CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
416 W. Congress St., Suite 100
Tucson, Arizona 85701
602-771-1601
http://www.azgs.az.gov
inquiries@azgs.az.gov

October 7, 1970

Mr. Austin Smith
Gold Bar Resources
1405 South Main
Salt Lake City, Utah

Dear Mr. Smith:

In accordance with our discussions in Salt Lake City on October 2, 1970, I am submitting an outline of a proposal for a lease-option purchase agreement of the Cashin claims.

Essex would be interested in two 6-month options to evaluate and prove the potential of the property. Payments during the first 6 months would be $1,250 per month anticipating this sum is approximately one-half of the interest due. If Essex elected to proceed with a second 6-month option the balance of the interest payments for the first 6 months would be paid in a lump sum. During the second 6 months, the full interest payments on the loan would be assumed by Essex.

If Essex elected to exercise its option at the end of the second 6-month option, the loan obligation would be assumed. The buy-out price would be $600,000 excluding the interest payments on the loan for the one year option period. This price would include approximately $325,000 of the loan.

Payment of the purchase price would be from a production royalty of 5% of net smelter return once operations commenced. Prior to production royalty payments a minimum annual payment of $50,000 per year would be made by Essex. All such payments would be deductible from the final purchase price of $600,000.

Mr. Austin Smith
Gold Bar Resources
Salt Lake City, Utah

October 7, 1970

The above proposal would be contingent upon your providing clear title to the property exclusive of the lien for the amount of the $325,000 loan.

Very truly yours,

ESSEX INTERNATIONAL, INC.

Howard Lanier, General Manager
Copper Operations

HL:td

cc: J.A. O'Connor
Ft. Wayne, Ind.

ALLEY METALLURGICAL PROCESSING
COMPANY, INCORPORATED
URANIUM BUILDING • MOAB, UTAH 84532

CASHIN MINE

GEOLOGICAL REPORT

SUBMITTED BY:

DAVID H. STALKER

GEOLOGY

The copper-silver deposits of the La Sal mining district occur along Northeast trending fissures in sedimentary rocks of Triassic age. In the district, the beds have a dip of 3 - 4^{o} to the Southwest but less than two miles North of the mines the dips are much steeper where they are cut by high angle faults along the Southwestern flank of the Paradox Valley anticline.

The anticline, like others in the region, has an intrusive core of salt and gypsum. The evaporite beds are part of the Paradox member of the Pennsylvanian Hermosa formation.

The nearest igneous rocks are in the La Sal mountains, 12 miles Northwest of the mines.

STRATIGRAPHY

Chinle Formation. The Triassic Chinle formation is not exposed at the surface, however, several drill holes penetrated the Chinle in the mine area. The formation is approximately 435 feet thick (Withington 1955) and is composed of red siltstone with interbedded red shale and fine grained sandstone. Several beds of conglomerate up to 30 feet thick are present in the lower part of the formation. In the mineralized portion of the Cashin fault, the shale has been altered to a green color and the sandstone and siltstone are bleached white.

Wingate Sandstone. The Wingate sandstone is of Upper Triassic age and conformably overlies the Chinle Formation.

The Wingate is a white, massive, fine grained crossbedded sandstone with thin lenses of shale near the top of the formation. Itis 290 feet thick in the mine area. The sandstone weathers to a buff color and in the drill holes, the sandstone graded into a deep red color at depth. The bleaching near the mine is believed to be the result of hydrothermal solutions and leaching due to acid solutions caused by the oxidation of the sulfides.

Kayenta Formation. The Kayenta formation is of Jurassic age and is gradational and conformable to the Wingate sand stone. The formation is approximately 200 feet thick and is predominently sandstone of various colors, but also contains red siltstone, thin-bedded shale and conglomerate (Winthington 1955). Local bleaching has taken place near the Cashin fault.

STRUCTURE

The La Sal district is cut by several Northeast faults that dip both Northwest and Southeast. The faults all have a normal displacement.

The Cashin fault is the largest in the district with a vertical displacement up to 60 feet. The fault strikes N. 40° E. to N. 50° E. and dips 65° to 70° N. W.

Two other prominent faults in the district strike N. 20° E. to N. 25° E. and dip 70- 75° S. E. The displacement on the two faults, the Cliffdweller and the Camp fault, is less than

25 feet. The Camp fault is offset by the Cashin fault forming a small graben within the larger graben formed by the Cliffdweller fault and the Cashin fault. The Cliffdweller fault is not shown on the geologic map but is located approximately 3/8 of a mile West of the Cashin Mine.

The Wingate sandstone on the Nyswonger Mesa is not highly fractured, but there are two sets of fractures that have the same general orientation as the faults in the mine area. The N. to N. 20° E. fractures are the most common and widespread. In the overlying Kayenta formation some slickensided surfaces occur along the N. 20° E. fractures. The N. 45° E. to N. 65° E. fractures occur near the Cashin fault and are small but very numerous locally. Both sets of fractures are mineralized near the Cashin fault.

GEOCHEMISTRY

Surface samples were taken on Nyswonger Mesa where the Cashin fault is exposed in the Wingate and Kayenta formations. Sampling was done by Robert Records. Twenty-four samples were tested for copper, silver, lead, and zinc.

The results show a strong copper anomaly more than 900 feet long on the footwall, with values ranging from 5 ppm to 18,500 ppm copper. The samples containing 5 ppm were taken in the Kayenta formation. Background values of the Wingate is 15 ppm copper as determined by two samples taken up La Sal Canyon away from any known mineralization.

Twelve samples taken on the hanging wall were only slightly anomalous with values ranging from 5 ppm to 60 ppm copper. Copper content of the samples in the Kayenta formation were less than 25 ppm and probably represent background content.

The large difference of the copper content in the foot wall and the hanging wall is due to the erosion of a five to eight foot section of interbedded shale on the footwall. Erosion has exposed the copper mineralization which is directly under the shale. The shale, which is in the upper 25 feet of the Wingate sandstone, is present in the hanging wall at depths ranging from seven to eighteen feet below the surface. Moderate copper mineralization occurs below the shale in the hanging wall. The shale evidently prevented the mineralizing solutions from rising any further in the section except along strong fractures.

Two samples were taken North of the air shaft in the Kayenta formation but they did not contain anomalous values, even though they were of fissure material.

The silver content of the samples range from less than ½ ppm to 3 ppm. The anomalous values (more than ¼ ppm)show a very good correlation with the high copper values.

Mercury content was also analyzed in five samples but the values showed no difference between samples taken for background and mineralized samples. The values range from 75 ppb to 140 ppb.

MINERALIZATION

The mineralization of the Cashin Mine was formed by ascending hydrothermal solutions which probably entered the Wingate sandstone in the vicinity of the Silver stope and then spread laterally along the fault and into the walls. The drilling program was mainly concerned with the Wingate formation and the possibilities of a manto type deposit.

Diamond drilling did not show the extent to which the mineralization pinches and swells along the fissure. Drill hole DDH- 3004 shows that the copper content in the mixed oxide- sulfide zone is still of 1% grade more than 75 feet from the fissure. This area is in the wall of the Silver stope and is probably the widest zone of mineralization. The footwall was not tested in this area.

The weathering of the primary minerals has resulted in a zonal distribution of the copper with secondary copper minerals now constituting nearly all of the mineralization. From the surface to a depth of 115 feet, malachite and a minor amount of azurite occur almost excusively. The copper content is not consistent as mineralized zones are separated by barren zones of more than 50 feet. Malachite is present at the surface on the footwall, with weak amounts occuring more than 100 feet from the fault, however, appreciable amounts of copper do occur about 15 feet below the surface.

Near the North end of the mineralization the oxide copper content decreases. This is probably due, in part, to the more impermeable, overlying Kayenta formation.

Residual primary sulfides (pyrite and chalcopyrite) occur less than 20 feet from the surface in this area.

Below the oxide zone, a mixture of malachite and secondary chalcocite occurs in a zone that is 65 feet thick in DDH - 3005 and contains some of the best mineralization. Bornite and covellite are sometimes associated with the chalcocite which is present as very fine disseminated grains and less frequently as seams along bedding planes. The malachite occurs as disseminations, seams along bedding planes, and as halos around chalcocite grains.

Below the mixed oxide-sulfide zone, the mineralization consists of chalcocite and minor amounts of chalcopyrite. The chalcopyrite is present as disseminated grains partially replaced by chalcocite. The sulfide zone in DDH 3002 ended at a depth of 225 feet, still in the Wingate sandstone but to the North the mineralization extended to the Chinle formation. The Chinle is unmineralized except for short intervals near the fault in the vicinity of the Silver stope.

Native copper and silver were not present in the drill core although specimens to 10" were found on the dump. A sample from the dump contained .90% strontium, however, additional taken of the core contained only trace amounts. The strontium is believed to be associated with barite and other gangue minerals in the fissure.

GRADE AND TONNAGE

The averages of the holes in the hanging wall range from 0.55% to 0.70% with an overall average of about 0.60%. It is likely that this average would hold for a distance of 75 feet away from the fault. An additional 25 feet on the footwall can be added making an overall width of 100 feet. Using a strike length of 1400 feet and a thickness of 250 feet the ore body would consist of 2,700,000 tons averaging 0.60%. Developing additional tonnage North of the airshaft is very possible, however, the unmineralized Kayenta formation overlies the Wingate sandstone and this would considerably increase the stripping ratio.

High-grade intervals up to 65 feet thick occur in the walls of the Silver stope. Additional drilling would be needed to test the continuity of the mineralization of the area which has a probable 200,000 tons averaging 1.5- 2.0% copper. The potential dimensions are 400 feet of length, 125 feet of width and a thickness of 50 feet.

DRILLING AND SAMPLING

The purpose of the drilling was to determine if the copper mineralization in the walls of the Cashin fissure was of sufficient grade and tonnage to be mined by an open-pit operation.

The drilling program included core drilling and drilling. Forty-three holes totaling 4379 feet were drilled on the surface and underground on the main haulage level of the mine. Core recovery was excellant, averaging better than 95%.

Drill holes were numbered according to the machine used for drilling. A longhole machine drilled the 1000 series holes of which there were 19 totaling 776 feet. Sixteen of the holes were drilled along the Cashin fissure and three were drilled along the Cliffdweller fault on the South side of La Sal Creek.

A CP - 22 drill, coring AX wireline, drilled the 2000 series holes. Seventeen holes totaling 1725 feet were drilled. Eleven of the holes were drilled underground.

The NX wireline holes were drilled with a Chicago-Pneuniatic #22 diamond drill and were numbered in a 300 series. The seven NX wireline holes, totaling 2207 feet, were all drilled on Nyswonger Mesa with the exception of DDH 3001 which was drilled in La Sal Creek Canyon. Four of the six holes on the mesa were drilled parallel to the fissure and two were drilled vertically.

Initially the core was sampled every foot by taking half of a 3- 4 inch piece. The lower part of DDH 3004 and drill holes 3005, 3006, and 3007, however, were sampled by splitting all the core and assaying one half. Sample intervals were approximately five feet.

Drill logs and assay data are lisited in appendix.

CONCLUSIONS AND RECOMMENDATIONS

The copper mineralizations at the Cashin Mine is not of sufficient grade to warrent additional expenditures by Valley Metallurgical Processing Co., Inc. The high content of copper sulfide and the difficulty in leaching such ore is also a factor that makes the property undesirable. It is recommended that the option be terminated at this time.

David H. Stalker

APPENDIX

GEOCHEMICAL ANALYSIS

IN PARTS PER MILLION

SAMPLE #.	CU	ZN	PB	AG	AS	HG (ppb)
GC #1	280 ppm	20 ppm	5 ppm	½ ppm		
GC #2	25	70	160	-¼		
Gc #3	20	525	30	-¼		
GC #4	25	165	20	¼		
GC #5	18,500	80	80	1½		
GC #6	475	95	300	1½		
GC #37	6,300	75	5	3		
GC #38	60	30	35	3/4		
GC #39	60	50	30	-¼		
GC #40	45	80	30	¼		
GC #41	55	90	5	-¼		
GC #42	750	30	10	-¼		
GC #53	5	35	25	-¼		
GC #54	25	35	10	-¼		
GC #55	5	10	50	-¼		
GC #56	15	10	5	-¼		
GC #57	5,800	100	5	2		
GC #58	775	35	25	1½		
GC #71	15	15	5	-¼		
GC #72	5	25	5	-¼		
GC #73	5	10	5	-¼		
GC #74	5	15	5	¼		
GC #75	5	45	155	¼		
GC #76	5	45	10	¼		
GC #80	10			½		

SAMPLE #.	CU	ZN	PB	AG	AS	HG (ppb)
GC #81	15			-¼		
1 Blank	20	20	5	1.½	5	115
2 Blank	10	60	5	-¼	5	75
2007 0.0' - 2.0'	10,000	300	140	1	60	140
2007 51' - 53'	7,300	140	1,700	4	30	120
2007 76' - 78'	1,150	125	5	¼	10	75
DDH-3003 #4	5			-¼		
DDH-3003 179'-181'	10			-¼		
DDH-3003 313'	10			-¼		

MICROSCOPIC STUDY OF COPPER ORES FROM CORES DRILLED ABOVE THE CASHIN PROSPECT, MONTROSE COUNTY, COLORADO

Sample #1

Megascopical aspect: Sandstone with graded bedding. Copper sulfides occur as impregnation and fissure filling. Copper oxides prevail at the exterior parts of the sample.

Microscopical aspect: Sandstone with regularly varying grain size, from an average of 50 microns diameter in the finer to 150 microns in the coarser beds.

The individual grains are well sorted and subrounded to sub-angular in shape.

The sandstone grains are cemented by copper sulfides.

In the leaner parts of the ore there is a distinct relation between grain size of the sandstone (and thus their pore space) and the copper mineralization.

Since the grains do not show signs of systematic replacement and the original bedding is well preserved, copper must have been introduced as pore space fillings in an unconsolidated stage or must have replaced any former cementing material.

Veinlets point to epigenetic emplacement at least of the present assemblage.

Copper minerals: Bornite is the most frequent copper sulfide. In its present condition bornite is apparently not stable and shows "sprungkrankheit", often a predecessor of descendant alteration. The alteration of the interstitial sandstone pore space fillings proceeds from the grain boundaries on by the formation of digenite in combination with chalcopyrite. In the veinlets (300 micron-2 mm wide) the replacement of bornite proceeds into oriented intergrowths of fusiform chalcopyrite and digenite. Digenite in turn is later replaced along Cu-oxide filled fractures by covellite.

Cu-oxide: Sulfide ratio: Judged by volume Cu-oxides do not account for more than 10% of the copper values, likely less since the principal mineral, malachite, is very porous. Oxidation proceeds along fractures and bedding planes and is not a widespread penetrative event.

The grade of the ore is such that direct shipping may be considered.

Leaching will require considerable amounts of sulfuric acid since there is no pyrite for acid generation. Recovery will be poor, anyhow, since the ores are too high grade! A concentration method that may be considered and does not require much capital investment is grinding to minus 100 micron (+200 mesh) and collecting the fine (mainly copper sulfides) and discarding the coarse fraction (mainly quartz grains).

Sample #2

Megascopical aspects: The sandstone is impregnated with copper sulfides. Copper oxides like azurite and malachite occur along the broad (1 - 1-1/2 cm) margin of the specimen.

Microscopical aspects: Sandstone is the host for the copper mineralization. Grains are subangular, and less well sorted compared to sample #1. The grain packing is thus better and pore space is less.

The mineralization is less of a pure pore space filling, more of a replacement type (also of quartz) and network of veinlets of hair-fracture style resulting in a less regular copper distribution over the rock than is the case with sample #1. The general aspect is that of small pockets (100 - 250 microns) of copper minerals with no or only a few quartz grains (some seem to be corroded). The pockets coalesce within the richer parts of the ore, forming continuous aggregates parallel to the bedding or are connected by paper thin fissure fillings of less than 10 micron width. I estimate that in the leaner parts about 20% of the Cu-values are tied up in these fissures. Apart from the Cu-oxide: sulfide ratio this is thus a less attractive ore for flotation concentration than sample #1.

Copper minerals: The principal copper mineral is bornite. It occurs in small pockets. In the inter-connecting pore space or micro fissures we have digenite. The bornite pockets contain two kinds of chalcopyrite: a fusiform, lamellar one closely related with digenite and irregular blebs containing pyrite replacement relics. Since pyrite is so clearly a relic and does not occur within bornite without chalcopyrite, I presume two phases of chalcopyrite: An early one, replaced by bornite, and a later one being the replacement product (combined with digenite) of bornite. Alteration products of a still further preceeded stage include idaite (Cu_5FeS_6) and covellite. These are the last sulfides to be formed before oxidation starts, beginning with azurite + goethite and ending with malachite + goethite. The partition of malachite and azurite is the same as that of the sulfides. The process proceeds through the stages of:

1) replacement of bornite by idaite, and of digenite by covellite + the formation of goethite into
2) an assemblage of covellite + goethite + azurite
3) into pure azurite and finally
4) replacement of azurite by malachite.

Cu-oxide: sulfide ratio: Although massive veinlets or pockets of azurite and more porous malachite do exist in a 1 cm wide zone, the bulk of the sulfides are still in sulfide form. Estimated are 60% sulfide, 15% mixtures of Cu-oxides and sulfides and 25% Cu-oxides (carbonates) with goethite.

The pyrite relics are too small and too rare to be considered of any help in a leaching process.

Sample #3

Megascopical aspects: Sandstone impregnated with copper-sulfides, thin (0.1 mm) coating of malachite.

Microscopical aspects: Texture similar to sample #2: sandstone of sub-angular grains of non-systematically varying grain size (averaging between 25 and 100 microns) frequency maximum at 60 microns. Cu-sulfides show a pocket-wise partition over the sample, with clear indications of replacement of quartz by the sulfides. The small pockets (averaging 200 - 250 microns) are connected by paper thin fissures, which occasionally cut across quartz grains. In the richer parts these pockets coalesce into larger aggregates parallel to the bedding in the sandstone (as indicated by quartz grain elongation and alignment).

Copper minerals: include chalcopyrite (50% of the sulfides), digenite (15%) and covellite (35%). Digenite and covellite prevail in the thin fissures and along the quartz-sulfide grain boundaries. The interior parts of the little sulfide pockets and their larger agglomerates show a remarkable texture. The texture consists of extremely fine intergrowths of chalcopyrite and lamellar covellite (of sub-micron width). The oriented intergrowths and constant volume relationship between chalcopyrite and covellite point to a breakdown of a Cu-Fe-mineral richer in copper than chalcopyrite (presumably bornite, but no bornite relics have been found). The breakdown of bornite simultaneously into chalcopyrite and covellite is incompatible with phase equilibria studies, no tie-lines exist. However, it was noticed that covellite exclusively occurs as a replacement product of digenite, and therefore need not be in equilibrium with chalcopyrite. Digenite + chalcopyrite are common as alteration products of bornite.

Cu-oxide: sulfide ratio: The amount of copper oxides is negligible in this sample. The grade of the ore estimated to be +10% copper allows for direct shipping. Flotation concentration will require -100 mesh, +200 mesh grinding for complete separation of the smaller sulfide aggregates (the most frequent interstitial aggregates measure about 75 micron diameter or about equal to the quartz grain sizes; the little pockets measure 200 - 250 microns). The concentrate will be contaminated with quartz because of sulfide coatings on quartz.

Sample #4

Megascopical aspects: Fine grained sandstone with Cu-sulfide impregnation and thin (1 mm) copper sulfide veinlets and a thin copper oxide coating.

Microscopical aspects: Grain size of the sandstone host rock varies between 50 and 100 microns. The grains are sub-angular. Copper mineralization mainly occurs as pore space filling but also in richer streaks resembling veins. Regular veins do occur too; they are narrow (0.1 - 1.0 mm) and have ragged outlines.

The distinction between pure pore space fillings and the stage in which they coalesce into streaky veins is hard to make since all stages in between are also present.

The process of coalescence is not only one of increase of intersitial copper mineralization but also one of replacement of quartz, such as shown by the ragged outlines of the quartz grains in the streaky veins.

Copper minerals: The textural difference between streaky veinlets and pure copper pore fillings is also largely borne out by the mineralogy. In the pure pore space fillings digenite (and its alteration product: covellite) prevail, whereas in the more high grade material, the same type as #3, of digenite-(and later Covellite)-chalcopyrite oriented intergrowths are dominant. Here, too, because of constant volume relationship between chalcopyrite and covellite-digenite, we are likely dealing with a breakdown product of bornite.

Cu-oxide: sulfide ratio: Apart from a very thin oxide-coating there are virtually no Cu-oxides in this sample. The ore is high grade material. If concentration by flotation is considered, comminution down to -100 and +200 mesh will be necessary to separate sulfides from silicates. Coating of quartz by copper-sulfides (digenite and covellite) still may exist. The +100 micron fraction will contain most of the silica. Upgrading of the copper values in the fine fraction will be easily obtained by milling and classification.

Conclusions

1) The amount of soluble copper (copper-carbonates and oxides) is insignificant for leaching purposes.
2) The ores are high grade, direct shipping to custom mill or smelter may be considered.
3) Any hydrometallurgical process will be inefficient without comminution of the ore since the more or less Isometric ore aggregates have a low surface to volume ratio.
4) Because of differences in mechanical properties between quartz grains and sulfides and the cementing nature of the sulfides grinding and classification will result in a concentration of the sulfides in the -150 mesh fraction.

F. Ypma
Associate Professor of
Economy Geology
Columbia University

New York, N. Y.
February 4, 1969

MR Andy Zenkl

VALLEY METALLURGICAL PROCESSING CO., INC.
URANIUM BUILDING
MOAB, UTAH 84532

January 2, 1969

Dr. Chas. H. Behre, Jr.
Behre Dolbear & Co., Inc.
11 Broadway
New York 4, New York 10000

Re: SUMMARY OF DATA

Dear Dr. Behre,

Under seperate cover we have mailed the following:

A progress report to Jan. 1, 1969; cross-sections of drill holes 3003, 3004, and 3005; bearings, vertical angles & depths of all the drill holes; sample map of Cliff Dweller holes and drill log with assays on hole #3003.

This data has been assembled by Dave Stalker. In addition Dave has covered some of the geology of the area and preliminary data on holes 3004, 3005, and 3006.

We are also waiting on Dave's data sheets, you will note on cross-section sheet showing hole 3003 the proposed location of holes 3007 and 3008 as you and Dave and I had agreed would be the best positions to drill for total cross-sectional evaluation.

My visual examination of the core from hole 3006 showed rather poor general mineralization with localized sections of core in short lengths showing good sulphide mineralization, especially at depths below 250 feet. As a result of this core, I personally feel we have approached the end of the ore zone along strike length to the Northeast, and do not feel any more holes are justified behond this location in a Northerly direction.

We are proceeding with preliminary metallurgical test work on the leachability of the ore. I have composited a sample representing an approxinate average grade and also representing an approxinate average oxide-sulphide ratio. Our preliminary work is being carried on by our metallurgist in our lab. His results will be available early next week.

& changed to [illegible]

Hole # 3007 is being moved on today and our present plans call for completion of both 3007 and 3008 by January 15, 1969. With completion of these two holes I feel that we have explored the Cashin ore zone sufficiently to determine grade, size and physical shape, enabling me to decide the feasibily of mining this ore.

Enclosed herein find the following items:

Statistical analysis data on holes 2007 and 3002; assays from the Iron King showing oxide-sulphide ratios and lime and iron contents of holes 2007, 2012 & 2014.

The statistical data in it's present form is not to meaningful and we are changing the format to compile more useful information. However the frequency occurence and the mean averages are helpful from these sheets, also the lack of normal distribution indicates thedif-fulty of ore value intrepretation.

The Iron King report definitely establishsthe high rationpresence of sulphides, depending on depth of the sample. In general I feel we are looking at an ore zone which contains copper as sulphide in at least 40% of the value.

To generalize on the entire ore body I am estimating without complete assay results or without finishing holes 3007 & 3008, that are going to have a length of 2000 feet, by a width of 100 feet and a depth of 275 feet, for a total of about 4,500,000 tons which will assay 0.60% to 0.70% total copper of which 30% to 40% will be as sulphides.

I am including the above paragraph primarily for the evaluation by Mr. Hudson and Mr. Connerat of this over-all picture and for you to confirm or disagree in a general way, as our option time is limited to six re-maining weeks and we should start thinking about dropping or continuing the option.

I realize many unanswered facets of the overall picture will influence our final decision, i.e., metallurgy, water rights, capital investment, mining method, etc., however I do not want to wait until the final week to start forming an opinion.

This ore will probably have a gross value of slightly over $5.00 per ton. Estimating mining and primary crushing at $1.25 to $1.50 and milling, leaching and flatation, if needed, at $2.50 per ton, plus finished product transportation, possible smelting, royalty or purchase and write-off of capital investment, it appears we have an ore body on which it is very questionable to make a profit.

Sincerely,

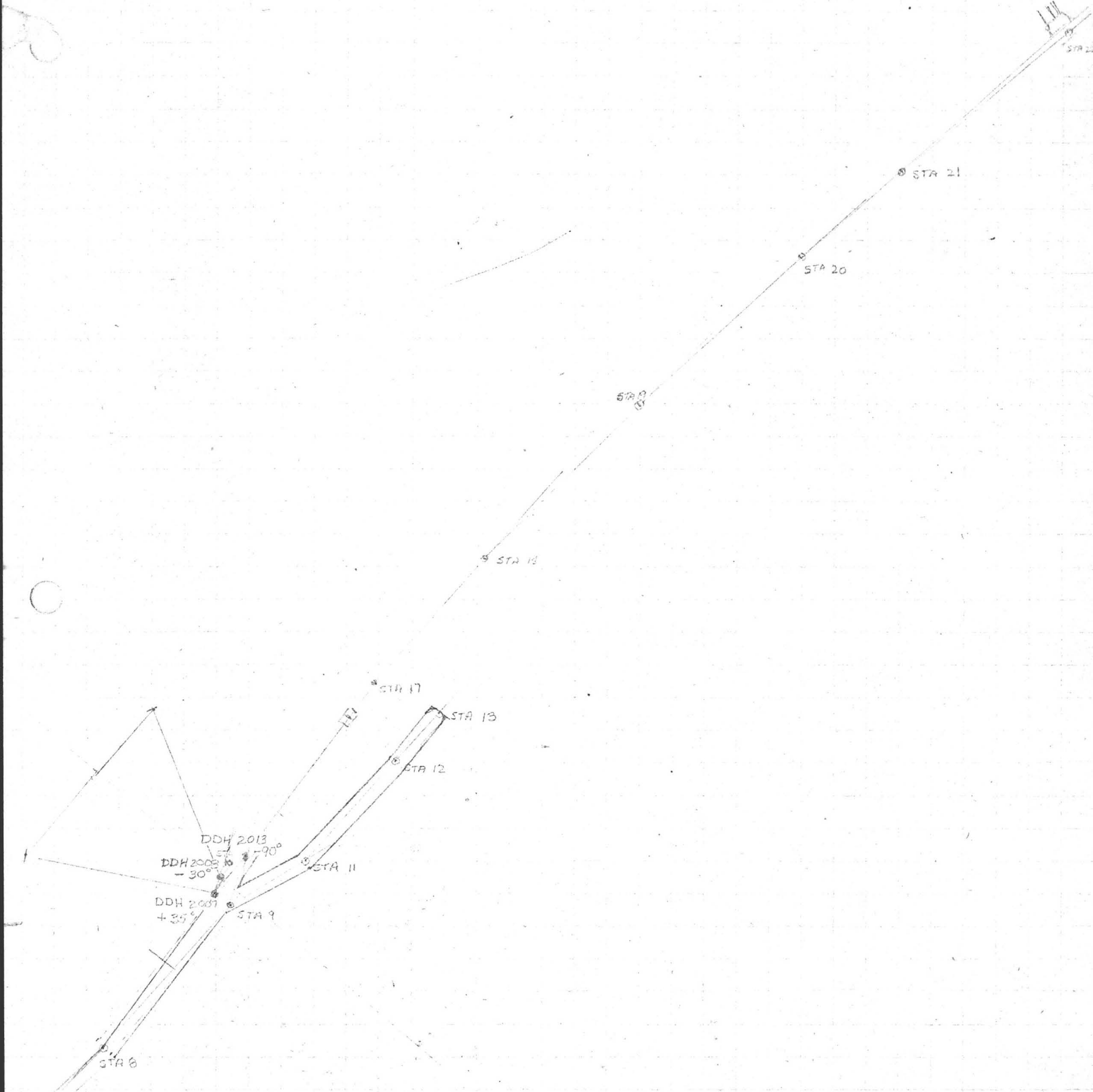
Andy

Andrew J. Zinkl

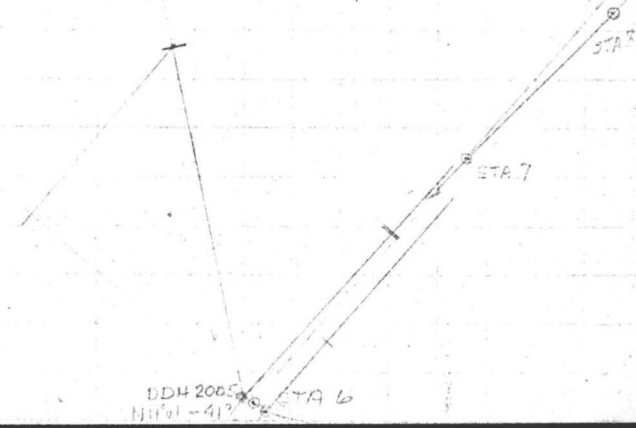
AJZ/ve
Encl.

Carbon Copies:

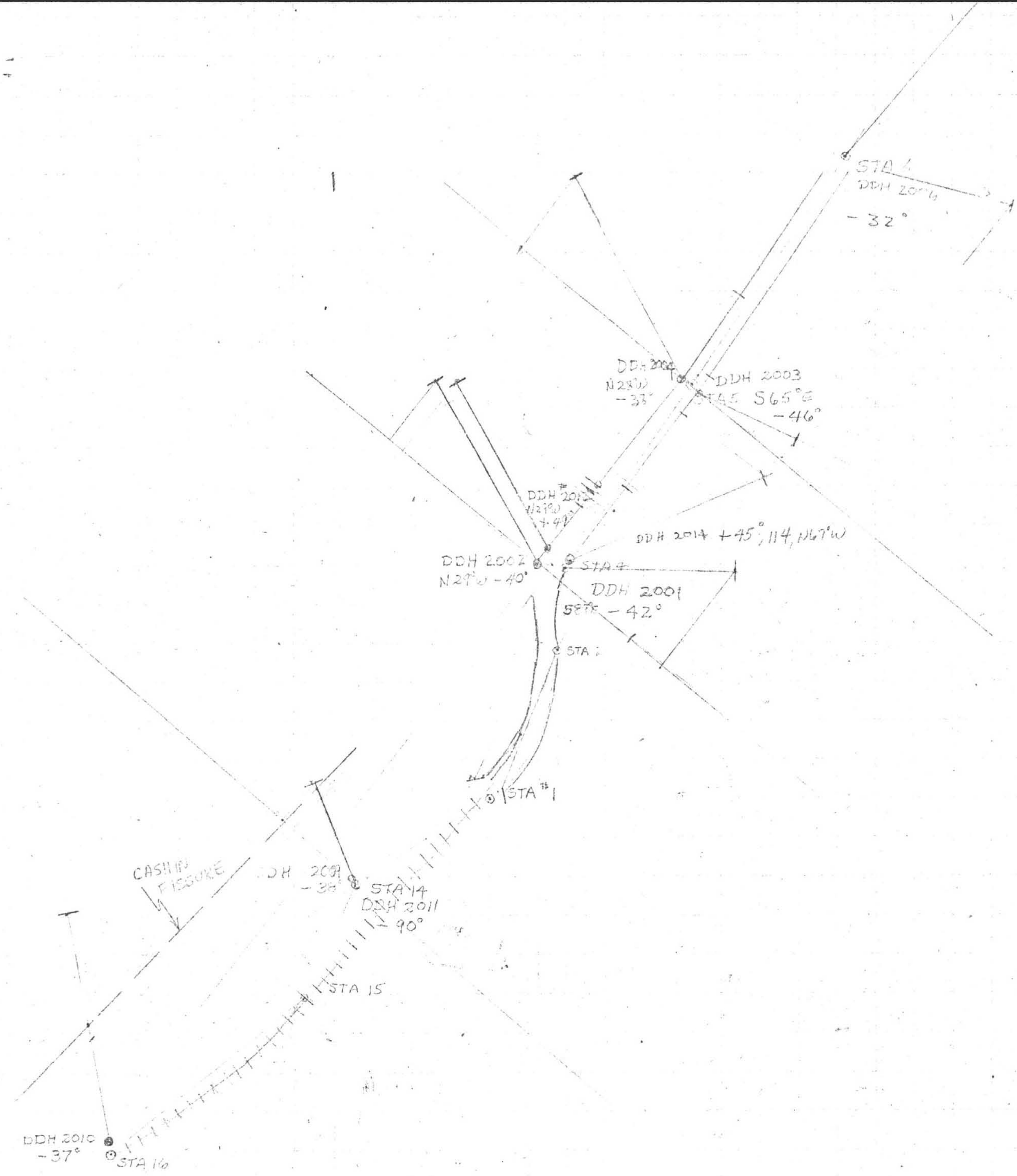
Mr. Percy W. Hudson
Mr. George H. Connerat
Mr. D.C. Linton
Mr. Andrew J. Zinkl
Mr. David Stalker



STA 21
STA 20
STA 13
STA 17
STA 12
DDH 2013
-90°
DDH 2008
-30°
STA 11
DDH 2007
+35°
STA 9
STA 8

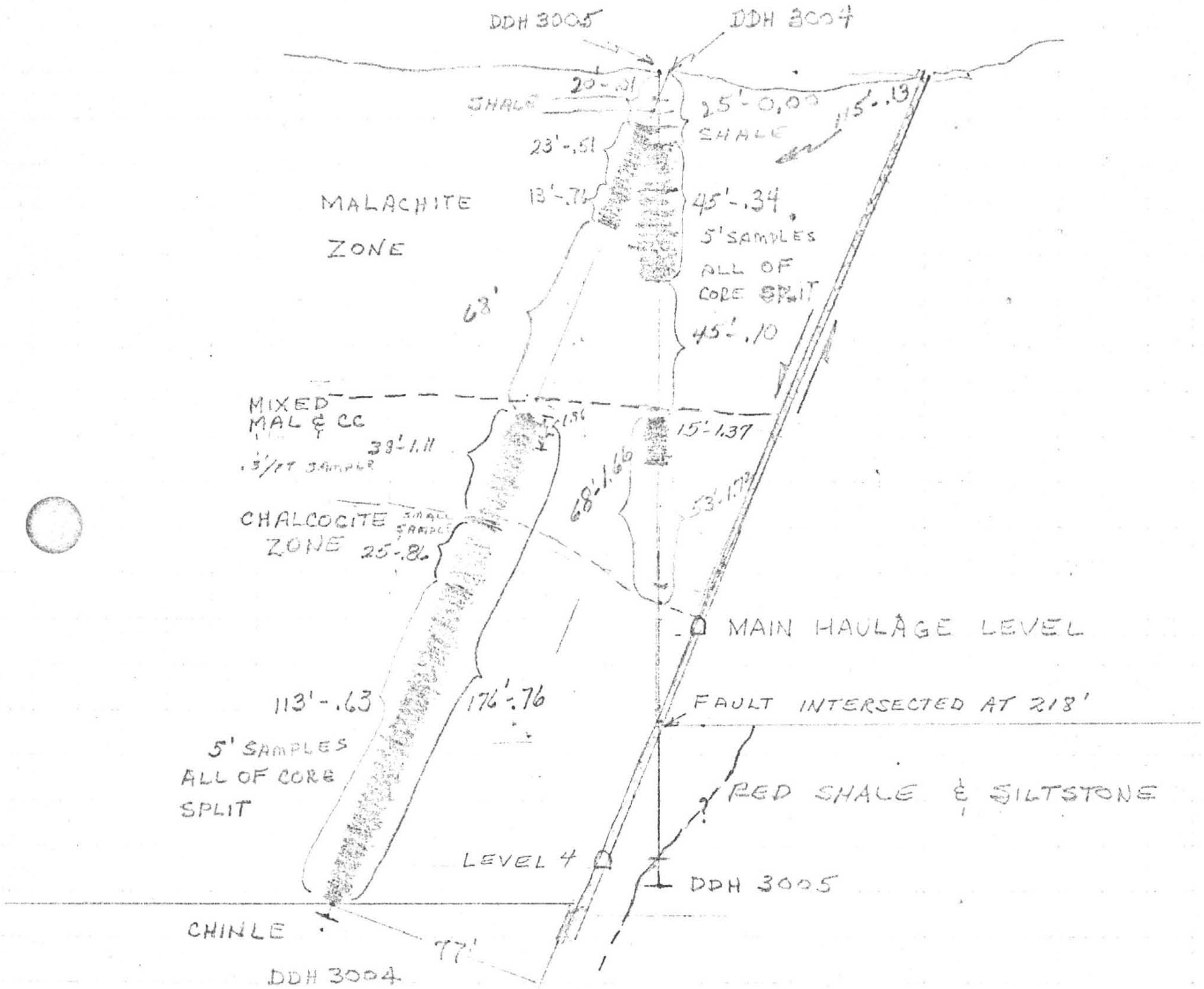


STA 7
DDH 2005
STA 6

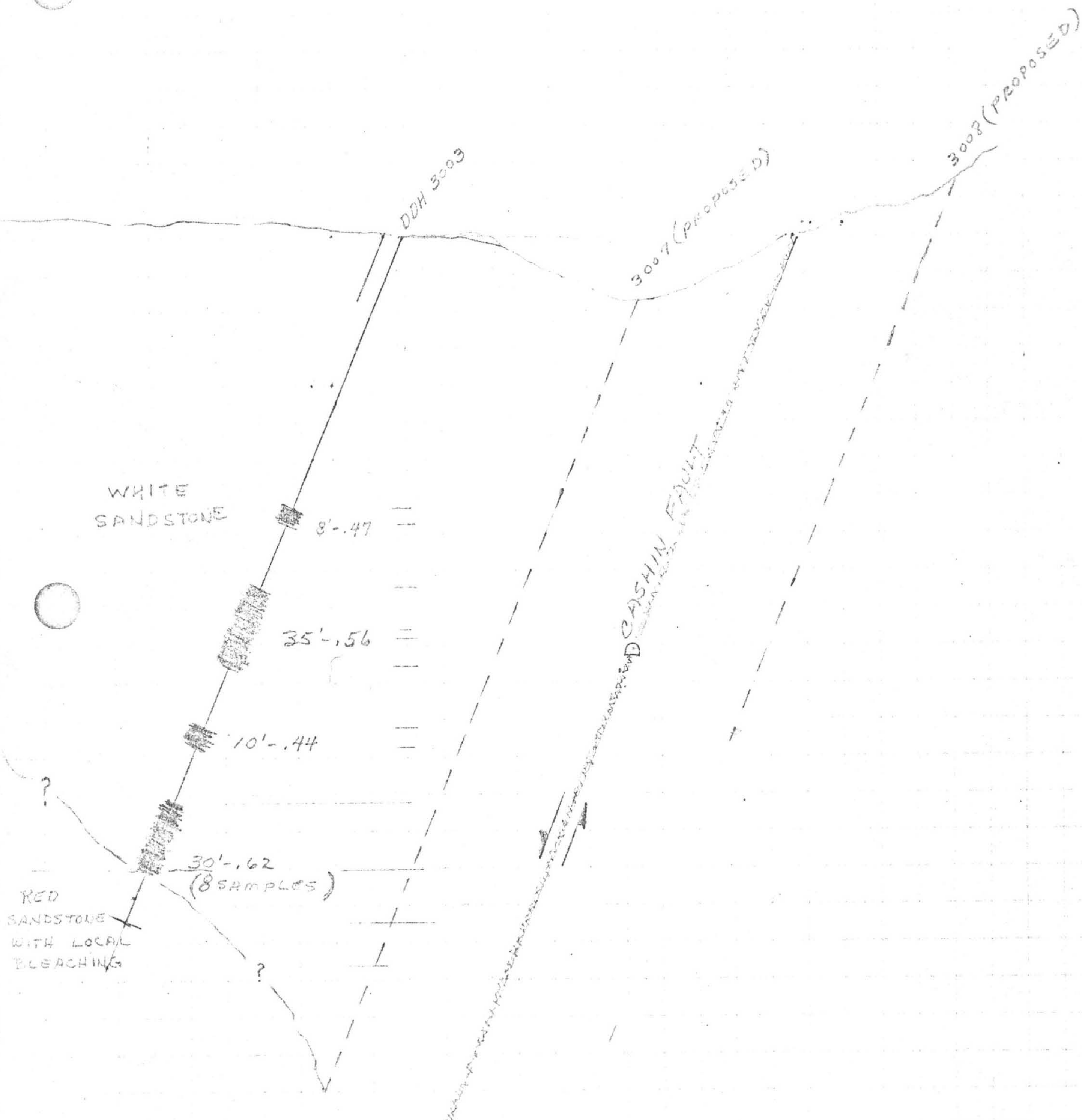


1" = 60'

UNDERGROUND - CASHIN MINE

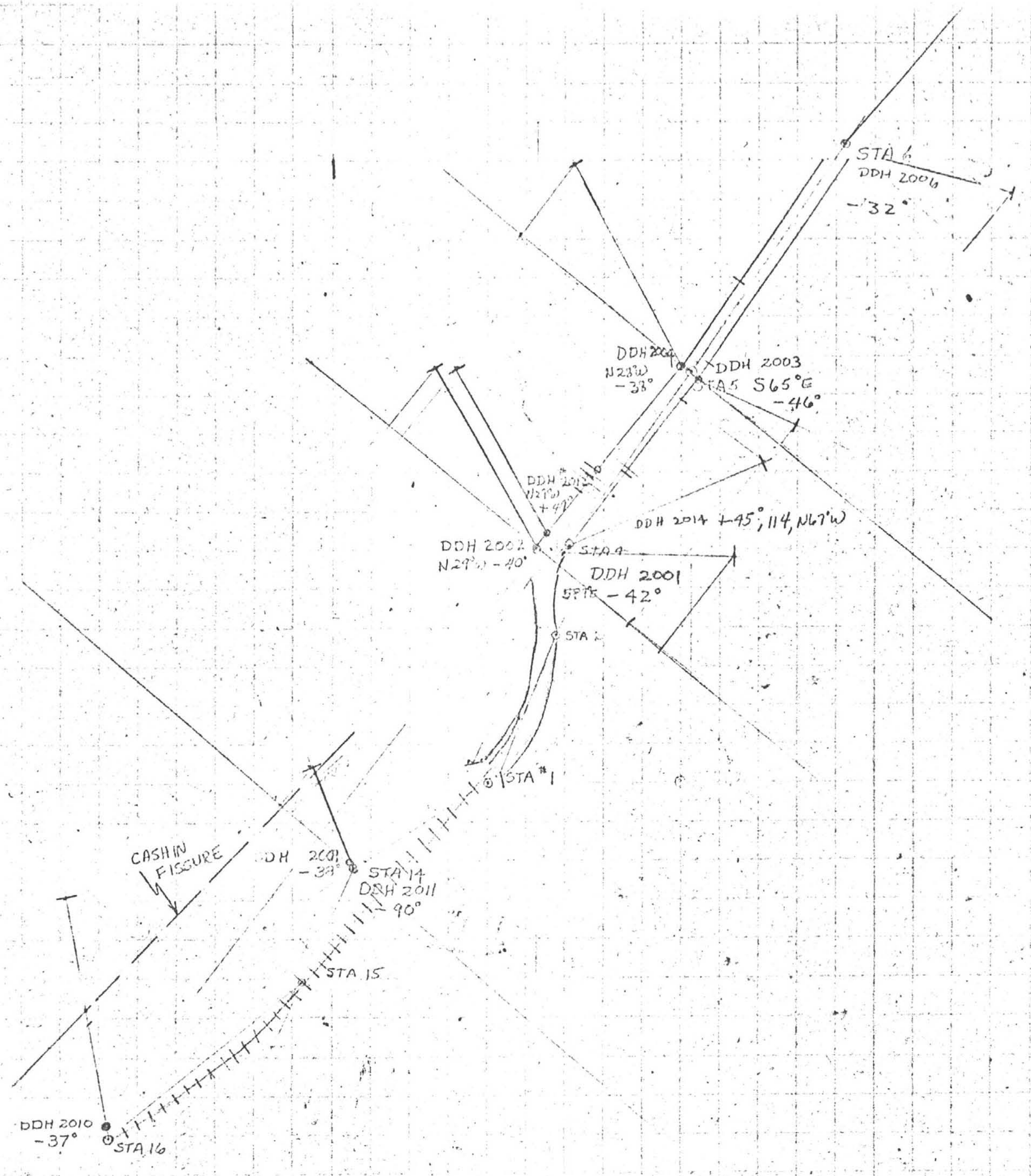

DDH 3005
DDH 3004
20'-.51
SHALE
25'-0.00
SHALE
115'-.13
23'-.51
13'-.76
MALACHITE
ZONE
45'-.34
5' SAMPLES
ALL OF
CORE SPLIT
68'
45'-.10
MIXED
MAL & CC
33'-1.11
15'-1.37
68'-1.66
53'-1.79
CHALCOCITE
ZONE
25-.86
MAIN HAULAGE LEVEL
113'-.63
176'-.76
FAULT INTERSECTED AT 218'
5' SAMPLES
ALL OF CORE
SPLIT
RED SHALE & SILTSTONE
LEVEL 4
DDH 3005
CHINLE
77'
DDH 3004

1" = 60'

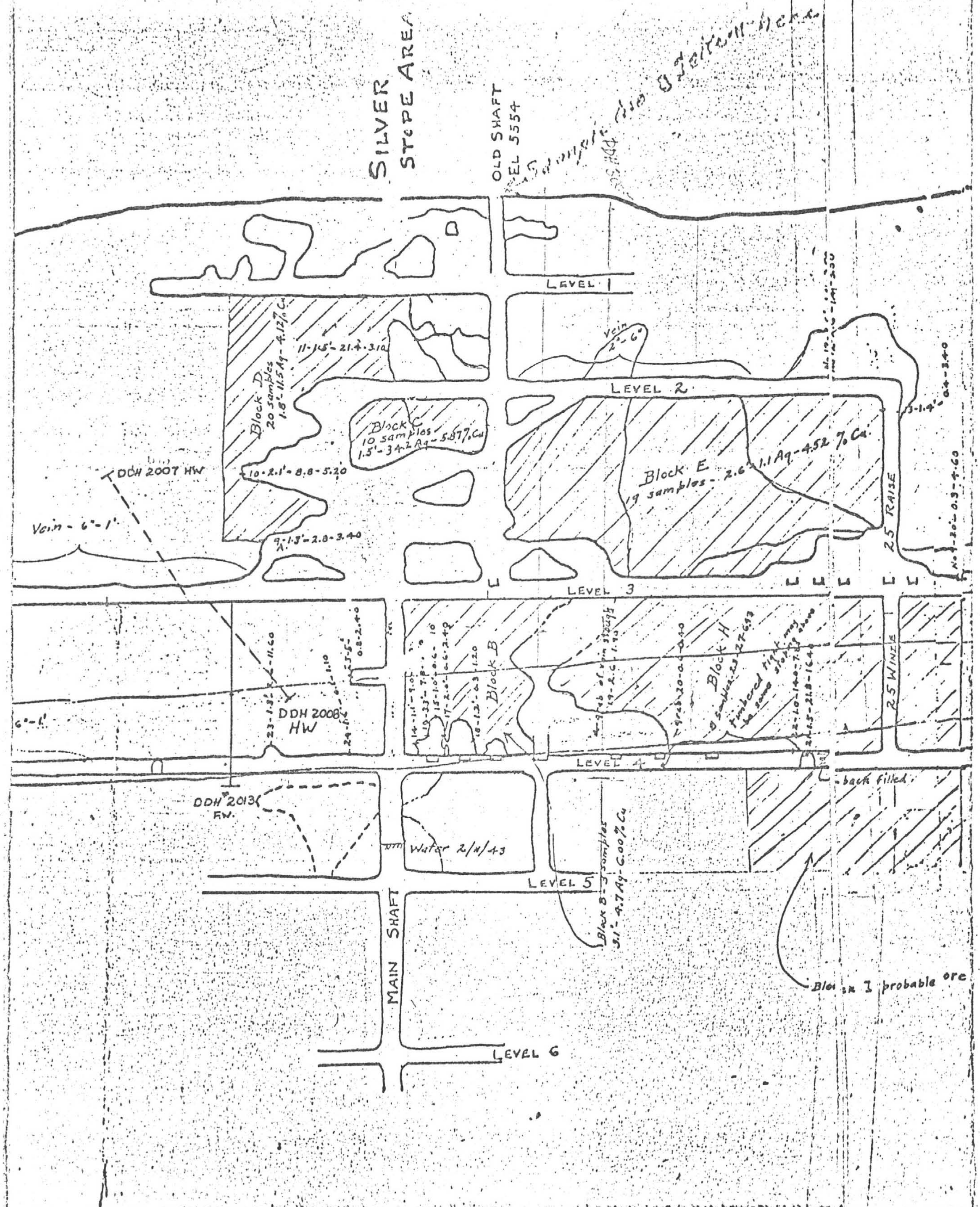


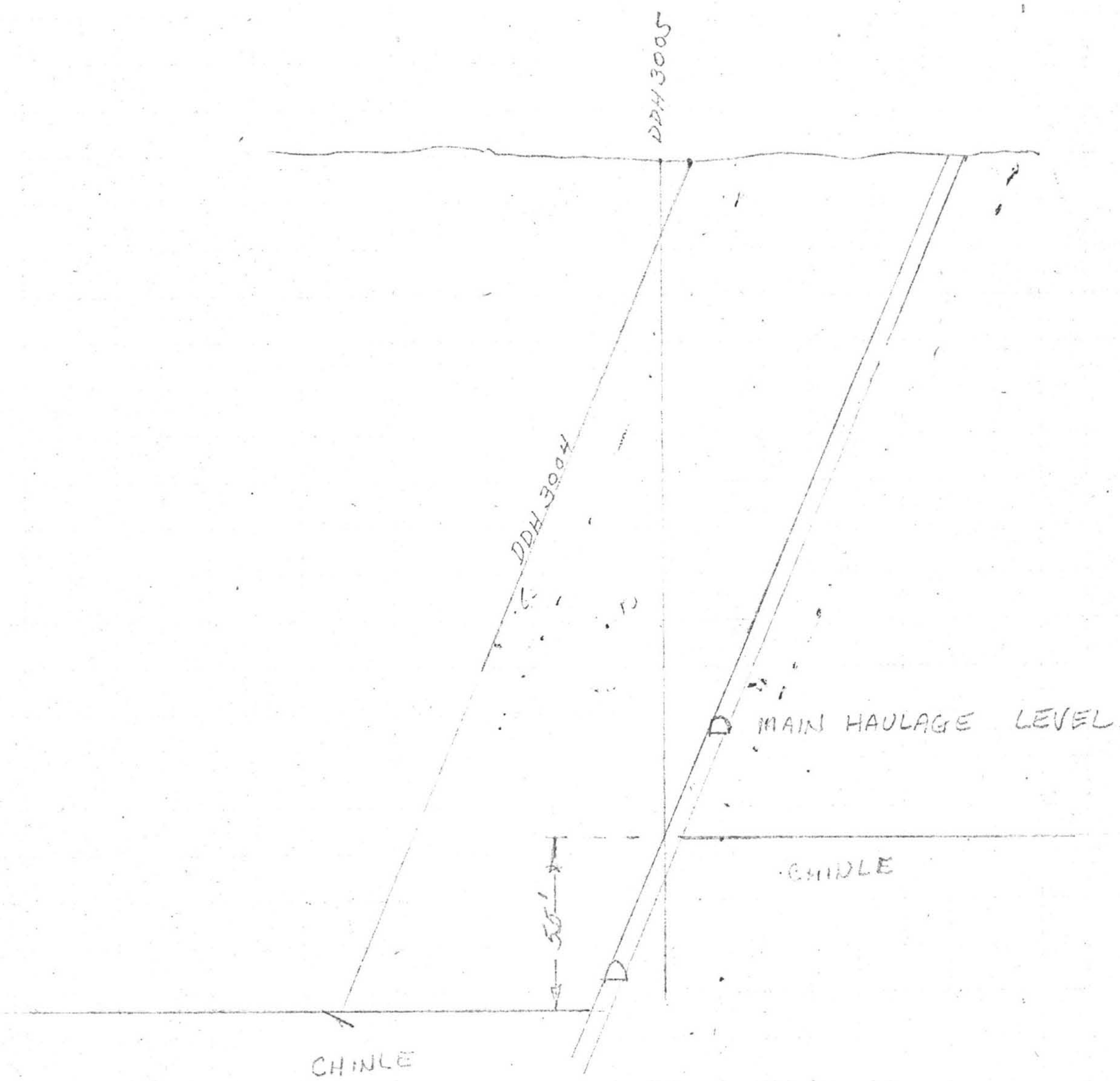
DDH 3003
3007 (PROPOSED)
3008 (PROPOSED)
WHITE SANDSTONE
8'-.47
35'-.56
10'-.44
30'-.62
(8 SAMPLES)
RED SANDSTONE WITH LOCAL BLEACHING
CASHIN FAULT
D
?
?

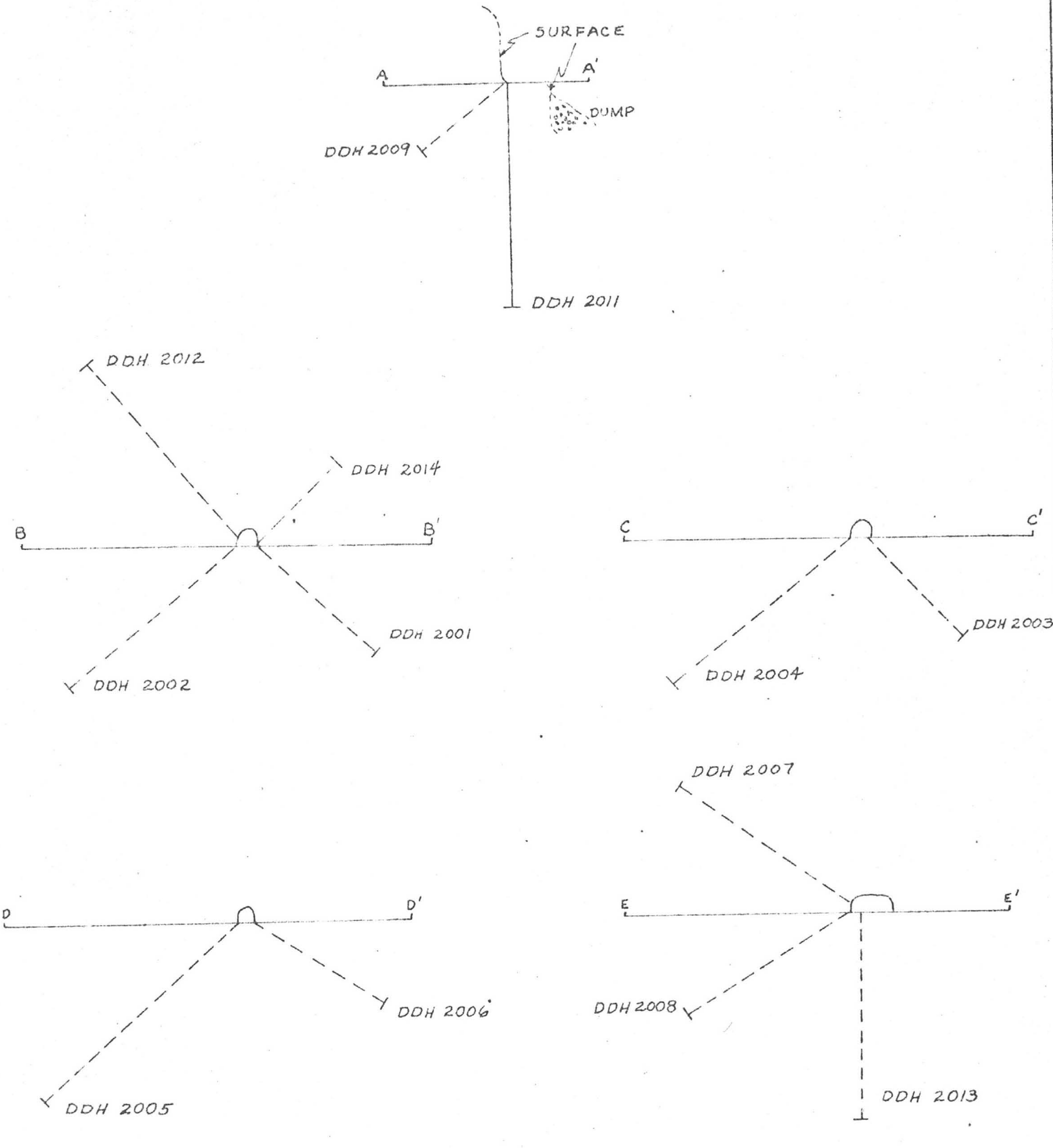
1" = 60'

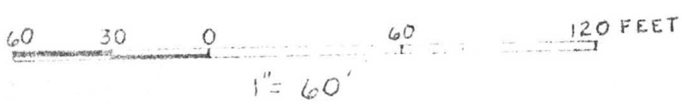


STA 6
DDH 2006
-32°
DDH 2004
N28W
-38°
DDH 2003
STA 5 S65°E
-46°
DDH 2014 +45°, 114, N67°W
DDH 2002
N29°W -40°
DDH 2001
-42°
STA 2
STA #1
CASH IN FISSURE
STA 14
DDH 2011
-90°
STA 15
DDH 2010
-37°
STA 16


SILVER
STOPE AREA
OLD SHAFT
EL 5554
LEVEL 1
LEVEL 2
LEVEL 3
LEVEL 4
LEVEL 5
LEVEL 6
MAIN SHAFT
Block D
20 samples
Block C
10 samples
Block E
19 samples
Block B
Block H
Vein - 6"-1'
Vein 2"-6"
DDH 2007 HW
DDH 2008 HW
DDH 2013 FW.
25 RAISE
25 WINZE
Water 2/4/43
back filled
Block I probable ore


DDH 300S
DDH 300H
MAIN HAULAGE LEVEL
CHINLE
55'
CHINLE





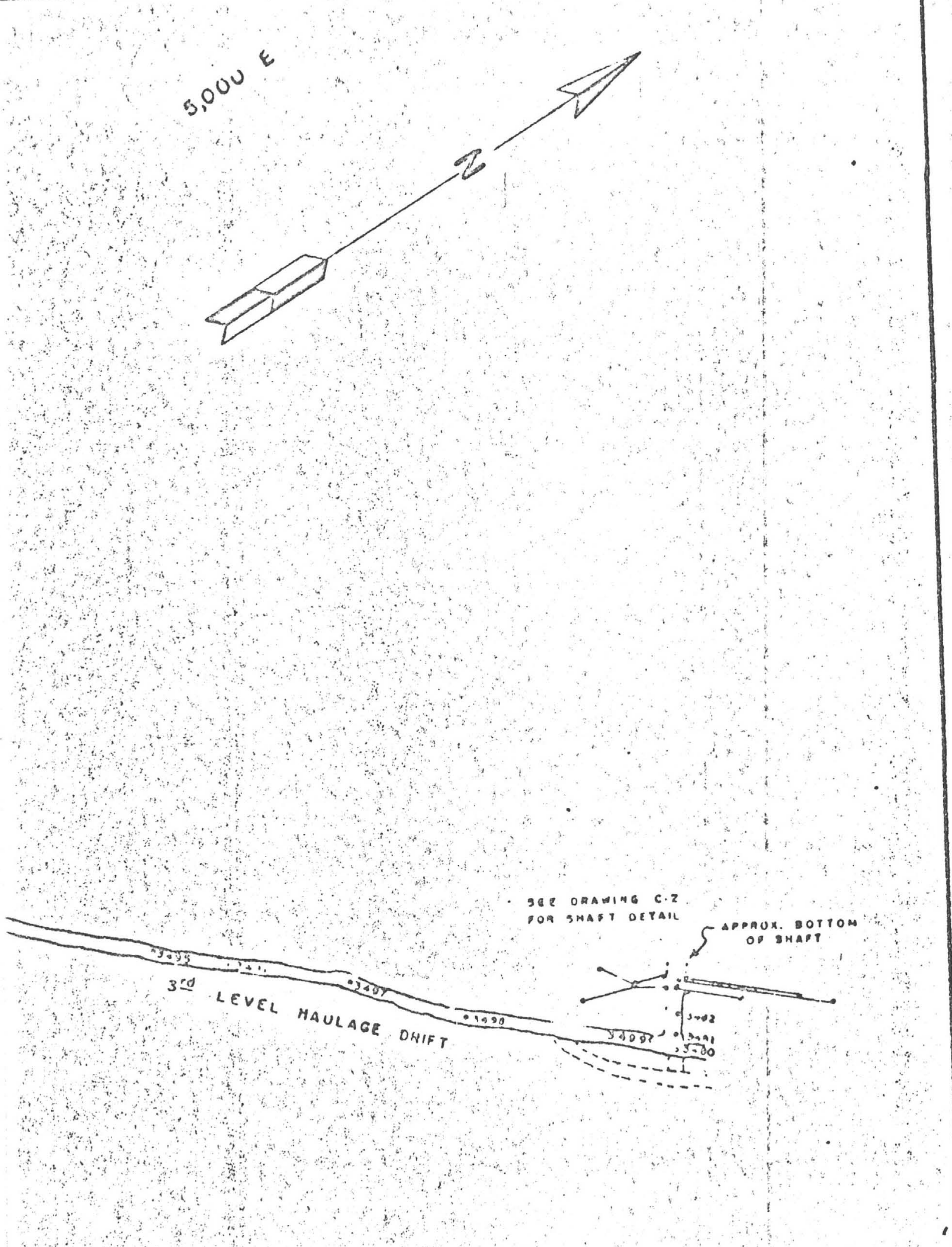
VALLEY METALLURGICAL PROCESSING COMPANY

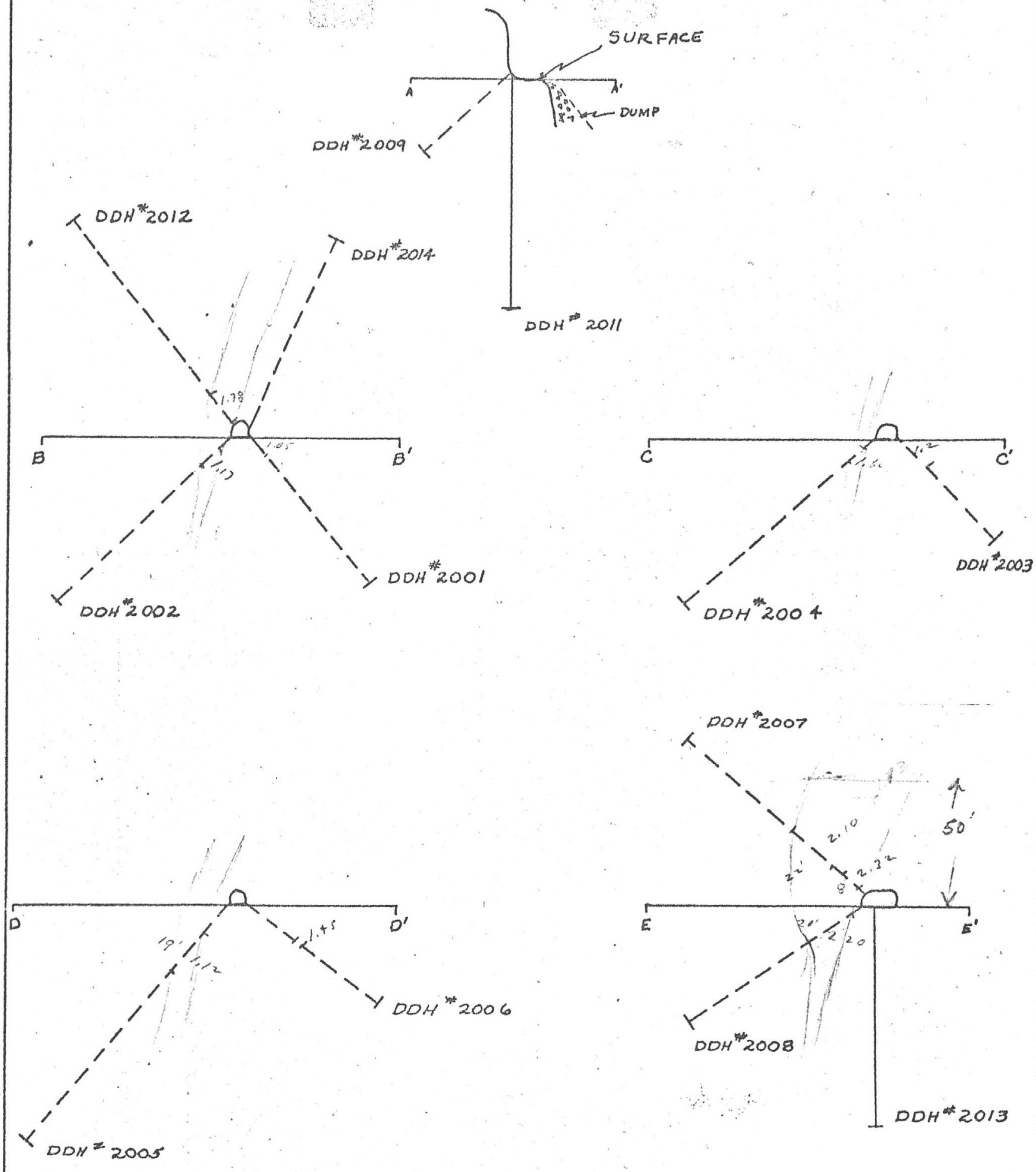
CASHIN MINE
MONTROSE COUNTY, COLO.

CROSSECTION OF UNDERGROUND DRILL HOLES, LOOKING N40°E

NOV, 1968 COMPILED BY D. STALKER

CAMP AREA & MINE





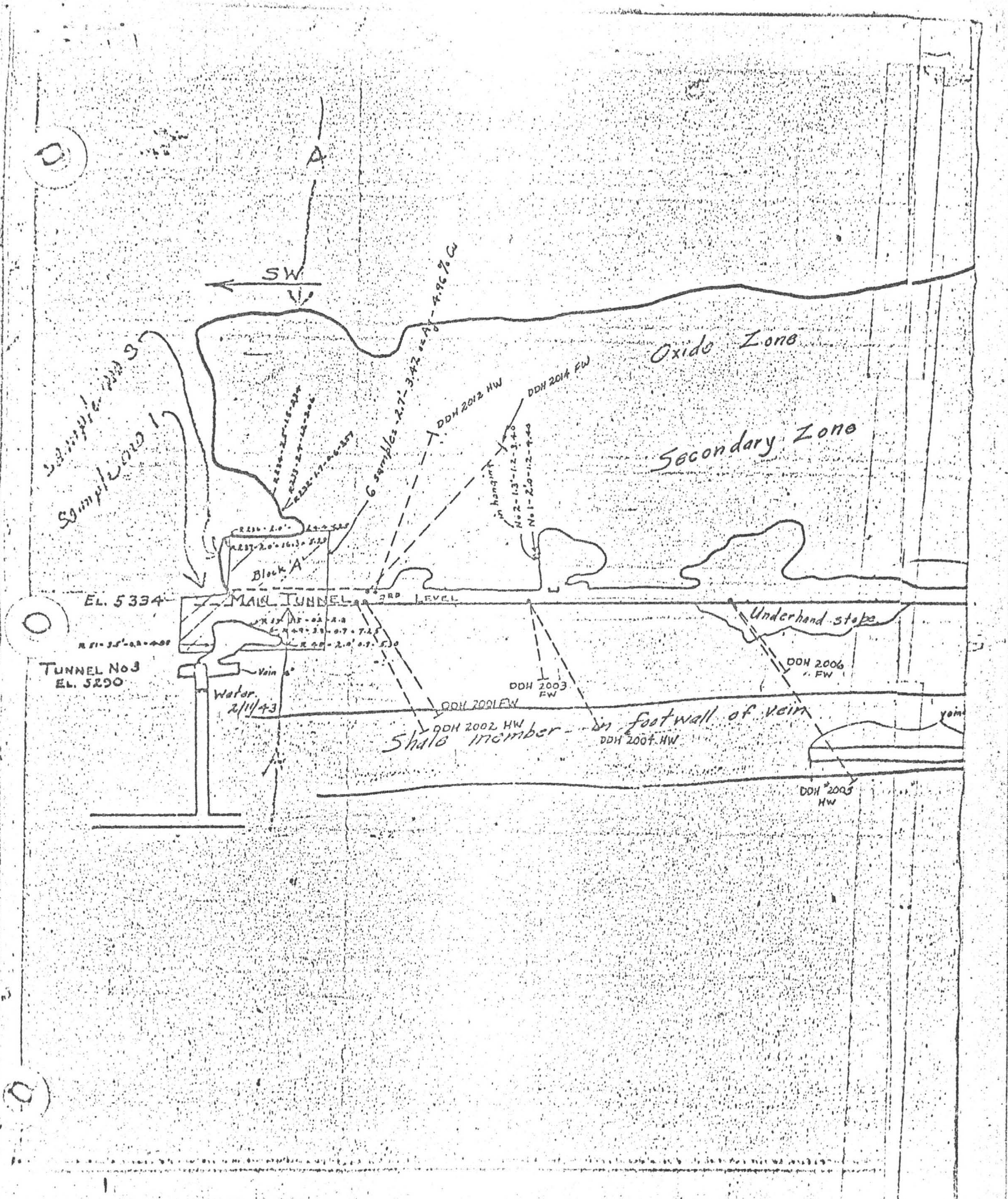
1" = 60'

VALLEY METALLURGICAL PROCESSING CO.

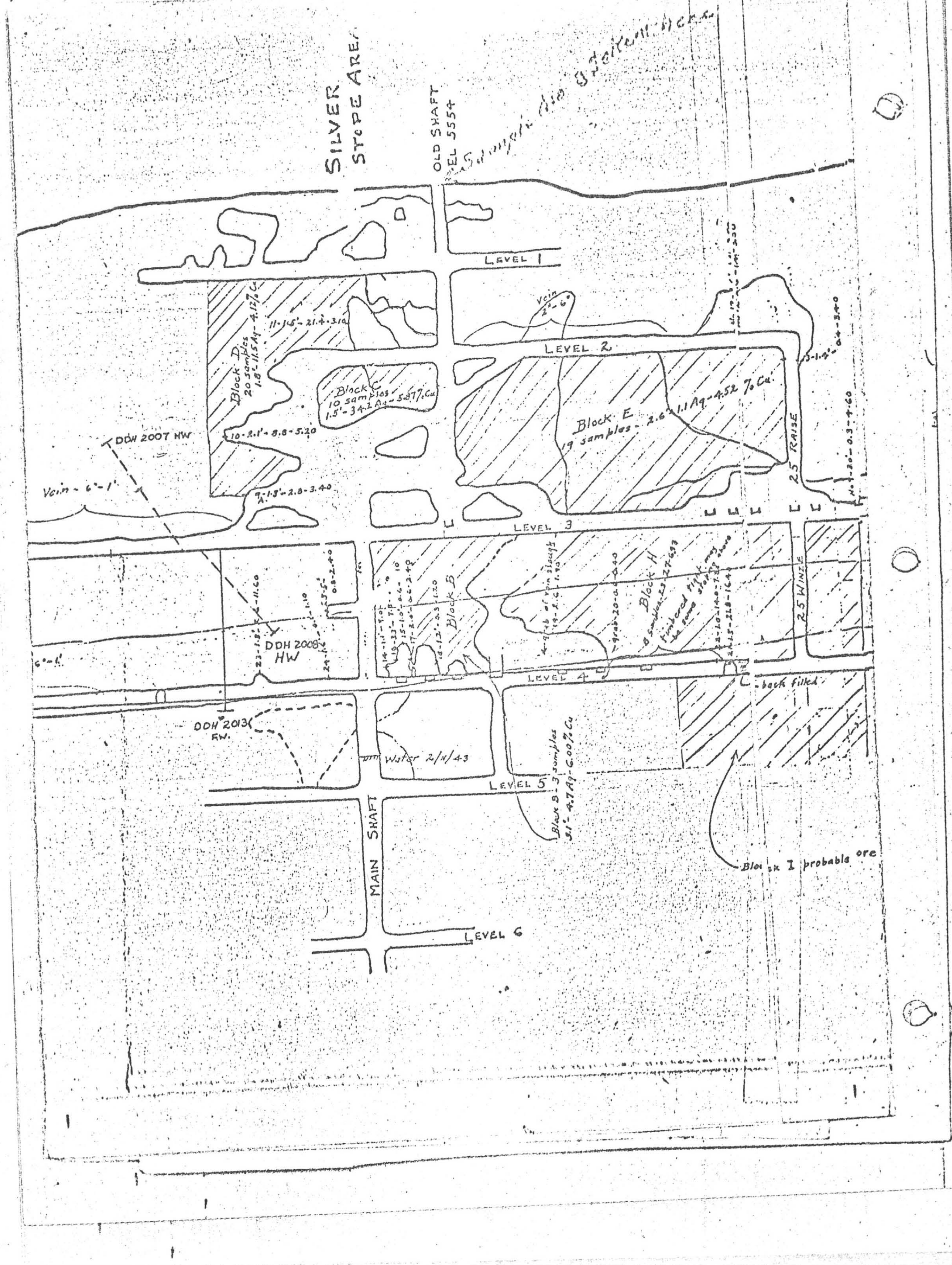
CASHIN MINE
MONTROSE CO. COLO.

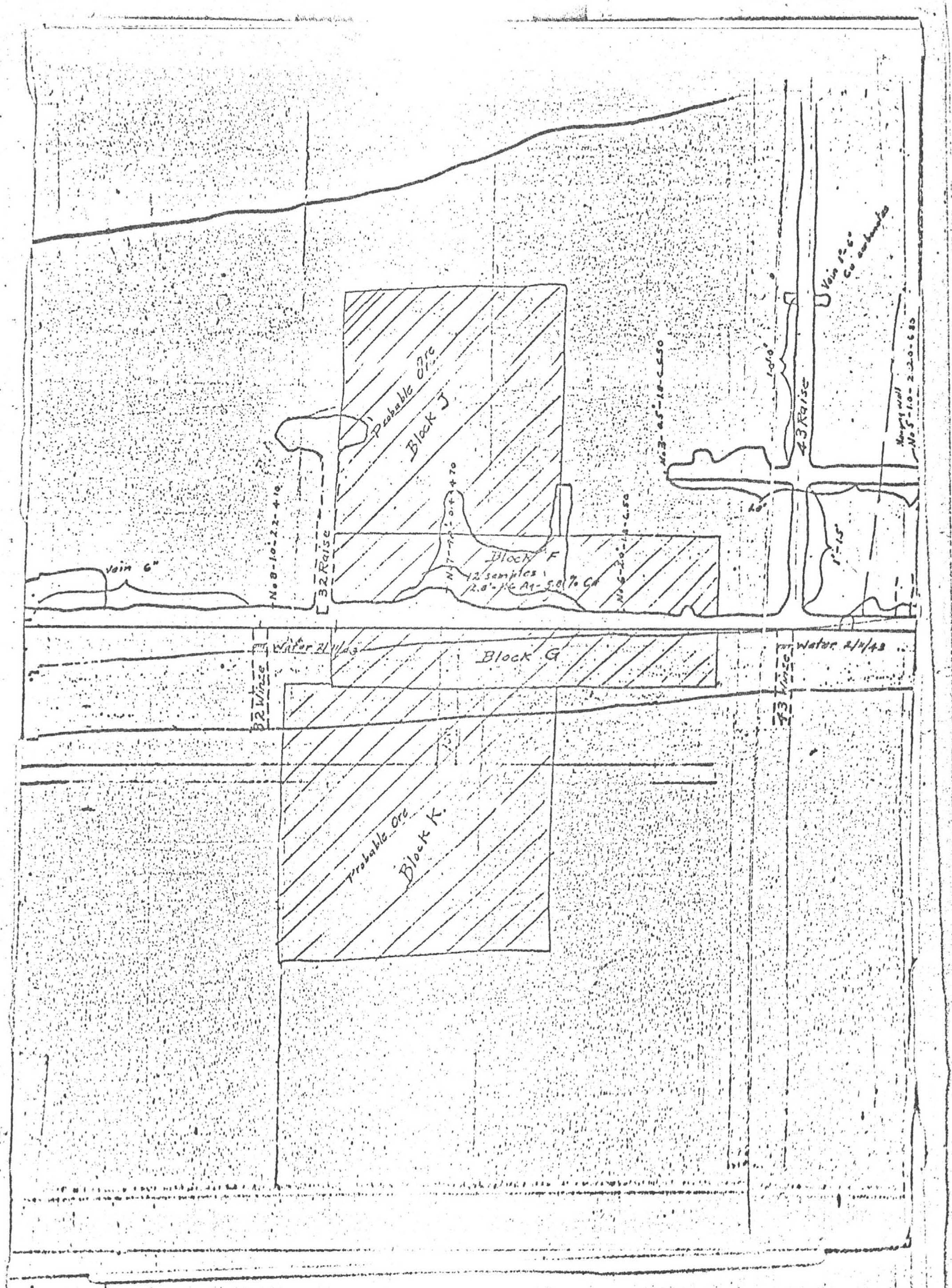
CROSSECTIONS OF
UNDERGROUND DRILL HOLES
LOOKING N 40° E

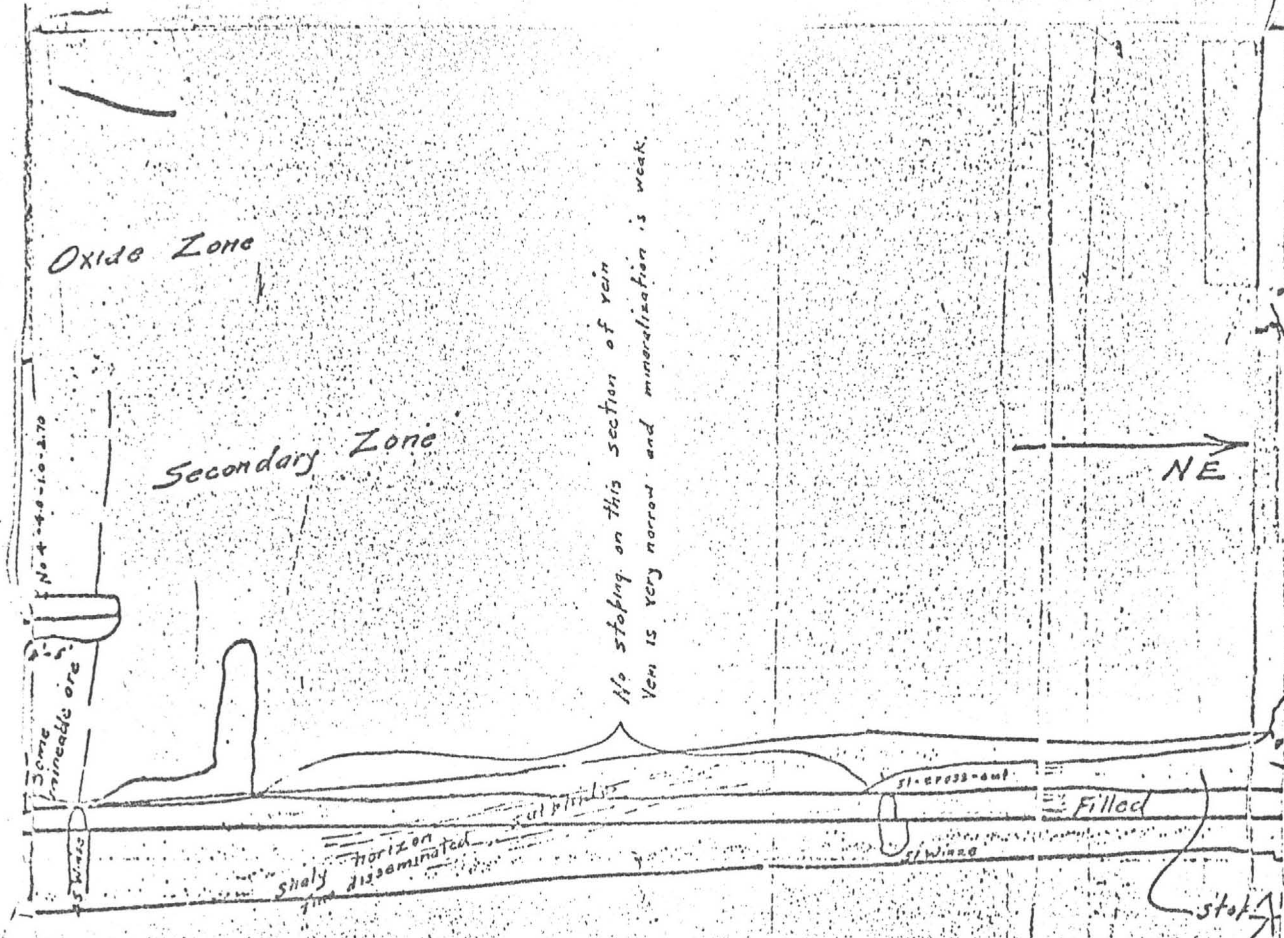
NOV., 1968 DRAWN BY D. STALKER



A
SW
Oxide Zone
Secondary Zone
6 samples - 2.7' - 3.42 oz Ag - 4.96 % Cu
DDH 2012 HW
DDH 2014 FW
Block 'A'
EL. 5334
MAIN TUNNEL
3RD LEVEL
Underhand stope
TUNNEL No 3
EL. 5290
Vein
Water 2/11/43
DDH 2001 FW
DDH 2002 HW
DDH 2003 FW
DDH 2004 HW
DDH 2006 FW
DDH 2005 HW
Shale member - in footwall of vein


SILVER STOPE AREA
OLD SHAFT EL 5554
LEVEL 1
LEVEL 2
LEVEL 3
LEVEL 4
LEVEL 5
LEVEL 6
MAIN SHAFT
Block D
20 samples
Block C
10 samples
Block E
19 samples
Block B
Block H
25 RAISE
25 WINZE
DDH 2007 HW
DDH 2008 HW
DDH 2013 FW.
Vein
back filled
Water 2/x/43
Block I probable ore


Probable Ore
Block J
Block F
12 samples
Block G
32 Raise
32 Winze
43 Raise
43 Winze
vein 6"
Probable Ore
Block K.
No 3-
No 5-1.0-2.20-6.85



Ore blocks.

Proposed development.

R. George H. Xyan samples. — other samples by L.W.C.

No - width in ft. ounces Ag - % Copper.
3 - 0.5 1.4 - 6.50

RED CHIEF TUNNEL

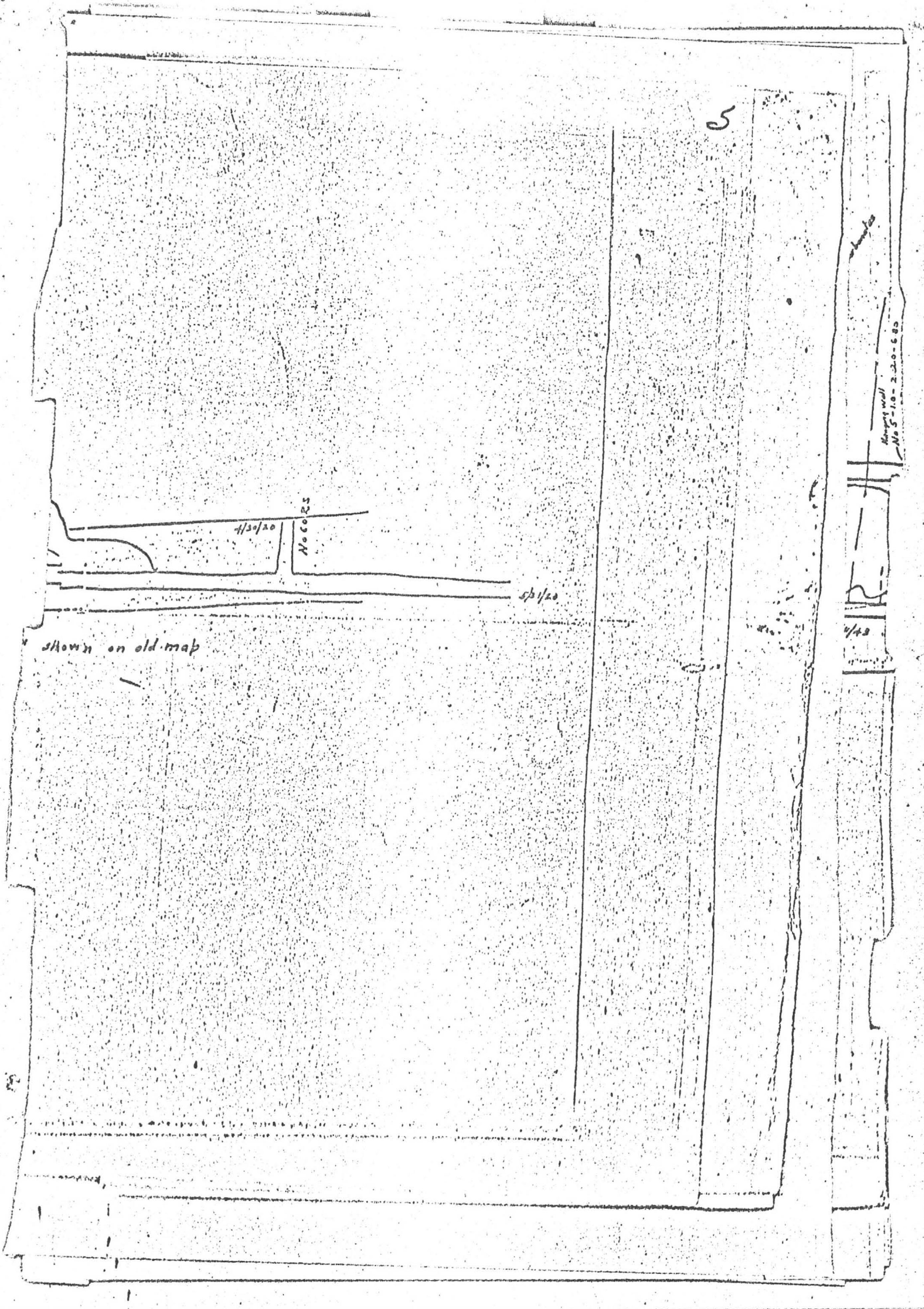
NEW CASHIN MINES, INC.

LA SAL MNG. DIST. MONTROSE CO. COLO.

NE-SW SECTION - 1" = 60'

DOCKET NO C-ND-7939

Louis W. Cramer


5
4/30/20
No 6025
5/31/20
shown on old map
No 5-1.0-2.20-6.80

VALLEY METALLURGICAL PROCESSING CO.

DRILL LOG CASHIN MINE

Doc Moore
Drillers Moore & Sharpe
Rig Gardner Denver 89 drill
G. D. 365 CFM Compressor

Hole No. 1001 (SLMH)
Location
Vertical Angle
Horiz. Bearing

Sample no.	Footage at	Copper %	Assay by *
#1	0-8	0.43	MAL
#2	8-16	0.09	"
#3	16-24	0.02	"
#4	24-32	0.01	"
#5	32-48	0.01	"

5 ⟌ 1.06
.20

Compiled by: Roads

Ccheced by: Zirkle

* MAL Mineral Assay Lab.
Grand Junction, Colo.

VALLEY METALLURGICAL PROCESSING CO.

DRILL LOG CASHIN MINE

Doc Moore
Drillers Moore & Sharpe
Rig Gardner Denver 89 drill
G.D. 365 CFM Compressor

Hole 1002 (SLMH)
Location
Vertical Angle
Horiz. Bearing

Sample No.	Footage at	Copper %	Assay * by
#1	0-8	o.ol	MAL
#2	8-16	0.05	"
#3	16-24	Trace	"
#4	24-32	0.00	"
#5	32-40	Trace	"
#6	40-48	0.00	"
		NIL	

Compiled by: ______________________

Checked by: ______________________

* MAL Mineral Assay Lab.
Grand Junction, Colo.

VALLEY METALLURGICAL PROCESSING CO.

DRILL LOG CASHIN MINE

Doc Moore
Drillers - Moore & Sharpe
Rig- Gardner-Denver-89 Drill
G.D. 365 CFM Compressor

Hole No. 1003 (SLMF)
Location
Vertical Angle
Horiz. Bearing

Sample No.	Footage at	Copper %	Assay by *
#1	24-32	0.05	MAL
#2	32-40	0.01	"
#3	40-48	N.D.**	"
#4	48-52	N?D.	"

Compiled by: ______________________

Checked by: ______________________

* MAL Mineral Assay Lab.
Grand Junction, Colo.
** N.D. none detectable

VALLEY METALLURGICAL PROCESSING CO.

DRILL LOG CASHIN MINE

Doc Moore
Drillers Moore & Sharpe
Rig G rdner Denver 89 drill
G.D. 365 CFM Compressor

Hole No 1003 (SLMF)
Location
Vertical Angle
Horiz. Bearing

Sample No.	Footage at	Copper	Assay * by
#1	0-8	0.33	MAL
#2	8-16	0.75	"
#3	16-24	0.32	"
#4	24-32	0.05	"
#5	32-40	0.01	"
#6	40-48	0.00	"
#7	48-52	0.00	"

7 | 1.46
.21

Compiled by: ______________________

Checked by: ______________________

* MAL Mineral Assay Lab.
Grand Junction, Colo.

VALLEY METALLURGICAL PROCESSING CO.

DRILL LOG CASHIN MENE

Doc Moore
Drillers Moore & Sharpe
Rig - Gardner Denver-89 Drill
G.D. 365 CMF compressor

Hole No 1004 (SLMH)
Location
Vertical Angle
Horiz. Bearing

Sample No.	Footage at	Copper %	Assay * by
#1	0-8	1.70	MAL
#2	8-16	0.34	"
#3	16-24	0.13	"
#4	24-32	0.55	"
#5	32-40	0.08	"
#6	40-48	0.03	"
#7	48-52	0.03	"

7 | 2.86
.41

Compiled by: ____________________

Checked by: ____________________

* MAL Mineral Assay Lab
Grand Junction, Colo.

VALLEY METALLURGICAL PROCESSING CO.

DRILL LOG CASHIN MINE

Doc Moore
Drillers Moore & sharpe
Rig-Gardner Denver-89 Drill
G.D. 365 CFM Compressor

Hole No. 1005 (SLMF)
Vertical Angle
Horiz. Bearing
Location

Sample No.	Footage at	Copper %	Assay by *
#1	0-8	0.01	MAL
#2	8-16	0.01	"
#3	16-24	0.03	"
#4	24-32	0.45	"
#5	32-40	0.45	"
#6	40-48	0.58	"
#7	48-52	0.15	"

7 | 1.68
.24

Compiled by: ______________________

Checked by: ______________________

* MAL Mineral Assay Lab.
Grand Junction, Colo.

VALLEY METALLURGICAL PROCESSING CO.

DRILL LOG CASHIN MINE

Doc Moore
Drillers Moore & Sharpe
Rig Gardner Denver 89 drill
G.D. 365 CFM Compressor

Hole No 1006(SLMF)
Location
Vertical Angle
Horiz. Bearing

Sample No	Footage at	Copper %	Assay By *
#1	0-8	0.08	MAL
#2	8-18	0.02	"
#3	16-24	0.98	"
#4	24-32	0.80	"
#5	32-40	0.07	"
#6	40-48	0.38	"
#7	48-52	0.33	"

7 | 2.66
.38%

Compiled by: ____________________

Chsecked by: ____________________

* MAL Mineral Assay Lab.
Grand Junction, Colo.

VALLEY METALLURGICAL PROCESSING CO.

DRILL LOG CASHIN MINE

Doc Moore
Drillers Moore & sharpe
Rig Gardner Denver 89 drill
G.D. 365 CFM Compressor

Hole No 1007 (SLMF)
Location
Vertical Angle
Horiz. Bearing

Sample No	Footage at	Copper %	Assay by *
#1	0-8	0.05	MAL
#2	8-16	0.02	"
#3	16-24	0.01	"
#4	24-32	N.D.**	"
#5	32-40	N.D.	"
#6	40-48	0.01	"
#7	40-52	0.07	"

nil

Compiled by: ______________________

Checked by : ______________________

* MAL Mineral Assay Lab.
Grand Junction, Colo.
** N.D, none detectable

VALLEY METALLURGICAL PROCESSING CO.

DRILL LOG CASHIN MINE

Doc Moore
Drillers Moore & Sharpe
Rig Gardner Denver 89 drill
G.D. 365 CFM Compressor

Hole No. 1008 (SLMF)
Location
Vertical Angle
Horiz. Bearing

Sample No	Footage at	Copper %	Assay by *
#1	0-8	0.01	MAL
#2	8-16	0.02	"
#3	16-24	0.12	"

nil

Compiled by: ____________________

Check by: ____________________

* MAL Mineral Assay Lab.
Grand Junction, Colo.

VALLEY METALLURGICAL PROCESSING
DRILL LOG CASHIN MINE

Adolphus Moore
Drillers-Moore
Rig-Gardner Denver 89 Drill
G.D. 365 CFM Compressor

Hole No. 1009 (SLMH)
Location
Vertocal Ang;e
Horiz. Bearing

Sample No.	Footage at	Copper%	Assay * by
#1	0-8	0.61	MAL
#2	0-16	1.11	"
#3	16-24	0.20	"
#4	24-32	0.05	"
#5	32-40	0.03	"

2.00
.50%

Compiled by: ______________________

Checked by: ______________________

* MAL Minerals Assay Lab.
Grand Junction, Colo.

VALLEY METALLURGICAL PROCESSING
DRILL LOG CASHIN MINE

Adolphus Moore
Drillers - Moore
Rig-Gardner Denver 89 Drill
G.D. 365 CFM Compressor

Hole No. 1010 (SLMH)
Location
Vertical Angle
Horiz. Bearing

Sample No.	Footage at	Copper %	Assay * by
#1	0-8	0.28	Mal
#2	8-16	0.41	"
#3	16-24	1.11	"
#4	24-32	0.90	"
#5	32-40	0.54	"
		3.24	
		.65	

Compiled by: ______________________

Checked by: ______________________

* MAL Minerals Assay Lab.
Grand Junction, Colo.

VALLEY METALLURGICAL PROCESSING
DRILL LOG CASHIN MINE

Adolphus Moore
Drillers-Moore
Rig-Gardner Denver 89 Drill
G.D. 365 CFM Compressor

Hole No. 1012 (SLMH)
Location
Vertical Angle
Horiz. Bearing

Sample No.	Footage at	Copper %	Assay by *
#1	0-8	0.83	MAL
#2	8-16	1.10	"
#3	16-24	0.62	"
#4	24-32	1.31	"
#5	32-40	0.49	"
		4.35	
		.87	

Compiled by; ______________________________

Checked by: ______________________________

* MAL Minerals Assay Lab.
Grand Junction, Colo.

VALLEY METALLURGICAL PROCESSING
DRILLLOG CASHIN MINE

Adolphus Moore
Drillers-Moore
Rig-Gardner Denver 89 Drill
G.D. 365 CFMS Compressor

Hole No. 1011 (SLMH)
Location
Vertical Angle
Horiz. Bearing

Sample No	Footage at	Copper%	Angle * by MAL
#1	0-8	0.11	MAL
#			
#2	8-16	0.73	"
#3	16-24	0.62	"
#4	24-32	0.43	"
#5	32-40	0.23	"

2.11
.42

Compiled by: ____________________

Checked by: ____________________

*MAL Minerals Assay Lab.
Grand Junction, Colo.

VALLEY METALLURGICAL PROCESSING
DRILL LOG CASHIN MINE

Adolphus Moore
Driller-Moore
Rig-Gardner Denver 89 Drill
G.D. 365 CFM Compressor

Hole No. 1013 (SLMH)
Location
Vertical Angle
Horiz. Bearing

Sample No.	Footage at	Copper %	Assay * by
#1	0-8	0.15	MAL
#2	8-16	0.52	"
#3	16-24	0.26	"
#4	24-32	0.11	"
#5	32-40	0.11"	"
		1.15	
		.23	

Compiled by: ____________________

Checked by: ____________________

* MAL Minerals Assay Lab.
Grand Junction, Colo.

Valley Metallurgical Processing
Drill Log Cashin Mine

Adolphus Moore
Driller-Moore
Rig-Gardner-Denver 89 Drill
G.D. 365 CFM Compressor

Hole No. 1014 (SLMH)
Location
Vertical Angle
Horiz. Bearing

Sample no.	Footage at	Copper %	Assay by *
#1	0-8	0.53	MAL
#2	8-16	0.72	"
#3	16-24	0.40	"
$4	24-32	0.68	"
#5	32-40	0.64	"

5/2.97
0.60

CompileD by: ______________________

Checked by: ______________________

* MAL Minerals Assay Lab.
Grand Junction, Colo.

VALLEY METALLURGICAL PROCESSING
DRILL LOG CASHIN MINE

Adolphus Moore
Driller-Moore
Rig-Gardner-Denver 89 Drill
G.D. 365 CFM Compressor

Hole No. 1015 (SLMH)
Location
Vertical Angle
Horiz. Bearing

Sample No.	Footage at	Copper %	Assay * by
#1	0-8	0.64	MAL
#2	8-16	0.43	"
#3	16.24	0.51	"
#4	24-32	0.49	"
#5	32-40	1.00	"

5)3.07
.61

Compiled by: ____________________

Checked by: ____________________

* MAL Minerals Assay Lab.
Grand Junction, Colo.

VALLEY METALLURGICAL PROCESSING
DRILL LOG CASHIN MINE

Adolphus Moore
Drillers-Moore
Rig-Gardner-denver 89 Drill
G.D. 365 CMF Compressor

Hole No. 1016 (SLMH)
Location
Vertical Angle
Horiz. Bearing

Sample No.	Footage at	Copper	Assay * by
#1	0-8	0.30	MAL
#2	8-16	0.40	"
#3	16-24	0.29	"
#4	24-32	0.29	"
#5	32-40	0.72	"
		5/2.00	
		0.40	

Compiled by: ____________________

Checked by: ____________________

* MAL Minerals Assay Lab.
Grand Junction, Colo.

VALLER METALLURGICAL PROCESSING
DRILL LOG CASHIN MINE

Adolphus Moore
Driller-Moore
Rig-Gardner-Denver 89 Drill
G.D. 365 CFM Compressor

Hole No. 1017 (SLMH)
Location
Vertical Angle
Horiz. Bearing

Sample No	Footage at	Copper %	Assay * by
#1	0-8	0.04	MAL
#2	8-16	0.04	"
#3	16-24	0.00	"

Compiled By: ______________________

Checked by: ______________________

* MAL Minerals Assay Lab.
Grand Junction, Colo.

DRILL LOG

Hole Number:	DDH 3001	Project:	Cashin Mine Montrose Co., Colo.
Bearing:	S 42° E	Date Started:	Oct. 25, 1968
Angle:	-80°	Date Completed:	Nov. 8, 1968
Total Depth:	487 ft.	Core Size:	NXWL

Location: La Sal Creek Canyon. N 89° W, 185ft. from portal of adit, on main haulage level.

DESCRIPTION		INTERVAL	%Cu
0-23	Alluvium	23.5	0.34
23-71	Wingate formation, white, fine grained, crossbedded, sandstone. Mineralization is mostly malachite to 29'.	24.5	0.36
		25.5	0.25
		26.5	0.26
		27.5	0.44
		28.5	0.33
29-39.5	Chalcocite with minor malachite and azurite as disseminations.	29.5	0.02
		32.0	0.18
		33.0	0.24
		34.0	0.16
		35.0	0.02
		36.0	0.23
37-39	Concentration of chalcocite above and below .5' of shale at 37.5.	37.0	2.10
		38.0	2.04
		39.0	0.50
		40.0	0.11
		41.0	0.06
		42.0	0.04
		43.0	0.08
		44.0	0.06
		45.0	0.04
		46.0	0.08
		47.0	0.01
		48.0	0.02
		49.0	0.02
		50.0	0.02
		51.0	0.02
		52.0	0.01
		53.0	0.04
		55.0	0.02
		58.0	0.02
		61.0	0.01
		64.0	0.04
		67.0	0.01
		70.0	0.02
71.5-475	Chinle formation. Interbedded red sandstone, shale, siltstone, and conglomerates.	73.0	0.02
		78.0	0.04
		83.0	---

DESCRIPTION		INTERVAL	%Cu
		88.0	0.04
		98.0	0.04
106-111	Altered to green gray.	108.0	0.04
122-126	Altered to green gray.	142.0	0.12
179-182	Cashin Fault, fractured, gouge small	177.0	0.01
	slips to 1".	197.0	0.02
		207.0	0.02
		217.0	0.02
		227.0	0.01
236.5-239.5	Conglomerate	237.0	0.01
		247.0	0.02
254.8-256.3	Conglomerate	257.0	0.01
		267.0	0.01
276.0	3' coarse conglomerate	277.0	0.02
		287.0	0.02
		297.0	0.04
		307.0	0.04
313.0	,5' gouge in red siltstone, rock is	317.0	0.01
	highly fractured 1' below and 5'	327.0	0.01
	above zone.	337.0	0.29
337-367	Coarse conglomerate	337.5	0.04
		339.5	0.01
		347.0	0.13
		357.0	0.01
		367.0	0.04
373.5-376.5	Highly fractured.	377.0	0.01
380-384	Conglomerate, small pebbles.	387.0	0.06
		397.0	0.02
407-408	Conglomerate, med. pebbles.	407.0	0.01
		412.0	0.04
		416.0	0.01
423-435	Conglomerate	427.0	0.01
		437.0	0.02
441.5-443	Conglomerate	447.0	0.01
463-475	Interbedded siltstone and conglomerate	467.0	0.02
	(base of Chinle?)	487.0	0.01
475-487	Red siltstone		
487	Bottom of hole.		

DRILL LOG

Hole Number:	DDH 3002	Project:	Cashin Mine Montrose Co., Colo.
Bearing:	--	Date Started:	Nov. 13, 1968
Angle:	-90°	Date Completed:	Nov. 18, 1968
Total Depth:	245 ft.	Core Size:	NXWL
Location:	Nyswonger Mesa, S 53° W, 730' from shaft.		

DESCRIPTION		INTERVAL	%Cu
0-226	White, fine grained, crossbedded, sandstone.	0.2	0.10
		1.0	0.08
		2.0	0.42
3.0-6.0	Strong Fe stain on fractures. Fractures are at 20° from long axis of core. Malachite is along bedding and dissemin-ated, manganese maybe mixed with limonite.	3.0	1.30
		4.0	0.52
		5.0	0.54
		6.0	1.10
6.0-21	Finely disseminated malachite.	7.0	0.36
		8.0	0.34
		9.0	0.42
		10.0	0.31
		11.0	0.30
		12.0	0.25
		13.0	0.36
		14.0	0.30
		15.0	0.30
		16.0	0.30
		17.0	0.41
		18.0	0.58
		19.0	0.28
		20.0	0.52
		21.0	1.00
22.0	2" of fractured altered sandstone.	22.0	0.71
		23.0	0.38
		24.0	0.52
		25.0	0.31
		26.0	2.50
		27.0	0.53
		28.0	0.25
29.0	Fractures at 20°. Weak to moderate Fe stain.	29.0	0.75
		30.0	0.62
30-37	Malachite is strong locally in zones to 8". Is along bedding and as dissem-inated grains.	31.0	0.80
		32.0	3.20
		33.0	2.00
		34.0	1.08
		35.0	0.67
		36.0	0.92
		37.0	0.66
		38.0	0.36
39-43	Malachite	39.0	1.90

DESCRIPTION		INTERVAL	%Cu
		40.0	1.60
		41.0	1.11
		42.0	0.92
		43.0	0.30
		44.0	0.64
		45.0	0.42
		46.0	0.23
		47.0	0.30
		48.0	0.20
		49.0	0.29
		50.0	0.44
		51.0	0.33
		52.0	0.30
		53.0	0.19
54-60	Moderate malachite. Weak pervasive Fe stain. Malachite halos around limonite grains is common.	54.0	0Q50
		55.0	2.53
		56.0	0.59
		57.0	0.55
		58.0	0.39
		59.0	0.50
		60.0	0.23
		61.0	0.24
		62.0	0.26
		63.0	0.35
64-72	Moderate malachite, mostly as disseminations.	64.0	0.85
		65.0	0.88
		66.0	0.64
		67.0	0.90
		68.0	0.38
		69.0	0.75
		70.0	0.40
		71.0	0.28
		72.0	0.64
		73.0	0.44
		74.0	0.36
		75.0	0.33
76-79	Moderate Fe stain locally.	76.0	0.38
		77Q0	1.10
78.5-	4" good disseminated malachite.	78.0	2.55
		79.0	0.31
		80.0	0.32
		81.0	0.44
		82.0	0.59
		83.0	0.45
		84.0	0.48
85-92	Good malachite with seams to ½".	85.0	1.10
		86.0	1.20
87.0-	Manganese on fractures.	87.0	1.10
		88.0	0.62
		89.0	0.85

DESCRIPTION		INTERVAL	%Cu
		90.0	2.10
		91.0	1.21
		92.0	0.16
		93.0	0.15
96-101-	Good disseminated malachite. Crossbedding at 100.0. Beds approx. ¼" thick. Some contain good malachite with intervening bed having very weak to moderate amounts. Fe stain along bedding.	96.0	0.19
		97.0	0.94
		98.0	0.75
		99.0	1.22
		100.0	1.10
		101.0	0.85
		102.0	0.15
103-108	Very fine grains of chalcocite, disseminated. Some bornite also.	103.0	0.21
		104.0	1.50
		105.0	2.12
		105.5	1.80
		106.0	1.31
		107.0	2.20
		108.0	2.52
		109.0	0.16
		110.0	0.73
111-111.5	1" zones of chalcocite.	111.0	0.25
		112.0	0.13
		113.0	0.15
		114.0	0.15
115-120	Moderate Fe stain.	116.0	0.82
		117.0	0.29
		118.0	0.54
		119.0	0.35
		120.0	0.82
		121.0	0.53
		122.0	0.08
		123.0	0.13
		124.0	0.85
124.5-127.5	Moderate disseminated malachite blebs to ¼". Thin seams at 127.	124.5	0.30
		125.0	0.30
		126.0	0.69
		127.0	0.20
		128.0	0.55
		129.0	0.85
		130.0	0.34
		131.0	0.20
		132.0	0.15
		133.0	0.18
134-141	Good malachite, as blebs and seams along bedding. Weak Fe stain. Manganese oxide along bedding at 141.	134.0	0.15
		135.0	1.22
		136.0	1.60
		137.0	0.31
		138.0	1.20
		139.0	0.70

DESCRIPTION		INTERVAL	%Cu
		140.0	0.50
141-148.5	Weak malachite.	141.0	0.68
		142.0	0.29
		143.0	0.35
		144.0	0.15
		145.0	0.15
		146.0	0.55
		147.0	0.66
148.5-150.5	Disseminated chalcocite.	148.0	0.15
		149.0	1.65
		150.0	2.40
151-156	Weak Fe stain. Increase in malachite along bedding at 153.	151.0	0.66
		152.0	0.24
		153.0	0.66
		154.0	1.20
		155.0	0.55
		156.0	1.25
		157.0	0.38
		158.0	0.10
159.5-161	Good disseminated malachite.	159.0	0.63
		160.0	1.25
		161.0	0.43
		162.0	0.50
		163.0	0.35
		164.0	0.98
165-167	Very Fine grains of disseminated chalcocite. Trace amounts of bornite and chalcopyrite. 2" zone of good malachite at base of sulfides.	165.0	0.80
		166.0	0.73
		167.0	1.50
		168.0	0.69
167-177	Weak to Moderate malachite. Malachite occurs only in very minor amounts below 177.	169.0	0.58
		170.0	0.06
		171.0	0.30
		172.0	0.48
		173.0	0.30
		174.0	0.30
		175.0	0.43
		176.0	0.50
		177.0	0.25
178-181	Fe stain on steep fractures.	178.0	0.25
		179.0	0.27
		180.0	0.22
		181.0	0.28
		182.0	0.34
		183.0	0.55
		184.0	0.38
		185.0	2.10
		186.0	0.63
		187.0	0.25
		188.0	0.40

DESCRIPTION		INTERVAL	%Cu
		189.0	0.58
		190.0	0.25
		191.0	0.40
		192.0	0.27
		193.0	0.35
		194.0	0.55
		195.0	0.95
		196.0	0.85
		197.0	0.60
		198.0	0.60
199-205	Chalcocite increases with some malach-	199.0	0.83
	ite and azurite from 203-205.	2200.0	0.79
		201.0	1.83
		202.0	1.60
		203.0	0.83
		204.0	0.70
205-206	Fractured with Mn staining.	205.0	0.58
206-223	Weak disseminated chalcocite $\frac{1}{4}$" seam	206.0	0.10
	at 223'.	207.0	0.19
		208.0	0.34
		209.0	0.49
		210.0	0.30
		211.0	0.33
		212.0	0.28
		213.0	0.21
		214.0	0.20
		216.0	0.28
		217.0	0.57
		218.0	0.34
		219.0	0.55
		220.0	0.49
		221.0	0.34
		222.0	0.43
223-	1" fault gouge or clay seam. Sand-	223.0	2.11
	stone is bleached white to 226.	224.0	0.10
		225.0	0.10
226-245	Red, fine grained crossbedded sandstone.		

DRILL LOG

Hole Number:	DDH 3003	Project:	Cashin Mine Montrose Co., Colo.
Bearing:	N 57° W	Date Started:	Nov. 20. 1968
Angle:	-68°	Date Completed:	Nov. 22, 1968
Total Depth:	303 ft.	Core Size:	NXWL
Location:	Nyswonger Mesa, S 71° W, 335' from shaft.		

DESCRIPTION		INTERVAL	%Cu
0-28.0	Wingate formation, white fine grained crossbedded sandstone. Interbedded green shale 15'-17'.	0-20	Trace
		21.0	0.06
		22.0	0.11
20-42	Very weak malachite as disseminations.	23.0	0.10
		24.0	0.30
		25.0	0.15
		26.0	0.07
		27.0	0.05
		28.0	0.18
		29.0	0.15
		30.0	0.08
		31.0	0.15
		32.0	0.13
		33.0	0.20
		34.0	0.29
		35.0	0.15
		36.0	0.15
		37.0	0.07
		38.0	0.07
		39.0	0.11
		40.0	0.06
		41.0	0.02
42-76	Local zones of weak to moderate Fe stains.	42.0	0.12
		43-117	Trace
		118.5	0.03
119-120	Disseminated chalcocite.	119.5	1.92
120-156	Trace to weak amounts of disseminated malachite.	120.0	0.50
		121.0	0.55
		122.0	0.20
		123.0	0.10
		124.0	0.13
		125.0	0.10
		126.0	0.25
		127.0	0.07
		128.0	0.04
		129.0	0.09
		130.0	0.09
		131.0	0.14
		132.0	0.09

DESCRIPTIONS		INTERVALS	%Cu
		133.0	0.09
		134.0	0.05
		135.0	0.02
		136.0	0.08
		137.0	0.11
		138.0	0.12
139-156	Weak to moderate Fe stain.	139.0	0.03
		139.5-153	Trace
		154.0	0.05
		155.0	0.03
156-160	Weak to moderate malachite.	156.0	0.38
		157.0	0.57
		157.5	0.85
		158.5	0.38
		159.5	1.80
160-171	Very weak disseminated malachite and azurite.	160.5	0.10
		161.5	0.09
		162.5	0.56
		163.5	0.08
		164.5	0.07
		165.5	0.07
		166.5	0.03
		167.5	0.14
		168.5	0.14
		169.5	0.17
		170.5	0.10
171-173	Good malachite along bedding and as disseminations.	171.5	1.61
		172.5	3.30
173	Top of chalcocite zone.	173.5	0.18
173-177.5	Weak to moderate disseminated chalcocite.	174.5	0.45
		175.5	0.80
		176.5	0.40
177.5-179.3	Good disseminated chalcocite.	177.5	0.74
		178.5	2.10
179.3-192	Weak chalcocite with high grades zones of 2" at 183.5, 187.0, and 192.0.	179.5	0.14
		180.5	0.11
		181.5	0.11
		182.5	0.12
		183.5	2.71
		184.5	0.08
		185.5	0.09
		186.5	0.06
		187.5	0.26
		187.7	1.11
		188.5	0.09
		189.5	0.53
		190.5	0.07
		191.5	0.10
192-194	Trace of malachite.	192.5	0.04
211.0	.5' good chalcocite.	193.5-211.0	Trace

DESCRIPTION		INTERVAL	%Cu
212.0	Finely disseminated pyrite & Galena??	212.0	0.04
212.5	.1' green shale with .3' of good chalcocite below it.	213.0	1.08
		214.0	0.40
		215.0	0.30
		216.0	1.31
		217.0	0.10
		218.0	0.10
		219.0	--
		220.0	1.00
		221.0-222.0	0.11-0.11
		223.0	0.18
		224.0	0.41
		225.0	0.30
		227.0	0.08
		228.0	0.14
		229.0	0.04
		229.5-233.0	Trace
		234.0	0.30
		235.0	0.13
		235.5-244.5	Trace
245.0-253.0	Interbedded green shales with finely disseminated chalcocite from 248-253.	250.0	0.10
		255.0	0.15
		255.5-260.5	0.44
		260.5-265.5	0.36
266.0-294.5	Weak to moderate chalcocite. Also trace of chalcopyrite ortarnished pyrite at 285.	265.5-270.0	0.64
		270.0-275.0	0.46
		275.0-280.0	0.73
280.0-303.0	Sandstone varies from white to dark gray to red.	290.0	0.01
		294.5	0.01
295.0	.3' of conglomerate.	295.0	0.01
		300.0	0.10
303.0	Bottom of hole		

DRILL LOG

Hole Number: DDH 3004
Bearing: N 37° W
Angle: -68°
Total Depth: 304 ft.
Location: Nyswonger Mesa, N 36° W, 85' from shaft.

Project: Cashin Mine, Montrose Co., Colo.
Date Started: Nov. 26, 1968
Date Completed: Dec. 10, 1968
Core Size: NXWL

DESCRIPTION		INTERVAL	%Cu
0-288	White, fine grained, crossbedded, sandstone, with interbedded shale, from 9-15'. Moderate to strong Fe stained zones from 0-32.0.	0.2	0.04
		1.0	0.03
		2.0-21.0	Trace
		22.0	0.27
21-45	Weak disseminated malachite, with 2-3" zones of moderate copper.	23.0	0.45
		24.0	0.29
		25.0	0.35
		26.0	0.67
		27.0	0.60
		28.0	0.22
		29.0	0.21
		30.0	0.15
		31.0	0.15
		32.0	2.06
		33.0	0.62
		34.0	2.80
		35.0	0.17
		36.0	0.98
		37.0	0.41
		38.0	0.11
		39.0	0.34
		40.0	0.11
		41.0	0.50
		42.0	0.15
		43.0	0.22
		44.0	0.11
45-70.5	Malachite is more evenly distributed. Black grains (cc?) occur along bedding, but in minor amounts. Moderate Fe stain 60.5-65.0.	45.0	0.47
		46.0	0.81
		47.0	1.09
		48.0	0.66
		49.0	1.73
		50.0	0.79
		51.0	0.69
		52.0	0.79
		53.0	0.59
		54.0	0.71
		55.0	0.59
		56.0	0.57
		57.0	0.46

DESCRIPTION		INTERVAL	%Cu
		58.0	0.13
		59.0	0.11
		60.0	0.08
		60.8	0.04
		61.5	0.14
		62.5	0.21
		63.5	0.32
		64.5	0.47
		65.5	0.69
		66.5	0.51
		67.5	0.60
		68.5	0.59
		69.5	0.45
70.5-119	Leached Zone with weak Fe stain locally and sparsely disseminated limonite grains.	70.5	0.03
		71.5	0.03
		72.5-118	Trace
119-128	Chalcocite zone. Strong enrichment 127-128.5.	119.0	0.09
		120.0	0.17
		121.0	0.35
		122.0	0.28
		123.0	0.25
		124.0	0.94
		125.0	1.17
		126.0	0.32
		127.0	5.38 (1.96)
128.5-130	Moderate Fe stain with weak malachite.	128.0	2.57
		129.0	0.20
		130.0	3.20
130-135	Zone with Moderate malachite and minor chalcocite.	130.8	0.18
		132.5-31.5	0.37-0.36
		133.5	0.47
		134.5	0.27
135-141	Moderate chalcocite.	135.5	0.74
		136.5	0.89
		137.5	1.24
		138.3	0.74
		139.0	0.79
		140.0	1.78
141-162	Predominently malachite.	141.0	0.99
		142.0	0.20
		143.0	0.16
		144.0	0.13
		145.0	0.20
		146.0	1.27
		147.0	1.09
		148.0	0.13
		148.8	0.69
		149.5	0.91

DESCRIPTION		INTERVAL	%Cu
		150.3	0.69
		151.0	1.50
		152.0	1.45
		153.0	1.73
		154.0	0.144
		155.0	1.93
		156.0	2.11
		157.0	2.44
		158.0	0.20
		159.0	0.89
		160.0	1.15
		161.0	0.84
162-303.5	Chalcocite zone, mineralization is very erratic with high grade intervals to 3' and very weakly mineralization zones to 10'. Chalcocite occurs mostly as disseminations. Bornite is present iin weak amounts.	162.0	0.43
		163.0	2.51
		164.0	0.38
		165.0	0.56
		166.0	0.79
		167.0	0.91
		168.0	0.38
		169.0	0.55
		170.0	2.74
		171.0	0.12
		172.0	0.11
		173.0	0.91
		173.8	2.81
		174.8	0.15
		175.5	0.10
		176.4	0.16
		177.3	2.54
		178.2	1.37
		179.0	0.81
		180.0	0.32
		181.0	0.23
		182.0	1.24
		183.0	0.28
		184.0	1.04
		185.0	0.18
		186.5-191.5	0.34
195.5-196.3	Chalcocite mixed with weak malachite and azurite.	191.5-196.5	0.63
		196.5-200	0.49
		200.9-205	0.51
		205.0-210	0.25
		210.0-215	0.33
		215.0-220.	1.32
		220.0-225	0.49
		225.0-230	0.55
		230.0-235	0.58
		235.0-240	0.78
241.5-243	Interbedded shale to 1".	240.0-245	1.21

DESCRIPTION		INTERVAL	%Cu
245-248	Very high grade chalcocite zone.	245.0-250	2.00
		250.0-255	0.33
		255.0-260	0.54
262.5-266	High grade chalcocite.	260.0-265	0.99
		265.0-270	0.35
		270.0-275	0.12
		275.0-280	0.75
286.0	2" mass of chalcocite with covellite	280.0-285	0.58
	coating.	285.0-290	0.75
288-299	Sandstone is mottled light and dark gray.	290.0-295	0.23
299-303.5	Green and red shale.	295.0-299.8	0.55
303.5-	Bottom of hole.	299.8-303.5	0.25

DRILL LOG

Hole Number:	DDH 3005	Project:	Cashin Mine Montrose Co., Colo.
Bearing:	--	Date Started:	Dec. 12, 1968
Angle:	-90°	Date Completed:	Dec. 17, 1968
Total Depth:	271'	Core Size:	NXWL
Location:	Nyswonger Mesa, N 20° W, 95' from shaft.		

DESCRIPTION		INTERVAL	%Cu
0-245	White, fine grained, crossbedded sand-	0-5	0.00
	stone. Strong Fe stain from 1.0-3.0 with	5-10	0.01
	sparse disseminated limonite grains.	10-15	0.00
	Bedding near horizontal.	15-20	0.00
14.5	1" zone with very fine grained dissemin-	20-25	0.01
	ated pyrite.	25-30	0.20
18.5	Fault, green shale in sandstone, but is	30-35	0.53
	not bedded. Zone contains fragments of	35-40	0.51
	sandstone and shale.	40-45	0.35
24-36	Weak to moderate Fe stain.	45-49.3	0.41
24.8	Weak malachite.	49.3-54.3	0.23
34-36	Good malachite mixed with Fe stain.	54.3-59.2	0.20
36-69	Weak malachite and disseminated blebs of	59.2-64.2	0.25
	azurite with disseminated limonite grains	64.2-69.0	0.40
	from 64-70.	69.0-74.0	0.03
69-92	Trace amounts of Cu with limonite	74.0-78.8	0.01
	disseminations locally.	78.8-83.8	0.01
		83.8-88.5	0.03
92-98	Weak malachite mixed with Fe stain.	88.5-93.5	0.38
		93.5-98.3	0.01
98-112	Weak mineralization. Vertical fractures	98.3-103.3	0.18
	at 112.	103.3-108.3	0.01
112	Strong Cu mineralization below. Mixed	108.3-112.8	0.25
	malachite and chalcocite to 195'.	112.8-117.8	1.20
112-116	Malachite with minor chalcocite.	117.8-121.8	1.42
116-121.5	Chalcocite.	121.8-127.5	1.50
121.5-129	Malachite.	127.5-132.5	1.61
129-134.7	Chalcocite.	132.5-137.2	1.87
134.7-158.5	Malachite with very minor chalcocite.	137.2-142.2	0.82
		142.2-146.6	1.61
		146.6-151.6	0.91
152.5-155	Very good malachite.	151.6-156.6	2.52
158.5-172.5	Mostly Chalcocite with minor malachite	156.6-161.6	2.52
	and weak Fe stain from 162-168.	161.6-166.3	1.00
		166.3-171.3	1.80
172.5-178	Malachite in zone with strong Fe stain.	171.3-176.0	2.81
178-192	Good chalcocite zone, coarse grains.	176.0-181.0	1.57
			0.[illegible]

DESCRIPTION		INTERVAL	%Cu
		181.0-186.0	0.69
		186.0-191.0	0.75
192.0	Chalcocite weakens. Weak malachite	191.0-195.5	0.91
	193.5-195.	195.5-200.5	0.08
		200.5-205.4	0.25
208-210	Good Malachite.	205.4-210.6	0.91
215-245.5	Fair to good chalcocite as disseminated	210.6-215.3	1.40
	grains.	215.3-221.0	0.05
218-219	Cashin fault. 3' of core not recovered.	221.0-227.5	0.09
	Lower contact of fault is 15° from vert-	227.5-232.5	1.20
	ical. Chalcocite is good along 15°	232.5-237.5	0.45
	fractures.	237.5-242.5	0.65
245-263	Interbedded dark brown to white sand-	242.5-247.5	0.03
	stone and siltstone. Also some thin beds	247.5-252.5	0.01
	of green shale. Chinle formation pro-	252.5-257.5	0.01
	bably begins below the fault, at about	257.5-262.5	0.01
	220.	262.5-266.7	0.00
260-262.5	Thin seams of chalcocite and fine	266.7-271.7	0.02
	grains of pyrite.		
263-271.7	Red siltstone and shale.		
271	.5' fragmented, but pieces have not		
	been rotated.		
271.7	Bottom of hole.		

DRILL LOG

Hole Number:	DDH 3006	Project:	Cashin Mine Montrose Co., Colo.
Bearing:	N 42° W	Date Started:	Dec. 27, 1968
Angle:	-68°	Date Completed:	Dec. 30, 1968
Total Depth:	323'	Core Size:	NXWL
Location:	Nyswonger Mesa, N 35° E, 230' from shaft.		

DESCRIPTION		INTERVAL	%Cu
0-306	White, to light gray, fine grained sand-stone. Green miciceous shale beds from 3.0-7.0.	0.0-5.0	0.01
		5.0-10.2	0.01
		10.2-15.2	0.58
		15.2-19.6	1.50
19-29	Very fine grains of disseminated pyrite. ¼" seams of pyrite at 27'.	19.6-24.6	0.01
		24.6-29.3	0.01
31-33	Thin micaceous shale beds.	29.3-34.3	0.01
		34.3-39.3	0.40
40.0	Weak malachite.	39.3-44.4	0.06
		44.4-49.3	0.00
		49.3-54.3	0.02
		54.3-59.0	0.01
		59.0-64.0	0.07
66-71	Very weak malachite and trace of pyrite remnants in limonite grains.	64.0-68.8	0.04
		68.8-73.8	0.04
		73.8-78.7	0.04
		78.7-83.7	0.00
		83.7-88.2	0.04
		88.2-93.2	0.03
98-128	Weak Fe stains with disseminated limonite grains.	93.2-98.0	0.00
		98.0-103.0	0.01
		103.0-107.8	0.03
		107.8-112.8	2.30
		112.8-117.4	--
		117.4-122.4	0.02
		122.4-127.1	0.02
128-137	Chalcocite zone with some bornite. Weak over all.	127.1-132.1	0.80
		132.1-136.7	0.30
137-144	Weak malachite in Fe stain.	136.7-141.7	0.38
144-156	Chalcocite. Local Fe stain and malachite.	141.7-146.4	0.30
		146.4-151.4	0.47
		151.4-156.2	0.09
156-169	Weak malachite and Fe stain.	156.2-161.2	0.09
		161.2-165.9	0.16
169-190	Disseminated chalcopyrite, partially replaced by chalcocite. Trace of pyrite.	165.9-170.9	0.25
		170.9-175.3	0.50
		175.3-180.3	0.42
		180.3-185.0	0.24

DESCRIPTION		INTERVAL	%Cu
		185.0-190.0	0.05
190-247.5	Trace of disseminated chalcocite and chalcopyrite.	190.0-194.8	0.05
		194.8-198.8	0.06
		198.8-204.8	0.15
		204.8-209.8	0.08
		209.8-214.8	0.10
		214.8-219.8	0.00
		219.8-224.3	0.00
		224.3-229.3	0.53
		229.3-233.8	0.15
		233.8-238.8	0.14
		238.8-243.5	1.50
247.5-290	Good chalcocite. Zones 3-4 Ft. are very enriched. Occurs along fractures, bedding and is also disseminated.	243.5-248.5	0.23
		248.5-253.2	6.20
		253.2-258.2	1.10
		258.2-263.0	2.00
		263.0-268.0	1.92
		268.0-272.4	0.47
		272.4-277.9	1.62
		277.9-282.2	2.15
		282.2-287.2	5.00
		287.2-291.8	1.21
290-306	Weak sulfide mineralization mixture of chalcocite and chalcopyrite.	291.8-296.8	0.80
		296.8-301.4	0.14
		301.4-306.4	0.29
306-322.7	Interbedded chocolate brown sandstone and green shale. Some primary sulfides along bedding in shale.	306.4-311.4	0.47
		311.4-316.4	0.06
		316.4-321.3	0.01
322.7	Bottom of hole.	321.3-322.7	0.00

DRILL LOG

Hole Number:	DDH 3007		Cashin Mine
Bearing:	N 45° W	Project:	Montrose Co., Colo.
Angle:	-68°	Date Started:	Jan. 2, 1968
Total Depth:	274'	Date Completed:	Jan. 4, 1968
Location:	Nsywonger Mesa, S 32° W, 315' from shaft.	Core Size:	NXWL

DESCRIPTION		INTERVAL	%Cu
0-264	White, finegrained, crossbedded sandstone.	0.9-4.7 0.31	0.31
	Shale seams interbedded to 5' bedding at	4.7-10.2	0.20
	70°, Very weak malachite to 22'.	10.2-15.2	0.30
		15.2-19.9	0.37
22-25	Moderate malachite with CC (?) grains	19.9-24.9	0.57
	along bedding.	24.9-30.0	0.60
25-66	Malachite occurs in weak amounts. Fe	30.0-35.0	0.33
	stain is in zones to 2" along bedding.	35.0-40.1	0.85
		40.1-45.1	0.26
		45.1-50.5	0.50
		50.5-55.5	0.41
		55.5-60.8	0.44
		60.8-65.8	0.17
66-116.5	Moderate malachite occurs in zones to 3'.	65.8-70.9	0.58
	Weak Fe stain is common along bedding.	70.9-75.9	1.23
	Sparsely disseminated limonite specks.	75.9-80.9	0.33
		80.9-85.9	0.45
		85.9-91.0	0.47
		91.0-96.0	0.63
		96.0-103.3	0.41
103-116.5	Blebs of azurite to ¼".	103.3-106.3	0.62
107-113	Moderate Fe stain.	106.3-111.3	1.00
		111.3-116.3	1.00
116.5-122	Chalcocite zone.	116.3-121.5	0.23
122-154	Weak malachite and weak Fe stain.	121.5-126.5	1.01
		126.5-131.5	0.25
		131.5-136.5	0.08
		136.5-141.8	0.11
		141.8-146.8	0.15
		146.8-151.8	0.09
154-159	Malachite increases, but is mixed with	151.8-156.8	0.35
	some chalcocite.	156.8-161.9	0.13
159-169	Moderate Fe stain with weak malachite.	161.9-166.9	0.33
169-201.5	Weak to moderate malachite with chalcoc-	166.9-171.9	0.06
	ite from 176.8-178.8.	171.9-176.9	0.08
		176.9-181.9	0.69
		181.9-186.9	0.83
		186.9-192.0	0.83

DESCRIPTION		INTERVAL	%Cu
		192.0-197.0	0.28
		197.0-202.1	0.93
201.5	Top of Chalcocite zone mineralization is weak except for concentrations in zones to 6".	202.1-207.1	0.22
		207.1-212.1	0.23
		212.1-217.1	0.36
		217.1-222.1	0.33
		222.1-227.1	1.47
		227.1-232.0	1.32
236-240	Thin shale units.	232.0-237.0	0.68
		237.0-242.0	0.70
		242.0-247.0	0.24
		247.0-252.0	0.05
		252.0-257.0	0.57
		257.0-262.0	0.30
264-274	Red sandstone.	262.0-267.0	0.13
		267.0-272.0	0.05
274.0	Bottom of hole.	272.0-274.0	0.05

DRILL LOG

Hole Number:	DDH 2001	Project:	Cashin Mine Montrose Co., Colo.
Bearing:	S 89° E	Date Started:	Oct. 2, 1968
Angle:	-42°	Date Completed:	Oct. 7, 1968
Total Depth:	89 ft.	Core Size:	AX

Location: Underground, main haulage level, footwall, 90' from portal

DESCRIPTION

0-3.7	No Recovery
3.7-46	White, fine grained crossbedded sandstone
3.7-18	Weak to moderate Fe stain
7.0-9.0	Good malachite, disseminated and as seams along bedding. Copper is leached in stronger Fe stained Zones.
9.0-20	Moderate malachite with minor black grains (chalcocite??)
20-88.7	Weak Copper Mineralization (malachite and chalcocite)
29.4	
38	Thin Shale Bed
46-88.7	Red sandstone with local bleaching

INTERVAL	%Cu
4.9	1.42
6.0	0.68 1.45
7.4	0.94
8.7	1.11
10.0	0.58
11.2	0.25
12.6	0.33
14.0	0.32
15.3	0.49
16.6	0.55
17.8	0.58
19.8	0.43
20.8	0.13
21.5	0.73
23.4	0.45
24.4	0.41
25.6	0.40
2727.0	0.43
27.8	0.46
28.4	0.34
0.29.4	0.47
30.8	0.27
32.0	0.45
33.4	0.21
34.5	0.47
3 35.8	0.16
37.0	0.57
38.0	0.43
39.0	1.66
40.0	0.32
41.2	0.42
43.5	0.03
46.0	0.04
48.0	0.04
50.0	0.03
51.5	0.14
54.9	0.14
58.0	0.13
60.0	0.13

DESCRIPTION		INTERVAL	%Cu
		65.5	0.06
		68.5	0.20
		72.0	0.04
		7575/5	0.10
		78.5	0.10
88.7	Bottom of hole	83.0	0.20

DRILL LOG

Hole Number:	DDH 2002	Project:	Cashin Mine Montrose Co., Colo.
Bearing:	N 29* W	Date Started:	Oct. 7, 1968
Angle:	-40*	Date Completed:	Oct. 8, 1968
Total Depth:	104 ft.	Core Size:	AX

Location: Under ground-main haulage level, hanging wall, 90' from portal.

DESCRIPTION		INTERVAL	Cu%
0-4.6	No Recovery	6.0	0.58
4.6-103.8	White, fine grained crossbedded sandstone	7.0	0.35
4.6-8.5	Moderate malachite	8.3	1.52
8.5-13.0	Moderate to good chalcocite as very fine	9.0	0.99
	disseminated grains. Includes minor	10.0	0.67
	malachite at 10.2. Moderate Fe stain	11.0	2.55
	along bedding.	13.0	0.35
13-23	Moderate malachite as disseminations and	14.5	0.80
	along bedding.	16.0	1.30
15.5-17	Strong Fe stain.	16.7	0.77
		18.0	0.55
		19.5	0.37
20-23	Mixed chalcocite and malachite	20.8	0.60
23-34.5	Weak malachite with short concentrations	22.0	0.84
	of CC	23.7	0.23
		25.3	0.11
		26.3	0.17
		27.8	0.14
		28.5	0.19
		29.5	0.07
		31.0	0.13
		32.3	0.19
		33.4	0.14
34.5	Chalcocite below with only a trace of	34.7	1.47
	malachite and azurite.	36.3	0.98
		37.3	1.62
		38.5	0.49
		40.0	0.59
		41.3	0.62
		42.5	0.37
		44.0	0.45
		45.3	0.35
46.7-52.0	Very fine grains of disseminated	46.5	0.26
	chalcocite.	47.5	3.27
		48.8	1.32
		50.4	2.52

DESCRIPTION		INTERVAL	Cu%
51.5-54.5	Moderate yellow-brown Fe stain.	51.0	0.49
		54.0	0.39
54.5-69	Weak to moderate medium grained chalcocite	56.2	0.20
57-57.5	Trace of azurite.	58.2	0.35
		60.0	0.38
		62.5	0.71
		65.0	1.33
		67.3	0.59
69-70.5	Good chalcocite disseminated and along	69.0	0.53
	fractures.	71.0	0.73
		73.5	0.65
		77.5	0.15
		79.5	0.18
83.5-84.3	Good chalcocite and trace of covellite	80.7	0.18
86.4-86.9	Green Shale	84.0	0.48
87.4	3" Zone of disseminated chalcocite	87.0	1.50
87.4-103.8	No mineralization	93.0	0.12
103.8	Bottom of hole.	98.5	0.12

DRILL LOG

Hole Number: DDH 2003
Bearing: S 65° E
Angle: -46°
Total Depth: 59.6
Location: Underground, main haulage level, footwall, 175' from portal.

Project: Cashin Mine, Montrose Co., Colo.
Date Started: Oct. 8, 1968
Date Completed: Oct. 8, 1968
Core Size: AX

DESCRIPTION		INTERVAL	%Cu
0-3.7	No Recovery	4.7	1.05
3.7-37.5	White, finegrained crossbedded sandstone	6.0	2.60
3.7-11.5	Moderate to good malachite disseminated	7.0	1.75
	and along bedding planes. Limonite seams	8.0	1.40
	along bedding.	9.8	1.28
11.5-16	Moderate to good chalcocite	10.8	1.16
		12.0	1.09
		13.3	1.51
		14.0	1.19
		15.5	1.20
16-29	Weak to moderate chalcocite	16.5	0.57
		17.5	0.60
		18.5	0.52
		19.5	0.68
		21.0	0.45
		22.5	0.26
		25.6	0.44
29.5	Thin shale bed. 3' of good disseminated	29.0	1.43
	chalcocite below shale.	32.5	0.14
37.5-59.6	Red, fine grained crossbedded sandstone,	38.5	0.06
	not mineralized.	44.5	0.04
		45.0	0.04
		48.0	0.01
		51.5	0.02
		54.5	0.05
		57.5	0.00
59.6	Bottom of hole	59.6	0.03

DRILL LOG

Hole Number:	DDH 2004	Project:	Cashin Mine Montrose Co., Colo.
Bearing:	N 28° W	Date Started:	Oct. 9, 1968
Angle:	-38°	Date Completed:	Oct. 9, 1968
Total Depth:	109.5	Core Size:	AX

Location: Underground, main haulage level, hanging wall, 175' from portal.

DESCRIPTION	
0-4.1	No Recovery
4.1-109.5	White, fine grained crossbedded sandstone Fracturing and Fe staining to 10'.
4.1-5.0	Weak malachite and minor chalcocite. Strong Fe stains on fractures.
5.0-7.5	Very good chalcocite occurs as fine grains and fracture filling to 1/10" wide.
7.5-11.5	Steep fractures. Disseminated malachite and blebs along bedding. Minor chalcocite
1 11.5-13.5	Finely disseminated chalcocite with very minor malachite.
13.5-17.5	Moderate malachite.
17.5-22.5	Malachite is very weak and does not occur below 22.5.
30.5-32.5	Moderate to strong chalcocite as fine disseminations and blebs to ½".
32.5-43.0	Weak chalcocite. Weak Fe stain locally.
43-53	Moderate disseminated chalcocite.

INTERVAL	%Cu
5.1	1.45
6.4	3.29
7.8	0.52
9.1	1.60
10.1	1.69 (1.62)
11.5	1.07
12.6	1.81
13.5	0.22
16.1	0.91
17.7	0.46
18.9	0.39
2020.1	0.17
21.6	0.13
23.3	0.18
24.2	0.26
26.0	0.08
27.4	0.11
28.5	0.10
30.0	0.33
31.5	17.69
33.0	0.18
34.2	0.36
35.7	0.16
36.7	0.37
38.0	0.53
39.3	0.22
40.7	0.07
41.9	0.05
43.0	0.62
45.0	0.47
47.6	0.43
49.9	0.55
52.0	0.37
5454.5	0.29
57.0	0.46
59.4	0.40
61.5	0.20
63.5	0.62
67.5	0.11

DESCRIPTION		INTERVAL	%Cu
68	Seams of chalcocite to 1/10" along bedding at 55°.	69.8	0.58
		71.8	0.35
74.2-75.2	Coarser grained chalcocite	74.0	0.83
77-83	Weak chalcocite	76.5	0.50
		7878.8	0.22
		81.0	0.20
83-86	Good chalcocite, mostly as very fine disseminations.	83.5	9.55
		86.0	0.65
87.5-	.2' Green Shale	88.0	0.65
90-91	Good chalcocite as disseminations and along fractures and bedding	90.0	0.35
		92.0	0.19
		94.3	0.18
		96.5	0.27
100.5-103.5	Moderate chalcocite as disseminations to 1/10" also along fractures	98.8	0.21
		100.3	0.35
103.5-109.8	Weak mineralization.	102.5	0.36
		104.7	0.32
		106.7	0.21
109.8	Bottom of hole.	109.8	0.16

DRILL LOG

Hole Number: DDH 2005
Bearing: N 11° W
Angle: -38°
Total Depth: 110 ft.
Location: Underground, mainhhaulage level, hanging wall, 280' from portal.

Project: Cashin Mine, Montrose Co., Colo.
Date Started: Oct. 10, 1968
Date Completed: Oct. 10, 1968
Core Size: AX

	DESCRIPTION	INTERVAL	%Cu
0-4.4	No recovery	5.7	0.45
4.4-16.5	Moderate to strongly Fe Stained sandstone. Good malachite locally but is mixed with chalcocite. Much of the mineralization is along the bedding.	6.8	0.12
		7.8	0.13
		9.2	0.16
		10.8	0.24
		12.0	0.87
		13.0	0.76
		14.5	0.17
16.5-128	White, fine grained crossbedded sandstone.	16.0	1.03
16.5-36.5	Moderate to good chalcocite occurs as disseminated grains.	17.0	0.73
		19.0	1.49
		20.3	0.60
		21.8	0.40
		23.0	0.69
		24.3	1.13
		25.5	0.41
		27.0	0.42
		28.3	0.94
		30.2	0.43
		31.5	0.20
		32.8	0.32
		34.0	2.17
		35.0	5.76
		36.2	0.75
36.5-84.5	Weak to moderate chalcocite as finely disseminated grains with a few high-grade zones of 1-2".	37.5	0.24
		38.8	0.48
		40.1	0.67
		41.4	0.73
		42.5	0.21
		43.6	0.30
		46.0	0.67
		48.3	0.52
		50.6	0.30
		53.1	0.14
		55.0	0.36
		57.2	0.40
		59.4	0065

DESCRIPTION		INTERVAL	%Cu
		60.9	0.32
		62.0	0.08
		63.3	0.12
		64.7	0.17
		67.5	0.08
		68.7	0.04
		70.2	0.05
		72.6	00.08
		74.7	0.06
		76.8	0.06
		78.8	0.06
		80.8	0.08
84.5-89.0	Interbedded green shales some chalcocite	82.9	0.30
	in shales.	85.3	0.27
86.5-88.5	High-Grade chalcocite zone.	87.7	2.35
89-100	Weak chalcocite as disseminated grains.	90.0	0.28
	Some moderate concentrations locally.	92.8	0.19
		95.3	0.25
		97.2	0.20
		99.5	0.30
100-119	Trace amounts of chalcocite.	100.8	0.30
		102.9	0.20
		105.2	0.20
		107.4	0.20
		109.7	0.30
		111.4	0.21
		113.7	0.19
		116.0	0.10
119-126	Weak to moderate chalcocite as	118.4	0.35
	disseminated grains.	120.4	0.44
		124.4	0.25
128-141.2	Red-Brown sandstone.	127.5	0.11
		129.5	0.03
		131.8	0.08
		134.2	0.06
		136.7	0.05
		138.8	0.09
141.2	Bottom of hole.	141.2	0.55

DRILL LOG

Hole Number:	DDH 2006	Project:	Cashin Mine Montrose Co., Colo.
Bearing:	S 76° E	Date Started:	Oct. 14, 1968
Total Depth:	74 ft.	Date Completed:	Oct. 14, 1968
Angle:	-32°	Core Size:	AX
Location:	Underground, main haulage level, footwall, 280' from portal.		

DESCRIPTION		INTERVAL	%Cu
0-3.8	No Recovery	4.8	0.19
3.8-63	White, fine grained crossbedded sandstone.	6.0	0.18
3.8-19.0	Weak malachite, sparse chalcocite grains	7.6	0.27
	with malachite halos.	9.0	0.41
		10.0	0.30
		11.5	0.43
		12.7	0.38
		14.0	0.30
		15.4	0.30
		16.5	0.45
		17.8	0.29
19	Top of chalcocite zone. Only trace amounts	19.0	0.70
	of malachite below. Chalcocite occurs as	20.0	0.57
	finely disseminated grains.	21.5	0.57
		23.0	0.56
		24.0	0.45
		25.0	0.60
		26.0	0.48
		27.5	1.08
28-32.5	Chalcocite occurs as fractures fillings	28.5	1.65
	masses to 1".	29.8	1.65
		31.0	0.43
32.5-33.2	Green Shale, broken unconsolidated.	32.5	0.91
		33.4	0.34
		34.4	0.61
		35.5	0.35
		37.0	1.02
		38.3	0.81
		39.5	0.35
		40.5	1.81
		42.0	0.80
43.0-45.5	Good chalcocite as disseminations and	43.2	0.24
	seams along bedding.	44.3	0.24
		45.5	0.16
47	.5' Good disseminated chalcocite.	47.2	0.16
47.5-61	Weak chalcocite. No visible mineralization	48.5	0.28
	below 61'.	50.0	0.19

DESCRIPTION		INTERVAL	%Cu
		51.5	0.19
		53.0	0.35
		54.0	0.16
		56.2	0.03
		58.4	0.04
		60.6	0.09
		62.0	0.05
63-73.7	Red sandstone.	64.2	0.06
		66.5	0.00
73.7	Bottom of hole.	68.7	0.06

DESCRI

56-57

70-82

78-79

84.5-

95.5-

102.5

106-1

107.8

DRILL LOG

Hole Number:	DDH 2007	Project:	Cashin Montre
Bearing:	N 80° W	Date Started:	Oct. I
Angle:	+35°	Date Completed:	Oct. I
Total Depth:	107.8 ft.	Core Size:	AX

Location: Underground, main haulage level, hanging wall, 530' from portal

DESCRIPTION		INTERVAL
0-2.8	No Recovery	3.8
2.8-107.8	White, fine grained crossbedded sandstone.	7.0
6.0-12.8	Moderate to good, very fine grain	8.0
	chalcocite.	9.0
		10.5
		12.0
12.8-18.5	Minor chalcocite.	13.8
		15.1
		16.0
		17.5
18.5-34.0	Good chalcocite as disseminated grains.	18.5
	Is very consistent with no barren zones.	20.3
	Between 32.6 and 34.0 the chalcocite	21.3
	also occurs as seams along bedding.	22.5
		23.8
		25.0
		26.5
		29.8
		31.0
		32.7
		33.5
34-40	Good malachite zone. Mal occurs as	35.0
	disseminations and irregular masses	36.5
	to 1". Weak Fe Stain 34.0-42.0.	37.4
		38.5
		39.5
40-70	Copper mineralization drops off shardly	40.8
	Very Weak malachite with moderate amount of	42.0
	of disseminated black grains in zones to	43.5
	6".	44.7
		46.0
		47.3
		48.4
		50.0
		51.0
		52.5
		53.5
		55.0

DRILL LOG

Hole Number:	DDH 2008	Project:	Cashin Mine Montrose Co., Colo.
Bearing:	N 23° W	Date Started:	Oct, 16, 1968
Angle:	-30°	Date Completed:	Oct. 16, 1968
Total Depth:	95 ft.	Core Size:	AX

Location: Underground, main haulage level, hanging wall, 540' from portal.

DESCRIPTION		INTERVAL	%Cu
0-4.5	No Recovery	5.8	1.20
4.5-94.8	White, friable, fine grained crossbedded,	7.0	0.44
	sandstone.	8.3	0.99
4.5-21	Very fine grained disseminated bornite and	9.6	0.87
	chalcocite with trace of covellite.	10.9	0.74
		12.0	0.50
		13.5	0.57
		14.8	0.57
		16.2	0.30
		17.5	0.44
		18.8	0.58
		20.1	0.20
21-24	Very good chalcocite zone some values in	21.0	6.66
	bornite. Widely spaced fractures 3/foot	22.1	4.74
	at 20-30° to long axis of core.	23.5	14.50
24-26	Moderate disseminated chalcocite.	24.8	0.58
26-94.8	Weak disseminated chalcocite mineralization.	26.0	1.86
	Grains are along bedding locally.	27.1	0.11
		28.5	0.15
		30.0	0.33
		31.0	0.61
		32.5	0.20
		34.0	0.52
		35.0	0.24
		36.5	0.16
		38.0	0.45
		39.0	0.22
		40.0	0.61
		41.5	0.36
		43.0	0.34
		44.5	0.37
		46.0	0.38
		47.5	0.29
		50.0	0.19
		51.5	0.27
		53.0	0.28
		54.0	0.22
		55.4	0.19
		56.4	0.26
		57.8	0.33
		59.0	0.34

DESCRIPTION		INTERVAL	%Cu
		60.3	0.17
		65.3	0.44
		67.8	0.14
		70.0	0.64
72-73	Thin shale beds.	72.0	1.43
		74.5	0.33
		77.0	0.21
		79.0	0.19
		81.0	0.23
		87.0	0.33
		88.4	0.18
		90.0	0.18
		91.7	0.15
		93.0	0.42
94.8	Bottom of hole.	94.8	0.41

DRILL LOG

Hole Number:	DDH 2009	Project:	Cashin Mine Montrose Co., Colo.
Bearing:	N 22° W	Date Started:	Oct. 17, 1968
Angle:	-38°	Date Completed:	Oct. 17, 1968
Total Depth:	55 ft.	Core Size:	AX

Location: La Sal Creek Canyon. 559° W, 60' from portal.

DESCRIPTION

0-3.7	No Recovery
3.7-49.5	White, fine grained, crossbedded sandstone.
3.7-13.0	Very weak malachite. Weak Fe stain 7.0-14.0. Disseminated black grains (Mn oxide or oxided cc.)
13.0-49.5	Only minor chalcocite.
19-36	Weak Fe stain.
33.0	Rock is broken, unconsolidated.
39.5-42.5	Azurite predominates as disseminations and as seams along bedding.
49.5-55.0	Open Stope??

INTERVAL	%Cu
5.0	0.25
6.0	0.03
7.5	0.13
8.5	0.01
10.0	0.01
11.5	0.00
13.0	0.29
13.5	0.48
15.0	0.46
16.0	0.77
17.8	0.57
19.5	0.82
21.0	0.45
22.5	0.46
24.0	0.49
25.0	0.39
26.5	0.49
28.0	0.63
29.0	0.70
30.5	0.63
31.5	1.10
33.0	4.80
35.0	0.88
36.5	1.10
37.5	1.51
39.0	1.00
40.5	0.68
41.5	0.49
42.8	0.65
43.8	0.44
45.5	0.18
46.5	0.39
48.0	0.33
49.5	0.38

DRILL LOG

Hole Number:	DDH 2010	Project:	Cashin Mine Montrose Co., Colo.
Bearing:	N 10° W	Date Started:	Oct. 22, 1968
Angle:	-37°	Date Completed:	Oct. 22, 1968
Total Depth:	108 ft.	Core Size:	AX

Location: La Sal Creek Canyon, S 48° W, 200' from portal.

DESCRIPTION

0-3.9	No Recovery
3.9-108	White, fine grained, friable crossbedded sandstone.
3.9-6.0	Moderate malachite. Chalcocite is strong in 3" zone at 4.5.
16.5-17.0	Good chalcocite as finely disseminated grains.
17-19	Moderate malachite along bedding planes.
24.5-27	Moderate to good malachite.
45-49	Malachite occurs as halos around black grains (chalcocite).

INTERVAL	%Cu
5.1	0.46
6.5	0.41
7.7	0.20
8.9	0.18
10.1	0.18
11.5	0.27
12.8	0.23
14.0	0.25
15.2	0.15
16.5	0.54
17.5	5.54
19.0	0.72
20.6	0.25
22.0	0.20
23.5	0.20
24.8	0.20
25.8	0.20
26.5	0.46
28.0	0.22
29.1	0.22
30.6	0.08
31.6	1.13
32.8	0.15
34.1	0.42
35.1	0.18
36.1	0.18
37.9	0.23
39.1	0.23
40.6	0.33
41.9	0.46
43.1	0.33
44.1	0.31
45.0	0.38
46.2	0.78
47.6	0.54
48.8	0.42
49.9	0.40
51.1	0.15
52.4	0.20
54.0	0.08
55.0	0.18

DESCRIPTION		INTERVAL	%Cu
		56.5	0.15
		57.5	0.08
58-60	Cashin Fault- Rock is found unconsolidated	59.0	1.90
	and broken moderate malachite.	60.0	0.73
60-.5	.5 finely disseminated chalcocite.	61.5	0.21
		62.5	0.35
		64.4	0.14
		64.6	0.15
		65.9	0.16
		67.3	0.41
		68.7	0.15
69.5-70.5	Weak disseminated azurite.	69.9	0.09
		71.3	0.15
73.0-88.0	Malachite increases along bedding.	72.4	0.44
		74.5	0.57
		76.0	0.59
		78.0	0.78
		80.0	0.49
		83.0	0.85
		84.0	0.54
		85.0	0.55
		87.1	0.38
88.0-108	Only trace amounts of carbonates.	88.0	0.47
		89.2	0.63
		90.4	0.42
		91.5	0.27
		93.0	--
		94.0	0.35
		95.5	0.32
		97.0	0.26
		98.3	0.37
		99.5	0.34
		101.0	0.28
		102.5	0.23
		104.0	0.28
105-105.5	Good chalcocite.	105.0	0.51
		106.0	0.35
108.0	Bottom of hole.	107.0	0.09

DESCRIPT

67.0

71-94

94-99

99.0

DRILL LOG

Hole Number: DDH 2011
Bearing:
Angle: -90°
Total Depth: 99 ft.
Location: La Sal Creek Canyon, S 58° W, 60' from portal.

Cas
Project: Mon
Date Started: Oct
Date Completed: Oct
Core Size: AX

DESCRIPTION		INTERVAL
0-4.3	No Recovery	5.3
4.3-34	White, fine grained, crossbedded sandstone.	6.5
	Bedding at 70° to long axis of core. Yellow	7.8
	brown Fe stain to 20'. Moderate disseminations	9.0
	of limonite to 10'. Malachite is weak to	10.2
	moderate to 22'.	11.7
		13.0
		14.2
		15.8
		17.0
		18.5
		19.5
		20.5
22-34	Weak malachite, occurs as disseminations	21.5
	and as halos around sparse amounts of chal-	22.5
	cocite grains.	23.5
		24.5
		25.5
		26.5
		27.5
		28.5
		29.5
		30.5
		31.5
32-32.7	Red, brown crossbedded fine grained sand-	32.5
	stone.	33.3
		34.0
		36.0
		38.0
		40.0
		42.0
		44.0
		46.0
		48.0
		50.0
		52.0
		54.0
		56.0
		58.0

DRILL LOG

Hole Number:	DDH 2012	Project:	Cashin Mine Montrose Co.
Bearing:	N 29° W	Date Started:	Oct. 30, 196
Angle:	+49°	Date Completed:	Oct. 30, 196
Total Depth:	110'	Core Size:	AX
Location:	Underground, main haulage level. 95' from portal.		

DESCRIPTION

0-3.7	No Recovery
3.7-109.7	White, friable, fine grained crossbedded sandstone.
3.7-4.7	Good chalcocite, finely disseminated.
7.0-11.5	Good malachite.
11.5-21.5	Moderate to good malachite is disseminated throughout the rock.
34-39	Moderate malachite as seams along bedding.
35.5-63	Weak Fe stain.
39-61.5	Weak malachite.

INTERVAL	%Cu
3.7-4.7	4.01
4.7-5.7	1.20
5.7-6.7	0.50
6.7-7.5	0.91
7.5-8.5	4.20
8.5-9.5	2.72
9.5-10.5	2.20
10.5-11.5	0.90
11.5-12.5	0.30
12.5-13.5	1.21
13.5-14.5	2.00
14.5-15.5	1.23
15.5-16.5	0.31
16.5-17.5	0.30
17.5-18.5	0.30
18.5-19.5	0.37
19.5-20.5	0.50
20.5-21.5	0.35
21.5-22.5	0.30
22.5-23.5	0.15
23.5-24.5	0.13
24.5-25.5	0.10
25.5-26.7	0.09
26.7-27.7	0.09
27.7-28.7	0.23
28.7-29.7	0.30
29.7-30.7	0.36
30.7-31.7	0.30
31.7-32.7	0.21
32.7-33.7	0.10
33.7-34.7	0.52
34.7-35.7	1.21
35.7-36.7	0.98
36.7-37.7	0.53
37.7-38.7	0.55
38.7-39.7	0.36
39.7-40.7	0.30

DESCRIPTION		INTERVAL	%Cu
		40.7-41.7	0.45
		41.7-42.7	0.45
		42.7-43.7	0.36
		43.7-44.7	0.55
		44.7-45.7	0.45
		45.7-46.7	0.40
47.5-48.5	Malachite blebs to ¼".	46.7-47.7	0.85
		47.7-48.7	1.50
		48.7-49.7	0.45
		49.7-50.0	0.36
		50.7-51.7	0.00
		51.7-52.7	0.05
		52.7-53.7	0.61
		54.7	0.52
		55.7	0.86
		56.7	0.08
		57.7	0.44
		58.7	0.28
		59.7	0.22
		60.7	0.30
61.5	Chalcocite with traces of bornite and malachite to bottom of hole.	61.7	3.72
		62.7	0.12
		63.7	0.78
		64.7	1.16
		65.7	0.05
		66.7	0.46
		67.7	0.58
		68.7	0.16
		69.7	0.30
		70.7	0.18
		71.7	0.38
		72.7	0.18
		73.7	0.20
		74.7	0.12
		75.7	0.14
		76.7	0.76
		77.7	0.20
		78.7	0.22
		79.7	0.24
		80.7	0.08
		81.7	0.12
		82.7	0.10
83.0-83.5	Moderate chalcocite.	83.7	0.88
		84.7	0.06
		85.7	0.06
		86.7	0.76
		87.7	3.26
		88.7	0.18
		89.7	0.04

DESCRIPTION		INTERVAL	%Cu
90-109	Only trace amounts of chalcocite. Sparse limonite grains are disseminated.	90.7	0.06
		91.7	0.06
		92.7	0.08
		93.7	0.06
		94.7	1.38
		95.7	0.08
		96.7	0.04
		97.7	0.38
		98.7	0.06
		99.7	0.04
		100.7	0.08
		101.7	0.12
		102.7	0.48
		103.7	0.06
		104.7	0.07
		105.7	0.06
		106.5	0.06
		107.4	1.96
		108.3	0.04
		109.0	1.54
109.7	Bottom of hole.	109.7	0.34

DRILL LOG

Hole Number:	DDH 2013	Project:	Cashin Mine Montrose Co., Colo.
Bearing:	--	Date Started:	Nov. 2, 1968
Angle:	-90°	Date Completed:	Nov. 2, 1968
Total Depth:	92 ft.	Core Size:	AX

Location: Underground, main haulage level, footwall, 550' from portal.

DESCRIPTION		INTERVAL	%Cu
0-5.1	No Recovery	6.4	0.32
5.1-48.5	White, friable, fine grained, crossbedded,	7.4	0.36
	sandstone.	8.4	0.50
5.1-31.7	Weak to moderate copper mineralization	9.4	0.80
	occurs as disseminated fine grains of	10.4	0.34
	chalcocite. No malachite or azurite.	11.4	0.28
		12.4	1.04
		13.4	0.28
		14.4	0.20
		15.4	0.34
		16.4	0.28
		17.7	0.24
		18.7	0.16
		19.7	0.17
		20.7	0.30
		21.7	0.48
		22.7	0.30
		23.7	0.02
		24.7	0.70
		25.7	0.62
		26.7	0.72
		27.7	0.28
		28.7	0.26
		29.7	0.50
		30.7	0.48
31.7-37.7	Chalcocite increases. Occurs as	31.7	0.70
	blebs to 1/4".	32.7	0.76
		33.7	0.78
		34.7	1.74
		35.7	2.67
		36.7	0.66
37.7-41	Weak chalcocite.	37.7	0.86
		38.7	0.26
		39.7	0.22
41-42.5	Good disseminated chalcocite.	40.7	0.38
		41.7	2.42
42.7-43.7	Steep fractures, 10° from long axis of	42.7	0.44
	core.	43.7	1.12
		44.7	0.50
		45.7	0.48

DESCRIPTION		INTERVALS	%Cu
46-48	Steep fractures, caliche along fractures.	46.7	0.22
48.5	Top of Chinle formation, fault gouge at 48.5. Strong Fe stain to 60.5. Altered shale and interbedded sandstone.	47.7	0.02
		48.7	0.12
		49.7	0.06
		50.7	0.04
		51.7	0.06
		52.7	0.04
		53.7	0.06
		54.7	0.14
		55.7	0.04
		56.7	0.18
		57.7	0.34
		58.7	0.04
		59.7	0.04
60.5-69	Mostly gray sandstone with some interbedded shale.	60.7	0.04
		61.7	0.03
		62.7	0.04
		63.7	0.04
		64.7	0.04
		65.7	0.06
		66.7	0.18
		67.7	0.04
		68.7	0.04
69-75.5	Finely disseminated sulfides in green shale.	69.7	1.22
		70.7	1.04
		71.7	0.44
		72.7	1.04
		73.7	1.36
		74.7	0.22
75.5-81.5	Green siltstone and shale.	75.7	0.08
		76.7	0.18
		77.7	0.48
		78.7	0.34
		79.7	0.08
		80.7	0.04
81.5-91.5	Red shale.	81.7	0.04
		82.7	0.08
		83.7	0.04
		84.7	0.06
		85.7	0.06
		86.7	0.04
		87.7	0.04
		88.7	0.04
		89.7	0.02
		90.7	0.06
91.5	Bottom of hole.	91.5	0.04

DRILL LOG

Hole Number:	DDH 2014	Project:	Cashin Mine Montrose Co., Colo.
Bearing:	N 67° E	Date Started:	Nov. 8, 1968
Angle:	+45°	Date Completed:	Nov. 8, 1968
Total Depth:	114 ft.	Core Size:	AX

Location: Underground, main haulage level. footwall, 90' from portal.

DESCRIPTION		INTERVAL	%Cu
0-3.7	No Recovery	4.7	0.81
3.7-113.8	White, fine grained, crossbedded sandstone.	5.8	2.90
3.7-7.0	Moderate malachite, but zones to 3" of	6.8	0.60
	strong chalcocite occur.	7.8	0.42
7.0-14.0	Weak mineralization. Steep fractures with	8.8	0.15
	Fe and Mn? Stain.	9.8	0.20
		10.8	0.18
		11.8	0.19
		12.8	0.15
		13.8	0.23
14.0-35	Moderate malachite mostly as disseminations.	14.8	0.52
		15.8	0.25
		16.8	0.09
		17.8	0.16
		18.8	0.25
		19.8	0.60
		20.8	0.33
		21.8	0.55
		22.8	0.55
		23.8	0.89
		24.8	0.58
		25.8	0.54
		26.8	0.27
		27.8	0.25
		28.8	0.25
		29.8	0.49
		30.8	0.64
32.0-35.0	Malachite is strong as seams along bedding.	31.8	2.20
		32.8	0.99
		33.8	1.11
		34.8	1.93
35.0-56.0	Weak copper mineralization.	35.8	0.55
36.0-41.0	Moderate Fe stain.	36.8	0.63
		37.8	0.40
		38.8	0.27
		39.8	0.04
			0.04

DESCRIPTION		INTERVAL %	%Cu
		40.8	0.04
41.0-56.0	Weak Fe stain.	41.8	0.05
		42.8	0.07
		43.8	0.11
		44.8	0.11
		45.8	0.11
		46.8	0.15
		47.8	0.11
		48.8	0.09
		49.8	0.08
		50.8	0.05
		51.8	0.17
		52.8	0.17
		53.8	0.19
		53.8-54.8	0.21
		54.8-55.8	0.20
56.0-73.0	Strong Cu mineralization. Mixture of	55.8-56.8	0.31
	chalcocite and malachite with some azurite.	56.8-57.8	0.50
		57.8-58.8	6.60
		58.8-59.8	0.65
		59.8-60.8	5.00
		60.8-61.8	5.30
		61.8-62.8	1.42
63.0-64.0	Moderate Fe stain. Malachite is good	62.8-63.8	0.51
	where stain does not occur.	63.8-64.8	1.40
		64.8-65.8	0.40
		65.8-66.8	0.98
		66.8-67.8	0.80
		67.8-68.8	5.00
		68.8-69.8	1.30
		69.8-70.8	1.20
71.0-72.0	Chalcocite masses to $\frac{1}{2}$" along bedding.	70.8-71.8	0.75
		71.8-72.8	0.61
73.0-85.0	Weak to moderate malachite as small	72.8-73.8	1.21
	disseminated grains.	73.8-74.8	0.25
		74.8-75.8	0.31
		75.8-76.8	0.30
		76.8-77.8	0.70
		77.8-78.8	0.35
		78.8-79.8	0.25
		79.8-80.8	0.35
		80.8-81.8	0.16
		81.8-82.8	0.16
		82.8-83.8	0.16
		83.8-84.8	0.14
85.0-90.0	Good malachite.	84.8-85.8	0.25
		85.8-86.8	1.43
		86.8-87.8	1.20
88-110	Weak intermittant Fe stain.	87.8-88.8	1.32
		88.8-89.8	0.50
		89.8-90.8	0.15

DESCRIPTION		INTERVAL	%Cu
		90.8-91.8	0.25
		91.8-92.8	0.56
		92.8-93.8	0.16
		93.8-94.8	0.45
		94.8-95.8	0.62
		95.8-96.8	0.08
		96.8-97.8	0.05
		97.8-98.8	0.05
		98.8-99.8	0.05
100-104	Moderate to good malachite along bedding.	99.8-100.8	0.40
		100.8-101.8	0.40
		101.8-102.8	1.51
		102.8-103.8	1.00
104-110	Weak Cu mineralization.	103.8-104.8	0.35
		104.8-105.8	0.40
		105.8-106.8	0.16
		106.8-107.8	0.10
		107.8-108.8	0.35
		108.8-109.8	0.40
110-113.8	Chalcocite zone, fine disseminated grains in zones 2-3".	109.8-110.8	0.35
		110.8-111.8	4.76
		111.8-112.8	0.35
113.8	Bottom of hole.	112.8-113.8	0.40

DRILL LOG

Hole Number:	DDH 2015	Project:	Cashin Mine Montrose Co., Colo.
Bearing:	S 62° W	Date Started:	Nov. 18, 1969
Angle:	+65°	Date Completed:	Nov. 20, 1968
Total Depth:	130 ft.	Core Size:	AX

Location: La Sal Creek Canyon. So. side of Creek. S 51° E, 40' from portal of adit on cashin fault So. of Creek.

DESCRIPTION		INTERVAL	%Cu
0-4.1	No Recovery	4.1	0.00
4.1-130.2	White, fine grained crossbedded, sandstone.	5.3	0.00
4.1-8.5	Limonite grains sparsely disseminated	6.6	0.01
	and along bedding planes.	7.8	0.01
8.5-17	Weak to moderate malachite mostly along	9.0	0.24
	bedding planes.	10.0	0.32
		11.2	0.35
		12.6	0.26
		13.6	0.70
		15.0	0.34
		16.2	0.31
17-30.5	Malachite is weak over all, with sparse	17.2	0.32
	disseminated limonite grains.	18.5	0.14
		19.8	0.19
		21.0	0.60
		22.2	0.20
		23.5	0.11
		24.5	0.09
		25.8	0.12
		27.0	0.12
		28.3	0.14
		29.3	0.08
		30.4	0.11
		31.8	0.10
		33.0	0.50
		34.2	0.21
		35.5	0.18
36.5-42	Good malachite, steep fractures. Also	36.8	1.70
	disseminated chalcocite and limonite.	38.0	0.60
		39.0	0.55
		40.2	0.48
		41.5	4.00
42-46	Moderate malachite mostly as dissemina-	42.5	0.70
	tions.	43.8	0.34
		45.0	0.34
		46.0	0.91
47-57.5	Weak malachite. Zone has intermittant	47.2	0.55
	Fe stain.	48.4	0.40
		49.6	0.20

DESCRIPTION		INTERVAL	%Cu
		50.8	0.24
		52.0	0.14
		53.2	0.14
		54.4	0.05
		55.6	0.09
		56.8	0.09
57.5-62	Good malachite as disseminations and along bedding, Limonite fills some fractures.	58.2	0.85
		59.4	0.36
		60.3	2.90
		61.0	1.50
62-70	Weak malachite. Weak Fe stain along bedding locally.	62.8	0.16
		64.1	0.08
		65.5	0.16
		66.5	0.23
		67.7	0.09
		68.8	0.09
70.0-72	Moderate malachite as disseminations.	70.0	0.44
		71.2	0.70
72-72.5	Finely disseminated chalcocite.	72.5	1.43
72.5-80.5	Moderate malachite Mn Ox ? along bedding.	73.5	0.15
		74.8	0.29
		76.0	0.47
		77.0	0.31
		78.44	0.25
		79.6	0.95
80.5-84	Moderate Fe stain, pervasive and along fractures.	81.0	1.11
		82.2	0.45
		83.5	0.27
84-112	Weal malachite as disseminations.	84.6	0.144
		85.8	0.11
		87.0	0.10
		88.3	0.14
		89.5	0.44
		90.8	0.12
		92.0	0.27
		93.0	0.28
		94.2	0.19
		95.5	0.18
		96.8	0.35
		98.0	0.35
		99.0	0.12
		100.0	0.12
		101.0	0.17
		102.0	0.32
		103.0	0.43
		105.0	0.16
106.5-108.3	Disseminated limonite.	106.0	0.24
		107.0	0.30
		108.0	0.25
		109.00	0.36

DESCRIPTION		INTERVAL	%Cu
		110.0	0.40
		111.0	0.13
112-130.2	Very weak malachite	112.0	0.09
		113.0	0.09
		114.0	0.09
		114.1	0.08
		115.0	0.08
		116.0	0.09
		117.0	0.13
		118.0	0.12
		119.0	0.10
		120.0	0.32
		121.0	0.28
		122.0	0.28
		123.0	0.28
		1124.0	0.24
		124.8	0.09
		125.6	0.09
		126.4	0.01
		127.2	0.00
		128.0	0.00
		128.8	0.00
130.2	Bottom of hole.	130.0	0.00

DESCRIPTION		INTERVAL	%Cu
		90.5	0.26
		91.5	0.26
		92.5	0.13
		93.5	0.07
		94.5	0.04
		95.5	0.04
		96.5	0.20
		97.5	0.22
		98.5	0.29
		99.5	0.23
		100.5	0.28
		101.5	0.32
		102.5	0.15
		103.5	0.11
		104.5	0.00
		105.5	0.00
		106.5	0.12
		107.5	0.09
108-117	Increase in malachite. Zone has several seams of chalcocite along bedding and disseminated grains of red, brown limonite.	108.5	0.37
		109.5	0.25
		110.5	0.23
		111.5	0.27
		112.5	0.45
		113.5	0.61
		114.5	0.58
		115.5	0.63
		116.5	0.36
		117.5	0.70
118-151	Malachite in trace amounts. Chalcocite grains occur erratically. Sandstone is darker gray.	118.5	0.19
		119.5	0.09
		120.5	0.00
		121.5	0.00
		122.5	0.00
		123.5	0.00
		124.5	0.00
125.0	.1" broken, unconsolidated.	125.5	0.12
		126.5	0.05
		127.5	0.03
		128.5	0.00
		129.5	0.00
		130.5	0.04
		131.5	0.05
		132.5	0.04
		133.5	0.15
		134.5	0.25
		135.5	0.10
		136.5	0.15
		137.5	0.10
		138.5	0.10
		139.5	0.04

DRILL LOG

Hole Number: DDH 2016
Bearing: S 8° W
Angle: +47°
Total Depth: 151 ft.
Location: La Sal Creek Canyon, So. side of creek, S 66° E, 105' from portal of adit, on Cashin fault, So. of creek.

Project: Cashin Mine Montrose Co., Colo.
Date Started: Nov. 21, 1968
Date Completed: Nov. 25, 1968
Core Size: AX

DESCRIPTION		INTERVAL	%Cu
0-2.9	No Recovery	3.0	0.00
2.9-118	White, fine grained, crossbedded, sandstone.	4.0	0.04
2.9-9.0	Scattered azurite with seam of malachite along bedding. Chalcocite and limonite along bedding.	5.0	0.56
		6.0	0.40
		7.0	1.25
9.0-22	Weak to moderate malachite. Very weakly disseminated chalcocite.	8.0	0.46
		9.0	0.14
		10.3	0.11
		11.5	0.17
		12.5	0.43
		13.5	0.56
		14.5	0.68
		15.5	0.80
		16.5	1.20
		17.5	0.48
		18.5	0.42
		19.5	0.11
		20.5	1.81
		21.5	1.82
		22.5	0.22
23-23.5	Fractured, unconsolidated.	23.5	0.28
		24.5	0.13
		25.5	0.25
		26.5	0.23
		27.5	0.26
		28.5	0.07
		29.5	0.20
		30.5	0.14
		31.5	0.17
32-77	Slight increase in malachite. Minor chalcocite occurs along bedding plane.	32.5	0.10
		33.5	0.20
		34.5	0.14
		35.5	0.30
		36.5	0.13
		37.5	0.20
		38.5	1.31
39.0	Weak Fe stain.	39.5	1.20

DESCRIPTION		INTERVAL	%Cu
		40.5	0.66
		41.5	0.45
		42.5	0.42
		43.5	0.41
		44.3	0.40
		45.2	0.57
		46.0	0.48
		47.0	1.32
		48.0	0.56
		49.0	0.70
		50.0	0.68
		51.0	0.64
		52.0	0.46
53-56	Moderate malachite as disseminations.	53.0	0.77
		54.0	0.58
		55.0	0.72
		56.0	0.32
		57.0	0.38
		58.0	0.38
		59.0	0.50
		60.0	0.23
		61.0	0.45
		62.0	0.34
		63.0	0.26
		64.0	0.36
		65.0	0.43
		66.0	0.23
		67.0	0.22
		68.0	0.45
		69.0	0.288
		70.0	0.18
		71.0	0.12
		72.0	0.42
		73.0	0.25
		74.0	0.43
		75.0	0.43
		76.0	0.83
77-82.5	Moderate Fe stain.	77.0	0.44
78-108	Malachite is very weak. Trace amounts of	78.0	0.15
	azurite and chalcocite.	79.0	0.09
		80.0	0.06
		81.0	0.12
		82.0	0.09
		83.0	0.03
		84.0	0.02
		84.83	0.15
		85.5	0.12
		86.5	0.14
		87.5	0.25
		88.5	0.23
		89.5	0.20

DESCRIPTION		INTERVAL	%Cu
		140.5	0.07
		141.5	0.06
		142.5	0.15
		143.5	0.00
		144.5	0.00
		145.5	0.00
		146.5	0.00
147-148	Rock is broken along bedding planes.	147.5	0.00
147-151	Scattered grains of red, brown limonite.	148.5	0.00
		149.5	0.00
		150.5	0.00
151.0	Bottom of hole.		

DRILL LOG

Hole Number: DDH 2017
Bearing: S 8° E
Angle: +42°
Total Depth: 106 ft.
Location: La Sal Creek Canyon, So. side of creek, S 69° E, 185' from portal adit, on Cashin fault, So. of creek.

Project: Cashin Mine, Montrose Co., Colo.
Date Started: Nov. 26, 1968
Date Completed: Nov. 29, 1968
Core Size: AX

DESCRIPTION		INTERVAL	%Cu
0-2.4	No Recovery	2.5	0.22
2.4-106.2	White, fine grained, crossbedded, sandstone.	3.5	0.43
2.4-20.8	Malachite is weak to moderate and occurs as disseminations and seams along bedding planes. Malachite is present also as halos around grains of chalcocite.	4.5-6.0	0.53-1.02
		7.0	0.86
		8.0	0.14
		9.0	0.29
		10.0	0.21
		11.0	0.42
		12.0	0.33
		13.0	0.52
		14.0	1.10
		15.0	0.70
		16.0	0.31
		17.0	0.91
		18.0	0.22
		19.0	0.41
		20.0	0.25
		21.0	0.16
		22.0	0.11
		23.0	0.28
24.5-28.5	Good malachite as seams along bedding planes and is also disseminated.	24.0	0.31
		24.8	2.82
		25.5	1.02
		26.5	1.60
		27.5	2.41
28.5-42	Weak copper mineralization, is mixture of malachite and chalcocite.	28.5	0.64
		29.5	0.20
		30.5	0.22
		31.5	0.22
		32.7	0.23
		33.7	0.28
		34.7	0.22
		35.7	0.20
		36.7	0.17
		37.7	0.23
		38.7	0.23
		39.7	0.24

DESCRIPTION		INTERVAL	%Cu
		40.7	0.17
		41.7	0.31
42-64.5	Weak to moderate malachite and disseminated	42.8	0.70
	limonite grains.	43.8	0.51
		44.8	0.66
45.0	6" broken zone	45.5	1.10
		46.5	0.50
		47.5	0.32
		48.5	0.83
		49.5	0.25
		50.5	0.83
		51.5	0.30
		52.5	0.24
		53.5	0.20
		54.5	0.21
		55.5	0.20
		56.5	0.29
		57.5	0.17
		58.5	0.14
		59.5	0.22
		60.5	0.16
		61.4	0.27
		62.4	1.20
		63.5	0.33
64.5-106.2	Copper mineralization is very weak.	64.5	0.10
	Moderate Fe stain to 72.5. Yellow,	65.5	0.03
	brown stain occurs locally to bottom of	66.5	0.01
	hole. Malachite is the only copper	67.5	0.02
	mineral recognizable.	68.5	0.03
		69.5	0.02
		70.5	0.04
		71.5	0.09
		72.5	0.05
		73.5	0.03
		74.5	0.18
		75.2	0.38
		76.2	0.10
		77.2	0.03
		78.2	0.00
		79.2	0.19
		80.2	0.47
		81.2	0.06
		82.4	0.02
		83.5	0.04
		84.5	0.01
		85.5	0.01
		86.5	0.00
		87.5	0.00
		88.5	0.00
		89.5	0.05

DESCRIPTION		INTERVAL	%Cu
		90.5	0.02
		91.5-92.8	0.02-0.05
		93.8	0.03
		94.8	0.00
		95.5	0.05
		96.5	0.67
		97.5	0.72
		98.5	0.07
		99.5	0.02
		100.5	0.00
		101.5	0.00
		102.5	0.02
		103.5	0.00
		104.5	0.00
		105.5	0.00
106.2	Bottom of hole.	106.0	0.55


CASAIN MINE
MONTROSE, COLO
R 19W
T 47 N.
15
14
13
21
22
23
28
27
26
INDEPENDENCE
INDEPENDENCE #1
INDEPENDENCE #2
INDEPENDENCE #3
INDEPENDENCE #4
INDEPENDENCE #5
SILVER BAR No. 1
SILVER BAR No. 3
SILVER BAR No. 4
SILVER BAR No. 5
SILVER BAR No. 7
SILVER BAR No. 9
SILVER BAR No. 10
SILVER BAR No. 14
SILVER BAR No. 15
SILVER BAR No. 16
SILVER BAR No. 17
SILVER BAR No. 18
SILVER BAR No. 19
SILVER BAR No. 20
19164 MALACHITE
19163 MICHIGAN
19163 HORSESHOE
13031 HUMBOLDT
13031 ANGELL
13031 BENNIE
13030 TITON
13030 TITON M.S.
LA SAL CREEK (PAT)
13030 CASAIN
13030 MAUDE
13031 MAUDE M.S.
13030 A REUCHEF
17486 CLIFF DWELLER
BIG DOT 2
BIG DOT 3
BIG DOT 4
RED BIRD
RED ROCK
RAINBOW
18541 BAY CITY
18541 QUEEN OF THE WEST
18541 WAY UP
18541 PARADOX
18541 PARADOX M.S.
18541 WHITE CHIEF
18541 GENERAL LEE
18541 COLORADO
18541 ISABELLA
18541 MORGAN
LEGEND
GOLD BAR RESOURCES INC
J.A. WARDLE
LYLE DAVIS ET AL
ALBERT & ORA WHITMEYER ET AL
APPARENTLY INVALID CLAIMS
CLAIM MAP
CASAIN MINE GROUP
PARADOX-NYSWONGER MESA
T 47N, R19W N.M.P.B.E.M.
MONTROSE COUNTY, COLORADO
SCALE: 1" = 600'
ESSEX INTERNATIONAL INC.
COMPILED BY G.E. JACKSON SEPTEMBER 1970
REVISIONS:

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
W. E. WRATHER, DIRECTOR

PREPARED IN COOPERATION WITH THE
U. S. ATOMIC ENERGY COMMISSION
COLORADO GEOLOGICAL SURVEY BOARD
AND COLORADO METAL MINING FUND BOARD

GEOLOGY OF THE
PARADOX QUADRANGLE
COLORADO
GQ 72

EXPLANATION

QUATERNARY — Pleistocene and Recent

Qal — **Alluvium**
Includes colluvium, talus, sheet wash, wind-blown deposits, valley fill, and stream deposits, undifferentiated.

Qg — **Terrace gravel**

Qfg — **Fanglomerate**
Poorly sorted, in places rudely bedded, sand and angular fragments and boulders derived from older formations; somewhat indurated.

UNCONFORMITY

CRETACEOUS — Lower and Upper Cretaceous

Kd — **Dakota sandstone**
Yellowish, lenticular sandstone and conglomerate with interbedded carbonaceous shale and impure coal.

UNCONFORMITY

Lower Cretaceous

Kbc — **Burro Canyon formation**
White, gray, and red sandstone and conglomerate with interbedded green and purplish shale.

JURASSIC — Upper Jurassic

Jmb / Jms — **Morrison formation**
Variegated shale and mudstone; white, gray, rusty-red, and buff sandstone; rusty-red conglomerate; local thin limestone beds. At the top the Brushy Basin shale member, Jmb, *consisting largely of bentonitic shale but including some sandstone and conglomerate lenses, and at the base the Salt Wash sandstone member,* Jms, *with more numerous and thicker sandstone beds.*

San Rafael group

Js — **Summerville formation**
Thin-bedded red, gray, green, and brown sandy shale and mudstone.

Middle and Upper Jurassic

Jec — **Entrada sandstone and Carmel formation undivided**
Orange, buff, and white, fine-grained, massive and crossbedded Entrada sandstone at the top. Red sandstone and mudstone of the Carmel formation at the base.

UNCONFORMITY

JURASSIC(?) — Glen Canyon group

Jn — **Navajo sandstone**
Buff and gray crossbedded, fine-grained sandstone.

Jk — **Kayenta formation**
Irregularly bedded, red, buff, gray, and lavender shale, siltstone, and fine- to coarse-grained sandstone.

Jw — **Wingate sandstone**
Fine-grained reddish-brown, cliff-forming sandstone, thick-bedded, massive and crossbedded.

TRIASSIC — Upper Triassic

Ŧc — **Chinle formation**
Red to orange-red siltstone, with interbedded lenses of red sandstone, shale, and limestone-pebble and clay-pellet conglomerate. Lenses of quartz-pebble conglomerate and grit at base.

Lower Triassic

Ŧm / Ŧmu / Ŧmm / Ŧml — **Moenkopi formation**
Chocolate-brown, ripple-bedded shale, brick-red sandy mudstone, reddish-brown and chocolate-brown sandstone, and purple and reddish-brown arkosic conglomerate. Local gypsum beds. The upper member, Ŧmu, *consisting of thin and ripple-bedded shale with interbedded sandstone; the middle member,* Ŧmm, *consisting of ledge-forming beds of shale, sandstone, and arkosic conglomerate; and the lower member,* Ŧml, *consisting of poorly sorted mudstone and local gypsum beds near base.* Ŧm, *where undifferentiated.*

UNCONFORMITY

PERMIAN(?)

Pcr — **Cutler and Rico formations undivided**
Maroon, red, mottled light-red, and purple conglomerate, arkose, and arkosic sandstone. Thin beds of sandy mudstone. Interbedded reddish and gray marine limestone at the base.

PENNSYLVANIAN

Phl / Php — **Hermosa formation**
At the top, gray fossiliferous limestone member with thin beds of shale, Phl, *and at the base, sandstone, black shale, gypsum, and salt of the Paradox member,* Php.

Contact
Dashed where approximately located.

Indefinite contact
Includes inferred contacts and indefinite boundaries of surficial deposits.

Fault
Dashed where approximately located; dotted where concealed. U, *upthrown side;* D, *downthrown side.*

Strike and dip of beds

Strike of vertical beds

Horizontal beds

Structure contours
Drawn on top of Entrada sandstone; dashed where approximately located; short dashes indicate projection above surface. Contour interval 100 feet. Datum is mean sea level.

Adit

Outline of patented claim
Located only approximately for purpose of discussion in the text (not accurate to the scale of the map).

LIST OF PATENTED CLAIMS

1. Cliff Dweller
2. Titon, mill site
3. Titon
4. Michigan
5. Humbolt
6. Malachite
7. Maud
8. Maud, mill site
9. Horse Shoe
10. Angell
11. Bennie
12. Red Chief
13. Red Chief, mill site
14. Cashin
15. Red Bird
16. Red Rock
17. Bay City
18. Rainbow
19. White Chief
20. Way Up
21. Queen of the West
22. General Lee
23. Colorado
24. Paradox
25. Paradox, mill site
26. Isabella
27. Morgan

Base map by Topographic Division
U. S. Geological Survey, 1949

Geology mapped in 1948 by C. F. Withington,
F. W. Cater, Jr., and E. J. McKay

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—W 8 7772

APPROXIMATE MEAN DECLINATION, 1955

GEOLOGIC MAP
OF THE
PARADOX QUADRANGLE, COLORADO

By
C. F. Withington

Scale 1:24000
1 Mile
Contour interval 20 feet
Datum is mean sea level

1955

CASHIN PROSPECT

GEOLOGY
OF THE
PARADOX QUADRANGLE, COLORADO

By
C. F. Withington

INTRODUCTION

The U. S. Geological Survey mapped the geology of the Paradox quadrangle, Colo., as part of a comprehensive study of carnotite deposits. The study, covering the principal carnotite-producing area in southwestern Colorado, included detailed examination of mines and geologic mapping of eighteen 7½-minute quadrangles, of which the Paradox quadrangle is one. Parts of the texts accompanying these maps have been standardized; these parts include some descriptions of geologic formations and general descriptions of regional structural setting, geologic history, and ore deposits. Comprehensive reports presenting, in greater detail, the geologic features are in preparation. Work was started in the area in 1939 with the cooperation of The Colorado State Geological Survey Board and the Colorado Metal Mining Fund Board, and continued through 1945 as a wartime strategic minerals project. Since 1947 the Geological Survey has been continuing this geologic study on behalf of the Division of Raw Materials of the Atomic Energy Commission. The Paradox quadrangle was mapped in 1948.

The Paradox quadrangle covers about 59 square miles in Montrose County, Colo., and lies in the Canyon Lands division of the Colorado Plateau physiographic province. Much of the quadrangle is a rugged area of mesas and canyons, but Paradox Valley, which traverses the northeastern part of the quadrangle, is relatively flat and featureless. Total relief within the quadrangle is about 2,360 feet; altitudes range from about 4,940 feet at the Dolores River in the eastern part of the quadrangle in Paradox Valley, to about 7,300 feet on Wray Mesa in the western part of the quadrangle. The Dolores River and its tributaries drain the area.

Precipitation, as measured in the town of Paradox, averages about 11 inches a year. The area is semiarid and supports a moderate growth of juniper and piñon on rocky terrain and abundant sagebrush and salt bush where the soils are thick. Cacti and sparse grasses are widely distributed. Some tamarisk, willow, and cottonwood trees grow along the Dolores River in Paradox Valley. Fruit and truck produce are grown in the irrigated parts of Paradox Valley.

Paradox Valley and the western part of La Sal Creek are accessible by Colorado Highway 90, which traverses the valley and crosses into the La Sal Creek Canyon in the western part of the quadrangle. The lower part of La Sal Creek Canyon and part of the Dolores River canyon are accessible by dry weather roads. The mesa tops can be reached only by stock trails.

REGIONAL GEOLOGY

Rocks exposed in the 18 quadrangles mapped consist of crystalline pre-Cambrian rocks and sedimentary rocks that range from late Paleozoic to Quaternary. Crystalline rocks crop out only in the northeastern part of the area along the flanks of the Uncompahgre Plateau; the rest of the area is underlain by sedimentary rocks. The latest Paleozoic and earliest Mesozoic units wedge out northeastward against the crystalline pre-Cambrian rocks, but later Mesozoic units were deposited on top of the pre-Cambrian rocks. Over most of the region the sedimentary beds are flat lying, but in places they are disrupted by high-angle faults or are folded into northwest-trending monoclines, shallow synclines, and strongly developed anticlines. The largest of the folds is the Uncompahgre Plateau uplift, a fold nearly 100 miles long that traverses the northeastern part of the area (fig. 1). Well-developed anticlines having intrusive cores of salt and gypsum underlie Sinbad Valley, Paradox Valley, and Gypsum Valley in the central part of the area; the Dolores anticline in the southwestern part of the area probably has a salt-gypsum core, although it is not exposed (fig. 1).

STRATIGRAPHY

The oldest rocks exposed in the Paradox quadrangle are of Pennsylvanian age. They are exposed together with rocks of Permian(?), Triassic, and Early Jurassic(?) age in scattered outcrops on the floor of Paradox Valley. Triassic and Jurassic rocks are exposed along the flanks of the valley, in the canyon walls, and on benches and mesas. Rocks of Cretaceous age occur in scattered outcrops on the high mesas in the western and southeastern parts of the quadrangle. Quaternary fanglomerates occur on the floor of the valley in isolated outcrops near the settlement of Bedrock. Recent deposits of windblown material and sheet wash are widely distributed on the mesa tops, along the benches, and on the valley floor.

The stratigraphic sequence is similar to that studied by Baker (1933) and Dane (1935) in nearby areas in Utah; most of the formations can be traced continuously from the Paradox quadrangle into Utah.

HERMOSA FORMATION

The Pennsylvanian Hermosa formation comprises two members in this area—the lower or Paradox member, consisting largely of intrusive salt and gypsum, and the upper or limestone member.

Paradox member.—The Paradox member is exposed in the quadrangle in scattered outcrops in the center of the Paradox Valley. It consists of cellular, sandy gypsum, limestone, and gray-black shale. Below the zone of leaching, salt is the most abundant single constituent. The beds in the Paradox member are highly contorted, and therefore neither stratigraphic sequence nor thickness can be determined. The log of the Wilcox number 2 well, which was drilled in the northeast part of the quadrangle in the floor of the valley, shows that at least 5,000 feet of the Paradox member was drilled before the well was abandoned (Barb, 1946, p. 285-286).

The Paradox member has been assigned to the lower Pennsylvanian by Baker (1933, p. 17-18) and Dane (1935, p. 27-29).

Limestone member.—The upper or limestone member of the Hermosa formation consists of gray fossiliferous limestone, shale, and arkosic sandstone. It crops out on the floor of the valley in small exposures. No complete section of the limestone member has been measured in the valley, but a well drilled 2 miles south of Bedrock on the Dolores River penetrated about 1,800 feet of the limestone member of the Hermosa formation.

CUTLER AND RICO FORMATIONS UNDIFFERENTIATED

The Cutler formation of Permian(?) age consists of maroon, purple, red, and mottled light-red arkosic sandstone and conglomerate and small quantities of reddish-brown sandy mudstone. The arkosic beds are derived largely from pre-Cambrian crystalline rocks that formed the ancestral Uncompahgre highland, a site now occupied in part by the Uncompahgre Plateau. The poorly sorted, rudely bedded layers and lenses consist of grains and pebbles of quartz, fresh feldspar, and dark minerals, and pebbles of granite, gneiss, schist, and quartzite. Interlayered with the arkosic material are thin irregular beds of sandy mudstone. At the base of the formation where it is in undisturbed contact with the Hermosa formation, beds of marine limestone and arkosic material alternate. These beds are lithologically similar to beds of the Rico formation in the San Juan Mountains and occupy relatively the same stratigraphic position. Because the sequence is thin and the age uncertain it has been mapped with the Cutler formation. The maximum thickness of the Cutler formation in this area is about 3,500 feet, as determined from surface exposures and oil-well logs. Only the top 600 feet of the Cutler formation is exposed in the Paradox quadrangle. The formation thickens to the northeast before wedging out on the southwest flank of the Uncompahgre Plateau.

MOENKOPI FORMATION

The Moenkopi formation of Early Triassic age unconformably overlies the Cutler formation. In the exposures on the northeast wall of Paradox Valley in the Paradox quadrangle, the formation consists of three units: a lower unit of poorly sorted sandy mudstone, a middle unit characterized by arkosic conglomerate and conglomeratic sandstone, and an upper unit of thin-bedded shale and lesser amounts of fine-grained sandstone.

The lower unit of the Moenkopi formation consists entirely of brick-red poorly sorted sandy mudstone and silty sandstone in which grains range in size from clay particles to granules as much as 3 mm across. The base of the member contains seams of gypsum and, in a few places, thin beds of gypsum.

The middle unit of the Moenkopi formation consists of purple and reddish-brown ledge-forming beds of arkosic conglomerate and conglomeratic sandstone, separated by beds of reddish-brown and chocolate-brown sandstone and shale. The conglomeratic beds are cross-laminated and fill channels cut in underlying beds, and show current lineations and ripple marks. Shale beds show fossil mud cracks.

The upper unit of the Moenkopi formation consists predominantly of reddish-brown and chocolate-brown shale and sandstone. The shale is micaceous; some bedding planes are sheeted with minute flakes of mica. Individual laminae in the shale are paper-thin and ripple-bedding is pervasive. Thin beds of coarse-grained sandstone are scattered throughout the unit.

The lithologic characteristics of the formation suggest that the lower unit of the formation was deposited by dumping of material in a body of standing water, the middle unit by deposition under fluvial conditions, and finally, in the upper unit, a return to deposition in a shallow body of water. The Moenkopi formation attains a maximum thickness in the northeast corner of the Paradox quadrangle of about 450 feet, about equally divided among the three units.

In the exposures in the southwest wall of the valley at the Dolores River, no differentiation between the units has been made as there is no complete exposure of the formation. About 500 feet of the Moenkopi formation, as determined from an oil-well log, occurs near the Dolores River about 2 miles south of Bedrock.

CHINLE FORMATION

The Upper Triassic Chinle formation consists of red to orange-red siltstone, with interbedded red fine-grained sandstone, shale, and limestone-pebble and clay-pellet conglomerate. These lithologic units are lenticular and discontinuous. The lower part of the formation contains numerous lenses of a distinctive limestone-pebble and clay-pellet conglomerate; in places the lowermost lenses contain quartz pebbles or consist of a relatively clean quartz grit. These quartz-bearing lenses are probably the stratigraphic equivalent of the Shinarump conglomerate, which is widely distributed in eastern Utah and northern Arizona. Much of the Chinle formation consists of indistinctly bedded red siltstone that breaks into angular fragments. Evenly bedded shale is rare. The sandstone layers differ in bedding characteristics; some layers are massive, whereas others are crossbedded, and still others are conspicuously ripple bedded. Almost everywhere the formation crops out as a steep slope broken in places by more resistant ledges of sandstone and conglomerate.

The Chinle formation ranges in thickness from about 425 feet in the southern part of the quadrangle to about 535 feet in the exposures on the northeast wall of Paradox Valley. The formation thins abruptly on the flanks of the Paradox Valley anticline.

GLEN CANYON GROUP

The Glen Canyon group, of Jurassic(?) age, comprises, in ascending order, the Wingate sandstone, the Kayenta formation, and the Navajo sandstone.

Wingate sandstone.—The Wingate sandstone conformably overlies the Chinle formation. The sandstone is a massive, fine-grained rock composed of clean, well-sorted quartz sand. It typically crops out as an impressive red or dark-brown wall, stained and streaked in places with a surficial red and black desert varnish. Vertical joints cut the sandstone from top to bottom; the spalling of vertically jointed slabs largely causes the recession of the cliff. The sandstone is divided into horizontal layers by extensive bedding planes spaced 2 to 50 feet apart. Within each horizontal layer the sandstone is crossbedded on a magnificent scale; great sweeping tangential crossbeds of eolian type, in places extending across the entire thickness of the horizontal layer, are disposed in all directions. The sandstone is rather poorly cemented and crumbles easily; this quality probably accounts for the readiness with which the rock disintegrates in faulted areas.

In the Paradox quadrangle the Wingate sandstone ranges in thickness from 250 to 300 feet. The formation thins abruptly on the flanks of the valley to about 100 feet.

Kayenta formation.—The Kayenta formation conformably overlies the Wingate sandstone; the contact between the two formations is gradational in most places. The formation is notable for its variety of rock types. Sandstone, red, buff, gray, and lavender in color, is the most abundant type; but the formation also contains considerable quantities of red siltstone, thin-bedded shale, and conglomerate. The conglomerate contains pebbles of sandstone, shale, and limestone. The sandstone is composed of rounded to subrounded quartz grains and minor quantities of mica, feldspar, and dark minerals. Most of the sandstone is thin bedded, crossbedded in part, and flaggy; some is massive. Individual sandstone beds are lenticular and discontinuous and interfinger with shale and, in places, with conglomerate. The Kayenta typically crops out in a series of benches and ledges. The ledges in many places overhang recesses where softer beds have eroded back. The lower part of the formation is more firmly cemented and forms resistant, thick ledges that protect the underlying Wingate sandstone from erosion.

The Kayenta formation in the Paradox quadrangle ranges in thickness from 180 feet to 260 feet. The formation is thinnest where it is exposed on the wall of the valley. Thin seams of gypsum are interspersed with the shale beds on the walls of the valley.

Navajo sandstone.—The Navajo sandstone conformably overlies the Kayenta formation. The Navajo is a gray to buff massive fine-grained clean quartz sandstone. Tangential crossbeds of tremendous size leave little doubt of the eolian origin of the sandstone. The sandstone weathers by disintegration; it tends to develop rounded topographic forms where exposed on slopes or benches and vertical cliffs where protected by overlying rocks.

The maximum thickness of the Navajo sandstone in the southern part of the quadrangle is about 180 feet. On the southwest wall of the valley the formation lenses out and is truncated by the overlying beds. The pinchout is both depositional and erosional. A few thin beds of water-laid green sandy shale are interspersed with the eolian-type sandstone.

SAN RAFAEL GROUP

In this area the San Rafael group, of Middle and Late Jurassic age, comprises, in ascending order, the Carmel formation, the Entrada sandstone, and the Summerville formation. The group crops out in a narrow band along canyon walls and on the sides of Paradox Valley. The Carmel formation and the Entrada sandstone were mapped as a single unit because in most places they form a narrow outcrop.

Carmel formation and Entrada sandstone.—The Carmel formation consists largely of red to buff, nonresistant horizontally bedded siltstone, mudstone, and sandstone. In some localities the basal beds consist of reworked Navajo sandstone. Pebbles and angular fragments of white and gray chert, as much as an inch in diameter, are scattered rather abundantly through the lower part of the formation and less abundantly through the upper part. These chert pebbles and angular fragments are sufficiently abundant locally to form layers of conglomerate. In many places the upper part of the formation contains scattered barite nodules as much as an inch in diameter.

In the area of the Paradox quadrangle the Carmel formation ranges from about 10 feet to 90 feet in thickness. This large range appears to be due chiefly to deposition on irregular eroded surfaces of Navajo sandstone or beds of the Kayenta formation. No definite evidence indicates that the Carmel formation of this area is of marine origin as is the Carmel of central Utah, but the Carmel of southwestern Colorado was probably deposited in shallow water marginal to a sea.

The Carmel formation grades upward, in most places without prominent breaks, into the Entrada sandstone. The Entrada sandstone, known locally as the "slick rim" because of its appearance, is perhaps the most picturesque of all the formations in the plateau region of Colorado. The smoothly rounded, in places bulging, orange, buff, and white cliffs formed by this sandstone are a distinctive and scenic feature of the region. Horizontal rows of pits resulting from differential weathering and ranging from a few inches to a foot or more across are characteristic of these cliffs. The Entrada consists of alternating horizontally bedded units and sweeping, eolian-type crossbedded units. The horizontally bedded units are most common in the basal part and in the uppermost lighter-colored part of the Entrada, whereas the crossbedded units are dominant in the middle part. The Entrada sandstone differs from the somewhat similar Wingate sandstone and Navajo sandstone by the sorting of sand into two distinct grain sizes. Subrounded to subangular quartz grains mostly less than 0.15 mm in diameter make up the bulk of the sandstone. The sandstone also contains larger grains, which are well rounded, have frosted surfaces, and range from 0.4 to 0.8 mm in diameter; most of these grains are quartz, but grains of chert are scattered among them. Most of the larger grains are distributed in thin layers along bedding planes.

Over most of the area the Entrada sandstone is 130 to 150 feet thick, except along the flank of the Paradox Valley anticline, where it thins to less than 100 feet.

Summerville formation.—The Summerville formation generally crops out as a steep, debris-covered slope, with very few good exposures. Where exposed the Summerville exhibits a remarkably even, thin, horizontal bedding. Beds are predominantly red of various shades, although some beds are green, brown, light yellow, or nearly white. Sandy and silty shales are the most abundant kinds of rock, but all gradations from claystone to clean, fine-grained sandstone are interbedded with them. Well-rounded amber-colored quartz grains with frosted or matte surfaces are disseminated throughout most of the formation, including beds consisting almost entirely of claystone. Thin beds of authigenic red and green chert are widespread. A thin discontinuous bed of dark-gray dense freshwater limestone occurs in the upper part of the formation. Sandstone beds are thicker and sandstone is more abundant in the lower part of the formation than in the upper part. Commonly the sandstone beds are ripple marked, and in places they show small-scale low-angle crossbedding.

The Summerville formation rests conformably on the Entrada sandstone, and, although a sharp lithologic change marks the contact, no cessation of deposition separated the two formations. The upper contact of the Summerville is uneven and channeled, and the channels are filled by the overlying basal sandstone beds of the Morrison formation. Locally, however, the contact is difficult to determine, because the overlying beds of shale and mudstone of the Morrison formation are similar to beds of the Summerville.

The Summerville formation in the Paradox quadrangle has a moderately uniform thickness that ranges from 85 to 100 feet except where it thins on the flanks of the Paradox Valley anticline.

MORRISON FORMATION

The Morrison formation, of Upper Jurassic age, is of special interest economically because of the uranium- and vanadium-bearing deposits it contains. The formation comprises two members in this area; the lower is the Salt Wash sandstone member and the upper is the Brushy Basin shale member. In the Paradox quadrangle the Morrison formation ranges in thickness from 700 to 800 feet. The Salt Wash sandstone member and the Brushy Basin shale member in general are of approximately equal thickness. In some areas, however, their thicknesses vary independently, whereas in other areas a thinning in one member is accompanied by a thickening in the other.

Salt Wash sandstone member.—The Salt Wash sandstone member ordinarily crops out above the slope-forming Summerville formation as a series of thick, resistant ledges and benches. Sandstone predominates and ranges in color from nearly white to gray, light buff, and rusty red. Interbedded with the sandstone are red shale and mudstone and locally a few thin lenses of dense gray limestone. Sandstone commonly occurs as strata traceable as ledges for considerable distances along the outcrop, but within each stratum individual beds are lenticular and discontinuous; beds wedge out laterally, and other beds occupying essentially the same stratigraphic position wedge in. Thus, any relatively continuous sandstone stratum ordinarily consists of numerous interfingering lenses, with superposed lenses in many places filling channels carved in underlying beds. Lenses are separated in places by mudstone and contain mudstone seams. Most of the sandstone is fine- to medium-fine-grained, crossbedded, and massive; single beds or lenses may attain a maximum thickness of 120 feet. Ripple marks, current lineations, rill marks, and cut-and-fill structures indicate that the Salt Wash was deposited under fluvial conditions.

The sandstone consists largely of subangular to subrounded quartz grains; but orthoclase, microcline, and albite grains occur in combined amounts of 10 to 15 percent. Chert and heavy-mineral grains are accessory. Considerable quantities of interstitial clay and numerous clay pellets occur in places, especially near the base of some of the sandstone lenses. Fossil wood, carbonaceous matter, and saurian bones occur locally.

The only complete sections of the Salt Wash sandstone member in the Paradox quadrangle are on Skein and Wray Mesas, where the thickness of the member ranges from 325 to 350 feet. On Nyswonger Mesa only the basal 50 to 100 feet remain.

Brushy Basin shale member.—The Brushy Basin shale member contrasts strongly in overall appearance with the underlying Salt Wash sandstone member. Although the lithologic differences are marked, the contact between the two members is gradational. The mapped contact, taken as the base of the lowermost layer of conglomerate lenses, is arbitrary in many respects and probably does not mark an identical stratigraphic horizon in all localities.

The Brushy Basin shale member consists predominantly of varicolored bentonitic shale and mudstone, with intercalated beds and lenses of conglomerate and sandstone, and a few thin layers of limestone. Because of its high proportion of soft, easily eroded bentonitic shale and mudstone, the Brushy Basin member forms smooth slopes covered with blocks and boulders weathered from the more resistant layers of the member and from the overlying formations. The shale and mudstone are thin bedded and range in color from pure white to pastel tints of red, blue, and green. Exposed surfaces of the rock are covered with a loose, fluffy layer of material several inches thick, caused by the swelling of the bentonitic material during periods of wet weather. Scattered through the shale and mudstone are thin beds of fine-grained hard silicified rock that breaks with a conchoidal fracture. The silica impregnating these beds may have been released during the devitrification of volcanic debris in adjacent beds. Beds of chert-pebble conglomerate a few inches to 25 feet thick occur at intervals throughout the member. These conglomerate beds are commonly dark rusty red and form conspicuous resistant ledges. Silicified saurian bones and wood are much more abundant in the Brushy Basin shale member than in the Salt Wash sandstone member, especially in some of the conglomerate beds.

The Brushy Basin shale member, like the Salt Wash sandstone member, undoubtedly was deposited under fluvial conditions. The conglomerate and sandstone lenses mark stream channels that crossed flood plains on which were deposited the fine-grained sediments now represented by the mudstone and shale.

Within the quadrangle the Brushy Basin shale member ranges from 300 to 400 feet in thickness, and erratically distributed local variations in thickness of 20 to 30 feet are common.

BURRO CANYON FORMATION

The name Burro Canyon formation was proposed by Stokes and Phoenix (1948) for the heterogeneous sequence of Lower Cretaceous conglomerate, sandstone, shale, and thin lenses of limestone that overlies the Morrison formation. The Burro Canyon characteristically crops out as a cliff or a series of thick, resistant ledges. The bulk of the formation consists of white, gray, and red sandstone and conglomerate that form beds up to 100 feet thick. These beds are massive, irregular, and lenticular. Crossbedding and festoon bedding are prevalent throughout the formation. The sandstone is poorly sorted and consists of quartz and lesser amounts of chert. The conglomerate consists largely of chert pebbles, but intermixed are pebbles of quartz, silicified limestone, quartzite, sandstone, and shale. In places the beds are highly silicified. A considerable part of the formation consists of bright-green mudstone and shale, and locally these predominate over the sandstone and conglomerate. Thin, discontinuous beds of dense gray limestone crop out in a few scattered localities. The formation was undoubtedly deposited under fluvial conditions. The lower contact is indistinct in many places and the formation appears to interfinger with the upper part of the Brushy Basin shale member; elsewhere local erosion surfaces intervene and the contact is sharp. The upper contact is an erosion surface of regional extent.

In the Paradox quadrangle, the thickness of the Burro Canyon formation on both Wray and Skein Mesas is about 100 feet.

DAKOTA SANDSTONE

The Dakota sandstone, of Early and Late Cretaceous age, consists principally of gray, yellow, and buff flaggy sandstone; less abundant are conglomerate, carbonaceous shale, and impure coal. Some of the sandstone is fine grained and thin bedded, but much of it is coarse grained and crossbedded. Scattered through the sandstone are irregular, discontinuous beds and lenses of conglomerate containing chert and quartz pebbles as much as 2 inches across. Interfingering with the sandstone beds are thin-bedded gray and black carbonaceous shales and thin coal seams and beds. Plant impressions abound in both the sandstone and the shale.

The entire thickness of the Dakota sandstone is not exposed in the quadrangle; the upper beds have been stripped off by erosion, but the beds that remain attain a maximum thickness of about 50 feet on Skein and Wray Mesas.

QUATERNARY DEPOSITS

The deposits of Quaternary age consist of wind-deposited material, alluvium, gravel, fanglomerate, talus, and landslide debris. Most of a light-red sandy and silty mantle that lies on benches and mesa tops is wind-deposited, although much of it has probably been reworked by water and intermixed with sheet wash. The greatest observed thickness in some dry washes on mesa tops is about 10 feet. These deposits have not been mapped where they are commonly spotty, discontinuous, or less than a foot thick. The soils that cover the floor of the valley differ somewhat from the wind-deposited material on the mesas. These valley soils are derived from the rocks exposed on the valley walls and floor, as well as windblown material and sheet wash. The fill in the Paradox quadrangle is more than 30 feet thick, as seen in the cut banks of West Paradox Creek.

Quaternary fanglomerates occur in scattered deposits in the floor of the valley. The fanglomerates are made up of pebbles and boulders of the rocks that make up the valley walls and floor. These deposits are well indurated with a calcitic matrix and consist of moderately well sorted rudely bedded subangular to subrounded boulders, as much as 4 feet in diameter, which grade upward to conglomeratic sandstone. Terrace gravels occur along the Dolores River in beds as much as 15 feet thick. The gravels are made up of pebbles and boulders consisting of several varieties of igneous rock, quartzitic rock, and sandstone. Most of the pebbles originated in the San Juan Mountains to the east. Considerable talus covers many of the steeper slopes; and landslide material, consisting largely of debris of the Brushy Basin member, occurs on Wray and Skein Mesas.

The fanglomerates and terrace gravels have been plotted separately on the geologic map; but inasmuch as the alluvium, wind-deposited material, valley fill, talus, and landslide debris are difficult to differentiate in some places, they have not been separated on the map.

STRUCTURE
REGIONAL SETTING

Many geologic structures on the Colorado Plateau are so large that a 7½-minute quadrangle covers only a small part of any complete structural unit. The larger structural units consist of salt anticlines, 25 to 65 miles long (fig. 1); uplifted blocks, 50 to 125 miles long, bounded by monoclinal folds; and domical uplifts, 8 to 20 miles across, around stocklike and laccolithic intrusions.

The salt anticlines trend northwest and lie in a group between eastward-dipping monoclines on the west side of the Plateau and westward-dipping monoclines on the east side of the Plateau. The cores of these anticlines consist of relatively plastic salt and gypsum, derived from the Paradox member of the Pennsylvanian Hermosa formation and intruded into overlying late Paleozoic and early Mesozoic rocks. All the anticlines are structurally similar in many respects, but each exhibits structural peculiarities not common to the rest; furthermore, all are more complex than their seemingly simple forms would suggest. Faults, grabens, and collapse and slump structures alter the forms of the anticlines. Erosion has removed much of the axial parts of these anticlines, leaving exposed large intrusive masses of the Paradox member and forming valleys such as Sinbad Valley, Paradox Valley, and Gypsum Valley in Colorado and similar valleys in Utah. Alternating with these anticlines are broad, shallow, simple synclines.

STRUCTURE IN PARADOX QUADRANGLE

The Paradox quadrangle covers part of the northwest end of Paradox Valley and the adjacent area to the south. The rock strata in the southern part of the quadrangle have dips of less than 2°. On the walls of the valley the dips increase sharply along the flanks of the salt core that underlies the valley. The pre-Morrison formations thin against the salt-gypsum core, and the older pre-Morrison formations dip more steeply than the younger. These relations can be seen more clearly in Gypsum Valley, which lies southeast of the area covered by the quadrangle.

Along the walls of Paradox Valley, blocks and slivers of a complex system of faults have been downthrown toward the floor of the valley. In places, graben structures, up to half a mile long and 500 feet wide, have formed along the southwest wall of the valley.

STRUCTURAL HISTORY

In order to understand the structural history of the Paradox quadrangle, it is necessary to understand the structural history of the adjoining part of southwestern Colorado. Parts of this history are still in doubt, because no clear record remains of some events; the record of other events, although legible, is subject to different interpretations. All the events described in the following discussion affected the Paradox quadrangle either directly or indirectly, although the evidence for some of them is not visible within the quadrangle boundaries.

Weak compressive forces, which probably began in early Pennsylvanian times, gently warped the region. This warping gave rise to the ancestral Uncompahgre highland, an element of the ancestral Rocky Mountains, and to the basin in which the Paradox member of the Hermosa formation of Pennsylvanian age was deposited. These major structural features controlled the pattern and the prevailing northwest-trending grain of the smaller structures later superimposed on them. The boundary between the highland and the basin, which is closely followed by the southwest margin of the present-day Uncompahgre Plateau, was a steep northwest-trending front, possibly a fault scarp, along which were deposited arkosic fanglomerates during late Pennsylvanian and Permian time. The older fanglomerates interfinger with Pennsylvanian marine sedimentary rocks of the Hermosa formation. The bulk of the fanglomerates probably is of Permian age and belongs to the Cutler formation. Intrusion of salt from the Paradox member, probably initiated by gentle regional deformation, began sometime during deposition of the Permian Cutler formation. Isostatic rise of salt ruptured the overlying Hermosa and Cutler formations, and at the end of Cutler deposition salt broke through to the surface. From then until flowage ceased, late in the Jurassic period, the elongate salt intrusions such as those in Paradox Valley and Gypsum Valley stood as actual topographic highs at one place or another along their lengths. The rate of upwelling of additional salt, perhaps accelerated by the increase of the static load of sediments accumulating in the surrounding areas, balanced or slightly exceeded the rate of removal of salt by solution and erosion at the surface. Consequently, all the Mesozoic formations below the Morrison formation wedge out against the flanks of the salt intrusions. Salt flowage was not everywhere continuous or at a uniform rate; rather, in many places it progressed spasmodically. Local surges of comparatively rapid intrusion gave rise to cupolas at different times and in different places along the salt masses. At the beginning of deposition of the Morrison, sediments finally covered the salt intrusions, perhaps because the supply of salt underlying the areas between the intrusions was exhausted. Relative quiescence prevailed throughout the remainder of the Mesozoic and probably through the early part of the Tertiary.

The second major period of deformation occurred in the Tertiary—probably during the Eocene (Hunt, written communication), but the date cannot be determined accurately. The region of the salt intrusions was compressed into a series of broad folds, guided and localized by the pre-existing salt intrusions. Although salt flowage was renewed, it seems unlikely that any considerable amount of new salt was forced into the intrusions; flowage probably consisted largely of redistribution of the salt already present. By the end of this period of deformation these folds had attained approximately their present structural form, except for modifications imposed by later collapse of the anticlines overlying the salt intrusions. Owing to the mobility of the rocks in the cores of the anticlines, normal faulting took place along the crests of the anticlines, probably during relaxation of compressive stresses after folding ceased. At this time the crests of the anticlines in places were dropped, as grabens, several hundred to a few thousand feet. A period of crustal quiescence followed, during which the highlands overlying the anticlines and domes were reduced by erosion and topographic relief became low throughout the area.

An additional system of normal faults was developed during the early Tertiary. These faults are northeast-trending, roughly normal to the axis of the salt-gypsum cores. They die out at the edges of the anticlines. The faults are mineralized with copper and silver minerals, which suggests that they are probably deep-seated.

During the middle Tertiary the entire Colorado Plateau was uplifted. This uplift rejuvenated the streams and increased ground-water circulation. The crests of the anticlines were breached, and the underlying salt was exposed to rapid solution and removal. With the abstraction of salt, renewed collapse of the anticlines began. Although much of the collapse was due directly to removal of salt by solution, it seems unlikely that all the collapse can be attributed to this process, as was believed by earlier workers in the area. Rather, much of the collapse apparently was caused by flowage of salt from the parts of the anticlines still overlain by thick layers of sediments to the parts from which the overlying sediments had been removed. Once the crests of the anticlines had been breached, the relatively plastic salt offered little support for the beds overlying the Paradox member of the Hermosa formation in the flanks of the anticlines; consequently these essentially unsupported beds slumped, probably along fractures and joints formed during earlier flexures. Small faults and folds in Quaternary deposits may indicate that collapse and local readjustments are still continuing.

MINERAL DEPOSITS

The commercially important mineral deposits in and adjacent to the Paradox quadrangle are those that contain uranium, vanadium, and radium and those that contain copper and silver.

URANIUM, VANADIUM, AND RADIUM DEPOSITS

Although deposits containing uranium, vanadium, and radium were discovered in 1899 near Roc Creek about 5 miles north of the Paradox quadrangle, intensive mining of these ores did not begin in the Plateau region until 1911. Thereafter the ores were mined primarily for their radium content until 1923, when the Belgian Congo pitchblende deposits began to supply radium. The mines were mostly idle from 1923 until 1937, but since 1937 they again have been exploited intensively, first for vanadium and in more recent years for both vanadium and uranium.

The deposits are commonly restricted to the upper layer of sandstone in the Salt Wash sandstone member of the Morrison formation, but a few deposits have been mined from the middle and lower layer of sandstone lenses. Within these layers of sandstone the deposits have a spotty distribution. Throughout the Colorado Plateau the ore bodies may range from small irregular masses containing only a few tons of ore to large tabular bodies containing many thousands of tons. In the Paradox quadrangle the deposits lie exclusively in the upper layer of the Salt Wash and contain only a few tons of ore each. The ore consists mainly of sandstone impregnated with uranium- and vanadium-bearing minerals.

MINERALOGY

The most common ore minerals are carnotite and a fine-grained, vanadium-bearing micaceous mineral. Carnotite [$K_2(UO_2)_2(VO_4)_2 \cdot 3H_2O$] is a yellow, fine-grained, earthy or powdery material. Tyuyamunite [$Ca(UO_2)_2(VO_4)_2 \cdot nH_2O$], the calcium analogue of carnotite, is also present and is nearly indistinguishable from carnotite. The micaceous vanadium mineral, which formerly was thought to be roscoelite, is now considered to be related to the nontronite or montmorillonite group of clay minerals. It forms aggregates of minute flakes coating or partly replacing and filling pore spaces in the sandstone. It colors the rock gray. Other vanadium ore minerals present are montroseite [$(Fe,V)_2O_3 \cdot nH_2O$], corvusite [$V_2O_4 \cdot 6V_2O_5 \cdot nH_2O$], and hewettite [$CaO \cdot 3V_2O_5 \cdot 9H_2O$]. Corvusite and montroseite occur together, forming compact masses of bluish-black ore, whereas hewettite commonly forms stringers and veinlets along joints and fractures. Recent deeper drilling and mining in the Plateau have indicated that below the zone of oxidation black oxides of uranium and vanadium, accompanied by pyrite and perhaps other sulfides, are more abundant, and uranyl vanadates are scarce or absent.

ORE BODIES

The ore consists mostly of sandstone selectively impregnated and in part replaced by uranium and vanadium minerals; but rich concentrations of carnotite and the micaceous vanadium clay mineral are also associated with thin mudstone partings, beds of mudstone pebbles, and carbonized fossil plant material. Many fossil logs replaced by nearly pure carnotite have been found. In general the ore minerals were deposited in irregular layers that roughly followed the sandstone beds. In most deposits the highest-grade concentrations of ore minerals occur in sharply bounded, elongate concretionary structures, called "rolls" by the miners. These rolls are encompassed by rich, veinlike concentrations of the micaceous vanadium-bearing clay mineral that curve across bedding planes. Within these rolls this mineral generally is distributed as diffusion layers, the richer layers commonly lying nearer the margins of the rolls; the distribution of carnotite in the rolls is less systematic. Margins of ore bodies may be vaguely or sharply defined. Vaguely defined margins may have mineralized sandstone extending well beyond the limits of commercial ore; on the other hand, sharply defined margins, such as occur along the surfaces of rolls, ordinarily mark the limits of both the mineralized sandstone and the commercial ore.

Although many rolls are small and irregular, the larger rolls are elongate and may extend with little change of direction for more than 100 feet. The elongate rolls in an ore body or group of ore bodies in a given area generally have a common orientation. This orientation is roughly parallel to the elongation of the ore bodies.

ORIGIN OF ORE

The origin of the uranium-vanadium ores in the Morrison formation is uncertain. In some respects the deposits are unique, and much of the evidence concerning the genesis of the ore is either not conclusive or appears to be contradictory. In this brief account only a small amount of evidence can be presented and the hypotheses can only be summarized.

Most of the deposits are closely associated with certain sedimentary features. Layers of ore lie essentially parallel to the bedding; most of the deposits occur in the thicker parts and commonly near the base of the sandstone lenses; the trend of the long direction of the deposits and the trend of the ore rolls in the sandstone are roughly parallel to the trend of the fossil logs in the sandstone and to the average or resultant dip of the crossbedding in the sandstone. These relations strongly suggest that primary structures in the sediments were ore deposits.

Recent investigations have revealed new data bearing on the origin of the ores (Waters and Granger, 1953). Below the zone of oxidation some of the ore consists chiefly of oxides, such as pitchblende and low-valent oxides of vanadium, and small quantities of sulfides such as pyrite, bornite, galena, and chalcopyrite; fully oxidized and fully hydrated minerals are either rare or nonexistent. A hard variety of uraninite, previously reported only from hydrothermal deposits, has been found in the Gray Daun mine in San Juan County, Utah (Rasor, 1952), and in the Happy Jack mine in White Canyon, Utah. Studies of lead-uranium ratios in ores from the Colorado Plateau indicate that, regardless of where or in what formation found, all the ores are of roughly the same age, and this age is no older than latest Cretaceous (Stieff and Stern, 1952). Some geologists believe that field relations in pre-Morrison formations at White Canyon (Benson et al., 1952) and Temple Mountain in Utah indicate that the deposits may be genetically related to faults and fractures. At the Rajah mine near Roc Creek, in Colorado, ore occurs along a fault and horsetails out into the wall rock.

Two main hypotheses have arisen to explain the origin of the ores. The oldest and probably the most widely held is the hypothesis that the ores are penesyngenetic and were formed soon after the enclosing rocks were deposited (Coffin, 1921; Hess, 1933; Fischer, 1937, 1942, 1950; and Fischer and Hilpert, 1952). Later movements of ground water may have dissolved and reprecipitated the ore constituents, but the essential materials were already present in the host rocks or in the waters permeating them. Although this hypothesis offers a reasonable explanation for the relation of ore to sedimentary features, it faces some difficulty in explaining: (1) the discrepancy between the age of the uranium and the age of the enclosing rock; (2) the broad stratigraphic distribution of uranium occurrences and association of ores with fractures in a few localities; and (3) the hydrothermal aspect of the mineral suites in some ores. The second hypothesis, and the one the author favors, is essentially a telethermal hypothesis and assumes the ore to have originated from a hypogene source. Proponents of this hypothesis believe that ore-bearing solutions originated at depth from an igneous source and ascended along fractures. After these solutions mingled with circulating ground waters the minerals precipitated in favorable beds as much as several miles from fractures. This hypothesis explains more readily the difficulties inherent in the penesyngenetic hypothesis, but it poses two other difficulties: (1) the hypothetical location of igneous source rocks, and (2) the difficulty of proving the connection between fractures and faults and the ore deposits. A third hypothesis, advanced by some geologists, suggests that the source of the ore metals was the volcanic material in the beds overlying the ore-bearing sandstones and that these metals were subsequently leached and redeposited in the beds that now contain the ore. This hypothesis encounters not only most of the difficulties in the penesyngenetic hypothesis but it presents some additional ones of its own.

SUGGESTIONS FOR PROSPECTING

Regardless of the origin of the deposits, certain habits of the deposits—habits that have been recognized through geologic mapping and exploration experience—are useful as guides for finding ore (Weir, 1952). In southwestern Colorado most of the deposits are in the uppermost sandstone stratum in the Salt Wash sandstone member of the Morrison formation. Generally the central or thicker parts of the sandstone lenses are more favorable—many deposits are in sandstone that is 40 feet or more thick; few deposits are in sandstone less than 20 feet thick. Crossbedded, relatively coarse-grained sandstone is more favorable than thinly or evenly bedded, fine-grained sandstone. Light yellow-brown sandstone speckled with limonite stain is more favorable than red or reddish-brown sandstone. Sandstone that contains considerable amounts of gray, altered mudstone, or is underlain by a considerable thickness of this rock, is more favorable than sandstone containing and underlain by red, unaltered mudstone—this guide is perhaps the most useful in diamond-drill exploration. If the deposits have a hypogene origin then localities where favorable host rocks are near or coextensive with areas of more intense deformation may be especially favorable for finding ore.

In the Paradox quadrangle none of the exposed host rocks appear to be especially favorable, although on Wray Mesa, where large areas of the Salt Wash sandstone member are covered by later deposits, deep drilling may discover favorable host rock. With careful prospecting, some deposits may be found in the Brushy Basin shale member.

COPPER AND SILVER DEPOSITS

The copper and silver deposits on La Sal Creek were discovered about 1885 and were worked intermittently until 1945. About 350,000 ounces of silver and 1,700,000 pounds of copper have been produced from the La Sal Creek district (Vanderwilt, 1947).

The deposits are found in normal faults that trend roughly northeast. All the ore has come from the faulted zone in the Wingate sandstone. The Cashin mine, the largest in the area, lies in a fault that trends N. 40° E. and dips 65° NW. The maximum displacement on the fault is about 40 feet. The Cliff Dweller mine is along a fault that trends N. 26° E. and dips 65°-70° E. The displacement on this fault is about 20 feet. The faults die out to the northeast on the flank of Paradox Valley.

About 20,000 ounces of silver and traces of gold have been recovered from La Sal Creek by placer mining (Vanderwilt, 1947).

Mineralogy.—The ore minerals (Fischer, 1936) consist chiefly of chalcopyrite and native copper. Some bornite, covellite, and hazenite are also present. The silver occurs in argentiferous covellite. The gangue minerals are barite, calcite, and dolomite. Sphalerite and galena have also been identified from mines, though production of zinc and lead from the area indicates that these minerals are not important.

Ore bodies.—The ore, as reported by Fischer (1936), consists of replacements of sand grains by chalcopyrite, brecciated chalcopyrite cemented by dolomite, and native copper occurring in veins cemented with barite and calcite. The native copper also occurs in masses of as much as 500 pounds each. Such masses have been reported toward the bottom of the vein. The vein ranges in width from 1 to 20 feet and extends in depth about 275 feet.

Origin of ore.—The mineralized material is attributed by Fischer (1936) to low-temperature hydrothermal solutions, with colloids playing an important part in forming the minerals. The age of the deposits is not known. The faults along which the mineralizing solutions traveled probably were formed during the Late Cretaceous or early Tertiary folding of the area. The early Tertiary intrusions in nearby areas, such as in the La Sal Mountains, probably played an important part in originating the ore-bearing solutions.

Suggestions for prospecting.—Although most of the faults have been prospected on the surface, both the Cashin and the Cliff Dweller faults disappear under the alluvium and incompetent sediments on Wray Mesa. Prospecting in the area where the faults apparently join might turn up a body similar to that of the Cashin mine. Drill holes of about 1,000 feet would be required to test the Wingate sandstone in this area.

THE MINES

Uranium, vanadium, and radium.—A small number of prospects containing a few tons of ore each have been located in the Paradox quadrangle. Most of these are on Wray Mesa, though a few have been located on Skein Mesa. These occur as isolated bodies of low-grade uranium and vanadium.

Cashin and Cliff Dweller mines.—Both the Cashin and the Cliff Dweller mines are located in the faulted Wingate sandstone. The Cashin mine extends into the Wingate sandstone about 3,000 feet and a winze has been driven 225 feet downward. A raise has been driven from the main adit to the surface, a distance of about 100 feet. The lower workings in the mine are inaccessible because of water. The Cliff Dweller mine is about three-quarters of a mile up La Sal Creek from the Cashin mine. It consists of an upper and a lower adit, the upper one about 900 feet long, and the lower one about 500 feet long. Both these adits are now inaccessible because of caving.

Several small prospects have been dug in the wall of Paradox Valley on the extension of the Cashin fault. Little mineralized material was found, and no production has been reported.

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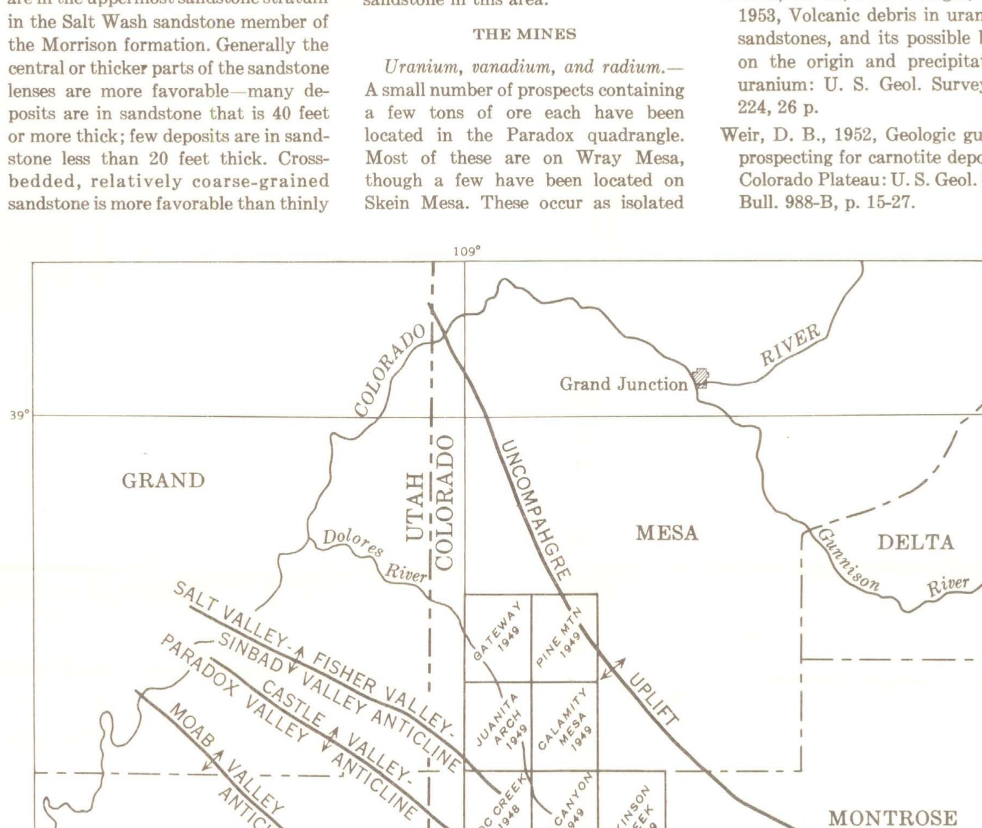
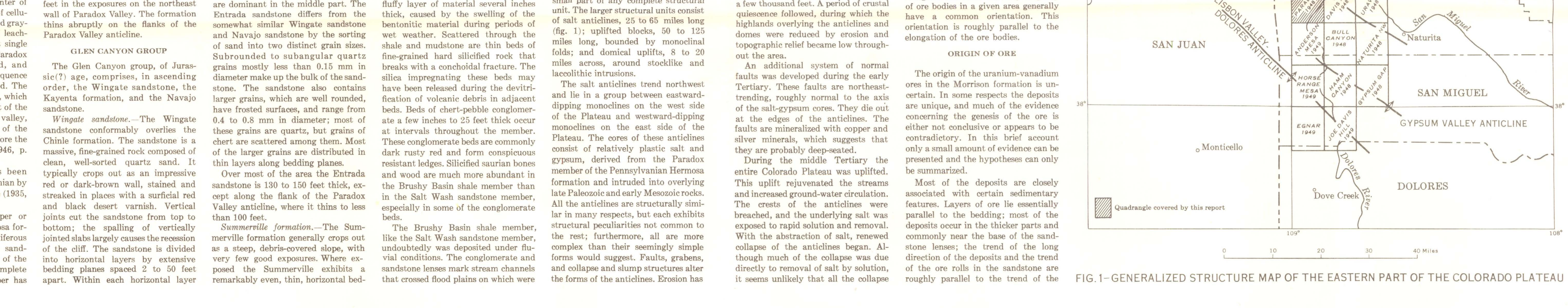
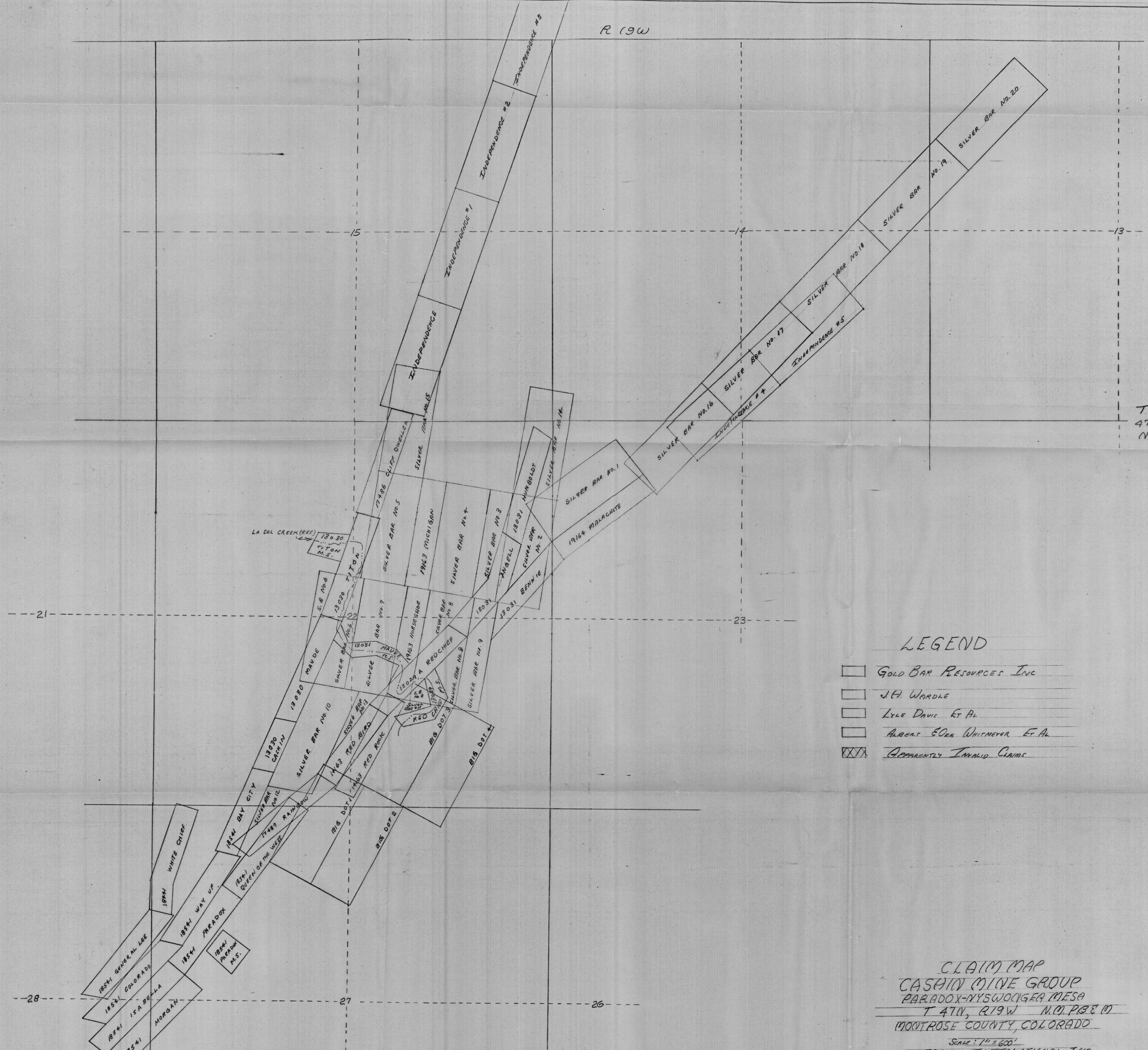


FIG. 1—GENERALIZED STRUCTURE MAP OF THE EASTERN PART OF THE COLORADO PLATEAU



SECTION ALONG LINE A-A'



LEGEND

- Gold Bar Resources Inc
- J.A. Wardle
- Lyle Davis Et Al
- Albert & Ora Whitmeyer Et Al
- Apparently Invalid Claims

CLAIM MAP
CASHIN MINE GROUP
PARADOX-NYSWONGER MESA
T 47N, R19W N.M.P.B.&M.

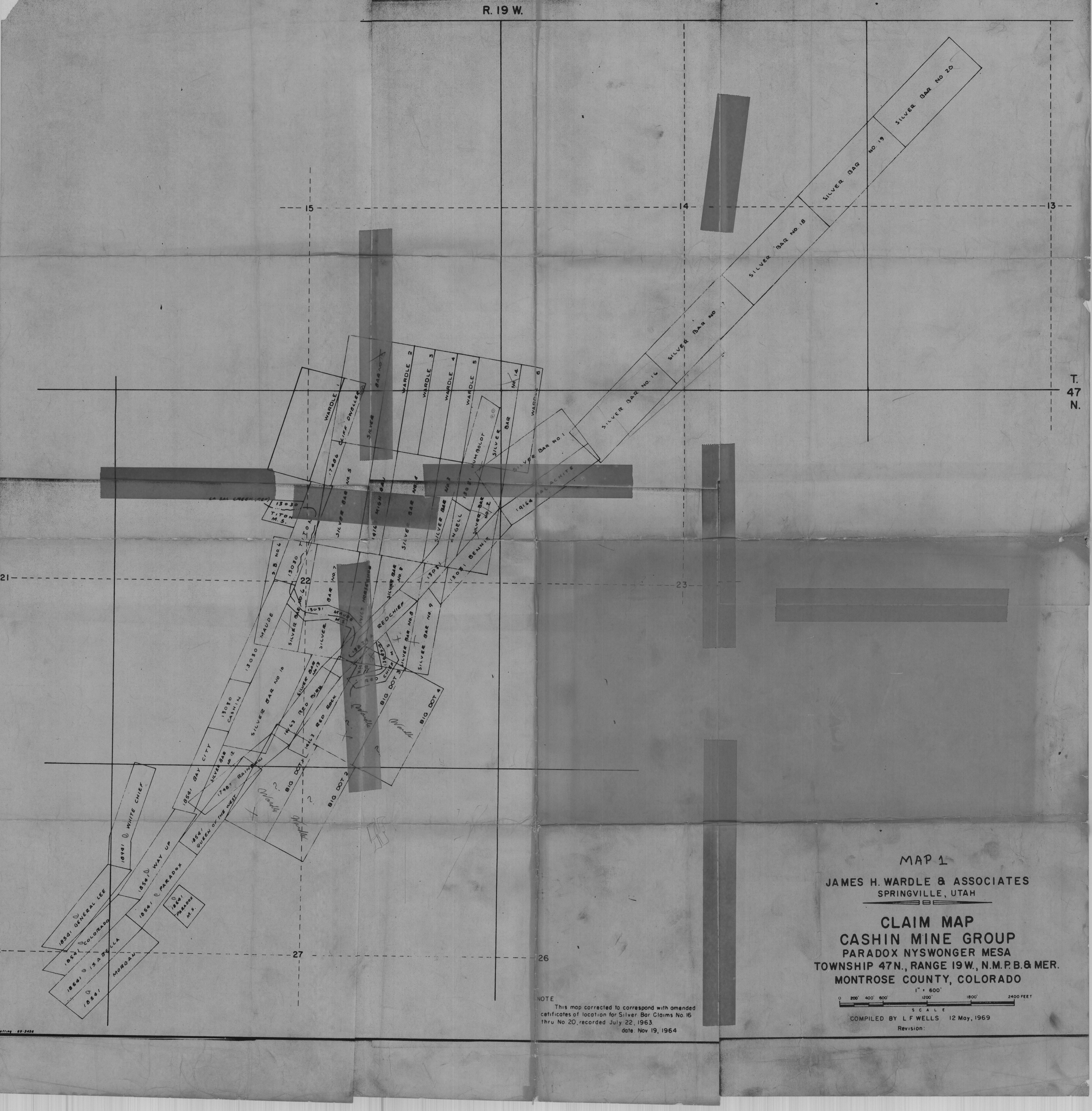
MONTROSE COUNTY, COLORADO

Scale: 1" = 600'

ESSEX INTERNATIONAL INC.

Compiled By G.E. Jackson September 1970

Revisions:



MAP 1

JAMES H. WARDLE & ASSOCIATES
SPRINGVILLE, UTAH

CLAIM MAP
CASHIN MINE GROUP
PARADOX NYSWONGER MESA
TOWNSHIP 47N., RANGE 19W., N.M.P.B.& MER.
MONTROSE COUNTY, COLORADO

1" = 600'

0 200' 400' 600' 1200' 1800' 2400 FEET
SCALE

COMPILED BY L.F WELLS 12 May, 1969
Revision:

NOTE
This map corrected to correspond with amended cetificates of location for Silver Bar Claims No. 16 thru No 20, recorded July 22, 1963.
date: Nov 19, 1964


SW
NE
Oxide Zone
Secondary Zone
Oxide Zone
Secondary Zone
OLD SHAFT
EL 5554
STOPE AREA
LEVEL 1
LEVEL 2
LEVEL 3
LEVEL 4
LEVEL 5
LEVEL 6
MAIN SHAFT
EL. 5334
MAIN TUNNEL 3RD LEVEL
TUNNEL No 3
EL 5290
Block 'A'
Block B
Block C
Block D
Block E
Block F
Block G
Block H
Block J
Block K
Block I probable ore
Probable Ore
Underhand stope
Shale member - in footwall of vein
Vein 6"
Water 2/11/43
Water 2/11/43
25 Raise
25 Winze
32 Raise
32 Winze
43 Raise
43 Winze
back filled
Filled
Stope shown on old map
No stoping on this section of vein
Vein is very narrow and mineralization is weak
ore blocks.
Proposed development.
R- George H. Ryan samples. — other samples by L.W.C.
No - width in ft. ounces-Ag - % Copper.
3 - 0.5 1.8 - 6.50
RED CHIEF TUNNEL
NEW CASHIN MINES, INC.
LA SAL MNG. DIST. MONTROSE CO. COLO.
NE-SW SECTION - 1"=60'
DOCKET No C-ND- 7939
Louis W. Cramer
2/9-11/43 incl.