CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
416 W. Congress St., Suite 100
Tucson, Arizona 85701
520-770-3500
http://www.azgs.az.gov
inquiries@azgs.az.gov

REPLY TO:

2940 N. CASA TOMAS
PHOENIX, ARIZONA 85016
TELEPHONE (602) 277-6053

Richard E. Mieritz
MINING CONSULTANT

ARIZONA REGISTERED
MINING ENGINEER AND GEOLOGIST

GEOLOGY
EXPLORATION
EVALUATION
FEASIBILITY
OPERATION

September 4, 1985

Mr. Sam A. Bittner
12076 Jackson Street
Omaha, Nebraska, 68154

Re: Monte Cristo

Dear Mr. Bittner:

Thank you for your letter of August 28, 1985, enclosing your check #012 to my order as well as the results of the samples you had analyzed by Princeton Testing Laboratory.

I am however returning your check in as much as it is incompletely filled out. Even if the bank would accept it, I would not cash same. Please complete the written portion of the amount and return to me at your earliest convenience.

As regards the amount of my INVOICE dated July 15, 1985. On June 27th I advised you requesting an advance to pay for the required assaying/testing. I requested $200.00. You then asked me how much you owed me--I replied I would send you a bill when the work was completed--to which you answered let me pay you now, so as of that moment--the amount was $600.00--FOR 4 hours on June 25th and a full day in the field on June 26th. This amounts to $200.00 for the 25th and $400.00 for the 26th. I also advised you there would be additional time, but I would not be able to estimate same. The balance of the time spen was in sample preparation, sample delivery and preparation of Report and Maps which you received about mid July.

You will recall we used my transportation to travel to the property--for which you were not charged--such as others might have done.

Return of the completed check would be appreciated.

Sincerely yours,

R. E. Mieritz,
Mining Consultant

REPLY TO:

2940 N. CASA TOMAS
PHOENIX, ARIZONA 85016
TELEPHONE (602) 277-6053

Richard E. Mieritz

MINING CONSULTANT

ARIZONA REGISTERED
MINING ENGINEER AND GEOLOGIST

GEOLOGY
EXPLORATION
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OPERATION

July 15, 1985

Mr. Sam Bittner
Monte Cristo Mining Corp.
12076 Jackson Street
Omaha, Nebraska, 68154

INVOICE

For Professional Services Rendered in connection with discussion, property visit and sample preparation and preparation of letter Report of Sample Analysis on the Monte Cristo Pegmatite property, Yavapai County, Arizona as authorized by yourself on June 26, 1985.

Office time,	June 25, Conference,	4 hrs.		
	July 1, Sample Prep.	2½ hrs.		
	July 8, Report Prep.	4 hrs.		
	July 13, Report Prep	3 hrs.		
	July 15, Map Prep.	2 hrs.		
Total Hours		15½ hrs	@ $50.00/hr. =	$ 775.00
Field time, June 26, 1 day @ $400.00/day			=	$ 400.00
TOTAL FEE				$1,175.00

Out of Pocket Expenses

Iron King Assay Office			$ 48.00	
Pacific Spectrochemical			$ 152.00	
Postage Sam Bittner	$ 12.85			
Pacific Spectro	$ 2.40	=	$ 15.25	
Telephone Iron King	$ 3.75			
Pacific	$ 6.15	=	$ 9.90	
				$ 225.15
Total Amount due				$1,400.15
CREDIT--Your check #001, June 27, 1985				$1,000.00(-)
Balance due.				$ 400.15

Please Remit to R. E. Mieritz at above address.

Amount Due is payable upon receipt of Invoice.

012

91-2/1221

Aug 28 1985

PAY TO THE ORDER OF Richard Mrinitz $ 400 ^{15}

DOLLARS

VALLEY NATIONAL BANK
43RD AVENUE - THOMAS ROAD OFFICE (079)
P. O. BOX 2947
PHOENIX, ARIZONA 85062 (12-84)

Movile Crafty Mem
Sam A Betham

⑈000012⑈ ⑆122100024⑆ 0015⑉9214⑈

A

GEOLOGIC EVALUATION

REPORT

on the

Monte Cristo Pegmatite Mine

Weaver Mining District

Yavapai County, Arizona

by

Richard E. Mieritz
Mining Consultant
Phoenix, Arizona

May 22, 1979

TABLE of CONTENTS

Included Exhibits:

INTRODUCTION:

At the request of and authorization by Mr. Chet Cheatwood, President of Verde Products, Inc., an Arizona corporation with offices in Phoenix, the writer personally visited and examined the Monte Cristo Mine (Monte Cristo claims) in Yavapai County, Arizona, on May 19, 1979 for the purpose of observing the pegmatite mineralization within the claimed boundary.

This report is based on the writer's field observations and the writer's knowledge of pegmatite mineralization within a recognized geologic pegmatic zone extending from Morristown to Kingman, Arizona, and beyond. The writer has examined several pegmatite properties within this zone. The writer also had access to earlier reports on the property by Einar C. Erickson and Robert Raabe.

Registered Professional Engineer (Mining)
CERTIFICATE EXPIRES
RICHARD E. MIERITZ
DEC. 31, 19
ARIZONA, U.S.A.

PROPERTY, LOCATION and ACCESSIBILITY:

The property consists of fifteen (15) standard lode mining claims, Monte Cristo #1 through #15, which are mostly located in the southern half of Sec. 34, T. 12 N., R. 5 W. and the northern quarter of Sec. 3, T. 11 N., R. 5 W., G. & S. R. B. & M., Yavapai County, Arizona. Mr. Cheatwood advises these claims have been filed with the U.S. Bureau of Land Management, Phoenix, Arizona, as required by Federal law. This action plus the observed development and assessment work completed on the property should establish the claims as a legal entity. (Map No. 3)

The property is accessible by passenger automobile. From Phoenix, travel northwesterly to Wickenburg, turn northerly on U.S. Highways 89 and 93, following Route 89 to Yarnell. (Route 93 heads northwesterly to Kingman, Arizona.) From the Ranch House Cafe in Yarnell, travel northeasterly on Route 89 to a gravel road junction 6.7 miles distant. Turn north, or left, onto the ranch type road and travel 1.6 miles to a "Y". At this point, bear left and continue for 1.7 miles to another "Y". Here, bear right and continue for 1.5 miles to a locked gate, through gate and 0.2 miles to third "Y" at which point, bear right for 0.2 miles to the pit. (See Maps No. 1 and 2.)

HISTORY, DEVELOPMENT and PRODUCTION:

The property dates back to 1917, when the pegmatites were mined for the beryl content. In the early 20's, the property produced mica. In the late 20's, more beryl and some euxenite (a mineral containing yttrium, erbium, cerium and uranium) were mined. After a long idleness, a mica mill was erected in 1947 and mica produced. This development consisted of a vertical shaft, an adit and some surface mining. Renewed beryl activity in the early - mid seventies saw a drilling exploration program completed. The results of this work appear to be difficult to obtain.

In 1975, Mr. Chet Cheatwood relocated the then "Dixie Queen" claims to the present Monte Cristo claims. Since then, 300 tons of mica have been mined and sold to Buckeye Mica Mill, Buckeye, Arizona. Feldspar has also been mined for test work (100 pound to 1/4 ton lots). This test work by Westwood Ceramics, Hiway Ceramics, Bice, etc. has shown the feldspar to be of high quality and purity, more so than the North Carolina feldspar currently supplying the California market.

Mr. Cheatwood has done much pre-mine work to prepare the available feldspar "ore" for mining and production on a scale to make the venture profitable. To further enhance the operation, negotiations are under way to purchase the now idle "feldspar" crushing and pulverizing mill at Kingman, Arizona.

CLIMATE and FACILITIES:

Except for a few days during the "rainy" period and the winter season, year round operation of the mine can be expected.

The mine workings are at an elevation of 5,000 feet.

No gas or electricity are available at the property. A rancher's stock watering well is a short distance from the workings.

REGISTERED GEOLOGIST
CERTIFICATE NO.
7784
RICHARD E.
MIERITZ
Date Signed
ARIZONA, U.S.A.

GENERAL GEOLOGY:

Arizona has a northwest trending zone of 50 to 70 miles in width which has many occurrences of pegmatite structures as veins, blobs, pipes and irregular masses. All these can be of small, medium or large volumes. This zone extends from Morristown - about 40 miles northwest of Phoenix - to Kingman and beyond towards Hoover Dam. (See Map No. 2.)

Pegmatites, in general, geologically are considered the "trash can" of mineralization because pegmatites usually are composed of high temperature minerals and elements not commonly associating themselves with the more common base and precious metals of lead, zinc, copper, gold, silver, etc.

Pegmatites are usually composed of, but not limited to, silica (quartz), feldspars (sodium and/or potassium), beryllium minerals, mica (biotite and/or muscovite), columbium, tantalum, titanium and many rare earth metals - minerals. The size, shape, geographic location nor the structural mode have any great influence on the composition or the constituent quality and/or quantities of any particular pegmatite deposit.

LOCAL GEOLOGY and MINERALIZATION:

The claimed area hosts the widespread pre-Cambrian granite which is part of the Bradshaw Complex common to the area. Most of the granite is "fresh" rock, however, some decomposition has occurred in local areas. Isolated islands of Yavapai schist are also present. (See Map No. 2.)

Here, within the claimed area, a moderate size pegmatite deposit has been moderately explored and developed. This deposit is located on

Monte Cristo #1 and #9 claims. (See Map No. 3.)

The major constituents of this pegmatite deposit are potash and soda feldspars, silica (white-gray, sometimes tan quartz), mica (muscovite, usually silvery of small to quite large plates) and beryl mineral most frequently in large crystal form.

Registered Professional Engineer (Mining)
CERTIFICATE EXPIRES
RICHARD E. MIERITZ
DEC. 31, 1974
ARIZONA, U.S.A.

DEVELOPMENT:

The deposit is developed by an Adit, several surface pits and trenches and more recently by surface excavation resulting in a vertical face exposure of 40-45 feet in height and some 300 feet in length. (See Photo.) The owner states two other Adits and two vertical shafts exist but are not accessible now.

The writer has surface mapped the deposit (Map No. 4) and checked the geological underground mapping as completed by R. Raabe (Map No. 5). The shaft shown on this map is not accessible - being filled by the recent work. A second shaft to the north also is not accessible. The depths are reported as 50 and 30 feet respectively. The two inaccessible Adits are located some 40 feet vertically below the present "bench" - flat area in the pit - and to the north - being driven to the south. It is reported that the pegmatite was intersected with these Adits.

ORE RESERVES:

Pegmatites, unlike base or precious metal deposits, where samples can be taken and assay contents or values obtained, must be visually examined and estimated. The mineral contents (quartz, feldspars, micas, beryl, etc.) must be visually estimated. Such estimates will vary from engineer-geologist to engineer-geologist, dependent on his knowledge and experience with pegmatites. The end result is that an ore reserve estimate is that - an estimate. However - the more the pegmatite is "opened" for visual examination, the more accurate the estimate will be.

Fortunately, the contained minerals in this deposit are very clearly distinguishable and identifiable by sight. Then too, the development thus far has exposed many faces for the "appraiser" to examine.

Ore Reserve classifications are defined as "Proven or Measured" (positive information in all directions), "Indicated" (positive information in some directions) and "Inferred" (geologic projections based on geologic evidence of the "known" mineralization).

The degree of development at the Monte Cristo deposit does not have sufficient "evidence" to classify an ore reserve into "Measured" except in a small, meaningless way. The degree of development at the deposit is more than required for "Indicated" ore. Thus, a situation exists which is midway between the two classifications and this reserve the writer designates as "Measured - Indicated". The second classification used here is "Inferred."

Map No. 4 (Surface Geology of the Deposit) suggests a deposit of near rectangular shape with surface dimensions of 250 feet in length and an average 100 feet in width. The vertical bank in the pit (See Photo) is estimated as 40 feet and the surface in the middle of the deposit about another 10 feet, say an average of 45 feet. To this figure, 15 additional feet should be added for the material below the present pit floor level. The two inaccessible shafts are reported (Erickson's Report, 1956) as having penetrated the pegmatite 30 to 50 feet below their collars.

The "block" thus has dimensions of 250 feet long, 100 feet wide and 60 feet deep or thick. These figures multiplied for volume and divided by 12 (cubic feet per ton in place) results in 125,000 tons. (See Map No. 4.)

The lower two inaccessible Adits are also reported as encountering the pegmatite deposit. It is therefore reasonable to assume by inference that a "block" of similar dimensions could exist below the above described "Ore Block" and in the amount of a similar tonnage - 125,000 tons. (See Map No. 5)

The writer thus credits the present pegmatite deposit with:

Measured - Indicated	- 125,000 tons
Inferred	- 125,000 tons

The pegmatite zone is in surface evidence for some 500 feet in a southwest direction but has not been explored, thus opening the way for additional potentials.

The pegmatite is composed of four recoverable, marketable minerals, namely, feldspars, quartz (silica), mica and beryl. The percentage of these minerals in pegmatites varies considerably deposit to deposit AND within any specific deposit. Based on the evidence observed by the writer during the visual examination of same, it is the opinion of the writer that the deposit will have the following mineral content average percentages.

Feldspars	70.0%
Silica	25.0%
Mica	3.5%
Beryl	1.5%
	100.0%

In the "Measured - Indicated" ore block there could be - in place:

Feldspars	87,500 tons
Silica	31,250 tons
Mica	4,375 tons
Beryl	1,875 tons
Pegmatite	125,000 tons

Registered Professional Engineer (Mining)
CERTIFICATE EXPIRES
RICHARD E. MIERITZ
DEC. 31, 19
ARIZONA, U.S.A.

MINE OPERATION:

Mr. Cheatwood states his objective is the production of feldspar - to mine, transport, mill in Kingman, Arizona and bag, marketing the final product for $90.00 per ton.

Simultaneous mining of the silica, mica and beryl would provide stockpiles of these minerals for future milling and marketing of a saleable product.

Mr. Cheatwood also states he is assured of a feldspar mining contract by experienced feldspar miners at $6.00/ton, mined and loaded into trucks. Other minerals would be mined and stockpiled for $3.00/ton.

A trucking charge contract to Kingman is indicated as being $13.00/ton - 10¢ a ton mile.

The milling cost at the Kingman plant has not been determined but the writer would estimate a $20.00/ton actual cost, not including capital cost writeoff.

VALUE in PLACE:

It has been estimated that 87,500 tons of feldspar exist. With an 85% mining efficiency projected, there should be 74,375 tons of recoverable feldspar. With a market price of $90.00/ton (Kingman), the "in place" value is $6,600.000.-.

The E.&M.J. April quotes for the other mineral commodities (minimum figures, specifications and price in each case) are:

Silica:	$35 - 46.00/ton, 50 lb. bags
Mica:	$30 - 35.00/ton, scrap
Beryl Ore:	$50 - 55.00/STU (1%), for 10-12%

The above "by products" could further enhance the "in place" value $2,160,000.- or a total of $8,800,000.- for the "Measured - Indicated" ore block.

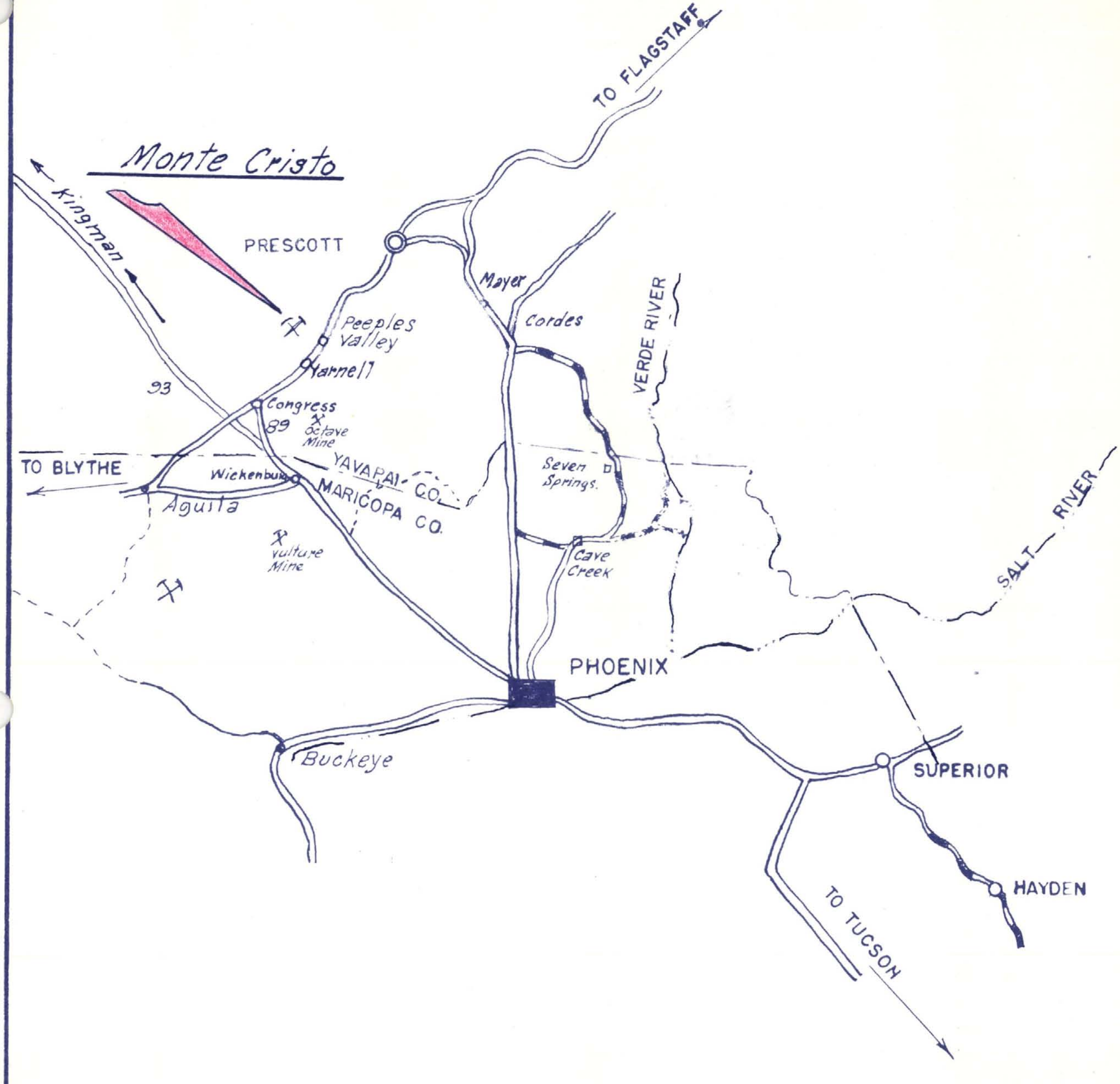
Respectfully submitted,

Registered Professional Engineer
CERTIFICATE EXPIRES
RICHARD E. MIERITZ
DEC. 31, 19
ARIZONA

REGISTERED GEOLOGIST
CERTIFICATE NO. 7784
RICHARD E. MIERITZ
Date Signed
ARIZONA, U.S.A.

R. E. Mieritz
Mining Consultant
Phoenix, Arizona

May 22, 1979



Registered Professional Engineer (Mining)
CERTIFICATE EXPIRES
RICHARD E. MIERITZ
DEC. 31, 19 66
ARIZONA, U.S.A.

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R.E.M.

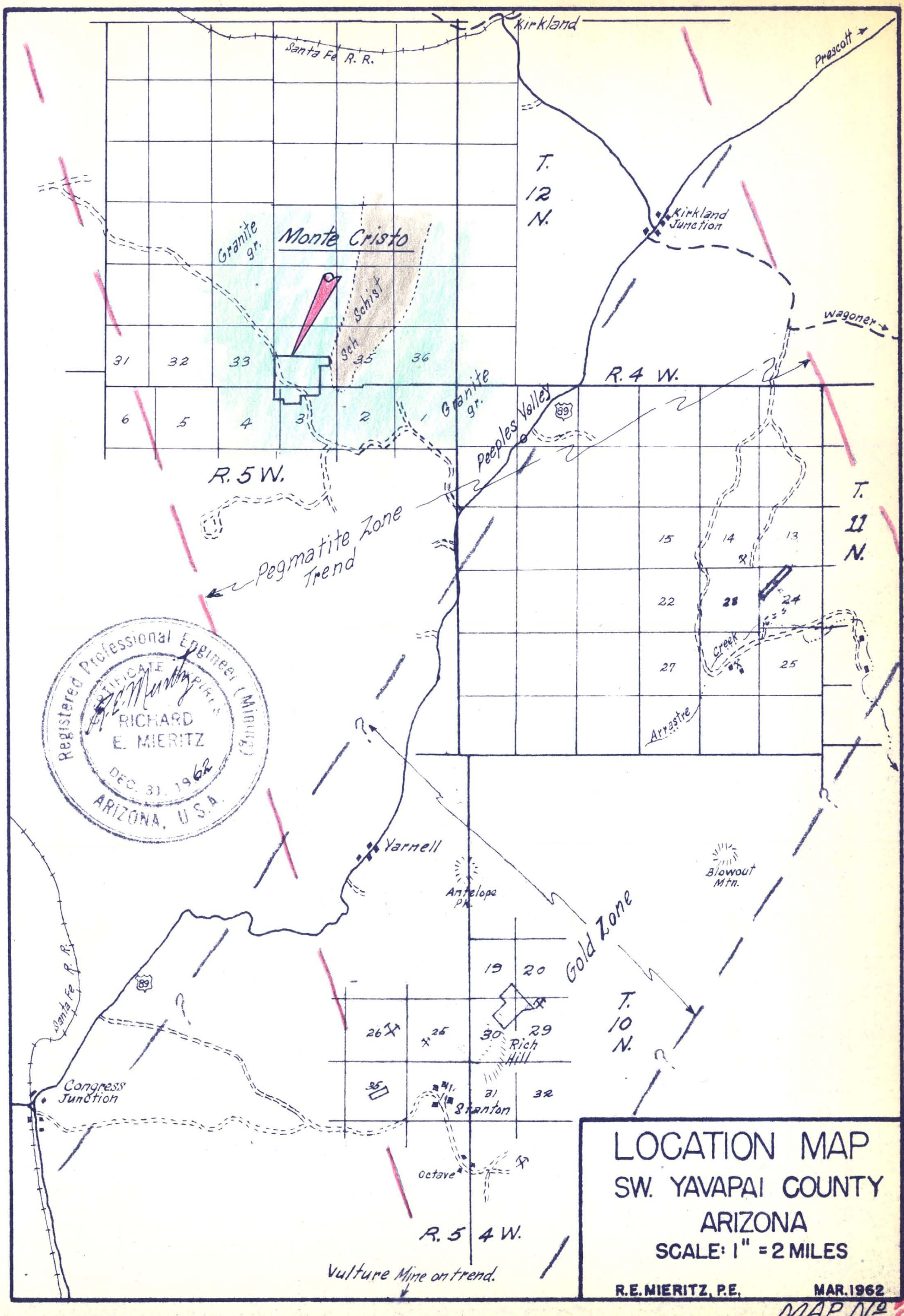
INDEX MAP
CENTRAL ARIZ.

SCALE: 1" = 27 MI.

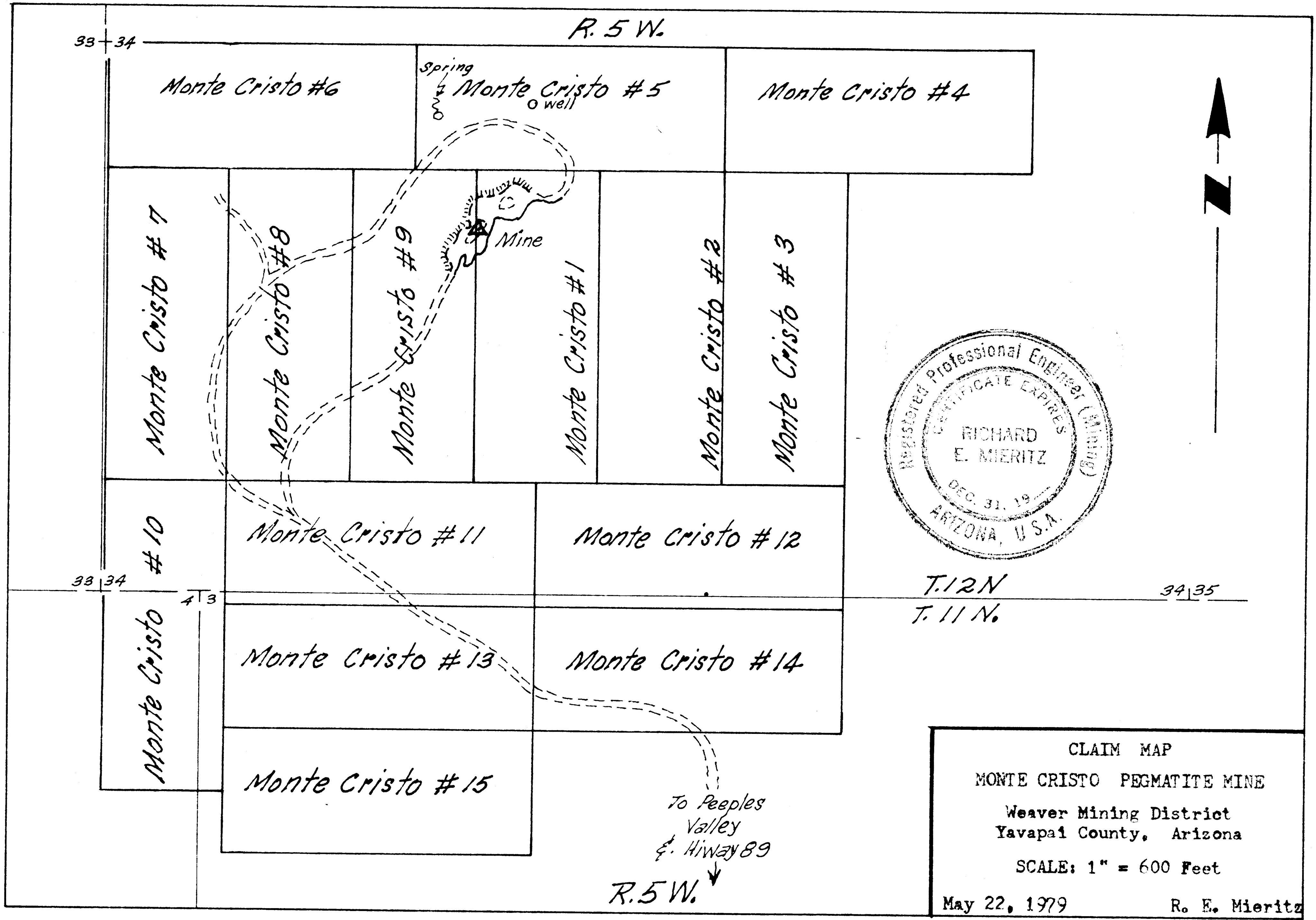
R.E. MIERITZ, P.E. MAR., 1962

MAP No 1

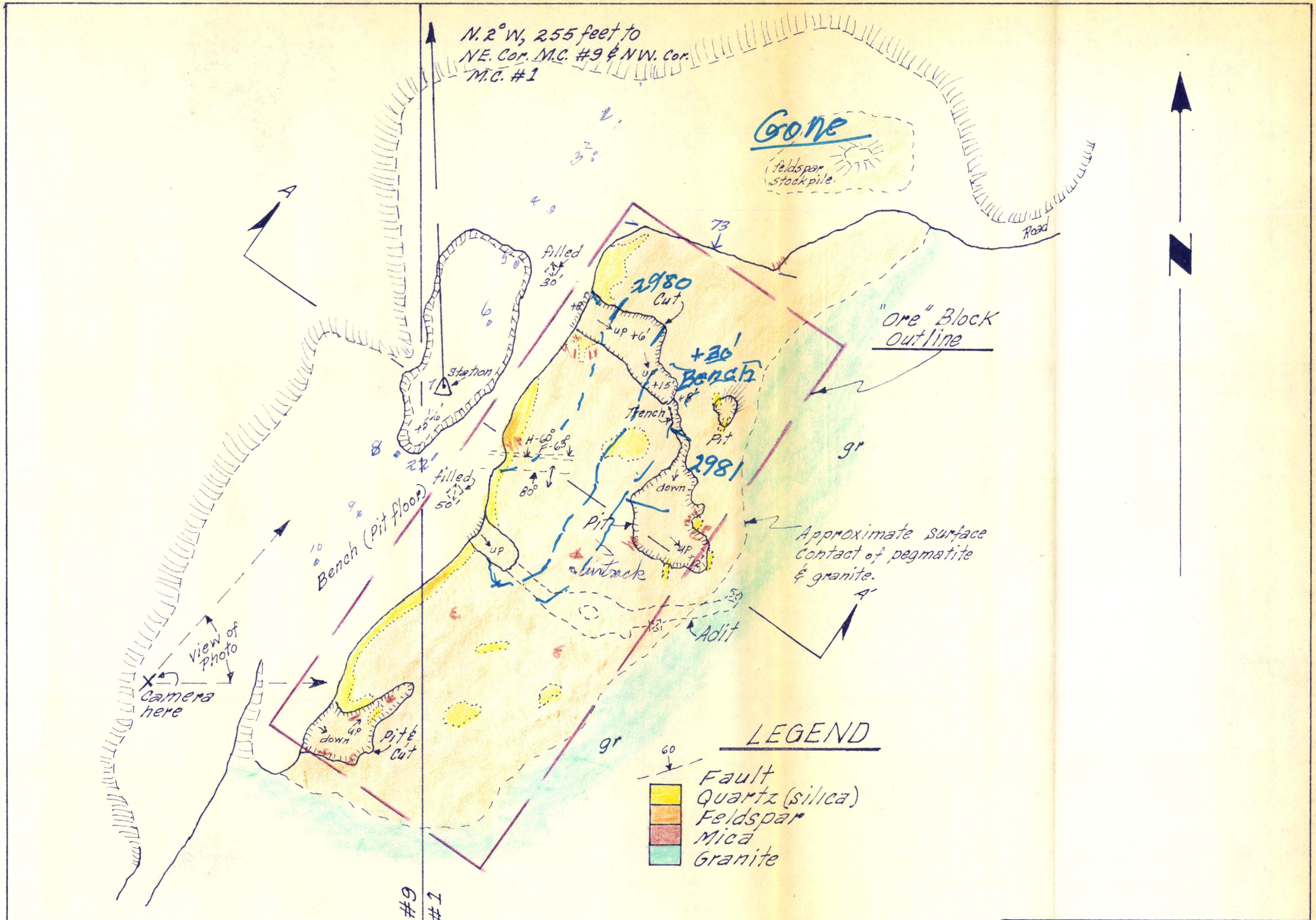
A-23 USE


Kirkland
Santa Fe R.R.
Prescott
T. 12 N.
Kirkland Junction
Granite gr.
Monte Cristo
Schist
Sch
Wagoner
31
32
33
35
36
R. 4 W.
6
5
4
3
2
1
Granite gr.
Peeples Valley
89
R. 5 W.
T. 11 N.
Pegmatite Zone Trend
15
14
13
22
23
24
27
25
Creek
Arrastre
Registered Professional Engineer (Mining)
Certificate Expires
RICHARD E. MIERITZ
DEC. 31, 1962
ARIZONA, U.S.A.
Yarnell
Antelope Pk.
Blowout Mtn.
Gold Zone
19
20
T. 10 N.
Santa Fe R.R.
89
26
25
30
29
Rich Hill
35
31
32
Congress Junction
Stanton
Octave
R. 5 4 W.
Vulture Mine on trend.
LOCATION MAP
SW. YAVAPAI COUNTY
ARIZONA
SCALE: 1" = 2 MILES
R.E. MIERITZ, P.E.
MAR. 1962

MAP No 2


R. 5 W.
33 34
Monte Cristo #6
Spring
Monte Cristo #5
o well
Monte Cristo #4
Monte Cristo #7
Monte Cristo #8
Monte Cristo #9
Mine
Monte Cristo #1
Monte Cristo #2
Monte Cristo #3
Registered Professional Engineer (Mining)
CERTIFICATE EXPIRES
RICHARD
E. MIERITZ
DEC. 31, 19
ARIZONA, U.S.A.
Monte Cristo #10
Monte Cristo #11
Monte Cristo #12
33 34
4 3
T. 12 N
T. 11 N.
34 35
Monte Cristo #13
Monte Cristo #14
Monte Cristo #15
To Peeples Valley & Hiway 89
R. 5 W.
CLAIM MAP
MONTE CRISTO PEGMATITE MINE
Weaver Mining District
Yavapai County, Arizona
SCALE: 1" = 600 Feet
May 22, 1979
R. E. Mieritz

MAP № 3



SURFACE GEOLOGIC MAP

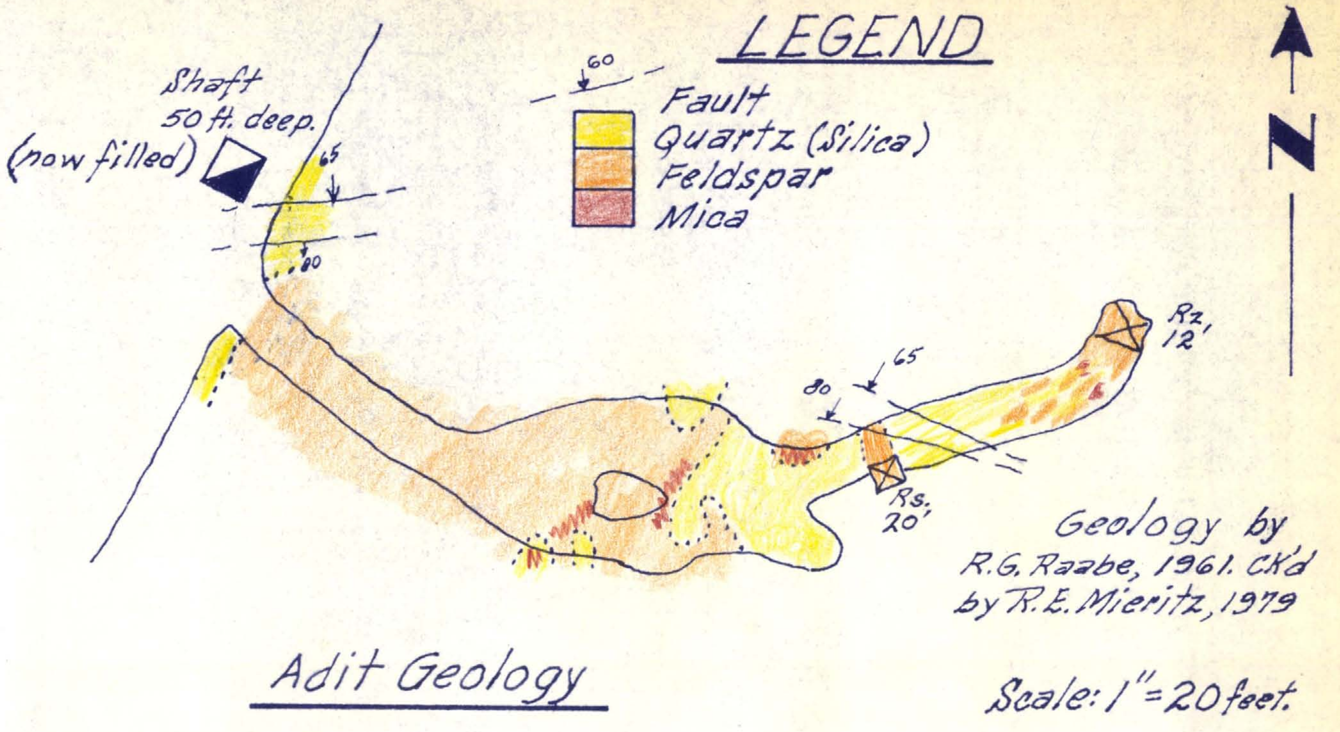
MONTE CRISTO PEGMATITE MINE

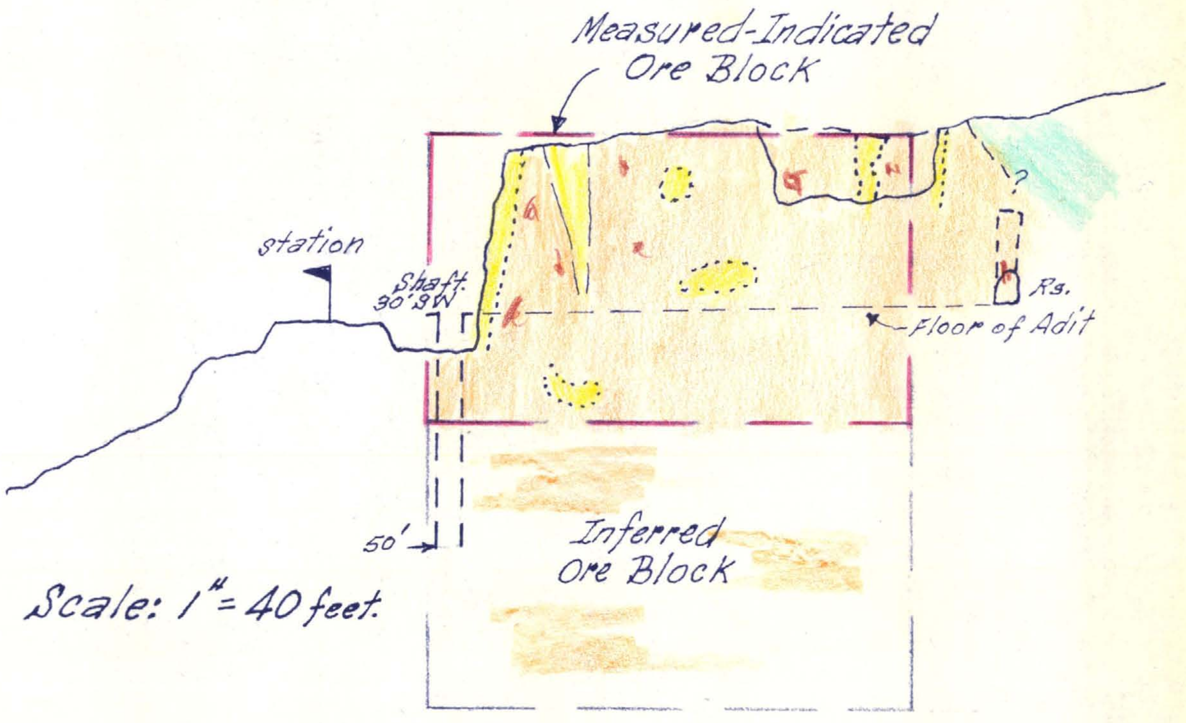
Weaver Mining District
Yavapai County, Arizona

SCALE: 1"= 40 Feet

May 22, 1979 R. E. Mieritz

MAP No 4





SECTION A-A' (S.55°E)
(from Map Nº 4) (looking N.35°E)

NOTE

This Section might well be typical of the Monte Cristo pegmatite deposit. Vertical elevations are writers estimates. Horizontal measurement by Brunton & Range Finder.

ADIT & SECTION MAP MONTE CRISTO PEGMATITE MINE
Weaver Mining District Yavapai County, Arizona
SCALE:- as noted
May 22, 1979 — R. E. Mieritz

MAP Nº 5

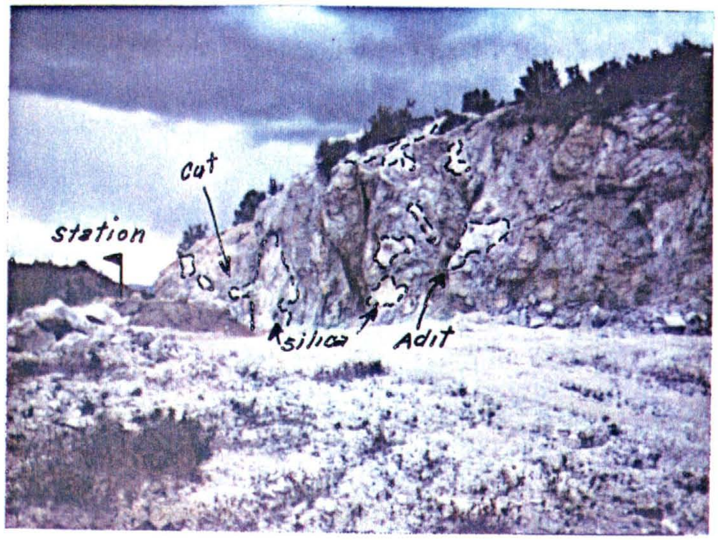


PHOTO: Looking northeast towards face or bank of Open Pit. Some of the Silica pods are outlined on the Photo. The position of the Adit is indicated - being about 8 feet above the present Pit floor.. The most northeastern Cut is also indicated. The start of this Cut is also about 8 feet above the Pit floor.

REPLY TO:

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Richard E. Mieritz
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GEOLOGY
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OPERATION

July 15, 1985

Mr. Sam Bittner
Monte Cristo Mining Co.
12076 Jackson Street
Omaha, Nebraska, 68154

Re: Monte Cristo Pegmatite

During a June 25th conference with yourself and contractor Don Kenton in my office, we planned, among other things, a visit to the Monte Cristo pegmatite property, Yavapai County, Arizona for the purpose of obtaining some samples which would represent the "general character" of the pegmatite outcrop which is primarily located on Monte Cristo No. 1 and Monte Cristo No. 9 claims.

The specific visit to the property was completed on June 26th--yourself, Mr. Kenton and the writer. Much time was consumed "walking in and out" (2.1 miles each way) due to the fact that both gates have five locks on each. This situation must be corrected before any future work can be commenced on the property.

On arrival at the property, the writer observed considerable physical changes as to relief and outline of the pegmatite outcrop and immediate area. These changes occurred since the writer's last visit to the property in May, 1982. The changes resulted from "hap-hazard" type of mining and rock moving operations. The writer has attempted to indicate these changes on the included Map, the initial map being prepared in May, 1979 when a report on the property was prepared for a Mr. Cheatwood.

During the field visit, the writer took four general "chip" samples of various lengths at strategic locations which could be tested by analysis various metal/mineral contents within the pegmatite. These samples were fire assayed for gold and silver. The same samples were Spectrochemical analyzed for other metals such as rare earths, the more common elements as silica, calcium, sodium, etc as well as for silver.

This "first step" analysis is necessary to justify further expenditures for the more expensive individual chemical analysis of metal/metals contained in the rocks--the samples.

The four samples taken by the writer were taken to the Iron King Assay Office, Humboldt, Arizona for sample crushing/pulverizing, rolling (for thorough mixing) and fire assayed for gold and silver. Balance of the total pulverized sample not used by Iron King Assay Office was taken to Phoenix by the writer where it was again rolled. The writer then took two portions of each sample, sending one group of four samples to Pacific Spectrochemical Laboratory, Los Angeles, California, for a spectrochemical analysis of each sample. The second portion of each of the four samples was sent to Mr. Sam Bittner, Omaha, Nebraska, so he could forward some of the samples to a laboratory of his choice to have each of the samples analyzed for various metals by the Atomic Absorbtion method--quantitatively.

The four samples taken by the writer are:

#2980 - Chip sample of 20 feet horizontally across a new northeast face of the "Pit" (See attached Map) which contains quartz (SiO_2), feldspar and some mica.

#2981 - Chip sample of 40 feet horizontally across new southeast upper bench face containing approximately 50% quartz and 50% feldspar with fair mica.

#2982 - Chip sample of 10 feet horizontally along northeast wall of the Adit (underground) beyond the caved portion of the Portal and quite close to the large cave just northwest of same. (See Map)

#2983 - Chip sample of 30 feet horizontally along the northwest wall of outcrop starting near Adit portal. Part of this face is newly exposed, the other part more or less undisturbed having weathered the unorthodoxed blasting of a previous operation. Most of the sample is quartz with little mica.

The included Sample Analysis Results lists the samples in columns, side by side horizontally and the contents of the various constituents vertically to provide and easy summary and comparison one sample with another.

The primary major minerals of the pegmatite are quartz (SiO_2), feldspars [(K, Na) $AlSi_xO_x$] and mica [(K, Na, Mg, Fe) $AlSi_xO_x$]. The elements here mentioned are the first six on the Spectrochemical Analysis. These minerals are visually observable in the pegmatite.

The low value of the Beryllium content definitely rules out the possibility of a homogenous disseminated distribution throughout the pegmatite of this metal. It is known however, that beryl/phenacite? does exist in the pegmatite but in small localized, isolated areas. This criteria indicates that a tedious hand sorting method to recover the beryllium values would be required in any future operation.

The indicated sprectrographic contents of some of the rare earth metals such as Gallium, Columbian, Tantalum and Yttrium are so low in value that it is difficult to generate an interest in such metals. As noted on the included Semiquantitative Analysis Sheet received **from Pacific Spectrochemical Laboratory, the rare earth metal Selenium,** is NOT DETERMINABLE by spectrographic methods.

The gold-silver fire assaying of these four samples confirms the Pacific Spectrographic result of silver, viz, basically zero.

In view of the analysis results thus far, it would appear that the only minerals/metal of value and available for concentration to a final product would be the quartz, feldspars and micas.

Please advise the writer when you have received the results of your test work by forwarding a copy of the results. The writer can then compare and analyze same and determine if further work should be done and what such work should be.

Respectfully submitted,

RICHARD E. MIERITZ

7784
RICHARD E. MIERITZ
ARIZONA, U.S.A.

Richard E. Mieritz
Mining Consultant

Attachments: Assay Certificate--Iron King Assay Office
Semiquantitative Analysis Report--Pacific Spectrochemical Laboratory, Inc.
SURFACE--SAMPLE MAP.

SAMPLE ANALYSIS REPORT SUMMARY

Pacific Spectrochemical Laboratory

Iron King Assay Office

SEMIQUANTITATIVE ANALYSIS

		2980	2981	2982	2983
Si	Silica	30.0%	34.0%	29.0%	30.0%
K	Potassium	4.9	4.6	20.0	5.3
Na	Sodium	4.3	3.0	7.7	5.3
Al	Aluminum	11.0	8.4	1.2 (?)	11.0
Fe	Iron	0.64	1.0	0.77	0.65
Mg	Magnesium	0.069	0.0055	0.0066	0.0086
Mn	Manganese	0.039	0.28 (?)	0.024	0.026
Pb	Lead	0.023	0.019	0.047	Tr 0.01
Ga	Gallium	0.0037	ND 0.003	0.011	0.0058
Ca	Calcium	0.091	0.15	0.034	0.024
Cu	Copper	0.0033	0.0061	0.0064	0.0046
Ag	Silver	0.00013	0.0019	Tr 0.0001	ND 0.0001
Ti	Titanium	0.021	0.013	ND 0.002	0.011
Ni	Nickel	0.00063	0.0011	0.0023	0.0019
Cr	Chromium	0.0097	0.016	0.027	0.021
Be	Beryllium	ND 0.0003	same	same	same
Cb	Columbium	ND 0.02	same	same	same
Ta	Tantalum	ND 0.06	same	same	same
Y	Yttrium	ND 0.009	same	same	same

FIRE ASSAY

		2980	2981	2982	2983
Au	Gold	Nil	Nil	Nil	Nil
Ag	Silver	Nil	Nil	Nil	Nil

NOTE:

The Aluminum content of sample 2982 is questioned because that sample is 80% feldspar. It probably is a typographic error--should be 12.0%
The Manganese content of sample 2981 is questioned--again, a possible typographic error.

TO:

RICHARD MIERITZ
2940 N. Casa Tomas
Phoenix, Arizona 85016

(213) 838-5939 (213) 870-3749

Pacific Spectrochemical Laboratory, Inc.
Chemical and Spectrographic Analysis
2558 Overland Avenue
Los Angeles, California 90064

PURCHASE ORDER NO.

July 11, 1985

SEMIQUANTITATIVE ANALYSIS

	2980	2981	2982	2983
Si	30.%	34.%	29.%	30.%
K	4.9	4.6	20.	5.3
Na	4.3	3.0	7.7	5.3
Al	11.	8.4	1.2	11.
Fe	0.64	1.0	0.77	0.65
Mg	0.069	0.0055	0.0066	0.0086
Mn	0.039	0.28	0.024	0.026
Pb	0.023	0.019	0.047	TR<0.01
Ga	0.0037	ND<0.003	0.011	0.0058
Ca	0.091	0.15	0.034	0.24
Cu	0.0033	0.0061	0.0064	0.0046
Ag	0.00013	0.0019	TR<0.0001	ND<0.0001
Ti	0.021	0.013	ND<0.002	0.011
Ni	0.00063	0.0011	0.0023	0.0019
Cr	0.0097	0.016	0.027	0.021
Be	ND<0.0003 ---------->			
Cb	ND<0.02 ---------->			
Ta	ND<0.06 ---------->			
Y	ND<0.009 ---------->			
Other rare earths	nil---------->			
Other elements	nil---------->			

Selenium is not determinable by spectrographic methods.

Respectfully submitted,

H. W. Johnson

PACIFIC SPECTROCHEMICAL LABORATORY, INC.

REGISTERED ASSAYER
CERTIFICATE NO.
15583
JIM ROY
WEATHERBY
Date Signed ....
ARIZONA, U.S.A.

IRON KING ASSAY, INC.

ASSAY CERTIFICATE

BOX 56 — PHONE 632-7410
HUMBOLDT, ARIZONA 86329

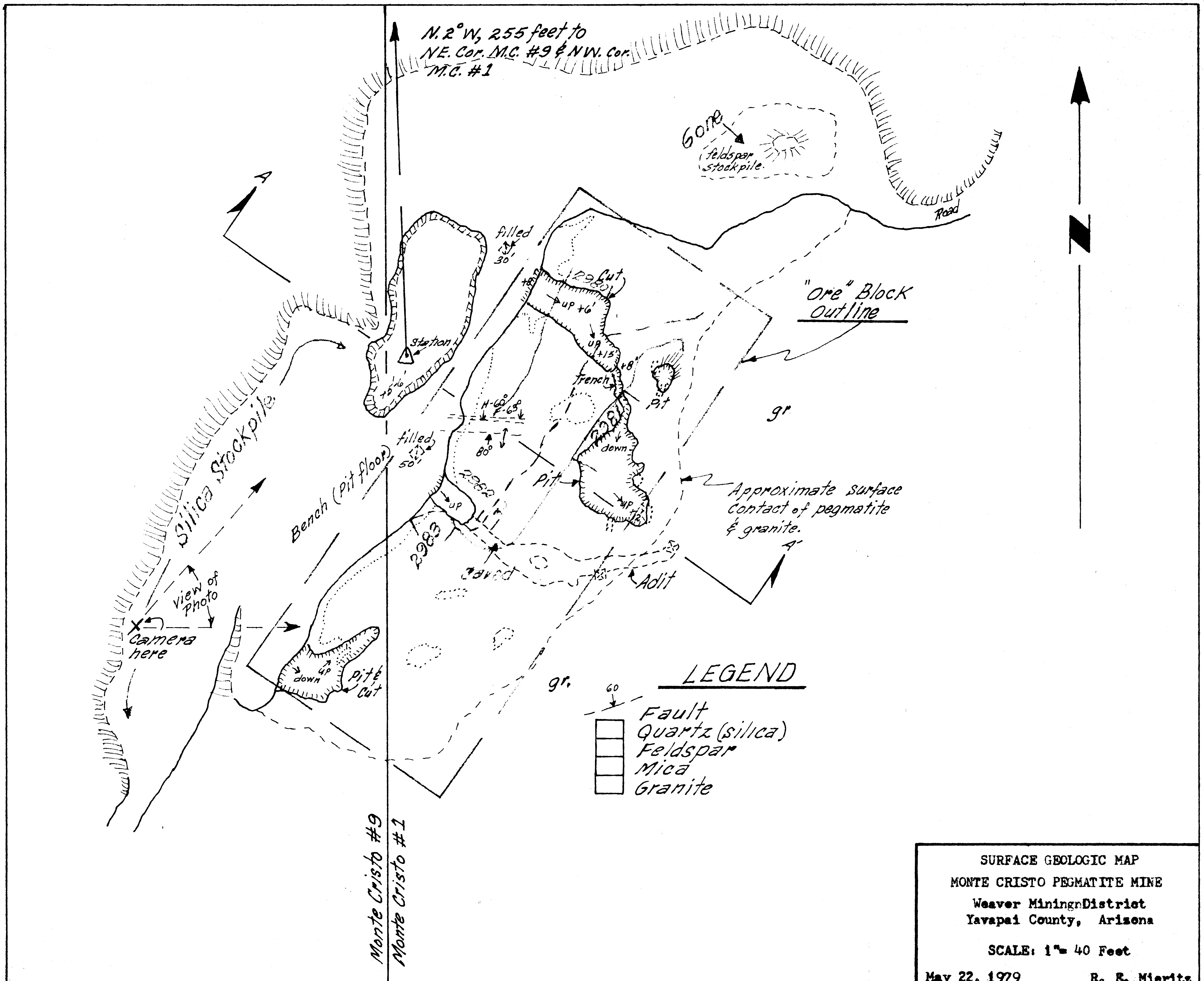
REGISTERED ASSAYER
CERTIFICATE NO.
14315
ROBERT G.
CROOK
Date Signed 7-8-85

Robert G. Crook

ASSAY MADE FOR
R.E. Mievitz
2940 Casa Tomas
Phoenix, Az 85016

REF. NO.	SAMPLE DESCRIPTION	Oz/Ton Au	Oz/Ton Ag			
6-28-1	# 2980	Nil	Nil			
2	# 2981	Nil	Nil			
3	# 2982	Nil	Nil			
4	# 2983	Nil	Nil			

CHARGES $48.00 Paid



SURFACE GEOLOGIC MAP
MONTE CRISTO PEGMATITE MINE
Weaver MiningrDistrict
Yavapai County, Arizona

SCALE: 1"= 40 Feet

May 22, 1979 R. E. Mieritz

MAP №___

August 27, 1985

Mr. Richard Mieritz
2940 Casa Tomas
Phoenix, Arizona 85016

Dear Mr. Mieritz:

I apologize to you. There was no intention on my part to delay sending you your check.

I kept waiting for reports so that I could send you everything at one time, but I ran into delays reciving reports from the consultants I contacted. I am sending you the lab -report I rec eived from Princeton, as well as a lett er from a chemical engineer with whom I consulted on a recovery process.

I am still waiting for information from Dow Chemical Company and two reports I am supposed to receive from the Bureau of Mines at Rolla, Missouri. When I finally receive thos I will forward them to you for your information.

I am inclosing the check you requested in your last bill. I was a little surprised by the amount, because when I left your House on June 27, I asked you the amount of b-ill due you and You told me $600.00. I then left you $1,000.00 to cover any other expenses you may run into.

Would you please look over your figures, perhaps you made a mistake. If you did, You can give me credit for any future work. But I am sending you the check you requested--perhaps it was my mistake and I misunstood.

Sincerely yours,

Sam Bittner

Sam Bittner

SB:mi

Rec'd 9-3-85

Returned ck 012
9-4-85

1565 Sixth Street
Trenton, NJ 08638
609-883-5050
TLX 84-3492

princeton testing laboratory

INORGANIC & PRECIOUS METALS DIVISION

TO: Mr. Sam A. Bittner
12076 Jackson Street
Omaha, Nebraska 68154

DATE: 26 Jul 85

JOB NO. 3498

AUTHORIZATION:

SAMPLE: Ores

REPORT OF ANALYSIS

Concentration %

	1	2	3	4	5
Germanium	nd	nd	nd	nd	.011
Boron	.05	.04	.08	.05	.06
Beryllium	<.01	<.01	<.01	<.01	8.68
Nickel	.002	.002	.002	.004	.004
Zinc	.002	.001	.004	.007	.007
Cadmium	.004	<.001	.005	.004	.003
Arsenic	.005	<.001	.005	.009	.006
Bismuth	.032	<.001	.042	.020	.022
Tin	.008	<.001	.007	.006	.004
Gallium	.004	<.001	.002	.013	.005
Lead	.005	<.001	.002	.003	.003
Tin	.016	.003	.015	.015	.012
Manganese	.05	.003	.10	.08	.12
Magnesium	.04	.009	.009	.03	.02
Copper	.003	.002	.006	.009	.002
Calcium	.09	.10	.01	.009	.025
Vanadium	.01	<.001	<.001	.011	.002
Niobium	<.001	<.001	<.001	.072	<.001

William F. Pickup, Director

Ronald McCloskey, Mgr

< less than ... ND ... not detected by the technique employed > greater than ND not detected

1565 Sixth Street
Trenton, NJ 08638
609-883-5050
TLX 84-3492

princeton testing laboratory

INORGANIC & PRECIOUS METALS DIVISION

DATE: 26 Jul 85

TO:

Sam Bittner
Page Two

JOB NO.

AUTHORIZATION:

SAMPLE:

REPORT OF ANALYSIS

SEMI-QUANTITATIVE SPECTROGRAPHIC ANALYSIS

		Concentration % Lot 4	Lot 5
Principal	100 – 10	Si, Al	Si
Major	10 – 1	Fe, Na	Be, Fe, Al
Strong	1 – .1	Mg, Ti	*Li, Na
Medium	.1 – .01	B, Pb, Ga, V, Nb, Zr	Mg, Ni, Ti
Weak	.01 – .001	Mn, Sn, Cr, Ni, Mo Cu, Co	B, Mn, Pb, Ga, Mo, V, Cu, Co, Zr, Ge
Trace	.001 – .0001	Ca, Ag	Ag
Faint Trace	< .0001	Be	

* Li, not positively identified

Not detected at the levels reported below:

< .1	Hg	Hg
< .01	Ba, As, Te, P, Tl, Li, Cd, Zn, Sr	Ba, As, Te, P, Tl, Cd, Zn, Sr
< .001	Sb, In, Bi	Sb, In, Bi, Ca, Nb
< .0001	Ge,	Sn, Cr

Ronald McCloskey

Ronald McCloskey, Mgr

William F. Pickup, Director

< less than ... ND ... not detected by the technique employed > greater than ND - not detected

1565 Sixth Street
Trenton, NJ 08638
609/883-5080
TLX 84-3402

princeton testing laboratory

INORGANIC & PRECIOUS METALS DIVISION

DATE: 26 jul 1985

JOB NO.

AUTHORIZATION:

SAMPLE:

TO:

Sam Bittner

Page Three

REPORT OF ANALYSIS

	oz/ton	
	Au	Ag
1	nd	.04
2	nd	.04
3	nd	.08
4	nd	nd
5	nd	nd

Ronald McCloskey

Ronald McCloskey, Mgr.

William F. Pickup ...

< less than ... > greater than ND - not detected

Dear Sam,

The mica sample you had analysed indicated niobium at a 0.078% concentration . This quantity may be a recoverable resource. Using ion exchange techniques low concentrations of metallic ions can be recovered and concentrated.

Ion exchange is a commercially predominant process for water purification and metal recovery from plating wastes. Nickel metal for example can be recovered down to a concentration less than 1 milligram per liter,(mg/l). Ion exchange is presently being used by Wyoming Fuels in western Nebraska to recover uranium. The aqueous source has a concentration of 50 mg/l.

In ion exchange a free liquid phase is passed through a rigid durable particulate phase, referred to as a resin bed. The resin contains bound ionic charges, either positive or negitive, in conjunction with "free" ions of the opposite charge. These free ions can be exchanged for ions of like charge in the liquid passed through the resin bed. The resin takes many forms, most often though, these are synthetic resins. Usually these resins are polystyrene copolymerized with other compounds. As the resin bed fills with recovered ions , free ions are displaced until all have been replaced. This point is called break-through. At break-though the bed must be recharged to replenish the free ions and recover the metallic resource. The recharge is generally accomplished by passing either strong acid or strong based through the resin to remove the metallic ions. This solution is called the regenerant, and is the concentrated metallic resource.

The steps necessary to determine the feasibility of recovering the niobium source would be as follows;

1) determine a method to dissolve the niobium into a aqueous solution,
2) testing availible ion exchange resins for their selectivity toward niobium,
3) testing regenerant solutions of niobium for concentration and quality,
4) locating an end user and fixing a price on the regenerant,
5) preparing a cost feaseability study.

I am presently researching literature on the subject of niobium recovery. I will notify you when I locate past work in this area. Finally, if sufficent interest to pursue this is generated, I can either arrange to have more specific investigations initiated, or direct you to organizations specializing in this field.

Sincerely,

Howard T. Ortiz

Howard T. Ortiz

Mr. Ortiz - is a chemical engineer with Lincoln Plating Co Lincoln, Nebraska

July 30, 1985

Mr. Sam Bittner
Monte Cristo Mining CKop.
12076 Jackson Street
Omaha, Nebraska, 68154

Re: Monte Cristo Pegmatite

Dear Mr. Bittner:

On July 15, 1985 I forwarded to you my letter Report on the Results of the samples taken on the Monte Cristo Pegmatite mining claims, Yavapai County, Arizona.

At the same time I sent you my final INVOICE which indicated a balance owing of $400.15. These invoices are payable upon receipt of same.

As of this writing, I have not hadda check from you as payment for the balance owing.

Would appreciate your taking care of this upon receipt of this letter. I am sure it has been an oversight on your part because of the great activity you enjoy.

Sincerel,

R. E. Mieritz.

August 24, 1985

Mr. Sam Bittner
12076 Jackson Street
Omaha, Nebraska, 68154

Re: Monte Cristo INVOICE

Dear Mr. Bittner:

It is now two (2) weeks since your phone call to me advising you were sending a check to cover the balance owing for my July 15, 1985 INVOICE for the Monte Cristo Work. It is now three (3) weeks since my July 30th letter to you reminding you of the balance owing for the July 15, 1985 INVOICE.

I am very disappointed in your performance particularly since you indicated earlier youseveral occasions the abundance of "funds" at your disposal.

It would appear that your priorities have somehow been re-shuffled. Payment of my INVOICE should not be predicated and dependent on the "receipt of ASSAYS" of samples you sent out. I enclose a self addressed stamped envelope for your use to send a check by return mail.

After receipt of same, we shall discuss the filing of the Affidavit of Labor for the Monte Cristo claims for the year 1984-85.

Sincerely,

R. E. Mieritz

STATE OF ARIZONA, } ss. I hereby certify that the within instrument was filed and recorded ______________, 19___, at ________M.

County of ____________

In Docket No. ____________, Page ____________, at the request of

Fee No.:

When recorded mail to:

RICHARD E. MIERITZ
CONSULTING MINING ENGINEER
2940 N. Casa Tomas
PHOENIX, ARIZONA
85016

Witness my hand and official seal.

____________ County Recorder

By ____________ Deputy Recorder

Fee: $

AFFIDAVIT OF PERFORMANCE OF ANNUAL WORK

State of Arizona } ss AMC #s 81977 thru 81988

County of Yavapai

1. Richard E. Mieritz, AGENT for MONTE CRISTO MINING Corp. (Sam Bittner)
Name
2940 N. Casa Tomas 12076 Jackson Street
Address
Phoenix, Arizona, 85016 Omaha, Nebraska, 68154
City State Zip
being duly sworn according to law deposes and says that they are a citizen of the United States more than eighteen years of age and that all of the facts set forth in this affidavit are true and correct according to the best of their knowledge, information and belief.

2. That they are personally acquainted with the mining claim/s named Monte Cristo No. 1 thru # 12 (Lode) situate in the Kirkland Mining District, Yavapai County, Arizona, the location of which is recorded in the office of the County Recorder of that County in Book 371, Pages 389 thru 400. Notice of location is posted in Section 34, Township 12 N., Range 5 W., G&SRB&M.

3. That between the dates of June 25, 1985 and August 5, 1985 at least One thousand two hundred dollars ($1,200.00) dollars worth of work and improvements were done and performed upon this claim not including location work.

4. The work and improvements were made by and at the expense of Sam Bittner, Monte Cristo Mining Co., 12076 Jackson St., Omaha, Nebraska, 68154, owners of the mine for the purpose of complying with the laws of the United States pertaining to assessments or annual work.

5. Richard E. Mieritz, Phoenix, Arizona and Don Kenton, Omaha, Nebraska were the names of the persons employed by the owner who labored to do the work and improvements.

6. The work and improvements done were Long length sampling in the mine pit area at various locations and collecting of a 4000 pound sample from the mine ~~bank run material for conducting metallurgical metal recovery tests of~~ the pegmatite material. All samples were analyzed rare earth and other constituents.

Dated August 14, 1985 Richard E. Mieritz
Signature

Subscribed to and sworn before me, a Notary Public, this 14th day of August, 1985, by Richard E Mieritz

My Commission Expires Aug. 27, 1988
My Commission expires ____________ Lee Anne Datum
Notary Public

STATE OF ARIZONA, } ss.
County of ________ }

I hereby certify that the within instrument was filed and recorded ________, 19__, at ________ M.

Fee No.:

In Docket No. ________, Page ________, at the request of ________

When recorded mail to:

RICHARD E. MIERITZ
CONSULTING MINING ENGINEER
2940 N. Casa Tomas
PHOENIX, ARIZONA
85016

Witness my hand and official seal.

________ County Recorder

By ________ Deputy Recorder

Fee: $

AFFIDAVIT OF PERFORMANCE OF ANNUAL WORK

State of Arizona } ss
County of Yavapai }

AMC #s 81977 thru 81988

1. Richard E. Mieritz, AGENT for MONTE CRISTO MINING Corp.(Sam Bittner)
Name
2940 N. Casa Tomas 12076 Jackson Street
Address
Phoenix, Arizona, 85016 Omaha, Nebraska, 68154
City State Zip
being duly sworn according to law deposes and says that they are a citizen of the United States more than eighteen years of age and that all of the facts set forth in this affidavit are true and correct according to the best of their knowledge, information and belief.

2. That they are personally acquainted with the mining claim/s named Monte Cristo No. 1 thru # 12 (Lode) situate in the Kirkland Mining District, Yavapai County, Arizona, the location of which is recorded in the office of the County Recorder of that County in Book 371, Pages 389 thru 400. Notice of location is posted in Section 34, Township 12 N., Range 5 W., G&SRB&M.

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6. The work and improvements done were Long length sampling in the mine pit area at various locations and collecting of a 4000 pound sample from the mine ~~bank run material for conducting metallurgical metal recovery tests of~~ the pegmatite material. All samples were analyzed rare earth and other constituents.

Dated August 14, 1985 Richard E. Mieritz
Signature

Subscribed to and sworn before me, a Notary Public, this 14th day of August, 1985, by Richard E. Mieritz

My Commission expires My Commission Expires Aug. 27, 1988

Lee Anne [illegible]
Notary Public

Glen & Virginia

10509 Ridgeview Rd.
Sun City
(602) 933-5611

Holiday Inn
PYRAMIDS
CAIRO - EGYPT

6-25 - Conf. 4 hrs.
6-26 - Trip 1 day.
7-1 - Samples 1½ hrs.
7-8 - Report 4 hrs
7-13 - " 3 hrs.
7-15 " Misc 1½

22 hrs. $ 1100.00

Exp.
[illegible] 48.00
Pacific 142.00
Postage 12.85 2.40 15.25
Tele- [illegible] 8.75
Pacific 6.15

225.15

Pacific Spectechnical

Of

c/o Baker

[redacted]

Mt.

2568 Oakland Ave

LA- 90064

$61.00

Be
Calumbite - Tantalum
Seluim
Ceasium
Yttrium -
Nickel
Strontium

Chimney
Bruce Baker
NY-State

TO:

RICHARD MIERITZ
2940 N. Casa Tomas
Phoenix, Arizona 85016

PURCHASE ORDER NO.

(213) 838-5939 (213) 870-3749

Pacific Spectrochemical Laboratory, Inc.
Chemical and Spectrographic Analysis
2558 Overland Avenue
Los Angeles, California 90064

July 11, 1985

SEMIQUANTITATIVE ANALYSIS

	2980	2981	2982	2983
Si *Silica*	30.%	34.%	29.%	30.%
K *Potassium*	4.9	4.6	20.	5.3
Na *Sodium*	4.3	3.0	7.7	5.3
Al *aluminum*	11.	8.4	1.2	11.
Fe *Iron*	0.64	1.0	0.77	0.65
Mg *Magnesium*	0.069	0.0055	0.0066	0.0086
Mn *Manganese*	0.039	0.28	0.024	0.026
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Ga *Gallium*	0.0037	ND<0.003	0.011	0.0058
Ca *Calcium*	0.091	0.15	0.034	0.24
Cu *Copper*	0.0033	0.0061	0.0064	0.0046
Ag *Silver*	0.00013	0.0019	TR<0.0001	ND<0.0001
Ti *Titanium*	0.021	0.013	ND<0.002	0.011
Ni *Nickel*	0.00063	0.0011	0.0023	0.0019
Cr *Chromium*	0.0097	0.016	0.027	0.021
Be *Beryllium*	ND<0.0003 -->			
Cb *Columbium*	ND<0.02 -->			
Ta *Tantalum*	ND<0.06 -->			
Y *Yttrium*	ND<0.009 -->			
Other rare earths	nil-->			
Other elements	nil-->			

Selenium is not determinable by spectrographic methods.

Feldspar -
K Na some Ca al-silic

Mica
K, -

Feld - 2.56
Be 2.69
Mica 2.80
Qtz 2.65

Respectfully submitted,

PACIFIC SPECTROCHEMICAL LABORATORY, INC.

Monte Cristo Mining Co.

c/o Sam Britton

12076 Jackson ~~[illegible]~~ Street

Omaha, Nebraska 68154

Bus 402-334-9025

off 712-328-1557

June 27, 1985

Monte Cristo Mining Co.
% Mr. Sam Bittner
~~2900 B. Street~~ 12076 Jackson ~~Jackson~~ Street
Omaha, Nebraska, 68~~105~~154

Home - 402-334-9025
off 712-328-1557

INVOICE

For Professional Services rendered in connection with discussion and property visits of the Monte Cristo Pegmatite claims, Yavapai County, Arizona.

June 25—Office time, Conference. 4 hours @ $50.00/hr.	$ 200.00
June 26—Field time, visit to property 1 day @ $400.00/day	$ 400.00
Total Fee	$ 600.00

Out-of-Pocket Expenses

June 26—Telephone call to Humboldt, Az. (Assayer)	$ 2.75
Total Fee and Expenses	$602.75

ck #001 (Valley) (0015-9214) $1000.—
$347.25 Cr.
Au Ag ~~Sioz~~ assay (myck 647) 48.00
$349.25 Cr
ck #652 the Spider 152.00
197.25
Amount due is payable upon Receipt of Invoice. 12.85 - Postage ovr

Please Remit to R. E. Mieritz at above address. 184.40
2.40 Postage Rec.
$182.00

July 1, 1985

Pacific Spectrochem
2558 Overland Ave.
Los Angeles, California, 90064

Att: Mr. Hal Johnson:

Thank you for talking to me this morning regarding your Spectro method and changes.

Herewith four samples--Nos 2980 through 2983 which are samples of Pegmatite that have been ground down to approximately 40 mesh. After being pulverized, the sample was rolled 50 times from each corner--so it should be quite throughly mixed.

My interest is primarily the Rare Earth minerals including but not limited to Be, columbian, tantalum, Yrittium, Ceasium, Selenium, etc.

When you have finished with the analysis, please send the original and one copy of the results to me at the above address.

I enclose my check No. 652 to the order of Pacific Spectrochem in the amount of $152.00--4 times the quoted price of $38.00 per sample.

I am sure the amount of sample I have sent will be sufficient for your purpose.

Can you recommend a LAB in California or else where which can do chemical analysis on the above mentioned metals--or perhaps Atomic Absorbtion analysis. I would perfer Chemical analysis.

Sincerely,

Richard E. Mieritz

Monte Cristo claims
AMC-203379- BK 1561-377-379 - 8-19-83
1 thru 9 & 12 1561-393, 399

Letter BLM - Edward W. Baldwin Locator. June 18, 1985
P.O. Box 909
Black Canyon City

Declaring claims null and void - no assessment for
1983 84

Visitor Charles Butler - 3-12-85
Box 465
Durango Colo. 81301

Blue Bell Allens claims
No visitors since mine dated 2-5-85

Pretty Lady -
No Visitors

Glen & Virginia Forney
10509, Ridgeview Rd.
Smithsburg 933-5611

S/2 Sec 34 - T12N. R5W
N/2 Sec 3 - T11N. R5W.

~~No~~	~~64864~~	~~1968~~	8	81984		
1	81977	1965	9	81985		
2	81978	1965	10	81986	1965	
3	81979		11	81987	1965	
4	81980		12	988	1965	203390
5	81981		13	(203391	~~1983~~	(~~Baldwin~~)
6	81982		14	(203392)	~~1983~~	"
7	81983		15	(203393)	~~1983~~	"

#1 - Bk 371 Page 389 - #12 - Page 400.

838-5939
870-3749

PACIFIC SPECTROCHEMICAL LABORATORY, INC.

CHEMICAL AND SPECTROGRAPHIC ANALYSIS

RESEARCH

2558 Overland Avenue

Los Angeles, California 90064

Laboratory Service Reported To:

RICHARD MIERITZ
2940 N. Casa Tomas
Phoenix, Arizona 85016

ATTENTION: ACCOUNTS PAYABLE

INVOICE NO. 76827

DATE July 11, 1985

Terms: NET CASH

	DESCRIPTION	UNIT PRICE	AMOUNT
4	SEMIQUANTITATIVE ANALYSIS Att. Hal Johnson SAMPLES: 2980 thru 2983	$38.00	$152.00
	Report 7-11-85		

Pd 7-1-85 - ck #1652 (in advance) letter & chk with samples.
RMieritz
7-12-85

Paid 7/13/85
H.W. Johnson

I checked back to original data. - Reported numbers are correct.
H.W.J.

Note: Is Aluminum content Sample 2982 a typo error - 12% instead of 1.2%? OK
Is Mn content sample 2981 a typo error? 0.028 instead of 0.28% OK

INVOICE

JOB #: MSC00005

Client name: Richard E. Mieritz

Billing address: 2940 N. Casa Thomas
Phoenix, AZ 85016

Phone number: (602) 277-6053

No. Samples: 4
Date Received: 6-28-85
Submitted by: R. E. Mieritz

ANALYTICAL REPORT

Client ID MSC00005	Lab ID	Fire Assay Au oz/ton	Fire Assay Ag oz/ton
2980	06-28- 1	<.001	<.01
2981	06-28- 2	<.001	<.01
2982	06-28- 3	<.001	<.01
2983	06-28- 4	<.001	<.01

REGISTERED ASSAYER
CERTIFICATE NO.
15583
JIM ROY
WEATHERBY
Date Signed
ARIZONA, U.S.A.

IRON KING ASSAY INC.

13-Jul-85

JOB #: MSC00005

Client name: Richard E. Mieritz

Billing address: 2940 N. Casa Thomas
Phoenix, AZ 85016

Phone number: (602) 277-6053

No. Samples: 4
Date Received: 6-28-85
Submitted by: R. E. Mieritz

ANALYTICAL REPORT

Client ID MSC00005	Lab ID	Fire Assay Au oz/ton	Ag oz/ton
2980	06-28- 1	<.001	<.01
2981	06-28- 2	<.001	<.01
2982	06-28- 3	<.001	<.01
2983	06-28- 4	<.001	<.01

REGISTERED ASSAYER
CERTIFICATE NO.
15583
JIM ROY
WEATHERBY
Date Signed 7-15
ARIZONA, U.S.A.

Jim Roy Weatherby

P.O. Box 56, Humboldt, AZ 86329 (602) 632-7410

3512
357
3155

Princeton Testing
Laboratories
Don McClusky.
~~609~~ 883 2050
1565-US1
Trenton N.J.
08638

REGISTERED ASSAYER CERTIFICATE NO. 15583 JIM ROY WEATHERBY Date Signed .... ARIZONA, U.S.A.

IRON KING ASSAY, INC.

ASSAY CERTIFICATE

BOX 56 — PHONE 632-7410
HUMBOLDT, ARIZONA 86329

REGISTERED ASSAYER CERTIFICATE NO. 14316 ROBERT G. CROOK Date Signed 9-8-85 ARIZONA, U.S.A.

Robert G. Crook

ASSAY MADE FOR
R.E. Mieritz
2940 Casa Tomas
Phoenix, AZ 85016

REF. NO.	SAMPLE DESCRIPTION	oz/ton Au	oz/ton Ag			
628-1	# 2980	Nil	Nil			
2	# 2981	Nil	Nil			
3	# 2982	Nil	Nil			
4	# 2983					

CHARGES $48.00 Paid

A

GEOLOGIC EVALUATION

REPORT

on the

Monte Cristo Pegmatite Mine

Weaver Mining District

Yavapai County, Arizona

by

Richard E. Mieritz
Mining Consultant
Phoenix, Arizona

May 22, 1979

INTRODUCTION:

At the request of and authorization by Mr. Chet Cheatwood, President of Verde Products, Inc., an Arizona corporation with offices in Phoenix, the writer personally visited and examined the Monte Cristo Mine (Monte Cristo claims) in Yavapai County, Arizona, on May 19, 1979 for the purpose of observing the pegmatite mineralization within the claimed boundary.

This report is based on the writer's field observations and the writer's knowledge of pegmatite mineralization within a recognized geologic pegmatic zone extending from Morristown to Kingman, Arizona, and beyond. The writer has examined several pegmatite properties within this zone. The writer also had access to earlier reports on the property by Einar C. Erickson and Robert Raabe.

Registered Professional Engineer (Mining)
CERTIFICATE
RICHARD E. MIERITZ
DEC. 31, 19
ARIZONA, U.S.A.

PROPERTY, LOCATION and ACCESSIBILITY:

The property consists of fifteen (15) standard lode mining claims, Monte Cristo #1 through #15, which are mostly located in the southern half of Sec. 34, T. 12 N., R. 5 W. and the northern quarter of Sec. 3, T. 11 N., R. 5 W., G. & S. R. B. & M., Yavapai County, Arizona. Mr. Cheatwood advises these claims have been filed with the U.S. Bureau of Land Management, Phoenix, Arizona, as required by Federal law. This action plus the observed development and assessment work completed on the property should establish the claims as a legal entity. (Map No. 3)

The property is accessible by passenger automobile. From Phoenix, travel northwesterly to Wickenburg, turn northerly on U.S. Highways 89 and 93, following Route 89 to Yarnell. (Route 93 heads northwesterly to Kingman, Arizona.) From the Ranch House Cafe in Yarnell, travel northeasterly on Route 89 to a gravel road junction 6.7 miles distant. Turn north, or left, onto the ranch type road and travel 1.6 miles to a "Y". At this point, bear left and continue for 1.7 miles to another "Y". Here, bear right and continue for 1.5 miles to a locked gate, through gate and 0.2 miles to third "Y" at which point, bear right for 0.2 miles to the pit. (See Maps No. 1 and 2.)

HISTORY, DEVELOPMENT and PRODUCTION:

The property dates back to 1917, when the pegmatites were mined for the beryl content. In the early 20's, the property produced mica. In the late 20's, more beryl and some euxenite (a mineral containing yttrium, erbium, cerium and uranium) were mined. After a long idleness, a mica mill was erected in 1947 and mica produced. This development consisted of a vertical shaft, an adit and some surface mining. Renewed beryl activity in the early - mid seventies saw a drilling exploration program completed. The results of this work appear to be difficult to obtain.

In 1975, Mr. Chet Cheatwood relocated the then "Dixie Queen" claims to the present Monte Cristo claims. Since then, 300 tons of mica have been mined and sold to Buckeye Mica Mill, Buckeye, Arizona. Feldspar has also been mined for test work (100 pound to 1/4 ton lots). This test work by Westwood Ceramics, Hiway Ceramics, Bice, etc. has shown the feldspar to be of high quality and purity, more so than the North Carolina feldspar currently supplying the California market.

Mr. Cheatwood has done much pre-mine work to prepare the available feldspar "ore" for mining and production on a scale to make the venture profitable. To further enhance the operation, negotiations are under way to purchase the now idle "feldspar" crushing and pulverizing mill at Kingman, Arizona.

CLIMATE and FACILITIES:

Except for a few days during the "rainy" period and the winter season, year round operation of the mine can be expected.

The mine workings are at an elevation of 5,000 feet.

No gas or electricity are available at the property. A rancher's stock watering well is a short distance from the workings.

REGISTERED GEOLOGIST CERTIFICATE NO. 7784 RICHARD E. MIERITZ Date Signed ARIZONA, U.S.A.

GENERAL GEOLOGY:

Arizona has a northwest trending zone of 50 to 70 miles in width which has many occurrences of pegmatite structures as veins, blobs, pipes and irregular masses. All these can be of small, medium or large volumes. This zone extends from Morristown - about 40 miles northwest of Phoenix - to Kingman and beyond towards Hoover Dam. (See Map No. 2.)

Pegmatites, in general, geologically are considered the "trash can" of mineralization because pegmatites usually are composed of high temperature minerals and elements not commonly associating themselves with the more common base and precious metals of lead, zinc, copper, gold, silver, etc.

Pegmatites are usually composed of, but not limited to, silica (quartz), feldspars (sodium and/or potassium), beryllium minerals, mica (biotite and/or muscovite), columbium, tantalum, titanium and many rare earth metals - minerals. The size, shape, geographic location nor the structural mode have any great influence on the composition or the constituent quality and/or quantities of any particular pegmatite deposit.

LOCAL GEOLOGY and MINERALIZATION:

The claimed area hosts the widespread pre-Cambrian granite which is part of the Bradshaw Complex common to the area. Most of the granite is "fresh" rock, however, some decomposition has occurred in local areas. Isolated islands of Yavapai schist are also present. (See Map No. 2.)

Here, within the claimed area, a moderate size pegmatite deposit has been moderately explored and developed. This deposit is located on

Monte Cristo #1 and #9 claims. (See Map No. 3.)

The major constituents of this pegmatite deposit are potash and soda feldspars, silica (white-gray, sometimes tan quartz), mica (muscovite, usually silvery of small to quite large plates) and beryl mineral most frequently in large crystal form.

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CERTIFICATE EXPIRES DEC. 31, 19
RICHARD E. MIERITZ
ARIZONA, U.S.A.

DEVELOPMENT:

The deposit is developed by an Adit, several surface pits and trenches and more recently by surface excavation resulting in a vertical face exposure of 40-45 feet in height and some 300 feet in length. (See Photo.) The owner states two other Adits and two vertical shafts exist but are not accessible now.

The writer has surface mapped the deposit (Map No. 4) and checked the geological underground mapping as completed by R. Raabe (Map No. 5). The shaft shown on this map is not accessible - being filled by the recent work. A second shaft to the north also is not accessible. The depths are reported as 50 and 30 feet respectively. The two inaccessible Adits are located some 40 feet vertically below the present "bench" - flat area in the pit - and to the north - being driven to the south. It is reported that the pegmatite was intersected with these Adits.

ORE RESERVES:

Pegmatites, unlike base or precious metal deposits, where samples can be taken and assay contents or values obtained, must be visually examined and estimated. The mineral contents (quartz, feldspars, micas, beryl, etc.) must be visually estimated. Such estimates will vary from engineer-geologist to engineer-geologist, dependent on his knowledge and experience with pegmatites. The end result is that an ore reserve estimate is that - an estimate. However - the more the pegmatite is "opened" for visual examination, the more accurate the estimate will be.

Fortunately, the contained minerals in this deposit are very clearly distinguishable and identifiable by sight. Then too, the development thus far has exposed many faces for the "appraiser" to examine.

Ore Reserve classifications are defined as "Proven or Measured" (positive information in all directions), "Indicated" (positive information in some directions) and "Inferred" (geologic projections based on geologic evidence of the "known" mineralization).

The degree of development at the Monte Cristo deposit does not have sufficient "evidence" to classify an ore reserve into "Measured" except in a small, meaningless way. The degree of development at the deposit is more than required for "Indicated" ore. Thus, a situation exists which is midway between the two classifications and this reserve the writer designates as "Measured - Indicated". The second classification used here is "Inferred."

Map No. 4 (Surface Geology of the Deposit) suggests a deposit of near rectangular shape with surface dimensions of 250 feet in length and an average 100 feet in width. The vertical bank in the pit (See Photo) is estimated as 40 feet and the surface in the middle of the deposit about another 10 feet, say an average of 45 feet. To this figure, 15 additional feet should be added for the material below the present pit floor level. The two inaccessible shafts are reported (Erickson's Report, 1956) as having penetrated the pegmatite 30 to 50 feet below their collars.

The "block" thus has dimensions of 250 feet long, 100 feet wide and 60 feet deep or thick. These figures multiplied for volume and divided by 12 (cubic feet per ton in place) results in 125,000 tons. (See Map No. 4.)

The lower two inaccessible Adits are also reported as encountering the pegmatite deposit. It is therefore reasonable to assume by inference that a "block" of similar dimensions could exist below the above described "Ore Block" and in the amount of a similar tonnage - 125,000 tons. (See Map No. 5)

The writer thus credits the present pegmatite deposit with:

Measured - Indicated	-	125,000 tons
Inferred	-	125,000 tons

The pegmatite zone is in surface evidence for some 500 feet in a south-west direction but has not been explored, thus opening the way for additional potentials.

The pegmatite is composed of four recoverable, marketable minerals, namely, feldspars, quartz (silica), mica and beryl. The percentage of these minerals in pegmatites varies considerably deposit to deposit AND within any specific deposit. Based on the evidence observed by the writer during the visual examination of same, it is the opinion of the writer that the deposit will have the following mineral content average percentages.

Feldspars	70.0%
Silica	25.0%
Mica	3.5%
Beryl	1.5%
	100.0%

In the "Measured - Indicated" ore block there could be - in place:

Feldspars	87,500 tons
Silica	31,250 tons
Mica	4,375 tons
Beryl	1,875 tons
Pegmatite	125,000 tons

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MINE OPERATION:

Mr. Cheatwood states his objective is the production of feldspar - to mine, transport, mill in Kingman, Arizona and bag, marketing the final product for $90.00 per ton.

Simultaneous mining of the silica, mica and beryl would provide stockpiles of these minerals for future milling and marketing of a saleable product.

Mr. Cheatwood also states he is assured of a feldspar mining contract by experienced feldspar miners at $6.00/ton, mined and loaded into trucks. Other minerals would be mined and stockpiled for $3.00/ton.

A trucking charge contract to Kingman is indicated as being $13.00/ton - 10¢ a ton mile.

The milling cost at the Kingman plant has not been determined but the writer would estimate a $20.00/ton actual cost, not including capital cost writeoff.

VALUE in PLACE:

It has been estimated that 87,500 tons of feldspar exist. With an 85% mining efficiency projected, there should be 74,375 tons of recoverable feldspar. With a market price of $90.00/ton (Kingman), the "in place" value is $6,600.000.-.

The E.&M.J. April quotes for the other mineral commodities (minimum figures, specifications and price in each case) are:

Silica:	$35 - 46.00/ton, 50 lb. bags
Mica:	$30 - 35.00/ton, scrap
Beryl Ore:	$50 - 55.00/STU (1%), for 10-12%

The above "by products" could further enhance the "in place" value $2,160,000.- or a total of $8,800,000.- for the "Measured - Indicated" ore block.

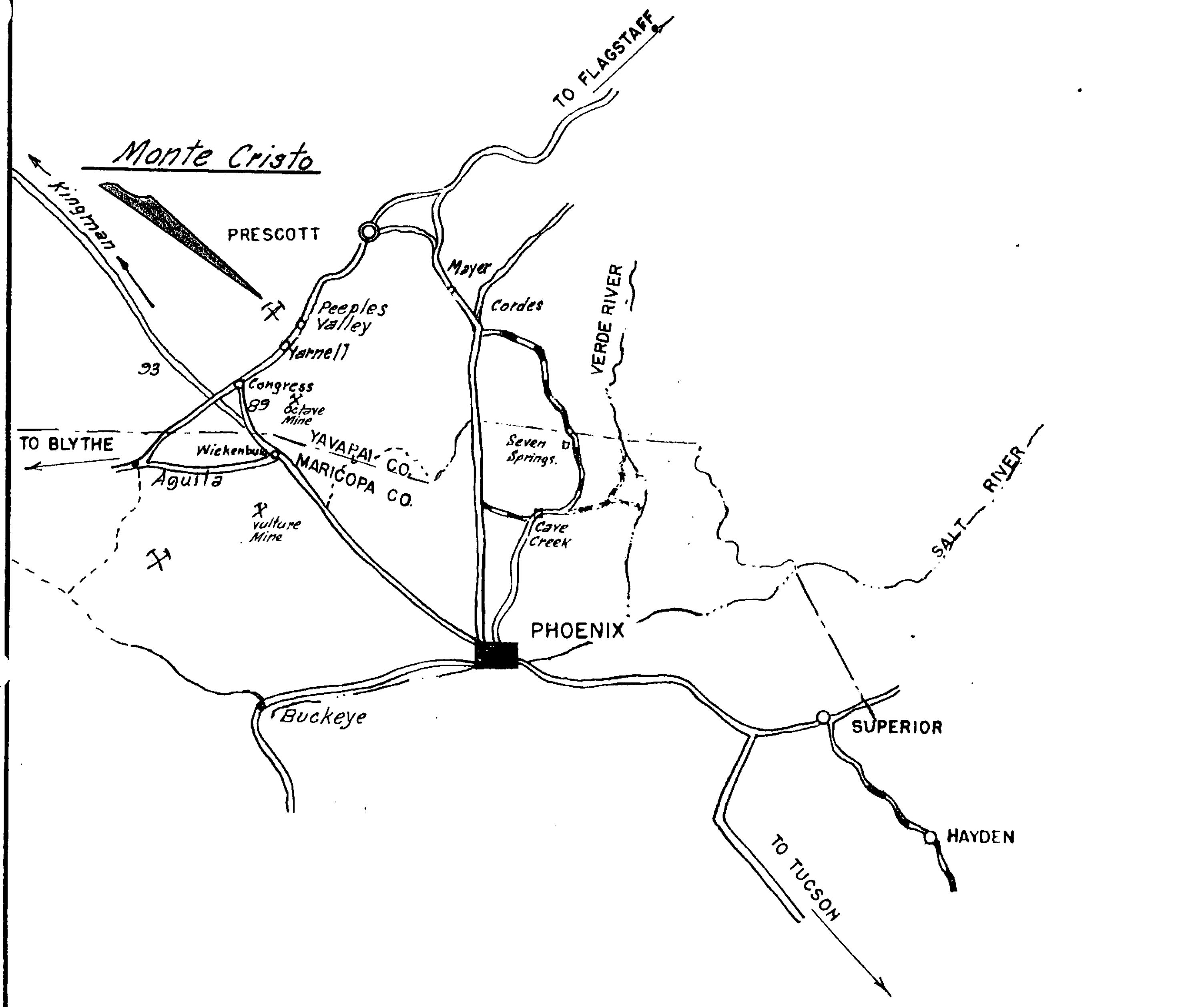
Respectfully submitted,

Registered Professional Engineer
CERTIFICATE EXPIRES
RICHARD E. MIERITZ
DEC. 31, 19
ARIZONA, U.S.A.

REGISTERED GEOLOGIST
CERTIFICATE NO. 7784
RICHARD E. MIERITZ
Date Signed 5/22/
ARIZONA, U.S.A.

R.E. Mieritz
Mining Consultant
Phoenix, Arizona

May 22, 1979



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DEC. 31, 19 66
ARIZONA, U.S.A.

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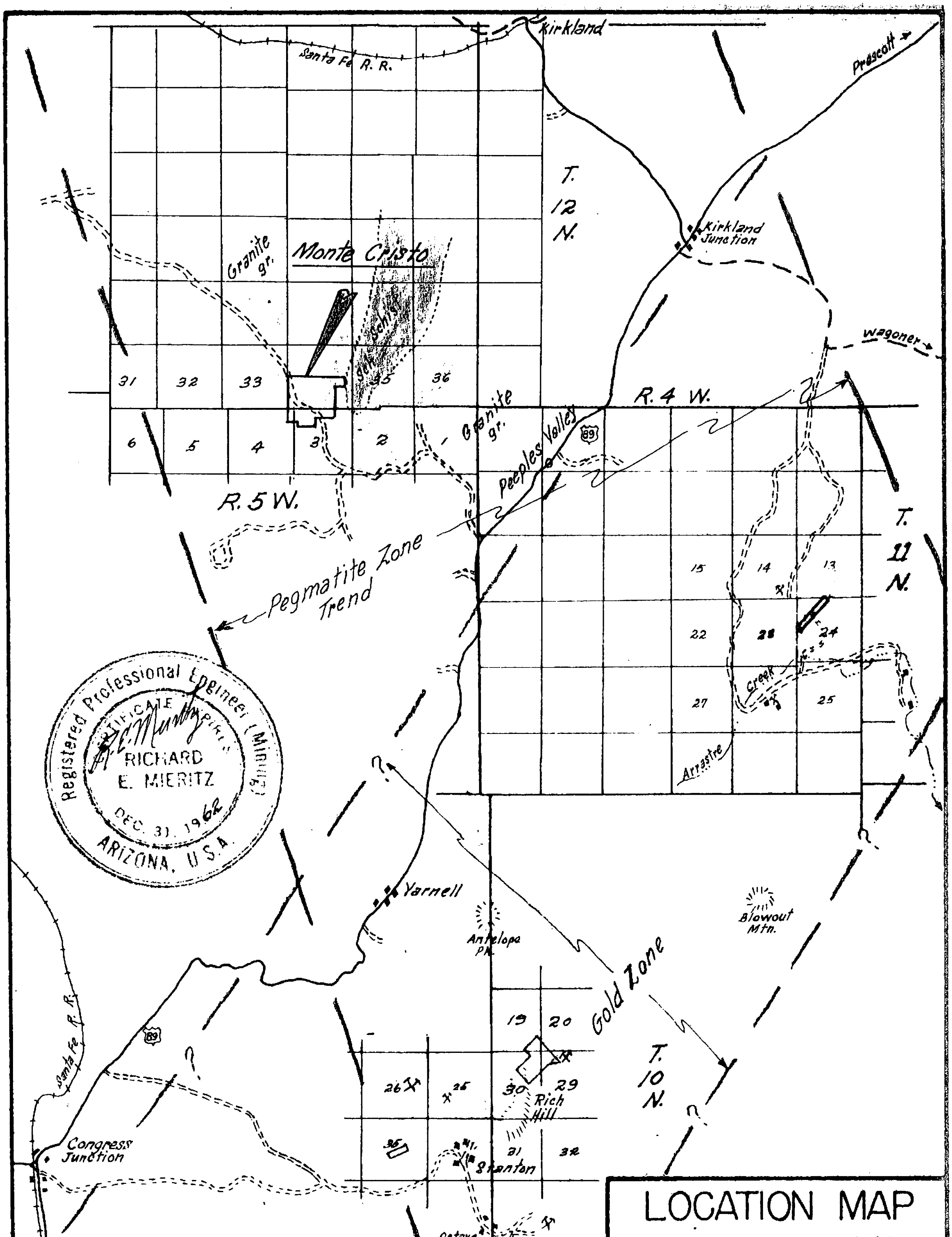
R.E.M.

INDEX MAP
CENTRAL ARIZ.

SCALE: 1" = 27 MI.

R.E. MIERITZ, P.E. MAR., 1962

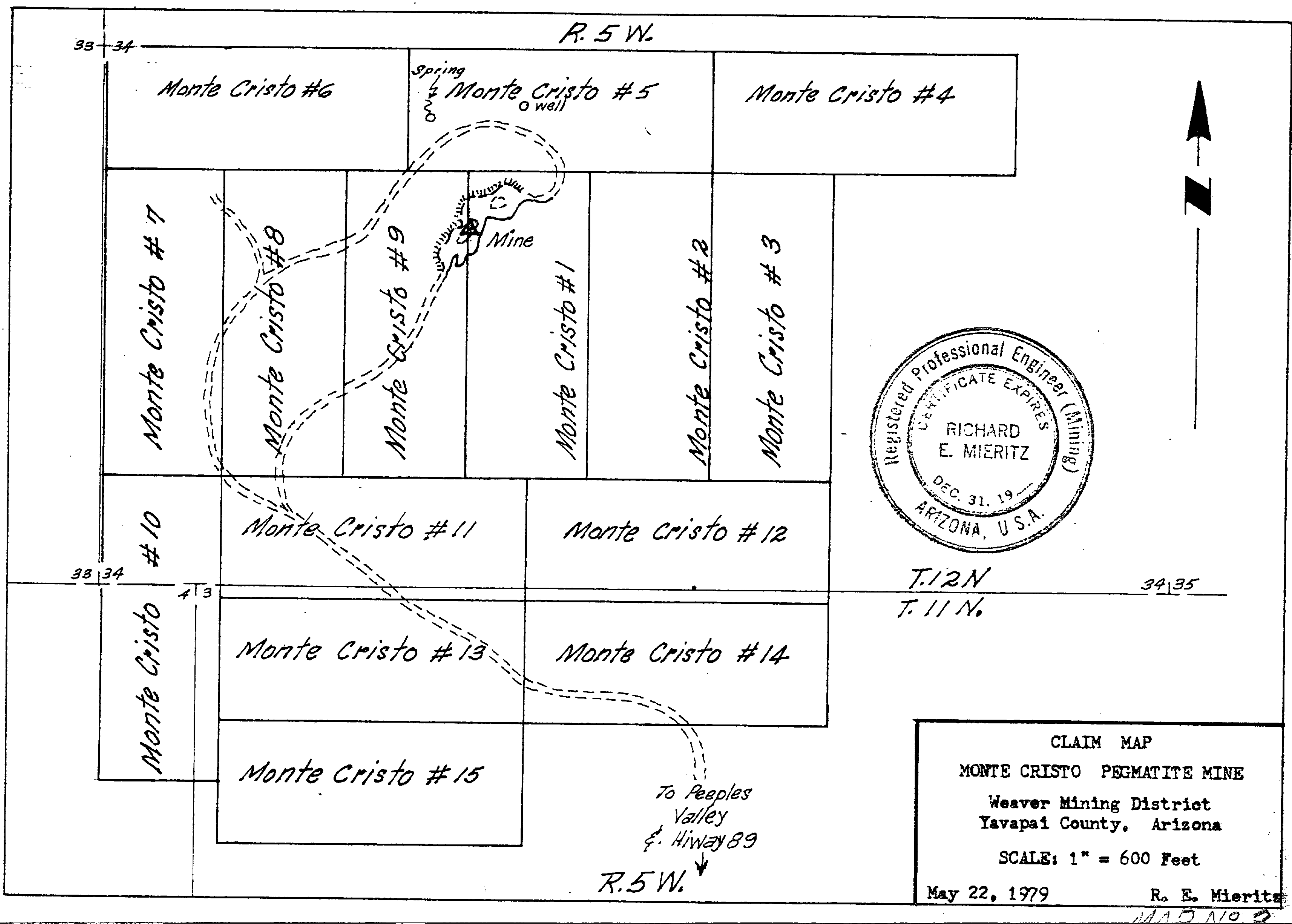
A-23 USE



LOCATION MAP
SW. YAVAPAI COUNTY
ARIZONA
SCALE: 1" = 2 MILES

R.E. MIERITZ, P.E. MAR. 1962

MAP No. 2



R. 5 W.
33 34
Monte Cristo #6
Spring
Monte Cristo #5
O well
Monte Cristo #4
Monte Cristo # 7
Monte Cristo #8
Monte Cristo #9
Mine
Monte Cristo #1
Monte Cristo #2
Monte Cristo # 3
N
Registered Professional Engineer (Mining)
CERTIFICATE EXPIRES
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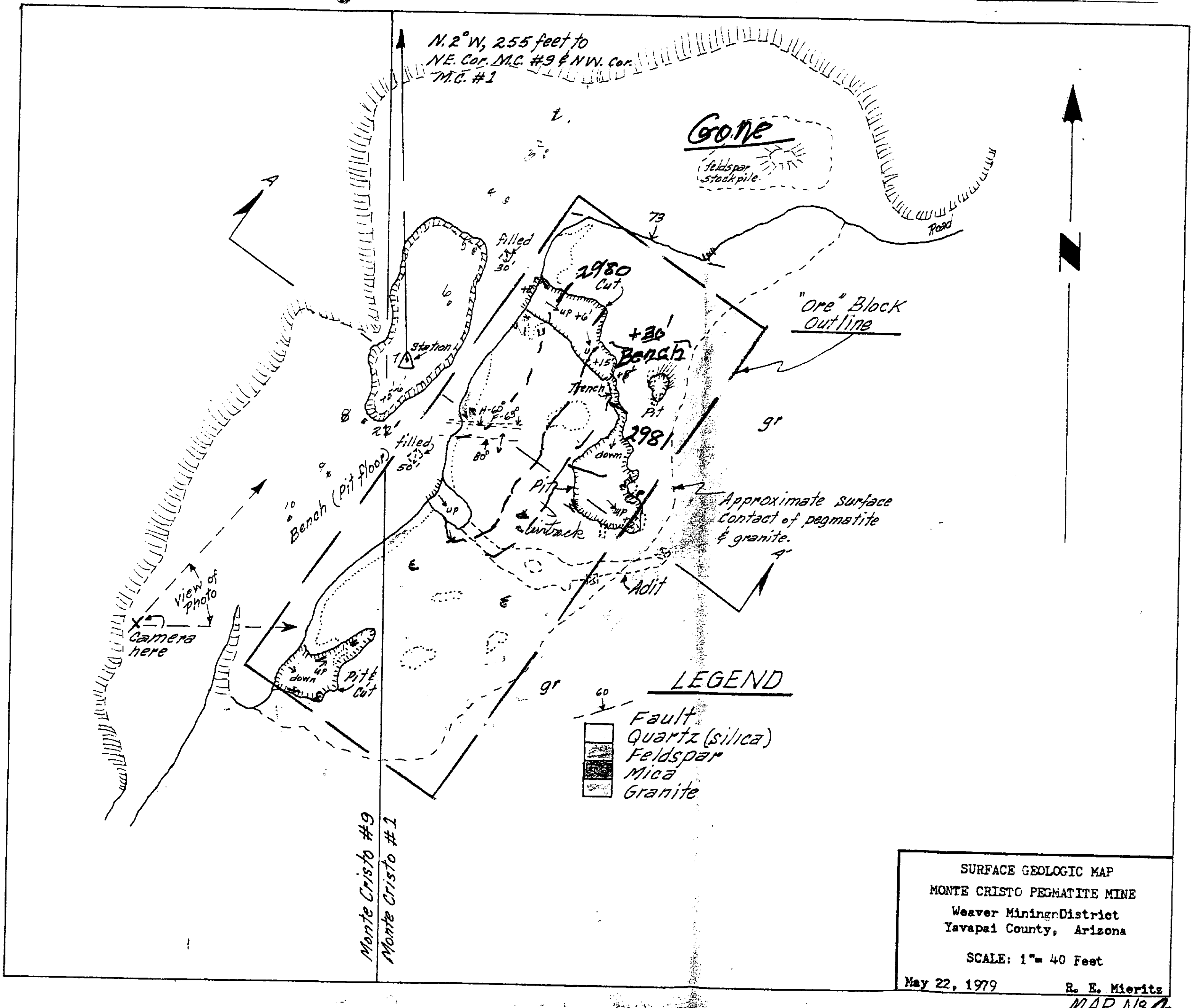
E. MIERITZ
DEC. 31, 19
ARIZONA, U.S.A.
#10
Monte Cristo #11
Monte Cristo #12
33 34
4 3
T. 12 N
T. 11 N.
34 35
Monte Cristo
Monte Cristo #13
Monte Cristo #14
Monte Cristo #15
To Peeples Valley & Hiway 89
R. 5 W.
CLAIM MAP
MONTE CRISTO PEGMATITE MINE
Weaver Mining District
Yavapai County, Arizona
SCALE: 1" = 600 Feet
May 22, 1979
R. E. Mieritz

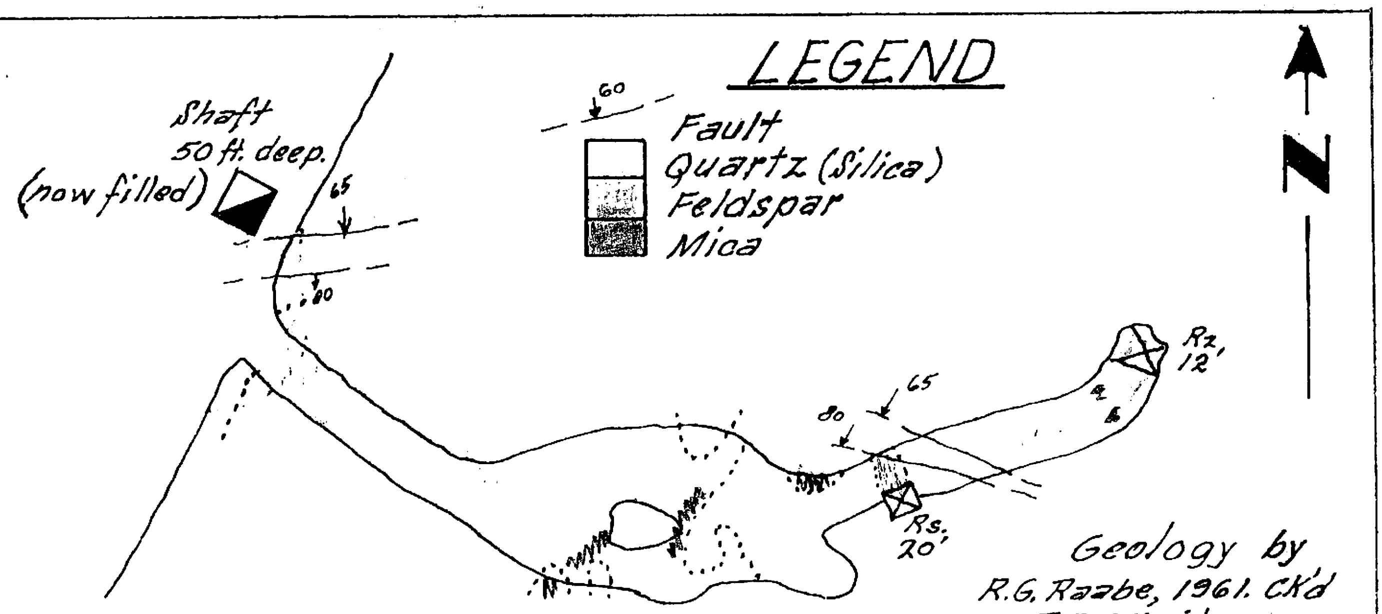


SURFACE GEOLOGIC MAP
MONTE CRISTO PEGMATITE MINE
Weaver MiningrDistrict
Yavapai County, Arizona

SCALE: 1"= 40 Feet

May 22, 1979 R. E. Mieritz

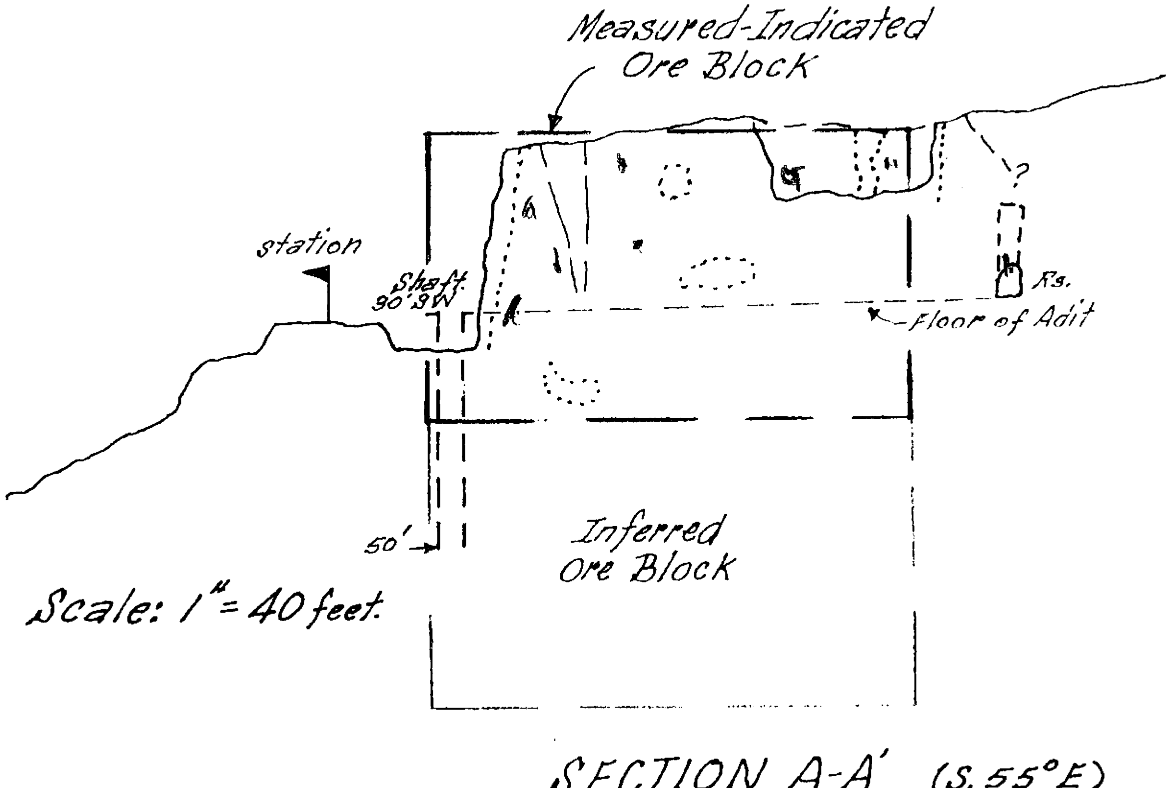
MAP No 4



Geology by
R.G. Raabe, 1961. CK'd
by R.E. Mieritz, 1979

Adit Geology

Scale: 1" = 20 feet.



Scale: 1" = 40 feet.

SECTION A-A' (S. 55° E)
(from Map № 4) (looking N. 35° E)

NOTE

This Section might well be typical of the Monte Cristo pegmatite deposit. Vertical elevations are writers estimates. Horizontal measurement by Brunton & Range Finder.

ADIT & SECTION MAP
MONTE CRISTO PEGMATITE MINE

Weaver Mining District
Yavapai County, Arizona

SCALE:- as noted

May 22, 1979 R. E. Mieritz

MAJOR BERYLLIUM RESERVES

THE ERICKSON REPORTS

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Cushionrail

ABSTRACT

MAJOR BERYLLIUM

Two reports by Einar C. Erickson, Geologist, one dated November 6, 1956, and the other dated February, 1966 describe a major Beryllium find in Yavapai County, Arizona at the 6000 foot level. Erickson reports after 7 drill holes made in 1966 that there is a "total reserve of 160,000 tons that will average more than .26% BeO" and that "Utilizing a multivariate statistical approach would state that the probability of a reserve of ore in excess of 1,000,000 tons is better than 80%"

The reserves of mica, also bearing commercial beryllium, is about equal to the deposit of beryl. Bismuth-gold with some rare earths are also found in the deposit.

According to the writer, there would be 66% in profit if the ore were made into beryllium metal which now sells at $150 per pound. 5% of the deposit consists of beryl crystal which would average over 5% beryllium, and some of it up to 20% beryllium.

The geologist recommends a 250 ton per day mill.

Available reports indicate there is only one beryllium mine in the United States at this point, and the reserves in this deposit will last less than 20 years at the present rate of consumption.

Perhaps the most important aspect of the deposit is the fact that the uses of beryllium have been greatly extended in the past five years. The newest uses include beryllium as mountings for microelectronic chips in the rapidly expanding computer market. It is also used for brake linings for large trucks as high heat has little effect on the metal.

beryllium
down-to-earth uses are soaring

CUSHIONRAIL NOT QUALIFIED TO EVALUATE ENGINEER REPORTS

Cushionrail

THE ERICKSON REPORT

MAJOR BERYLLIUM RESERVES IN ARIZONA

July 16, 1981

These claims are under exclusive option to CUSHIONRAIL until August 5, 1981. Originally, Cushionrail obtained an option in 1977 for the total price of $250,000, but the property became entangled with adverse claims to the ownership by Dr. Robert L. Ross. This was resolved only in 1981.

The corporation has been interested in obtaining these claims since 1970, but there has been no market for the materials until recently when the expansion of the computer business using beryllium as the holder for the chips became prevalent. This coupled with the new space vehicle using the metal for brakes and for the windshield, plus other uses has caused beryllium to become extremely expensive.

There are two items which make the property attractive:

1. There are no other known beryllium deposits in the United States according to Fortune Magazine, June 15, 1981.
2. There is a current shortage of the ore.

THE ERICKSON REPORT

THE ECONOMIC GEOLOGY OF THE MONTE CRISTO CLAIMS YAVAPAI COUNTY, ARIZONA
By Einar C. Erickson

SECTION 1

Introduction

1.1 GENERAL

This report is a revised summary of a series of reports of reports of investigations conducted by the writer on the beryllium mineralization occurring on the Monte Cristo Claims since 1956. This present revision and summary was requested by Mr. Arnold Gilliam, Chairman of the Board, Associated Petroleum and Mining Co.

Certain areas of the investigations not completed during the earlier work because of lack of finances are discussed in only the detail permitted by the amount of information available at this writing.

Essentially, the contents of two major reports, one submitted to Mr. J. Phillips of Phoenix, Arizona in 1956, and a second submitted to Dr. R. Ross in 1960, have been drawn upon to prepare this revision. The first report was geological in character, the second report had as its continuing objectives the following eleven fields of inquiry and study:

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MAJOR BERYLLIUM RESERVES IN ARIZONA

1. The identification of host rock types into which the beryllium mineralization has been introduced.

2. To initiate a study of the structural control of the mineralization.

3. A study of the temperatures of mineralization to establish geochemical parameters for the beryllium (BeO) mineralization. and from which inferences might be made as to the extension of mineralization below the present surface. Important for drilling.

4. To identify the beryllium minerals previous sampling indicated may also contribute BeO, other than beryl important for mining and beneficiation.

5. To set up a preliminary drilling program of at least four holes to explore the subsurface of the immediate mineralized area. These were drilled, but the data was not fully studied because of lack of finances.

6. To begin a mapping project of the mineralized area, as well as the altered area. Important for the overall interpretation of the mineralization, and to guide the future exploration drilling.

7. To study the alteration phenomenon associated with the beryllium mineralization and to determine its possible use in exploration and subsurface formation evaluation that might lead to extensions of tonnages of ore.

8. To initiate an analysis of the ore for possible by-product recovery of other values besides beryllium.

9. To establish topographic and elevational control for structural cross sections to be prepared for use in the evaluation of subsurface data obtained during drilling activities.

10. To select samples from various areas for analysis both petrologically and petrographically.

11. To continue research on possible methods of beneficiation of the ores, and to develop a method and program of exploitation preparatory to the establishment of a mining and milling installation.

The total results achieved and the degree to which each of the above objectives were completed depended on the time allotted to each phase and objective and the available finances. In one aspect or another each of the above objectives are discussed in this report and areas that were incomplete will be obvious and will provide a series of recommendations to continue and complete the original program.

Scope

1.2 This report therefore assembles the results of the various studies and investigations entered into to resolve and accomplish the program intended.

Under separate sections of this report the results of each area of investigation will be reported and recommendations as to completing the important aspects will be made so the ultimate accumulation of data, important for a successful operation, can be acquired and utilized.

Originally only limited field time was allotted to accomplish the geological work, geochemical investigations, structural work and mapping. Mapping is in various stages of completion and needs to be completed.

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THE ERICKSON REPORT

MAJOR BERYLLIUM RESERVES IN ARIZONA

Examinations were made of the surface mineralization and underground investigations were accomplished in the limited workings that were on the property in 1956. Many of these workings have been obliterated by further work since that time and are now not accessible. At the time of the original examination there were two shafts and many open cuts which had exposed the beryllium zone of mineralization very well.

Samples taken during the field investigations are compiled and reported herein.

Drilling accomplished on the property is the subject of a section revised for this report, with a set of summary drill logs.

New maps, available from the State and Federal Agencies all prepared since these investigations started, have been added to this report. A new claim map has also been prepared and a new compilation of the old maps has been made, incomplete as it is.

History

SECTION 2

2.1 GENERAL BACKGROUND

Mr. Regan is reported to have first worked the bull quartz outcropping which capped beryl-mica and bismuth-gold complex ore. This was prior to 1917. W. Young came into the area in 1917, taking up much of the land for cattle and agricultural purposes. In the early 1920's mica was first mined from the property which the writer understands consisted, then, of less than one half of a claim (10 acres). In 1928 Mr. A. Flagg first examined the property from an engineering standpoint. Two of the Regan boys removed some 400 sacks of beryl soon after and during this period. They are reported to have mined the property for euxenite. Not long after this the property became idle and remained so until Mr. Westover relocated the property during the early 1940's. In 1947 Mr. H. G. Smith bought half a claim, installed a mill for the recovery of mica, and may have recovered some beryl. Some attempt was also made at the recovery of bismuth-gold ore through gravity methods. The success of this activity is not known.

Mr. Floyd Kent leased the claims from Smith and located additional claims which made up the group examined in 1956 at which time it was called the Dixie Queen Mine.

Prior to 1956 Mr. Kent leased the property to Mr. B. Doolin who did not perform and consequently the claim, in 1956, was put into the hands of the Dixie Queen Mine under the management of J. Phillips. Upon the death of Mr. Phillips the writer understands the claims reverted back to Floyd Kent, and subsequently they were leased to R. Toss and ALBERCO. Thereafter through circumstances little known to the writer, they were acquired by Associated Petroleum and Mining Co. whose management has initiated the present work and activity. (Note: R. Ross re-acquired the claims and has given an option to Cushionrail International.)

Except for an official claim mapping activity and work required to establish coordinate and elevational control of the new claims with the old drilling results, no field work or new

THE ERICKSON REPORT

MAJOR BERYLLIUM RESERVES IN ARIZONA

work other than revisional and compilation and associated research to accomplish the revision was undertaken.

The above history is based on the information the writer has available, and as this and other sections are treated as independent units, further revision and detail may be desired, and can be added to this section without interrupting the balance of the report.

Location

SECTION 3

3.1 GENERAL

The eight Monte Crisco Lode Claims, unpatented, are located in Section 34, of Township 12 North, Range 5 west, and Section 3, of Township 11 North, Range 5 West, in Yavapai County, Arizona.

The Monte Cristo claims are located in the east central part of Arizona about 35 miles southwest of Prescott, Arizona, in the Weaver Mountains, just a short distance from Lounce Lookout. The claims are at an elevation of about 4900 feet above sea level.

The claims are on the east side of the Weaver Mountains which form an arcuate pattern of peaks and indented structural and geomorphic features embracing Peeples Valley.

A fair dirt road junctions 3 miles north of Yarnell with Highway 89, and leads five and a half miles or so to the property. The claims are 22 miles north of Wickenburg, Arizona, and several hours drive from Phoenix, Arizona.

Geographically, the claims are located in the center portion of the Mountain Region or Mexican Highland, the southeastern area of the Great Basin Province. The claims are west of the large San Francisco Volcanic fields and southwest of the extreme edge of the Colorado Plateau.

Drainage in the area is east and northeast to northwest into an intricate system that circles the Weaver Mountains and eventually drains into the Sonoran Desert. The draining system outline the Weaver uplift very well.

In general, accessibility is not a problem, practically any vehicle can be driven right to the mining site. However, explitation activities may require some road improvements.

The geomorphic location of the claims can be observed on the maps.

The claims are well located for all year round mining and milling activities.

Climate & Vegetation

SECTION 4

4.1 GENERAL

The climate is one that would favor an all year round mining and milling activity.

A mean temperature is not available for this area, but there is less than 50 days of freeze and thaw annually, and about 20 days in which there may be a thunderstorm. There is varied rainfall, precipitation is 8-12 inches annually. The area is part of the semi-arid desert climatic zone and part of the transition zone between the desert and Pine biome.

MAJOR BERYLLIUM RESERVES IN ARIZONA

The vegetation would not provide any timber resources such as might be required for certain mining activities.

The claims are at an elevation of about 5000 feet, again suggesting an equable climate. Vegetation is therefore limited because of lack of water and the type of igneous terrain. Some pinion and juniper survive as well as nineteen varieties of desert shrubs, none of which have any economic importance.

Power & Water

SECTION 5

5.1 GENERAL

Arizona Bureau of Mines puts out a map showing all of the transportation facilities and power lines in the State of Arizona. These can be obtained by writing to the Arizone Bureau of Mines, University of Arizona, Tucson, Arizona.

Dr. R. Ross initiated a power study in 1961 which was not completed, but preliminary information suggested that commercial power could be available for a deposit at that time of $35,000, from which a certain percentage of usage would be deducted on a monthly basis over a given period of time, and would threfore constitute an advance deposit. However, this may have to be researched again, depending on the program that may be planned for the property.

For an installation of less than 200 tons per day beneficiation plant, commercial power would not be recommended. Should the original installation exceed 200 tons per day capacity, commercial power would be recommended. Since the potential of the property, in the opinion of the writer, is such to justify at least a 250 ton per day plant, it is recommended that commercial power be investigated. An existing power line from which transformer facilities could be taken is only about 7 miles from the property.

250 Ton per day Mill Recommended

A 250 ton per day plant would have a water requirement. Shallow wells have been drilled in the ficinity of the claims for stock purposes and indicate the water table is within 100 feet of the general surface. However, water requirements sufficient to operate a minimum processing plant of 250 tons per day capacity would require at least one well or series of wells capable of producing up to 250 gallons of water per minute. For general purposes one might consider as a rough tool that for each ton of daily capacity the water requirements will be one gallon per minute.

Such a well or series of wells would have to be about a 12 inch diameter hole, cased to at least 9 inches, and probably about 400 feet deep. A well this deep would take advantage of the structural acquifers in the area. Some water would be available through dewatering processes in connecting with a possible open pit exploitation program as indicated by the occurrence of water in several of the exploratory drill holes.

A submersible pump wired for 220-440--20 hp with pipe and wiring would cost between $1600 and $2000. The well would cost about $12.00 per foot to drill and case, or less if a rotary rig was utilized, or about $5,000 maximum.

MAJOR BERYLLIUM RESERVES IN ARIZONA

This would include site work and access, as well as location of the site.

To develop water it is recommended that a rotary drilling rig be employed, which can explore the water zone with a $5\frac{1}{4}$ inch hole and once acceptable water has been found and tested, the required depth established, then casing and pump installation can proceed through a series of reaming activities and casing. The same type drilling rig could be utilized for exploration of the subsurface to further block out and delineate the beryllium mineralization. Considerable money could be saved in this type of combined activity.

The use of a rotary type combination drilling rig of which there are several types (both Failing and Mayhew models) available through certain contractors could save more than 50% of the water well development cost as well as the drilling, based on the experience of drilling the property when the first series of holes were drilled.

It is therefore recommended that should a beneficiation program calling for the installation of more than 200 tons per day be planned, then water wells capable of producing at least one gallon per minute per ton capacity would have to be drilled near or on the claim area.

Commercial power would then be recommended.

Transportation

SECTION 6

6.1 GENERAL

Rail and air facilities are located fourteen miles south at Congress Junction; at Wickenburg, 33 miles south, and at Prescott, Arizona, 35 miles north, all on Highway 89.

Heavy aircraft facilities are located at Prescott and Phoenix which would be the main centers of equipment, supply and labor.

Light aircraft facilities are available in the area, the writer is a licensed Pilot and has landed aircraft near the property. An excellent facility for such light aircraft as that of a Cessna 180, could be prepared a short distance from the claim area. Emergency parts and supplies could then be flown in as required.

The writer is acquainted with, and in some instances has equipment, houses and accounts in the Phoenix and Prescott areas.

Thus, the property is well situated in regard to various supply centers, transportation and rail facilities, and highway transportation which would be demanded for any contemplated mining and milling operation.

Methods

SECTION 7

7.1 GENERAL

The claims were first examined in reconnaissance fashion

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and then more detailed work was started in each area that needed investigating. Not all of this work was completed, but what was is compiled into the reports accompanying this report and into the various sections that follow.

Map APM-1 essentially compiles the results of plane table work, location of drill holes, some sampling, and the general features of the mineralized area, but it is not completed and should be in order to further provide data for guiding the drilling activities which will be required to block out the mineralization and extend the known tonnages of beryllium ore.

A new map of the claims was prepared by Barkdull, land surveyor, and has been refined into maps APM - and APM-3

New techniques of geochemistry and structural geology were employed, and their valuable and important evidences are compiled to the degree this work has been accomplished.

Samples for petrographic and petrological work were taken but because of lack of finances the laboratory work on these samples, to obtain important rock type data, was not completed.

Claims

SECTION 8

8.1 CLAIMS

Mr. Thomas H. Barkdull, Registered Land Surveyor, completed a survey of the claims in December 1966. Further revisions were made of the claim map in January 1966. A photographic reproduction was obtained on a 3 x 4 inch slide of Mr. Barkdull's survey and the final revision was assembled as map APM-2 which accompanies this report.

A section of the original claim survey was also utilized to prepare a base map for the additional work that will be required to complete the geological and mineralogical study of the claims, and this has been prepared as map APM-3, also included with this report.

8.2 UNPATENTED CLAIMS

The present claim group held by Associated Petroleum and Mining Co. is made up of eight (8) unpatented lode mining claims all of the regular size of 1500 feet by 600 feet, 20 acres each. They consist of the following:

Monte Cristo 1 through 8, inclusive.

Essentially, mineralization so far exploited and explored occurs on the Monte Cristo claims No. 6 and 5. These claims are located in Section 34, Township 12 North, Range 5 West and Section 3, Township 11 North, Range 5 West.

Geology

SECTION 9

9.1 GENERAL

During the ten years that have elapsed since the geological work was first initiated on the Monte Cristo claim area, more

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geological data has become available including the Resume of the Geology of Arizona by E. D. Wilson (Bulletin 171-A) and new geological maps of Yavapai County have been prepared. A copy of the new county map is included.

Extremely new technical treatment of data has also been developed, such as the MULTIVARIATE STATISTICAL ANALYSIS -A DECISION TOOL FOR MINERAL EXPLORATION, described by D. P. Harris in the 1965 Symposium on Systems Engineering held at the University of Arizona, and available in a three volume set on Computer and Computer Applications from the college of Mines. Such a new approach to field geology requires an exhaustive treatment of field data and demands a more profound treatment of geological data. It is with some satisfaction that the writer in revising the earlier reports finds that much of this had been anticipated.

Successful exploration for mineral deposits depends now on examining as many facets of potential information in the field as one can conjure up in the mind, though keeping in mind the ever limiting factors of finances and ultimate objectives.

9.2 HISTORICAL GEOLOGY

Paleotectonic studies throughout the state of Arizona show that large parts of Arizona were covered with seaways during the early periods of earth history, and a more particular record has been left for the Cambrian, Devonian, Mississippian, Pennsylvanian and Permian periods of the Paleozoic Era. Everywhere deposition of sediments were thin. In many areas in the more elevated portions of the land masses south of the present Colorado Plateau there were no sedimentary rocks deposited: or if they were they were removed during some subsequent period of time, perhaps during the Mesozoic or even Cenozoic Eras.

Significant activities in the development of the continental land masses which originated on the distant geological past bear upon the present land configuration and possible mineral deposits, and are linked with the genetical history of each deposit. Much of Arizona in Devonian time had been depicted as being above water until subsurface work revealed the presence of Devonian beds in the eastern parts of the state and Tertiary conglomerates suggested the former presence of Devonian beds in the western part. Evidently the later Cretaceous and Tertiary structures that were developed were little influenced by these widespread and thin sediments.

In Triassic time a broad peninsula projected northwestward through central Arizona, obliquely from Cananea, Mexico to Mesquite, Nevada. Nearly all beryllium occurrences in Arizona and southeastern Nevada are found within the outlines of this peninsula. It is within this area that prospecting for beryllium is being concentrated, and where future discoveries may be made and in the central portion of this peninsula the Monte Cristo claims are located.

Where the Sonoran Desert is now there was a trough of sed-

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imentation that continued to sink into Jurassic time. This peninsula and trough presaged the direction and position of the later orogenic belt and cyclic metallization that occurred including many of the large copper deposits. The area embracing the claims had an eventful history, with periodic uplift, faulting, volcanic activity and tectonic and palingenetic episodes. Orogenic activities finally resulted in such uplift and subsequent erosion that for most of the area of the claims only very ancient Archean rocks were exposed of undifferentiated granites, schists, granite gneisses.

Intrusives and dynamic metamorphism of the Nevadan Orogeny are assignable. The Larmide Orogeny introduced additional igneous activity and considerable deformation, folding, thrusting and faulting, especially in southeastern Arizona. Large stocks were introduced into the central part of the State accompanied by other tectonic activities. Much of this igneous activity still remains to be dated.

High angle faults cut and offset the bedrock in the region of the claims. These structures form a regmatic pattern which exerts control over mineralization in the adjacent mining districts. Some of these structures predate the Larmide Orogeny, some are part of it, and the majority are middle or late Tertiary. Mild volcanic activity accompanied the sedimentation and lava flows are locally present in and on top of young formations. To the west of the Weaver Mountains extensive basaltic flows exist.

9.3 STRATIGRAPHY

Since there are no sedimentary rocks on the claim area, and only limited occurrences of metamorphic rocks, there is little or no data around which to formulate a discussion of this topic.

9.4 IGNEOUS GEOLOGY

The area to which mineralization is confined as far as it is presently known, is one of undifferentiated igneous rocks. It is important, for future exploration to be effective, to differentiate these igneous rocks into their early and late units, and to pursue to completion the petrographically oriented program which was not completed in earlier programs because of the lack of finances.

The Weaver Mountains appear to be part of a regional exposure of pre-Cambrian Granitic rocks associated with a porphyry and gabrro complex.

Essentially the beryllium ores of the claim area occur in structural controls that developed during Laramide times and which were pressure outlets during Tertiary metalization activities. A detailed paragenetic sequence for the episodes of mineralization would be one of the important aspects of information that would materialize from a quantitative mineralogical investigation.

The one significant fact in the area is that the beryllium ores all seem to be delimited to and by the granitic host rocks. Only as the granitic units were able to adjust themselves to multiple vector forces and finally under the exerted pressures actually

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weakened to provide fracture systems into which the ore matrix was emplaced have they importance.

SECTION 10

10.1 GENERAL

Investigations in the field were initiated to study and to establish the structural control of the beryllium mineralization. Since there are no stratigraphic units to deal with, the igneous terrain alone must be studied to obtain structural information, and the methods employed to do this are those usually called Granitic Tectonics.

10.2 GRANITIC TECTONICS

Important structural information has materialized from the employment of this method. Several hundred feet south of the main area of mineralization, an area was selected in the host granitic rocks to make a special study of the orientation of crystals, essentially the feldspars, to obtain fine-structure and ore controls of the area. At least four more studies should be completed in and near the deposit to fully exhaust the idea that is possible from this approach, three in the other directions near the ore body, and at least one at some distance from the mineralization in unaltered rock to ascertain the continuity or uniqueness of the structural control; information extremely useful for further exploration in the area.

There are two groups of orientations which have to be separated from each other. The first group is the regional lineament tectonic fabric or direction of preferred orientation. These directions are North-South, North 45° West, and East-West. These structures will be found throughout the region and will have only a small role to play in mineralization. When these regional or lineament directions are removed, the preferred orientations are easily seen, as it is these directions which can be found geologically to be the main influence on ore localization of the beryllium mineralization and the development of the near surface type of bull quartz-beryl-mica deposit, something similar to pegmatitic deposits.

The preferred directions are North 20° East, North 40° East, and North 80° East. For all practical purposes, the mineralization should be controlled by these preferred directions, and faulting, dilational development will be found to correspond essentially to these directions. In areas of igneous rocks, the crystal orientation method is the only way to deduce what may be at depth and in time would have been consequent, or finally imposed upon the nearer surface rocks.

It will be noted that the regional direction of orientation of the Weaver Mountains is North 45° West, so this direction is expected to modify in part and control or influence in part, the structural features associated with the beryllium mineralization and mineral emplacement.

These features, then, when fully mapped in the area, will permit one to control and pin point subsurface drilling.

As further-field work is completed a dimensional picture of the structural features of the deposit will emerge. The

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significance will then be seen, especially since mineralization at depth will be essentially confined by the structural features of the host rock and the confining altered zone, which itself is limited to the area having the preferred structures.

Geochemistry

SECTION 11

11.1 GENERAL

Dr. H. W. Yoder and Dr. H. E. Eugster of the Geophical laboratory, Carnegie Institution of Washington, studied the temperature composition relationships of the muscovite-paragonite join. Their work demonstrated that the amount of sodium which can substitute for potassium in the muscovite (mica) structure in the mica minerals is directly proportional to the temperature. They analyzed muscovites from various geological environments and found that the socium-potassium ratio did vary in a manner that one would expect, considering the environments from which the samples came. Pressure has a secondary although significant influence on the Na-K substitution in muscovite. Thus a method for the determination of the temperatures at which the muscovite formed could be developed, this would provide the mineral investigator with a good useful method of quantitative geothermometry and perhaps lead to important exploratory functions and contributions. Assuming the mica from the deposit would make a good useful geothermometer, samples were taken for this purpose.

In 1960, C. Hedge, associated with the writer at the University of Arizona Geochemical Laboratory, conducted similar experimental studies. Since there was an abundance of muscovite associated with the beryllium mineralization at the Monte Cristo claims, analytical studies were performed on samples from the deposit. Beryllium in the area under investigation is associated with the higher temperatures. The results will provide a control on subsurface drilling results if micas are brought back to the surface during the course of drilling which should vary from the limits of mineralization.

11.2 MUSCOVITE TEMPERATURE RESULTS

The mica for a sample was removed from a large bery crystal on the west side of the deposit. The sample yielded a Sodium contest = atomic % 6.37, Temperature 410° C. The temperature of mineralization must have been of about 410°C because of the intricate association of the mica within the beryl.

On another sample away from bery crystals, but within the confined structural area the sample yielded a Socium Content = % 8.65, Temperature 415°C.

Other samples led to tentative conclusions.

11.3 CONCLUSIONS

Tentative conclusions based on the above results permit one to establish a trend which is extremely useful. Bery crystals

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have formed at a temperature somewhat lower than the extremely altered rock variety which contains a great deal of mica but no visible beryl. At temperatures lower than 415° C beryl crystals seem to have formed in abundance. Where the temperature in the deposit exceeded 415°C it appears that no beryl crystallized, at least in large crystals or economic deposits. The elemental suite which crystallized into mica seems to have crystallized at a higher temperature and then as cooling took place, beryl at somewhat shallow depths compared with the other were formed.

Perhaps it may be that at even greater depth beryllium minerals of lower temperature may be found to occur in greater abundance. Bertrandite, an important high grade mineral of beryllium seems to form at 310°C. Thus the temperature data is most important. Micas found at the surface upon analysis may provide information on the possibilities of subsurface beryllium mineralization if their temperatures are found to exceed 415°C.

On the north side of the mineralization zone where the third sample was taken, there is no visible beryl, but there is considerable muscovite and different red and white minerals which are suspected of containing beryllium in a mineral form other than beryl. Mineralogical analysis for BeO content should be made.

The higher temperatures seemed to have prevailed during the early phases of emplacement of the micas, alkalic altered feldspars, and intense quartz bodies. As the temperature dropped beryllium minerals of the silicate variety, beryl in particular, formed and with plentiful beryllium in the environment, exceedingly large crystals were formed, some more than twelve inches across and several feet long. If these temperatures prevailed to any depth, and if the beryllium source continued to supply beryllia in sufficient amounts, there could be a large continuous zone of mineralization rich in beryllium and perhaps going at considerable depth. Other minerals might replace beryl, however, as temperatures changed, such as chrysoberyl, as indicated in hole DH-7 at a depth of 150 feet.

Beryl at 150 foot depth

With such proof of mineralization at the surface areas and at that depth, there should be further drilling to explore the area and to block out additional tonnages.

Other sampled areas indicate a transition zone between the high temperature upper portion of the mineralized mass through a zone where beryllium minerals other than beryl may occur in the lower temperature zone where the important beryl minerals were fully developed, crystallographically and of unusually large size.

The delineation of temperature gradients for the deposit and a construction of a dimensional model of the deposit

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will permit an evaluation of the mineralization perhaps not otherwise obtainable. Quantitative analysis will also be desired for beryllia content on such samples as may show a temperature of 410°C or so where no visible beryl can be seen.

The significance of the association of high temperature micas with a red disseminated mineral (believed to be beryllian-garnet) will be known as soon as the red mineral has been full identified.

It will also be noted that the micas having the 10% sodium, generally are located physically above the beryl zone and do not have the red mineral suite.

We have three criteria that will be useful for directing and evaluating future drilling.

1. High sodium content on the upper mica zone, no red minerals, therefore, barren, but associated above good zones or near them.

2. Intermediate or lower sodium content, red minerals in association, no visible beryl. Economic beryllium deposit.

3. Lower low sodium zone, visible beryl, no apparent red minerals, lower temperature, rich ore, high beryllium content.

Another item of importance. The high temperature micas are those restricted to the large "book" micas, those that might be of economic importance as a by-product.

It is not an expensive nor a difficult thing to do or have done to have mica analyses made and sodium potassium contents determined. The value of the information is apparent, and future work in the area should utilize this new approach.

Mineralization

SECTION 12

12.1 GENERAL

A paper dealing with Unified Field Geology by the writer shows data for considering deposits of beryllium that had been emplaced at temperatures greater than the critical temperature of water. (375.5°C as pneumatolytic deposits. Those for which a temperature of less than 375.5°C ~~is established~~ would be called or considered as hydrothermal. The Monte Cristo deposit as shown from the temperatures obtained from the analysis of the micas show the deposit to be in the pneumatolytic category.

12.2 PNEUMATOLYTIC MINERALIZATION

The Monte Cristo beryllium mineralization has been verified as taking place above the critical temperature of water, above 375.5° The pressure of mineralization would have been up to 3500 Atms. and probably took place originally at some depth. Probably the mineralization took place originally at a depth of up to 50,000 feet. Erosion has exposed the present deposit at its upper limits only.

This means that the mineralization has been barely exposed and

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that nearly 100% of the original mineralization must exist in the area.

There must exist in all probability a large beryllium deposit, most likely the greater tonnages will be found at shallow depths (the top of which is suggested by the drilling results to be about 100 to 150 feet below the present surface) so open pit mining methods can be employed.

12.3 QUANTITATIVE ANALYSES

Bulk samples were taken from three places on the property. Sample No. D-10 was taken from a 14 foot wide exposed zone of soft white altered rock. It assayed 0.35% BeO, or about 4% beryl equivalent. This assay represents material more than 25 feet wide. This provides a minimum grade from which to get an idea of mining in the northern area.

Sample No. D-12 was taken from a zone of mineralization where the red (beryllian garnet ?) mineral was abundant and which is located on the southern end of a highly berylliferous zone. Sample D-12 assayed 1.16%BeO or about 11% beryl or equivalent. This is high grade ore.

Sample D-10 and D-12 were taken about 250 feet apart and this becomes an indication of the extent of the deposit, and perhaps its subsurface expression, since the two areas sampled are continuously connected for the entire distance with visible beryl mineralization.

Recall, that this is in the intermediate temperature zone above the lower temperature zone. Richer beryllia mineralization is expected just below this zone.

By linear intercept methods of measurement and analysis it is estimated that the main beryl zone, the 410°C zone, would yield about 5% of its total mass as large bery crystals based also in examination of the central shaft down to a depth of 36 feet, all that was accessible in 1956.

It is suggested by the assays obtained to date that the deposit will provide a milling grade better than .26% BdO, or more than 2% Beryl equivalent. It could easily approach a 1% BeO grade or tenor.

The U.S. bureau of Mines has developed a process, highly economic for the extraction of low grade beryllium deposits.

High Mill Grade Material

The cut off grade in 1956 Bureau of Mines process was .10 percent BeO. This indicates a superior deposit at the Monte Cristo claims of more than double the Bureau of Mines cut off ore.

From sampling it would indicate the ores should be checked for molybdenum, bismuth, copper, silver, vanadium and cadmium for possible by-product recovery.

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Mineralogy—Petrology

SECTION 13

13.1 GENERAL

This section reports the results from only limited work which is most important for beneficiation purposes and for mining and future exploration activity.

13.2 BERYLLIUM MINERALS

While there are many beryllium minerals (more than 60) only a few of these occur in the Monte Cristo deposit. These however, are the most important of the many beryllium minerals and have been demonstrated by commercial as well as U.S. Bureau Agencies to be the most easily processed and recovered.

The most important and abundant beryllium mineral on the Monte Cristo claims is beryl:

BERYL: $3BeO.Al_2O_3.6SiO_2$

It contains about 12% BeO

This mineral occurrs on elongate hexagonal crystals up to 3 feet long, but also as small irregular shaped crystals as well. It will be the most important mineral in the deposit unless future drilling finds more important quantities of other minerals at depth.

PHENACITY: $2BeO.SiO_2$

It contains up to 42% BeO.

This mineral occurs as a small white crystal. It is not abundant and should have only a minor role in the upper parts of the deposit.

CHRYSOBERYL: $BeO.Al_2O_3$

This contains up to 20% BeO

This mineral is found occurring in small amounts in the upper zone but increasing in quantity in the vicinity of drill hole No. 7 where the mineral was found at a depth of 108 feet and appears to represent the main constituent of that area along with at least one other unidentified beryllium mineral.

Large Beryl crystals were observed throughout the more than 300 feet of open cut workongs, irregular spaced, but often making up to 50% of the mass, but estimated to make up about 5% of the total, down to at least 50 feet as determined by the shaft that penetrated to this depth. It might be expected that the main beryl zone will extend to a depth between 50 to 100 feet. Below this the chrysoberyl zone will predominate.

Drilling

SECTION 14

14.1 GENERAL

A total of eight holes were pin pointed, of these finances only permitted the sites for five of them to be prepared. The holes that were drilled were: D-1, D-2, D-4, D-5 and

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D-7. Samples from each drill hole for each two feet were taken, but limited finances only permitted a minimum of assaying. The results that are available are included in this report.

The elevation of Hole D-4 is 4900 feet, and establishes the elevation for the area.

14.2 DRILL RESULTS

Drill Hole No. 1: This hole was aborted at a depth of 48 feet because of hard rock. A rotary drill rig was utilized but the rock was too hard for it. New drill rigs are now available capable of easily drilling this hard type formation. Rigs by George E. Failing of Enid, Oklahoma and by Mayhew of Dallas, Texas are capable of this type of drilling.

Large beryl crystals and yellow crystals of beryl along with much mica was observed in this hole. The drill hole penetrated granodiorite material in the upper 20 feet, then entered the quartz monzonite transition zone of red-beryllian garnet zone, and then into the quartz monzonitic beryl zone. A new off set hole should be drilled to a depth of at least 400 feet.

DRILL HOLE 2: This hole was drilled to a depth if 150 feet where water was encountered and the recovery was impossible because of insufficient air pressure. DH-2 passed through upper granodiorite rock which did assay .044% BeO indicating DH-2 is more centrally located for deeper drilling purposes since the normally barren host rock is carrying values in this spot. This was encountered to a depth of about 42 feet. At a depth of 120 feet visible mineralization was observed and samples sent for analysis gave a value of .50% BeO for the interval to a depth of 156 feet. It is assumed the mineralization persists to greater depth.

This drill hole therefore did appreciable increase the total tonnage potential of the deposit considerably.

Drill Hole No. 7: Only one other hole need be discussed here in view of the incomplete nature of the data. Drill hole No. 7 wasdrilled on the north side of the deposit. Micrometric work on samples from this deposit were made because of the small green mineral observed on this drill hole from about 104 feet deep to the termination of the hole at 172 feet.

Finances did not permit a full analysis of the drill hole, but it was determined petrographically that the upper portion of the hole passed through granodiorite rock, 64 feet thick, which was being altered over to quartz monzonithic rock. The green mineral was identified by Dr. Williams as chrysoberyl. The total chrysoberyl content for the quartz monzonitic zone from 104 feet to 172 feet was .40%. Further drilling is recommended for this area. A hole at least 500 feet may be required.

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Ore Genesis

14.3 CONCLUSIONS

In addition to conclusions being drawn in each section, it can be added here that the drilling results further supports the idea of a granitic pre-cambrian rock was involved in a deep seated palagenetic activity which resulted in a hydrothermal-pneumatolytic episode mineralizing and injecting material into structurally prepared zones. The granitic rock was altered to a granodiorite type composition rock bordering a zone of beryllium mineralization which is confined to a quartz-mononitic end product of alteration which varies in specific composition but which reflects the quartz masses and feldspathic masses in the three established zones.

The drilling indicates that the quartz masses were derived from de-silicated subsurface rocks, and that the quartz and barren feldspathic masses will be about 100 feet thick, or less, below which occurs a quartz monzonite, dipping to the south, at shallower depth to the north, and that this quartz monzonitic rock is the main host to the beryllium mineralization which consists of beryl in the upper zone, and beryl Chrysoberyl in the lower zone, subject to modification as more subsurface data and deeper data is obtained. Other less important minerals also occur.

Before exploitation of the ore body it should be obvious much more drilling will have to be completed.

Ore Reserves

SECTION 15

15.1 GENERAL

Specific blocked out reserves require complete engineering data, completed drilling programs, and detailed assay and analysis in order to establish firm and specific reserves. This type of complete quantitative data is not entirely available for the Monte Cristo deposit of beryllium mineralization.

However, from the limited drill results, and the limited mapping of the deposit, it can be stated that the probably reserves of the deposit are at least 60,000 tons and that one can infer from the drilling results a total reserve of 160,000 tons that will average more than .26% BeO.

15.2 TARGET TONNAGE

Probable One Million Tons

The drilling does suggest a considerably larger reserve than the actual measured tonnage. The dimensions of the deposit also suggest more ore extending to the east and to the north and south. From the combined results of all of the preceding report, the writer utilizing a multivariate statistical approach

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would state that the probability of a reserve of ore in excess of 1,000,000 tons is better than 80%.

Thus, this becomes the target tonnage that further drilling and geological investigations can expect to delineate. If the mineralization persists to a great depth, below 150 feet, and it should be stated here that the target tonnage would be above 170 feet depth, then more reserves may exist than 1,000,000 tons.

Previous tests indicates a good recovery is possible on these ores. Tests resulted in a 90% recovery of beryl with all of the chrysoberyl being recovered.

A market research should be initiated and the more recent technological advances should be researched.

Respectfully Submitted

/s/ Einar C. Erickson

Registered Professional
Engineer
Tucson, Arizona
February 1966

Ed. Note: A copy of the original and slightly more complete report is available, including maps etc. These claims were in litigation until recently and are now settled. An option assigned to Cushionrail was formalized and signed on April 17, 1977.

Concentrated Deposits Extremely Rare

Beryllium is estimated to occur in earth's igneous rock to the extent of 0.0006%. It's abundance is 1/7th of that of tin. Unfortunately, these rocks usually contain too little beryllium for significant concentration.

Uses

A thin sheet of beryllium is used in the transmission of X-rays and its use for windows is important particularly as X-rays become longer and more easily absorbed. An increasingly important use of Beryllium is as a target in cyclotrons and other machines with high-energy beams for generating neutrons.

Beryllium is the only stable light metal with high melting point. This fact, coupled with its good electrical conductivity and high modulus of elasticity make it an important potential in construction. Beryllium copper alloys are used where spring qualities are required in combination with corrosion resistance. The unusal hardness of beryllium copper has resulted in its use for tools where the sparking might be dangerous. It has a special usefulness in forming powerful self-generating protective surface films. In certain silver alloys, beryllium has the effect of reducing tarnishing. It is also used to promote fluidity and soundness in casting with copper, aluminum and magnesium.

THE ECONOMIC GEOLOGY OF THE
DIXIE QUEEN - MONTE CRISTO CLAIMS
YAVAPAI COUNTY, ARIZONA

A PRELIMINARY REPORT ON THE ORE DEPOSITS

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INTRODUCTION

General Statement: The Dixie Queen - Monte Cristo Claims, 1 through 15 inclusive, examined by the writer consist of 15 unaptented claims generally considered to be the Smith & Kent Mining Claims. The claims were examined on October 23, 1956 at the request of Mr. J. Phillips of Phoenix, Arizona.

Essentially the claims examined appear to have been properly staked in accordance with the mining regulations of the State of Arizona. Open cuts had been made for necessary discovery holes. For the purpose of this report the field examination was confined to claimes..No. 1, 2, 9 and 5.

History of the Properties: A Mr. Regan had worked the Bull Quartz outcropping which capped beryl-mica and bismuth-gold complex ores, prior to 1917. Mr. W. Young came into the area in 1917 taking up much of the land for cattle and agricultural purposes. In the early 1920's mica was mined from the property which the writer understands consisted of less than half of a normal claim. In 1928 Mr. A. Flagg first examined the property. Two of the Regan boys removed some 400 sacks of beryl soon after and during this period as well, and mined the property for Euxenite. Not long after this the property became idle and remained so until 1947. A Mr. Westover had relocated the property during the 1940's and in 1947, Mr. H. G. Smith bought half a claim, installed a mill for the recovery of mica. Some attempt was also made to recover the bismuth-gold ores. Mr. Kent leased the claims from Smith and located the additional claims which comprise the present group in 1953. The property was leased to a Mr. B. Doolin who did not perform and consequently in 1956 the properties were put into the hands of the Dixie Queen Mining Corporation. Mr. G. A. Tognoni prepared the only map of the claims the writer is aware of. Other than the above and except for the writer's own examination at two different occasions in 1956 there appears to be no other additional work performed on the properties.

Location and Acessibility: The mining claims are located in the east central part of Arizona, in Yavapai County about thirty-five miles southwest of Prescott. The claims are approximately eleven miles out of Yarnell, Arizona in the Weaver Mountains, just a short distance from Lounce Lookout at an elevation of about 6,000 feet.

The claims are located in Section 3 and 4 of Township 10 North, and section 34 of Township 11 N, R 5 W. Geologically, the claims are located in the center portion of the mountain region or Mexican Highland, southeastern area of the Great Basin province. The claims are west of the large San Francisco Volcanio field and southwest of the extreme edge of the Colorado Plateau. The draining in the area is to the southwest toward the Sonoran desert.

The mineral claims are accessible from the east via good graded roads from Highway 89 six miles from the properties. Accessibility is not a problem. Practically any vehicle can be driven right to the mining site proper.

Climate and Vegitation: The climate is considered to be semi-arid with the precipitation amounting to less than 14 inches per year in the area of the claims. There are approximately 90 days of freeze and thaw in the area, although all year operations are mintainable. There is less than 30 days of thunderstorms in the area, but this fact does suggest that some preventive work should be done on roads and consideration should be given to plant installations so that sudden flood washes will do little damage. The climate is excellent for working, however, with cool nights all year and equable days most of the time.

The vegitation is limited because of the lack of water as well as the type of outcropping rock. Relatively little decayed granite does not support much life. However, some pinion pine and juniper survive as well as nineteen varieties of desert shrubs. None of the local vegitation species are considered at present to be of economic importance or use, except for some limited logging materials for certain types of mining activities.

Scope of Report: The scope of this report is limited to the several claims examined, and therefore to the time spent in the field by the writer. A sufficiently complete investigation was made to permit the writer to evaluate the existing mineralization, to deal with the general geology of the area and to commence the geochemical study necessary to analize the history and nature and merit of the ore under investigation. The investigations were conducted in the drifts that had been put in by Mexican miners, and which were typically Mexican; to the two shafts on the properties and to the larger open cuts and bench mining exposures that had been made on the claims. The objective ofthe present investigation was primarily to provide a geologic report on the area being exploited, and to initiate the detailed study necessary for providing assay data for the eventual installation of a mill to handle the excellent ores that exist and determine their complex character, history and origin and quantity.

Present Work and Methods: A total of three days have been spent by the writer in the area prior to the submittal of this report. The claims were examined first in reconnaisance fashion, and then detailed work was done where the ore area had the greatest exposure and where mining was being done and from where a future mill reserve would be obtained. A map of the workings was made by Brunton compass and pacing and therefore is of approximate accuracy only, but sufficient to aid in the activities to be undertaken. The geologic contacts and structures were delimited and the controls of the ores delineated. Samples were teaken to provide minimum grade and maximum tenor assays for the different materials considered of economic importance.

GEOLOGY

Principal Features: Paleotectomic studies show that large parts of Arizona were covered with seaways during parts of Cambrian, Devonian, Mississippian, Pennsylvanian, and Dermian time. Everywhere the deposits were thin; and in many places in the mountain and desert regions south of the Colorado Plauteau they were never deposited or were removed in Mesozoic and Cenozoic time.

Much of the Arizona in Devonian time had been depicted above water unitl subsurface work revealed the presence of Devonian beds in the eastern parts of the state and Territory conglomerates suggested the former presence of Devonian beds in the western part. Evidently the later Cretaceous and Territory structures that were developed were little influenced by these widespread and thin sediments.

In Triassic time a broad peninsula projected northwestward through central Arizona, obliquely from Canada, Mexico to Mesquito, Nevada. Where the Sonoran Desert is now there was a trough of sedimentation that continued to sink into Jurassic time. This peninsula and through presaged the direction and position of later orogenic belt and the cyclic metalizations that occured. The area of the claims was very eventful as far as geologic history goes with periodic uplifts, faulting, volcanism and tectonicactivities. Oregenic activities finally resulted in such uplifts and subsequent erosion that Archean rocks were exposed. Intrusive and dynamic metamorphism of Nevada Orogeny are assignable. The Larmide Orogency introduced additional igneous activity and considerable folding and thrusting, especially in southeastern Arizona. Tremendous stocks were intruded into the central part of the state accompanied by other tectonic activites.

High-angle faults cut and offset the bedrock in the region. They trend in many directions. They predate the Laramide orogeny, some are part of it, and the majority are middle and late Tertiary. Because of block faulting, regional warping and perhaps other factors, the central and southern part of Arizona became an area of aggradation in late Tartiary time. Mild Volcanic activity accompanied the sedimentation and lava flows are locally present in and on top of young formations. Uplift and subsidence of intermontane trough areas continued intermittently into Quarternary time. Eroded meterial from the trenched areas supplied the relatively thin vaneer of Quaternary terrace and stream alluvium.

Tertiary volcanic rocks are nearly everywhere, and in one place represent continuing volcanic activity down to the Pueblo Indian cultural times.

In general the ranges trend northerly in southeastern Arizona and northwesterly in central and southwestern Arizona. This alignment is probably due to late Teriary faults. Considerable time has elapsed since the last major movements, because extensive pediments have formed across many faults and true fault scraps are few.

Stratigraphy: No sedimentary rocks were observed on the claims examined. Essentially the claims were compoised of igneous rocks.

Igneous Geology of the Dixie Queen Claims: The Weaver Mountains appear to be part of a regional exposure of Pre-Cambiran Granite associated with aporphyry and gabbro complex. Tertiary volcanic form inclosing uncomformable relationships to the north and east of the area. As the particular granitic complex acts only as a host to a much later mineralization epoch they are not discussed in detail. They appear to have contritubed no chemical factors to localization of the ores. Essentially the ores of the claims occur in structural controls that developed during Larmide times and which were pressure outlets during Tertiary metalization activities.

The one significant fact in the area is that the ores will all be delimited by the granitic host rocks. Only as the granites were able to adjust themselves to multiple vector forces and finally under the exerted pressures actually weakened to provice fracture systems into which the ore matrix was expelled have they importance.

ECONOMIC MINERAL DEPOSITS

General Statement: The writer is not aware of what production has been had from the claims examined. He is aware that recently hand cobbed beryllium crystals brought $500.00 per ton, and that mica shipments have been made that have brought current prices. Bismuth had been concentrated previously among gold and Columbian-Tantalum ores. To what extent is not known. A map of the workings conducted to date showing the position of shafts and drifts accompanies this report in the back packet.

Mineralization: A geochemical study of the mineralization and the relationship of the mineral deposits on the claims to the adjoining and host igneous rocks is still under way. Until such time that it is completed the writer considers the area to have probably followed the pattern given below:

With the exertion of stress during late Nevadan and early Laramide oregenic activities on the pre-cambrian rocks of the area a fracture system of an eastwest trend was developed. This set was eventually cominated by a north-south facture set which became increasingly weaker zone. At depth, below the pre-cambrian complex, palingenesis is considered to have taken place. This is to say that a melting-in-place due to release, and provision for an outlet, of pressure took place as the near surface facture sets developed. A release in pressure caused the subsurface rocks to liquidify. This Palingenesis, or granitization as some call it, may have been accompanied by considerable heat and release of liquids and gasseous materials. At any rate, the semi-liquid rock mass began to ascend in the direction of pressure release. In doing so it thrust aside the invaded formation along the lines of the facture systems, lifted them in some degree, assimilated portions of the adjacent host rock and melted portions of the overlying materials. Since the only direction of yielding was towards the surface the differentiating material undergoing complex chemical reactions and cooling migrated upward. As it did so the cold adjacent rocks created convection currents, differential crystalization of portions of the material took place and gravitative separates of liquids and solids took place in such a manner that a silicate melt accumulated near the top of the ascending mass with trapped gaseous and separated liquids immediately below which escaped as opening fracture permitted.

Assimilation, which is a process of chemical dissolution, rather than melting, and which depends for its effectiveness largely upton the gas content of the ascending mass, is most pronounced at theroof of the mass, where, by the process of "stopping" tongues of the melt, insunate themselves along joints, cracks, fissures and weaker lines of the adjacent rocks, gradually prying loose blocks of these rocks called zenoliths, which sink into and are engulfed in the ascending mass. Such evidences seemed to exist in the open cuts examined with some of the xenoliths being nearly digested or melted as well. Palingenesis also occured in the immediate rocks enclosing the ascending mass. This resulted in a more crystalline granite rock separating the ore emplacement and the surrounding granite masses.

Through chemical interactions, gravitative separation and fractional crystallization, the ascending mass, which was originally rich in beryllium and the necessary constituents of mica, separated into their various component part differing in character from the original melt by the increased local concentration and accumulation of the materials having an affinity for one another. The mass cooled quite slowly as the melt and its host rock were poor conductors of heat and as a consequence larger crystals developed during this congealing action.

The emplacement is not pegmatitic, but rather a solidified mass of an original silicate melt rich in the aluminates and having an abundance of beryllia, bismuth, some gold, rare earths, and mica elements which now constitute an ore body of sufficient proportions and concentrationto be of economic importance worthy of serious exploitation.

BERYLLIUM DEPOSITS

There are some thirty recognized minerals containing beryllium. In the ore body on the claims three of the most significant of these are recognized: Beryl ($3BeO \cdot Al_2O_3 \cdot 6SiO_2$) which occurs in small elongate crystals of a bluish-green hue. Phenacite ($2BeO \cdot SiO_2$) occuring as small white crystals in the mica zones and in the white altered material characteristic of the deposit. The Phenacite occurs more abundantely in the material high in aluminates. However the phenacite is now only considered of minor importance. It is the chrysoberyl ($BeO \cdot Al_2O_3$) that occurs in large crystals which can be hand cobbed. A secondary mineral, bertrandite, ($Be_4Si_2O_7$-$(OH)_2$, occurs on these large crystals also.

For milling purposes it is the small beryl crystals that will comprise the bulk of the mill feed. And because muscovite, mica, appears to be a preferred host for beryllium the scattered mica will necessarily have to be processed. The mica can then be removed separately as a by product.

The writer observed crystals of beryl as much as 18 inches in cross section and several feet long, stacked like cord wood in the upper exposed areas of the ore deposit. The unique nature of beryllium as a divalent element permitted it to be admitted into the trivalent and quadrivalent structures of aluminum and silicon respectively. So while the crystals of the larger sizes can be removed by hand or mechanically, an excellent mill feed remains behind in the silicon-aluminum complex.

Immediately below the quartz capping the large crystalsof beryl and Chrysoberyl begin to appear. Green beryl occurs in masses in the quartz itself but the main occurrances are in the materials below. The large crystals have an irregular spacing, but are often found in collected accumulations and often comprise in excess of fifty percent of the ore mass. Large crystals were examined in place throughout a distance of three hundred feet in a zone estimated to be more than twenty feet wide. This width is the presently opened width only, the true width may be many times this when the ore deposit is fully delineated. In the old workings where one shaft had penetrated to a depth of more than 50 feet, the southern shaft, and where another shaft had pene- trated into the material approximately 30 feet, the crystals were still observed in place.

The southern shaft visible on the above photograph where the head frame stands, is near the central portion of the deposit as it is now opened up. The crystals near the bottom indicate that an approx- imate 70 feet can be considered the proven depth extension of the ore body. The depth from all indications is going to be much more than thiss. The problem of reserves is not going to be a major one. The northern most shaft, of smaller dimensions appearsto be east of the main facture set which proficed the depositional area for the ore deposit. It is in this area that other values will be found besides beryl.

Three photos show how the southern part of the open bench cut. The characteristics of the altered ore matrix is visible. The gray, broken and factured capping is essentially all quartz. At the base of the wall the large beryl crystals are coming in. Seldom are they separated by more than a few feet of distance and they often occur in masses of three to a dozen or more crystals. They are easily dis- tinquishable because of their hardness and yellow to greenish color. Mica is also abundant throughout the mass.

The fracture so visible here are those caused by differential pressures near the surface, freeze, thaw, etc., and reflect no actual control. The writer is standing on the sulphide zone just west of the granite-ore contact. The sulphide zone is of no consequence and may have not been connected in anyway with the present ore deposit.

The sulphides could have been introduced at a much earlier period when some local gold deposits were emplaced.

BERYLLIUM RESERVES

The following assays have been received by the writer:

Beryllium .52% Sample No. 2, taken from open bench cut.

Beryllium .26% Sample taken from the sides of the north shaft.

Beryllium .11% Sample taken from the waste material deposited by previous working of mica.

Beryllium 11.40% Sample of large crystal, high grade.

The samples were assayed by Minerals Refining Co., of Salt Lake City, Utah and Murry White Laboratories of Salt Lake City (Garfield), Utah.

The high assay illustrates the grade of the crystals that can be hand cobbed from the ore deposit. The writer by measurement grid techniques calculated that the ore deposit will yield not less than 5% of its mass as large crystals. As much as 50% locally, can be expected, but a conservative average could be considered as 14%. This figure then means that an average of 280 pounds of beryl and chrysoberyl crystals can be expected per ton of the ore material, and not less than 100 pounds. (Ed. note. With .5% ore running $4.00/lb, = .1 would equal $8.00 / lb and 1.% would equal $80 per pound) Beryllia, or BeO runs, as a rule of thumb about 10% of the crystal and would therefore yield between 10 and 28 pounds of the BeO for which in 1956 market, the cobb material is valued between $23 to $64 per ton, minimum, in 1956.

Remaining in the ore material is an ore of .52% BeO, in the southern half of the deposit, and .26% BeO in the northern half with 300 feet of linear extent so far delineated. It is the material that will be utilized as a mill feed.

The U.S. Bureau of Mines has developed a process, highly economic, for the extraction of low grade beryllium. At this time the minimum profitable mill feed for their process is not less than .15%, and .25% is considered excellent. As the range of the ore material after the extraction of the BeO in the hand cobbed crystals is between .26% and .52%, the ore deposit is considered excellent for a milling operation.

In sampling the ore for obtaining a mill feed grade assay, the writer deliberately refrained from taking obviously higher grade materials in the channel area where the ore was sampled. As a result, the future mill tests will reflect a higher assay than the above because of the concentration of beryllium in the micas and from smaller crystals which will be left in the ore material, and from crystals that may fragment or break during the firsst mechanical separation.

In actual mining, the ore deposit will be expected to yield nearly 20% of its mass as removable crystals with a mill feed of .50% to 1.00% BeO.

For reserve purposes the writer, from measurements made in the field, estimates the following ore quanties:

Proven reserves: 30,000 tons.

Probable reserves: 30,000 tons, each zone 20'x 300'x 70'.

Inferred reserves: 160,000 tons.

For the inferred reserves the writer can measure a width on the surface of 20 feet. 40 feet can be asssumed because of the additional surface exposures and the extent of the quartz and mica outcroppings, and that the linear extent is at least 300 feet, would give four times the volume when the material can be assumed to go twice the proven 70 feet depth. As each unit volume will contain 30,000 tons, then four such units would contain 120,000 tons. Additional reserves of an inferred order are assumed because the altered zone has an extension of 80 feet at least which could easily double the reserves of of 120,00 tons, but only a 50% figure is considered to give that degree of conservatism. The problem of reserve is not great as they appear to exist in quartity.

MICA RESERVES

By weight, the mica content of the ore deposit is approximately 12%. For every ton of removable ore, there would be not less than 100 pounds of mica, as a minimum, with the expected yield of 200 pounds. Minerals Refining Co of Salt Lake estimated the content of the mica to run between 10 and 12%. But the mica occurs irregularily, and not to the detriment of the ore, as usually it occurs in large massess which can be mined directly. Because of the beryllium content of the mica is of mill feed grade, the mica can be processed first and recovered, clean, as a by-produce in large quantities which will bring premium prices.

Scrap mica brings from $25.00 to $30.00 a ton, but a number of tests not yet completed, suggests that the dielectric characteristics, it may meet a market for micas of certain types which bring up to $140.00 per ton.

For evaluation purposes, however, the mica content is expected to yeild approximately $4.00 per ton. This could be considered a minimum, and does not include evaluations for large masses.

The tonnage of material containing mica is approximately the same as that calculated for the beryl ores.

OTHER ORE RESERVES

Complete geochemical tests on the ore material is yet to be completed, but in the preliminary examination several additional by products are certain to be considered.

BISMUTH: Ore assays from the altered zone in the northern half of the ore deposit yields a variable content of bismuth. The assays obtained from the White Laboratories varies from .01% bismuth to 3.42%. These occurances are from anomalies and indicate that a later phase of gaseous mineralization may have taken place. This results in zones that will be of high grade bismuth, and zones that will be barren or of low grade. In the milling, bismuth can be extracted as a by product and can be expectedd to yield a considerable amount. The metal prices quoted on November 1, 1956 lists bismuth at $2.25 per pound. It is expected bismuth will yield a profit as a by product from the beryllium milling.

STRONTIUM: Strontium occurs in amounts from 2 to

20 pounds per ton, and an average of 8 pounds per ton is considered probable. Strontium has been quoted at $11.00 per pound as a concentrate. Strontium occurs in the altered northern half of the deposit, with traces only in the southern half.

ZINC: This metal could also be extracted, but metallurgical tests would be required. Approximately 6 pounds per ton occurs in the ore.

NICKEL: Sox pounds of this metal occurs per ton in the ore material.

YTTRIUM: The recent demand for this element at approximately $100 per pound should motivate consideration. There is a half pound per ton of this material in the ore.

Except for minor amounts of Columbium and Tantalum, there appears to be no other ore recoverable in the ore.

MILLING

The field investigation and assaying to date prove this ore deposit to be an excellent mining opportunity for high grade beryl crystals and mica masses. But more important is the milling possibilities that exist. The reserves are adequate for a mill capable of handling not less than 100 tons a day.

A. W. Runke of the U.S. Bureau of Mines at Rapid City, South Dakota will be contacted. He had run previous beryllium tests in a new flotation process that he developed. Besides running the beryllium tests he will analize the ore material for the other values and his final report will include the recoverable quantities of each mineral and element involved. Water development is not a problem because at the depth of 70 feet, adequate water appears to exist, and this is only a short distance from the mine proper.

MARKETS AND USES OF ORES

Byryllium: The beryllium industry has increased in size about 24 times in the past 18 years. The price of beryllium ore has increased in about the same

MAJOR BERYLLIUM

proportion. It is listed as a stregetic metal.

The domestic resources are small, with most of the reserves coming from Brazil and the Union of South Africa.

Its ductility, x-ray penetrability, high melting point, low density and high modulus, give it many and varied uses. It is used in the nuclear energy field as it has a low neutron absorber and has the ability to moderate the velocity of neutrons.

It is used in Beryllium-copper alloys as a high strength, high hardness alloy. It is an alloy inducing high resistance to fatigue and impact in the aircraft manufacturing industry and there are over 70 applications in military equipment and related devices.

The price and outlook for beryllium is excellent.

The ore deposit examined lends itself to a good sized operation with a profitable future ahead.

Mica: Mica has uses depending on its grade, cleaness, diaelectric constant size, and other factors. It has commercial use in the building trades, electrical industry and industrial rock processes. It can always be sold as scrap mica.

Bismuth: Bismuth production has been essentially as a by produce item. It is becoming more important in the development of nuclear energy. It's absorption cross section for thermal neutrons is very low, second only to beryllium. The alloys of bismuth are being investigated as coolants for the nuclear energy production pile. Five tons of the metal would be required for an enriched reactor of 100,000 kw output.

35% of the past bismuth production has been used in the pharmaceutical business. About 60% was used in the fabricating alloy industry.

It is suspected, but not yet definately proved, that some gold can also be recovered with the bismuth. The installation of automatic panners in the tailing circuit will remove what values may exist.

The markets for hand cobbed beryllium are good. Arvada, Colorado is a purchasing point for Beryllium.

MINING OPERATIONS

The mill location will probably be to the north or west of the mining property. The topography will permit gravity feed to the mill, probably by conveyer belt system. Water exists in the bottom of the drainage area just below the mine, and will control the mill site.

Mining itself will proceed as an open pit operation with benches being developed until approximately 100 feet is attained in depth. Then probably the open cut can be made to go down further. The probable final width of the open pit will exceed 100 feet and be nearly 500 feet long, depending on the linear and lateral extentions of the ores.

After the removal of the quartz and when the workings have developed in and around the granitic masses, the material can probably be worked with methods that will not fragment the large crystals, leaving them intact for removal. The altered matrix material, once a face is developed, can probably be removed by shovel apparatus and ripping equipment.

The problems to be solved are not great nor difficult. For low cost, full mechanization of the operation will probably be aimed for.

It would be wise to conduct a drilling program to fully delineate the full reserve potential and grade of the material at depth. It is not necessary to core drill the deposit, and churn drilling while being inexpensive, would give the required minimum of recovery necessary to valuate the subsurface data. Ore reserves to a depth of 100 feet do not appear to be a problem. The writer considers that the ore deposit has the possibility of 500 feet depth, or more. Mining operations should be conducted to insure that an expansion and depth is attained. Little dead work will be required.

CONCLUSIONS

The writer concludes that the ore deposit examined has ore reserves that will exceed one hundred thousand tons containing recoverable amounts of beryllium, mica, bismuth and a number of other profitable elements and materials. It lends itself to inexpensive open pit mining, all year around operations, and will provide necessary water resources and mill feed to create an excellent milling installation.

The writer is still working on milling data and geochemical data that will contribute to the operation as a whole and provide the necessary data for setting up the flotation processes and preparing for the mining operation that will be required to exploit fully the ore deposit.

If additional information is required which does not appear in the above report, the writer will be glad to furnish the same.

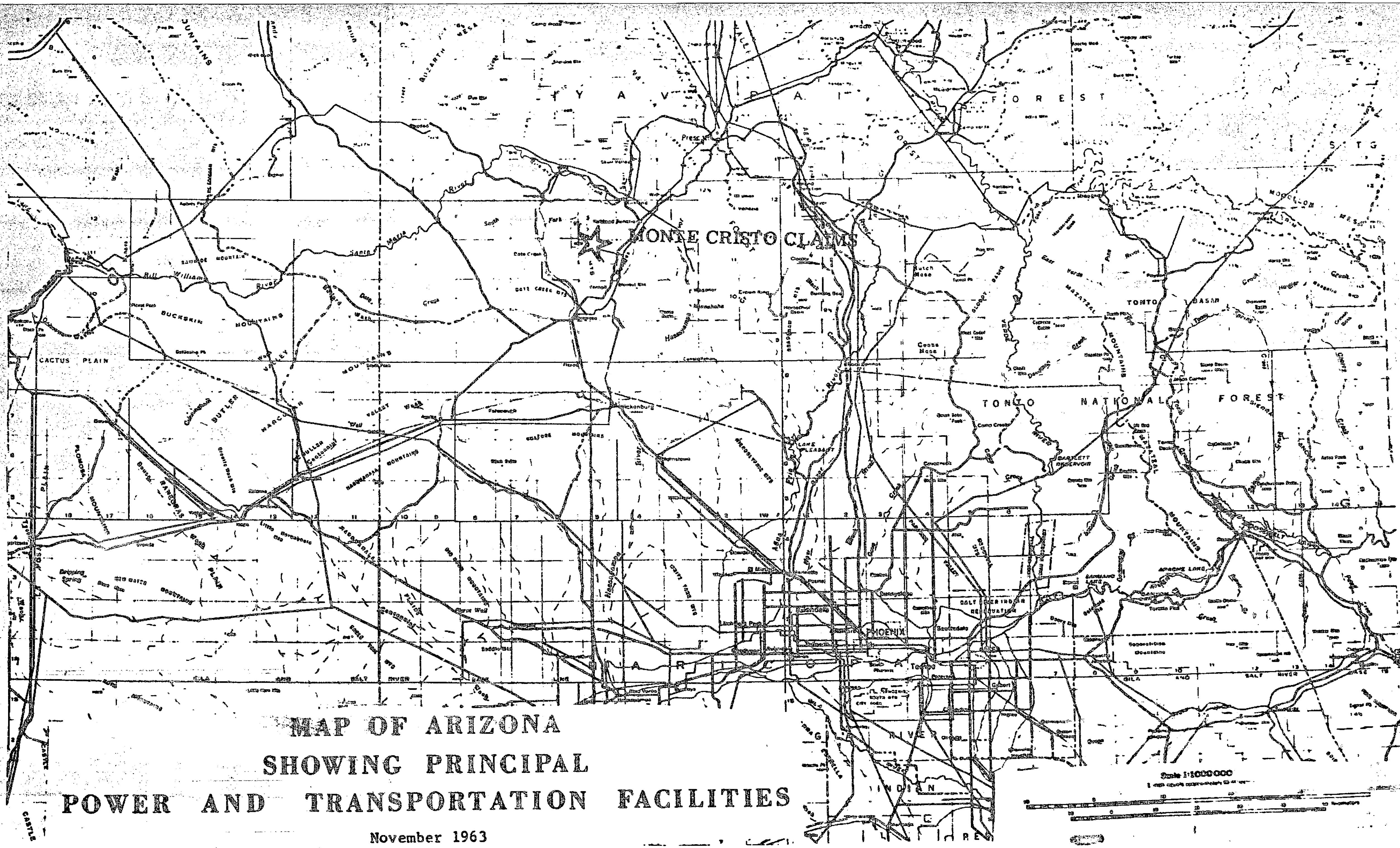
Respectfully submitted,

(Signed)

Einar C. Erickson
Geologist

November 6, 1956

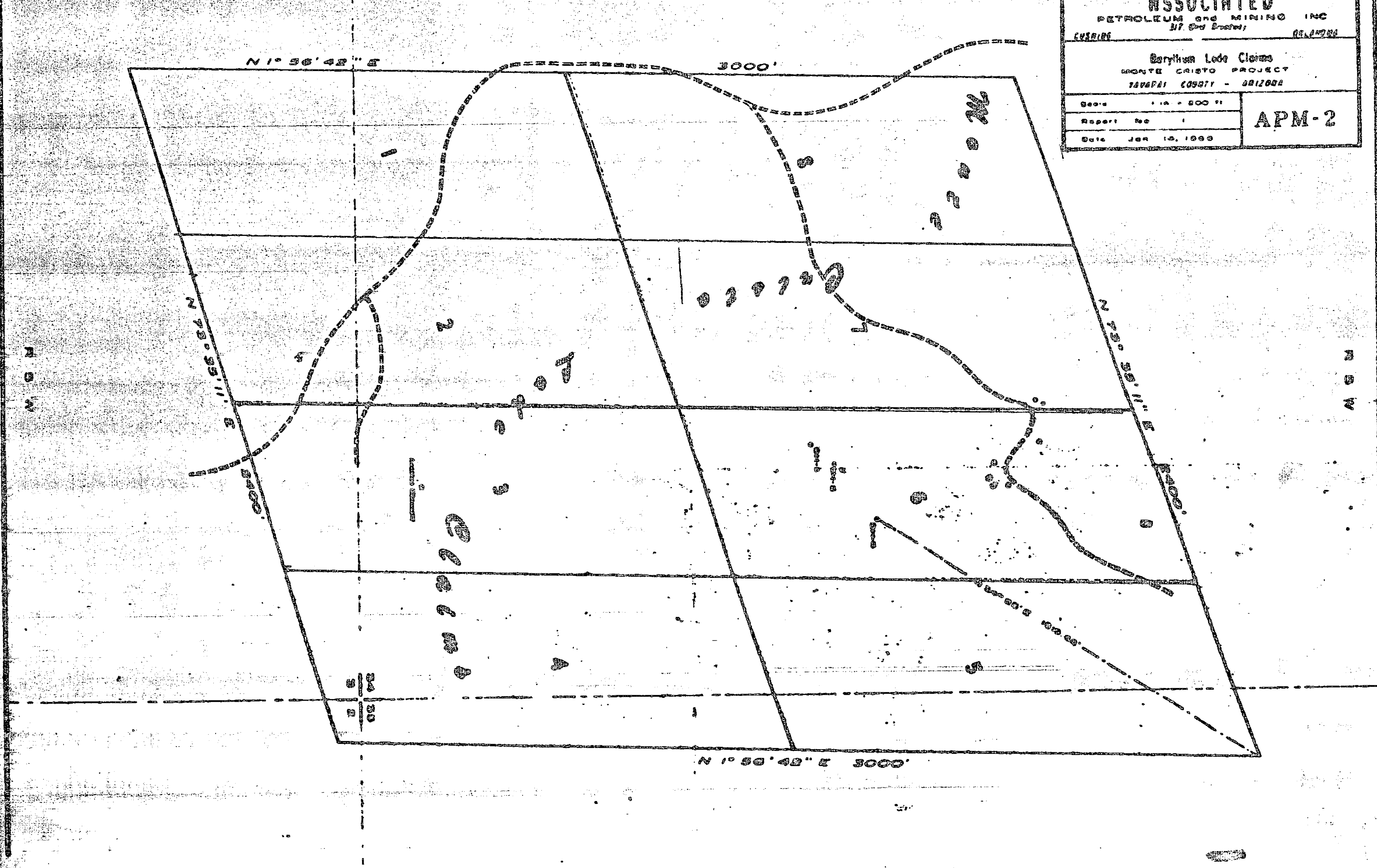
709 Cline
Las Vegas, Nev.
702-870-6771

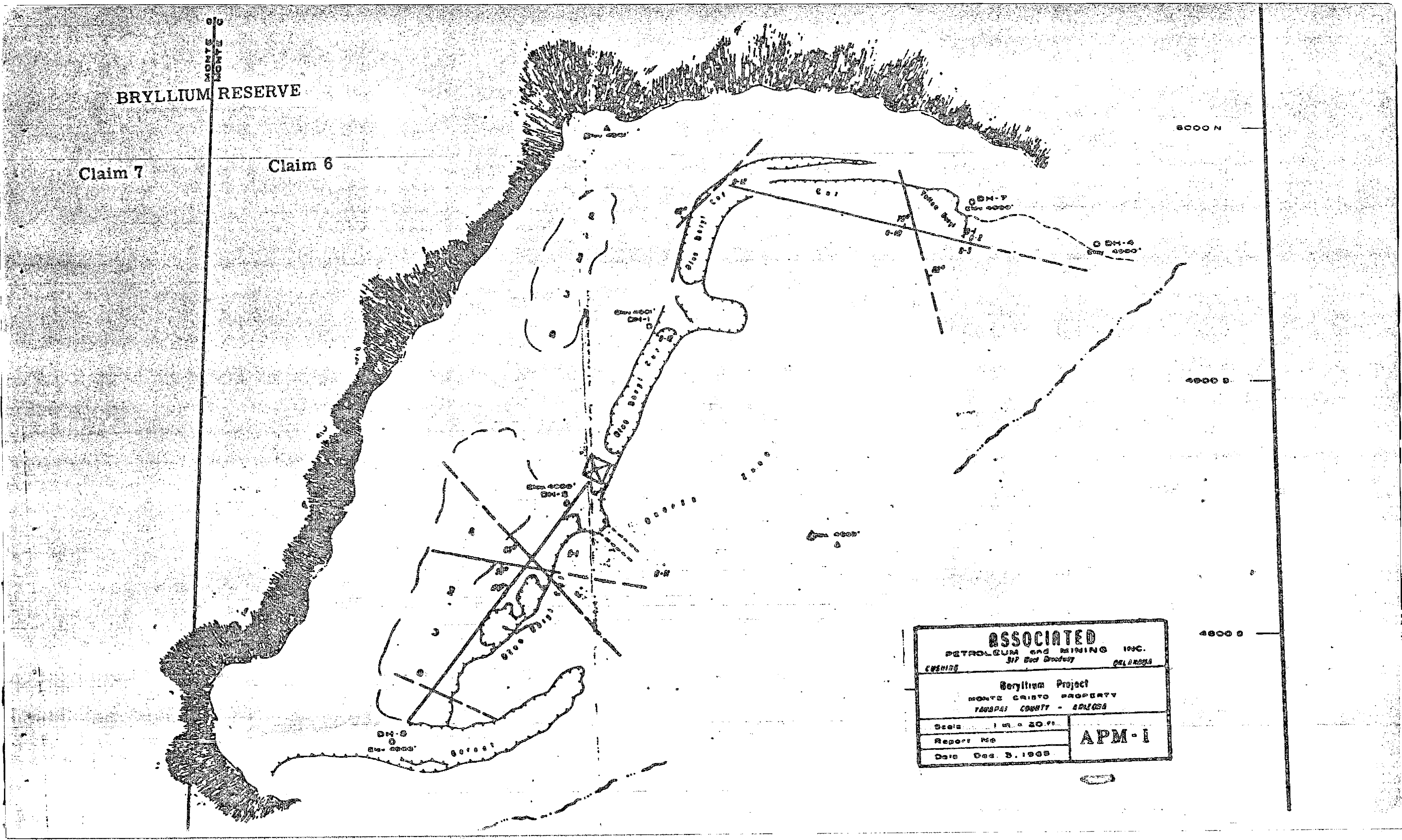


MAP OF ARIZONA
SHOWING PRINCIPAL
POWER AND TRANSPORTATION FACILITIES

November 1963

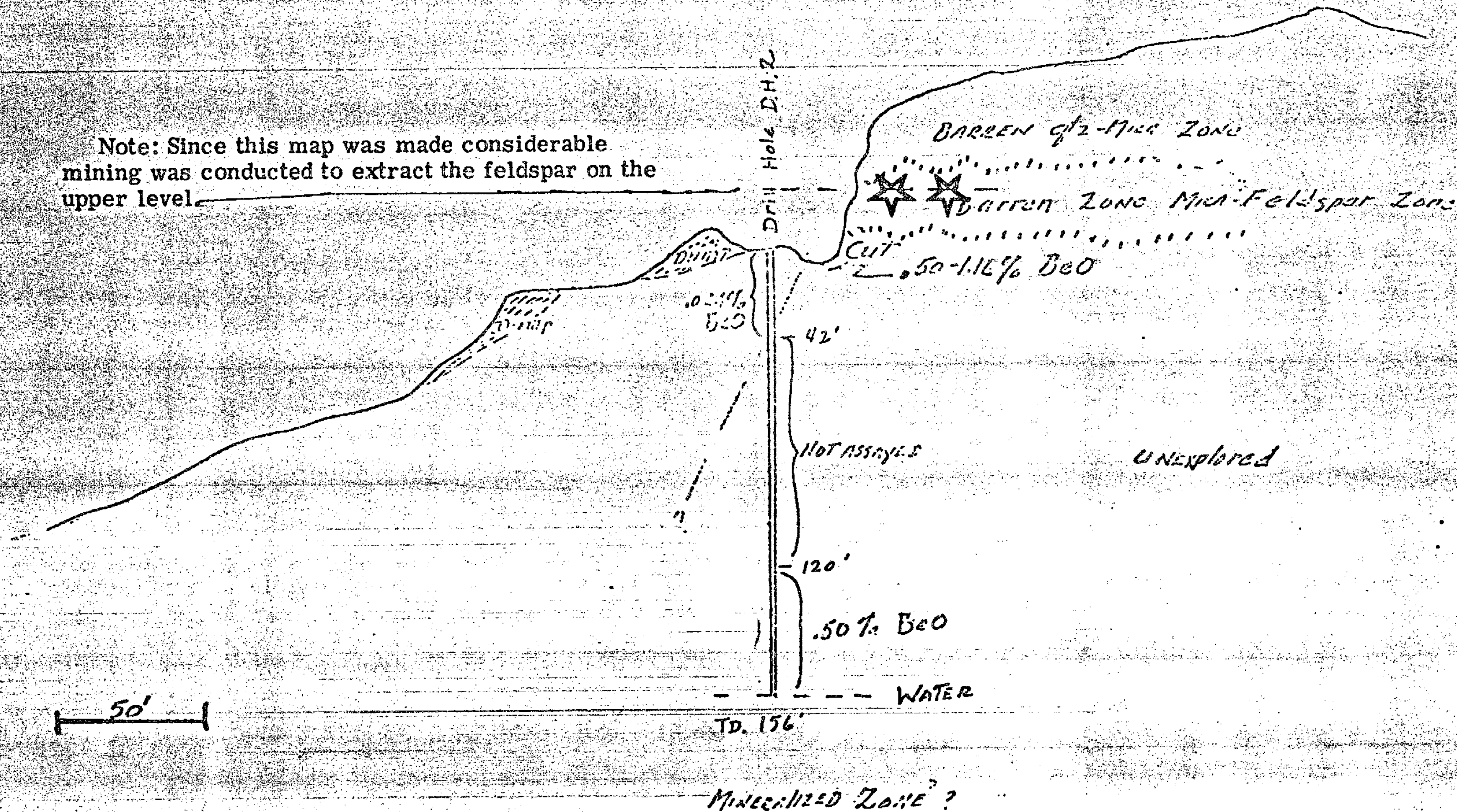
MONTE CHRISTO BERYLLIUM CLAIMS




BRYLLIUM RESERVE
Claim 7
Claim 6
DH-7
DH-4
DH-1
DH-5
DH-9
ASSOCIATED
PETROLEUM and MINING INC.
Beryllium Project
MONTE CRISTO PROPERTY
Scale 1 in. = 20 ft.
Report No
APM-I

CROSS CUT OF A TYPICAL DRILL HOLE - MONTE CHRISTO

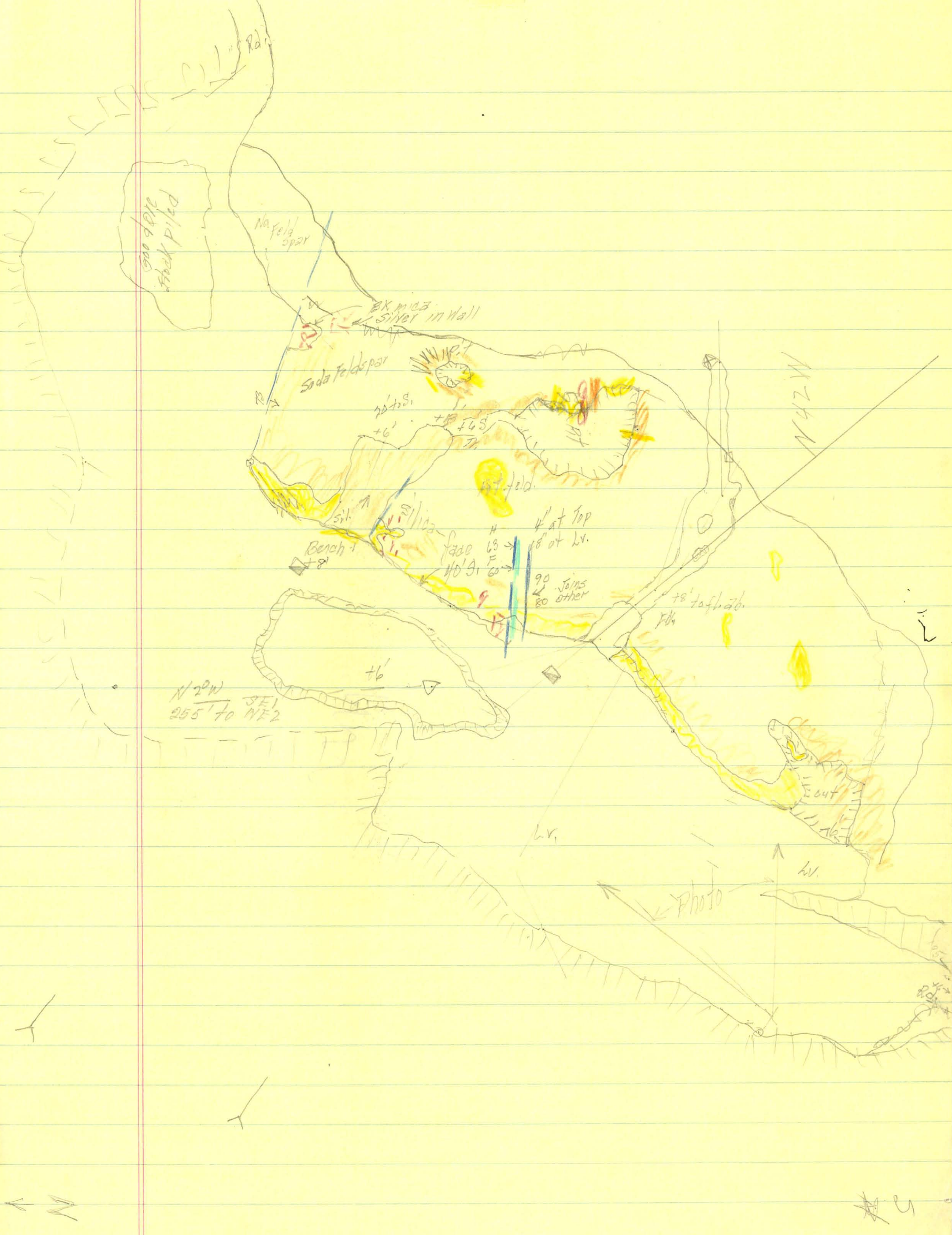
Note: Since this map was made considerable mining was conducted to extract the feldspar on the upper level.



Holiday Inn®

PYRAMIDS
CAIRO - EGYPT

Sam Bittner -
Omaha - called
6-19-85 wants
to meet Tuesday
6-25-85 - Will
Call.


Rd.
Good ore
Rock piled
Na Feld spar
BK mica
Silver in Wall
Soda Feldspar
20' to Si.
+6'
+45
Si.
sil.
silica
fade
4' at Top
18" at Lv.
90
80
Joins other
Bench
+8'
+6'
N 2° W
255' to NE 2
+8' to fl. 26.
Lv.
Photo
cut
N 42 W

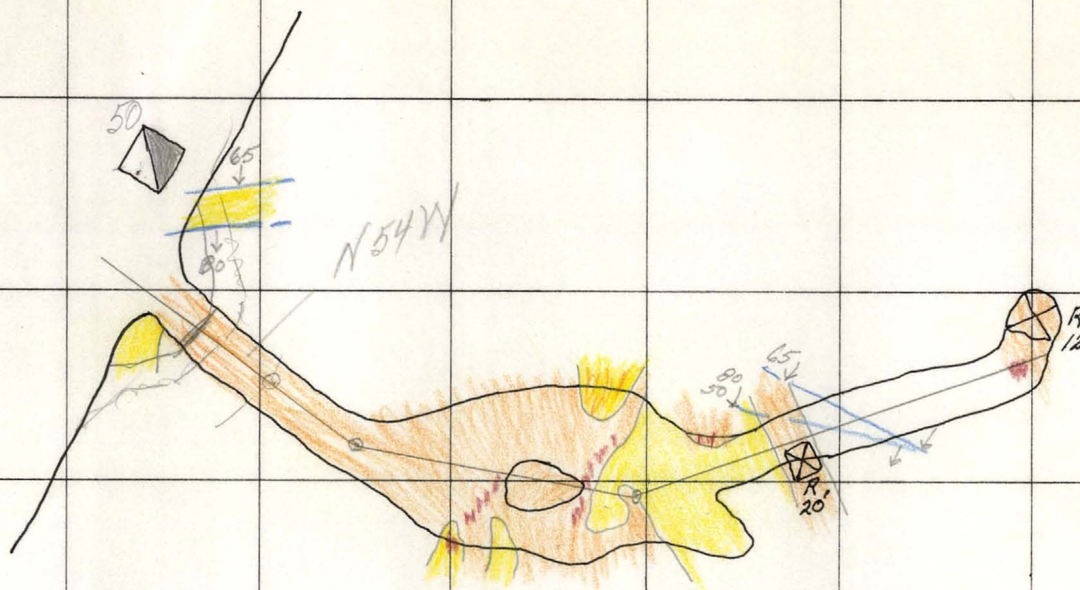
SKETCH OF PEGMATITE OUTCROP
AT DIXIE QUEEN SHAFT

View looking SE from road near shaft

EXPLANATION

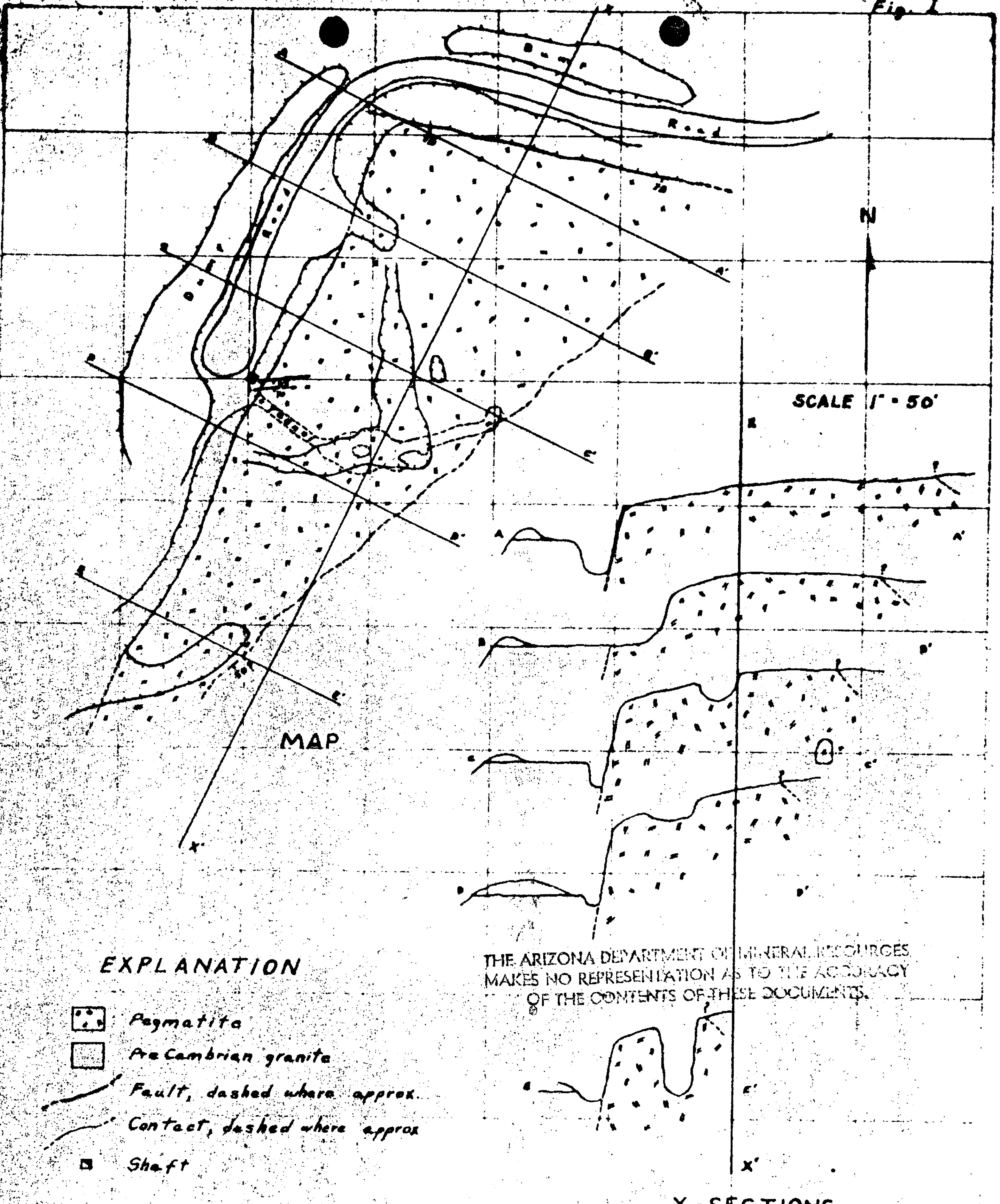
- Beryl crystals
- Muscovite clusters
- f Feldspar
- Q Quartz
- Fault

SCALE 1" = 20'



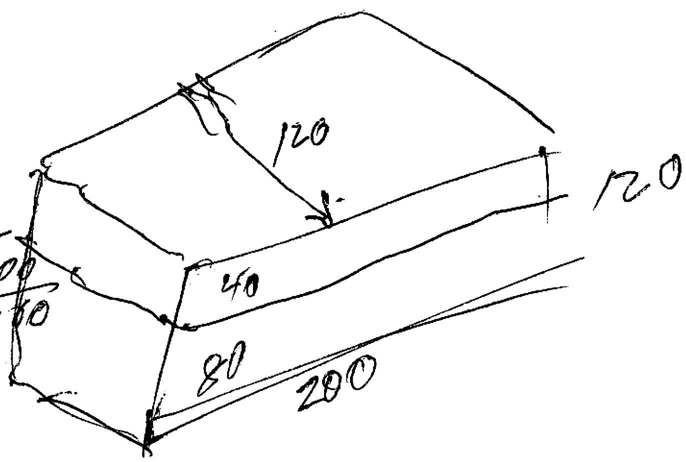
MINE Monte Cristo LOCATION LEVEL #1 claim
GEOLOGY BY SURVEY DATE May 19, 1979 SCALE 1"=20
N E EL.

Fig. 1



MINE Dixie Queen LOCATION Weaver Mts. Ariz LEVEL
GEOLOGY BY C.B. Cook SURVEY Sketch Map SCALE DATE 1/5/61

~~10~~
2000
120
2000
420,000



1200
200
$\boxed{240000}$

10
~~120~~ X 120 X ~~200~~
~~12~~

Santa
Zeb. Longguth \ Det.
Chet Cheatwood / ~~866-08~~86

Jarnell - Monte Cristo - Open and
Mine Feldspar
Fagnoni - Erickson → Mill at Kingman
15 claims $ → Riverside Bank
Feldspar ←

Calif
Thx Inc. arg. Pres. ~~Rodney Muller att Bicuric~~
Verde Products - Gra Jerry Mandell
3023 N Central -
Westwood Ceramic Supply Co.

6 mine
3 Waste
13 Haul
22 at Kingman

Ranch House Cafe 499.6 6.7
left turn 506.3 1.6
dirt road to left 507.9 1.7
rt. turn 509.6 1.5
gate c̄ lock 11.1 0.2 edge of prop.
"Y" - take rt 11.3 0.2 5.2 miles
pit 11.5

300 Tons - Mica - Smith.
1/4 ton lots spar Testwork - Westwood.
Airway Ceramics - Yuma
Bird - Hamilton

25000

125,000

70

87,500.00

87,500

64 90

787,000

This is a process which I obtained from the Bureau of Mines whcih could be practically applied to the ore, if we wished to purify the beryl instead of selling it as an exide

The difference is that as an oxide we could sell the raw ore for $6.50 a lb., If purified, the beryll could run as high as $200 lper lb.

JANUARY 1948

ES
DEPARTMENT OF THE INTERIOR
J. A. KRUG, SECRETARY

BUREAU OF MINES
JAMES BOYD, DIRECTOR

REPORT OF INVESTIGATIONS

FLOTATION OF BERYLLIUM ORES

BY

J. S. KENNEDY AND R. G. O'MEARA

R. I. 4166,
January 1948.

REPORT OF INVESTIGATIONS

UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

FLOTATION OF BERYLLIUM ORES[1]

By J. S. Kennedy[2] and R. G. O'Meara[2]

CONTENTS

2/ Metallurgists, Rolla Division, Metallurgical Branch, Rolla, Mo.

TABLES

INTRODUCTION

Beryllium is a strategic metal of ever-increasing peacetime importance because of the unusual properties of beryllium-copper alloys. These unusual characteristics are the combination of high strength and hardness, high fatigue resistance, and high wear resistance in alloys that have the corrosion resistance of copper.

The principal industrial source of beryllium is the mineral beryl, a beryllium-aluminum silicate that occurs in pegmatites associated with quartz, feldspar, mica, and smaller amounts of various accessory minerals. The beryl is usually recovered in processing the pegmatites for the recovery of some of the other mineral constituents. Pegmatite deposits are found in various parts of the United States, but those in the Black Hills of South Dakota are the source of most of domestic production.

The beryl marketed from the South Dakota pegmatite deposits occurs as coarse crystals, which are obtained by hand sorting. These pegmatites also contain finer crystals and fragments of crystals, which are not recovered by the sorting practice. In addition, numerous low-grade deposits in the area contain finely disseminated beryl that could be recovered only by fine grinding and beneficiation.

An impending shortage of beryllium became apparent soon after the last war began, and it was evident from the character of the known reserves of beryl that hand-sorting could not increase production. To alleviate the shortage, the Bureau of Mines undertook to find new ore bodies of beryl or other beryllium minerals such as helvite, a silicate of beryllium, manganese, and iron containing sulfur, from which beryllium could be produced. Many of the explored deposits were too low-grade or contained beryllium minerals in particles too fine to be recovered by the customary hand sorting, and both fine grinding and beneficiation were necessary to recover suitable concentrates.

Consequently, considerable work on the beneficiation of beryllium ores was done by the Bureau of Mines in conjunction with the exploratory work. Most of it was on the beryl-bearing pegmatites from various localities in the Black Hills. Other pegmatites tested were from near Drake, Colo., Portland, Conn., Taos County, N. Mex., and the Ruby Mountains, Nev. The helvite-bearing tactites from Iron Mountain, N. Mex., were also tested.

ACKNOWLEDGMENTS

This paper is one of many reporting on various aspects of the Bureau's program for more effective utilization of the domestic mineral resources. Mineral resources are now investigated by the Mining Branch, L. B. Moon, chief, and the Metallurgical Branch, O. C. Ralston, chief. The work discussed in this paper, however, was done under the Central Region organization with R. S. Dean, former assistant director, and E. D. Gardner, regional engineer of the Central Region.

The scope of the paper falls in the province of the Metallurgical Branch, whose activities embrace the separation of difficulty beneficiated ores, the production of pure metals from domestic deposits, the exploitation of marginal ore reserves, the recovery of secondary metals, and the improvement of present industrial metallurgical practice. The work was done at the Mississippi Valley Experiment Station, Rolla Division, Metallurgical Branch, of which R. G. Knickerbocker is now chief.

Acknowledgments are due to C. Travis Anderson, formerly assistant regional engineer of the Central Region, for his helpful suggestions and criticism.

DEVELOPMENT OF FLOTATION PROCEDURE

Initial Testing

The initial flotation work was on a beryl-bearing pegmatite from the Black Hills Keystone Corporation, Keystone, S. Dak. The sample contained 0.66 percent beryllia or 5.6 percent beryl. The principal gangue minerals were albite, muscovite, and quartz, together with small amounts of other minerals consisting mainly of tourmaline.

The practice and reagents commonly used in the so-called soap flotation of nonmetallic minerals were first tried. Some of the ores in their natural state were amenable to flotation; others were not unless first thoroughly scrubbed with an alkali and washed to remove surface alteration products. Still others were not amenable to any conventional treatment. A method of cleaning the mineral surfaces with hydrofluoric acid was developed that insured flotation of beryllium minerals in the various ores.

The ore was ground wet in stages to minus 100-mesh and deslimed for flotation. Anionic collectors, such as sodium resinate, sodium oleate, Orso (Proctor and Gamble Co.), Tallol (Gulf States Paper Co.), fish liver-oil fatty acid type C (Arista Oil Product Co.), and oleic acid were used for floating the beryl from the sands. Oleic acid was the most selective of the group of reagents, but recovery and grade of concentrate of the natural ores were low.

Surface Preparation for Flotation

Scrubbing with both caustic and hydrofluoric acid was tested as a means of preparing the mineral surfaces for flotation. Samples of the ground ore were conditioned for 30 minutes, and the sands were washed free of caustic or hydrofluoric acid before a rougher beryl concentrate was floated. The comparative flotation tests in which the ore was not scrubbed, but merely deslimed, and those in which it was scrubbed before flotation either with sodium hydroxide or hydrofluoric acid are discussed in tests 1, 2, and 3, respectively.

Test 1. - Flotation of Deslimed Ore

A portion of the deslimed minus 100-mesh ore from which the coarse mica also was removed by scalping on a screen coarser than 100-mesh was floated to obtain a beryl rougher concentrate. The reagents used in the rougher were 0.72 pound of oleic acid and 0.36 pound of pine oil per ton of ore. The rougher concentrate was cleaned twice without additional reagents to depress the gangue. The results of the test are given in table 1.

TABLE 1. - Flotation of deslimed ore

Product	Weight, percent	Analysis, percent BeO	Percent of total BeO
Concentrate	2.0	3.72	11.4
Middling	3.7	1.68	9.5
Tailing	67.5	.57	58.9
Slime	26.3	.50	20.1
Mica	.5	.19	.1
Composite	100.0	.65	100.0

Test 2. - Flotation of Deslimed Ore after Scrubbing with Sodium Hydroxide

Another portion of the deslimed minus 100-mesh ore from which the mica was removed in the manner discussed previously was agitated with 6.0 pounds of sodium hydroxide per ton of ore for 30 minutes in a pulp of 50-percent solids. The sand was then settled and washed free of sodium hydroxide. A beryl rougher concentrate was floated from the sand with 0.72 pound of oleic acid and 0.36 pound of pine oil per ton of ore. The rougher concentrate was cleaned twice without additional reagents to depress the remaining gangue. The results of the flotation test are shown in table 2.

TABLE 2. - Flotation of deslimed ore after scrubbing with sodium hydroxide

Product	Weight, percent	Analysis, percent BeO	Percent of total BeO
Concentrate	1.0	2.42	3.9
Middling	2.4	1.11	4.4
Tailing	71.3	.60	69.9
Slime	24.1	.54	21.3
Mica	1.2	.29	.5
Composite	100.0	.61	100.0

Test 3. - Flotation of Deslimed Ore After Scrubbing with Hydrofluoric Acid

A third portion of the deslimed minus 100-mesh ore, from which the coarse mica was removed, was blunged with 4.6 pounds of hydrofluoric acid (47 percent H_2F_2) per ton of ore for 30 minutes in a pulp of 50 percent solids. The sand was then settled and washed free of acid. A rougher beryl concentrate was floated with 0.36 pound of oleic acid and 0.18 pound of pine oil per ton of ore and cleaned twice. No additional reagents were added in the cleaning. The results of the test are given in table 3.

TABLE 3. - Flotation of deslimed ore after scrubbing with hydrofluoric acid

Product	Weight, percent	Analysis, percent BeO	Percent of total BeO
Concentrate	8.1	7.62	81.0
Middling	20.4	.15	4.0
Tailing	61.8	.07	5.7
Slime	7.4	.93	9.0
Mica	2.3	.11	.3
Composite	100.0	.76	100.0

The best grade of concentrate and the highest beryllia recovery were obtained from the deslimed minus 100-mesh ore, which had been scrubbed with hydrofluoric acid. This concentrate represented a recovery of 81.0 percent of the beryllia and contained 7.62 percent beryllia, but it also contained appreciable tourmaline.

Effect of Recirculating Acid Upon Flotation

Three tests were made to study the effect of recirculating the acid wash as a means of reducing acid consumption in the preparation of the ore for flotation. In test 1, a charge of the minus 100-mesh ore was scrubbed with 9.2 pounds of hydrofluoric acid per ton of ore and deslimed. In test 2 the acid recovered in desliming the first sample together with 4.6 pounds per ton of fresh hydrofluoric acid were used. Likewise, in test 3 the recovered acid from the second test and 2.3 pounds per ton of hydrofluoric acid were used. The reagents used in flotation were 0.36 pound of oleic acid and 0.18 pound of pine oil, and the flotation procedure was the same in each test. The results of the tests 1, 2, and 3 are shown in tables 4, 5, and 6, respectively.

TABLE 4. - Flotation with fresh acid

Product	Weight, percent	Analysis, percent BeO	Percent of total BeO
Beryl concentrate	4.2	9.78	65.4
Middling	18.3	.41	11.9
Tailing	55.9	.07	6.2
Slime	15.3	.49	11.9
Mica	6.3	.46	4.6
Composite	100.0	.63	100.0

TABLE 5. - Flotation with recirculated and fresh acid

Product	Weight, percent	Analysis, percent BeO	Percent of total BeO
Beryl concentrate	6.0	9.06	70.2
Middling	24.0	.24	7.4
Tailing	49.2	.13	8.3
Slime	19.0	.55	13.5
Mica	1.8	.27	.6
Composite	100.0	.77	100.0

TABLE 6. - Flotation with fresh acid and second recirculated acid

Product	Weight, percent	Analysis, percent BeO	Percent of total BeO
Beryl concentrate	2.9	10.60	43.9
Middling	11.4	1.15	18.8
Tailing	64.8	.23	21.2
Slime	20.1	.55	15.8
Mica	.8	.25	.3
Composite	100.0	0.70	100.0

In tests 1 and 2, the pH of the scrubbed pulp was 2.5 at the end of the 30-minute conditioning period. In test 3, the pH of the conditioner was 4.0 after a 30-minute conditioning interval. The results of these tests indicate that a pH of 2.5 should be maintained during scrubbing. The minimum amount of hydrofluoric acid required was not determined, but it would not exceed 3.45 pounds per ton, and even less might be used if a pH of 2.5 were maintained by some other acid.

The effect of forming the hydrofluoric acid direct in the pulp by the use of fluorite and sulfuric acid also was investigated. A sample of the minus 100-mesh deslimed ore was conditioned for 30 minutes with 17.6 pounds of fluorite and 22.0 pounds of sulfuric acid, which is the stoichiometric ratio for the production of 9.2 pounds of hydrofluoric acid per ton of ore. The sand was then washed free of acid, and a beryl rougher concentrate was floated with 0.72 pound of oleic acid and 0.36 pound of pine oil per ton of ore. The rougher concentrate was cleaned three times. No additional reagents were used in the first cleaner, but in the second cleaner, 2.0 pounds of sulfuric acid and 0.04 pound of reagent A.M. 118.5B per ton of ore was used, and in the third cleaner 1.0 pound of sulfuric acid was used. The results of the test are shown in table 7.

TABLE 7. - Flotation of ore scrubbed with hydrofluoric acid formed direct in the pulp

Product	Weight, percent	Analysis, percent BeO	Percent of total BeO
Beryl concentrate	3.0	7.18	29.7
Middling	2.4	2.99	9.9
Tailing	65.0	.44	39.3
Slime	28.7	.53	20.9
Mica	.9	.12	.2
Composite	100.0	.72	100.0

The test indicates the possibility of substituting fluorite and sulfuric acid for hydrofluoric acid as the conditioning agents.

Effect of Temperature upon the Flotation of Beryl

The effect of temperature upon flotation of beryl also was studied. In one test, ice was used to lower the temperature of the flotation pulp to 11° C., and in the second test hot water was used to raise the temperature of the flotation pulp to 62° C. In both tests the flotation conditions, except temperature, were the same. The ore was conditioned in these tests with 9.2 pounds of hydrofluoric acid per ton of ore, washed, and deslimed. After this treatment, a beryl rougher concentrate was floated from the sands with 0.7 pound of oleic acid and 0.36 pound of pine oil per ton of ore. The rougher concentrates were cleaned five times with 2.0 pounds of sulfuric acid and 0.08 pound of A.M. 118.5B in the fourth cleaner and 2.0 pounds of sulfuric acid to the ton in the final cleaner. No additional reagents were used in the first three cleaners. The results of these tests are shown in tables 8 and 9.

TABLE 8. - Flotation of ore at a pulp temperature of 11° C.

Product	Weight, percent	Analysis, percent BeO	Percent of total BeO
Beryl concentrate	5.4	8.62	72.3
Middling	40.5	.20	13.2
Tailing	35.6	.06	3.3
Slime	17.0	.41	10.8
Mica	1.5	.17	.4
Composite	100.0	.64	100.0

TABLE 9. - Flotation of ore at a pulp temperature of 62° C.

Product	Weight, percent	Analysis, percent BeO	Percent of total BeO
Beryl concentrate	4.2	10.20	66.6
Middling	10.3	.74	12.0
Tailing	72.4	.10	11.2
Slime	12.0	.53	9.9
Mica	1.1	.18	.3
Composite	100.0	.64	100.0

The results of tests indicate that flotation of beryl is not critically affected by temperature. Good recovery and a good grade of concentrate were obtained at both low and high temperatures.

Separation of Beryl from Tourmaline

Further tests were made to separate the beryl and tourmaline by cationic reagents in cleaner circuits acidified with either sulfuric acid or with hydrofluoric acid. An amine hydrochloride (Armour & Co. Reagent A.M. 118.5B) was used as the cationic collector. It was found that in sulfuric acid circuits tourmaline was floated from beryl, and in hydrofluoric acid circuits beryl was floated from tourmaline.

The results of the flotation and the operating data of the tests with sulfuric acid and hydrofluoric acid in the cleaning circuit are shown, respectively, in tables 10 and 11.

TABLE 10. - Flotation of tourmaline from beryl in cleaner circuit with sulfuric acid

Metallurgical data

Product	Weight, percent	Analysis, percent BeO	Percent of total BeO
Tourmaline concentrate	2.3	3.60	11.5
Beryl concentrate	5.2	10.00	72.4
Middling	15.9	.16	3.5
Tailing	67.8	.07	6.6
Slime	6.4	.59	5.3
Mica	2.4	.21	.7
Composite	100.0	.71	100.0

Operating data

Reagent	Pounds per ton of ore							
	Roughing operation		Cleaning operation					
			Conditioners		Cleaners			
	Conditioner	Rougher	3	4	1	2	3	4
Hydrofluoric acid (47%).	9.2	-	-	-	-	-	-	-
Oleic acid	-	0.72	-	-	-	-	-	-
Pine oil	-	.36	-	-	-	-	-	-
Sulfuric acid	-	-	2.0	2.0	-	-	-	-
A.M. 118.5B	-	-	-	-	-	-	0.08	0.08
pH	2.0	7.0	2.0	2.0	7.0	7.0	2.0	2.0
Time, minutes	30	3	5	5	2	2	1	1

TABLE 11. - Flotation of beryl from tourmaline in cleaner circuit with hydrofluoric acid

Metallurgical data

Product	Weight, percent	Analysis, percent BeO	Percent of total BeO
Beryl concentrate	4.6	8.72	59.5
Tourmaline concentrate	.9	5.28	7.0
Middling	18.1	.25	6.7
Tailing	57.9	.15	12.8
Slime	14.0	.62	12.8
Mica	4.5	.18	1.2
Composite	100.0	.67	100.0

Operating data

Reagent	Pounds per ton of ore							
	Roughing operation		Cleaning operation					
			Conditioners		Cleaners			
	Conditioner	Rougher	3	4	1	2	3	4
Hydrofluoric acid (47%)	9.2	-	2.3	2.3	-	-	-	-
Oleic acid	-	0.72	-	-	-	-	-	-
Pine oil	-	.36	-	-	-	-	-	-
A.M. 118.5B	-	-	-	-	-	-	0.08	0.08
pH	2.0	7.5	2.0	2.0	7.5	7.5	2.0	2.0
Time, minutes	30	5	5	5	4	4	1	1

The flotation of tourmaline from beryl in the cleaner circuits with sulfuric acid made a high-grade beryl concentrate (cleaner tailing) with a high recovery of beryl.

Methods of Analyses

Three methods of analysis - gravimetric,[3] colorimetric,[4] and fluorometric[5] - are used for the determination of beryllium. The gravimetric method, which is the oldest of the analytical procedures, was followed early in the investigation on beneficiation, either as in the reference cited or as modified for removal of phosphorus by the analytical laboratory at Rolla. The fluorometric method was developed at the Eastern Experiment Station, College Park, Md., in 1943 and was subsequently used to expedite the experimental work. The analyses by the gravimetric and the fluorometric method were verified by grain counts, metallurgical balances, and umpire analyses from time to time. Confirmation of the determinations in this manner indicated that the results are as reliable as can be obtained for beryllium.

3/ Siemens-Konzern, Beryllium, Its Production and Application (translated by Richard Rinbach and A. J. Michel): Reinhold Publishing Co., New York, 1932.

4/ Bureau of Mines, The Determination of Beryllium by Colorimetric Titration, Using Quinalizarin: Bureau of Mines Laboratory, Salt Lake City, Utah. Unpublished.

5/ Industrial and Engineering Chemistry, Determination of Beryllium in Ores: Anal. ed., vol. 18, March 1946, p. 179.

Flotation of Various Beryllium Ores

The laboratory flotation procedure developed for the treatment of beryl ores was applied to samples from various localities. The samples for the most part were pegmatites in which the beryllium occurred as beryl, but one tactite containing beryllium in the form of helvite also was tested. The laboratory procedure and reagents in the testing were essentially the same, but slight variations were made insofar as necessary to separate minor amounts of such accessory minerals as tourmaline and apatite.

The essential steps of the concentration practice were as follows: The ore was wet-ground in stages to minus 100-mesh. The coarse, flaky mica was removed by sizing the ground material on a screen with slightly larger openings than the limiting size of the grind. The screen undersize was settled and the finest slime, which actually represented only a very small part of the weight of the ore, was decanted. The sand was conditioned as a pulp of 50-percent solids with hydrofluoric acid for 30 minutes and then the sands were washed free from acid. The washed, deslimed, minus 100-mesh ore freed from mica was next conditioned with oleic acid and pine oil. The beryl was floated, and the rougher concentrate was cleaned in a neutral or basic circuit to depress gangue minerals other than tourmaline. The tourmaline was floated from the beryl by an amine hydrochloride such as AM-118.5B. With ores containing no tourmaline the cleaning step in an acid circuit was omitted. Apatite was floated from the ores with the customary reagents before the cleaning step with hydrofluric acid for the beryl flotation.

The samples of beryllium-bearing material tested are given in table 12.

TABLE 12. - Samples tested

Source	Description
Black Hills Keystone Corp., Keystone, S. Dak.	High-grade beryl-bearing pegmatite.
Old Mike mine dump, Custer, S. Dak.	Low-grade beryl-bearing pegmatite.
Harding mine, Taos County, N. Mex.	Low-grade beryl-bearing pegmatite.
R. O. Huddleston Property, Ruby Mountains, Nev.	Beryl-bearing pegmatite.
Gotta-Walden Property, Portland, Conn.	Beryl-bearing pegmatite.
Hyatt Ranch Property, Larimer County, Colo.	Low-grade beryl-bearing pegmatite.
Iron Mountain, Winston, N. Mex.	Helvite-danalite-bearing tactite.

The concentration tests on the samples are discussed hereafter in the sample order under their respective headings.

Flotation of High-Grade Beryl Ore from the Black Hills Keystone Corp., Keystone, S. Dak.

The ore contained 1.86 percent beryllia and was a pegmatite containing an appreciable amount of beryl. The gangue minerals were albite, muscovite, and quartz, with small amounts of other minerals, mainly tourmaline. The results of the flotation of the ore are given in table 13.

TABLE 13. - Flotation of high-grade beryl ore - Black Hills Keystone Corp., Keystone, S. Dak.

Metallurgical data

Product	Weight, percent	Analysis, percent BeO[1]	Percent of total BeO
Beryl concentrate	16.0	10.90	90.2
Tourmaline concentrate	3.4	2.07	3.6
Middling	25.1	.07	.9
Tailing	45.7	.10	2.4
Slime	6.3	.68	2.2
Mica	3.5	.37	.7
Composite	100.0	1.93	100.0

Operating data

Reagent	Pounds per ton of ore							
	Roughing operation		Cleaning operation					
			Conditioners		Cleaners			
	Conditioner	Rougher	3	4	1	2	3	4
Hydrofluoric acid (47%)	9.2	-	-	-	-	-	-	-
Oleic acid	-	0.72	-	-	-	0.18	-	-
Pine oil	-	.36	-	-	-	.18	-	-
Sulfuric acid	-	-	2.0	2.0	-	-	-	-
A.M. 118.5B	-	-	-	-	-	-	0.08	0.08
pH	2.0	7.0	2.0	2.0	7.0	7.0	2.0	2.0
Time, minutes	30	4	5	5	3	2	3	2

1/ Beryllia analyses determined by gravimetric method.

Flotation of Low-Grade Beryl Ore from the Dump at the Old Mike Mine, Custer, S. Dak.

The sample, containing 0.25 percent beryllia, was essentially quartz, microcline, and muscovite. Small amounts of scheelite, biotite, and beryl were present. The microcline was somewhat altered to kaolin by weathering.

The results of a typical flotation test on the ore are given in table 14.

The beryl rougher concentrate was conditioned with hydrofluoric acid for additional scrubbing of the contained beryl before cleaning.

TABLE 14. - Flotation of low-grade beryl ore from dump of Old Mike mine, Custer, S. Dak.

Metallurgical data

Product	Weight, percent	Analysis, percent BeO 1/	Percent of total BeO
Beryl concentrate	4.0	3.04	58.0
Middling	19.7	.04	3.8
Tailing	28.9	.02	2.8
Slime	43.0	.16	32.7
Mica	4.4	.13	2.7
Composite	100.0	.21	100.0

Operating data

Reagent	Pounds per ton of crude ore				
	Roughing operation		Cleaning operation		
	Conditioner	Rougher	Conditioner 1	Cleaners 1	Cleaners 2
Hydrofluoric acid (47%)	9.2	-	4.6	-	-
Oleic acid	-	0.36	-	0.36	-
Pine oil	-	.18	-	.09	-
pH	2.0	7.0	2.0	7.0	7.0
Time, minutes	2/10	3	15	2	2

1/ Beryllia analyses determined by gravimetric method.
2/ After 10 minutes conditioning time, the acid was consumed by the charge. The charge was then deslimed but not washed.

Flotation of a High-grade Beryl Composite from Custer, S. Dak.

A composite of eight high-grade beryl samples from the Custer district was prepared to aid in studying the recovery of beryl by flotation. Equal weights of samples from the Old Mike, Helen, Michand, Duncan, Wood Tin, Ingersoll, Put, and Eureka mines were composited.

The composite contained 1.01 percent beryllia (gravimetric method) or 1.29 percent beryllia (fluorescent method) and was essentially albite, muscovite, and quartz, with appreciable amounts of amblygonite and schorlite tourmaline, small amounts of beryl and goethite, and minor amounts of microcline, apatite, and spodumene.

Flotation of the ore and the concentration results are shown in table 15.

The schorlite, amblygonite,and apatite minerals were floated on the first rougher.

TABLE 14. - Flotation of low-grade beryl ore from dump of Old Mike mine, Custer, S. Dak.

Metallurgical data

Product	Weight, percent	Analysis, percent BeO[1]	Percent of total BeO
Beryl concentrate	4.0	3.04	58.0
Middling	19.7	.04	3.8
Tailing	28.9	.02	2.8
Slime	43.0	.16	32.7
Mica	4.4	.13	2.7
Composite	100.0	.21	100.0

Operating data

Reagent	Pounds per ton of crude ore				
	Roughing operation		Cleaning operation		
	Conditioner	Rougher	Conditioner 1	Cleaners 1	Cleaners 2
Hydrofluoric acid (47%)	9.2	-	4.6	-	-
Oleic acid	-	0.36	-	0.36	-
Pine oil	-	.18	-	.09	-
pH	2.0	7.0	2.0	7.0	7.0
Time, minutes	2/10	3	15	2	2

1/ Beryllia analyses determined by gravimetric method.
2/ After 10 minutes conditioning time, the acid was consumed by the charge. The charge was then deslimed but not washed.

Flotation of a High-grade Beryl Composite from Custer, S. Dak.

A composite of eight high-grade beryl samples from the Custer district was prepared to aid in studying the recovery of beryl by flotation. Equal weights of samples from the Old Mike, Helen, Michand, Duncan, Wood Tin, Ingersoll, Put, and Eureka mines were composited.

The composite contained 1.01 percent beryllia (gravimetric method) or 1.29 percent beryllia (fluorescent method) and was essentially albite, muscovite, and quartz, with appreciable amounts of amblygonite and schorlite tourmaline, small amounts of beryl and goethite, and minor amounts of microcline, apatite, and spodumene.

Flotation of the ore and the concentration results are shown in table 15.

The schorlite, amblygonite, and apatite minerals were floated on the first rougher.

TABLE 15. - Flotation of high-grade beryl ore from Custer, S. Dak.

Metallurgical data

Product	Weight, percent	Analysis, percent BeO		Percent of total BeO	
		Rolla 1/	College Park 2/	Rolla	College Park
Beryl concentrate	8.6	11.00	11.60	73.2	71.1
Schorlite) Amblygonite) Concentrate .... Apatite)	5.0	.32	.90	1.2	3.2
Middling	7.0	1.31	1.45	7.1	7.2
Tailing	58.3	.13	.02	5.9	.8
Slime	9.6	.76	1.04	5.6	7.1
Mica	11.5	.79	1.30	7.0	10.6
Composite	100.0	1.29	1.40	100.0	100.0

Operating data

Reagent	Pounds per ton of ore				
	Conditioner before rougher 2	Roughers 1	Roughers 2	Rougher 2-cleaners 1	Rougher 2-cleaners 2
Hydrofluoric acid	9.2	-	-	-	-
Oleic acid	-	0.36	0.54	-	-
Frother B-24 3/	-	-	.09	-	-
pH	2.4 to 2.9	8.1	8.2	8.2	8.1
Time, minutes	30	3	4	3	2

1/ Gravimetric method.
2/ Fluorometric method.
3/ E. I. Du Pont de Nemours & Co.

Flotation of Low-grade Beryl Ore from the Harding Property, Taos County, N. Mex.

The sample contained 0.40 percent beryllia and consisted of quartz, orthoclase, microcline, albite, apatite, beryl, and lepidolite. The beryl had a pink color and was closely associated with the apatite.

Apatite was floated on the first rougher, and beryl was floated on the second. No tourmaline was present in the ore, and acid cleaner circuits were not required.

TABLE 16. - Flotation of low-grade beryl ore from Harding Property, Taos County, N. Mex.

Metallurgical data

Product	Weight, percent	Analysis, percent BeO[1]	Percent of total BeO
Beryl concentrate	2.7	9.40	70.8
Apatite concentrate	2.3	.20	1.3
Middling	20.6	.13	7.5
Tailing	49.4	.02	2.7
Slime	12.7	.43	15.3
Mica	12.3	.07	2.4
Composite	100.0	.36	100.0

Operating data

Reagent	Pounds per ton of crude ore: Roughing operation: Conditioner 2	Rougher 1	Rougher 2	Cleaner-Rougher 2: 1
Oleic acid	-	0.54	0.36	-
Hydrofluoric acid	9.2	-	-	-
pH	2.6 to 3.0	7.8	7.5	7.7
Time, minutes	30	1	2	1

1/ Beryllia analyses determined by gravimetric method.

Flotation of Beryl from the R. O. Huddleston Property, Ruby Mountains, Nev.

The ore contained 1.03 percent beryllia and was mainly albite, orthoclase and microcline feldspars, and quartz, with appreciable beryl and muscovite and small amounts of hematite, apatite, spessartite and zircon. Iron and manganese oxide stainings also were present in small amounts.

TABLE 17. - Flotation of beryl from the R. O. Huddleston Property, Ruby Mountains, Nev.

Metallurgical data

Product	Weight, percent	Analysis, percent BeO[1]	Percent of total BeO
Beryl concentrate	8.30	11.10	84.4
Middling	14.82	.08	1.1
Tailing	60.20	.04	2.2
Slime	13.03	.75	8.9
Mica	3.65	1.01	3.4
Composite	100.0	1.09	100.0

Operating data

Reagent	Pounds per ton of ore: Conditioner	Rougher	Cleaners 1	Cleaners 2
Hydrofluoric acid	9.2	-	-	-
Oleic acid	-	0.90	-	-
Frother B-24[2]	-	.16	-	-
pH	2.5 to 3.1	6.8	7.8	7.8
Time, minutes	30	4	3	1

1/ Beryllia analyses determined by fluorometric method.
2/ E. I. Du Pont de Nemours & Co.

Flotation of Low-grade Beryl Ore from the Gotta-Walden Property, Portland, Conn.

The sample containing 0.23 percent beryllia was composed of quartz, feldspar, muscovite, biotite, almandite (garnet), and beryl. It was the rejected portion from hand sorting of beryl, feldspar, quartz, and mica from the ore.

TABLE 18. - Flotation of low-grade beryl ore from Gotta-Walden Property, Portland, Conn.

Metallurgical data

Product	Weight, percent	Analysis, percent BeO		Percent of total BeO	
		Rolla 1/	College Park 2/	Rolla	College Park
Beryl concentrate	1.17	3/9.50	10.50	46.7	60.6
Middling	1.37	.41	.36	2.4	2.4
Tailing	75.00	.07	.01	22.1	3.7
Slime	6.00	.25	.21	6.3	6.2
Plus 100-mesh mica	6.31	.04	.06	1.0	1.9
Mica flotation concentrate	9.84	.40	.35	16.5	16.9
Magnetic product	.31	3.87	5.43	5.0	8.3
Composite	100.00	.24	.20	100.0	100.0

Operating data

Reagent	Pounds per ton of ore				
	Conditioner	Roughers 1	Roughers 2	Rougher 2-cleaners 1	Rougher 2-cleaners 2
Hydrofluoric acid	9.2	-	-	-	-
E. P. 487 4/	-	0.4	-	-	-
Oleic acid	-	-	0.36	-	-
Pine oil	-	-	0.9	-	-
pH	2.8 to 3.1	3.5	8.0	7.9	8.0
Time, minutes	30	2	3	2	2

1/ Gravimetric method.
2/ Fluorometric method.
3/ The beryl concentrate contained 90 percent beryl by petrographic grain count.
4/ Emulsol Corp., Chicago, Ill.

The mica concentrate was floated on the first rougher.

The magnetic material was removed from the beryl concentrate in a Frantz ferrofilter.

Flotation of Low-grade Beryl Ore from the Hyatt Ranch Property, Larimer County, Colo.

The sample contained 0.10 percent beryllia, as analyzed by the fluorometric method at Rolla, 0.09 percent by the same method at College Park, and 0.06 percent by the gravimetric method. It was composed mainly of albite, orthoclase and microcline feldspars, quartz, and muscovite, with minor amounts of tourmaline, apatite, beryl, and a little iron oxide as staining.

TABLE 19. - Flotation of low-grade beryl ore from Hyatt Ranch Property, Larimer County, Colo.

Metallurgical data

Product	Weight, percent	Analysis, percent BeO 1/	Percent of total BeO
Beryl concentrate	2.2	2.80	64.9
Middling	4.5	.57	27.1
Tailing	86.4	.00	.0
Slime	6.9	.11	8.0
Composite	100.0	.09	100.0

Operating data

Reagent	Pounds per ton of crude ore: Conditioner	Rougher	Cleaners 1	Cleaners 2
Hydrofluoric acid	9.2	-	-	-
Frother B-23	-	0.07	-	-
Oleic acid	-	.36	-	-
pH	2.7 to 2.8	7.3	-	-
Time, minutes	30	2	2	1

1/ Beryllia analyses determined by fluorometric method.

Flotation of Helvite Ore from Iron Mountain, Winston, N. Mex.

The sample contained 1.44 percent beryllia, or about 18 percent helvite. Other minerals present and the approximate amounts were magnetite and other opaque minerals, 35 percent; fluorite, 30 percent; sillimanite, 9 percent; and minor amounts of chlorite, hematite, apophyllite, quartz, chalcedony, psilomelane, wad, pyrosmalite, clay, and calcite, amounting to 8 percent in all.

A slight variation in the concentration practice was followed. The ore was wet-ground in stages to minus 100-mesh and scrubbed as a pulp of 50 percent solids with 18.4 pounds per ton of hydrofluoric acid. At the end of the scrubbing period the acid was consumed and the pH of the pulp was 7.5. The helvite was then floated with oleic acid and pine oil without the customary washing and desliming. The rougher concentrate was cleaned twice to depress gangue minerals other than magnetite, and the magnetite was then separated by a low-intensity magnetic separator. The results of a typical test are given in table 20.

TABLE 20. - Flotation and magnetic separation of Helvite ore from Iron Mountain, Winston, N. Mex.

Metallurgical data

Product	Weight, percent	Analysis, percent BeO	Percent of total BeO
Helvite-Danalite concentrate..	24.5	4.73	84.3
Magnetite concentrate	19.0	.18	2.5
Middling	16.5	.74	8.9
Tailing	40.0	.15	4.3
Composite (heads)	100.0	1.37	100.0

Operating data

Reagent	Pounds per ton of feed			
	Conditioner	Rougher	Cleaners 1	Cleaners 2
Hydrofluoric acid (47%)	18.4	-	-	-
Oleic acid	-	0.54	-	-
Pine oil	-	.18	-	-
pH	2.0 to 7.5	7.5	7.5	7.5
Time, minutes	15	6	5	4

In this particular case the ore contained fluorite, and hydrochloric acid was substituted for hydrofluoric acid with similar results.

DISCUSSION

Under the impetus of war demands for beryllium, the Bureau of Mines undertook investigation of concentration of beryllium ores. The beryllium ores included beryl-bearing pegmatites from South Dakota, New Mexico, Nevade, Colorado, Connecticut, and a helvite-bearing tactite from New Mexico. Although various concentration methods were adaptable for removing minor amounts of certain accessory minerals, flotation was the most applicable method. Some of the ores were amenable to flotation in their natural state, others would respond to flotation only after scrubbing with an alkali to remove the alteration products, and still others were not amenable even after this treatment.

A flotation procedure was developed that was satisfactory for all the ores tested. Moreover, it enhanced the flotation of beryl even though the beryl was amenable to flotation after an alkali scrubbing. The essence of the separation was the removal of alteration products prior to flotation by scrubbing with hydrofluoric acid either added direct or formed in the pulp by the interaction of a fluoride and sulfuric acid. If the scrubbed pulp was still acid, washing to remove the acid was necessary before flotation; if the acid was consumed, so that the acidity of the pulp was not excessive, the washing step was unnecessary. Residual hydrofluoric acid from the scrubbing could be recirculated. The ore was then floated with oleic acid and pine oil and cleaned according to the procedure indicated by the grade of the rougher concentrate and the contaminants. Meticulous control of the temperature of the pulp was unnecessary. Tourmaline was later floated from the beryl concentrate by an amine hydrochloride in a sulfuric-acid circuit.

High-grade concentrates and high recoveries were obtained from beryl ores containing as little as 0.35 percent beryllia. Fair recoveries and lower-grade concentrates were obtained from ores containing less than 0.35 percent beryllia. Helvite also responded to the flotation procedure.