476 - 486	10			Tr	.05
486 - 496	10			Tr	.85
496 - 506	10			Tr	.10
506 - 516	10			Tr	.05
516 - 526	10			Tr	.10
526 - 536	10			Tr	.20
536 - 546	10			Tr	.05
546 - 553	7			.04	.30
553 - 563	10			Tr	.20
563 - 573	10			Tr	.05
573 - 583	10			Tr	.05
583 - 593	10			Tr	.05
593 - 603	10			Tr	.10
603 - 613	10			Tr	.05
613 - 623	10			Tr	.05
623 - 635	12	.06	Tr	.02	.04
635 - 639	4	.24	Tr	.02	.14
639 - 645	6	.32	Tr	.03	.25
645 - 654	9	1.20	Tr	.21	.51
654 - 660	6	.28	Tr	.28	.05
660 - 665	5	.88	Tr	.39	.21
665 - 670	5	Tr	nil	.03	.13
670 - 675	5	Tr	nil	.03	.11

20

carbonate ↑

↓ stock

THIN ENRICHED

0.28 %

0.84 oz A

AH 1

		Ag	Au	Cu	Pb
675 - 680	5	.Tr	nil	.02	.03
680 - 685	5	Tr	nil	.04	.04
685 - 690	5	Tr	nil	.02	.03
690 - 695	5	Tr	nil	.04	.04
695 - 700	5	Tr	nil	.01	.03
700 - 705	5	Tr	nil	.005	.03
705 - 710	5	Tr	nil	.005	.04
710 - 715	5	Tr	nil	.005	.05
715 - 720	5	.14	Tr	.02	.02
720 - 725	5	Tr	nil	.01	.01
725 - 730	5	Tr	nil	.01	.02
730 - 735	5	.01	nil	.34	.04
735 - 740	5	.01	nil	.05	.03
740 - 745	5	.01	nil	.11	.05
745 - 750	5	.03	nil	.06	.07
750 - 755	5	Tr	nil	.02	.01
755 - 765	10	nil	Tr	Tr	Tr
765 - 775	10	nil	Tr	Tr	.05
775 - 785	10	nil	Tr	Tr	.05
785 - 795	10	nil	Tr	Tr	.15
795 - 805	10	.30	.003	.15	.20
805 - 815	10	nil	Tr	Tr	.20
815 - 820	5	nil	Tr	Tr	.05
820 - 825	5	.10	Tr	.46	.05
825 - 830	5	nil	Tr	Tr	.05
830 - 835	5	nil	Tr	Tr	.05
835 - 840	5	nil	Tr	Tr	.20

A H 1

			Ag	Au	Cu	Pb
840 -	845	5	nil	Tr	Tr	.32
845 -	850	5	nil	.01	.04	.05
850 -	855	5	nil	Tr	Tr	.05
855 -	860	5	.10	.02	.15	.05
860 -	868	8	nil	Tr	Tr	.63

ARGENTA AH - 3

from - to	Interval	Ag	Au	Cu	Pb	Zn
39 - 440	5'			.011	.019	
85 - 94	9'	Tr	Nil	.044	.24	
117 - 125	8'			.006	.028	
209 - 215	6'			.004	.018	
302 - 307	5'	.10	.015	.04	1.69	Tr
307 - 317	10'	.46	.002	.02	.05	ND
317 - 327	10'	.30	.002	.01	.20	ND
327 - 337	10'	.20	.025	.02	.63	Tr
337 - 342	5'	.05	.005	.04	.05	.15
342 - 347	5'	.25	.040	.27	1.16	1.70
347 - 352	5'	.25	.010	.05	.32	1.00
352 - 357	5'	1.70	.015	.05	.74	Tr
357 - 362	5'	ND	.002	Tr	.05	ND
362 - 368	6'	ND	.002	Tr	.05	ND
368 - 373	5	ND	Tr	Tr	Tr	ND
373 - 383	10'	.05	.002	Tr	.05	ND
383 - 388	5'	.05	.002	.04	.42	ND
388 - 398	10'	Tr	Tr	.02	.05	ND
398 - 408	10'	Tr	Tr	.02	.05	ND
408 - 418	10'	.05	.010	.34	1.59	2.40
418 - 423	5' ~~.05~~	.05 ~~.010~~	.010 ~~.24~~	.34 ~~1.59~~	1.59	4.50
423 - 433	10'	Tr	nil	.13	1.36	3.18
433 - 443	10'	.06	nil	.01	.05	.02
443 - 448	5'	.06	.01	.08	.66	1.71
448 - 458	10'	.05	tr	.01	.05	ND
458 - 468	10' ~~ND~~	ND ~~1~~	tr	tr ~~.05~~	.05	ND
468 - 478	10'	ND	tr	.02	.05	tr

SUPERGENE ZONE 25' 0.26 %

From - To	Interval	Ag	Au	Cu	Pb	Zn
478 - 488	10'	.05	tr	tr	.05	tr
488 - 493	5'	ND	tr	.12	.32	.80
493 - 503	10'	ND	tr	tr	tr	tr
503 - 513	10'	ND	tr	tr	.15	.35
513 - 518	5'	.80	tr	.05	.32	4.10
518 - 528	10'	.05	tr	.17	.53	1.70
528 - 538	10'	.05	tr	.07	.05	.60
538 - 548	10	ND	tr	tr	.05	ND
548 - 553	5	ND	tr	tr	.10	.18
553 - 558	5	.05	tr	.07	.42	1.30
558 - 568	10	ND	tr	tr	.10	tr
568 - 578	10	.05	tr	tr	.10	tr
578 - 588	10	ND	tr	tr	.10	ND
588 - 593	5	ND	tr	tr	.21	ND
593 - 603	10	.30	tr	.17	.21	.80
603 - 613	10	ND	tr.	.05	.32	tr
613 - 623	10	ND	tr	.02	.21	.40
623 - 633	10	.10	tr	.05	.05	.75
633 - 643	10	ND	tr	.07	.05	.65
643 - 653	10	tr	nil	.03	.29	.77
653 - 663	10	.10	.01	.05	.09	.43
663 - 673	10	.16	nil	.09	.04	.27
673 - 683	10'	.34	.01	.17	.13	.49
683 - 693	10'	.05	tr	.02	.15	ND
693 - 703	10'	ND	tr	tr	.15	ND
703 - 713	10'	.05	tr	.05	.30	.95

AH 4

From	To	Int	Ag	Au	Cu	Pb	Zn
0 -	61		Amsden				
61 -			Stock				
268	273	5	.05	.002	.05	.05	.50
273 -	278	5	nil	Tr	Tr	.05	nil
278 -	283	5	nil	Tr	Tr	.05	nil
283 -	293	10	nil	Tr	Tr	.05	nil
293 -	303	10	nil	Tr	Tr	.05	nil
303 -	313	10	nil	Tr	Tr	.05	nil
313 -	323	10	nil	Tr	Tr	.05	Tr
323 -	333	10	nil	Tr	.02	.05	.05
333 -	343	10	.05	Tr	.05	.10	1.35
343 -	353	10	.05	Tr	Tr	.25	nil
353 -	363	10	nil	Tr	Tr	.10	nil
363 -	373	10	nil	Tr	Tr	.15	nil
373 -	374	lost					
374 -	384	10	nil	Tr	.02	.10	nil
384 -	394	10	tr	nil	.02	.03	.04
394 -	404	10	tr	nil	.01	.04	.03
404 -	414	10	.28	.01	.04	.42	1.18
414 -	424	no assay					
424 -	434	10	nil	tr	tr	.30	nil
484 -	494	10	nil	tr	.02	.05	nil
494 -	499	5	nil	tr	.02	.10	nil
499 -	504	5	.34	.04	.21	.19	.30
504 -	514	10	nil	tr	.02	.10	nil
564 -	574	10	[illegible]	tr	.86	.30	[illegible]