PRINTED: 08/07/2001

ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES AZMILS DATA

PRIMARY NAME: GREY HORSE

ALTERNATE NAMES:
- CORAL CANYON CLAIM
- ESPERANZA GROUP
- U.S. VANADIUM GROUP
- SULLIVAN CLAIMS
- BLACK CAP

PINAL COUNTY MILS NUMBER: 348

LOCATION: TOWNSHIP 4 S RANGE 14 E SECTION 3 QUARTER S2
LATITUDE: N 33DEG 06MIN 45SEC LONGITUDE: W 110DEG 54MIN 10SEC
TOPO MAP NAME: KEARNY - 7.5 MIN

CURRENT STATUS: PAST PRODUCER

COMMODITY:
- VANADIUM
- LEAD
- MOLYBDENUM

BIBLIOGRAPHY:

ADMMR GREY HORSE FILE
ADMMR GREY HORSE MINE CARD
ADOT HIWAY MAP, PINAL CO., 1949, ADMMR MAPS
THE MINERALOGICAL RECORD, JULY-AUG. 1980, P. 231-233, NOV-DEC 1980, P. 388
RANSOME, F.L. RAY FOLIO 1923, P. 23
A.L. FLAGG, VANADIUM REPORTS- BOOK NAMED VANADIUM EXTRACTION

PRINAME
GREY HORSE

NUMBER **348** | FILE **F** | CONT **0** | CONT1 **N**

ALTNAME1
CORAL CANYON CLAIM

ALTNAME2
ESPERANZA GROUP

ALTNAME3
U.S. VANADIUM GROUP

ALTNAME4
SULLIVAN CLAIMS

ALTNAME5
BLACK CAP

ALTNAME6

CURSTAT	MNAME	NLATDEG	NLATMIN
PAST PRODUCER	**KEARNY - 7.5 MIN**	**33**	**06**

NLATSEC	WLONGDEG	WLONGMIN	WLONGSEC	TOWN	RANGE	SECTION	QUARTER	COM1
45	**110**	**54**	**10**	**4 S**	**14 E**	**3**	**S2**	**V**

MODI1	COM2	MODI2	COM3	MODI3	COM4	MODI4
	PB		**MO**			

COM5	MODI5	COM6	MODI6	COM7	MODI7

BIB1
ADMMR GREY HORSE FILE

BIB2
ADMMR GREY HORSE MINE CARD

BIB3
ADOT HIWAY MAP, PINAL CO., 1949, ADMMR MAPS

BIB4
THE MINERALOGICAL RECORD, JULY-AUG, 1980,

U. S. Vanadium
Development Co.

Phoenix, Arizona

U. S. Vanadium
Development Co.

Phoenix, Arizona

SEE: BOOK V-VII A. L. FLAGG VANADIUM REPORTS

PROBABLY no mineral development in the United States is today attracting more attention than that of the United States Vanadium Development Co., with thirty-six (36) debt-free, high grade ore bearing claims in the famous Ray Consolidated Copper mines district of Arizona. The most sanguine claims of the directorate of the company have been more than affirmed by some of the country's best known and most competent engineers.

Already bodies of this vanadium bearing ore have been blocked out. A large force of men under a competent superintendent is engaged in the work of development. Plans for the erection of a 100-ton concentrating mill and reduction plant are under way, and an unlimited market has presented itself, assuring speedy disposition of the products of the company whenever they become available.

The officers comprise some of the most highly respected and most successful business and professional men of the Southwest, men whose names carry assurance of stability and broadmindedness. The stockholders, over three hundred in number, are conservative, far-seeing citizens, for the most part resident in Arizona, investors, not speculators. They have seen their stock go to par in a wonderfully short time and are making no effort to dispose of their holdings even at the advanced figure.

The purpose of this little book is not to set forth in glowing terms the dreams of promoters or the possibilities of a prospect. It is to present briefly facts and only facts, so far as they are obtainable. Extravagance in expression is avoided, conservatism predominates and only those statements are made that are substantiated by facts.

In a letter just received from Superintendent Lowe, he states the winze and lower tunnel are still in rich ore and that we have 25,000 tons of ore now on the dumps, sacked and blocked out.

Estimating this ore at $100 per ton, which we consider a very low price, would give $2,500,000 worth of ore ready for the mill. This would mean $2.50 for every share of stock now outstanding.

OFFICERS AND DIRECTORS

DR. E. PAYNE PALMER, *President*

DR. O. E. PLATH, *Vice-President*

FRANKLIN D. LANE, *Secretary-Treasurer*

PETER MOHN H. H. TEMPLE

Mines located 3½ miles Northeast of Ray Junction, Pinal County, Arizona.

Property consists of 36 claims free from debt, bond or lease.

Our shipping station is Erman; only 2½ miles from our main works with easy grade and good road.

Abstract of Report on U. S. Vanadium Development Co., by C. J. Price, Mining Engineer

Los Angeles, Cal., October 11, 1916.

GEOLOGY

Limestone and diabase is the main rock formation of the district, with intrusions of diorite, andesite and other eruptive sediment rocks.

A very pronounced line of demarkation between the lime and diabase formation occurs on the Western portion of your Claims.

This line of demarkation is so pronounced that it can readily be traced by the naked eye across the country for miles.

WATER

A never failing supply of excellent water for domestic purposes is supplied by a spring on the Northwestern portion of your property, and I have no doubt but what plenty of water for at least 100 ton concentrating plant can be developed by cross-cutting on the bed rock in the gulch a short distance below the camp, or the same condition might apply in the gulch a short distance below the Gray Horse tunnel.

EQUIPMENT

The property is equipped with drill steel, hammers, picks, shovels, steel rails, cars, wheel barrows, blacksmith tools, etc., sufficient to prosecute development on a moderate scale.

Several large tents, lumber, a large cooking range, dishes, chairs, and in fact all kitchen utensils for taking cars of 15 to 20 men, had recently arrived at the property and is being whipped into shape near the spring (mentioned under "water") for a permanent camp.

VEIN OR VEINS

Several veins, varying in width from a few inches to 5 and 6 feet outcrop in various places, and traverses your property in a more or less Easterly and Westerly direction.

Considerable overburden consisting of gravel and earth soil covers the majority of your claims, especially is this the case where the limestone formation occurs.

This makes the tracing of the outcrop of the veins on the surface difficult.

DEVELOPMENT

Gray Horse Vein

On the Gray Horse Claim the best ore showing on your property is found, and the principal development of your group of claims has centered here. A tunnel, 210 feet long, has been run into the hill on this vein and an uprise 80 feet long, has been made to the surface, some 20 feet from the face of the tunnel, or 190 feet in from its portal. This tunnel has followed a well defiined fissure, or clevage, its entire distance and is in ore the entire 210 feet, said ore is continuous up to the surface as proved by upraise and open cut work on the surface.

Some 500 tons of good commercial ore is piled up on the dumps from this development work, and the best or richest ore exposed to date is in the floor of this tunnel as proven by samples carefully taken by a reputable engineer last February. A winze being sunk in one of the ore shoots below this tunnel level at the present time is producing excellent ore.

As stated, ore is continuous in this tunnel, but two well defined rich shoots are exposed in this tunnel trending into the mouth (Easterly) at an angle of about 20 degrees from the horizontal. A third shoot is exposed in the upraise and the tunnel was just cutting into it at the time of my visit. This same condition may continue on into the Apex Claim (see map) as I am told the outcrop has been found on the Eastern end of this claim.

Esperanza Vein

A tunnel 25 feet long, a shallow winze and several surface pits show this vein fairly well defined for a distance of two or three thousand feet in length and is 5 or 6 feet wide on the bottom of the winze. Showing of vanadium is very good.

Black Cap Vein

Ore is exposed in at least two places on this claim, showing vanadium crystals. Work to date is very meagre, but possibilities good.

RECOMMENDATIONS

For the present I recommend that you continue the present tunnel on the Gray Horse Vein, following the Clevage or fissure, which in this instance was a channel that gave vent to the vanadium gasses, or solution, that came up from below, and in receding deposited the vanadium values in the gangue or vein matter with which it came in contact. You will in all probability encounter high and low grade shoots alternately as you advance, similar to those you have already passed through.

Also, sink a winze in one of the high grade shoots of ore already encountered, preforably the second one in from the mouth of the tunnel. In sinking follow the ore, even though you may have to sink on the incline.

On the Esperanza Vein I recommend you to sink a small shaft from the surface to a depth of 50 or 60 feet, then drift east and west on the vein from the foot of the shaft.

Tunneling on the Black Cap and sinking on the Ready Cash veins could be carried on simultaneously providing you wish to crowd prospecting.

It is essential that you complete your wagon road and ship a couple of carloads of ore to some reliable testing plant for treatment in order to ascertain the best method of recovering your values. This test should be closely followed by some member of your company, or some one in whom you have implicit confidence.

After this test is complete it should be in order for you to decide whether to continue shipping or figure on your own reduction plant.

CONCLUSIONS

The quantity of ore in sight on your property, from the small amount of prospecting done, and the high prices quoted for vanadium, leads one to believe that you have a valuable property, and one that warrants vigorous prospecting and developing.
Respectfully submitted,

(Signed) C. J. PRICE,
Mining Engineer.

Topeka, Kas., Nov. 2, 1916.

To the President and Board of Directors,
of the U. S. Vanadium Development Co.,
Phoenix, Arizona.

Gentleman:

I paid a second visit to your property on October 29th, and was greatly pleased with the progress made in development work and the large amount and excellent quality of ore exposed by this work since my original report of October 11th.

The winze from the Gray Horse tunnel recommended by me at that time had on the 29th ulto., attained a depth of 29 feet, all in high grade ore. In fact, some of the richest ore yet encountered on the property is attained from the bottom of this winze.

The Gray Horse tunnel, extending East, has cut some good commercial ore, and at the time of my recent visit, the face of this tunnel was showing up well.

The prospecting on the Esperanza and Black Cap veins are in ore, but has not advanced far enough to determine the extent and possibility of these veins.

Improvement shown in your property by following recommendations made by me in my original report, prove my deductions at that time were correct and you are proving a large body of high grade ore.

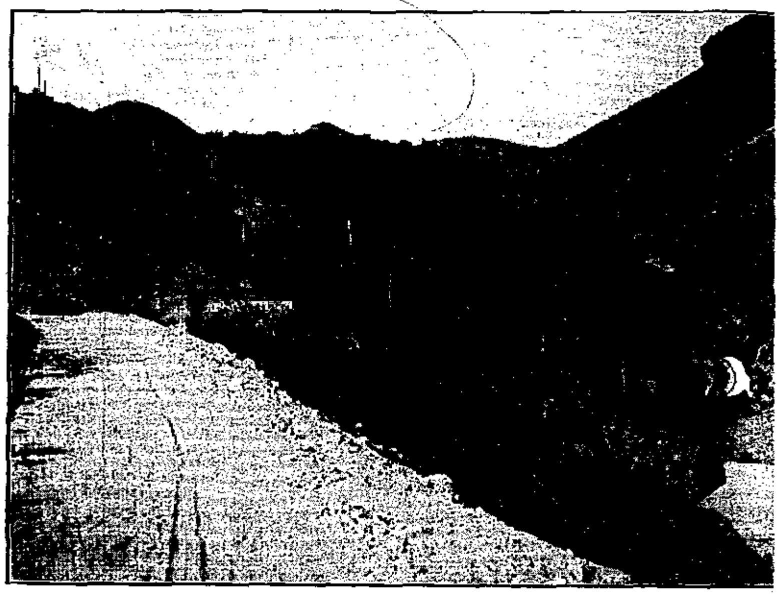
When the winze above referred to attains a depth of 50 or 60 feet, I recommend that you run another tunnel, some 80 feet below the present one, and almost in line with it. You will, no doubt, encounter ore near its portal, and should drive on the cleavage or fissure, followed in the upper tunnel. This tunnel will eventually connect with the winze now being sunk, and will be your main working tunnel, as it is the lowest place at which you can attack this vein without sinking.

I congratulate you on your proven ore body.

Sincerely yours,

(Signed) C. J. PRICE,
Mining Engineer.

The winze referred to in Mr. Price's letter of November 2nd has been sunk and the lower tunnel has been driven in and connected with the winze and we are now sinking on the winze and driving the tunnel ahead and there is rich ore in both of these workings. The new road has been completed to our main workings and we are now having the ore thoroughly tested by different processes to determine which process will save the greatest amount of the ore values, and when this is finished it is the intention to install a plant for the treatment of the ore at once.



ASSAY OFFICE OF J. S. NEALL.
307 N. First St. P. O. Box 1148
Phone 1035.

Phoenix, Ariz., Feb. 24, 1916.

This is to certify that the samples submitted to me for assay by U. S. Vanadium Development Company contain as follows per ton of 2000 pounds:

Marks	Percentage Vanadium Pentoxide
5	3.75
14	8.20
3 Tunnel	10.45

J. S. NEALL, Assayer.

Abstract *of* Report on the U. S. Vanadium Mine By J. C. Steele, Mining Engineer

Phoenix, Arizona, February 21, 1916.

canvas sheet and was broken to 1-inch size before quartering.

In making up samples for analysis, a composite sample composed of proportionate parts of each sample as the sample represented feet of ore, viz: 3 feet, 3 parts; 5 feet, 5 parts, respectively, was the relative weight of pulp taken to make a composite sample. This method was only used where the ore was fairly uniform and on consecutive samples. As a check on this work, the average of the tunnel samples give only a difference of .05% from the dump sample.

The sampling was made with the object of ascertaining the average value of all ore developed. Selected samples will give much higher results and it is probable that careful mining will eliminate waste, thereby increasing the grade of the ore.

SAMPLINGS

The dump at the Gray Horse was trenched for about 60 feet and a shoveled sample taken the entire length of the trench; this was broken and quartered on canvas and reduced to about 4 pounds. The tunnel was sampled at intervals of about 10 feet; the points are more definitely illustrated on map No. 1.

This sampling was executed in a systematic way by cutting about 2 pounds from each foot of ore, which would give a 10-pound sample from a 5-foot cross-section of ore. The ore, if cut from the roof, fell on a

A feature worthy of consideration is the fact that the samples Nos. 9 to 15 to 18 inclusive, and cut from the floor of the tunnel, averaged 4% and are represented by composite Sample D.

Composite A, made of Nos. 1 to 5 inclusive, was from the roof of the tunnel covering about the same distance on the vein shows 1.90% V^2 O^5 or Vanadium Pentoxide. It was observed that the ore was of better grade; however, great care was taken in cleaning up, then cutting up several inches and brushing up again before cutting the sample. A sample from the dump at the shaft over the tunnel gave returns of 1.70%, which indicates an increase in value with depth when compared to 2.6% the average of all samples taken from the tunnel.

The inclement weather prevented a more extended examination of the surface cuts and outcrop.

The percent given for all assays is the percentage of Vanadium Pentoxide or $V^2 O^5$, this being the chemical form of the product as obtained by analysis.

ORE RESERVES

In the present state of development, the basis is very limited for ~~the usual~~ determination of positive ore. By reference to map No. 2, Block A., contains 3,100 tons above the tunnel. The samples as cut give an average width of about 5 feet and to be fairly safe 4 feet is taken as a basis of width or thickness.

Block B, contains 4,800 tons and extends 75 feet below A to about a level of the proposed lower tunnel. In some cases 50 feet of depth is allowed as positive ore, providing the vein is not less than 4 feet thick; also that the ore occurs in a well defined chute and not in lenses, and that there is no indication of faulting.

From the fact that this is a true fissure and all other features are favorable, one-half of Block B, or 2,400 tons is considered positive ore. The dumps contain over 500 tons $\times$ 3,100 $\times$ 2,400 tons plus 2,400, one-half of B = 17,000 tons probable ore. The possible ore is an elastic problem, having a wide range of possibilities, as a basis for comparative calculation 50% of the tonnage as indicated in Blocks D to J inclusive, would give 101,200 $\div$ 2 = 50,600 tons, the above estimates are only made to illustrate the possibilities.

The Esperanza and Ready Cash veins will produce Vanadium ore, there is now probably 1,000 tons which could be mined from the surface, with development, a large tonnage of valuable ore is considered probable.

SUMMARY OF ORE RESERVES

Positive ore	6,000 tons
Probable ore	17,000 tons
Probable ore	50,600 tons

Assays

No. Sample	No. Feet Cut	
1	8	
2	1	
3	5	
4	4	
5	3	Composite sample
	21	A. Assay = 1.9%
6	4	
7	5	
8	3	
14	1	
	13	B. Assay = 2.8%
9	1	
15	3.5	
16	5	
17	3	
18	7	
	19.5	C. Assay = 4%
19	8.5	
20	3	
21	1	
22	3	
	15.5	Assay = 1.6%

The foot percentage average = 2.6%

SAMPLE

No. 12	Dump Gray Horse tunnel assay	2.65%
No. 13-2	Class D. Gray Horse tunnel assay	.88%
No. 10	Ready Cash cut in gulch	1.1 %
No. 23	Ready Cash dump	.40%
No. 24	Ready Cash cut N. of vein	.25%
No. 25	Esperanza 6 feet face winze	1.66%
No. 26	Esperanza dump	1.55%
No. 27	Gray Horse dump at shaft	1.70%

INDUSTRIAL APPLICATION

The most important use for vanadium is in the manufacture of special steel alloys. Owing to the properties above referred to the vanadium introduced into the molten iron decomposes the suboxide of iron with the result that the easily fusible vanadium oxide passes into the slag, together with the Vanadium Nitride formed at the same time; the vanadium thus acts as a scavenger, removing the deleterious nitrogen and oxide compounds, leaving a strong coherent metal which is at the same time free from "dryness." The vanadium in solid solution in the carbonless portions of the iron renders the metal coherent and less liable to disintegration, at the same time exerting a third influence by its chemically combined carbon; there is an increase in strength in the inverse ratio to the percentage of graphite present in the iron. The amount of vanadium remaining in the steel does not amount to more than 0.22 per cent.

There is a marked increase in the figures given for tensile and transverse tests by cast-iron treated with vanadium. Increased compression power is also produced without loss of hardness. The most valuable property, however, is its resistance to abrasion, rendering the vanadium iron extremely suitable for locomotive and automobile cylinders and bushings; in the case of cylinders, the metal assumes a mirror-like polish which has distinct advantages.

The introduction of vanadium into iron practically eliminates the troublesome porosity which so often spoils a complex piece of casting. In the case of steels, the advantage of the introduction of vanadium is at once apparent when it is realized that the static power is unaltered, while the dynamic power is enormously increased, thus affording a steel particularly suitable for all parts of the machines which are subject to continual shock. On this account it has been used for motors of every kind.

The vanadium steels are most useful for high-speed tools on account of their increased hardness on the temperatures risings at a red heat they do not lose any of their properties. The effect on steel is three-fold:

1. It dissolves in the carbonless portion of the iron, which it toughens and renders more impermeable to the carbide, doing much to prevent segregation of the carbide.

2. It removes the deleterious oxides and nitrides and dissolves gases and toughens the steel.

3. It forms complex carbides with other carbide-forming metals, such as chronium and nickel, if these metals are present, thus enhancing the static strength of the steel.

Vanadium bronzes and other alloys are also coming into use; they show an increased strength and toughness and are more compact, without any loss of electrical conductivity. The bronzes show a resistance to abrasion, which renders them suitable for trolley wheels and bronze gears.

CONCLUSION

The foregoing facts and deductions are self-explanatory and need no further comment. The excellent showing made by the veins and the valuable metallic contents justify the writer in stating that it is a property of great merit and vast possibilities.

Respectfully submitted,

(Signed) J. C. STEELE,
Mining Engineer.

AMERICAN VANADIUM COMPANY

From Engineering and Mining Journal, August 26, 1916.

"VANADIUM has caused a sensation this week through the announcement that all the stock of the American Vanadium Co., which practically controls most of the output and has built up a large business in the sale of the ore and metal and in the making of vanadium steel, has been sold to a syndicate of Philadelphia and New York capitalists for $7,000,00 which is $1,000 per share. The price is payable $650 in cash and $350 in notes or stock of the new company which is to be organized. The old company is owned in Philadelphia and Pittsburgh and has $700,000 stock. The new company which will retain the name of the old, will have a capital of $13,500,000, made up of $5,000,000 of 7% preferred stock, $6,000.000 of common, and $2,500,000 of 6% short-term notes. At the head of the syndicate which takes over the company are, J. L. Replogle and Kuhn, Loeb & Co. With them are associated Cassatt & Co., of Philadelphia, Chandler Bros. & Co., Harrison Williams, and half a dozen others. Mr. Replogle, now vice-president and general manager of the company, will be made president after the conclusion of the sale. James J. Flannery, head of the present company, will become chairman of the board."

Standard Corporation Service (New York) for August, 1916.

AMERICAN VANADIUM COMPANY

(1) TRANSFER TO BANKING SYNDICATE PLANNED—A dispatch from Pittsburgh, Pa., August 21, 1916, stated that this company, controlled by the Flannery interests of Pittsburgh, the largest concern of its kind in the world, probably would pass into the hands of an Eastern Banking Syndicate which was offered $7,000,000, or $1,000 for each of its 7,000 shares. It was understood that the syndicate represented a group of steel men who contemplated the formation of a new company for the production of vanadium. It was known definitely that the works were to remain at Kirwan Station, near Bridgeville, Pa., where the company has an investment of more than $600,000.

James J. Flannery held more than a controlling interest in the company and was its president. He had advised the acceptance of the bankers' proposition by the other stockholders. An option had been taken on two-thirds of the stock.

The Vanadium Company, was a close corporation. The last quotations on the stock, so far as could be learned, were $500 to $550, with a small sale recently. The company was organized in 1906 by the Flannery interests, and was capitalized at $700,000, which was represented by preferred stock only at $100 par. There were no bonds. It had large ore deposits in Peru. Vanadium, the company's sole product, was quoted at approximately $250 a pound.

(2) RECAPITULATION — It was stated August 23, 1916, in connection with the recapitulation of the company that the new organization would have a capital of $13,500,000, represented by $5,000,000 preferred stock, $6,000,000 common stock and approximately $2,500,00 in 6% short-term notes. The stockholders of the old company had been offered $65 in cash in 6% notes for each share of old stock. This exchange would call for $4,550,000 in cash and $2,450,000 in 6% notes, the old company having been capitalized at $700,000 in stock and being free from bonded indebtedness.

The stock of the company would be underwritten by a syndicate composed of Kuhn, Loeb & Co., Cassatt & Co., of Philadelphia; J. L. Replogel, vice-president of the company; Chandler Bros. & Co., Harrison Williams, and others. Subscriptions to the syndicate had been closed, the issues having been oversubscribed about 300%. The largest participants in the syndicate underwriting were said to be J. L. Replogel, Harrison Williams and Kuhn, Loeb & Co.

ESPERANZA GROUP

Pinal

Riverside District

T4S R14E Sec. 3

Also called Grey Horse Mine

Andy Clark, professional mineral specimen collector, brought in a sample of vanadinite from the Gray Horse property in Pinal County. He reports that the property has been long abandoned and has restaked it as the Coral Canyon Claim. KAP WR 8/19/76

WR AWB 5/31/80 Andy Clark and Gary Fleck donated one vanadinite specimen from the Gray Horse Mine year Ray Arizona to the Mineral Museum.

Arizona Department of Mines and Mineral Resources

INFORMATION FROM MINE CARDS IN MUSEUM

ARIZONA
PINAL ~~GILA~~ COUNTY
GRAY HORSE MINE
(Near Riverside)
75 - 80' level

MILS #348

ESPERANZA GROUP (?)

MM-7258 Vanadinite

ESPERANZA GROUP PINAL COUNTY

See: Book V-VII A. L. Flagg Vanadium REports

USBM U File Reports Vanadium Low Grade

Arizona Mining Journal Oct 1917 p. 13
April 1918 p. 20

68 EAST CONGRESS P. O. BOX 5076

UNITED STATES VANADIUM CORPORATION

Unit of Union Carbide UCC and Carbon Corporation

LEAD-VANADATE AGENT FOR METALS RESERVE COMPANY

TUCSON, ARIZONA

September 24th, 1942.

J. S. Coupal, Director,
Department of Mineral Resources,
413 Home Builders Bldg.,
Phoenix, Ariz.

Dear Mr. Coupal:

We would appreciate your sending us the blueprint copies of the assay maps of Dr. Palmer's vanadium property near Kelvin which were left at your office some time back.

Very truly yours,
G. Donald Emigh
In Charge of Operations

esm/G.Donald Emigh

Gre, Horse (f)
Pinal

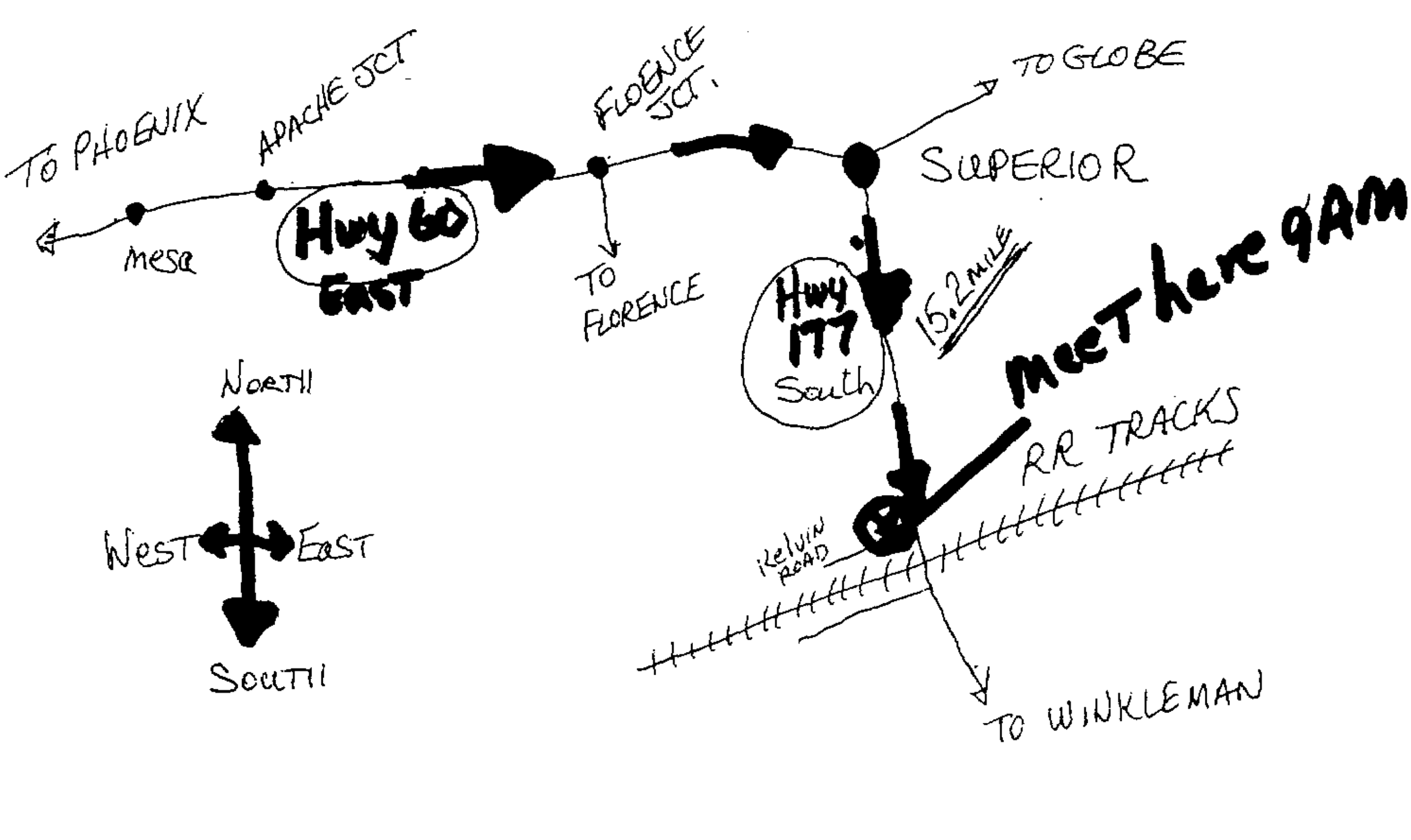
GREYHORSE MINE

SATURDAY OCTOBER 28, 2000 9 AM

COALITION TRIP HOSTED BY MARICOPA LAPIDARY SOCIETY
QUESTIONS : LEADER : MARK OPPEDAHL PH: 602-923-8284

WHAT : VANADINITE(generally bright red to orange –red), CALCITE (white rhombohedrons and blades), cerussite(white), wulfenite(yellow & small), descloizite Also hemetite crystals, coral fossils on limestone, even picture rock has been found on the way.

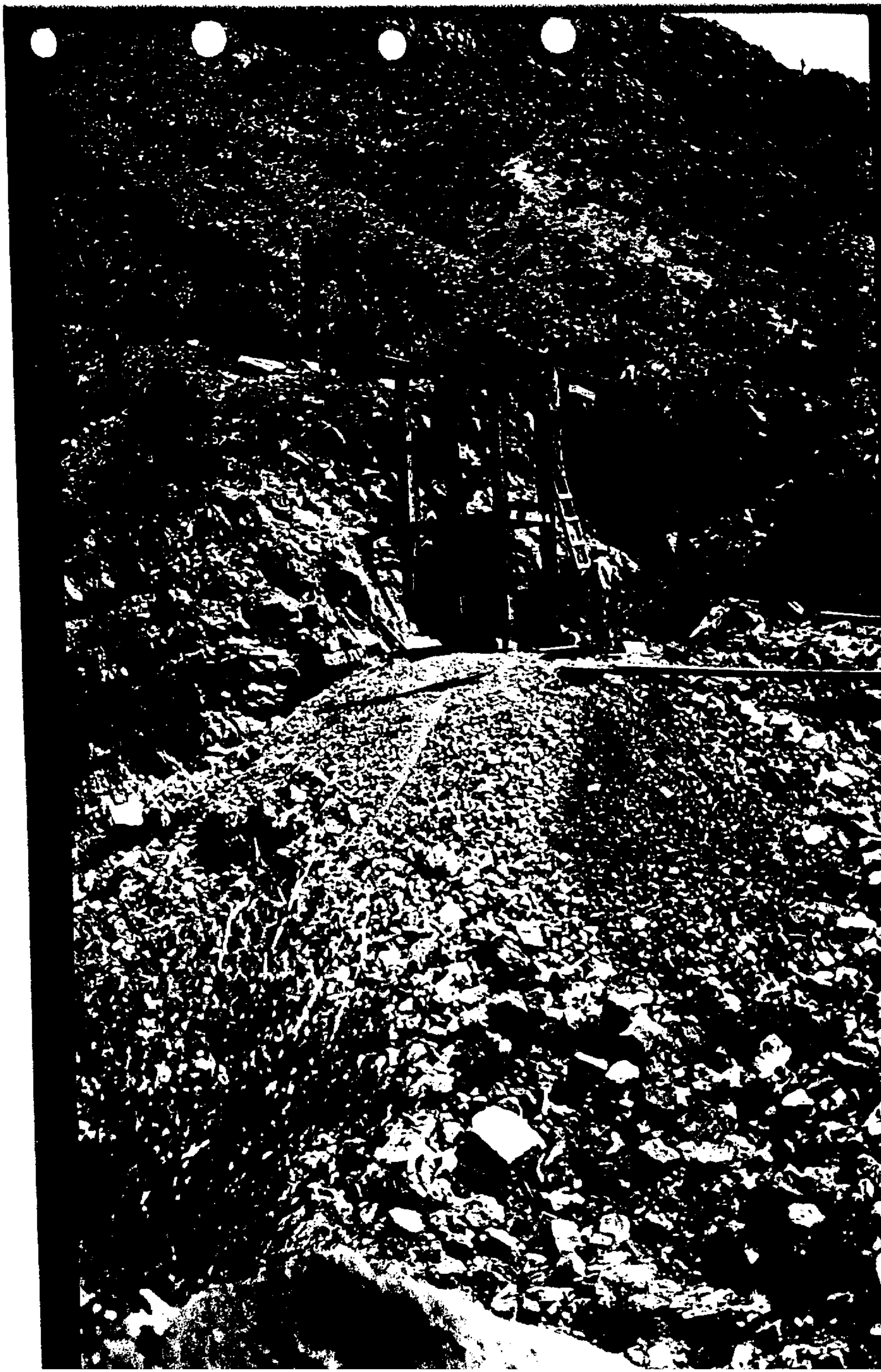
MAP: KEARNY TOPO , PINAL COUNTY
MEET: AT 9AM SOUTH OF SUPERIOR OFF HWY 177 AT THE KELVIN RR TRACKS AND HWY 177. THIS IS 15.2 MILES SOUTH OF SUPERIOR.
DIRECTIONS: FROM PHOENIX TRAVEL U.S. 60 EAST (SUPERSTITION) TO SUPERIOR , TURN SOUTH ON HWY 177 15.2 MILES and meet near the junction of Hwy 177 and the Kelvin road turnoff with RR tracks. The mine is another 6 miles beyond this juncture. Cars should not go to the mine, but carpool from the meet spot. SOME Clearance is needed to the mine.
BRING YOUR NORMAL ROCK TOOLS , LUNCH AND A CHAIR. USUALLY GOOD COLLECTING IS AFFORDED HERE. THERE WAS AN ARTICLE ABOUT THIS MINE IN MINERALOGICAL RECORD IN AUGUST 1980.



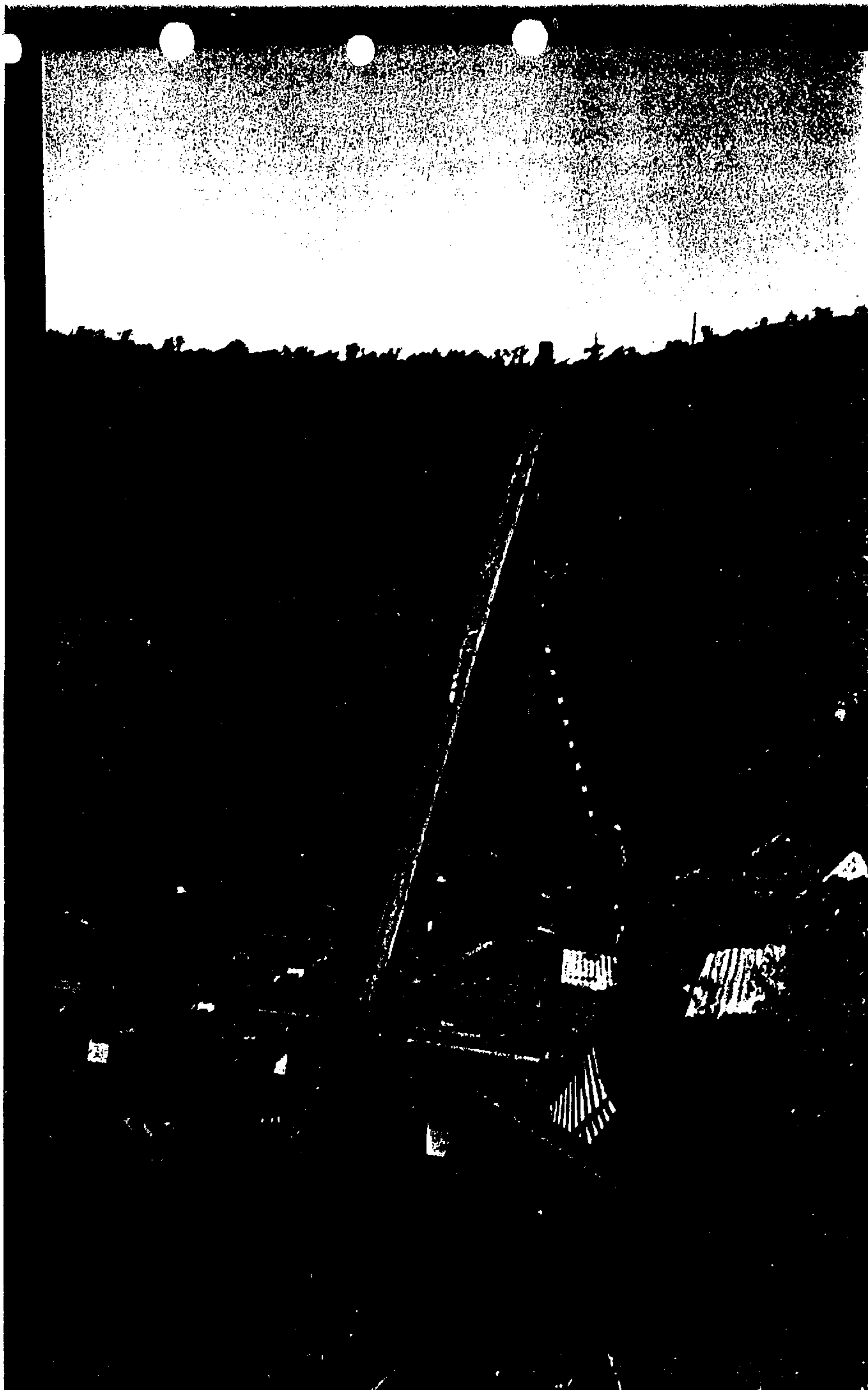
0-164-1
1925
BY-RLF.

0-164-2
1925
BY -ALF

SHAFT
BOXWORK



11-164-3
1925
BY ALF



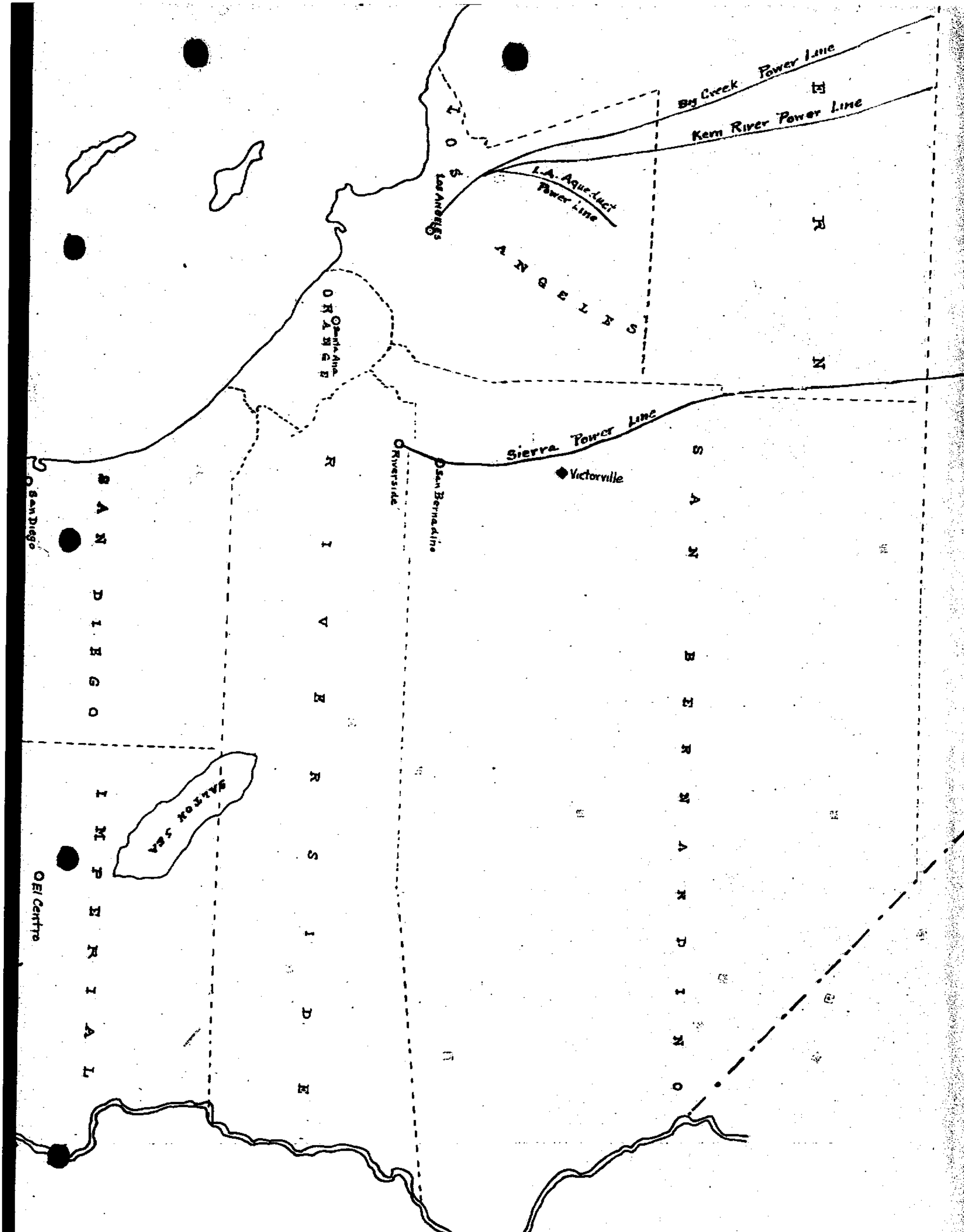
U-164-1
1925
BY-ALF


5296

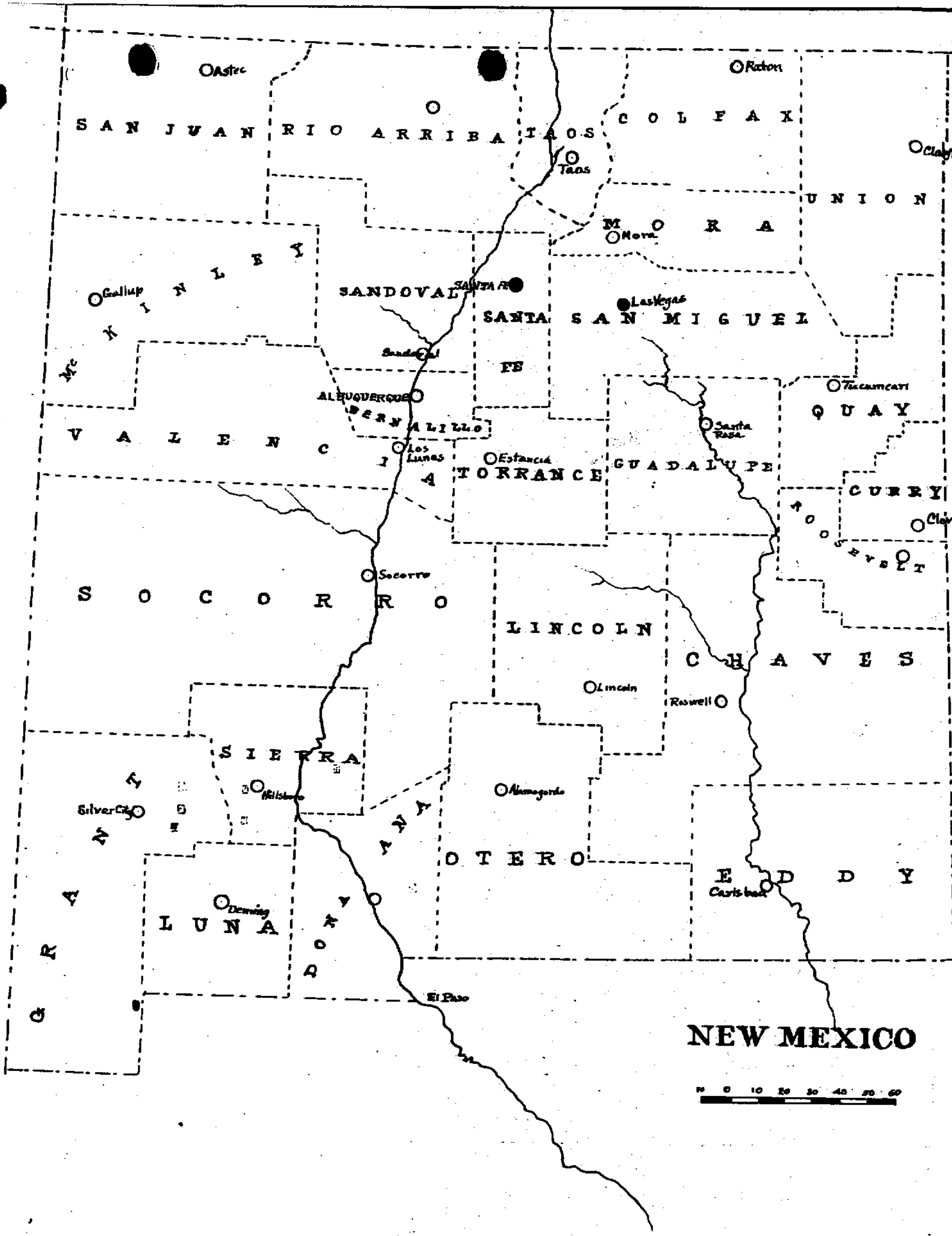

5296


5297


5297



CALIFORNIA
(Southern Part)


NEW MEXICO
SAN JUAN
RIO ARRIBA
TAOS
COLFAX
UNION
MORA
McKINLEY
SANDOVAL
SANTA FE
SAN MIGUEL
QUAY
BERNALILLO
VALENCIA
TORRANCE
GUADALUPE
CURRY
ROOSEVELT
SOCORRO
LINCOLN
CHAVES
SIERRA
GRANT
LUNA
DONA ANA
OTERO
EDDY
Aztec
Raton
Clayton
Taos
Mora
Gallup
Santa Fe
Las Vegas
Sandoval
Tucumcari
Albuquerque
Santa Rosa
Los Lunas
Estancia
Clovis
Socorro
Lincoln
Roswell
Hillsboro
Silver City
Alamogordo
Deming
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El Paso
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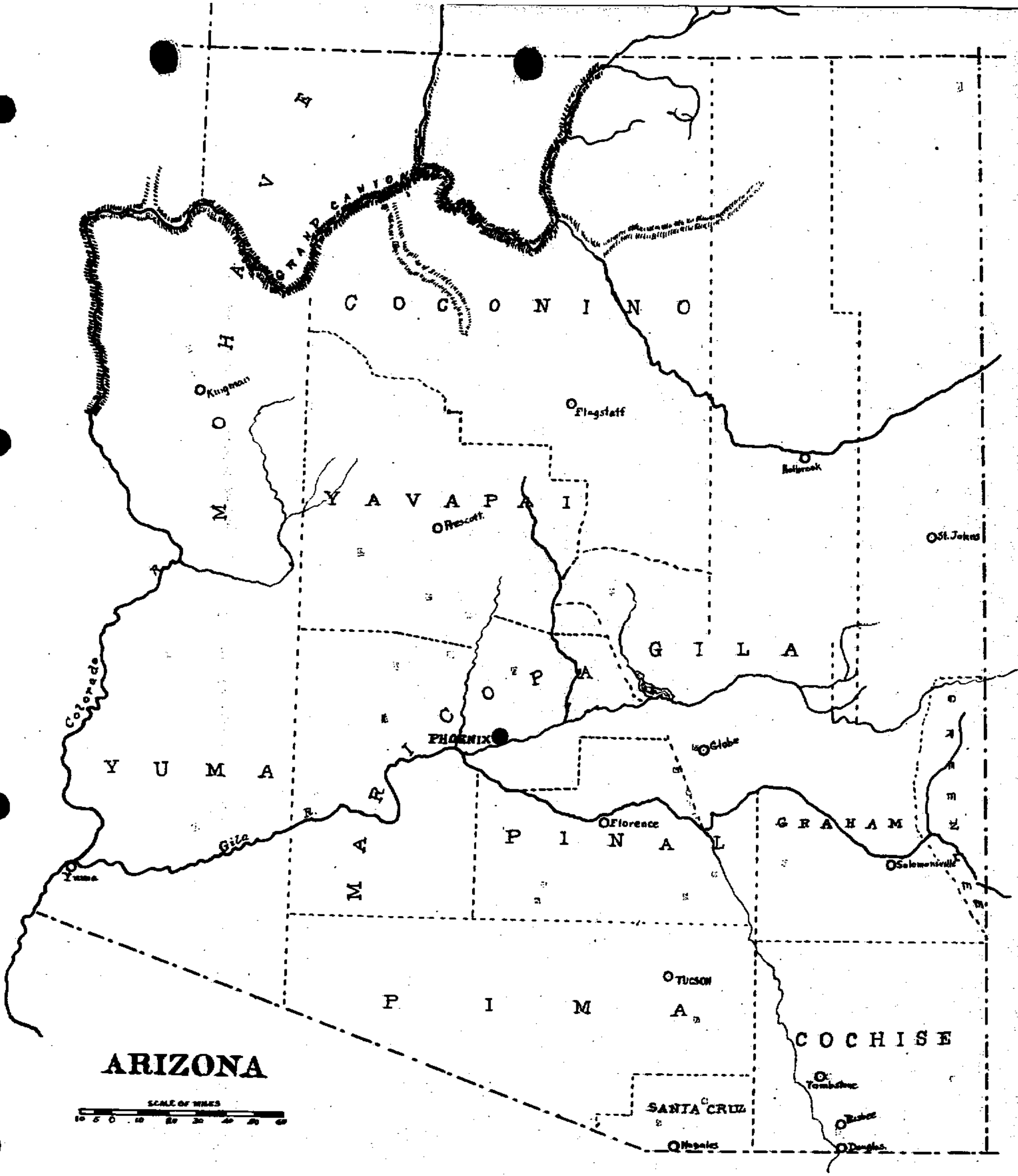
ARIZONA
SCALE OF MILES
MOHAVE
COCONINO
YAVAPAI
MARICOPA
YUMA
GILA
PINAL
GRAHAM
PIMA
COCHISE
SANTA CRUZ
GRAND CANYON
Colorado
Gila
Kingman
Flagstaff
Prescott
St. Johns
PHOENIX
Globe
Florence
Solomonsville
Yuma
Tucson
Tombstone
Bisbee
Douglas
Nogales

REPORT

ON

U. S. VANADIUM DEVELOPMENT CO. PROPERTY

KELVIN, ARIZONA.

LOCATION:

The property of the U. S. Vanadium Development Company, consisting of forty-one lode claims, a water right and a mill site, is located in the Riverside mining district, in the Mescal mountains near the northeastern boundary of Pinal County, Arizona. The camp is six miles from the Kelvin postoffice. The elevations of the property range from 2200 feet to 3800 feet above sea level.

TOPOGRAPHY:

The area covered by the property is one of strong relief, divided nearly through the middle by a north-south, steep-sided, narrow canyon. The topographic features are determined chiefly by faulting and the resistance to erosion offered by the sedimentary rocks which cap the highest points.

GEOLOGY:

The principal rock masses within the limits of the property are the Cambrian sedimentaries belonging to the Apache group as described by Frederick Leslie Ransome, of the U. S. Geological Survey in his extensive studies of the Globe and Ray quadrangles. The lowest member of the group found on this property is the Mescal limestone above which is the Troy quartzite. In a few exposures a typical gray dolomitic limestone is seen which carries about fourteen percent magnesium. The greater part of the Mescal limestone, however, is typically shaly and cherty. The flow of vesicular basalt, noted by Ransome in other parts of the quadrangles mentioned and considered co-extensive with the Mescal limestone is absent in the area under discussion.

In addition to the sedimentary rocks mentioned there are extensive intrusions of diabase, occurring principally as irregular masses though occasionally as narrow dikes. The diabase frequently envelops large blocks of Mescal limestone. Only the upper contact of the diabase has been exposed on this property.

Dikes of dacite from eight to twelve thick and narrow dikes of differentiated diabase magma occur also but neither are considered of any importance in a study of the ore deposits.

Along the northern limits of the property are extensive areas of recent conglomerate which is of little importance in connection with the present investigations.

The diabase weathers to gentle slopes and hollows or rounded ridges producing a characteristic olive-green soil. The Mescal limestone, which is conspicuously cherty and frequently shaly, tends to weather unevenly, the cherty or shaly layers standing out roughly in parallel ribs, conforming in general to the dip and strike of the beds. The overlying quartzites show characteristic small, step-like faces in the cliffs which rise abruptly along the east side of the canyon.

MINERALOGY:

The only vanadium minerals recognized beyond doubt are vanadinite and descloizite. In addition to these minerals there occurs in all the quartz veins and sparingly in the silicified limestones near the veins, more especially the enveloped block of Mescal limestone, a dull, black mineral carrying 1.82% V_2O_5 7.8% Fe_2O_3 1.44% MoO_3 and 1.64% PbO besides other undetermined constituents. In thin sections it appears as small aggregates of minute rounded grains or slender fan-like forms. They are opaque but have very sharp outlines. It is always associated with descloizite but there is insufficient evidence to determine what the relation is.

Microscopic investigation of sections made from representative types of limestones, quartzites and diabases disclose no vanadium minerals at all.

The vanadinite and descloizite occur in typical forms. The characteristic prismatic, smooth-faced crystals of vanadinite predominate though curious combinations of partly hollow crystals are not uncommon. Frequently large vugs lined with vanadinite crystals which in turn are encrusted with drusy or small regular rombohedrons of calcite. In some instance there is an intricate intergrowth of calcite and vanadinite, evidence of contemporaneous origin. The vanadinite occurs almost equally as a cementing material in brecciated limestone or as a coating on the sides of open fissures or seams.

The descloizite is always found in small, almost microscopic crystals. The faces are usually smooth and the edges sharp. The descloizite is evidently of later origin than the vanadinite for it occurs as a crust of minute crystals on the faces of well formed vanadinite crystals. It is a noticeable fact that the descloizite shows a preference for the more silicified limestone areas and the quartz veins though always occurring in cracks or seams.

It is generally conceded that both vanadinite and descloizite are secondary minerals. Their mode of occurence in this deposit offers nothing in contradiction of this theory. In fact certain physical conditions surrounding the occurence of vanadinite are almost conclusive evidence of secondary origin.

The quartz filling of the Grey Horse vein appears to be in part a replacement of limestone by silicification. This is also true of the less extensively explored Esperanza vein. In the more compact, high siliceous portions of the vein such as is exposed in level 2826 and in a corresponding section directly below on level 2810, descloizite is the predominant mineral. It is in this section that the black unidentified mineral mentioned before is found. This should not be confounded with the prominent black spots, averaging one-eighth inch in diameter which so conspicuously mark the quartz. These spots are composed of iron oxide and some manganese. In the quartz are also small bright yellow crystals of wulfenite, always associated with well formed quartz crystals which line small cavities in the vein.

To the west of the area above mentioned descloizite is less prominent. The limestone becomes more crushed and shattered as the surface is approached and appears to have been subjected to considerable leaching. In this zone of more extensive crushing the vanadinite predominates. The area of greatest deposition appears to be approximately fifty feet east and west from the entrance to level 2810 and is limited by about fifteen feet on either side of this line. It extends downward to a point about three feet below the 2743 level. Below this point there is a rapid decrease in the vanadium content.

ORE DEPOSITS:

Sampling of the parts of the property at some distance from the camp indicate values in the quartzites and diabase that are of little commercial importance under present conditions. In like manner the Troy quartzite has been eliminated. By this process of elimination the areas or zones of commercial possibilities were reduced to (1) the quartz vein developed in the Grey Horse claim, (2) the particular strata of Mescal limestone, limited above by Troy quartzite and below by the intrusive diabase, (3) an indeterminate zone of diabase, approximately thirty feet in thickness, measured downward from the contact with the overlying Mescal limestone. To the foregoing might be added certain portions of the silicified block of Mescal limestone on the Grey Horse and Sunny South claims, which is apparently completely enveloped by intrusive diabase.

Sampling of the quartz vein at intervals of five feet in the Grey Horse workings and on the less extensively developed Esperanza claim indicate an average of 1.44% V_2O_5 over an average width of 3.1 feet.

The particular strata of cherty to shaly Mescal limestone lying on top of the diabase averages 1.14% V_2O_5 along the irregular outcrop between two points approximately 1400 feet apart horizontally. Over this distance the limestone averages eight feet in thickness. In places it carries relatively high percentages of V_2O_5 as for example sample 532 which carried 4.50% V_2O_5. This is a sample across four feet of shaly limestone resting on the diabase and exposed in the cliff about a thousand feet north of the mill.

For a horizontal distance of nearly 1800 feet along the cliff and immediately below the limestone mentioned above the diabase averages 0.94% V_2O_5. In the lower tunnel of the Grey Horse workings, east from the fault separating diabase from the conglomerate, the diabase was sampled in the roof and on the sides for a distance of 114 feet at intervals of five feet. The average vanadium content was 1.10% V_2O_5. Fresh diabase from the interior of large boulders detached near the limestone contact in the vicinity of sample 532 assayed 1.29% V_2O_5.

Samples from the large block of included, silicified limestone, taken on the roof and sides of the workings wherever accessible show an average of 0.98% V_2O_5. None of the samples included in this estimate came from the areas of crushed limestone in which vanadinite and descloizite are so prominent. In the crushed and more open parts of this same block, where the vanadinite and descloizite occur so abundantly the average is 1.33% V_2O_5. This embraces a block roughly 115 feet from east to west which is not to exceed 40 feet in width (from north to south) and of sixty feet mean height. It is the ground originally opened up as the "vanadium mine". A concentration test on this ore showed that it would yield concentrates in the ratio of about 35 to 1 containing 2.96% V_2O_5. On selected ore, chosen for the considerable amount of vanadinite present, concentrates were made in the mill that ran slightly over 12% V_2O_5. However, such results were possible only with selected ore and were accompanied by high tailings loss, as much as 0.71% V_2O_5being left in the tailings.

No estimate is made of the actual tonnage of ore in sight. The surfaces sampled are described above and two dimensions given. They are also shown on the accompanying geological maps. It is assumed that the principal sources of vanadium ore will be in the shaly and cherty limestone immediately overlying the diabase and some twenty to thirty feet of diabase underneath, a nearly flat deposit, dipping slightly southwest, having a total combined thickness of about thirty-five feet. Eastward from the outcrop sampled the limestone will probably maintain its average thickness as indicated. It may increase in thickness for in the next deep canyon to the east these particular strata are thicker. The diabase is also quite uniform in thickness so far as is known. Tonnage, then, is a matter of determining the limits eastward to which these two formations carry commercial quantities of vanadium. This could not be determined with the means at hand.

<u>DEVELOPMENT:</u>

The principal development work on the property is on the Grey Horse claim. It consists of approximately one thousand feet of tunnels, drifts and crosscuts and two hundred sixty feet of shafts, winzes and raises. The greater part of this work has been on the Grey Horse vein, a quartz vein filling a fissure which has a general east-west strike and dips to the south from 70 to 80 degrees. So far as opened up this vein follows the contact between the diabase and an enveloped block of silicified Mescal limestone for the greater part of its course. For a short distance the fissure is bounded on both north and south by the limestone. As depth is gained the quartz filling is being replaced in part by a thoroughly leached porphyry which has been well mineralized at one time.

ORE GENESIS:

Regarding the source of the vanadium in the various types of deposits on the property little has been determined. It seems beyond question that the vanadinite and descloizite are of secondary origin. If the dull, black, unidentified vanadium bearing mineral in the quartz vein is a primary mineral perhaps all the descloizite with which it seems to be closely associated is the result of the breaking down of this mineral.

There seem to be two possible theories for the origin of the vanadium. The first of these assures that the vanadium is one of the original primary constituents of the diabase. F. W. Clarke in "The Data of Geochemistry" 3d ed.:U.S.Geological Survey Bulletin 616 p 27 states that the igneous rocks of the United States carry an average of 0.17% vanadium. However, in Chemical Analyses of Igneous Rocks, 1889-1913, U.S.Geological Survey Professional Paper No. 99 in the division of superior analyses of fresh rocks only one diabase is given as carrying vanadium. It should be noted that this diabase, which is probably of the same age, occurs on Black Peak some three or four miles north of Globe or about thirty miles north east of this property. Among the superior analyses of altered rocks in the same publication but two diabases out of a total of 192 studied show vanadium. Among the inferior analyses embracing 183 specimens none showed vanadium. Another interesting fact brought out in the publication referred to is that certain gabbros rich in magnetite and magnetic iron ores show high percentages of vanadium. Examples may be found on pages 731-733 and 743. The relation between the vanadium and the magnetite which occurs as an accessory mineral in the diabase in this area, is not quite clear. Tests conducted so far are inconclusive and a decision is withheld until further experiments can be carried out.

If the assumption that the vanadium has its origin in the diabase the vanadium in the overlying Mescal limestone and in the enveloped, silicified block of limestone might easily have been derived from the gases given off by the diabase in cooling or by heated solutions from the same source. The secondary minerals could have been deposited by cold solutions which had leached vanadium from the surrounding diabase.

The second theory regarding the origin of the vanadium assumes it to be a component of the sedimentary rocks. There is no evidence in support of this theory however, in the information gathered during these studies. An analysis indicates the presence or absence of vanadium but affords no evidence as to its origin. Microscopic investigations reveal nothing resembling any known vanadium bearing mineral in the sedimentary rocks.

TREATMENT OF THE ORES:

Research carried on in conjunction with the other studies on which this report is based has led to some very important conclusions regarding the treatment of this ore.

The average tenor of the largest deposits of vanadium bearing rock is such that in order to be worked for profit the deposit must be mined, milled and treated cheaply and efficiently. In general, milling operations on low grade ores do not yield high percentages of recovery. The indications are that in this case a very high recovery will be made.

The question of mining the deposit is not a serious one. It is so situated that attack can be made through adits. The location will permit of delivery by gravity to the treatment plant. The physical characteristics of the deposit are such that the ore can be cheaply mined in large quantities by some well known stoping method.

As was anticipated, early investigations proved conclusively the inadvisability of considering any form of mechanical concentration by either wet or dry methods. Even if a satisfactory method of concentration could be devised the amount of ore ammenable to concentration is not large enough to justify the construction of any considerable sized plant.

Early experiments settled definitely the question of the preliminary medhanical treatment of the ore. The nature of the contained vanadium makes fine grinding absolutely essential. All ore must be crushed to -150 mesh. The crushing plant will be of simple, standard design, crushing wet after the initial breaking from run of mine size. The plant will require only the simplest, most efficient crushing and grinding equipment without accessories other than the few necessary screens and sampling devices.

Details of the chemical process for the extraction of the vanadium are not sufficiently complete as yet to justify any but general statements. The matter of a process will be made the subject of a complete report at a later date. Sufficient progress has been made with the investigations to permit the principal steps in the process to be outlined. They are (1) the solution of the ore as a whole, excepting of course the "insoluble" (2) the extraction of all the valuable contents (3) separation of the parts extracted, (4) conversion of each to its most desirable marketable form. The basic principles of the process have been determined but as yet the mechanical details have not been worked out. Sufficient data has been collected to indicate the lines to be followed in designing a commercially successful plant for the extraction of a high percentage of the total vanadium content.

CONCLUSIONS:

The result of sampling indicates a nearly horizontal deposit of vanadium bearing rock averaging between 1.0% and 1.5% V_2O_5 outcropping for a minimum length of 1400 feet with an average thickness of thirty feet. Other bodies of rock carrying vanadium pentoxide in excess of one percent are present though their extent has not been definitely determined. There is evidently a sufficient tonnage of material in sight carrying 1% or more of V_2O_5 to make the deposits of commercial importance when a successful process has been perfected for the recovery of the vanadium.

Experimental work now in progress has already demonstrated the possibility of recovering a very high percentage of the total vanadium in material containing less than 1% V_2O_5. In addition other valuable substances will be recovered as by-products. Mechanical details and final estimates of production costs are yet to be determined. However, it is anticipated that a successful commercial method of treatment for these deposits can be perfected.

Respectfully submitted,

(Signed) Arthur L. Flagg

Camp Vanadium,
Kelvin, Arizona.
August 9th, 1919.

ASSAYS.

No Sample	% V_2O_5	Location
510	0.71	Oversize, mill tailings dump; 500 tons,
511	0.35	North half face lower tunnel, 5/18. 20 in vein matter,
512	0.32	South half face lower tunnel, 5/18/19 black limestone,
513	0.00	Red limestone, NW corner of winze, upper level. Sect.261,
514	0.00	Black limestone in east end of "stope" upper level,
515	0.25	Pink limestone above No. 514, Sect. 262,
516	0.60	Hard, dense, siliceous material, upper dump, Sect. 263,
517	0.67	Face south drift, upper tunnel, Sect. 264,
518	0.18	Face north drift, upper tunnel, pink limestone, Sect. 266,
519	1.33	Face Crosscut N25, lower tunnel, 5/31,
520	0.77	Face lower tunnel, 5/31,
521	0.72	Face lower tunnel, one foot vein matter, 6/5/19,
522	0.65	Face lower tunnel, red clay gouge on footwall, 6/6/19,
523	0.32	Whole face lower tunnel, all black limestone, 6/6/19,
524	0.16	Face north crosscut (N25) lower tunnel, 6/6/19,
525	0.07	Gen. Sample by Hare slide rock between Camp Spring and YoungSpring
526	0.63	Sample of 400 pounds oversize for tests,
527	1.08	Face lower tunnel; 30 inches quartz next footwall, 6/9/19,
528	1.00	Face lower tunnel, black limestone (not including 527) 6/9/19,
529	0.67	Face crosscut N25, pink and black limestone 6/9/19,
530	1.26	Diabase at contact, NE camp (see map)
531	1.26	Diabase 30 ft below contact NE camp, (See map)
532	4.50	Silicified limestone, loc. 530, NE camp (see map)
533	2.88	Metamorphosed quartzite above #532, NE camp (see map)
534	2.70	Limestone at contact, NE camp (see map)
535	0.76	Face north drift, end of upper tunnel,
536	0.44	Sta. 53 plus 5 feet east, roof and sides,
537	0.61	Sta. 53 plus 10 feet east, roof and sides,
538	0.65	Sta. 53 plus 15 feet east, roof and sides,
539	0.61	Sta. 53 plus 20 feet east, roof and sides,
540	0.43	In upper tunnel at junction of two end drifts; across the V,
541	0.04	Gouge on contact diabase-limestone, Stas. 53-54,
542A	3.42	North wall of drift; Sta. 53 less 5 feet west,
542B	1.80	Loc. 542A roof only,
543	3.24	East side of raise 52B across roof only,
544	3.96	West side of raise 52B across roof only,
545	2.16	Muck pile under raise 52B,
546	0.72	5 feet west of sample 544,
547	2.16	10 feet west of sample 544,
548	2.34	15 feet west of sample 544,
549	0.64	20 feet west of sample 544,
550	0.56	25 feet west of sample 544,soft white material north half of roof,
551	0.80	25 feet west of sample 544,south half of roof,2 ft hard material,
552	1.04	30 feet west of sample 544, mostly crushed and leached material,
553	2.00	East end raise 52A; 6 to 7 feet west of sample 552, roof only,
554	0.68	West end of "Descloizite Drift" an intermediate level,4 ft roof,
555	0.80	Samp. 554 plus 5 ft east; four feet hard material,
556	0.48	North wall, roof to floor, loc. 555,
557	0.72	Hard, silicified limestone 5 feet east loc. 555,
558	0.40	North wall, loc. 557,
559	0.72	Roof only, 5 feet east Samp. 557,
560	0.80	North wall, loc. 559,30 in dust colored limestone
561	0.48	North wall, loc. 559;18 in limestone and 3 in talc under Samp. 560
562	0.40	Loc.560 plus 5 feet east; two feet of vein,
563	0.80	Five feet east Samp. 562;2 feet vein in roof,
564	3.12	Five feet east Samp. 563;2 feet vein in roof,
565	2.88	Six feet east Samp. 564;2 feet vein in roof; softer and more open,
566	0.96	Muck pile along bottom "Descloizite Drift"; about 15 tons,

567	0.72	Loc.565 plus five feet east; 18 inches vein,
568	1.26	Face lower tunnel,6/13/19 30 in hard black limestone on foot-wall,
569	1.20	Quartz streak, 6 in.wide on wall at Sta. 52,
570	0.72	Quartz streak 20 in. wide, roof of hole 5 ft. west Sta. 52,
571	0.65	Loc. 570 limestone on north wall,
572	0.72	Across roof ten feet west Sta. 52; 30 in quartz,
573	1.13	Across roof 15 feet west of Sta. 52; 46 in quartz,
574	0.88	Across roof 20 feet west of Sta. 52; 56 in quartz,
575	0.72	Opposite loc. 574; black limestone in roof of hole,
576	0.72	Roof, 25 feet west Sta. 52 across 42 in quartz,
577	1.12	Roof, 30 feet west of Sta 52 across 48 in quartz,
578	1.36	Roof, 35 feet west of Sta 52, across 42 in quartz,
579	1.12	South wall loc. 578,
580	0.96	Across 30 in roof, 5 feet west samp. 578,
581	1.04	Across 30 in roof, 10 feet west samp. 578,
582	1.20	Hole on south side drift; 5 ft.east Samp.581.Limestone all around,
583	0.48	Two feet west Sta. 52; across 5 ft.north from drift,side of stope,
584	0.92	Samp across E and N sides "stope" 10 feet above floor,
585	0.85	Lower tunnel, Sta. 1 roof and sides,
586	0.84	Lower Tunnel, Sta. 1 plus 5 ft roof and sides,
587	0.76	Lower tunnel, Sta. 1 plus 10 ft roof and sides,
588	0.60	Lower tunnel, Sta. 1 plus 15 ft roof and sides,
589	0.76	Lower tunnel, Sta. 1 plus 20 ft roof and sides,
590	0.40	Lower tunnel, Sta. 1 plus 25 ft roof and sides,
591	0.80	Lower tunnel, Sta. 1 plus 30 ft roof and sides,
592	1.04	Lower tunnel, Sta. 1 plus 35 ft roof and sides,
593	1.04	Lower tunnel, Sta. 1 plus 40 ft roof and sides,
594	0.48	Lower tunnel, Sta. 1 plus 45 ft roof and sides,
595	0.40	Lower tunnel, Sta. 1 plus 50 ft roof and sides,
596	0.60	Lower tunnel,Sta. 1 plus 55 ft roof and sides,
597	1.48	Lower tunnel, Sta. 1 plus 60 ft roof and sides,
598	1.20	Lower tunnel, Sta. 1 plus 65 ft roof and sides,
599	1.52	Lower tunnel, Sta. 1 plus 70 ft roof and sides,
600	1.04	Lower tunnel, Sta. 1 plus 75 ft roof and sides,
601	0.96	Lower tunnel, across slip at Sta. 2 plus 2 ft east; 3.5 ft wide,
602	0.80	Lower tunnel, Sta. 2 plus 22 ft east; roof and south side,
603	1.28	Lower tunnel, Sta. 2 plus 30 ft roof and sides,
604	1.04	Lower tunnel, Sta. 2 plus 35 ft roof and sides,
605	1.44	Lower tunnel, Sta. 2 plus 40 ft roof and sides,
606	1.36	Lower tunnel, Sta. 2 plus 45 ft roof and sides,
607	1.04	Lower tunnel, Sta. 2 plus 50 ft roof and sides,
608	1.04	Lower tunnel, Sta. 2 plus 55 ft roof and sides,
609	1.04	Lower tunnel, Sta. 2 plus 60 ft roof and sides,
610	0.48	Lower tunnel, Sta. 2 plus 65 ft roof and sides,
611	1.36	Lower tunnel, Sta. 2 plus 70 ft roof and sides,
612	1.60	Lower tunnel, Sta. 2 plus 75 ft roof and sides,
613	0.48	Lower tunnel, Sta. 2 plus 80 ft roof and sides,
614	0.60	Lower tunnel, Sta. 2 plus 85 ft roof and sides,
615	1.04	Lower tunnel, Sta. 2 plus 90 ft roof and sides,
616	0.84	Lower tunnel, Sta. 2 plus 95 ft roof and sides,
617	1.84	Lower tunnel, Sta. 2 plus 100 ft roof and sides,
618	1.84	Lower tunnel,Sta. 2 plus 105 ft roof and sides,
619	1.84	Lower tunnel,Sta. 2 plus 110 ft north side of drift only,
620	0.88	Lower tunnel, Sta. 3 roof and sides,
621	0.88	Lower tunnel, west side of through raise; 3 ft ov vein matter,
622	1.12	Lower tunnel, all around west side of through raise,
623	0.64	Lower tunnel, all around south side of through raise,
624	0.48	Lower tunnel, all around east side of through raise,
625	0.80	Lower tunnel, Sta. 4 roof 3.5 quartz vein,
626	0.80	Lower tunnel, Loc. 265 north wall only,
627	0.88	Lower tunnel, Sta. 4 plus 5 ft. east, roof, south wall, 1 ft on north wall.
628	0.88	Lower tunnel,Sta.4 plus 10 ft east;roof,south wall & 1 ft north wall
629	0.88	Lower tunnel,Sta.4 plus 15 ft east;roof,south wall & 1 ft north wall
630	0.32	Lower tunnel,Sta.4 plus 15 ft east; north wall only,
631	0.40	Lower tunnel,Sta.4 plus 20 ft south wall and roof,

632	0.40	Lower tunnel, Sta. 4 plus 25 ft;south wall and roof,
633	0.64	Lower tunnel, Sta. 4 plus 30 ft;south wall and roof,
634	0.40	Lower tunnel, Sta. 4 plus 35 ft;south wall and roof,
635	0.52	Lower tunnel, Sta. 5 plus 10 ft;south wall and roof,
636	0.48	Lower tunnel, Sta. 5 plus 15 ft;south wall and roof,
637	0.48	Lower tunnel,Sta. 5 plus 20 ft;south wall and roof,
638	0.92	Lower tunnel Sta. 5 plus 25 ft;roof only, five ft wide,
639	0.88	Lower tunnel Sta. 5 plus 30 ft;roof only, 4 ft wide,
640	1.12	Lower tunnel Sta. 5 plus 35 ft;roof only, 4 ft wide,
641	1.04	Lower tunnel Sta. 5 plus 40 ft;roof only, 4 ft wide,
642	0.88	Lower tunnel Sta. 5 plus 40 ft;south side of drift,
643	0.69	Lower tunnel Sta. 5 plus 40 ft;north side of drift,
644	0.88	Lower tunnel Sta. 5 plus 45 ft;roof and south side of drift,
645	0.68	Diabase-Limestone contact in cliff; 4-ft bedded quartzite,
646	1.12	Diabase-sedimentary contact; 2 ft. quartzite above No. 645,
647	0.40	Diabase-sed.Contact; included limestone in diabase,3-ft below No.645
648	1.28	Diabase-sed.cont;10-ft shaly limestone,
649	0.84	Diabase-sed.cont;25-ft limestone above No. 648,
650	0.48	Diabase-sed.cont;black-white quartzite above No. 649,
651	0.40	Dump loc.Jumbo No. 1 shaft,
652	0.91	Dacite dike on trail near No. 651,
653	0.91	Quartz streak 10 in; crosscut 5 N lower tunnel,
654	0.77	Quartz,Gravel,Queen creek,
655	0.24	Face lower tunnel 6/30/19; 40 in vein,-quartz,porphyry and talc,
656	0.24	Loc. 656 10 in quartz and diabase on foot-wall,
657	0.88	Lower tunnel, XC 25; Sta. 25 cap to floor on eastwall,crushed limestone,
658	0.77	Lower tunnel,XC 25;Sta.25 plus 5 ft,east wall,black limestone,
659	0.20	Lower tunnel;XC 25;Sta.25 plus 10 ft,limestone on east wall,
660	0.42	Lower tunnel; XC 25;Sta.25 plus 10 ft,roof,limestone west to fault,
661	0.18	Lower tunnel;XC 25;Sta.25 plus 15 ft,east wall,hard blk limestone,
662	0.61	Lower tunnel;XC 25;Sta.26 east wall and 2 ft of roof to fault,
663	0.69	Lower tunnel,XC 25;Sta. 26 plus 5 ft,east wall and 3 ft. roof,
664	0.53	Lower tunnel,XC 25; Sta.26 Plus 10 ft, east wall and 4 ft roof,
665	0.32	Lower tunnel, XC 25 Face, 7/1/19
666	0.71	Lower tunnel, XC 25 opposite 663, diabase,
667	0.56	Lower tunnel, XC 25 opposite 659, diabase,
668	0.80	Lower tunnel, XC 5 S, face 7/1/19,
669	0.32	Lower tunnel, face 7/1/19 3 ft porphyry,
670	0.36	Lower tunnel, face 7/1/19 2 ft mixed altered limestone and diabase
671	1.33	Intermediate drift, broken ore under Stas. 32 and 33,
672	0.45	Quartzite, above loc Pacific claim on hill-top,
673	0.40	Jumbo Loc. tunnel; across 8 ft. silicified limestone,
674	0.69	Diabase in wash opp loc. 673,
675	1.98	Quartzite boulder,
676	0.45	Sedimentary from creek bed,
677	0.53	Quartzite E side wash by NW Cor. North Star claim,
678	0.64	Diabase near SW cor North Star claim,
679	0.61	Diabase dike at Camp Spring,
680	0.58	Quartzite breccia west of Samp. 679,
681	0.41	Massive quartzite east of diabase Samp. 679,
682	0.90	Limestone in cliff, 4 ft. thick,
683	0.88	Limestone in cliff, 2 ft thick, NW of Sample 682 about 15 ft,
684	0.61	Cherty limestone, 3 ft thick, about 125 ft NW sample 683,
685	0.88	Cherty limestone, 10 ft thick, underneath 684, less siliceous,
686	0.72	Cherty limestone, in cliff, north of 685,
687	0.42	Quartzite with specularite,
688	0.96	Float from cliff,
689	0.48	Light grey limestone from cliff, 5 ft.
690	0.96	Limestone above 689, from 12 to 15 ft thick,
691	1.09	Limestone 8 ft thick, north of 690,
692	1.52	Limestone, 3 to 4 ft thick,
693	1.14	Lower tunnel, Sta. 10 plus 4 ft west roof and south side,
694	0.93	Lower tunnel, Sta. 10 plus 4 ft west, north side,
695	1.25	Lower tunnel, Sta. 10 roof and south side,
696	0.81	Lower tunnel, Sta. 10 north side,
697	1.98	Lower tunnel, Sta. 10 plus 5 ft; roof only, 4.5 ft wide,

698	0.91	Lower tunnel, Sta. 10 plus 5 ft; south wall,
699	0.65	Lower tunnel, Sta. 10 plus 5 ft; north wall,
700	0.48	Lower tunnel, Sta. 10 plus 10 ft. roof only, 5 ft. wide,
701	0.93	Lower tunnel, Sta. 10 plus 10 ft; south wall,
702	0.35	Lower tunnel, Sta. 10 plus 10 ft; north wall,
703	0.81	Lower tunnel, Sta. 10 plus 15 ft; roof only,
704	0.61	Lower tunnel, Sta. 10 plus 15 ft; south side,
705	0.39	Lower tunnel, Sta. 10 plus 15 ft; north side,
706	1.01	Lower tunnel, Sta. 11 roof and north side,
707	0.99	Sta. 10 plus 10 feet east, roof and north side,
708	0.84	Quartzite, south side of open-cut and winze (Esperanza) 28" quartz
709	1.06	Diabase north side of open-cut (Esperanza) Loc. 707,
710	2.96	Concentrates from panning 2 lbs samp. 671,
711	1.82	Float material obtained in panning samp. 671,
712	0.63	Tailings from panning samp. 671,
713	0.58	Duplicate sample 513, Slide 261,
714	o.43	Float F 24,
715	0.32	Duplicate 514 Slide 262,
716	0.44	Face crosscut 5N limestone in top,
717	0.45	Float 23 F,
718	0.28	Face crosscut 5N, diabase in bottom,
719	0.44	Station 5A plus 5 ft north; roof only,
720	0.55	Float 32 F,
721	0.30	Float F 24 B,
722	0.28	Sta. 5A plus 10 ft north, roof only,
723	0.38	Sta. 28 top and sides, crushed limestone,
724	0.28	Sta. 27 plus 10 ft east; top and sides,
725	0.30	Loc. 724 plus 10 ft east; top and sides,
726	0.55	Float F 22 B,
727	0.50	Sta. 11 plus 5 ft east; roof, 4 ft wide,
728	0.25	Sta. 11 plus 10 ft east; roof, 4 ft wide,
729	0.33	Sta. 11 plus 15 ft east; roof, 4 ft wide,
730	0.40	Sta. 11 plus 20 ft east; roof, 4 ft wide,
731	0.35	Sta. 31 plus 5 feet roof only,
732	0.25	Sta. 31 plus 10 ft; roof only,
733	0.35	Sta. 31 plus 20 ft; roof only,
734	0.33	Sta. 31 plus 25 ft; roof only,
735	0.35	Sta. 31 plus 25 ft; roof only,
736	0.35	Face Sta. 31 plus 26 feet,
737	0.32	Face of short drift north from intermediate level,west of shaft,
738	0.39	Face of short drift south from intermediate level,west of shaft,
739	0.71	Sta. 33 in roof, 40 inches wide,
740	0.27	Sta. 33 plus 5 ft, west; roof, three feet,
741	0.22	Sta. 33 plus 10 ft west; roof 26 inches wide,
742	0.17	Sta. 33 plus 15 ft west; roof 24 inches wide,
743	0.23	Face, west of Sta. 33,
744	0.40	Dump, New Orleans shaft,
745	0.23	300-ft S45E from Loc. Mt North Pork No. 8; Red quartzite,
746	0.23	Quartzite included in diabase, 300 ft. north loc. 745,
747	0.25	Roof, east face lower drift off first winze from lower tunnel,
748	0.34	Diabase under Loc. 747,
749	0.27	Green-gray, shaly limestone in cliff,
750	0.27	Cherty limestone, loc. 749,
751	0.35	Quartzite at contact with diabase dike; just under conglomarate,
752	0.21	Six inch streak of iron in centre of diabase dike;near loc. 751,
753	0.30	Cherty limestone in cliff,
754	0.40	Silicified limestone in cliff,
755	0.30	Limestone in cliff,
756	0.16	Dolomitic limestone,
757	0.08	Silica "ladrillo"
758	0.44	Contact phase quartzite at dacite dike, Young's spring,
759	0.10	Sta. 11 plus 25 ft roof only, 4 ft wide,
760	0.20	Sta. 11 plus 30 ft; roof, 4 ft wide,
761	0.36	Sta. 12 plus 5 ft; roof, 4 ft wide,
762	0.47	Float F 23 C,
763	0.30	Dup. 757,
764	0.51	Float F 22 C,
765	0.36	Float F 24 C.

ANALYSES.

	530	531	532	533	534	674	678	710	711
H_2O			0.23		0.13	0.70	0.22	0.19	
$Si\ O_2$	53.50	54.00	12.00	12.99	60.00	59.35	63.42	32.80	
Fe_2O_3	12.37	7.80	2.00	60.49	1.60	12.90	14.80		7.08
Fe C								14.81	
Cs O (Probably Ca /TAP)	10.00	10.10	35.00		11.60	4.99	4.59	.61	
Mg O	1.54	.03	1.16		.51	5.27	4.93		
Al_2O_3	16.11	16.76	7.50		8.90	13.39	9.15		
$C\ O_2$	1.42	5.62	34.70		3.14	2.06	.06	.92	
$S\ O_3$	.23	.08	.37		.05	1.04	2.66		
$Mn\ O_2$	.39	.19				.07	.09		
V_2O_5	1.26	1.26	4.50	2.88	2.70	.69	.64	2.96	1.82
$Mo\ O_3$	1.60	3.40	1.60	6.60	2.90	.17	.02	2.04	1.44
Cl	.61	.71	.93		.59			.80	
Pb O								1.64	
Pb								37.56	
As_2O_3								.32	
S								3.28	
P_2O_5								.02	
Zn								2.88	
K_2O						Tr			
Sr_2O						Tr			

METALLURGICAL TREATMENT OF VANADINITE CONCENTRATES FOR THE RECOVERY OF LEAD AND VANADIUM

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The process to be described is a method adapted and recommended for the treatment of lead-vanadium ores carrying high percentages of lead and vanadium with low percentage of silica or quartz. The vanadium content of the ore should be from 10 to 15 per cent V_2O_5; the lead content should be from 45 to 50 per cent; and the amount of silica should not be greater than 17 or 18 per cent of the total. Thus it is seen that a fairly high-grade concentrate must be used.

The method is also especially adapted to ores containing a small amount of molybdenum as wulfenite, an ore which usually occurs with vanadinite. Ordinarily, chemical reagents which precipitate vanadium from solution also precipitate molybdenum, due to their related chemical properties. So that unless special allowance is made for this, the final vanadium product will contain some molybdenum. By the method to be outlined, the vanadium obtained is practically free from molybdenum.

The actual details of the treatment are as follows:

1 ton Vanadinite concentrates of the grade previously specified are smelted either in a small lead blast furnace, or in a suitable reverberatory furnace, with about 800 pounds of caustic soda and 200 pounds of soda ash, together with sufficient coal or coke to reduce the lead

which is obtained as a metal. Any gold or silver values which may be present in the ore are carried out into the lead, and may be recovered when present in sufficient quantities.

The slag obtained from this smelting process contains the vanadium which is then extracted by either pouring into water while still molten or by allowing it to cool, and then pulverizing it. In either case, the slag is treated with boiling water and the residue filtered off. The resulting solution is always strongly alkaline, and contains from 90 to 95 per cent of the vanadium originally present in the concentrates used.

A thick emulsion of slaked lime is then added to the liquor obtained above and the mixture boiled with agitation. The lime precipitates all of the vanadium but leaves the molybdenum in solution. The vanadium is obtained as calcium vanadate, and after drying usually contains from 15 to 18 per cent V_2O_5. This product may be sold either in this form, or it may be improved at a small additional cost by leaching with sulfuric acid, filtering off the insoluble residue, and then precipitating the vanadium by boiling the acid solution. The product obtained is vanadium pentoxide containing from 85 to 90 per cent V_2O_5.

The actual cost of treatment of the concentrates for fluxes and other chemicals together with an estimate on the labor, etc., is given as follows:

Cost Per Ton of Concentrates

800 lbs. caustic soda @ \$4.30 per cwt.	\$34.40
200 lbs. soda ash @ \$2.90 per cwt.	5.80
900 lbs. 60° B. sulfuric acid @ \$16.00 per ton, ...	7.20
200 lbs. lime @ \$25.00 per ton, ...	2.50
100 lbs. coal, or coke, ...	.25
Labor, power, depreciation, etc.	15.00
Total estimated cost per ton, ...	\$65.15

The above figures are given on the basis of a 10-ton plant. The value of the products obtained, using a concentrate containing 12½ per cent V_2O_5 and 50 per cent of lead, and assuming 90 per cent recoveries, would be as follows:

900 lbs. lead @ \$5.00 per cwt.	\$45.00
225 lbs. vanadium pentoxide @ \$1.20 per lb.	270.00
Value of products per ton of concentrates, ...	\$315.00

No estimate as to the cost of producing a ton of vanadinite concentrates of the specified grade has been given, owing to the varying conditions encountered in their production. The grade and amount of raw ore available, location of mines, and water supply are all important factors which vary so greatly that a reasonable estimate to fit any condition could not be made. However, if the supply of raw ore is assured, the costs for concentration under the most adverse conditions, added to the costs of chemical treatment, should allow an attractive margin of profit.

J. E. Conley, U. S. Bureau of Mines,
Golden, Colorado, April 5, 1919.

Also known as
Esperanza Group (1918)
D. J. Sullivan Mine (1912)