CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
1520 West Adams St.
Phoenix, AZ 85007
602-771-1601
http://www.azgs.az.gov
inquiries@azgs.az.gov

The following file is part of the

Arizona Department of Mines and Mineral Resources Mining Collection

ACCESS STATEMENT

These digitized collections are accessible for purposes of education and research. We have indicated what we know about copyright and rights of privacy, publicity, or trademark. Due to the nature of archival collections, we are not always able to identify this information. We are eager to hear from any rights owners, so that we may obtain accurate information. Upon request, we will remove material from public view while we address a rights issue.

CONSTRAINTS STATEMENT

The Arizona Geological Survey does not claim to control all rights for all materials in its collection. These rights include, but are not limited to: copyright, privacy rights, and cultural protection rights. The User hereby assumes all responsibility for obtaining any rights to use the material in excess of "fair use."

The Survey makes no intellectual property claims to the products created by individual authors in the manuscript collections, except when the author deeded those rights to the Survey or when those authors were employed by the State of Arizona and created intellectual products as a function of their official duties. The Survey does maintain property rights to the physical and digital representations of the works.

QUALITY STATEMENT

The Arizona Geological Survey is not responsible for the accuracy of the records, information, or opinions that may be contained in the files. The Survey collects, catalogs, and archives data on mineral properties regardless of its views of the veracity or accuracy of those data.

PRINTED: 06/20/2002

ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES AZMILS DATA

PRIMARY NAME: ROCK HOUSE GROUP

ALTERNATE NAMES:
- AMERICAN FIBER GROUP
- ARIZONA CLAIM
- MAY CLAIM
- MONTEZUMA CLAIM
- EARL PIERCE PROPERTY

GILA COUNTY MILS NUMBER: 380

LOCATION: TOWNSHIP 7 N RANGE 15 E SECTION 15 QUARTER N2
LATITUDE: N 33DEG 57MIN 20SEC LONGITUDE: W 110DEG 48MIN 03SEC
TOPO MAP NAME: MCFADDEN PEAK - 15 MIN

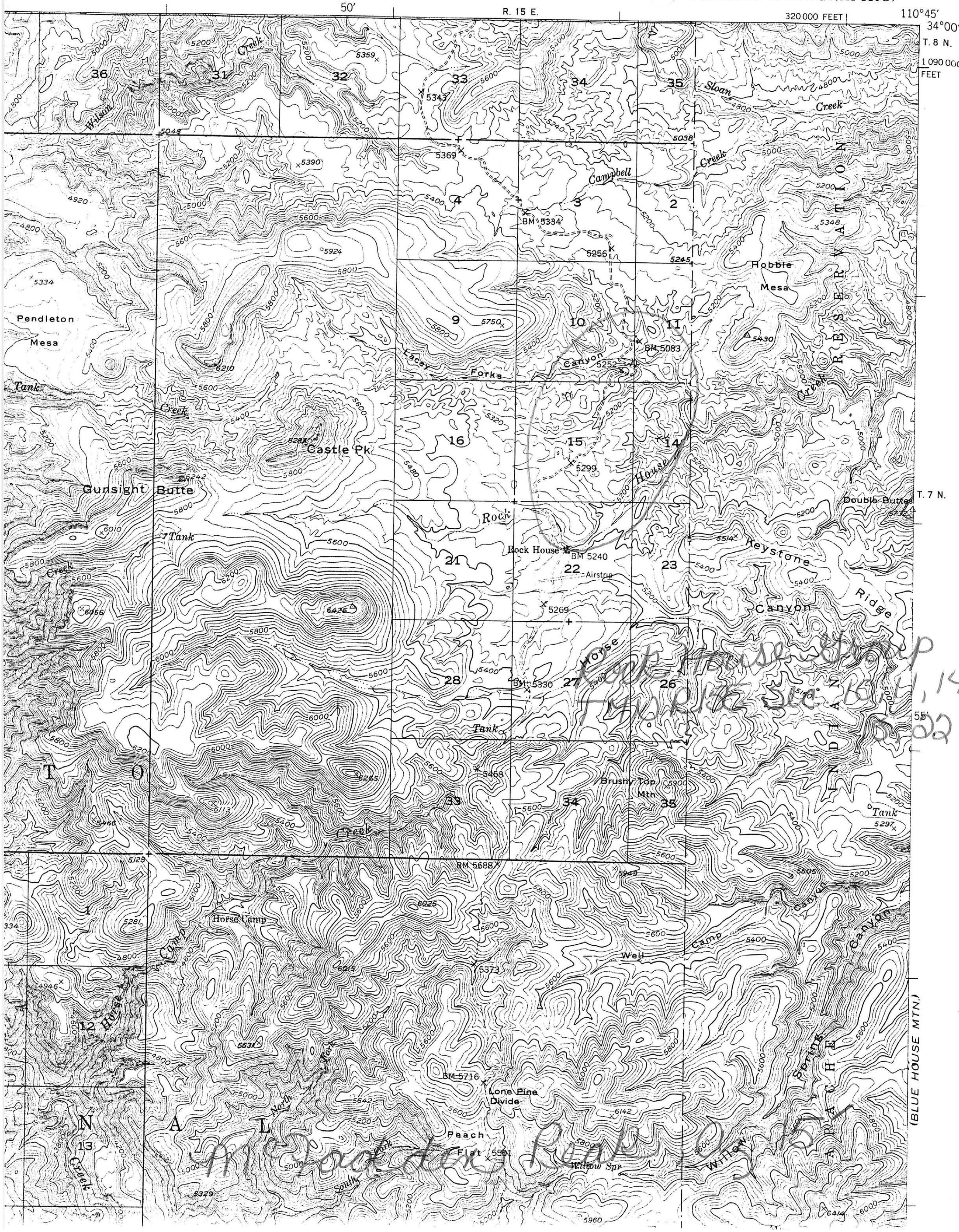
CURRENT STATUS: PAST PRODUCER

COMMODITY:
- ASBESTOS

BIBLIOGRAPHY:
- ADMMR ROCK HOUSE GROUP FILE
- ADMMR MAPS (PHX UPSTAIRS FLAT FILE #7)
- WILSON E D "ASB DPSTS AZ" AZBM BULL 126 P 76
- USBM IC 7706, P 86-90
- CLAIMS EXTEND INTO SEC 10, 11, 14, 22

NITED STATES
MENT OF THE ARMY
PS OF ENGINEERS

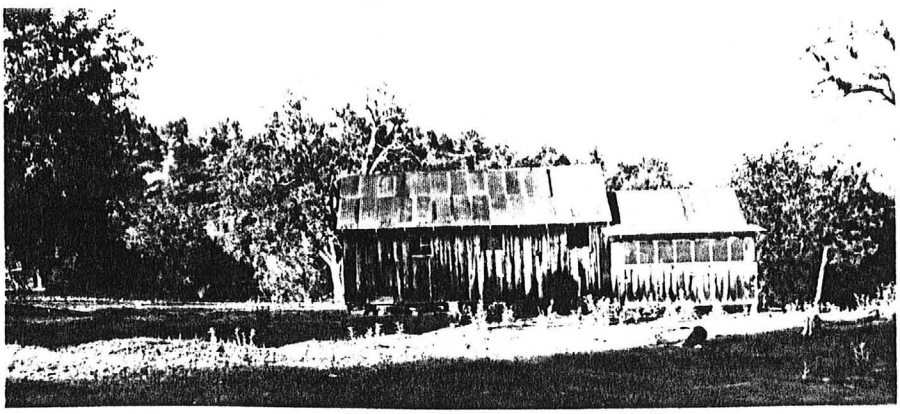
MCFADDEN PEAK QUADRANGLE
ARIZONA-GILA CO.
15 MI TE SERIES (TOPOGRAPHIC)



JUL • 76

A-170-30

JUL • 76



A-170-31

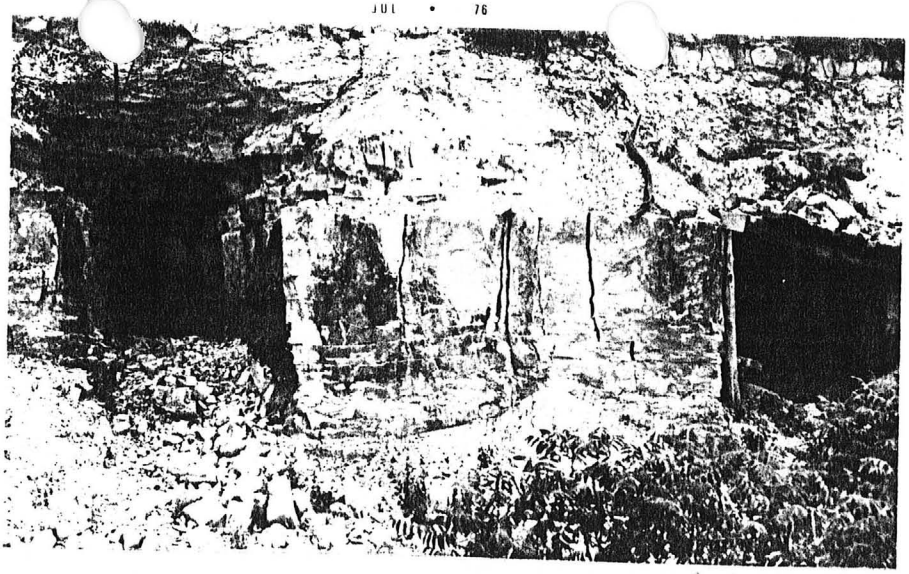
Rock House Camp at Mill Site

JUL • 76

A-170-32

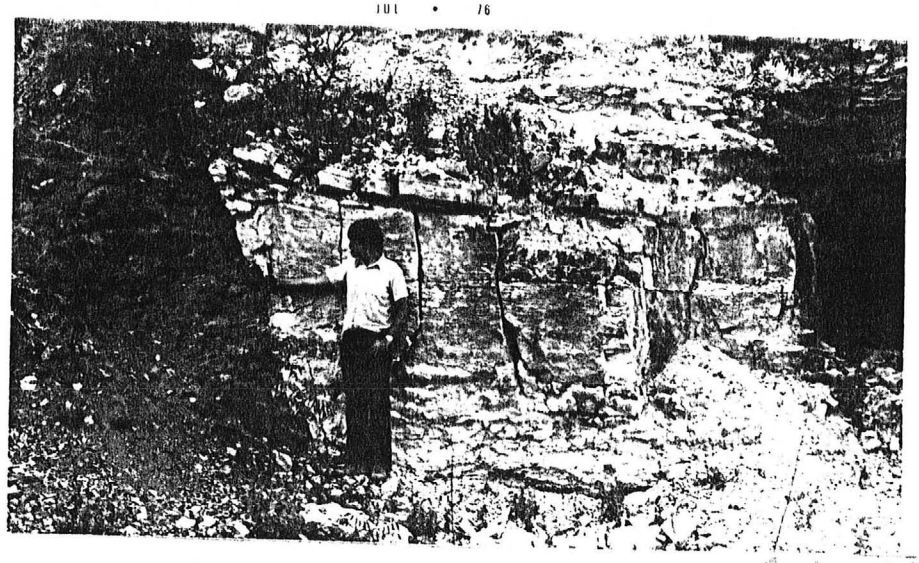
Mill Foundations Oldest in Center

JUL • 76



A-170-33

JUL • 76



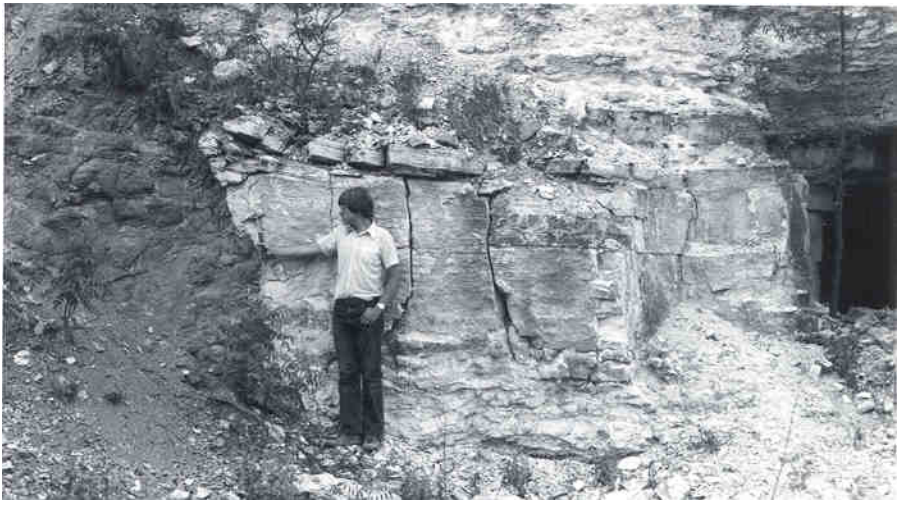
A-170-34

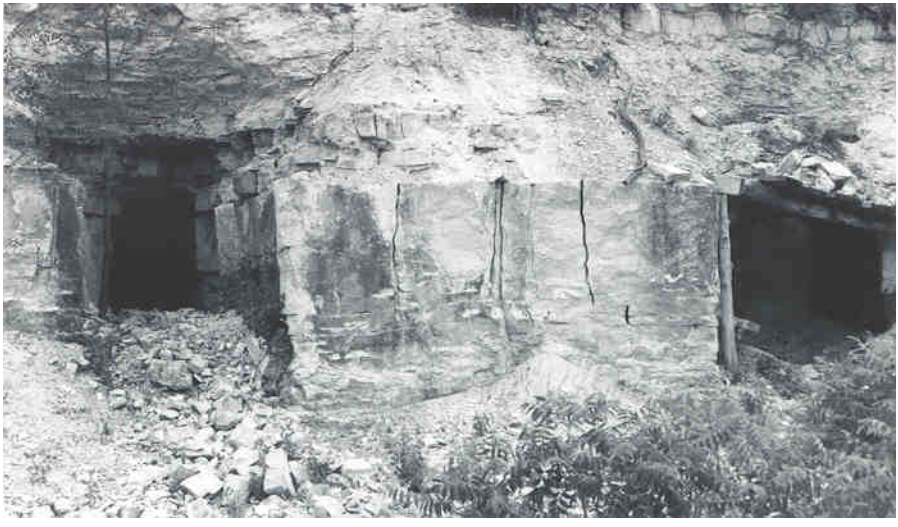
Twin Adits With Diabase Roll

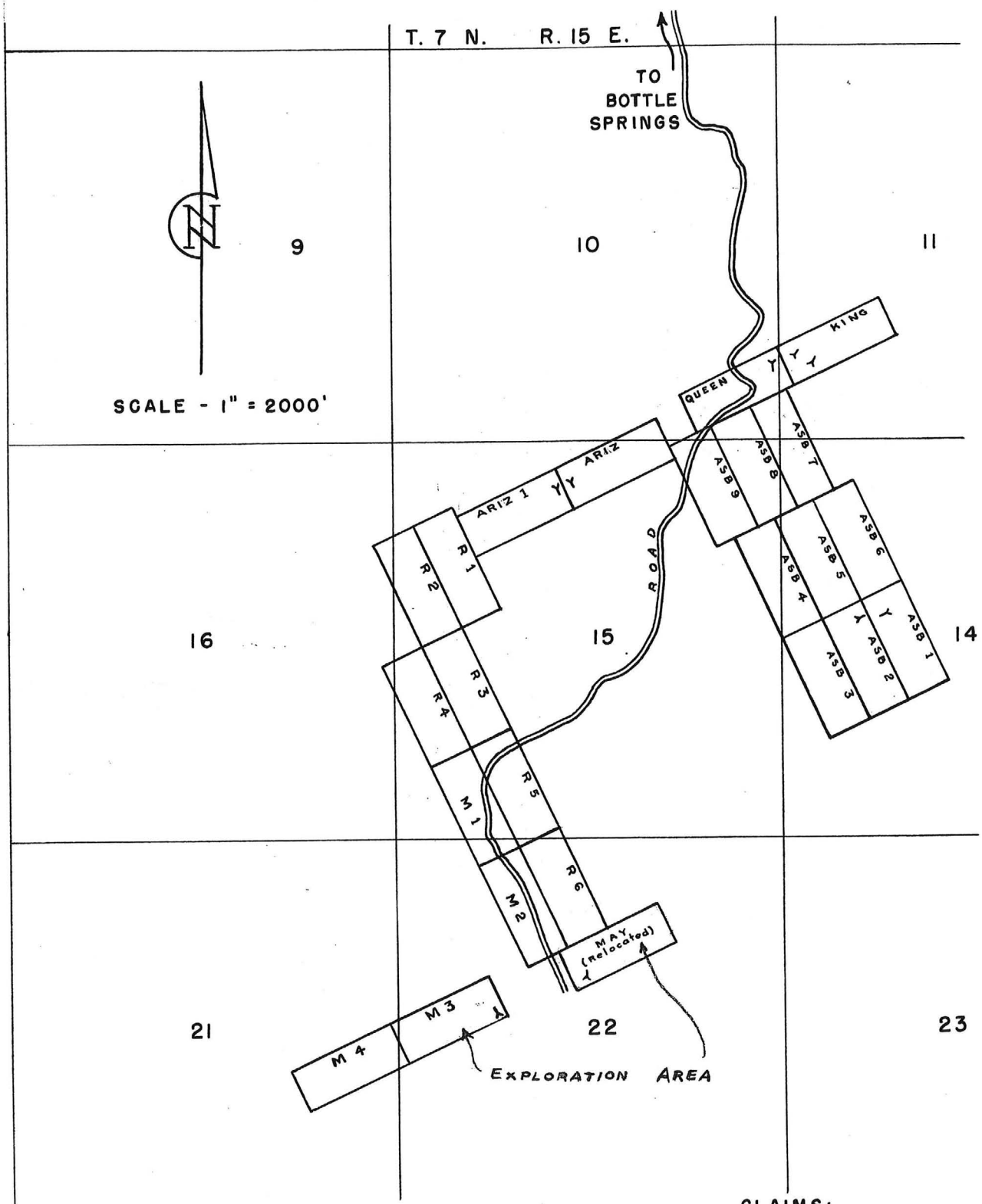
JUL • 76

A-170-35

900-Foot Cut







CLAIMS:

ARIZ	-	ARIZONA
ASB	-	ASBESTOS
M	-	MONTEZUMA
R	-	ROSE

COPIED FROM DOCKET MAP

DMEA 2789

FIGURE 2. - CLAIM MAP - AMERICAN FIBER CORP.
GILA COUNTY, ARIZONA

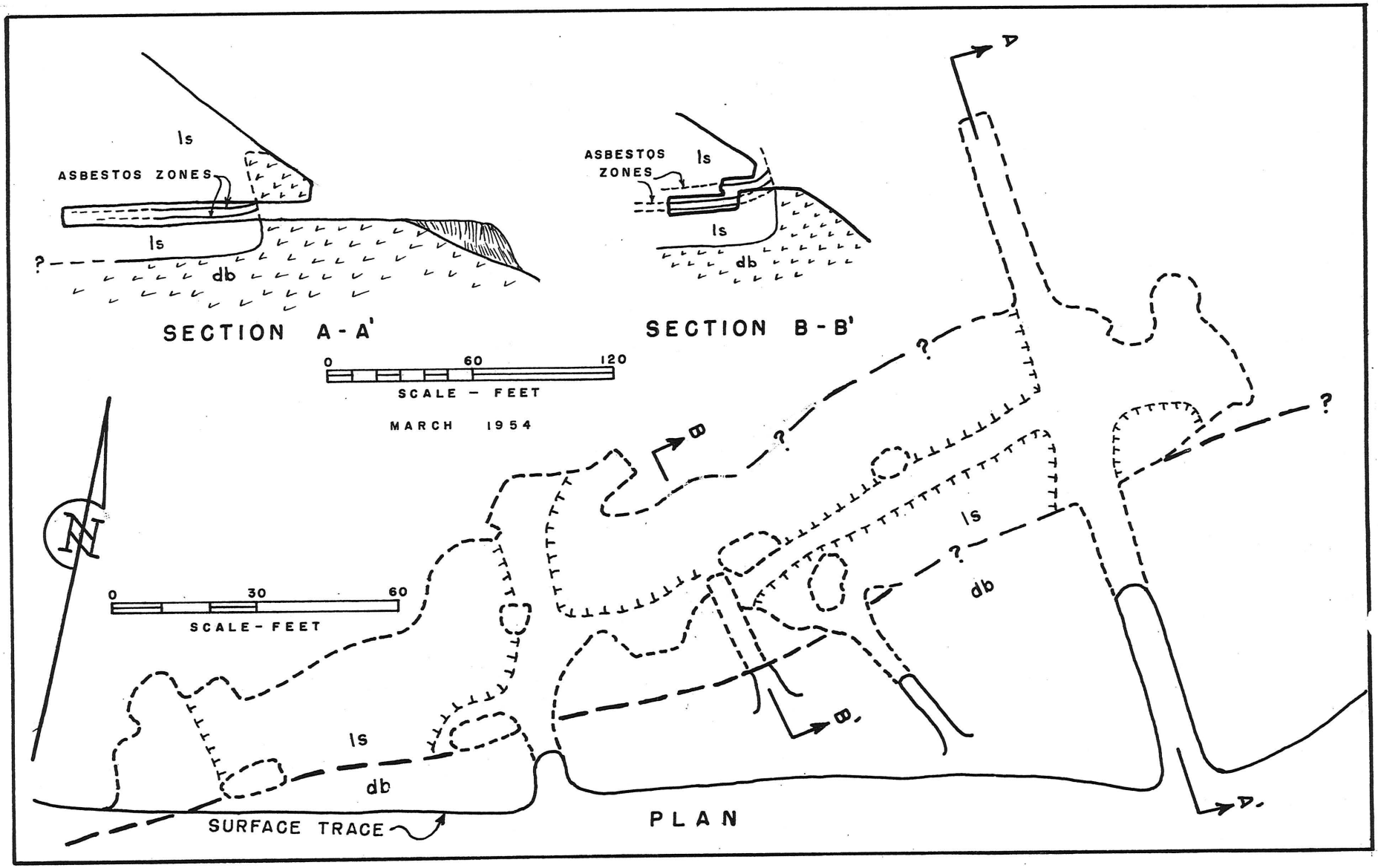


FIGURE 30. - PLAN AND SECTIONS - MAY MINE - AMERICAN FIBER COMPANY

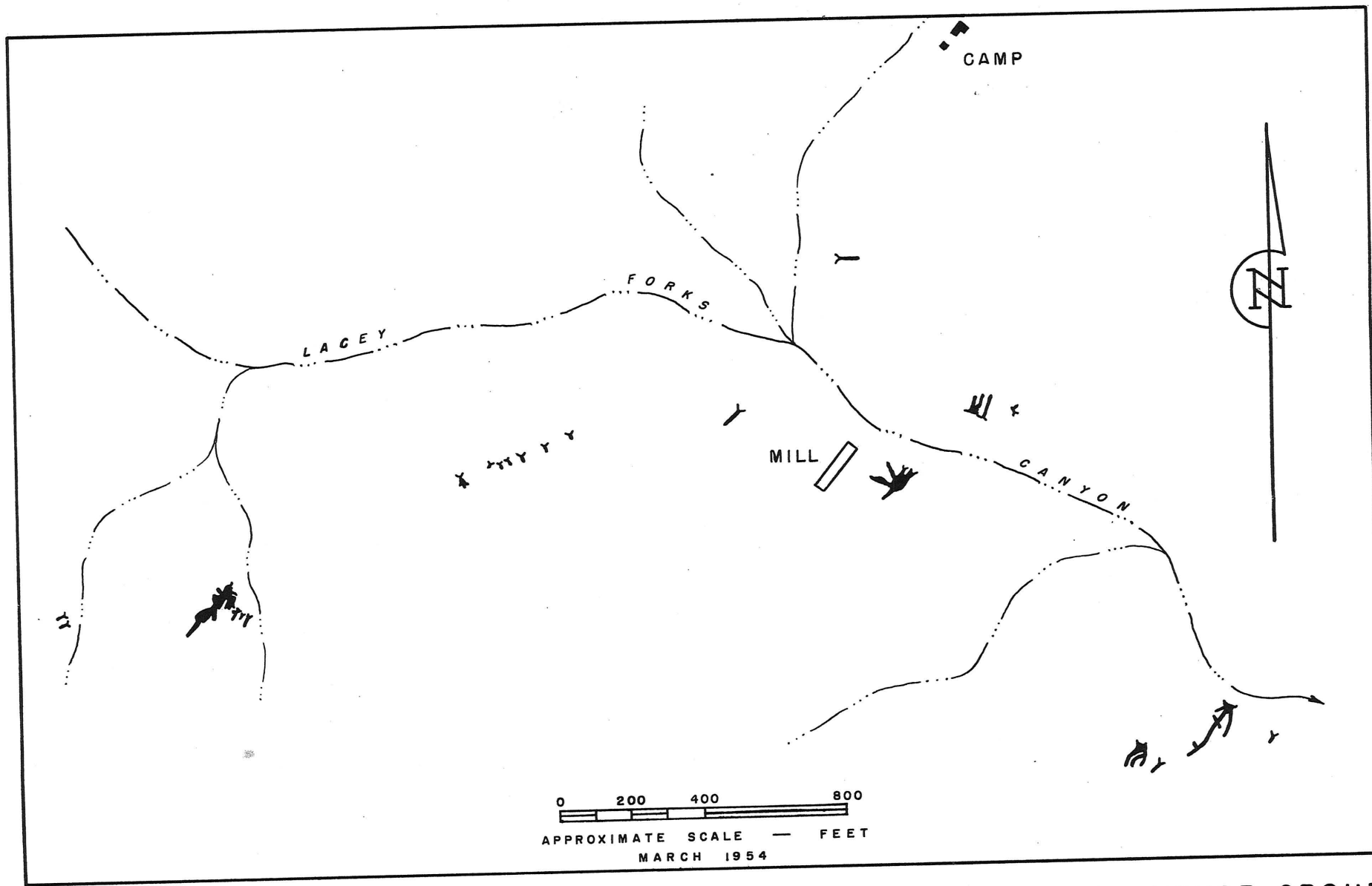


FIGURE 29. - SKETCH LOCATION MAP - NORTH END ROCK HOUSE GROUP
AMERICAN FIBER COMPANY

ROCK HOUSE GROUP GILA COUNTY

American Fiber Corp. Properties - (Rock House Mines & Mill) Letter 2-1-60
Correspondence files under "Asbestos"

Grady Gulledge, 848 W. Earll Drive, Phoenix and P.O. Box 606, Globe, Arizona, says he is the owner of the above property. LAS Phone call 8-22-60

Grady Gulledge called the office and stated that the assessment work on the Rock House asbestos claims and others was completed and he plans to start working the Rock House after the first of the year. He is negotiating a contract with Metate for the milling of his crude ore. LAS WR 11-3-61

Grady Gulledge stated that Pan American Co., Inc,, had been reorganized to include Grant Sattem of Flagstaff. The new group has acquired the Wright Claims and the Anderson properties. It is now planned to resume operations at the Rock House in April. Jerry Weathers recently did some geological work for them. LAS 2-15-63

Mr. Jack P. Bird and son Jack from 205 N. San Francisco St., Flagstaff, advised that he had taken over the management of the following mining corporations: Pan American Fiber Corp. (Rock House Mines) Flag Investment Corp. (Arizona Asbestos Uranium Co. - Turner Smith, Hanson) now all Flag Investment. GBG WR 12-13-68

References: IC 7706

ABM Bull. 126, p. 76

ARIZONA DEPARTMENT OF MINERAL RESOURCES
MINERAL BUILDING, FAIRGROUNDS
PHOENIX, ARIZONA

~~December 10, 1957~~

February 13, 1958

To the Owner or Operator of the Arizona Mining Property named below:

EARL PIERCE MINE (Property) ASBESTOS (ore)

We have an old listing of the above property which we would like to have brought up to date.

Please fill out the enclosed Mine Owner's Report form with as complete detail as possible and attach copies of reports, maps, assay returns, shipment returns or other data which you have not sent us before and which might interest a prospective buyer in looking at the property.

FRANK P. KNIGHT,
Director.

Enc: Mine Owner's Report

DEPARTMENT OF MINERAL RESOURCES
STATE OF ARIZONA
Mineral Building, Fairgrounds
PHOENIX, ARIZONA

Return

PHOENIX
FEB 13
9-PM
1958
ARIZ.

Mr. Earl Pierce

~~Young, Arizona~~

Released

August 7, 1941

Mr. Earl Pierce
Young, Arizona

Dear Mr. Pierce:

I have your letter of August 3 relative to the asbestos property you have listed with the Department of Mineral Resources. We note that you desire to change your price and terms and this is being changed in our records.

When we submit copies of these reports to the people who write us that they are interested in properties, we have to remember that it is on the basis of these reports that the person decides that he will look into that property further and possibly make further examination. Those properties often get turned down on the basis of the report. One of the most common reasons for being turned down is the amount of the cash payment required. Taken as a whole, people are not willing to put up much of a down payment. They are quite willing to spend their money on the development of a property with the idea that that which they develop will meet the regular payments, but nothing scares a person so much as the demand for a large cash payment before they can even start development.

I am very much afraid that even with your revised terms the cash payment desired will keep many people from even looking into it.

However, there is a growing demand for asbestos; our foreign supply is being cut off; and we have had more interest in Arizona asbestos properties during the last couple of months than every before and we will, of course, submit copies of your report, as revised, to all those who make inquiries.

Hoping that we can do something for you, I am,

Yours very truly,

Chairman, Board of Governors
Arizona Department of Mineral Resources

CFW:LP

Young, Ariz. Aug. 3. '41.

Mr. J. S. Coupal.
518 Title & Trust Bldg
Phoenix, Ariz.

Dear Mr. Coupal:

When I listed my asbestos property with you for sale I asked $35000 cash or $45000 on terms. But have decided to take $25000 cash or $35000 on terms as follows:— $16000 down, $19000 divided in three equal payments one each year for three years, paying a royalty on fiber as follows, 15% on number 1— 10% on #2 5% on #3, to apply against purchase price. I have owned the property some 9 or 10 years and want to get out of the mining business. I have three horses and plenty of water. There is no machinery at the

present time if there is any at time of sale the actual cost of Machinery will be added.

I am about 4 miles south from where Roger Coplin property on Sloan Creek is that you looked at.

I have plenty of fish in sight.

I have 19 claims.

12 September 1941

Mr. Earl Pierce,
Young,
Arizona.

My dear Mr. Pierce:

I thank you for your letter of September 6 calling attention to error in the terms of sale on your EARL PIERCE MINE.

The corrections have been made, and I am enclosing herewith a copy, which I trust you will now find correct.

Regretting any inconvenience caused you, and assuring you of our desire to be helpful, I am

Yours very truly,

J. S. Coupal

JSC-jrf
encl.

Young, Ariz. Sept 6, 1941.

Dear Mr Engel:

according to the duplicate you sent me of my property you have listed you made a mistake in price. I wrote you $25000 cash and $35000 on terms - $16000 down and balance $19000 divided in 3 equal payments etc. —

You have $16000 down and balance $1800 will your correct it - if you have it that way?

If anyone is interested I will be willing to give them time to do some work before they make a payment which will be agreed upon when they get the property.

Respt -

Earl Sires,

Young Ariz.

Yuma, Arizona July 25, 1940

J. S. Coupal

Phoenix, Arizona,

Dear Mr Coupal:

In answer to your letter of July 11 will write a brief description and you can add to report what you want to and if you want any more information just ask me and I will give it to you.

Just North of camp is a large Mesa you come down a little slope into camp which lays in a flat. The mountains the fiber lays in are not very high but a gentle slope No deep canyons and are flat on top. It is not thickly timbered Mostly Juniper, some oak, Mahuut and a few pines.

The weather is not to bad in Winter My Wife and I live here all the year.

P.S. I appreciate your help and if you are up in this part of country would be glad to have you come see me. You can also get here by way of Holbrook from Holbrook you take the road to Young,

15 March 1940

Mr. Earl Pierce,
Young,
Arizona.

Dear Mr. Pierce:

On February 24, I sent you a blank Mine Owners Report with the request that you fill it out in detail covering your asbestos property and return to this office for filing.

To date, this report has not been returned. I should like to have this information, as I now have a call for information on chrysotile asbestos properties. The party interested in such properties is -

Mr. P. D. Ross,
3782 Denker Avenue,
Los Angeles, California.

I should suggest that you get in touch with Mr. Ross, and also that you send in a report for our files.

With best wishes, I am

Yours very truly,

J. S. Coupal
Director

JSC-jrf

21 February 1940

Mr. Earl Pierce,
Young,
Arizona.

Dear Mr. Pierce:

I thank you for your letter of February 12 regarding the sale of your mining property.

I am enclosing herewith a blank Mine Owners Report, which I should suggest that you fill out in detail and return to this office so that we may have the information on file regarding your property in case we have an inquiry for a mine such as yours.

I should suggest that you return this report as early as possible - giving details in full.

With best wishes, I am

Yours very truly,

J. S. Coupal
Director

JSC-jrf

encl.

Young, Ariz. Dec. 12, 1939.

J. S. Coupal,
Phoenix, Ariz.

Dear Sir:- I noticed in Pay Dirt where you was asking for a list of properties for sale.

I would like to sell my Asbestos property.

I have 19 claims in a group can show number one fiber on most all of them my fiber is Chrysotile.

I am enclosing a small samples of Number one fiber.

The way I have been working my property runs better than 5% #1 as you can see by what I sold last year, last year I sold 248 lbs of #1 and 766 lbs of #2.

Market was mentioned last year Hoping you can find me a buyer I am,

Yours Resp'y
Earl Pierce,
Young, Ariz.

ME-10

DEPARTMENT OF MINERAL RESOURCES
STATE OF ARIZONA
MINE OWNER'S REPORT

Date: September 6, 1941

Mine: EARL PIERCE MINE

District: Flourine Mining District, Gila County, Arizona

Location: North of Globe. 4 miles south of Roger Q. Kyle's property on Sloan Creek.

Former Name:

Owner: Earl Pierce

Address: Young, Arizona

Operator: Same

Address:

President:

Gen. Mgr:

Mine Supt:

Mill Supt:

Principal Metals: Asbestos

Men Employed: One at present

Production Rate

Mill: Type & Capacity.

Power: Amt. & Type

Operations: Present: Doing assessment work.

EARL PIERCE MINE

Asbestos

Operations Planned:

Gila 4 - 2 T 7 N, R 15 E

Earl Pierce, Young '41

Number of Claims, Title, etc: 19 claims in a group - can give clear deed.

Description: Topog. & Geog: Diabase and quartzite true contact, magnesia lime, some shale and curly lime.

Mine Workings: Amt. & Condition: 12 tunnels in fair condition.

Geology & Mineralization: Diabase, magnesia lime, serpentine, soapstone

Ore: Positive & Probable, Ore Dumps, Tailings: Ore in various grades (Plenty of fiber in sight).

Mine, Mill Equipment & Flow Sheet:

Road Conditions, Route: Roads are passable. Globe over Apache Trail to Pleasant Valley or Young, then on to mine - this road has a sign on it - ask for information at Hoaglands.

Water supply: Well and two springs (Plenty of water).

Brief History: Have three livable houses, a log cabin, need a little repair and a garage. (3 houses).

Have magnesium lime, serpentine and soapstone - have from 3 to 4 ledges of asbestos bearing mineral; in some places will run from 5 to 6 feet apart.

Special Problems, Reports Filed: Lack of money to operate and market conditions.

Remarks:

If property for sale: Price, terms and address to negotiate:

Cash Price $25,000.00; On terms $35,000.00 - $16,000.00 down, and balance of $19,000.00 divided in 3 equal payments, one each year for 3 years, paying a royalty on fiber as follows: 15% on #1; 10% on #2; 5% on #3 - to apply against purchase price.

Signed: EARL PIERCE
Young, Arizona

ASBESTOS SURVEY

NAME OF PROPERTY AMERICAN FIBER CORP. (PIERCE PROPERTY)

OWNER - Name AMERICAN FIBER CORP. OPERATOR: Name SAME

Address 328 W OAK ST GLOBE, PHONE Address BOX 65A YOUNG ARIZ

TYPE OF ORE: CHRYSOTILE

Length of Fibre 2" ON DOWN

Soft SOFT SEMI SOFT Hard SOME - NOT SHIPPING

PRODUCTION (tons of crude ore)

Past 6T/MONTH FIBER WHEN OPERATING (#1 - 1/3, #2 1/3, #3 & UNDER 1/3

Present SAME
Monthly

Estimated Future Production MORE IN SPRING
Monthly

ORE RESERVES:

Ore in Place IN FACES BUT NOT BLOCKED OUT

Probable Ore 100 T ALL GRADES OR MORE

IS YOUR ORE THE TYPE THAT COULD BE MILLED WITH OTHER ORE IN YOUR DISTRICT?

YES

MILL CAPACITY
16-20T ORE/8HR
10T FIBER/8HR WITHOUT RERUN

Signed: Bob Stinson
SUPT.

March, 1954

Arizona Department of Mineral Resources
Phoenix, Arizona

American Fiber Corp. (Pierce Property)

Owner-American Fiber Corp.,
328 W. Oak St.,
Globe, Arizona.
Operator-American Fiber Corp.,
P. O. Box 65A,
Young, Arizona

This pompany is now operating at the May or Rock House mine. Other mines being idle for the present. Only a few men were on the payroll at the time of visit, as the entire night shift had been fired shortly previous, but a new crew was being hired to replace those discharged. The company is discussing a loan with the government, but to date the conditions of the proposed loans have not been to the liking of the company and have been rejected. The company is going ahead with some exploration of ore bodies other than the one which they are now mining and if the loan falls through might continue and explore the ground favored by the government, but but probably in a more economical manner.

Past production has been about 6 tons of fiber per month when operating., about 1/3 number 1, 1/3 numer 2, and 1/3 number 3 and under according to Mr. Leturno, Mine Supt.

The mill has a capacity of16 to 20 tons per 8 hours, and used punched screen, which Mr. Leturno tells the writer are very satisfactory, though expensive, with much less fiber of a given grade falling in a shorter grade.

Crude reserves.

Very little ore can be considered blocked out, but it is in the faces, and what with reserves in some of their other mines, not know being worked, it is very probable that at least 100 tons of fiber are present. Developement may raise this considerably.

ME-10

DEPARTMENT OF MINERAL RESOURCES
STATE OF ARIZONA
OWNERS MINE REPORT

Date March 18, 1940

Mine Earl Pierce Mine

District Flourine Mining District

Location North of Globe

Former name

Owner Earl Pierce

Address Young, Arizona

Operator Same

Address

President Same

Gen. Mgr.

Mine Supt. Same

Mill Supt.

Principal Metals Asbestos -

Men Employed One at present

Production Rate

Mill: Type & Cap.

Power: Amt. & Type

Operations: Present Doing assessment work

Operations Planned

Number Claims, Title, etc. 19 claims in a group - can give clear deed

Description: Topog. & Geog. Diabase and quartzite true contact - magnesia lime, some shale and curly lime.

Mine Workings: Amt. & Condition
12 tunnels in fair condition

(over)

Geology & Mineralization

Diabase, magnesia lime, serpentine, soapstone

Ore: Positive & Probable, Ore Dumps, Tailings

Ore in various grades

Mine, Mill Equipment & Flow Sheet

Road Conditions, Route Roads are passable. Globe over Apache Trail to Pleasant Valley or Young, then on to mine - this road has a sign on it - ask for information at Hoghland's

Water Supply Well and two springs

Brief History Have three liveable houses, a log cabin, need a little repair and a garage. Have magnesium lime, serpentine and soapstone - have from 3 to ledges of asbestos bearing mineral - in some places will run from 5 to 6 feet apart

Special Problems, Reports Filed

Lack of money to operate and market conditions

Remarks

If property for sale: Price, terms and address to negotiate.

Cash price $35,000 - on terms $45,000 with 20% down with 2 years to pay for property - payments to be made every 6 months - pay a royalty on fiber shipped - let royalty apply against purchase price

Signed..... Earl Pierce .....
Young, Arizona

Use additional sheets if necessary.

Just north of camp is a large mesa you come down a little slope into camp which lays in a flat. The mountains the fiber lays in are not very high have a gentle slope no deep canyons, and are flat on top. It is not thickly timbered mostly Juniper, some Oak, Walnut and a few Pines.

The weather is not too bad in Winter. My wife and I live here all the year. Roads could be kept open in Winter without very much work.

I am east of Castle Butte about 1-1/2 miles airline. North of Sombrero Butte about 6 miles airline and about 45 miles north of Globe airline. I am in Township 7 Xl R. 15 East I think.

My asbestos is Chrysotile. White silky I have some harsh and semi-harsh. I have fiber showing in all tunels various grades. I am sending you a sample of fiber.

The reason I have not leased they always want most all of the fiber and just want to gauge don't want to do any development work.

If I could get a loan from government like the gold and silver mines do so I could buy some machinery I know I could get out some good fiber.

Resp't.

/sd/ Earl Pierce.

THE ROCK HOUSE GROUP — PIERCE GROUP —

PAN AMERICAN FIBER CORPORATION — LETURNO - 11 Nowall Pan Amer

GRADY
GULLEDGE

848 WEST EARLL DR., PHOENIX, ARIZONA 85013
PHONE 265-4448

AUG 15th 1968
PAN-AMER, FIBER
"OWNER"

MINING

GERALD WEATHERS
REGISTERED - CONSULTING GEOLOGIST
3928 EAST MEADOWBROOK AVE.
PHOENIX 18, ARIZONA

CRestwood 4-9795

MINING
GROUND WATER
ENGINEERING GEOLOGY

A S B E S T O S

A COMPILATION OF INFORMATION ON THE ASBESTOS INDUSTRY & AN EVALUATION OF THE ROCK HOUSE CHRYSOTILE ASBESTOS PROPERTY OF THE PAN AMERICAN FIBER CORP. GLOBE, ARIZONA

By Gerald Weathers

GERALD WEATHERS
REGISTERED - CONSULTING GEOLOGIST
3928 EAST MEADOWBROOK AVE.
PHOENIX 18, ARIZONA

CRestwood 4-9795

MINING
GROUND WATER
ENGINEERING GEOLOGY

Typed on Letterhead
Orig Only

INTRODUCTION AND SUMMARY

The writer was engaged by the principals of Pan American Fiber Corporation to evaluate the commercial potential of their asbestos holdings in the Fluorine Mining District, Gila County, Arizona, and to present a survey of the asbestos industry including a comparison of the Arizona industry with other chrysotile fiber producers.

The information was derived from various sources listed in the reference, as well as from a field examination. Part I concerns the entire industry; whereas Part II is confined to a geologic investigation and evaluation of the Pan American Rock House chrysotile asbestos property.

PART I

Asbestos is a naturally fibrous mineral silicate used in the insulation, filter, asbestos-cement, flooring and other industries. Value of the fiber is dependent primarily upon its length, varying from Grade 1, selling for approximately $1,500, per short ton, to No. 7 grade, worth about $65. per short ton.

Asbestos is a mineral of strategic importance because of the demand, scarcity and high cost of production. Of the four important commercial forms, chrysotile asbestos constitutes 95% of the world supply. Canada produces 70% of the world

supply and exports 95% of it to the U. S. The U. S. produces only 1.7% of the world supply, but uses two-thirds of the world supply, excluding Russian production. It is predicted the U.S. production is unlikely to exceed 7% of the supply in the next decade and that Canadian mines can produce no more than one-half the demand.

Arizona is the only present source of natural low-iron chrysotile spinning fiber in the Western Hemisphere. Arizona's asbestos producers have a general reputation of poor, inconsistent grading and an undependable source of supply.

PART II

The Rock House property (79 unpatented contiguous lode claims), forming a block of 1,422 acres in the Fluorine Mining District, Gila County, Arizona, is located approximately 35 miles due north of Globe. It is underlain by a broad plateau of nearly horizontal rock, ~~ranging in altitude from 4,800 to 5,800 feet~~ at an elevation of approx 5200 feet. The climate is moderate and the property is accessible throughout the year except for short periods of time during the winter when the road is temporarily blocked by ~~infrequent~~ snow ~~storms~~.

The prospect, first located in 1915, produced asbestos fiber ~~sporadically~~ intermittently until 1950. A steady milled production was maintained thereafter until 1960 when the mill burned. Mining operations were suspended in June 1961 pending receipt of sufficient exploration and development funds. ~~Estimated~~ Total ~~past~~ production was approximately 3,200 tons of all grades of chrysotile asbestos fiber.

The deposits occur as thin, nearly horizontal chrysotile asbestos veins in the lower and middle members of the pre-Cambrian Mescal limestone in close proximity to diabase. Exploration consisted of driving adits into cliff faces where outcropping asbestos was observed. Ore was extracted following a modified room and pillar or longwall stoping with hand emplaced backfill system of mining. Approximately 3% of the rock mined was asbestos fiber. The hand-cobbed and milled ore was hauled to Globe for warehousing or further processing and sold f.o.b. Globe, Arizona.

Calculated proven ore reserves are 499 tons valued at $298,450. The property has an estimated potential production of 266,000 tons of asbestos fiber evaluated at $158,536,000. Total estimated costs of production are $122,470,000, resulting in an estimated profit of $36,060,000. A 23% depletion allowance is applicable to the asbestos industry, ~~taxes are paid on 77 per cent of the income, not including purchases or royalty payments, provided the percentage depletion allowance does not exceed 50% of the net income.~~ as explained in the IRC

It is recommended the property's geologically favorable areas be drilled on a grid pattern to delineate underlying asbestos ore deposits. A recommended Phase I exploration program is outlined in the report; subsequent prospecting recommendations should follow a detailed geologic study for additional specific exploration targets.

Summations and Recommendations pertaining to the Arizona asbestos industry are:

1. The product, a low-iron chrysotile asbestos of all grades should be well received by an industry unable to meet its demands.

2. The expected gross per unit volume should be high.

3. Exploration should be preceded by close Geological studies of the deposits.

4. A more economical mining method designed for greater production per man hour should be adapted to these deposits.

5. Milling techniques and products should be improved.

6. Quality control of the asbestos must be exercised to produce asbestos grades to conform to industrial use specifications.

7. A dependable supply of the product must be assured.

8. The entry into the Arizona and U. S. asbestos industry will require a large monetary outlay to block out sufficient ore reserves; to develop the mines and follow more economical mining method; to build an efficient mill and to develop markets for all grades of asbestos produced.

PART I

THE ASBESTOS INDUSTRY

DEFINITION OF ASBESTOS MINERALS

Asbestos is a word of Greek origin meaning inestinguishible applied to a group of naturally fibrous mineral silicates for which no adequate substitutes are available. Asbestos' flexible, fibrous structure, resistance to fire, time, weather, acids and alkalies, low heat conductivity, electrical insulation properties and high tensile strength make it an important raw material for many purposes. (10)

The important commercial asbestos minerals are amosite (brown asbestos), crocidolite (blue asbestos) and chrysotile (white asbestos).

Amosite ($(Fe, Mg)SiO_3$ --)a complex iron magnesium hydrous silicate, classed with the amphibole minerals, is characterized by long strong fibers, some attaining a length of 11 inches. This iron rich fiber is produced exclusively in South Africa.

Crocidolite ($Na\ Fe\ (SiO_3)$--)a soda-iron monoclinic amphibole, is characterized by fibers ranging in length from $1\frac{1}{2}$" to less than 1/8 inch with a higher tensile strength, but a lower resistance to heat than other varieties. This iron-rich fiber is produced principally in South Africa, with a lesser production from Western Australia, Bolivia and New Quebec, Canada.

Chrysotile ($H_4\ Mg_3\ Si_2\ O_9$), a hydrous magnesium silicate, is the fibrous form of the mineral serpentine. It occurs in aggregates of

fine, crystalline silky flexible fibers, ranging in lengths in excess of 6 inches (extreme of 24 inches reported) to less than 1/8 inch, of high tensile strength. Single fiber diameters can be obtained as fine as 0.0000007 inches. In general, chrysotile constitutes about 95% of the world supplies, and is more constant and dependable in quality than other varieties of asbestos.

The principal source of chrysotile is from Quebec, Canada with lesser amounts produced in Soviet Russia, Southern Rhodesia, Swaziland, Cyprus and in the United States.

Arizona is the only present source of natural low-iron chrysotile spinning fiber in the Western Hemisphere that meets the Navy specifications (-2% Fe) for covering electric cables.

ANALYSES

Table I shows the average composition of the principal types of asbestos, and illustrates the characteristic low-iron content of chrysotile fiber from Arizona, as compared with the Canadian fiber.

TABLE I

AVERAGE COMPOSITION OF PRINCIPAL TYPES OF ASBESTOS (note low iron content of Arizona Chrysotile Asbestos)

	CHRYSOTILE CANADIAN	CHRYSOTILE ARIZONA	CROCIDOLITE	AMOSITE
SiO_2	40.49	41.56	51.22	49.58
Al_2O_3	1.27	1.27	--	2.25
Fe_2O_3	2.53	0.64	34.08	39.64
MgO	41.41	42.05	2.48	4.79
CaO	--	--	0.03	0.53
Na_2O	--	--	7.07	--
H_2O	14.06	14.31	4.50	3.16
MnO_2	--	--	0.10	--
Total	99.76%	99.83%	99.48%	99.95%

OCCURRENCE

Most of the world's deposits of asbestos are of the chrysotile variety. It always occurs with the massive form of serpentine in serpentinized ultra basic rocks or in serpentinized limestone. The majority of the asbestos veins within the serpentine occur as "cross fibers" or fibers arranged in aggregate form normal to the serpentine band. A lesser percent of "slip fiber", overlapping fibers horizontal to the serpentine band, is found. Individual descriptions of the various deposits are found under the heading, "Distribution".

GRADING AND CLASSIFICATION

Unmanufactured asbestos is marketed by grades, the products of the milling process. There is no world-wide standardization either of nomenclature or of composition of individual grades, although the Canadian standard is followed in the U. S. and is gradually being adopted in other countries.

Asbestos is divided into "crude asbestos", a hand selected cross-vein material in its native form, and "milled asbestos"; all grades produced by mechanical treatment of asbestos ore.

Mill fibers in Canada are classified by a standard screen test made on a Quebec Standard Asbestos Testing Machine. The machine consists of a nest of three screens and a pan resting on a table. The screens are vibrated horizontally with a 1½ inch throw by an eccentric revolving 300 r.p.m. The trays with screened bottoms measure 24½ inches x 14 3/4 inches x 3½ inches deep. The screen in the top tray has 1/2 inch openings (0.105 in. wire), No. 2 tray has a 4 mesh screen (.063 in. wire), No. 3 tray has 10 mesh (0.047 in. wire) and Box 4 is a solid bottom pan. To make the test, 16 oz. of asbestos is placed

on the top tray and the device is vibrated for exactly two minutes. The residue on each screen is weighed separately and the weight recorded in ounces, thus a fiber testing 0-8-6-2 has 8 ounces in the second screen, 6 in the third and 2 in the pan.

The main grades are:

Crude Fibers (hand cobbed)

Group 1: Crude No. 1, 3/4 in. staple and longer.

Group 2: Crude No. 2, 3/8 in. staple up to 3/4 in.

Mill Fibers (machine processed)

Group 3: Textile spinning fibers testing over 0-8-6-2.

Group 4: Shingle fibers (testing below 0-8-6-2 and including 0-1.5-9.5-5.0)

Group 5: Paper fibers, below 0-1.5-9.5-5.0 and including 0-0-8-8.

Group 6: Waste stucco plaster, below 0-0-8-8 and over 0-0-5-11.

Group 7: Shorts, 0-0-5-11 and below.

Group 8: Sand weighing over 35 lbs. per cubic foot and under 75 lbs.

Group 9: Sand and gravel weighing over 75 lbs. per cubic foot.

Some mines have their own classifications, which vary, but essentially are based on fiber length.

Arizona fiber classification is as follows:

Crude Grade	Length of Fiber
No. 1	3/4 inch or longer
No. 2	3/8 to 3/4 inch
No. 3	1/8 to 3/8 inch
No. 4	Less than 1/8 inch

Historically, Arizona producers have a reputation of poor grading, inconsistent grading, supplying of products not suitable for specific requirements, and a source of supply that is not dependable, although the deposits provide some of the highest quality asbestos available.

PRICE HISTORY

Prices of asbestos are regularly published for Canadian and domestic materials and because the Canadian asbestos dominates the market, its prices influence the price structure of the entire industry.

The following tabulation indicates the price and price trend for Canadian standard grades in dollars per short ton, f.o.b. mines in Quebec:

AVERAGE VALUE PER SHORT TON, F. O. B. QUEBEC MINES

Type	1940	Oct. 1951	1956	1960	March 10 1962
Crude #1	$ 725.00	$1,500.	$1,562.50	$1,475.	$1,475.
Crude #2	250.00	900.	925.00	875.	875.
Spinning #3	155.00	475.	462.50	650.	650.
Shingle #4	67.50	170.	197.50	245.	245.
Paper (5)	42.50	119.	125.00	150.	150.
Waste (6)	23.00	70.		86.	86.
Shorts (7)	14.25	63.		80.	80.

Arizona prices have been quoted in the open market since 1952. The following table lists the prices f.o.b. Globe, Arizona, in dollars per short ton:

AVERAGE VALUE PER SHORT TON, F. O. B. GLOBE, ARIZONA

Year	Crude No.1	Crude No. 2	Crude No. 3	Filter Fiber
1952	$1,350.	$950.	$412.	$450.
1953	1,350.	1,025.	412.	437.
1954	1,650.	975.	475.	350.
1955	1,650.	975.	425.	350.
1956	1,625.	900.	400.	350.
1960	(1,400. (1,725.	(750. 1,100.	(370. (600.	(375. (550.
1962	(1,475. (1,650.	800. 1,000.	(425. (450.	(385. (400.

Since the close of the government purchase depot in 1958, the purchase prices of the various grades are determined by negotiation between the buyer and seller.

DISTRIBUTION

Foreign

CANADA

QUEBEC:

The world's largest asbestos mines and milling facilities are in Quebec, Canada. The series of deposits begin about 80 miles north of the Vermont border and extend within a northeasterly trending belt of serpentized peridotite for about 150 miles, encompassing an area 70 miles long by 6 miles wide or 420 square miles.

The proportion of fiber to rock mined in most of the deposits averages 5 to 7%, although some contain as low as 1½% to 2% fiber. The millfeed is 7½ to 8% fiber and the spinning grade averages 4% of the total production.

The Thetford ore body, a deposit owned by one of the seven companies operating in this area, is pear shaped, 2,200 feet long by 1,300 feet wide, and has been mined to a depth of 1,000 feet below the surface. The asbestos is a high-quality chrysotile occurring as cross fibers in a serpentine and peridotite formation of post-Ordovician age. The principal production is from cross fiber veins ranging from a knife edge to 5 inches across, wherein 99% of the fibers are less than 3/8 in. long.

ONTARIO:

The Johns-Manville Corporation has developed a large property in the Cochrane District of Ontario, Canada, where chrysotile asbestos fibers occur in a large serpentized sill. Maximum width of the veins are 1 inch; non-spinning fiber is produced.

BRITISH COLUMBIA:

A low-iron chrysotile deposit has been developed near McDame Mountain, Northern British Columbia.

NEW FOUNDLAND:

Chrysotile asbestos deposits have been developed near Lewis Brook and between White Bay and Notre Dame Bay.

U. S. S. R.

Russia is probably the second largest producer of asbestos. Most of their deposits are of the chrysotile variety, similar to the Canadian deposits. They are centered in the Bashenova District in the Ural Mountains in an area about 21 km long by 1,000 meters wide. About twenty open pits in this area produce cross fiber asbestos from ellipsoidal masses of serpentine in peridotite, reaching measurements of 3,500 feet long by 1,000 feet wide. The percentage of fiber recovery is similar to the Canadian deposits.

AFRICA

SOUTHERN RHODESIA:

Southern Rhodesia is the third largest producer of asbestos fiber. The asbestos occurs as a high grade chrysotile fiber in an ultra-basic dunite-serpentine complex intruded by granite gneiss. The deposits are found in three separate districts in the south central part of the country. The most important, the Bulawayo District, produces spinning fiber up to 3 inches in length from a serpentine mass extending 10½ miles in length by 3 miles wide. The principal deposit is found in a zone about 2,000 feet long and 300 feet wide. The Mashaba District, about 46 miles east of the Bulawayo District, contains a similar but smaller deposit. The Lomagundi District, about 200 miles northeast of the Bulawayo District, (about 200 miles northeast of the Bulawayo District,) produces fiber of a poorer quality.

UNION OF SOUTH AFRICA:

Chrysotile, all of the world's amosite and most of the world's crocidolite asbestos is produced from the Union of South Africa. The largest production is from Transvaal and Cape of Good Hope with smaller production from Natal.

TRANSVAAL:

Chrysotile is produced in the Carolina District of Transvaal from deposits similar geologically to those in Arizona.

The only known commercial deposits of amosite occur in northeastern Transvaal near Penge. The amosite is found in a northwestward trending belt as cross fiber veins associated with diabase sills in a series of shales, slates and quartzites. The fiber, averaging 6 inches in length, occurs in three bands separated by 5, 6 and 9 feet of waste.

Crocidolite is found with amosite in the Petersburg District in the western part of the amosite belt.

CAPE PROVINCE:

The largest deposits of crocidolite in the world occur in a northward trending belt of sedimentary, bedded ironstones extending for a distance of 240 miles and a width of 30 miles in northern Cape of Good Hope. The fiber ranges from - 1/2 inch to 2 inches in length; with 10 to 20% of it spinning fiber.

NATAL:

Small intermittent production of chrysotile is obtained from a deposit near Kranz Kop, Zululand.

SWAZILAND:

High-grade chrysotile is produced from cross fiber veins in serpentine from an area about 12 miles southeast of Barberton in the Transvaal.

OTHER COUNTRIES

Other asbestos producing countries are as follows:

VENEZUELA	-	Chrysotile in an area near Valencia of the Quebec type.
BOLIVIA	-	Crocidolite occurs in 12 inch veins in sandstones in Mendeze Canton.
GREECE	-	A deposit occurs near Kozani.
ITALY	-	A chrysotile deposit has been developed at Toreno.
AUSTRALIA	-	Chrysotile is produced in Western Australia and New South Wales. Crocidolite occurs in the Hamersley Ranges of Western Australia and at Hawker, South Australia.
NEW ZEALAND	-	Chrysotile in a maximum of 3 inch veins in a serpentine area occurs near Mt. Arthur, Takaka.
CHINA	-	Chrysotile deposits are found in Paotow Wuchuan, Kuyang and Laiyuan Districts.

JAPAN - Chrysotile occurs in irregular veins in serpentine in Hokkaido and southwestern Honsu Districts.

FINLAND - Amphibole type asbestos is mined at Tuusmiemi.

CYPRUS - Chrysotile deposits are located at Amiandos, Mt. Troodos.

INDIA - Chrysotile from serpentinized magnesium limestone in contact with traprock sills occur in Cuddapah, Mysore and Hasan Districts.

MOROCCO - Chrysotile from a contact zone of greenstone with granodiorite is found in the vicinity of Bou Azzer.

UNITED STATES

Although asbestos is found in many parts of the United States, commercial production is practically limited to the deposits of Vermont and Arizona.

VERMONT:

The Vermont chrysotile asbestos deposits are extensions of the Quebec Canadian belt, and occur near Lowell, Eden and Hyde Park in the extreme northern portion of the state.

Minor amounts of cross fiber are mined from veins rarely exceeding 3/4 of an inch in width and the majority of the production is of the slip fiber type in which the high-iron spinning grade is about 3% of the total production.

ARIZONA:

The Arizona low-iron chrysotile asbestos deposits occur in Central Arizona, principally in Gila and Pinal Counties near Globe. The major deposits are in numerous localities over an area 60 miles long by 25 miles wide (1,500 square miles) in the Salt River and Cherry Creek Basins north of Globe. (Refer to Fig. 3, Location Map, Asbestos Deposits, Central Arizona Region and Fig. 1, General Loca-

tion Map of Arizona Chrysotile Occurrences).

The asbestos bearing horizons are in the Pre-Cambrian Mescal limestone formation of the Apache Group. The veins, primarily of the cross fiber type, occur as limestone replacement deposits in serpentine bands parallel to bedding in proximity to diabase intrusions. The serpentine bands vary in thickness from a few inches to a little over 2 feet and contain as many as 20 veins carrying fiber, grading from harsh to soft and silky, ranging from a fraction of an inch to several inches in length. These veins are seldom continuous over long distances and may swell or pinch suddenly; therefore, the probable volume and grade is difficult to predict without adequate prior exploration. According to recent statistics, 3% of the rock mined contains fiber; millfeed is 24% fiber, and approximately 63% of the fiber produced is a soft, low-iron, high tensile strength spinning fiber. (17) It's strategic importance is emphasized by the fact that chrysotile is one of three critical commodities remaining on the government stockpiling program.

In 1960, the following six companies were active in Arizona; Jaquays Mining Corporation, Kyle Asbestos Mine of Arizona, Le Tourneau Asbestos Corporation, Metate Asbestos Corporation, Pan American Fiber Corporation and Phillips Asbestos Mines.

OTHER OCCURRENCES:

Small quantities of asbestos have been produced in Alaska, California, Georgia, Idaho, Maryland, North Carolina, Oregon, Pennsylvania, South Carolina, Virginia, Washington and Wyoming.

EXPLORATION

"Exploration is a necessary preliminary step in the development and exploitation of asbestos deposits - - - Geologic mapping of serpentine and associated formations is of great assistance in prospecting".[14] These statements recognize and emphasize the importance of the Mining Geologist's role in the mining industry, which is essentially to find ore and to determine its form and extent. These objectives are usually accomplished through a detailed study of the mineralized rock to establish local controlling factors for the ore deposition to project target areas.

Recent applications of geophysical tools such as the magnetometer survey of areas underlain by large masses of serpentine help to outline target areas, as does the geologic field prospecting and mapping of serpentine outcrops.

The methods of proving the ore bodies by exploration vary according to the deposit, but normally include drilling along a grid pattern those areas judged geologically favorable for ore deposition.

The drilling results not only delineate the asbestos bearing zones, but give data on the spacing and thickness of veins, percentage of fiber content, length and grade of the fiber, and the elevations of the fiber zones in the ore body.

ARIZONA:

Most of the exploration in the Arizona asbestos area is accomplished by driving adits from asbestos bearing outcrops into hillsides along the serpentine horizon and widening these into stopes where ore occurs. The mining efforts are abandoned when the asbestos pinches out or becomes noncommercial.

Diamond drilling behind the outcrops was attempted during 1952, but gave discouraging results since low core recovery was experienced in the asbestos zone and the bits tended to become plugged with asbestos.

The wagon drill, mounted on a 4-wheel drive vehicle, was introduced from the uranium fields about 1956. This low-cost drilling method proved very successful for shallow ore bodies, but its use has not spread in the district, principally because no strong, well-capitalized mining company capable of carrying out an exploration program is engaged in the asbestos mining business in Arizona. One of the few successful small mining companies has accepted and is using long hole techniques utilizing sectional steel. By drilling short holes upward and downward from underground workings, this operator has located additional ore fiber zones missed by former miners and has reopened an abandoned mine thought to be mined out.

The government has recognized the strategic importance of chrysotile asbestos and the dependence of the U. S. upon foreign sources for supply. Because of the critical shortage of low-iron chrysotile of textile grades, those properties showing a potential for producing chrysotile are eligible for O.M.E. loans.

MINING

The problem of mining ore as cheaply as possible with a minimum ore loss is a constant challenge to the Mining Engineer. Systematic mining methods are usually selected and adapted to the type of deposit being mined.

Canadian deposits were formerly mined by quarrying, glory hole, and open pitting followed by shrinkage stoping; however, the block caving method was found to be the most economical and is becoming of general use.

The Southern Rhodesian deposits were formerly mined by open pitting, but underground block caving methods are now most predominant.

In the Union of South Africa, the smaller companies usually use open pit mining methods; larger operations have extensive underground mines.

The U.S.S.R. originally used hand methods, which have gradually been replaced by open pit mining methods.

The chrysotile deposits of Vermont are mined by open pit methods with quarry benches 125 feet high and 600 feet wide.

The Arizona chrysotile asbestos deposits have been mined by driving adits into the cliff faces and expanding them into stopes using modified room and pillar methods. As much of the waste as possible is hand shovelled into backfill. Since the ore to waste ratio is high, the miners move as little waste as possible and the stopes in most mines rarely exceed five feet in height.

Statistics from the most successful present mining operation show an average production of 0.68 tons per man shift from the mine and 0.47 tons per man shift of hand-cobbed ore produced for milling. These figures partially explain the high cost of mining in this district.

VI. MILLING:

The commercial value of a chrysotile asbestos deposit is dependent upon the fiber content of the rock, volume of the fiber bearing rock, the proportions of the fiber lengths and the price structure for the mined and milled material. The value of the chrysotile asbestos mined depends primarily upon the fiber length (No. 1 grade long fiber is worth 15 times more than the Group 7 grade). Therefore the milling problem is to separate the fiber from the enclosing rock with a minimum of fiber breakage; to recover as much of the fiber as possible, free from dirt and rock; to expand and fluff the fiber; and to grade the fiber into different length groups suited to use requirements.

The concentration process separates the fibrous serpentine from a massive form of the same mineral, eliminating the possibility of chemical composition or specific gravity differences as a basis for separation. Fortunately, the fibrous structure of the asbestos permits it to be divided into filaments amenable to separation from the gangue. Asbestos fiber milling entails repetitive crushing and screening and removal of the fiber after each stage (as soon as it is released from the rock) with air suction hoods. After removing as much of the fiber as possible by crushing and screening down to 1/4 inch size, further reduction is accomplished by fiberizers. The fiberizer, a high speed hamer mill, breaks the rock by rapidly applied impact, reducing fiber breakage to a minimum. The product

from this operation is screened and the fiber collected by air suction, a process that is repeated several times. Dust from this process is collected in a dust chamber, blended, bagged and sold as floats.

ARIZONA MILLING

Originally, the two longer crude grades of chrysotile asbestos were produced by hand-cobbing. Later, this method was replaced by mechanical hand-cobbing wherein the ore passed through a jaw crusher, a set of rolls and a screen divided into the proper mesh to produce the 4 crude grades. Still later, fiberizers were added and the fiberized material was air lifted to a bagging room.

Until very recently, the milling capacity of the largest plant was 15 tons millfeed per day. Three new mills were built about 1959 along a stretch of Highway 70, three miles east of Globe, referred to as "Asbestos Row". The larger mill receives a rough hand-cobbed ore from the mine and has a reported production of 16 tons of asbestos fiber daily. The estimated maximum combined daily production possible at present from the district is 64 tons of crudes and 32 tons of fiberized asbestos.

By comparison, the twelve mills operating in Canada had a combined milling capacity of 51,800 short tons per day in 1956. In recent years these Canadian producers have concentrated on methods of improving the fiberizing process with a minimum of fiber breakage and to prepare fiber, particularly the shorts, to conform with exacting specifications regarding grading and dust removal to meet the special requirements of the consuming industries.

WORLD PRODUCTION

World production of unmanufactured asbestos averaged 605,000 tons per year during 1938-39 and increased to 2,680,000 tons in 1961. The principal asbestos producing countries in the order of importance are Canada, Soviet Union, Southern Rhodesia, Union of South Africa and Swaziland. Excluding Russia, Canada accounts for about 70% of the world production.

In 1961 United States production was 45,000 tons or 1.7% of the world output and most of this was of the shorter chrysotile grades.

Table 3 [14] following is a compilation of the world production of asbestos for the periods 1947 through 1956. The world production for the period 1960 and 1961, as compiled by the U. S. Bureau of Mines (Table II, Appendix) is also shown in tabular form.

The total Arizona production figures are confidential and not available for publication, but are probably less than 70,000 tons. The current production is estimated to be 600 tons per year or 1.3% of the total U. S. production.

CONSUMPTION

The United States is the world's largest consumer of asbestos, using about two-thirds of the world supply or, excluding Russia, 95% of the world supply. Although Canada furnishes 95% of the U. S. imports, the majority is of shorter non-strategic grades. Thus, Southern Rhodesian imports are more important than the tonnage basis would indicate as they constitute a greater per cent of spinning fiber.

The value of 1960 imports was 63 Million Dollars; 1961 imports were valued at 59 Million Dollars.

CONTROL OF ASBESTOS INDUSTRY

Political

Asbestos is regarded as a mineral of strategic importance and its sources and marketing are controlled both politically and commercially.

"The U.S.S.R. deposits are under absolute control of the State. All other producing areas of primary importance -- Canada, Southern Rhodesia, Union of South Africa, and Swaziland - are within the political orbit of the British Commonwealth. Moderately important deposits in Cyprus, Australia, and New Zealand are also within the British sphere. Deposits of moderate importance outside the British Commonwealth are in the United States, Venezuela, Italy, Finland, India, China and Japan. Relatively small deposits are controlled politically by Argentina, Bolivia, Portugal, France, Turkey, French Morocco, and several other countries.

Commercial Control

"The only large asbestos producer in the United States - Vermont Asbestos Mines - is a subsidiary of the Rubberoid Company of New York City and is controlled by United States capital. All of the small United States companies are similarly controlled.

"Commercial control of the Canadian asbestos industry is diverse. The largest operationin Quebec, Canada, in fact, the largest operation in the world - that of Canadian Johns Manville, is a subsidiary of the Johns-Manville Corp. of New York City".(14) Other Canadian companies are similarly subsidiaries or captive mining operations controlled by U. S. or British asbestos fabricating corporations.

In 1951 there were eight small concerns marketing raw asbestos products in the United States and over 300 plants engaged in the manufacture of a large variety of asbestos products. Of the manufacturers, four owned and operated Canadian mines and one is a subsidiary of a large British asbestos mining and manufacturing concern.

These controls include export controls exercised by the governments of the various producing countries and consignment of raw products by controlling political or commercial groups to specific markets.

It is evident that the independent manufacturers must depend on surpluses from captive mines.

Utilization

Asbestos has a large variety of uses dependent upon the length of the fiber (which splits it into two broad classifications of spinning or non-spinning fiber) and on the fact that it has physical characteristics similar to those of organic fibers yet it is non-combustible, noncorrosive and therefore can be adapted for use in the heat insulation, electrical insulation, frictional, textile, plastic, filter, packing, gasket and asbestos cement industries.

A current list gives the following applications: Raw asbestos, 39 different uses; asbestos yarn - 19; asbestos cloth - 49; asbestos felt 7; asbestos tape - 11; wick packing - 2; asbestos paper - 40; asbestos millboard - 19; asbestos cement - 28; asbestos composition material - 9; asbestos products in theaters - 10; a total of 231 different applications for which many products are marketed.

At the close of World War II, the United States War Production Board determined the use of asbestos for products other than asbestos-cements was 63% for fabrication of insulating materials, 32% for mechanical and electrical applications and 5% for general usage.

Prior to World War II, the market for asbestos fiber was primarily in the eastern portion of the United States. Since that time, asbestos fabrication plants have been constructed in California and their asbestos consumption is steadily rising particularly in the filter, asbestos-cement, insulation, composition flooring, and roofing industries.

Arizona Potential

The large freight differential from Quebec to the Los Angeles port should allow a well organized chrysotile mining operation to obtain local west coast markets, particularly with those independent manufacturers who depend upon surpluses from captive mines for their supply. Arizona producers must be able to guarantee a continuous supply of asbestos meeting certain specifications before their production will become generally accepted in these markets.

Forecast

The trend in asbestos consumption is expected to follow the industrial production and building construction industries growth. The domestic production is unlikely to exceed 60,000 tons per year or 7% of the required supply.

One of the most critical problems in the United States isthe lack of an adequate source of spinning and filter grade chrysotile fiber.

PART II

A GEOLOGIC INVESTIGATION AND EVALUATION OF THE ROCK HOUSE CHRYSOTILE ASBESTOS PROPERTY OF THE PAN AMERICAN FIBER CORP. GLOBE, ARIZONA

INTRODUCTION

The writer made a reconnaissance of the property during the period January 17 - 21st, 1962, to investigate the general geology of the area and the asbestos occurrences on it. Fortunately, the writer had made prior examinations of nearby asbestos deposits and also, a mass of dispersed but excellently prepared geologic, mining, and marketing information was available in the bunk house located on the property. Mr. Grady Gulledge supplied many authenticated company records and acted as a guide during the field work. Mine workings were examined in detail during the period March 11 - 15th, 1962.

Sources of information pertaining to these prospects are published geological bulletins authored by Mr. L. A. Stewart of the U. S. Bureau of Mines, and Mr. E. D. Wilson of the Arizona Bureau of Mines, plus verbal comments of Mr. A. F. Shride of the U. S. Geological Survey, all recognized authorities on the Arizona chrysotile asbestos deposits. These, as well as other sources of information, are noted in the reference.

A general description of the Arizona asbestos deposits was given in Part I. The area of occurrence, covering some 1,500 square miles, and the location of the Rock House Property, is shown on the map, Fig. 3.

THE ROCK HOUSE PROPERTY OF PAN AMERICAN FIBER CORP.

The prospect, known locally as theRock House Property, consists of a nucleus of 20 unpatented lode claims. Seventynine additional unpatented, surveyed, contiguous lode mining claims, all with the prefix A.F.C. and each measuring 1,320 feet by 600 feet, have been located over and around this nucleus, forming a block of 1,422 acres. (Fig. 6)

The writer examined a lease-purchase contract for the 20 original claims between the owner and Pan American Fiber Company, plus a legal instrument wherein the representatives of the American Fiber Corporation had quit claimed their interests as sole owners of the A.F.C. claims to the Pan American Fiber Corporation. These documents appear to be in correct order; however, the writer has no formal legal training and it is recommended the documents and any legalities pertaining to the property be further investigated by an attorney experienced in such matters.

LOCATION AND ACCESSIBILITY

The property is located in Sections 10, 11, 14, 15, 16, 21, 22 and 23; T 7 N, R 15 E, Fluorine Mining District, Gila County, Arizona, an area immediately west of the Fort Apache Indian Reservation in central Arizona. (Fig. 7)

The property can be reached by travelling north of Globe, Arizona on a macadam road known as the Apache Trail or Highway 88, from its intersection with U. S. Highway 60-70, for 22 miles; thence northeastward on Highway 288 for 68 miles via Young to Bottle Spring. (The first 6 miles of the road are macadam, remainder a well-maintained gravel road); thence south on the Bottle Spring dirt road for 21 miles to the site of the present main workings in the vicinity of Rock House;

a distance of 111 miles or 3½ hours by road. (Fig. 2)

A new paved highway is under construction from Payson through Heber to Showlow. This road, within 22 miles of Young, will provide an access road from the north.

An airport, regularly accommodating two-engine planes, is located at Young, Arizona.

The area is accessible throughout the year except for occasional snow storms, which temporarily block the road. The road to Bottle Spring from Globe is well maintained; from Bottle Spring to the mine it is infrequently maintained, although it is a main access road frequently travelled by local ranchers.

PHYSIOGRAPHY

The region is situated on a broad plateau of nearly horizontal rock ranging in elevation from 4,800 feet to 5,800 feet above sea level. The plateau has been dissected by eastward draining tributaries to Canyon Creek, forming a series of mesas of about 25 to 80 feet relief separated by narrow, flat bottom valleys.

CLIMATE, VEGETATION AND WATER

The average yearly precipitation is approximately 20 inches; snow fall about 28 inches. Thunderstorms are prevalent during July and August; infrequent snowstorms occur from December to March. The periods between are dry. Summer temperatures are mild; winter temperatures are low enough to freeze surface and near surface water.

Oak and juniper grow in the lower elevations, whereas yellow pine predominates above 5,600 feet.

Water for culinary purposes has been developed from a small spring in Section 11 (average flow 6 gallons per minute). Water is

also pumped from a shallow well located near the main office building at Rock House. The asbestos milling operation does not require water; however, the development of additional sources of water if required does not appear to present a major problem.

HISTORY

The nucleus of the present property was located in 1915 by Messrs. E. V. Pierce and H. P. Wrightman. It was purchased in 1928 by the Emsco Asbestos Company of Los Angeles, who improved the road from Bottle Spring, established a camp and constructed a mill. Operations ceased during the depression of the thirties and the claims reverted to the owner, who produced small quantities of asbestos until his death in 1953. The Bottle Spring Asbestos Company optioned the claims in 1950 and in 1952 built an improved 15-ton per day mill for producing crude grades. Subsequently, the name of the company was changed to the American Fiber Company. A small, but steady milled production was maintained by American Fiber Company through March 1, 1960 when the mill burned. Shipments were made to local mills after that time. The Pan American Fiber Corporation, through its President, Mr. Grady Gulledge, acquired the property in November, 1961. Operations ceased as of June 20, 1961;however, and it is dormant at the present time pending acquisition of sufficient funds for proper exploration and development on a scale to insure its continued successful commercial operation.

PAST PRODUCTION

About three tons of crude grade asbestos were transported via horseback to Globe prior to 1921.

As noted in the previous section, production after 1921 was sporadic until the American Fiber Company built a mill on the property in 1952. After this time a steady milled production was maintained. A tabulation of the incomplete production records is as follows:

Year	Fiber Produced All Grades, Tons	Value
1952	41.45	
1955	123.0	$ 101,750.
1956	1,261.5	399,451.
1957	1,085.0	219,740.
1958	363.65	148,095.
1959	238.8	76,944.
1960	131.04	34, 806.
Total	3,244.44	$980,786.

The complete production records from this property are not available. A copy of the 1960 production records (Table VI, appendix) shows the value of the fiber is based on the net return after milling and haulage costs have been deducted.

FACILITIES

Facilities on the northwestern portion of the property are two cement block cabins and three frame cabins about 12 feet wide by 16 feet long. On the southeastern portion of the property is a newly constructed, modern, 10 bedroom cement block, combination bunk house, office and kitchen, 91 feet long by 26 feet wide, plus a galvanized iron covered garage and several dispersed small frame cabins.

A 1,500 gallon water tank is located near the cabin on the northeastern portion of the property and two tanks with a total capacity of 7,000 gallons, are located near the bunk house.

Electrical power for the operation of a submersible water pump and the electrical appliances in the bunk house, is supplied by a Witt 9.6 KVA power unit. No other source of electrical power is available in the vicinity.

An inventory of the mine and vehicular equipment on the property at the time of the writer's examination, appears in the appendix, Table V.

An airstrip 3,200 feet long, 5,300 feet in elevation and marked on the airway map as an emergency landing field, is located immediately south of the bunk house. (Fig. 6).

The nearby village of Young in Pleasant Valley, population 200 (approx.), has gas stations, general stores, motels, a school and three telephones. All electrical power is supplied by owner-operated power units. Abundant water is available at shallow depths. Installation of R.E.A. power is predicted for the near future.

The town of Globe, Arizona, well recognized as the f.o.b. quotation source for Arizona asbestos fiber, is serviced by the Southern Pacific Railway.

Three asbestos mills have been constructed on Highway 70, three miles east of Globe within the past two years.

The Southwest Forest Industries' 32.5 Million Dollar pulp mill, located between Heber and Snowflake, Arizona, was placed inoperation during the early part of 1962. At present, it produces newsprint and kraft paper; however, its presence offers an opportunity to establish another industry by combining the shorter grades of asbestos with paper to produce an asbestos-paper product.

LABOR

Except for key personnel, Indian labor is used exclusively in the chrysotile mines. Wages for the Indians range from $1.25 to $2.50 per hour; absenteeism is about 5% of the labor force.(17)

GEOLOGY

Stratrigraphy

The asbestos bearing deposits are in the pre-Cambrian Mescal limestone formation of the Apache Group. From bottom to top, the Apache group is comprised of the Scanlon conglomerate, Pioneer shale, Barnes conglomerate, Dripping Spring quartzite (host rock for uranium deposits), Mescal limestone, and Troy quartzite. Surface outcrops on the property are Mescal limestone, and intrusive diabase. The depth from the mesa tops to the asbestos ore horizons is seldom over 100 feet.

The Mescal limestone has been divided into three members: a lower member 175 to 200 feet thick; an algae member 80 to 150 feet thick; and an upper member 10 to 80 feet thick.

Lower Member:

Individual beds in the lower member vary from an inch to 6 feet in thickness. The thin beds are impure dolomitic limestones; the thicker beds are crystalline limestone and occur within the top 45 feet of this member. Nodules and masses of chert occur within the limestone strata.

Middle Member:

The middle member referred to as the algae member is massive and composed almost entirely of spheroidal masses with a concentric shell like structure of several inches in diameter. This member weathers in cliff form presenting an easily recognized horizon.

Upper Member:

The upper member is composed of layers of siltstone, thin shale and silty limestone beds.

Diabase:

Diabase sills and dikes, ranging from a few inches to several hundred feet thick have intruded the Apache group. These sills are usually found along bedding planes, but locally diabase dikes have cut across the bedding. (Refer to Fig. 4) The diabase forms valley floors as well as the base of the gentle slopes of the mesas overlain by cliff forming Mescal limestone. (Refer to Fig. 6)

STRUCTURE

The property is underlain by a broad anticlinal structure that has been broken into fault troughs. Locally, the formation varies in strike and dip due to faulting, that took place before, during and after intrusion of the limestone by diabase. The diabase intrusives arched the limestone following bedding plane and thrust faults to form many localized discordant structures. (Refer to Fig. 5, Sec. B-B' for a generalized cross section of the Rock House area).

RELATION OF ASBESTOS TO GEOLOGY

The asbestos deposits are in proximity to the diabase. Shride notes the bedding plane faults in the limestone provided channels for mineralizing solutions, wherein the limestone was replaced by serpentine. (15) Since the limestone is found within the top 45 feet of the lower member, and in the middle algae member, most of the commercially important chrysotile asbestos serpentine zones are within these horizons. Exceptions are noted in other massive limestone beds and along major thrust faults.

The chrysotile asbestos occurs as crossfiber (fibers are approximately perpendicular to the walls of the veins) and slip fiber or fiber that lies in a nearly flat position along fault planes. The asbestos fiber is referred to as soft or harsh. Soft fiber feels silky and can be twisted or bent between the fingers. Harsh fiber is splintery, prickly and brittle; it breaks when twisted between the fingers.

The asbestos is found in veins within massive serpentine. These veins range from a fraction to several inches wide and roughly parallel the walls of the serpentine band; they seldom are continuous but split, converge, swell or pinch out. Because of this vacillation, it is impractical to sample the asbestos for thickness and the grade is commonly estimated by determining the average cumulative thickness of the fiber in the ore zones exposed at the working faces.

The serpentine bands varying from a few inches to a few feet thick may carry from 1 to 20 veins of fiber. Often the serpentine zones are separated by a few feet of barren limestone and as one pinches out another may continue at a different elevation.

GEOLOGIC CONTROL

The writer has previous experience in a limestone replacement type ore body in another district wherein approximately 100 stratigraphic marker beds were recognized; these were particularly useful in the ore bearing horizons.

Locally, a horizon known as the "Oscar", a dark barren serpentine band is recognized as a marker bed, usually associated with asbestos. It is believed this stratigraphic control can be expanded.

Structural control is evidenced by the presence of ore associated with arching and faulting of the limestone formations; mappable Geologic features that can be projected with some certainty.

The proximity of the diabase intrusive is another important mappable geologic feature that controls the implacement of the asbestos ore bodies.

In summation, the deposition of the thin, nearly horizontal asbestos veins are controlled closely by stratigraphic, structural and intrusive factors. Thus, a thorough geologic study of the property and its asbestos occurrence as related to these features will be of great assistance in establishing target areas for exploration guidance.

Fortunately, preliminary geologic investigations of this type were commenced on the Rock House property. Thus, certain areas already recognized as being geologically favorable for asbestos occurrences can be drilled while geologic investigations of the property are continued.

As noted in Part I of this report, the drilling results can be used to delineate the asbestos bearing zones, to provide data on the spacing and thickness of the veins, to provide samples for determining the percentage of the fiber content, length, and grade, and to provide the elevations of the fiber as encountered in the drill holes. The continued study will enable the Geologist to project the ore bodies and predict with confidence the proposed drilling programs will result in expanded ore reserves at a minimum cost for exploration.

PAST EXPLORATION

Similar to other Arizona asbestos deposits, the Rock House property was originally explored by prospecting the cliffs for asbestos exposures. When asbestos was found, an adit was driven into the hillside following it until the vein pinched out or became noncommercial. This type of exploration resulted in many small non-continuous operations wherein the workings seldom extended 150 feet beyond the rim. Any parallel vein

occurring above or below the ore horizon followed was missed entirely. Because of the erratic nature of any one horizon, much of the past production is described by various writers as desultory, sporadic, discontinuous, etc.

In 1956 the truck mounted wagon drill was brought into this area by Mr. Paul Bennett, a drilling contractor, from the uranium exploration districts. The American Fiber Company contracted for its use on the Rock House property with the following results as presented by their Chief Geologist, Mr. J. Thiel Sullivan in 1956, "The exploration drilling program of the Rock House property was a success from all points of view. Sufficient reserve tonnage was found; many important geologic and mining questions were answered; we learned how to drill limestone replacement asbestos deposits and to interpret the results correctly. (Previous exploration drilling of asbestos deposits in Arizona has been limited and unsuccessful)" (18) Mr. Sullivan's reports, covering exploration results and proposed exploration, contain a tabulation showing a total of 418 holes drilled, a maximum footage of 24,380 or 58 feet per hole average. The total cost was $24,380 or $1.00 per foot drilling cost.

The following data was extracted from another tabulation:

246 wagon drill holes were drilled during the drilling program from April to July, 1956. 52 were ore holes (two inches or more fiber); 84 were mineralized or less than 2" of recoverable fiber, and 110 were non-mineralized. Percentagewise, 20.2% were ore holes, 35.1% mineralized and 44.7% barren. The holes averaged 59 feet in depth at a cost of $1.15 per foot or the total drilling cost was

$18,000. The calculated proven ore reserves based on this drilling program were 1,326 tons valued at $397,800. The drilling cost was 4.5% of the estimated value, proving 0.09 tons per foot of drilling or an estimated ore value of $27 per foot of drilling. The areas drilled were located behind the outcrops and workings of the various mines operated by the American Fiber Company. The lengths of the fiber encountered in the ore holes averaged as follows:

Mine	Average Length of fiber
Claim No. 27 Mine, north end	2.28"
Victory Mine	2.60"
Asbestos No. 2	2.29"
Montezuma No. 2	4.24"
Montezuma No. 3	5.06"
May	3.45"
Total average fiber length	3.32"

Some inherent disadvantages of wagon drilling are a lack of complete fiber recovery due to fibers adhering to the sides of the hole and loss of fiber in open cracks and fissures encountered in the hole; however, the results are a great improvement over past exploratory methods and offer a feasible economic method of determining asbestos ore reserves underlying the property.

MINING

Mines on the property were opened by driving an adit into the cliff face along asbestos mineralization and expanding the adit, following a modified room and pillar or longwall stoping with hand emplaced backfill method of mining, as long as ore persisted. The

waste was removed first, leaving the asbestos vein in the back or floor or both. Then the asbestos veins were shot separately, the asbestos hand-cobbed and the higher grade crudes transported from the mine to the mill. The ratio of commercial fiber to tons of rock removed ranges from 1 to 25 to 1 to 50; a ratio of 1 ton of fiber per 34 tons of waste is regarded as average. About 50% of the waste was left in the mines as backfill and the remainder trammed to the dump.

The workings are easily accessible except in places where they are backfilled.

Mining costs are difficult to obtain, as accurate cost accounting was seldom practiced. The figure used in this report is taken from a very recent publication covering the Jaquays mining operation, wherein the exploration, development and mining costs approximates $8 per ton of rock removed.(17)

TRANSPORTATION

The distance via the present road from the property to the mill near Globe is approximately 100 miles. Truckers have received 10¢ per ton mile for this haul. Trucking rates in other districts average 6¢ per ton mile if the haulage continues for a lengthy period. It is possible to shorten the haulage to Globe to a distance of approximately 55 miles by improving the road via Cherry Creek. (Refer to Fig. 7, McFadden Peak Quadrangle, showing the property location and proposed route).

MILLING

Historically, Arizona asbestos prices have been quoted f.o.b. Globe. The three major asbestos mills in the area are located on the Southern Pacific Railroad siding along Highway 70, three miles east

of Globe. The rapidly developing Heber-Showlow area, serviced by the Santa Fe Railroad provides another possible millsite, as do the mine sites.

The Globe asbestos mill in past years charged $25 per ton of millfeed to custom mill ore. The new Jaquays mill prices are $20. per ton of millfeed to custom mill the crude grades of asbestos. Costs of $10 to $20 per ton have been quoted to the writer for milling the asbestos ore. The mills each produce about 2 tons of crude fiber per hour per 8-hour day and about 1 ton of fiberized fiber per hour per 8 hour day.

Mill erection costs are estimated to range from $25,000 to $35,000. per ton millfeed capacity.

DESCRIPTION OF MINES ON THE ROCK HOUSE PROPERTY

Montezuma - The Montezuma Mine is located on the southeast portion of the property in Section 22 within the Montezuma No. 1 Claim, extending from coordinates 7,000 to 7,700 feet north and from 21,500 to 22,500 feet east, (Refer to Fig. 6)

The asbestos deposit occurs in gently westward dipping beds of a down dropped block of the Mescal limestone. (Refer to Fig. 9).

The semi-harsh asbestos was first mined by following the outcropping asbestos downdip and also by open pit methods. Later American Fiber Corp. wagon drilled the area under the supervision of their Geologist, greatly expanding the ore reserves. During this drilling program, 109 holes were drilled, totalling 4,958 feet at a cost of $5,966.30. Of these holes 28 were ore holes (plus 2" fiber), 38 mineralized and 43 barren. The 669 tons of ore blocked out by this drilling program was evaluated at $200,700.; a very low figure based upon the inefficient

recovery from the milling operation. These proven reserves were mined, along a lenticular area averaging 120 feet wide, extending about 1,000 feet northeastward approximately parallel to the eastward facing limestone escarpment. (Fig. 8)

Ore reserves remaining are discussed in the portion of this report pertaining to ore reserves.

May Mine - The May Mine is located in Section 22, extending from coordinates 8,000 to 8,900 feet north and from 23,000 to 23,800 feet east. (Fig. 6).

The geologic setting is similar to the Montezuma Mine.

American Fiber Corp. drilled 63 holes in this area, for a total of 5,221 feet at a cost of $5,806.10. Of these holes, 12 were ore holes (plus 2" of fiber), 20 mineralized and 31 barren. The 396 tons of asbestos ore reserves blocked out were evaluated at $118,800. This figure is based upon a value of $300 per ton for the fiber; however a mill at least as efficient as the Jacquays Mill should recover fiber of the first four grades worth $596. per ton. (Table VIII)

The soft and semi-harsh asbestos fiber mined occurred in a lenticular form extending about 920 feet northeastward, parallel to the limestone escarpment over a width of approximately 40 feet. (Fig. 10)

This mined area of 42,500 square feet (planimeter) represents 17,200 tons of rock or 510 tons of all grades of fiber removed.

Asbestos No. 2 Mine - The Asbestos No. 2 area is located in Sections 22 and 15 extending from coordinates 9,700 to 11,100 north and 24,400 to 24,670 east within portions of Claims 17 and 28. (Fig. 6)

As described by American Fiber's Geologist, "the area is characterized by two reverse faults, several large diabase dikes, and complex

folding of the limestone beds". (18) (Fig. 11)

A drift was driven above the ore bearing horizon located by the drilling program, but the reserves were not mined. The ore reserve estimations appear in the following portion of the report covering ore reserves.

No. 27 Mine - The No. 27 Mine is northeast of the Asbestos No. 2 Mine in Sections 15 and 14, within portions of Claims 46 and 27, deriving its name from the latter claim. (Fig. 6).

The mine was opened by driving an adit westward through the diabase into the asbestos vein above a roll in the diabase. The asbestos was then mined, as delineated by wagon drilling, toward the southwest.

The soft silky fiber occurrences in the present workings are noted on the map of the underground workings. (Fig. 13).

Asbestos No. 3 Mine - The Asbestos No. 3 Mine is located in Sections 15 and 14, Claim 46. (Fig. 6).

American Fiber's Geologist noted this area to be characterized by "a large diabase dike following the fault plane of a large reverse fault which cuts across the area. The limestone beds adjacent to the fault are extremely drag folded and fractured. Two short drifts have explored the top two ore zones. The fiber exposed is very long and soft". (18) Refer to the map of the underground workings for locations and grades of presently exposed fiber, Fig. 14.

Asbestos No. 4 Mine - The Asbestos No. 4 Mine is located in Section 14, claim 46, about 500 feet northeast of Asbestos No. 3. (Fig. 6).

The geologic setting is very similar to Asbestos No. 3. Refer to the map of the underground workings for locations and grades of exposed fiber. Fig. 14.

Rose No. 1 Mine - The Rose No. 1 Mine is characterized by three normal faults underlain by a diabase "roll". Asbestos is exposed for about 400 feet along a cliff face.

Rose Nos. 2 and 3 - These mines are marked by faulted limestone beds and adjacent diabase intrusions. Asbestos fiber occurs in outcrops near the mines for a total length of about 1,100 feet.

Queen Mine - Queen Mine is located in Section10, Claims 84 and 85.

The area is faulted and uplifted by two diabase rolls. Asbestos fiber is exposed in the old mine workings and for a length of about 1,500 feet in adjacent outcrops.

Arizona Mine - The Arizona Mine is located in Section 10, Claim 86. The limestone beds have been faulted and uplifted by a diabase "roll". Asbestos fiber was observed in the faces of the old workings.

King Mine - The King Mine is located in Section 10, Claim83.

The underlying limestone has been faulted and uplifted by two diabase "rolls". Asbestos fiber has been traced in outcrops for about 1,200 feet around the hillside.

ORE RESERVES

The twelve separate mining areas, referred to as the Montezuma, May, Asbestos #2, 27 Mine, Asbestos #3, Asbestos #4, Rose #3, Rose #2, Rose No. 1, Arizona, Queen and King (Fig. 6) are aligned roughly from south to north along the eastward facing escarpment of the Mescal limestone.

All accessible mines in these areas were examined and asbestos mineralization noted. Ore reserves were checked, the various available maps updated, and the reserves plotted on them. The ore reserve

calculations are based on these maps and recorded drill hole information. Of course, the drill hole information cannot be verified without drilling occasional adjacent check holes.

Estimates of Proven Ore Reserves:

Montezuma - (Fig. 8) No significant asbestos ore reserves were observed. A block of ground measuring approximately 1,000 feet in a northerly direction by 120 feet wide was mined. A planimeter measurement indicates 86,500 square feet of area was mined, representing 35,000 tons of rock or 1,160 tons of fiber removed. It is possible continued drilling beyond the mine workings will prove extension ore.

May (Fig. 10) - Asbestos of ore grade was noted in various places in the northeastern faces of the mine. A planimeter survey of the outline of the ore reserves compared with the limits of the present mine working indicates 46 tons of asbestos ore remaining. Based on an average price of $596 per ton, the available reserves are 39 tons of recoverable fiber valued at $23,300.

Asbestos No. 2 (Fig. 11) - Asbestos ore averaging 2.54 inches thick was blocked out on the Asbestos No. 2 property. Approximately 400 feet of drift was driven just above the asbestos to where a fault raised the vein to the level of the drift. An average of 2" of soft, silky asbestos was observed in the drift along its northern portion. Another $1\frac{1}{2}$ inches to 2 inches of fiber was observed in the floor about midway in the drift. The block of ore reserves is within an area approximately 400 feet long by 65 feet wide, encompassing 28,900 square feet (planimeter). This represents 376 tons of recoverable fiber of the first four grades, valued at $225,000. It is possible to expand the ore reserves beyond its present outline.

27 Mine (Fig. 13) - Asbestos ore averaging 3.06 inches in thickness was blocked out in the 27 Mine within an area approximately 400 feet long by 140 feet wide. Workings now extend to the southern extremity of this block of ore. Remaining ore reserves are within an area of 4,260 square feet (planimeter) representing 76 recoverable tons of fiber of the first four grades, valued at $45,400.

Asbestos No. 3 - Soft asbestos fiber of ore grade was noted in the face of the underground workings; however, no record was found of drill holes beyond the face. It is estimated that 5 tons of developed or proven ore reserves remain in the faces of the workings.

Asbestos No. 4 - Soft asbestos fiber of ore grade occurs in the face of the underground workings; however, no record was found of drill holes beyond the workings. Proven reserves are estimated as 3 tons. (Fig. 14).

No asbestos fiber of ore grade was observed in the remaining underground workings on the property.

Tabulation of Estimated Proven Ore Reserves:

Mine	Tons Recoverable	Value (Based on $596 average per ton)
May	39	$ 23,300.
Asbestos No. 2	376	225,000.
27 Mine	76	45,400.
Asbestos No. 3	5	2,970.
Asbestos No. 4	3	1,780.
	499	$ 298,450.

POTENTIAL OF THE ROCK HOUSE PROPERTIES

Potential Production Area:

One of the major difficulties of the Arizona asbestos industry is to evaluate the ore deposits, due to their erratic nature. Very little information is available concerning their continuance in other horizons or the overall extent of ore bodies.

In this investigation, the possible extent of the asbestos bearing horizons is estimated by superimposing a plan map of the areas mined (from individual mines in the district having a long history of production) upon a plan map of their respective claim boundaries. This ratio is then applied to the Rock House property. Thus, the plans of the Regal, Victory, and Eldorado Mines, indicate an average of 6.3 acres (representing an elongated ore body) has been mined from the containing 20 acre claim or about 30% of the claims have been mined.

The Rock House property has 12 separate partially mined areas within seventeen different claims, plus many serpentine bearing outcrops aligned roughly northeasterly across the entire property. Therefore, it is very probable the claims containing the favorable asbestos horizons and also asbestos prospects could be expanded into a similar ratio of potential productive area to overlying claim boundary.

The potential and evaluation of the Rock House property is based largely upon these observations, combined with the geologic features of the property, its past production record, information concerning the Arizona asbestos mines from noted authorities and the results of the field examinations.

The whole of the Rock House properties are underlain by those members of the Mescal formation, which ordinarily carry asbestos

deposits excepting the portion covered by diabase. If a conservative ratio of the potential productive area to the overlying claims is applied to the Rock House property, it is judged that 25% of the area carries asbestos ore and the potential is 356 acres of which 15% would be left as pillars, etc., or a total of 303 acres are judged to be underlain by recoverable asbestos of ore grade. Drilling results indicate the ore bodies on the property with a cut off grade of 2" accumulative of fiber, carry an average of 3.32" of fiber, which, for convenience and conservatism is rounded off to 3". The potential is 43,560 $feet^2$ x 1/4' = 10,890 cubic feet per acre. Since 12.4 cubic feet of fiber in place equals one ton; then each acre contains 878 tons of asbestos ore or 266,000 recoverable tons of 3" (accumulative) fiber underlies the 356 acres to be mined.

Average Value of Fiber per Ton:

The value per ton is another figure subject to much controversy, a factor dependent upon the grades mined, efficiency of the mill and prevailing selling prices. This value is especially difficult to obtain from the Rock House production records because:

1. Often the operators sold only the first three grades and discarded the remainder. Then only the net value after deducting haulage, milling and other costs was recorded. (Ref. Table VI, Appendix).

2. Much of the recent shipments have consisted of the lesser grades from the dumps left by former operators.

3. Settlement sheets from the government ore buyers show past sales of shorter grades from the Rock House property have contained as much as 50% fiber of a higher grade, proving the inefficiency of the present mills (See Table VII, Appendix).

4. Fiber shipped from the Rock House property was evaluated from $250 per ton to over $1,000. per ton.

Thus, it is difficult to compile statistics from production records showing the average value of recoverable fiber in the rock.

The writer has taken the figures presented in Table VIII, Ref. No. 17, covering the production from the Jaquays Mining and Milling Operation as being most representative of the proportional percent of the fibers present in the asbestos ore from this district.

During the year of 1958, 24,660 tons of rock were mined, of which 2,335 tons of hand-cobbed ore were trucked to the mill. Of this amount 574.53 tons of fiber were recovered, representing 24.6% of the ore milled. Grades below Group No. 4 filter fiber or 75.4% of the millfeed were not separated, but were left in the mill tailings to be sold as stucco grade to West Coast users. These combined shorter grades are valued at an average of $125. per ton. According to the table, the first four grades were sold at an average price of $673.95 per ton. Sales for the remaining 1761 tons of millfeed are not quoted.

In the following estimate of value per ton, excluding grades below 4, the percentages of the grades of fibers present, regarded as representative of the Arizona asbestos deposits are taken from Table No. VIII. The values of the first four grades per ton are based upon the average prices per ton received from the sale of the Rock House production.

ESTIMATED VALUE PER TON OF FIBER OF THE FIRST FOUR GRADES:

Grade	% of Total Fiber Recovered	Average Value Per Ton	Value
1	18.9	$ 1,510.	$ 285.
2	11.9	900.	107.
3	32.7	400.	131.
4	36.5	200.	73.
		The estimated value per ton of fiber produced (excluding grades below 4)	$ 596.

ESTIMATED POTENTIAL:

The potential production is estimated as 266,000 tons valued at $596. per ton for the first four grades, or $158,536,000.

ESTIMATED PRODUCTION COSTS:

Exploration: Refer to "Estimate of Total Drilling cost and Rate of Progress" for derivation of this figure. $1,706,000.

Mining and Development: According to Table VIII, about 34 tons of waste are mined per ton of ore or 266,000 x 34 = 9,044,000 tons of ore to be mined at the current average cost of $8 per ton [17] = $ 72,352,000.

Transportation: The ore is usually semi-processed at the mine site and the millfeed is trucked to Globe. Table VIII indicates 12% of the rock mined is milled; therefore 9,044,000 tons x .12 = 1,085,280 tons to be trucked to Globe at the current average cost of $10 per ton or $10,852,800.

Milling Costs: 1,085,280 x $20 per ton $21,705,600.

Marketing and Research: Cost estimated at 5% of the value of the ore or $ 7,926,800.

Contingencies to cover mining equipment costs, mill erection costs (to be amortized) and miscellaneous overhead are estimated at another 5% of the ore value or $ 7,926,800.

Total Cost $122,470,000.

ESTIMATED PROFIT: $ 36,060.000.

SOURCES OF ADDITIONAL PROFIT:

It is possible to increase the profit estimated in the previous section in numerous ways as follows:

1. To find in the ore deposits an increase in the overall fiber length, or the number of mineable fiber bands.
2. To find an increase in the estimated per cent of area containing fiber.
3. Lower the costof mining.
4. Reduce the haulage cost and distance to the mill and warehouse.

5. Increase the mill efficiency (more fiber recovery, less fiber breakage).

6. Fiberize and sell the recoverable portion of the 75% of millfeed of less than 4 grade.

7. Upgrade the value of the lower grade products by producing grades for specific uses.

8. Develop a market for the resulting large limestone waste dumps (potential buyers are the growing agricultural industry or paper mill industry).

Percentage Tabulation of Costs and Values:

A percentage breakdown of the various costs and values excluding the fiber of less than 4 grade is estimated as follows:

Item	% of Total Cost	% of Value	Cost or Value per Ton of Fiber Produced (Est.)
Exploration	1.39	1.08	$ 6.44
Mining & Development	59.08	45.64	272.01
Transportation	8.86	6.84	40.77
Milling	17.73	13.69	81.59
Market & Research	6.47	5.00	29.80
Contingencies	6.47	5.00	29.80
Profit		22.75	135.59
Total	100.%	100.0%	$ 596.00

PERCENTAGE DEPLETION ALLOWANCE

A very important consideration is the profit remaining after taxes. Fortunately, our government has recognized that each ton of ore mined depletes the reserve and has allowed a deduction for depletion, wherein taxes are paid on a per cent of the income, dependent upon the type of mineral extracted, as follows:

PERCENTAGE DEPLETION ALLOWANCE

"The law recognizes that capital is consumed in the process of extracting minerals, oil and gas, other natural deposits, and timber - - - The law, therefore, provides a deduction for depletion, which is intended as compensation for the exhaustion of assets consumed in the production of income through severance of minerals, oil and gas, other natural deposits, and timber. Sec. 611 (14,402).

"The depletion deduction is available to the owner of an economic interest in the mineral property, mine tailings, or timber - - -.

"In the case of the mines, wells and other natural deposits - - the allowance for depletion shal be - - a percent - - of the gross income fromthe property - - (23% for asbestos deposits). Such allowance shall not exceed 50% of the taxpayer's taxable income from the property - - -.

"Gross income from the property means - - - the gross income from mining - - .

"The term 'mining' includes not merely the extraction of the ores or minerals from the ground, but also the ordinary treatment processes normally applied by mine owners or operators in order to obtain the commercially marketable mineral product, and so much of the transportation of ores from the point of extraction to the plant or mills in which ordinary treatment processes are applied - - -"(8)

As explained above, a depletion allowance of 23 percent is applied to the asbestos industry. The accepted practice in Arizona asbestos industry is to pay taxes on 77 per cent of the net income (excluding

purchases or royalty payments) provided the resulting percentage depletion allowance does not exceed 50% of the net income.

RECOMMENDED EXPLORATION METHODS

Hole Spacing and Drilling Cost Per Acre:

It is proposed the geologically favorable areas be explored for their asbestos content by drilling them on a grid pattern with holes at 100 foot intervals at the intersection of grid lines laid out at an acute angle. When fiber of ore grade is encountered, offsetting holes 50 feet distant can be drilled to prove the persistence of the ore. It is estimated this drilling program will require 8 initial holes per acre, plus an average of 6 additional holes per acre. The holes will average 100 feet in depth or 1,400 feet per acre at an average cost of $1.00 per foot. Holes should bottom 10 feet below the limestone-diabase contact, samples to be taken every foot in the ore horizon and every three feet above the ore horizon. The total cost of drilling per acre is estimated at $1,400. An additional cost of $600 per acre will be required for geologic and engineering services, sampling, etc. or a total estimated cost of $2,000 per acre to explore for the underlying asbestos ore.

Total Drilling Cost and Rate of Progress:

A Planimeter survey of the area underlain by diabase indicates that 356 acres can be omitted from the proposed drilling program. An additional 20% of the balance or 213 acres can be regarded as geologically unfavorable for ore deposition. Thus, to completely drill the remaining 853 acres will require an expenditure of $1,706,000. The drilling rate should average 200 feet per day per drill and would

require 20 years to drill out the entire body using one drill. Obviously, such a program is impractical and after sufficient ore reserves are blocked out to warrant the mining and milling expenditures, the mining of the ore should begin. If it is judged that sufficient reserves to warrant this step should be valued at 2 Million Dollars and the per cent of the ore holes remain the same as in the past exploration program, then about $108,000. will be required to block out 7,956 tons of fiber valued at $2,386,800.

Drill Rig:

It is recommended that a 4-wheel drive truck mounted drilling rig be used that does not force air down the drill stem, but instead utilizes a vacuum application, designed to draw the fiber up through an enlarged opening in the center of the drill steel, resulting in complete recovery of fiber from the bottom of the hole.

Sampling:

It is recommended that a modified field type Quebec Standard Asbestos Testing Machine with portable electrical source be obtained for the Geologist's use in field evaluation of the samples. Thus, the sample can be graded in the field and the ore deposit can be more quickly and accurately evaluated.

PROPOSED INITIAL EXPLORATION PHASE I

The longest and softest asbestos fiber observed occurs in the 27 and Asbestos Nos. 2, 3 and 4 Mines. Many outcrops of asbestos between these mines indicate the persistence of the deposits and the probability of increasing the ore reserves in this area. (Fig. 6). Therefore, it is recommended the initial exploration program, Phase I, consist of a series of wagon drill holes to be drilled beyond the workings of these

mines, extending along a north-easterly trending belt, west of the limestone escarpment. (Fig. 6). Fortunately, the majority of the area recommended is accessible via 4-wheel drive truck mounted drill rig, and also some of the necessary drill site access roads were constructed by the former operator in anticipation of a similar exploration program.

The initial drilling recommended extends from the 27 Mine, northeastward for 6,000 feet over an average width of approximately 685 feet covering an area of about 94 acres. This program would cost $188,000. based upon an estimated $2,000 per acre drilling costs.

Phase II and subsequent drilling programs should follow a detailed geologic study for target areas.

Other Properties:

Other asbestos properties in which Pan American Fiber Corporation has an interest, but were not examined for this report, are the American Asbestos Cement Properties, the Apache Indian Reservation asbestos deposit and the area in the vicinity of the airstrip south of Rock House.

The American Asbestos Cement Corp. property consists of 93 contiguous claims located in Secs. 24, 25, 26, 35 and 36, T8N, R14E, and Sec. 19, 20, 29, 30, 32 and 33, T 8 N, R 15E, approximately 7 miles northwest of the Pan American Fiber property. (Fig. 3) The property has a long history of asbestos production and definitely warrants a detailed examination.

The Fort Apache Indian Reservation asbestos properties are located in T7N, R15E, approximately 3 miles northeast of the Rock House property. (Fig. 15) This property also warrants a thorough examination and evaluation.

The area in the vicinity of the airstrip is underlain by formations favorable to the deposition of asbestos and likewise warrants further geologic investigation.

MARCH 31, 1962

GERALD WEATHERS

REFERENCE

1. BATEMAN, Alan M., Economic Mineral Deposits: PP 737-743 (1947)

2. BOWLES, Oliver and Stoddard, B. H., Minerals Yearbook 1936: U.S.B.M. (1936)

3. BOWLES, Oliver, Asbestos: Minerals Facts and Problems: Bulletin No. 556, U.S.B.M. (1956).

4. DANA, Manual of Mineralogy: (1946)

5. KENNEDY, D. O. and ROMAN, Victoria M., Asbestos, Minerals Yearbook Vol. U.S.B.M. (1960)

6. LADOO and Myers, Nonmetallic Minerals: (1951)

7. Mining World, Arizona Asbestos Industry is Growing Steadily around Globe: Vol. 22, No. 10, PP 44-45, September 1960.

8. PRENTICE-HALL, Federal Taxes: Vol. 2 14,401 (1960)

9. RICE, B.S.J., Asbestos Mineral Commodities of California: Bulletin 176. (1957)

10. ROSATO, D. V., Asbestos; Its Industrial Applications: (1957)

11. RUKEYSER, Walter A., The Chrysotile Asbestos Properties of the American Asbestos Cement Corp., Globe, Arizona: (1953 - unpublished).

12. RYDER, Oscar B., Asbestos - A Summary of Information on Uses, Production, Trade and Supply: Industrial Materials Series Report No. M-3: U. S. Tariff Commission (1951)

13. SEATON, FRED A., Sec., The Asbestos Industry in 1960: Mineral Market Report MMS No. 3152, U.S.B.M. (1960)

14. SEATON, Fred A., Sec., A Materials Survey and Information on Asbestos: U,S.B.M. (1959).

15. STEWART, L.A., Chrysotile Asbestos Deposits of Arizona: U.S.B.M. I.C. 7706 (1955).

16. Chrysotile-Asbestos Deposits of Arizona (Supplement to Information Circular 7706): U.S.B.M. IC 7745 (1956).

17. STEWART, L. A., Mining Methods and Costs, Regal Asbestos Mine, Jaquays Mining Corp., Gila County, Arizona; U.S.B.M. IC 7986 (1961)

18. SULLIVAN, J. Thiel, Exploration Drilling Program, Rock House Property (1956 unpublished) Copy attached.

19. WILSON, Eldred D., Asbestos Deposits of Arizona: Arizona Bureau of Mines Bulletin 126 (1928)