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UNITED STATES
DEPARTMENT OF THE INTERIOR
J. A. KRUG, SECRETARY

BUREAU OF MINES
R. R. SAYERS, DIRECTOR

REPORT OF INVESTIGATIONS

EXPLORATION OF ALUNITE DEPOSITS
MARYSVALE, PIUTE COUNTY, UTAH



BY

JOHN H. HILD

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EXPLORATION OF ALUNITE DEPOSITS, MARYSVALE
PIUTE COUNTY, UTAH^{1/}

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INTRODUCTION

Alunite occurs within a radius of 10 miles of Marysville, Piute County, Utah, in veins and as replacements of igneous rocks. A number of each type of deposit was explored by the Bureau of Mines, in cooperation with the Geological Survey, under the Strategic Minerals program during 1942. The exploratory work comprised geologic and topographic mapping, diamond drilling, bulldozer and hand trenching, sinking test pits, rehabilitation of old workings, sampling alunite exposures, and constructing and repairing roads.

ACKNOWLEDGMENTS

In its program of exploration of mineral deposits, the Bureau of Mines has as its primary objective the more effective utilization of our mineral resources to the end that they make the greatest possible contribution to national security and economy. It is the policy of the Bureau to publish the facts developed by each exploratory project as soon as practicable after its conclusion. The Mining Branch, Lowell B. Moon, chief, conducts preliminary examinations, performs the actual exploratory work, and prepares the final report. The Metallurgical Branch, R. G. Knickerbocker, chief, analyzes samples and performs beneficiation tests. Both these branches are under the supervision of Dr. R. S. Dean, assistant director.

With particular reference to this publication, acknowledgment is given to Richard E. Mieritz and William E. Young, who assisted on the project at various times; P. T. Allsman, chief, Salt Lake Division, Mining Branch, who advised on exploratory problems and gave valuable assistance in preparing the report and illustrations; A. P. T. Schumann, for preparing the illustrations; and to Gordon L. Bell, Max Willard, and Eugene Callaghan, of the Geological Survey, who cooperated as representatives of that agency.

The Kalunite Corporation and the Piute County officials were particularly accommodating in furnishing equipment for road work and otherwise.

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- 1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is made: "Reprinted from Bureau of Mines Report of Investigations 3972."
2/ Mining engineer, Salt Lake City, Utah.

J. R. Thoenen^{3/} made a field reconnaissance and prepared a preliminary report on the alunite deposits, and J. Koster, R. G. Knickerbocker, A. L. Fox, and P. R. Perry prepared a report^{4/} that describes in detail a process for recovering potash and alumina from alunite ores.

The geology of the alunite deposits has been described by Callaghan.^{5/} Butler and Gale,^{6/} Laughlin,^{7/} and Butler.^{8/}

LOCATION AND ACCESSIBILITY

The alunite deposits are accessible from Marysvale, Piute County, Utah (fig. 1). This town is on U. S. Highway 89, approximately 200 miles south of Salt Lake City, Utah. Marysvale is the terminus of a branch of the Denver and Rio Grande Western Railroad, which carries a daily passenger and freight train. This town is also served by auto stages and truck lines.

The Mineral Products and related vein-type alunite deposits are approximately 10 miles by airline distance southwest of Marysvale. Automotive communication is over a rough and unimproved road with grades ranging from 4 to 26 percent. Daily travel to and from this deposit can be made only during 5 months of the year because of heavy snows at the high altitude.

The replacement-type alunite deposits practically surround Marysvale within a 6-mile radius. All deposits, with few exceptions, are reached by local unimproved roads from Marysvale. These exceptions are the deposits on Marysvale Peak and Manning Creek. The majority of the deposits lie to the northeast of Marysvale in the Antelope Range.

PHYSICAL FEATURES AND CLIMATE

The vein-type alunite outcrops on ridges and saddles of the Tushar Mountains. The altitude at the deposits ranges from 9,900 feet to 11,300 feet. Altitudes in excess of 12,000 feet are attained in the nearby vicinity. The topography of the area of these deposits is rough and of high relief.

Vegetation in the area is abundant, consisting chiefly of aspen, juniper, pine trees, underbrush, grass, and ferns.

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- ^{3/} Thoenen, J. R., Alunite Resources of the United States: Bureau of Mines Rept. of Investigations 3561, 1941, pp. 20-34.
- ^{4/} Koster, J., Knickerbocker, R. G., Fox, A. L., and Perry, P. R., Progress Report, Metallurgical Division: Bureau of Mines Rept. of Investigations 3438, 1939.
- ^{5/} Callaghan, Eugene, Preliminary Report on the Alunite Deposits of the Marysvale Region, Utah: Geol. Survey Bull. 886-D, 1938, pp. 91-134.
- ^{6/} Butler, B. S., and Gale, H. S., Alunite, a Newly Discovered Deposit Near Marysvale and Beaver, Utah: Geol. Survey Bull. 511, 1912, 64 pp.
- ^{7/} Laughlin, G. F., Recent Alunite Developments Near Marysvale and Beaver, Utah: Geol. Survey Bull. 620, 1915, pp. 237-270.
- ^{8/} Butler, B. S., Ore Deposits of Utah: Geol. Survey Prof. Paper 111, 1920, pp. 181-183.

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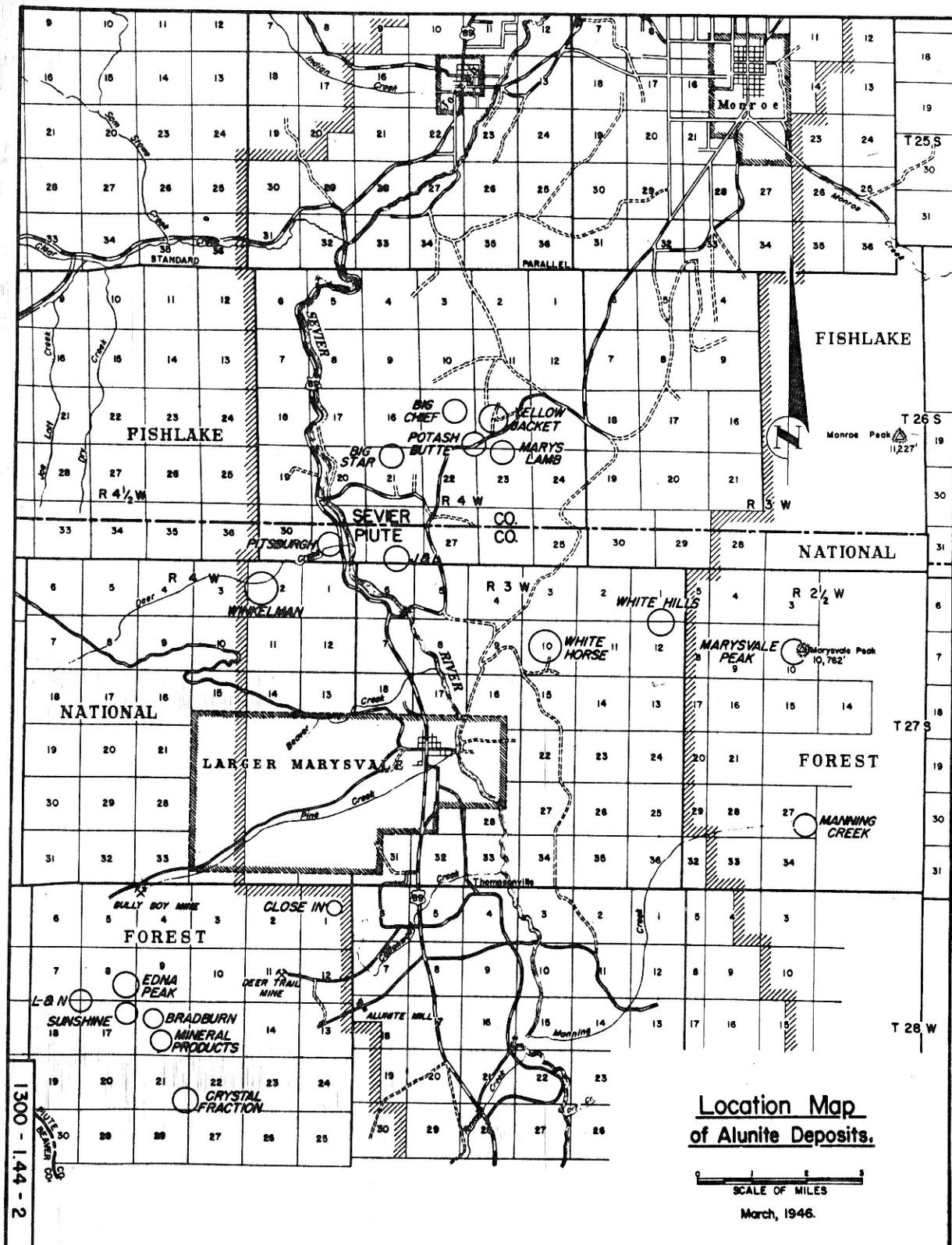


Fig. 1, Location Map of Alunite Claims, Sevier and Piute Counties, Utah.

Climatic conditions during the seven wintry months of the year are very severe, with high winds and heavy snowfall. For the other five months the climate is dry and warm.

The majority of the replacement alunite deposits lie in the Antelope Range northeast of Marysvale. The altitude of these deposits ranges from a high of 7,900 feet to a low of 6,400 feet. The topography is of moderate relief, and the surface is sparsely covered with vegetation.

The climatic conditions of this area are mild and semiarid during the spring, summer, and fall, with light snowfall in winter.

HISTORY

Alunite was discovered in the Marysvale district in 1910. Several of the vein and replacement deposits were worked during World War I for the extraction of potash. During World War II, mining activity was revived, and experimental processes were attempted for extracting alumina, potash, and sulfuric acid from alunite by Kalunite, Inc., in a plant built by the Defense Plant Corporation at Salt Lake City, Utah.

PRODUCTION

Production records previous to 1941 for all of the alunite mined in the Marysvale area are not available. However, it is estimated that 262,000 tons was produced from vein type deposits and 3,600 tons from replacement-type deposits.

During 1943, Kalunite, Inc., mined and shipped to its plant at Salt Lake City 12,000 tons of replacement-type ore.

PROPERTY AND OWNERSHIP

Table 1 gives the names of properties, number of claims, location, and ownership of properties which the Bureau of Mines explored.

DESCRIPTION OF THE DEPOSITS

The alunite deposits of the Marysvale area occur in the Tertiary Bullion Canyon volcanic sequence, which consists of latite flows, tuff, and breccia. Purplish-gray latite breccia is the most conspicuous, if not the most common, in the district.

The ore deposits fall into two types - the vein deposits and the replacement deposits. The vein deposits consist chiefly of pink, coarse-grained alunite with a minor amount of fine-grained alunite concentrated in tabular and lenticular shoots. The vein alunite is the high-potash variety, which is relatively pure alunite. The replacement deposits consist chiefly of very fine-grained alunite associated with a highly variable proportion of quartz.

TABLE 1. - Properties and ownership

| Names | No. of claims | | Area, acres | Subdivision | | | Owners | Address of owner | Deposit type |
|------------------|---------------|------------|----------------|------------------|-------|------|-----------------------------------------------------|--------------------------------------|--------------|
| | Patented | Unpatented | | Sec. | T. | R. | | | |
| Mineral Products | 12 | Several | 248.268 | 16 & 17 | 28 S. | 4 W. | Mineral Products Co. Division of Armour & Co. | Marysvale, Utah | Vein. |
| L & N..... | 10 | | 206.890 | 7 & 8 17 & 18 | 28 S. | 4 W. | Florence Mining & Milling Co. | 510 American Bldg., Savannah, Ga. | Vein. |
| Christmas..... | 1 | | 20.68 | 17 | 28 S. | 4 W. | H. Spencer Gibbs Vivian Bradafi | Marysvale, Utah Marysvale, Utah | Vein. |
| Sunshine..... | 2 | | 41.38 | 17 | 28 S. | 4 W. | Florence Mining & Milling Co. | 510 American Bldg., Savannah, Ga. | Vein. |
| Winkelman..... | 8 | 3 | 227.579 | 2 & 3 | 27 S. | 4 W. | Aluminum Potash Co. of America | David Eccles Bldg., Ogden, Utah | Replacement. |
| Yellow Jacket... | 26 | | 537.914 | 14 | 24 S. | 3 W. | A. S. & R. Co. Leased, Kalunite, Inc. | Murray, Utah Salt Lake City, Utah | Replacement. |
| White Horse..... | 8 | | 165.512 | 10 & 15 | 27 S. | 3 W. | Empico Alunite Co. Leased, Kalunite, Inc. | Marysvale, Utah | Replacement. |
| Close In..... | | 12 | 248.268 | 1 | 28 S. | 4 W. | Max Krotki | Marysvale, Utah | Replacement. |
| J & L..... | 10 | | 206.890 | 28 | 26 S. | 4 W. | Aluminum, Inc. | 1121 Schofield Cleveland, Ohio | Replacement. |
| White Hills..... | | 8 | 165.512 | 1 & 12 | 27 S. | 3 W. | Max Krotki | Marysvale, Utah | Replacement. |

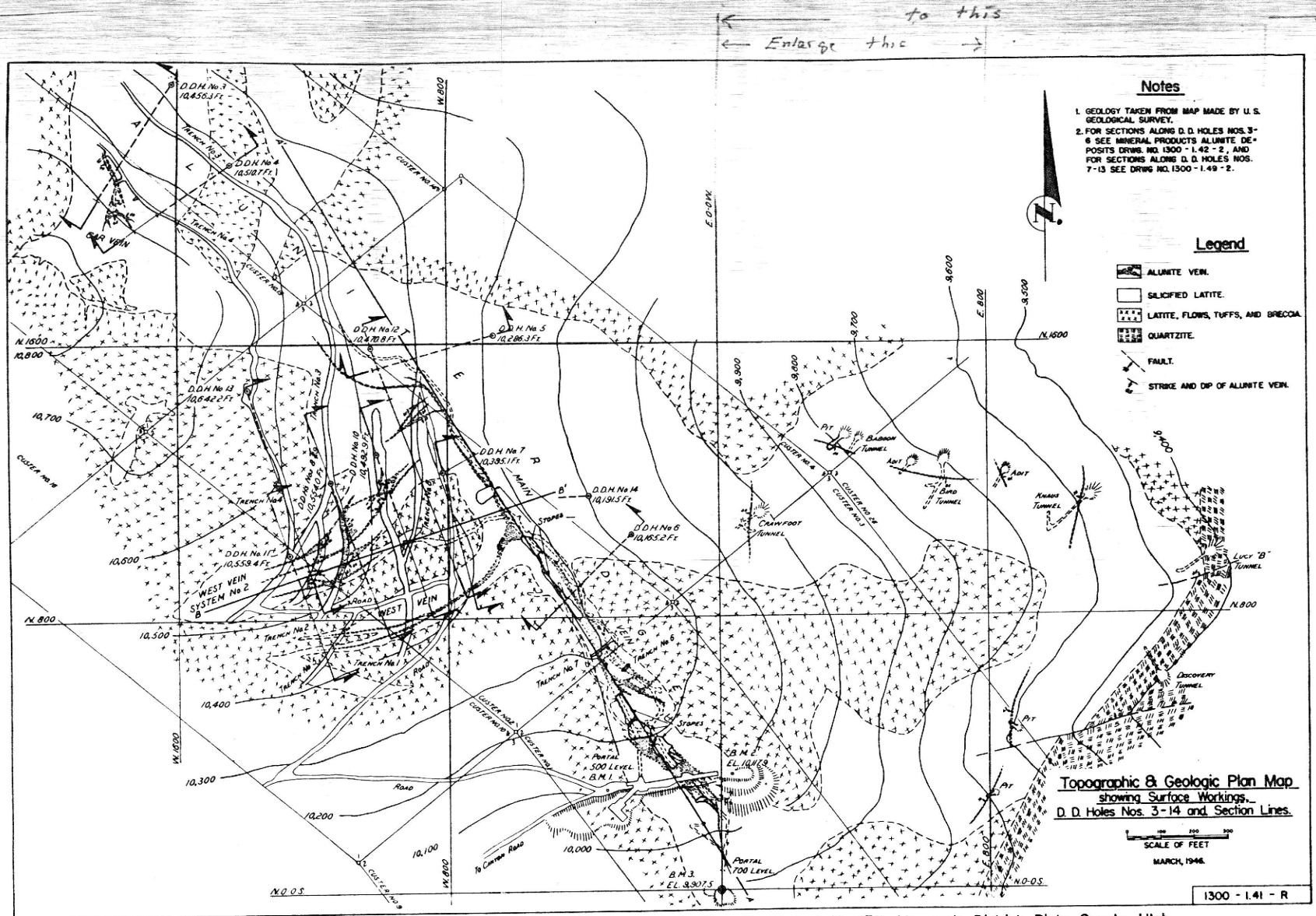


Fig. 2a, Topographic and Geologic Plan Map of Mineral Products Alunite Deposits, Project Na 1311. Marysvale District, Piute County, Utah.

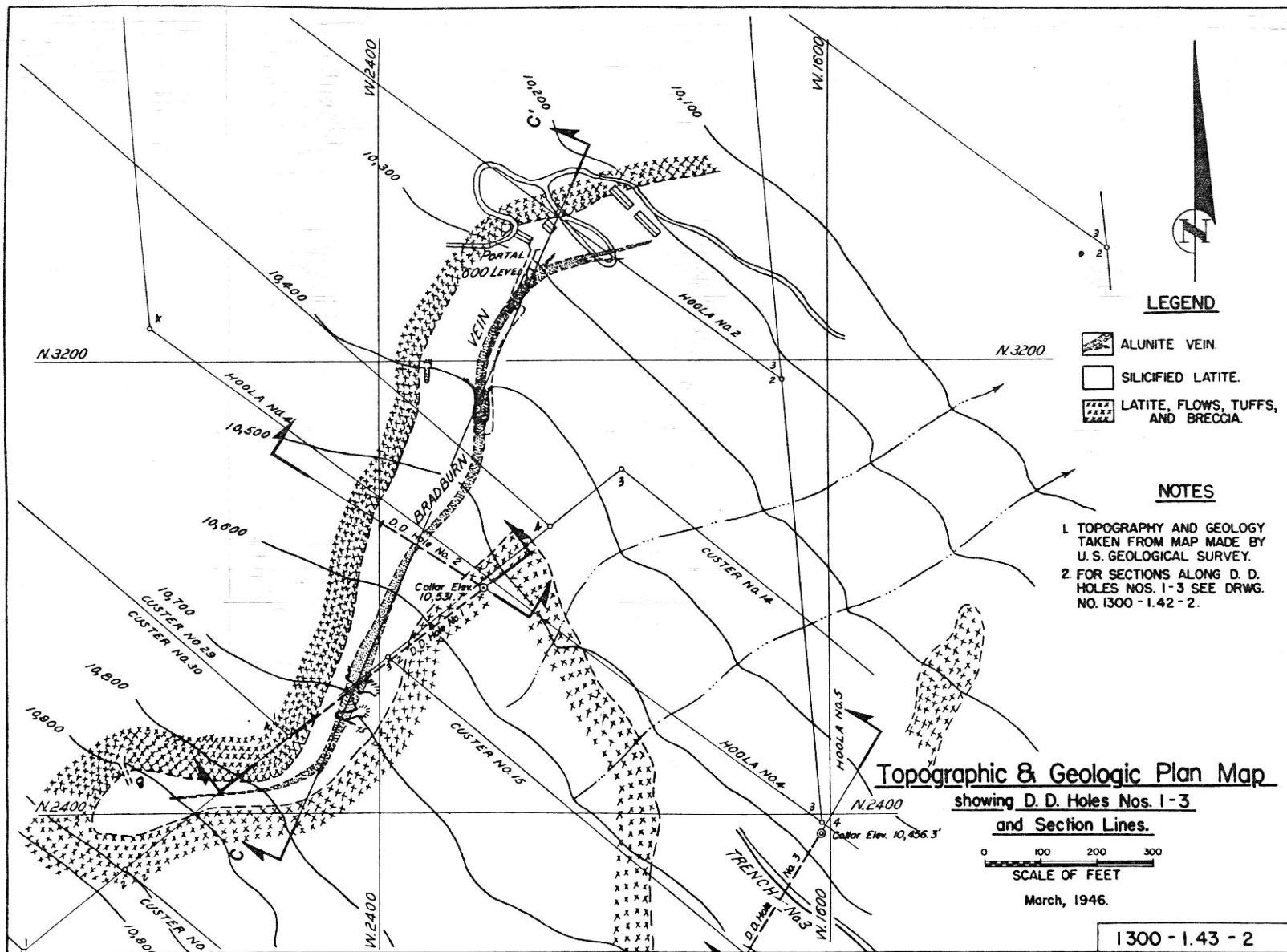


Fig. 2b, Geologic Map of Bradburn Alunite Deposit, Marysvale District, Piute County, Utah.

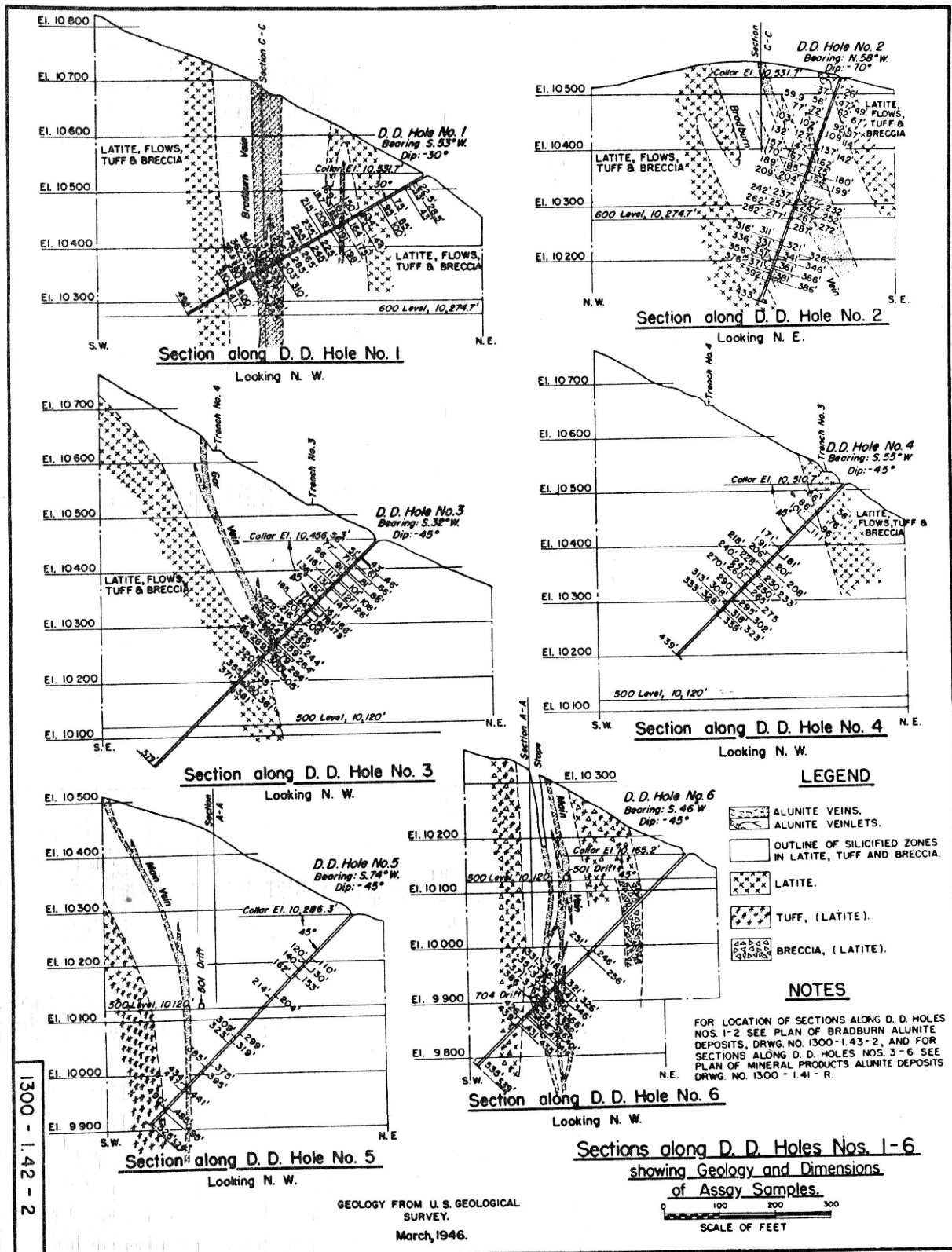


Fig. 3, Geologic Sections, Mineral Products Alunitic Deposits, Marysville District, Piute County, Utah.

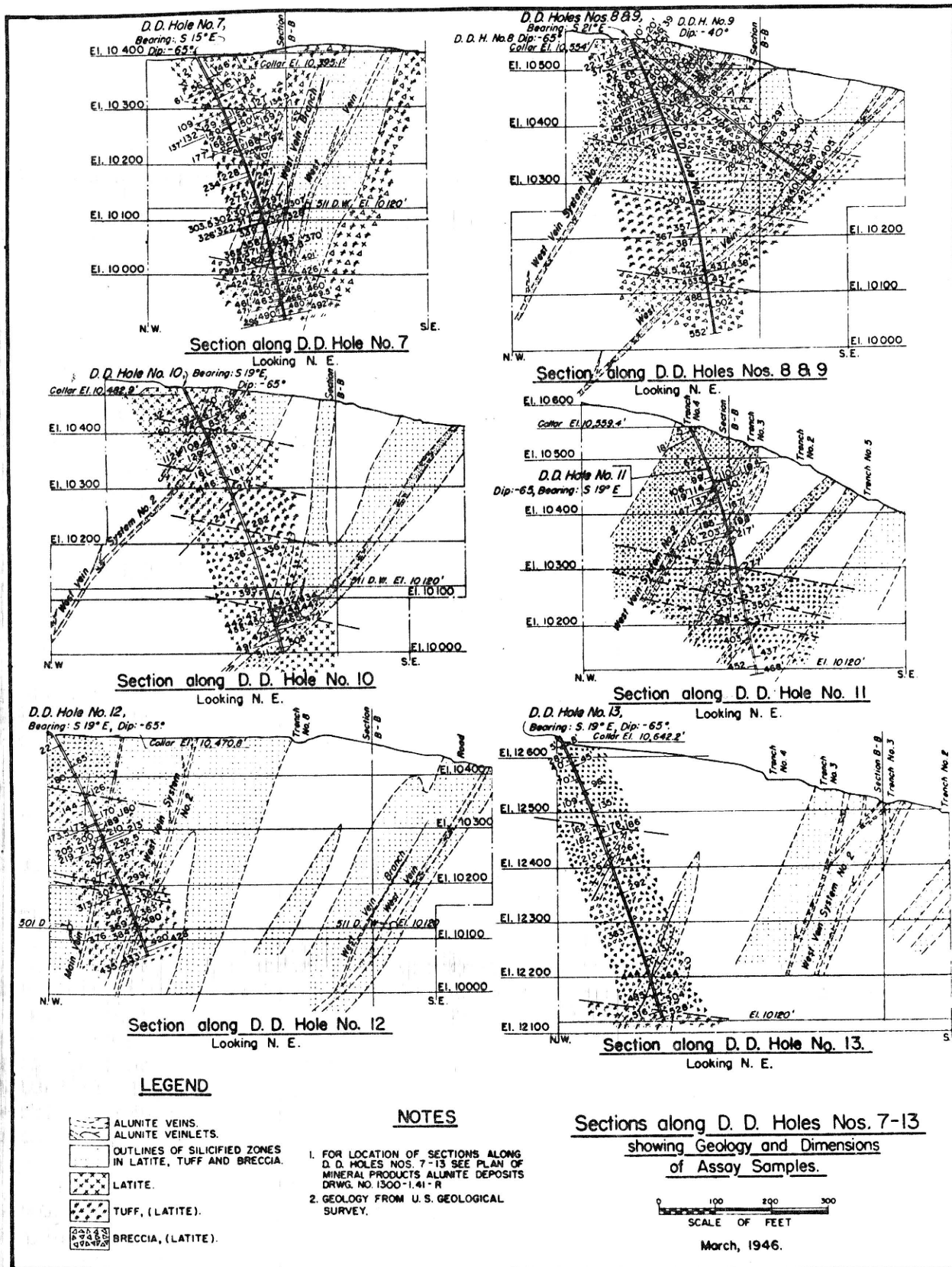


Fig. 4, Geologic Sections, Mineral Products Alunitic Deposits, Marysvale District, Piute County, Utah.

INDIVIDUAL PROPERTIES

Mineral ProductsDescription of Deposit

Figure 1 shows the location of the Mineral Products property. Figures 2a and 2b show a plan of the Mineral Products vein system and location of drill holes, and figures 3 and 4 show sections along drill holes.

The ore occurs either as hard, pink coarsely crystalline, or gray to white finely crystalline alunite in veins that fill fractures in the silicified, partly alunitized, and weakly pyritized volcanic rocks. The veins are commonly banded and roughly parallel to the walls. There is a suggestion that the thicker bands of alunite are formed in the wider parts of the vein. The crystals have grown normal to the sides of the bands and are commonly grouped in plumose aggregates. Coarsely crystalline alunite also lines cavities in the white, fine-grained alunite.

There are two distinct trends to the vein system. The main vein system strikes N. 35° W. and ranges in dips from 85° northeast to steeply southwest. The larger veins of the west vein system strike N. 60° E. and dip approximately 85° northwest.

The veins are not simple lenses but consist of many veins that pinch and swell along the strike and dip, forming a stockwork pattern in the system. There is splitting and rejoining of the veins, and the enclosed material contains many small veinlets of alunite. The hanging wall and footwall of the larger crystalline veins are clearly defined even though mineralization has penetrated the walls for considerable distances. Some of the veins are sheared along the strike, and vein alunite fills part of some transverse fractures that cross the main vein. None of the fractures observed have displacements of more than a few inches.

Sampling and Analyses

Trenches, drill cores, and underground workings were sampled in detail. The trenches were sampled by continuous channel cuts along the bottom of the trench, and the material from each 5-foot section was sacked separately, except where breaks were chosen at contacts and the length was reduced to suit the condition. The drill cores were sampled continuously at variable intervals, dependent on the nature of the rock encountered. The underground workings were sampled by channels cut normal to the strike and across the back of the working at 10-foot intervals.

Table 2 gives the diamond-drill holes and summary of analyses of ore encountered. Appendix 1 shows the analyses of drill holes, composites, and samples from underground workings and trenches.

TABLE 2. - Principal alunite veins cut in diamond-drill holes 1 to 13, inclusive,
Mineral Products alunite deposit, Marysvale, Piute County, Utah

| D.D.H. No. | Dip, degrees | Bearing, degrees | Collar elevation, ft. | Depth, feet | Alunite veins | | Alunitization | | Al ₂ O ₃ | SO ₃ | K ₂ O | Remarks |
|---------------|-----------------|---------------------|--------------------------|----------------|---------------|-----|---------------|------|--------------------------------|-----------------|------------------|--------------------------------------------------------------------------------------------------------|
| | | | | | From- | To- | From- | To- | | | | |
| 1 | -30 | S. 53 W. | 10,531.69 | 498 | | | 144 | 169 | 17.0 | | | Bradburn vein. |
| | | | | | 169 | 175 | | | 26.9 | | | |
| | | | | | | | 175 | 303 | 16.9 | | | |
| | | | | | 303 | 352 | | | 33.5 | 33.1 | 8.8 | |
| | | | | | | 352 | 417 | 17.4 | | | | |
| 2 | -70 | N. 58 W. | 10,531.69 | 433 | | | 26 | 162 | 19.8 | | | Bradburn vein. |
| | | | | | 162 | 185 | | | 35.3 | 37.0 | 9.5 | |
| | | | | | 189 | 199 | | | 35.4 | 34.8 | 8.9 | |
| | | | | | | | 199 | 232 | 14.6 | | | |
| | | | | | 232 | 252 | | | 34.8 | 28.9 | 8.1 | |
| | | | | | | 252 | 272 | 23.8 | | | | |
| 3 | -45 | S. 32 W. | 10,456.25 | 579 | | | 244 | 305 | 15.0 | | | Main vein. Areas of alunite veins that are 2 feet or less in width. Probably Main vein. |
| 4 | -45 | S. 55 W. | 10,510.69 | 439 | | | 323 | 338 | 19.1 | 17.7 | 3.0 | |
| 5 | -45 | S. 74 W. | 10,286.30 | 529 | 434 | 411 | | | 36.9 | | | |
| 6 | -45 | S. 46 W. | 10,165.36 | 539 | | | | | 20.3 | 22.0 | 6.1 | |
| | | | | | | | 366 | 386 | 19.5 | 22.9 | 6.2 | |
| | | | | | | | | | | | | |
| 7 | -65 | S. 15 E. | 10,395.10 | 496 | | | 132 | 140 | 16.0 | 12.0 | | West vein. |
| | | | | | | | 303 | 363 | 17.9 | 15.5 | | |
| | | | | | 363 | 371 | | | 35.8 | 35.9 | 9.6 | |
| | | | | | | 371 | 401 | 21.6 | 19.5 | | | |
| | | | | | | 461 | 470 | 25.6 | 19.5 | | | |
| 8 | -65 | S. 21 E. | 10,554.03 | 552 | | | 0 | 116 | 17.4 | 19.3 | | 10.1 |
| | | | | | 116 | 129 | | | 34.3 | 34.1 | | |
| | | | | | | | 129 | 177 | 17.7 | 18.0 | | |
| | | | | | | | 427 | 431 | 16.9 | 15.7 | | |

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TABLE 2. - Principal alunite veins cut in diamond-drill holes 1 to 13, inclusive, Mineral Products alunite deposit, Marysvale, Piute County, Utah (Cont'd)

| D.D.H. No. | Dip, degrees | Bearing, degrees | Collar elevation, ft. | Depth, feet | Alunite veins | | Alunitization | | | Remarks | | | |
|------------|--------------|------------------|-----------------------|-------------|---------------|------|---------------|------|--------------------------------|---------|-----------------|------------------|--|
| | | | | | From- | To- | From- | To- | Al ₂ O ₃ | | SO ₃ | K ₂ O | |
| 9 | -40 | S. 21 E. | 10,554.03 | 421 | 431 | 442 | 442 | 453 | 30.0 | 29.0 | 8.3 | West vein. | |
| | | | | | | | 20.9 | 16.0 | | | | | |
| | | | | | | | 20.6 | 20.5 | | | | | |
| | | | | | 30 | 36 | 33.4 | 33.3 | 9.7 | | | | |
| | | | | | | | 18.6 | 18.0 | | | | | |
| | | | | | 100 | 110 | 35.9 | 35.9 | 10.5 | | | | |
| 10 | -65 | S. 19 E. | 10,482.94 | 511 | | | 110 | 137 | 17.6 | 16.6 | | West vein | |
| | | | | | 137 | 159 | 33.1 | 28.6 | 9. | | | | |
| | | | | | | | 15.1 | 12.3 | | | | | |
| | | | | | 401 | 404 | 24.9 | 17.3 | | | | | |
| | | | | | | | 13.9 | 13.9 | | | | | |
| | | | | | 98 | 112 | 30.1 | 28.8 | 8.7 | | | | |
| 11 | -6 | S. 19 E. | 10,559.37 | 468 | 465 | 479 | 437 | 450 | 23.2 | 15.3 | | West vein. | |
| | | | | | | | 32.8 | 32.3 | 8.9 | | | | |
| | | | | | | | 17.7 | 16.7 | | | | | |
| 12 | -65 | S. 19 E. | 10,470.83 | 435 | | | 479 | 505 | 15.2 | 14.5 | | Main vein. | |
| | | | | | | | 99 | 119 | 36.1 | 35.3 | 10.1 | | |
| | | | | | | | 119 | 130 | 16.6 | 14.3 | | | |
| | | | | | | | 185 | 198 | 16.6 | 14.3 | | | |
| 13 | -65 | S. 19 E. | 10,642.22 | 528 | | | 198 | 210 | 36.3 | 25.6 | 7.4 | Main vein. | |
| | | | | | | | 144 | 200 | 14.0 | 17.1 | | | |
| | | | | | | | 200 | 210 | 33.8 | 34.7 | 9.7 | | |
| | | | | | | | 376 | 380 | 31.9 | 30.9 | 8.4 | | |
| | | | | 226 | 236 | 20.6 | 16.2 | | | | | | |
| | | | | 504 | 516 | 34.1 | 10.5 | 2.8 | | | | | |

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Mine Workings

Figure 5 shows a plan of the underground workings and sample locations. Figure 6 shows the trenching system and sample locations.

The mine is developed by two adit levels - an upper called the 500 and a lower called the 700. The two levels are connected by a two-compartment incline winze. The drifts, crosscuts, and raises on the 500-foot level total approximately 3,300 feet, whereas on the 700-foot level a total of 1,300 feet has been driven. Most of the work has been within the limits of the alunite veins. The reported production was mined entirely from above the 500-foot level. Mining was completed by overhand shrinkage stopes, which were opened to the surface in many places. Chute openings to the stopes were spaced at 50-foot intervals along the drifts.

Work by the Bureau of Mines

The deposit is in a remote region that is not easily accessible. Adverse climatic conditions, with subzero temperatures and heavy snowfall, prohibited any exploratory work between October and May.

During the first season six diamond-drill holes totaling 3,017 feet were drilled to explore the lateral and vertical extensions of the Main and Bradburn veins. During the second season, a temporary camp was established in the Clyde Basin, half a mile south of the deposit and 700 to 1,500 feet lower in elevation. Approximately 1-1/2 miles of new and rehabilitated roads were constructed between the camp and the deposit. Exploration work consisted of 5,500 feet of bulldozer-excavated trenches, 1,370 feet of smaller trenches, and seven diamond-drill holes totaling 3,500 feet.