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

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THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS

The Atchison, Topeka & Santa Fe Railway Co., Coast Lines

# Technical Publication No. 557

*Class I, Mining Geology, No. 46*

# Distribution of Silver in Base-metal Ores

*By* SAMUEL G. LASKY

SOCORRO, NEW MEXICO

DISCUSSION OF THIS PAPER IS INVITED. It should preferably be presented in person at the New York Meeting, February, 1935, when an abstract of the paper will be presented. If this is impossible, discussion in writing may be sent to the Editor, American Institute of Mining and Metallurgical Engineers, 29 West 39th Street, New York, N. Y., for presentation by the Secretary or othe representative of the author. Unless special arrangement is made, the discussion of this paper will close April 1, 1935. Any discussion offered thereafter should preferably be in the form of a new paper.

29 WEST 39th STREET
NEW YORK, N. Y.

*All papers issued by the Institute are abstracted month by month in Mining and Metallurgy. This paper is issued with the August, 1934, number. Members are urged to go through the abstracts each month and select and request such papers as they can use.*

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chloride Ref.

# Distribution of Silver in Base-metal Ores*

By Samuel G. Lasky,† Socorro, New Mexico

(New York Meeting, February, 1935)

The writer has been interested in determining the mineralogic distribution of silver in the base-metal ore of the Ground Hog mine of the Asarco Mining Co. in the Central mining district of New Mexico.[1] This ore consists of a varitextured mixture of sphalerite, chalcopyrite, galena and pyrite in a quartz gangue. The average ore contains 14 per cent of zinc, 9.5 per cent of lead, 5 per cent of copper, and 10 oz. of silver per ton. Generally it is accepted that the silver in ores of this type, in which no definite silver minerals can be recognized, is contained in the base-metal minerals. Published assays of pure mineral specimens from many districts show that each of the base-metal minerals contributes in some degree to the total silver content of the ores, and to determine the proportionate amount contributed by each mineral in any specific ore it has been the practice to assay selected specimens of each mineral, the purity of which has been determined microscopically. There being no such assays available for the Ground Hog ore, and it being impracticable to have enough of them made to give average results, the writer resorted to a mathematical attack upon composite assays of large quantities of ore and concentrates. Surprising results were obtained, and it is the threefold purpose of this paper to present these results, to describe the mathematical method used, and to point out the value of using this method even when assays of pure specimens are available.

## Value of the Mathematical Method

The obvious way of attacking the problem would be to separate *cleanly* large quantities of ore into its component minerals and then to determine the average silver content of each mineral by assay of representative samples. Since an absolutely clean separation is not feasible, it has been the practice, as mentioned above, to assay pure specimens of the different minerals. No one will contend seriously that the silver content of a base-metal mineral is constant throughout any particular deposit, and it will

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* Published by permission of the Directors of the U.S. Geological Survey and of the New Mexico Bureau of Mines and Mineral Resources.

† U. S. Geological Survey.

[1] S. G. Lasky: Geology and Ore Deposits of the Bayard Area of the Central Mining District, New Mexico: U.S. Geol. Survey *Bull.* in preparation.

$$\mathrm{Pb}x + \mathrm{Cu}y = \mathrm{Ag} \qquad [1]$$

where Pb = assay percentage of lead,
Cu = assay percentage of copper,
Ag = ounces of silver per ton,
$x$ = ounces of silver contributed by each per cent of lead,
$y$ = ounces of silver contributed by each per cent of copper.

By inserting the assay values for two ore products, two equations are obtained that can be solved simultaneously. Or, if desired, the equations may be graphed and the values of $x$ and $y$ read from the intersection; if the assays used are from two such widely separated kinds of material as lead and copper concentrates, the curves will intersect at an angle large enough so that the intersection values will be reliable.

A consideration of assays of the zinc concentrate derived from Ground Hog ore and of the associated tailing, which contains most of the pyrite, indicates that the silver content of the sphalerite and pyrite in this ore is negligible, and that for purposes of calculation all silver may be assumed associated with the galena and chalcopyrite. By inserting in equation 1 assay values of lead and copper concentrates for a particular 9-month period, equations 2 and 3 respectively are formed. These concentrates represent 31,000 tons of ore containing 8.04 per cent of lead, 5.13 per cent of copper, 14.07 per cent of zinc, and 9.65 oz. of silver per ton.

$$37.0x + 12.2y = 41.2 \qquad [2]$$
$$7.6x + 24.3y = 12.9 \qquad [3]$$

Fig. 1 is the graphic solution of equations 2 and 3, from which it is seen that $x$ equals 1.05 oz. of silver for each per cent of lead (90.9 oz. per ton of galena) and that $y$ equals 0.20 oz. for each per cent of copper (6.9 oz. per ton of chalcopyrite). If it appears that the sphalerite is contributing an appreciable amount of silver, equation 1 may be amplified to read

$$\mathrm{Pb}x + \mathrm{Cu}y + \mathrm{Zn}z = \mathrm{Ag} \qquad [4]$$

and by using also the assays of the zinc concentrate, three equations can be obtained similar to equations 2 and 3 from which the three unknowns can be determined readily. For the Ground Hog concentrates these three equations for the same period covered by equations 2 and 3 are as follows:

$$\begin{aligned} 37.0x + 12.2y + 9.1z &= 41.2 \text{ (lead concentrate)} \\ 7.6x + 24.3y + 8.7z &= 12.9 \text{ (copper concentrate)} \\ 2.2x + 1.8y + 56.9z &= 3.9 \text{ (zinc concentrate)} \end{aligned} \qquad [5]$$

By solving these equations simultaneously the following results are obtained:

## Solution by Use of Crude-ore Assays

Strictly speaking, the ratios given above indicate only the mineral association of silver in the concentrates. By inference, it would be assumed ordinarily that these ratios describe also the mineralogic distribution of silver in the crude ore, but this can and should be independently computed from periodic composite assays of the ore mined. Monthly composite assays are always at hand, and if such assays for half a year or more are used in the computations, the tonnage of ore represented is large enough to permit reliance upon the results obtained.

An equation similar to equation 4 or to equation 6 may be set up for each month, thus giving six or more equations in three or four unknowns. Whenever there are more independent equations than unknowns in a system, it is not possible to find values for the unknowns that will satisfy precisely all the equations, and the problem then becomes one of finding values that give the best solution for the system as a whole. This can be done by the method of least squares, in which each equation contributes to the solution. Several steps are involved but they are simple and one need know nothing about the theory behind the method.[2]

1. The unknowns in each equation must be written in the same order; i. e., $x$ first, $y$ second, etc.

Table 1.—*Monthly Composite Assays of Crude Ore from the Ground Hog Mine*

| | Lead, Per Cent | Copper, Per Cent | Zinc, Per Cent | Silver, Oz. per Ton |
|---|---|---|---|---|
| June, 1932 | 9.49 | 5.48 | 12.39 | 9.77 |
| July | 10.45 | 5.39 | 13.08 | 10.75 |
| August | 7.47 | 5.19 | 13.77 | 8.53 |
| September | 7.47 | 5.70 | 12.76 | 10.25 |
| October | 8.13 | 5.36 | 16.80 | 10.17 |
| November | 9.65 | 4.80 | 13.42 | 9.99 |
| December | 8.53 | 4.93 | 13.09 | 9.82 |
| Jan–Feb., 1933 | 8.58 | 4.56 | 14.67 | 9.63 |
| Average | 8.58 | 5.12 | 13.93 | 9.85 |

2. Multiply each equation by the coefficient of the first unknown in that equation and add the resulting equations. The sum is known as the First Normal Equation.

[2] See G. N. Bauer: Mathematics Preparatory to Statistics and Finance. New York, 1929. Macmillan.

These ratios should approximate closely those obtained from the concentrate assays and should differ from them only to the slight extent that the least square solution varies from a precise solution. But in reality the two sets of ratios differ considerably, and we are confronted with the anomaly that the galena in the crude ore is only slightly richer in silver than the chalcopyrite and only four times as rich as the sphalerite, whereas in concentrates derived from that ore the galena seems to be 13 times as rich as the chalcopyrite and 60 times as rich as the sphalerite. Furthermore, according to the crude-ore ratios, the galena contributes only 35 per cent of the silver, the chalcopyrite 47 per cent, and the sphalerite 18 per cent, whereas according to the concentrate ratios the galena should contribute 86 per cent, the chalcopyrite only 11 per cent, and the sphalerite only 3 per cent. Obviously, *the original premise that all the silver in this ore is contributed by the base-metal minerals is wrong*, and the crude ore must contain a silver mineral (or minerals) that is associated with chalcopyrite and sphalerite but that is floated with galena during concentration. As indicated by a microscopic examination of the ore, whatever silver minerals are present are submicroscopic in size, and they are evidently supergene minerals, for it is highly improbable that hypogene particles of such size can be liberated by crushing in an amount large enough to permit a notable change in the mineral association of the silver during concentration. The galena contains the usual minute dots of another mineral, which by analogy with the experimental results obtained by Nissen and Hoyt[3] is believed by some geologists to be a silver mineral, but these dots are much too small to be liberated in any appreciable amount even by the finest grinding used in milling operations. In the freshest Ground Hog ore mined to date, however, much of the chalcopyrite and sphalerite has a thin black chalcocitic tarnish or coating. This coating, and the sphalerite itself, would be ideal precipitants of supergene silver; the tarnished and coated surfaces would be ground together during the several stages of crushing and grinding of the ore preparatory to the flotation treatment, and the particles of supergene silver minerals in the coatings would tend to be rubbed loose. Once loose, they would come under the influence of the flotation reagents and would be driven into one of the base-metal concentrates, the particular concentrate being determined by the details of the flotation treatment.

If this explanation is valid, the implications are important. Obviously neither set of calculated ratios indicates by itself true conditions in *untarnished* ore. The silver-lead ratio calculated for the crude ore may be accepted for untarnished ore, however, because the supergene silver is associated with chalcopyrite and sphalerite; likewise the silver-copper and silver-zinc ratios as determined for the concentrates may be con-

[3] A. E. Nissen and S. L. Hoyt: On the Occurrence of Silver in Argentiferous Galena Ores. *Econ. Geol.* (1915) **10**, 172–179.

The quantitative determination of these features is not practicable in any other way.

At the Ground Hog mine, half of the average silver content of the ore mined during a particular 9-month period was contributed by submicroscopic supergene silver minerals two-thirds of which was associated with chalcopyrite and one-third with sphalerite, only a third of the total silver being contributed by galena; during concentration of the ore, however, the supergene silver minerals largely were driven into the lead concentrate, the practical result being that this concentrate contains over four-fifths of the silver in the mill heads.

## Acknowledgments

The writer is indebted to the officials of the Ground Hog mine for placing their records of production at his disposal and for permission to publish the assay figures given herein. He wishes also to acknowledge his appreciation to those with whom he discussed the problem, particularly to Dr. Sterling B. Talmage, Professor of Geology, R. H. Reese, Professor of Mathematics, and A. S. Walter, Professor of Ore Dressing, at the New Mexico School of Mines, and S. Power Warren, Professor of Ore Dressing at the Colorado School of Mines. Messrs. H. G. Ferguson, C. P. Ross and C. S. Ross of the U. S. Geological Survey read the manuscript and offered welcome criticism.

Chloride geology

Have made a prelim geologic map —

concentrating on the vein systems

---

Eastern part of area predominately granitic and dioritic

Pre ∈ int. rx

Western part — qtz-feld gneisses and amphibolites: (represent met. felsic & basic vol. rx.

Trend N — steep dips

These cut by a variety of dikes incl. pegs, qtz monz. lamprophyres (latter may be LARAMIDE)

Uncle ABE - 1944

oxidized vein

65° - 70° inclined

shaft (125')

opened on 50' Level

8' - 10' wide

Shipments in 1944

made from development

ran 8 - 9% Pb

10 oz Ag

0.09 Au

0.40 Cu

Tennessee - Schoolkill
↳ Schuylkill

50 gpm

1894 —

1917 USSR

| Heads | | |
|---|---|---|
| Au | 0.185 | 185 400 = $740.00 |
| Ag | 2.26 | 22.00 |
| Pb | 3.43 | 3.43 20 $30 = 68.60 |
| Zn | 5.15 | 5.15 20 = 103.00 |
| | | .4 = $41.2 |

96
30
41
$167.00

# Santa Fe Mining Inc.

INTERNAL CORRESPONDENCE

TO R. G. Marvin DATE March 25, 1983

FROM Wm. H. Crutchfield, Jr. SUBJECT 76.0360-II
Chloride Project

Subject: The Chloride Project ~~including~~ which includes the Minnesota-Connor Group and adjacent patented and unpatented lode claims ~~on~~ in the Chloride District, Mohave County, Arizona:

My long interest in the above district was ~~sharply~~ increased in mid-1982 through Mr. C. G. Patterson, Chloride, a prominent and successful Mohave County mining man whom I've known for over 25 years.

No 4 At that time he gave me his ~~heretofore proprietary~~ previously undisclosed file consisting of various reports and assay data ~~etc.~~ dating from 1902 through 1949 on the Minnesota-Connor Group consisting of one patented and seven unpatented claims located in the central part of the Chloride District. Mr. Patterson was then in the process of purchasing these claims from the estate of the last operator - a Russell Lord. In the past month Mr. Patterson has obtained the deed to these claims and is agreeable to giving Santa Fe Mining a first opportunity to negotiate within a reasonable time frame.

Based on two inspections of the claims and, in anticipation of Mr. Patterson's pending ownership, I instructed Exploration Research Associates several months ago to undertake, as time permitted, a reconnaissance emphasizing mapping of vein structures in relation to known or assumed claim boundaries. Attached is the map result of this effort with claim ownership outlined.

Also attached for background is Exploration Research Associates December 13, 1982 report sustaining my opinion that the district has "excellent potential for economic mineralization".

Reportedly no significant drilling has been done within the Minnesota-Connor Group. It should be noted that the deepest mining therein was from the steel-set 724-foot Pluto shaft circa 1917-1918. Apart from this depth (in sulfide ore) most of the past mining, ending ~~circa~~ in 1944, worked only shallow high grade silver-gold-lead supergene mineralization. The sulfide mineralization below the water table (approx. 100-feet) ~~has barely been~~ is essentially untested. The oxide-sulfide interface and the sulfide zone below will therefore be the primary objective of ~~our~~ the proposed drilling program outlined below.

A prime drill target (see attached map) is the Manzanita-Uncle Able mineralized zone some 2600-feet in length. In 1944 the Uncle Abe, from limited drifting in sulfides from a 125-foot shaft, reportedly made shipments assaying 8-9 percent lead, 10 oz. silver,

0.09 oz. gold, and 0.40 percent copper. (Keep these data together on same page)

Another primary target derived from the recent mapping by John Childs and Larry Bradfish of Exploration Research is an interesting intersection of untested NE-SW veins with the known NW-SE Pluto and Minnesota veins within the Connor North Extension claim. A 1923 report by a Kingman mining engineer, included ~~in~~ with the Patterson data, states for the district "---- I have generally found the ore shoots to uniformly dip ~~(sic. rake)~~ at rather flat angles to the north and to be materially influenced by crossing or intersecting veins and dikes ----"

A third target, initial budget permitting, would be the Jupiter mine area within Mr. Patterson's Times Square claims. Here Childs and Bradfish mapped several parallel veins within a zone width of approximatley 200-feet. (See ~~map~~ attached map).

Primary targets apart from Patterson ownership include the patented Altata, Cinco~~de~~ de Mayo, Silver Age, Silver Knight, and possibly the Johnny Bull end on with the past important producer (1600 foot depth) Tennessee Mine.

Cinco de Mayo

Assuming successful negotiations with Mr. Patterson or ~~pre-fectly~~ preferably before finalization, should the negotiation climate permit, a local mineral surveyor must be retained to locate all of the Patterson claims including his adjacent Times Square group. These must be adequately referenced to a bench mark net with elevations in order to permit subsequent large scale photogrammetry, subsequent geologic mapping and mine planning at a scale of 1-inch ~~equals~~ to 100-feet, and very importantly, permit Santa Fe Mining to file locations on existing open fractions between the several existing claims of importance. This survey could range from $5,000.00 to $10,000.00

Drilling costs (SANS PAUL EBY) of the above three primary targets are tentatively estimated at: ~~[illegible]~~ center on page

TARGET. 1. Manzanita - Uncle Abe

| | | |
|---|---|---|
| 10 core holes | | |
| 2500 feet | | |
| 2500 X $30.00 | = | $ 75,000.00 |

TARGET. 2. Minnesota North Ext.

| | |
|---|---|
| 6 core holes | |
| 5000 feet | $150,000.00 |

TARGET. 3. Times Square - Jupiter Mine

| | |
|---|---|
| 4 core holes | |
| 1600 feet | $ 48,000.00 |
| TOTAL | $273,000.00 |

SANTA FE

If results at Target 1 MANZANITA-UNCLE ABE prove up, negotiations for adjoining patents Altata, Conco de Mayo, Silver Age, Silver Knight and possibly Johnny Bull should be initiated. Of course there is the likely possibility that our drilling activity will draw attention to these adjoining patents and we may therefore be forced into negotiations for them prematurely. Acquisition cost of these will be determined by the acquisition cost of the Patterson claims.

Mining engineer supervision cost beginning with claim locations, establishment of baselines and bench marks, plus the actual drilling program is unknown at this writing. Our previous satisfaction with Chapman, Wood and Griswold suggests receiving an estimate from ~~them~~. that COMPANY.

Before, and during the drilling, Exploration Research should be involved in interpretative aspects of the program, including large scale mapping [redacted] with emphasis on vein geometry. This reinforcement of the program is estimated to cost $15,000.00

Again, depending on ~~on-going~~ favorable geologic results, as the program advances, aerial photography of the area of interest and preparation of a topographic map at a scale of 1 inch = 100 feet with a 5-foot contour interval should be made to facilitate detailed geologic mapping and subsequent mine ~~design~~ logistics and layout. This should be accomplished for an estimated $7,500.00.

In summary, excluding acquisition and mining engineering costs, the initial phases of the Chloride Project should ~~cost~~ amount to an estimated $300,000.00.

Respectfully submitted,

Wm. H. Crutchfield, Jr.

WHC:law

Attachments: 1) Expl. Research Minnesota-Connor Dec. 13, 1982 Report

2) JANUARY 15, 1983 Map showing approx. claim boundaries and vein structures in the Chloride Project area of interest. Ownership legend included.

3) Letter supplement to (2) above dated 14 January 1983.

SANTA FE

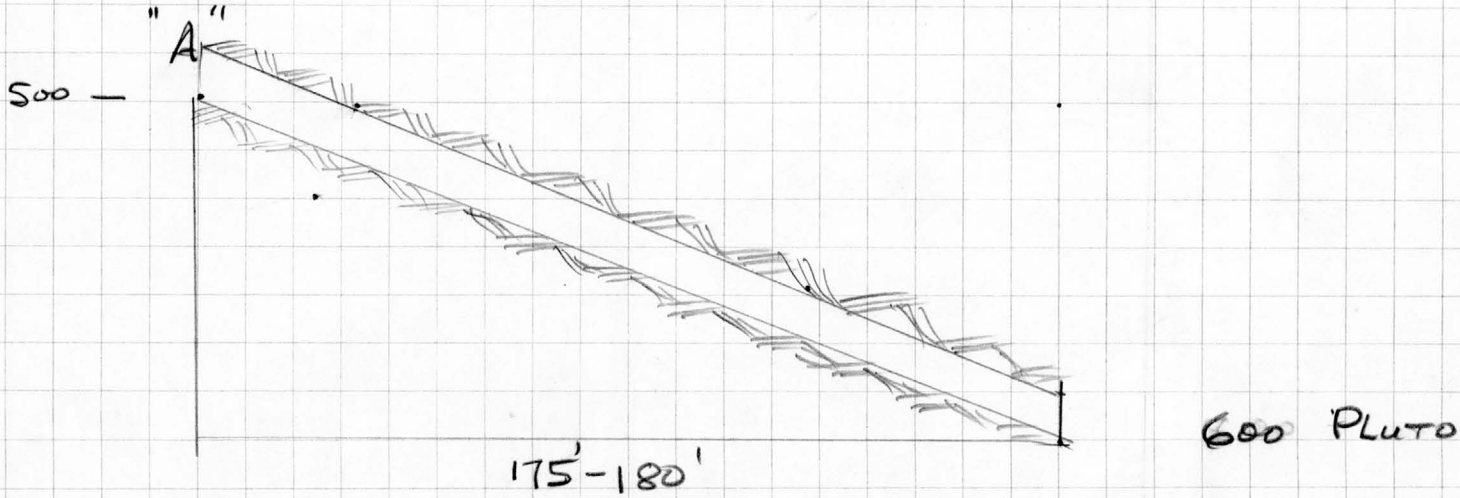
The following written in 1949
Pluto 724
Stations cut 600 & 700 levels

Some drifting North on 600 — ore was scattered
on 700 just cut the vein (38' width at that point and
lying west of the shaft.) ~~ok~~ good ore on FW
and some on HW but only started to drift on
the vein "when we were ordered to close down"

death of owner

~~death of owner~~

Area between 500 ~~ft~~ level of old "A" shaft
and 600 level of Pluto shaft was never explored;
it would represent about 175 or 180 feet on the
incline due to the slope of the hill, the collar
of the Pluto being 70 feet lower than the "A"



August 27, 1982
76.0360 II
Chloride Project

# Notes

Option / Lease - Purchase Agreement
w/ time to examine, and test the property

Length of option ?

Bond and Lease? Price & terms thereafter?

Uncle ABe ~~Mine~~ ~~Mine~~ Prospect

65°-70° Shaft @ Uncle ABe following
FW ~~for to depth~~ to TD of 125'.
It is opened on the 50'-level
and at bottom of shaft.
An Oxidized ore to that depth.

Vein 8'-10' in width

| | | | |
|---|---|---|---|
| 8%-9% | Pb | 160# @ | 43.20 |
| 10 oz | Ag | ~ | $70.00 |
| .09 oz | Au | ~ | $31.00 |
| 0.40 | Cu | 8# ~ | $5.00 |
| | | | $149.00 / T |

~~Therefore~~

Terms: Suggestion

1. No down payment or at most only a nominal payment $25,000.00
2. One year to sample, map, drill or do such other work that we might feel necessary before ~~and~~ undertaking to equip, ~~[illegible]~~, and mine the property

3. Payments by royalty, under 10 percent if possible, following the free period. Cash payments of $~~500.00~~ $1,000.00 per month to apply against royalty.

Another Suggestion: re items 2 and 3 above.

~~Second~~

2. At close of option period payment of cash in amount not to exclude staking fees – that is the amount the owner has put into the property in such a way as to help the buyer.

3. Monthly payments (applied to purchase price) equivalent to average wages until property is productive. Finally royalty payment based on sliding scale ranging from 2 to 10-percent depending on grade of ore.

Costs

Creede silver – $38/T cost shrinkage mining

~~$2,500,000 – 250 TPD Mill~~

Milling $18.00 /T

New 250 TPD Mill Cost $6,500,000

Mining 250 Days/yr

Milling 350 do

Shrinkage - T Per Man Shift _____

Cut & Fill

Square Set

NOTES

6'-15' in width — 450' length — 300' vertical depth

Tennessee

MAR 15 Prices

.05 oz/T Au = $428.50 = $21.50

3.50 oz/T Ag = $10.95 = $38.33

$59.83/T

0.004 ~~0.004~~ × 2000

0.4% Cu = 8#

1% = 20#

3.3% Pb = 66# @ $0.20 = $13.20/T

5.7% ZN = 114# @ $ ~~0.20~~ $0.38 = $43.32

$56.52

$56.52 + 59.83 = $116.35/T Gross Value

Need $150.00

17 claims — ~~Contr~~ Owned by C.G. Patterson

Strike NW — Dip 85° E

2 miles traceable

Sphalerite — galena

ore occurs in shoots in the vein which rake down to the north at 40°.

Test

Uncle ABE

Manzanita

Kingman

24 road miles

~~1600'~~ Aug 1944 1600'

last operators — 1944-1947 work done on higher ZN values 900 level so large ore body ~~to~~ south of Tenn shaft — virgin ground

early 1880's Barry

(2) Notes

Minnesota - Connor Mines, Inc. 1½ mi SE of Chloride

Uncle ABE

1944 operating

oxidized material -

65°-70° Inclined shaft following FW of vein

5.5
250
275°
110
Elevation 1375°

5½" 60 yrs before NW 1300' strike length

UNCLE ABE

Ore shoot - 200' in length

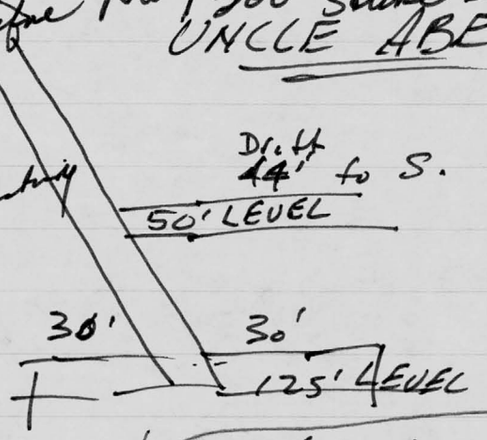
August 1944

Mining World

1944 =

Started operating in Dec '43

5 cars - oxidized ore




10'-12' vein width in places.?

Report

opens to surface (had to be to w) (~~must have been~~

Vein 8'-10' width

Shipments ran 8-9% Pb $.24/# x 160 = 38

10 oz Ag $10.00 $100

0.09 oz Au $350 31

0.40 Cu $.72 x8 = 5.76

~175.00

*Shaft bottomed in the lean area between the sulfides and the oxidized ores

Initially test drill NW-SE striking the Manzanita - Uncle ABE vein structure - outcrop length

See Attached MAP

and

Claim of Minnesota - Connor Mines, Inc.

MANZANITA - 1948

103 Tons shipping ORE Jan - Nov $856/T

AS&R

EL PASO

| | | | |
|---|---|---|---|
| 98 oz Au | 0.95 | Incline shaft | $380 - |
| 3,389 oz Ag | 32.9 | Two levels | $329 - |
| 2,032# Cu | 19.7 #/T | 100' | 14.75 |
| 20,128# Pb | 195 #/T | 150' | $39 - |
| 12,873# Zn | 124.9 #/T | Drifting 250' | $47.46 |
| | | | 856.46 |

③ Notes

1500' MANZANITA — ~~50' level~~

NW Strike length March 1942

6 x 250 = 1500
6 strike
00 length

Cleaned out 100' shaft
w/ 15' X-cut to vein
plus 35' drifting
July 1, 1942 — 1st shipment
15 shipments

Silver / gold ~~gold / silver~~ ratios.

all ore taken from within 100' of surface

total production

1½ miles SE of chloride

| | | |
|---|---|---|
| Au | 164.78 oz | 48:1 |
| Ag | 7873.45 oz | |
| Pb | 59,185 # | (29.52 tons) |
| Zn | 29,170. # | (14,585 tons) |
| Cu | 5035 # | (2.517 tons) |

Minnesota - Connor — 724' steel shaft
Ag cabinet specimens —

~~3000' from~~

* Habit of ore in shoots — characteristic of the district

use

Manzanita — 50' level assay
.09 Au $36.00
11.55 oz Ag $116.00
3.4% Cu 68# x .78 $53

128:1

TEST 1) Manzanita — Double ABC vein structure $200.00
totalling approx 2800' of strike length.

2)

(4)

Minnesota - Connor

Barry early 1880's

Developed ~~one~~ shoot from its ~~th~~ apex on the Connor (patented) to a depth of 300' on the Minnesota claim; this shoot raked north as it descended and @ 300' vertical depth it was well within the Minnesota boundaries.

Barry put up a small stamp mill which he operated

Oct. 28/1937 letter report P.S. Virgin

good history

Barry sold property in 1900 to the Philadelphia and Arizona Mining Co.

250 ton mill built 1900-1901

depth carried to 535' ~~level~~ in the Minnesota (incline) shaft and stoped down to the 400 level, the ore shoot being continuous along this 1000' or more feet in the rake of the shoots from its apex on the Connor to the 500' level of the most northerly shaft (A) of the Minnesota.

(see Jacobson 1913 MAP)

~~Enrichment~~

"little of any stoping below 400' level.

"On 400 and just above were considerable bodies of high grade ore as shown by assay data.

"Undoubtedly the increased enrichment at the 400 level was due to the union at that point to a parallel vein with the Minnesota vein, as our underground X-Cut in 1912 did not encounter this vein when we drove from the Pluto shaft into the old workings"

No

Jacobson 1923 Report

Note – RAKE OF SHOOTS: FLAT TO North
& influence of intersections

p. 4 Tennessee – "now about the only property worked below the 100' level.

Emphasize depth penetration & lack thereof.

Patterson
Minnesota-Connor Group
Chloride, Arizona

See Mn-Con re # of Claims including Dixie group by Pat

Interest in this group and ~~some~~ several ~~adjacent~~ adjoining lode claims was generated in mid-1982 through ~~receipt of some 25~~ Mr. C. G. "Pat" Patterson ~~of Chlor~~ of Chloride ~~at~~ whom I've known for over 25 years. Mr. Patterson, now in his late 70's gave me ~~privileged~~ here to fore ~~privileged~~ undisclosed information ~~including~~ made up of various reports, ~~and~~ assay data, ~~etc.~~ on the group dating from 1902 to 1949.

~~Mark Liggett and Exploration Research Associates and I made~~ A ~~one day~~ reconnaissance ~~of the area~~ of the claims ~~Minnesota-Connor group shortly thereafter increased my interest. However Mr. Patterson showed strong located in the central portion of the Chloride Distrib~~, showed that these claims covered ~~were covering~~ several of the main vein systems in the central portion of the Chloride

District and in my opinion ~~were~~ merited ~~worthy of~~ further reconnaissance ~~study~~ mapping and sampling. ~~Since then~~

To date a ~~map~~ claim map (attached) ~~with~~ showing ~~the~~ numerous ~~strong~~ outcrops ~~within the various claims~~ has been derived from a few days of field work by geologists of Exploration Research Associates. John Childs and Larry Bradfish.

~~Dete~~

~~Since the Minnesota-Connor group~~

~~If~~ ~~Mr.~~ Until ~~very recently~~ the past month Nothing more than ~~reconnaissance~~ recon ~~cursory~~ study of the claims was possible since Mr. Patterson's pending purchase of the claims was ~~slowed by~~ ~~tied up in~~ ~~Probate~~ probate ~~Court~~ action. ~~However~~ Mr. Patterson has ~~just~~ now received ~~the~~ deeds to the seven lode claims comprising ~~the Minnesota~~ ~~[illegible]~~ group and has informed me that he ~~[illegible]~~ ~~would like to be negotiate with Santa Fe Mining~~ is willing to enter negotiations with Santa Fe Mining. ~~It~~ should be added ~~for negotiation purposes~~ that Mr. Patterson also owns a ~~contiguous group of~~ five lode Times Square group ~~five lode claims known as the Times Square~~

7 claims one patented 6-unpatented

five contiguous lode claims southeast of the Minn Co Group known as the Times Square group that should be included in ~~the said~~ the negotiations.

In my opinion I believe the Patterson holdings represent a quality prospect. ~~worthy of exploration~~

~~No~~

~~To my knowledge~~

No ~~significant~~ exploratory drilling has been performed along the strong vein ~~exposures~~ outcrops within the Patterson claims. ~~The deepest vertical penetration made in 19 has been the steel-set Pluto shaft at 724 feet on the~~

to my knowledge

The deepest mining was from the ~~724 fo~~ 724-foot steel-set ~~the~~ Pluto shaft circa 1917-1918. It should be noted that most of the past mining on the claim group, ending in 1944, worked only shallow high grade silver-gold supergene mineralization; the deeper sulfide mineralization ~~around 100 feet~~ below the water table, ~~has~~ (around 100-feet) has generally not been tested.

Tennessee, 1600 Golconda

~~It~~ ~~This~~ ~~such~~ Shallow mining within the Patterson claims is typified by ~~is typical of~~ the Manzanita - Uncle Abe vein ~~some~~ some 2800 feet in length and varying from ~~54~~ to 10 feet in width. ~~In the close of operations in~~ 1944 the Uncle Abe shaft ~~was at 125~~ had ~~only~~ been sunk only to the 125-foot level.

exposed and interpretive

see Min-Con Report - zones - Uncle ABE - Manzanita.

A ~~report~~ 1944 World Mining news item ~~in~~ re the Uncle Abe reported a vein width of 8 to 10 feet

"and ~~and~~ shipments made from development ran from 8 to 9 percent lead, 10 ~~ounces~~ oz silver, 0.09 oz gold and about 0.40 percent copper".

~~¶ It is my plan to test drill the Manzanita - Uncle Abe ~~other~~ mineralization~~

Tennessee - Golconda

¶ The shallow Manzanita - Uncle Abe is high priority.

See Childs-~~Fish~~ Bradfish ~~Tim~~ outline

¶ other targets —
E-W structures with NW trends
NW of Pluto shaft.

¶ Times Square - Jupiter Mine vein structural zone

~~¶ Survey - claims~~

~~¶ In summary~~

Primary Patterson Group

¶ The northwest striking Manzanita - Uncle Abe vein structure represents a primary ~~and~~ ~~ab initial~~ drilling target. Another primary target ~~within~~ is the recently Childs-Bradfish mapped juncture ~~area of an east-west~~ of an northeast - ~~southwest~~ vein system with the northwest Minnesota - Connor / Pluto veins. ~~This fracture intersection~~ Past mining history ~~although drifting north from the 700-foot level toward this intersection was reconnoi~~

Introduction and Primary Objectives



~~A third Another primary target within the group Patterson ownership would~~

within the district showed tonnage and grade enhancement at vein inflections and intersections.

A third area of interest is in the Jupiter mine area ~~held by Mr. Patterson~~ within ~~one~~ one of Mr. Patterson's Times Square claims. Here Childs and Bradfish mapped ~~a series zone of veins~~ of several parallel veins within a ~~a narrow width of 200 feet~~ zone width of 200 feet.

¶ Primary targets outside of Patterson's holdings consist of the ~~New Yorker owned~~ patented Altata, ~~and~~ Cinco de Mayo, (~~see claim map~~) ~~claims and~~ Silver Age, ~~Cla~~ Silver Age, and possibly the Johnny Bull claims.

Minnesota-Connor Times Square

~~¶~~

Plan of Action

1. Negotiate with Mr. Patterson for his Minnesota-Connor and Times Square groups totalling ~~17~~ 1 patented and 16 unpatented claims. ~~Suggest both both Mr. Trubey~~

~~2. Providing negotia~~

2) Providing negotiations are satisfactory to Santa Fe Mining the above ~~claims holdings should be retracted~~

see p. 5

15 February 1983

**RECOMMENDATIONS FOR ADDITIONAL WORK ON AND ADJACENT TO LANDS CONTROLLED BY PATTERSON/LORD, CHLORIDE DISTRICT**

DIXIE CLAIMS
Jupiter under lease by Patterson

**CHLORIDE**

**I. Introduction**

(A) Properties are assigned priority for drilling within three groupings as follows:

1) Lands controlled by Patterson/Lord

2) Lands recommended for acquisition other than Patterson/Lord claims

3) Combined lands - from geological, economic standpoint

(B) The following criteria have been used in assigning properties priority:

1) Production history

2) Tenor of ore and analytical results

3) Strike length and width of vein and alteration envelope

* Verbalize & tape
C. G. Patterson

4) Structure

5) Accessibility

6) Tenor of ore versus depth

7) Land availability and strategic importance

## II. Patterson-Lord Claims

(A) Manzanita - Primary target

(B) Uncle Abe - Primary target

(C) Minnesota-Conner/Pluto - Secondary target 724'

(D) Hidden Treasure - Secondary target

(E) Jupiter - Secondary target

(F) Manzanita Extension - Secondary target

(G) Grant 120/62N - Tertiary target

(H) Motherlode - Tertiary target

(I) Dorothy - Tertiary target

## III. Lands Recommended for Acquisition Other Than Patterson/Lord Claims

(A) Silver Age - Primary target

(B) Altata - Primary target

(C) Johnny Bull - Primary target?

(D) Emerson/Hamlin - Secondary target - high in Au 0.6 w/ Py

(E) Lone Jack - Secondary target

(F) Blackfoot Claims - Secondary target Bob Dixon - Chloride

## IV. Combined Lands

geologic on - economic basis

(A) The following is a list in order of priority of all drilling targets including lands controlled by Patterson/Lord and lands recommended for acquisition. Priority in this section does not take into account land availability.

1. <u>Primary Targets</u>

a) Manzanita

b) Uncle Abe

c) Silver Age

d) Altata

e) Johnny Bull - Optional 600'-900' intercepts

2) <u>Secondary Targets</u>

a) Minnesota-Conner

b) Hidden Treasure ADITS.

c) Jupiter - chip sampled.

d) Emerson - 50oz Ag .5% ZN Pb .3%
High Au in Pg - Stoped to surface 2'-3' wide vein

e) Manzanita Extension (North)

f) Lone Jack/Blackfoot chip sampled - Patterson mined, good ore

3) <u>Tertiary Targets</u>

a) Grant

b) Motherlode

c) Dorothy

## V. Mineral Surveying

(A) A registered mineral surveyor will be required prior to preparation of a topographic map or completion of land acquisition.

1) Objectives:

a) Reoccupy and survey existing claim corners.

b) Relocate claims for which corners cannot be found.

c) Establish aerial control points which as much as possible should coincide with claim corners.

2) Contractor Cost: $5,000 to $12,000

(rough estimate)

Inter Mountain Aerial
Salt Lake

* Devlin Associates
Kingman
Mineral Survey

JACK M. KESLER
P.O. Box 48
Kingman
US Mineral Surveyor

On going



**VI. Phase I Geologic Evaluation** (Prior to preparation of a topographic base map at 1" = 100')

A. Tasks

1) Prepare and examine thin sections on approximately 12 key rock types from the Chloride district

Bek Mts

| | |
|---|---|
| Geologists: 4 man-days | $1,428.00 |
| Direct Costs | 120.00 |
| | $1,628.00 |

2) Examine some of the more important mines in the Chloride district adjacent to properties already examined. This work will include brief examination of the following area:

Bek Mts

| | |
|---|---|
| Payroll | Midnight |
| Tennessee-Schuylkill | Towne |
| New Tennessee | Georgia |

Geologists: 5 man-days $1,785.00

3) Examine structural setting of the ore shoots and veins on the properties already examined in reconnaissance. Attempt to establish structural criteria for predicting

Bek Mts

the occurrence and geometry of ore shoots.

Geologists: 8 man-days $2,856.00

4) Sampling

a) Collect assay samples from additional mine workings and veins

semiquantitative - trace elements - Arsenic -

b) Collect E-spec samples from various rock types in and adjacent to the area already examined

| | |
|---|---|
| Geologists: 8 man-days | $2,856.00 |
| Assay samples | |
| (30 at $17.10/sample) | 513.00 |
| Emission Spectrometer<br>E-spec samples | 450.00 |
| | $3,819.00 |

Must be done

5) As part of Items 1 to 4 above, existing claim corners and key points in workings and along veins should be identified for inclusion in the mineral survey and aerial photography planned for the area of interest.

**Other Direct Costs for Items 1 through 5 above:**

| | |
|---|---|
| Per diem 15 days at $40/day | $600.00 |
| Mileage LA/Kingman/LA | 134.00 |
| (670 miles at $0.20/mile) | |
| Field vehicle mileage | |
| (1050 miles at $0.35/mile) | 367.00 |
| | $1,101.00 |
| TOTAL FOR TASK VI | $11,109.00 |

Don't need before initial phase I drilling —



## VII. Preparation of Topographic Maps of the Area of Interest

(A) A one-mile by two-mile area will be covered extending roughly from the Johnny Bull Mine on the north to the Pinkham Mine on the south and from the Towne Mine on the west to the Hidden Treasure (extension) Mine on the east.

(B) **Tasks**

1. Set up aerial control markers on all surveyed points as requested by aerial survey firm and on surveyed or critical points at existing workings.

| | |
|---|---|
| 3 Geologist man-days: | $1,071.00 |
| Materials: | 200.00 |
| | $1,271.00 |

2. Aerial photography of the area of interest and preparation of a topographic map at a scale of 1 inch = 100 feet with a 5-foot contour interval. Data products will include reproducible inked maps,

one set of 9x9-inch color aerial photographs and one set of reproducible orthophotographs.

Contractor: Aerial survey firm

6 firm estimate

$3,500 to $10,000

$5000.00

Don't need before initial Phase I drilling



**VIII. Phase II Geological Evaluation** (After preparation of a topographic base map at 1" = 100')

(A) **Tasks**

1) Remap the veins which have been proposed as primary and secondary drilling targets with particular attention to structural setting and geometry of veins.

Geologists: 20 man-days $7,140.00

2) Prepare a geologic map of the area of interest in the Chloride district at the scale of 1 inch = 100 feet

Geologists: 35 man-days $12,495.00

**Direct Costs for Items 1 through 2 above:**

| | |
|---|---|
| Per diem 25 days at $40.00/day | $1,000.00 |
| Mileage: LA/Kingman/LA | |
| (2 trips 1340 miles at $0.20/mile) | 268.00 |
| Field vehicle mileage | |
| (1875 miles at $0.35/mile) | 656.00 |

| | |
|---|---|
| Reproduction costs | 800.00 |
| TOTAL FOR TASK VIII | $22,359.00 |

## IX. Phase I Drill Targets

(A) Manzanita Mine

— Start with oxide/sulfide interface

1) 3-4 drill sites

where is raking orebody?

2) 7 drill holes

3) Drill intercepts range in depth from 75-175 feet down dip from surface exposure of the vein

4) Total footage = 1405 feet

(B) Uncle Abe Mine

125' transition zone

1) 3 drill sites

2) 6 drill holes

3) Drill intercepts range in depth from 70-200 feet down dip from surface exposure of vein

4) Total footage = 887 feet

(C) Silver Age Mine

1) 3 drill sites

3 @ 250'
2 @ 350'
1 @ 600'

2) 6 drill holes

3) Drill intercepts range in depth from 250-600 feet

down dip from surface exposures of the vein

4) Total footage = 2,219 feet

(D) Altata Mine

get below enrichment blanket of cu

1) 2 drill sites

ignoring oxide ore.

2) 4 drill holes

3) Drill intercepts range in depth from 210-300 feet down dip from surface exposures of the vein

4) Total footage = 1050 feet

(E) Johnny Bull (optional)

1) 3 drill sites

2) 6 drill holes

3) Drill intercepts range in depth from 600-900 feet below surface exposures of the vein

4) Total footage = 3607 feet

## X. Drilling Program

### (A) Site Selection and Survey

| | |
|---|---|
| Geologists: 8 man-days | $2,852.00 |
| Direct Costs | 538.00 |
| | $3,390.00 |

### (B) Excavation and Drill Pad Preparation

| | |
|---|---|
| Geologists: 4 man-days | $1,426.00 |
| Bulldozer and other Direct Costs | 3,004.00 |
| | $4,430.00 |

### (C) Drilling

| | |
|---|---|
| Core drilling: 5560 ft at $30/ft | $166,800.00 |
| Drilling support charges CAMERA stand by time | 2,575.00 |
| Geologists: 14 man-days | 4,991.00 |
| Direct costs | 854.00 |
| Assays (230 samples at $17.10/sample) | 3,933.00 |
| Splitting and shipping samples (split cores 10 samples per hole) | 872.00 |
| | $180,025.00 |

(D) Data reduction and report preparation

| | |
|---|---|
| Geologist: 84 man-days | $29,948.00 |
| Direct Costs | 900.00 |
| | $30,848.00 |
| TOTAL FOR DRILLING PROGRAM (TASK X) | $218,694.00 |
| Mineral Survey | 10,000 |
| TASK VI | 11,109 |
| TASK VII | 6,271 |
| TASK VIII | 22,359 |
| TASK IX | 218,000 |
| Grand Total | $ 268,433 |
| Grand Total with Johnny Bull - | $345,000 |

## XI. BENEFICIATION STUDIES