

Strategic Metals (Tantalum, Columbium, Beryllium) in Pegmatites of
Copper Mountain, Fremont County, Wyoming

A preliminary report

By Mark L. Chatman

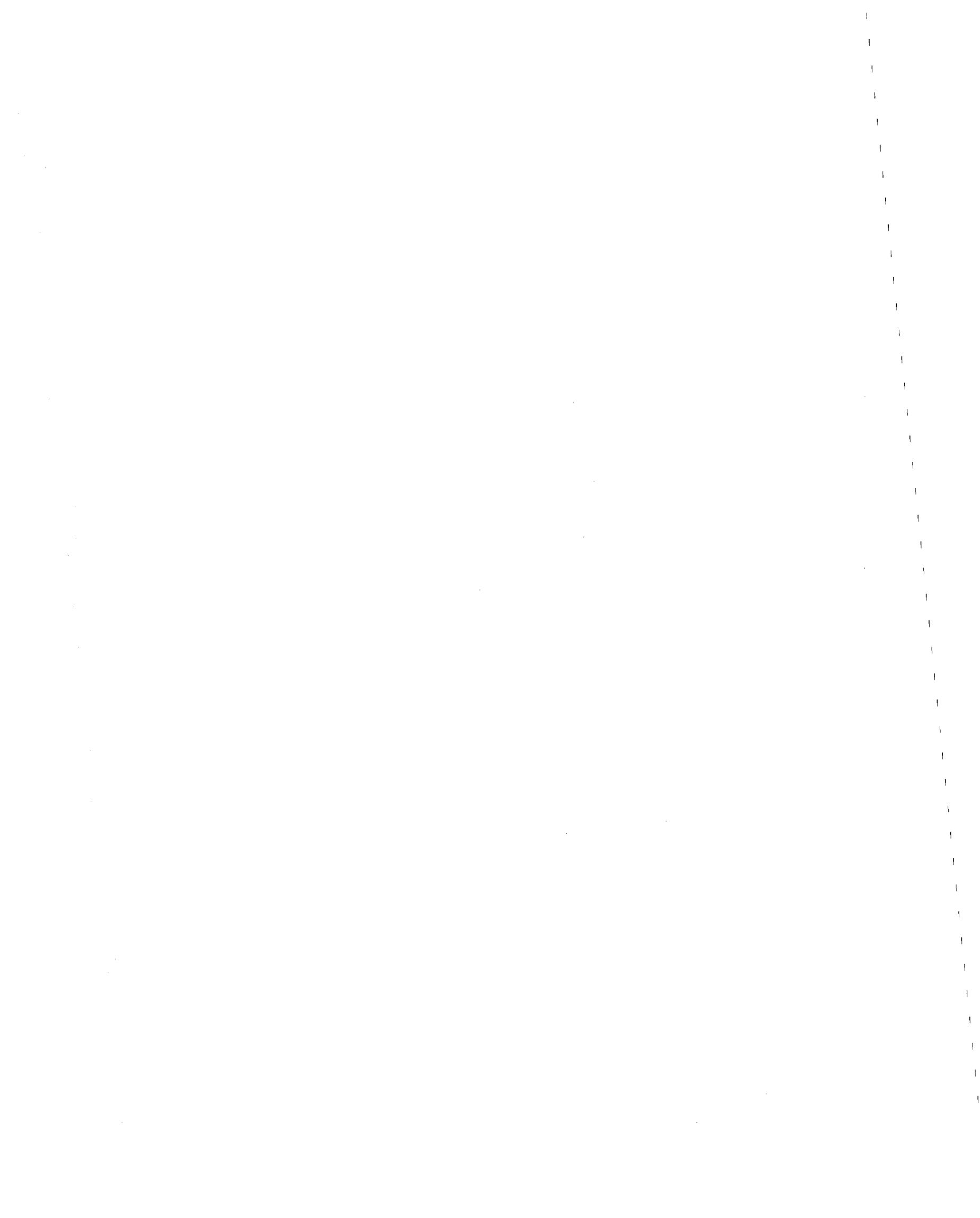
***** OFR 15-89

UNITED STATES DEPARTMENT OF THE INTERIOR
Manuel Lujan, Jr., Secretary

BUREAU OF MINES
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REPORT DOCUMENTATION PAGE	1. REPORT NO. BuMines OFR 15-89	2.	3. Recipient's Accession No. PB89 214217AS	
4. Title and Subtitle STRATEGIC METALS (TANTALUM, COLUMBIUM, BERYLLIUM) IN PEGMATITES OF COPPER MOUNTAIN, FREMONT COUNTY, WYOMING A preliminary report			5. Report Date 03/31/89	
7. Author(s) Mark L. Chatman			8. Performing Organization Rept. No. OFR-	
9. Performing Organization Name and Address U.S. Bureau of Mines Division of Resource Evaluation Intermountain Field Operations Center-RE P.O. Box 25086, Denver Federal Center Denver, CO 80225-0086			10. Project/Task/Work Unit No.	
12. Sponsoring Organization Name and Address U.S. Bureau of Mines Division of Resource Evaluation Intermountain Field Operations Center-RE P.O. Box 25086, Denver Federal Center Denver, CO 80225-0086			11. Contract(C) or Grant(G) No. (C) (G) none	
15. Supplementary Notes Details of metal recovery tests to be published in 1989 in RI format by Division of Minerals and Materials Science, Salt Lake City Research Center			13. Type of Report & Period Covered Open file; 1987-1988	
16. Abstract (Limit: 200 words) In 1987 and 1988, the Bureau of Mines evaluated pegmatites and granitic rocks on the south side of Copper Mountain, Fremont County, WY, primarily for the strategic metals tantalum, columbium, and beryllium. The U.S. relies on foreign imports for over 90 percent of the tantalum and columbium consumed annually, and has no major known tantalum deposit. Widely spaced reconnaissance sampling identified subeconomic tantalum resources in two pegmatites on Copper Mountain, amounting to 1.5 million short tons at grades of 0.02 percent to 0.03 percent Ta ₂ O ₅ (tantalum pentoxide). Tantalum content is 0.8 million pounds of Ta ₂ O ₅ , or about 1/5 of the total tantalum resources delineated in the U.S. Tantalum recovery testing showed that 70% recovery is possible. Additionally, columbium and beryllium could be byproducts of tantalum mining. Tungsten, gold, silver, and copper, primarily in quartz veins, are not present in economic amounts. Sample assays suggest additional tantalum resources could be present in other pegmatites in the study area, but more sampling work is required to determine resources. Unsampled pegmatites on an adjacent 2 square miles of land should be examined. Discovery of more tantalum resources could help alleviate U.S. dependence on foreign imports.				
17. Document Analysis a. Descriptors Tantalum Copper Mountain, Wyoming Columbium Domestic resources-critical & strategic materials Niobium Pegmatites Beryllium Bonneville Prospect Tantalite-columbite b. Identifiers/Open-Ended Terms Advanced Materials Fremont County, Wyoming Strategic Materials Geology Critical Materials Mineral resources National Defense Stockpile Economic minerals c. COSATI Field/Group				
18. Availability Statement: No restrictions			19. Security Class (This Report)	21. No. of Pages 7
			20. Security Class (This Page)	22. Price



CONTENTS

	Page
Abstract.....	4
Introduction.....	5
Physiography, location, and access.....	6
Previous work.....	8
Mining history and mineral ownership.....	8
Geologic setting.....	10
Tantalum, columbium, and beryllium in pegmatites at Copper Mountain...	12
Methods of investigation.....	13
Results of investigation.....	13
Mineralogy.....	14
Results of chemical analyses.....	15
Tantalum resources and columbium byproducts.....	17
Preliminary tantalum recovery investigations.....	19
Beryllium.....	20
Tungsten.....	20
Gold, silver, and copper.....	21
Recommendations for further work.....	21
Economics of investigated resources.....	22
Uses and economics of tantalum.....	22
Traditional sources.....	22
Grades.....	24
Prices.....	24
Uses and economics of columbium.....	25
Uses and economics of beryllium.....	26

CONTENTS--Continued

	Page
Conclusions.....	27
References.....	29

ILLUSTRATIONS

1. Location of the Copper Mountain area, Fremont County, WY.....	7
2. Photograph of outcropping pegmatites and granitic rocks (light areas) on the eastern slope of Cottonwood Creek drainage.....	11
3. Photograph of the western end of the tantalum resource zone at the Bonneville #1 prospect.....	18

PLATE

1. Map showing pegmatites and sample localities in the Copper Mountain area.....	back
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TABLE

1. Ranges of tantalum and columbium concentrations.....	16
2. Descriptions of foreign granitic rock-hosted tantalum deposits.	23

APPENDIXES

A. Assays of pegmatite and granitic rock samples.....	34
B. Assays of samples from quartz veins and tungsten occurrences..	66
C. Data on laboratory analyses performed on Copper Mountain samples.....	71

UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

°	degree of trend or inclination	ppm	part per million
\$	dollar (U.S.)	%	percent
ft	foot	lb	pound (avoirdupois)
in.	inch	lb/ft ³	pound per cubic foot
mi	mile	st	short ton (2,000 lbs)
ppb	part per billion	sq mi	square mile

STRATEGIC METALS (TANTALUM, COLUMBIUM, BERYLLIUM) IN PEGMATITES OF
COPPER MOUNTAIN, FREMONT COUNTY, WYOMING

A preliminary report

By Mark L. Chatman¹

ABSTRACT

In 1987 and 1988, the Bureau of Mines evaluated pegmatites and granitic rocks on the south side of Copper Mountain, Fremont County, WY, primarily for the strategic metals tantalum, columbium, and beryllium. The U.S. relies on foreign imports for over 90 percent of the tantalum and columbium consumed annually, and has no major known tantalum deposit.

Widely spaced reconnaissance sampling identified subeconomic tantalum resources in two pegmatites on Copper Mountain, amounting to 1.5 million short tons at grades of 0.02 percent to 0.03 percent Ta₂O₅ (tantalum pentoxide). Tantalum content is 0.8 million pounds of Ta₂O₅, or about 1/5 of the total tantalum resources delineated in the U.S. Tantalum recovery testing showed that 70% recovery is possible. Additionally, columbium and beryllium could be byproducts of tantalum mining. Tungsten, gold, silver, and copper, primarily in quartz veins, are not present in economic amounts.

Sample assays suggest additional tantalum resources could be present in other pegmatites in the study area, but more sampling work is required to determine resources. Unsampled pegmatites on an adjacent 2 square miles of land should be examined. Discovery of more tantalum resources could help alleviate U.S. dependence on foreign imports.

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INTRODUCTION

The Bureau of Mines' Intermountain Field Operations Center (IFOC), Denver, CO, and the Bureau's Salt Lake City Research Center, Salt Lake City, UT, are jointly studying domestic sources of tantalum. Pegmatites and related intrusive rocks at Copper Mountain, Fremont County, WY, were mapped and sampled by IFOC personnel; preliminary resource estimates were made. The results are the subject of this report. Salt Lake City Research Center is developing a gravity/hydrometallurgical recovery process for tantalum and columbium² from these pegmatite rocks. Recovery of beryllium and mica is also being investigated. Results of the recovery tests will be published separately.

The Bureau of Mines is working to reduce national dependency on imported minerals and metals which have key uses in industry and defense (1, p. 12)³. Tantalum, columbium, and beryllium all are of current interest in this regard. The U.S. imports about 90% of its annually consumed tantalum and 100% of annually consumed columbium; the balance of tantalum comes from domestic recycling (2, p. 160; 3, p. 2). Except for minor amounts of byproduct material produced in the early 1980's, there has been no domestic mining of tantalum or columbium since 1959 (4, p. 291; 5, p. 455). The beryllium resource situation is stronger, with about 89% of the annual demand met through domestic mining (6, p. 22). However, the strategic importance of beryllium is demonstrated by its placement on the Department of Defense list

² Columbium and niobium are synonymous names for the chemical element; use of the original name columbium has persisted in the metallurgical industry (7, pp. 222-223).

³ Underlined numbers in parentheses refer to items in the list of references, preceding the appendixes at the end of this report.

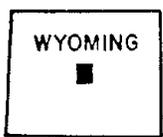
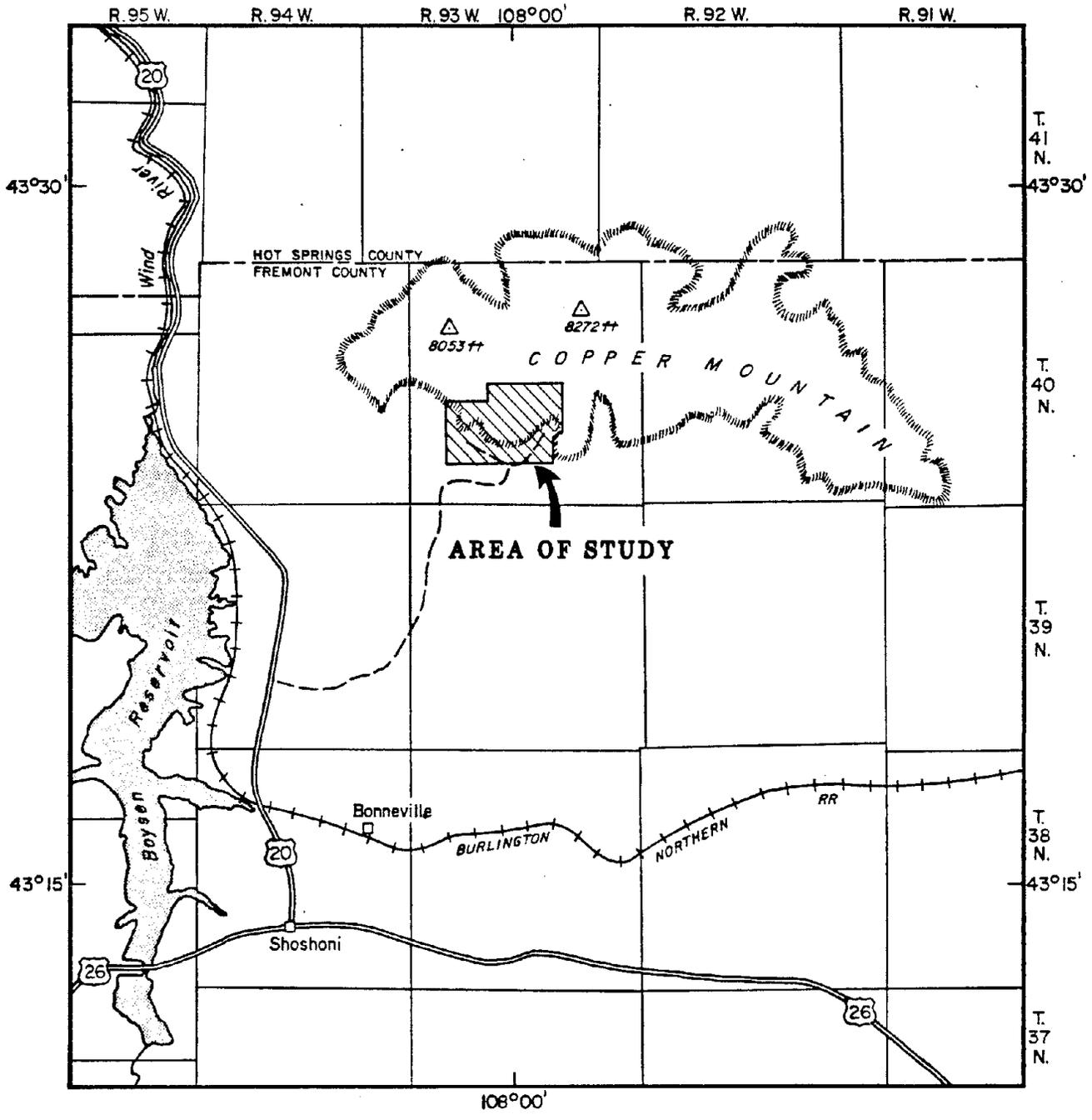
of high-technology strategic and critical materials (8, p. 1) in response to beryllium applications in the field of advanced materials, such as beryllium-copper alloys (9, p. 14). The lack of large domestic refining capacity for beryllium is an additional concern. There are just two refineries: Brush Wellman Inc., in Cleveland, OH, is the only domestically owned plant; the Cabot Wrought Products Div. (Cabot Corp.) beryllium-copper alloying plant in Reading, PA, has been sold to NGK Insulators Inc., of Japan (6, p. 22; 10, p. 158).

The National Defense Stockpile contains tantalum, columbium, and beryllium in various forms but stocks of all these metals are below existing goals (2, p. 161; 6, p. 23; 11, p. 43). Recent studies have shown stockpiled tantalum and columbium metal powders to be of insufficient quality, and in need of metallurgical upgrading (4, pp. 292-293; 12, p. 4A).

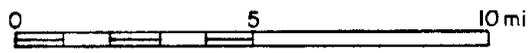
This study focused on tantalum because concentrations at Copper Mountain are hosted in high tonnage pegmatites and are near ore grade. By evaluating possible domestic tantalum sources now, the Nation will be better prepared to put certain properties into production in the event of foreign supply interruption. Columbium and beryllium would be byproducts rather than coproducts at Copper Mountain due to low concentrations relative to current ore grades.

PHYSIOGRAPHY, LOCATION, AND ACCESS

Copper Mountain is in the Bridger (eastern Owl Creek) Mountains, a part of the Middle Rocky Mountains that adjoins the northern Wind River physiographic basin (13, p. 13; 14, p. 14). This preliminary mineral resource study was limited to a network of pegmatites occupying about 3 1/2 sq mi of the southern flank of Copper Mountain (fig. 1), where elevations range from about 5,950 ft



MAP LOCATION



EXPLANATION

- PEAK-- Showing elevation in feet above sea level
- FEDERAL HIGHWAY
- UNIMPROVED ROAD
- RAILROAD

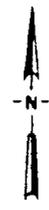


Figure 1.--Location of the Copper Mountain area, Fremont County, WY.

in the south, to about 7,500 ft in the northeast. The two largest drainages in the study area are Hoodoo Creek and Cottonwood Creek (pl. 1), which are tributary to the Wind River. The area is semiarid, with sparse vegetation limited to juniper, sage, small cacti, and grasses. The town of Shoshoni is about 18 mi by road to the south. A Burlington Northern Railroad line is accessible at Bonneville about 3 mi north of Shoshoni (fig. 1). Dirt roads that provide access to the area have a bentonitic soil base and often become impassable after precipitation.

PREVIOUS WORK

Parts of Copper Mountain pertinent to this Bureau study have been evaluated through geologic and structural mapping and through petrologic work by several investigators (15-23). Some of the most recent work was published in 1985 by Hausel and others (24) and Mueller and others (25). Economic evaluations of the pegmatites were done by Wimmeler (26), Hanley and others (27), Harrer and MacLaren (28), MacLaren and Young (29), and Harris (30). Work in the 1940's and 1950's on tantalum resources in the Copper Mountain area resulted in estimates of 4,000 to 10,000 lbs of Ta_2O_5 (tantalum pentoxide) overall (31), and 2,100 lbs Ta_2O_5 in the uppermost 50 ft of pegmatite rock on the Bonneville #8 prospect (28). These amounts are lower than resources estimated in the current study. Economics of the tungsten deposits are discussed in Frey and Wilson (32).

MINING HISTORY AND MINERAL OWNERSHIP

From about 1886 to the present, the study area has been prospected sporadically for several minerals and metals, including: the pegmatite minerals feldspar, beryl, tantalite-columbite, and mica (lepidolite, a source of lithium, and muscovite); tungsten which occurs as scheelite in quartz veins

and replacement deposits in schists; and copper, gold, and silver in quartz veins. Actual production of any of these has been low.

Mine production within the area studied was dominantly from pegmatites, although amounts produced are generally undocumented. Feldspar mining from 1969 to 1978 centered on the Quien Sabe and Blue Spar Mines (pl. 1), with about 5,000 st per year of microcline and orthoclase produced from the Blue Spar during 1977 and 1978 (33, pp. 304-305). Several other open cuts on similar feldspar in the vicinity were presumably opened during this time period (sample localities 29-30, 62-64, 83, and 191-192, pl. 1). In 1980 and 1981, the Bonneville #1 prospect (formerly called Whippet #1) was mined for feldspar (30, p. 2). Initially, the area's feldspar production was sold for dental-grade ceramics, but most was shipped to Kansas City for use as abrasive in Bon Ami cleansers (33, pp. 304-305).

Small amounts of tantalite-columbite crystals were hand-cobbed from pegmatites on the Bonneville #1 and #8 prospects (formerly Whippet #1 and #8) during 1986-1988; the amount probably did not exceed 50 lb (34). Previously, in 1937, 300 lb of tantalite-columbite crystals, which reportedly assayed 82% Ta_2O_5 and were worth about \$1,000, were mined from the Bonneville #8 prospect. The minerals were purchased by Fansteel Metallurgical Corp. (now Fansteel Inc., North Chicago, IL); end use was not reported. About the same time, some beryl crystals were hand-cobbed from pits where samples 195-206 were collected in the current study (26, pp. 3-4). Sporadic efforts to hand-cobb beryl from the Bonneville #1 prospect resulted in a small, undocumented production from the 1970's to 1988 that was sold to a beryllium refiner (34).

Tungsten prospecting and mining took place sporadically from the late 1930's until about 1956; less than 100 st of tungsten trioxide (WO_3) concentrates were produced, with most (about 45 st) coming from the Romur Mine. About 1,300 st of WO_3 reserves were defined at the Comet Mine in 1943 as a result of Bureau of Mines war efforts to increase tungsten availability, but the amount mined since is not documented. (See 32, 35, pp. 180-181). Reserve and production data of the Whippet and Stardust Mines are not available.

Numerous unpatented mining claims are in the study area. Most were filed between 1958 and 1985 for pegmatite minerals, including beryl, feldspar, lepidolite, tantalite, and tourmaline. Other claims for copper, gold, iron, and uranium were staked in 1970, 1978, and 1983. Most of the land and minerals are public domain administered by the U.S. Department of the Interior, Bureau of Land Management; exceptions are shown on plate 1.

GEOLOGIC SETTING

Precambrian-age crystalline rocks that comprise the study area are mostly metasedimentary schist sequences which were intruded by quartz-scheelite veins and replacement zones (a minor tungsten source), quartz veins, and amphibolite dikes (21, 22, 32, p. 4). Later Archean granitic magmas intruded the schists, forming migmatite with select schist layers, and forming granitic intrusions (mostly dikes) in several localities (15, p. 81, 19, p. 46, 21). The granitic rocks, most recently age-dated as 2.6 billion years old (36, p. 338), are medium to coarse grained and composed predominantly of quartz, microcline, albite, and muscovite, with accessory biotite and garnet (21). The granitic magma is a likely source of copper, gold, and silver in quartz vein



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Figure 2.-- Outcropping pegmatites and granitic rocks (light areas) on the eastern slope of Cottonwood Creek drainage. Dark areas are schist.

occurrences on Copper Mountain, although at least one Cu-Au-Ag occurrence on the mountain was shown to be hosted in older mafic dikes (24).

Copper Mountain pegmatites (fig. 2) formed as a late stage magmatic differentiation from the large granitic intrusion that is mostly buried under Copper Mountain, but outcrops in several places as granitic sheets and irregular bodies. The pegmatites contain the economic minerals beryl, tantalite-columbite, feldspar, and micas. Many of the pegmatites underwent albitization (15, p. 91), a process now thought to be important for the formation of economic tantalum concentrations (37, pp. 1889-1890).

Both pegmatites and granitic rocks contain xenoliths of the schist wallrock. Post-Precambrian tectonics and faulting largely altered the structure of Copper Mountain's southern flank but did not affect the economic geology of the pegmatites (38, pp. 48-50; 39, p. 209; 40, p. 116; 41, pp. 586, 597; 42, p. 117).

TANTALUM, COLUMBIUM, AND BERYLLIUM IN PEGMATITES AT COPPER MOUNTAIN

As of August 1988, about five weeks of field time had been expended in the project area to map and sample exposed pegmatites and their granitic source rocks and evaluate their tantalum resource potential. Samples were evaluated also for columbium and beryllium because byproduct potential of those metals could improve overall economic viability of the area.

Quartz-scheelite veins, emplaced in the study-area schists prior to the pegmatites, were sampled for tantalum content. Previously, they had been prospected and mined for tungsten. Smaller quartz veins, apparently not genetically related to either quartz-scheelite vein or pegmatite emplacement, had been prospected historically for their low amounts of copper, gold, and

silver at several localities within the study area. Several of these veins were sampled because they also represented potential byproduct mineral value.

METHODS OF INVESTIGATION

A total of 358 rock samples was collected mainly from pegmatites, granitic rocks, and adjoining schist wallrock (appendix A). Pegmatites with a thickness of at least 2 ft, and granitic rocks were mapped and sampled (pl. 1). Most laboratory analytical work was done at Bondar-Clegg & Co., Ltd., who determined concentrations of tantalum, columbium, and beryllium in 338 samples using neutron activation, X-ray fluorescence, and atomic absorption spectrometry, respectively. Selected samples were also analyzed for 40 other elements, including calcium, copper, gold, lithium, potassium, silver, sodium, tungsten, and uranium. The complete list of elements and respective detection limits are in appendix C.

Some of the initial reconnaissance samples and all bulk samples for metallurgical testing were analyzed by the Bureau's Salt Lake City Research Center. Some analyses on initial reconnaissance samples were done at Chemex Labs, Inc., Sparks, NV. The list of samples, elements determined, analytical methods, and detection limits pertaining to these laboratories are listed in appendix C.

Assays from samples collected from quartz veins and shear zones at prospects for tungsten, copper, gold or silver are reported in appendix B. These were done at Bondar-Clegg & Co., Ltd.

RESULTS OF INVESTIGATION

Tantalum resources preliminarily were identified in two pegmatites, based on reconnaissance samples, and the Copper Mountain study area was shown, in general, to be geologically favorable for additional tantalum resources in

pegmatites. The granitic source rocks themselves were too low in tantalum content for current resource consideration. Grades of columbium and beryllium are so low that these metals can be considered only as possible byproducts of tantalum production. The quartz vein tungsten occurrences are not a tantalum source; neither are the smaller quartz veins with low concentrations of copper, gold, and silver.

Mineralogy

Predominant minerals in the pegmatites are quartz, feldspar, and muscovite. Accessory minerals include beryl, garnet, tourmaline, fluorapatite, and lepidolite. Specific identified tantalum and columbium minerals are: tantalite-columbite, an iron- and manganese-rich oxide that is a solid solution series of the two metals; tapiolite, a mineral that is dimorphous with tantalite-columbite; and pyrochlore-microlite (30, p. 3), an oxide mineral that can contain fluorine.

Efforts were made to locate tantalum/columbium minerals during this study to use as an indicator of resource potential, though no resources could be delineated at many of the localities with visible tantalum and columbium minerals. Tantalum- and columbium-bearing minerals were identified during this study at nine new localities (at or near the sites of samples 45-47, 67-68, 106, 150-153, 154-155, 156-157, 160-162, 216, and 218-219; see pl. 1). Tantalum- and columbium-bearing minerals previously were reported at three localities in the study area (at or near the sites of samples 143-149, 196-209, and 228-242; see pl. 1).

Tantalum and columbium also can be present in accessory minerals of pegmatites, including micas, garnet, tourmaline, and zircon (43, p. 448). A correlation between large amounts of tourmaline and higher tantalum

concentrations is apparent in the Copper Mountain sample assays. In several samples, the presence of fluorapatite correlates with higher tantalum levels. A similar correlation is noted with tantalum and muscovite and lepidolite.

Beryllium is in the oxide mineral beryl, and though assays for beryllium oxide (BeO) are generally low in study area samples, beryl crystals weighing up to 1,500 lbs have been reported on Copper Mountain (44, p. 17).

Results of Chemical Analysis

The pegmatites and their granitic source rocks are alkaline igneous intrusions, enriched in sodium and potassium feldspars, and low in calcium feldspars. Average sodium (Na) content in both the pegmatites and granitic rocks is 3.4% Na, based on analysis of 196 pegmatite samples and 63 granitic rock samples. Potassium (K) averages 2.8% in the pegmatites (15 samples) and 2.0% in the granitic rocks (3 samples), while calcium (Ca) concentrations are lower, averaging 0.15% Ca in 15 pegmatite samples and 0.52% in 3 granitic rock samples.

The pegmatites have undergone secondary albitization (sodium metasomatism during which albite is formed), as evidenced by the presence of cleavelandite at numerous localities (15, pp. 69-70). A study of pegmatites from several localities in the world showed that secondary albitization correlates to higher tantalum levels, and that metasomatic processes in general are essential for tantalum mineralization to occur in pegmatites (37, pp. 1889-1890).

Tantalum minerals tend to precipitate in later, volatile-enriched phases of pegmatite formation (45, p. 500). This late stage tantalum deposition is evident in tantalum deposits, where pegmatites that have been segregated to a greater degree through metasomatic processes tend to contain richer ores (37,

p. 1896). Lithium content in the Copper Mountain pegmatites demonstrates alteration in a volatile-rich environment. Lithium (Li) was detected in all 18 pegmatite samples tested for the element; the average was 0.016% Li, and the maximum was 0.55% Li, detected in select, lepidolite-rich sample 219 (not included in the weighted average cited above).

In the study area, 198 pegmatite samples averaged 780 ppm rubidium (Rb). Rubidium at that concentration is thought to be an indicator of high tantalum potential in pegmatites. The Bernic Lake pegmatite in Manitoba, Canada, a source of primary tantalum, showed a mean rubidium concentration comparable to the Copper Mountain samples (679 ppm Rb in 104 samples) (37, p. 1890).

Comparison of the tantalum and columbium content in study area samples showed more tantalum in the pegmatites than in their granitic source rocks (table 1).

Table 1. - Ranges of tantalum and columbium concentrations

Sample type	Concentration range	
	Ta ₂ O ₅	Cb ₂ O ₅
Pegmatite	0 to 0.104% ⁴	0 to 0.019% ⁴
Granitic rock	0 to 0.006% ⁵	0.001 to 0.020%.

⁴ Select samples of certain pegmatite zones contained higher levels of Ta₂O₅ and/or Cb₂O₅: sample 222 (muscovite-rich zone) 0.046% Cb₂O₅; sample 146 (fine-grained feldspar zone) 0.468% Ta₂O₅; sample 219 (lepidolite-rich zone) 0.650% Ta₂O₅; sample 236 (muscovite-rich zone, bulk sample) 0.147% Ta₂O₅.

⁵ Four samples classed as granitic rock exceeded 0.02% Ta₂O₅, but all four contained pegmatitic zones (samples 285, 293, 296, 297). Average tantalum concentration in granitic rocks world-wide is lower (0.0005 to 0.0009% Ta₂O₅) (45, p. 505) than at Copper Mountain.

Tantalum is a rare element in nature, with an average crustal abundance of about 2.8 ppm Ta_2O_5 ; the more plentiful columbium, in comparison, averages 29 ppm Cb_2O_5 (columbium pentoxide). In igneous rocks the averages are 6.0 ppm Ta_2O_5 and 34 ppm Cb_2O_5 , but in columbium-tantalum mineral deposits, columbium, on the average, exceeds tantalum by a ratio of 164:1 (45, p. 505; 46, pp. 18-19).

Tantalum Resources and Columbium Byproducts

Tantalum concentrations were high enough in two of the pegmatites sampled at Copper Mountain that preliminary resource estimates were made based on assays of widely spaced reconnaissance samples. They are the pegmatite at the Bonneville #1 and #3 prospects (site of samples 216-235, pl. 1), and the pegmatite at the Bonneville #7 and #8 prospects (site of samples 138-157, pl. 1). Combined, the two pegmatites have identified, subeconomic resources⁶ totaling 0.8 million lb of contained Ta_2O_5 with 0.5 million lb of contained Cb_2O_5 in 1.5 million st of rock⁷.

Resources at the Bonneville #1 and #3 prospects amount to 1.1 million st of 0.02% Ta_2O_5 with 0.02% Cb_2O_5 . Grades were estimated from a weighted average of assay concentrations from 13 samples (216-218, 220-223, 225, 227, 232-235). Samples of segregated zones at a single locality were first averaged together to obtain a representative composite grade at that locality. The resource zone (fig. 3, pl. 1) is about 950 ft long, averages 18 ft in width, with an estimated depth of 800 ft (twice the exposed depth),

⁶ Reserve and resource classifications used in this report are those defined in BuMines Mineral Facts and Problems, 1985 Edition (47, pp. 2-7).

⁷ To estimate rock tonnage, a factor of 12 ft³/ton was applied.



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Figure 3.--The western end of the tantalum resource zone at the Bonneville #1 prospect.

and is located in that part of the pegmatite between the large Bonneville #1 prospect excavation (east wall) and the site of sample 216. The western part of the resource zone is enriched in muscovite and beryl, and has a barren core that is adjacent and to the south. Core composition is coarse-grained quartz and feldspar. Eastward from the site of sample 220, the pegmatite thins and the core is not present.

Resources at the Bonneville #7 and #8 prospects amount to 0.4 million st of $0.03\% \text{Ta}_2\text{O}_5$ with $0.004\% \text{Cb}_2\text{O}_5$. Grades were estimated from a weighted average of assay concentrations from 19 samples (138-152, 154-157). Assays of samples of segregated zones at a single locality were first combined by weighted average to obtain a representative composite grade at that locality. The resource zone (pl. 1) is about 1,100 ft long, averages 16 ft in width, with an estimated depth of 300 ft (twice the exposed depth), and is composed of feldspar-quartz-muscovite pegmatite with scattered beryl, lepidolite, and tantalite-columbite or tapiolite. A small core zone, consisting of very fine-grained sugary-textured felsite, is less than 5 ft thick, and rich in garnet, fluorapatite, and tapiolite. Much of the tantalum is concentrated in this core, but surrounding pegmatite rock also contains sufficient tantalum to be considered resource material.

Preliminary Tantalum Recovery Investigations

Research on tantalum extraction technology has been directed towards a process that could allow economical processing of larger tonnages of the low-grade rock by eliminating high-cost sorting. Past pegmatite beneficiation methods required tantalum and columbium minerals to be present in selectively minable zones to be economical (43, p. 448), a situation that developed largely from the need for intensive hand-sorting of ores to make a useable

product. Preliminary investigation by the Bureau's Salt Lake City Research Center using gravity concentration has produced a concentrate with 41% combined Ta_2O_5/Cb_2O_5 at 70% overall recovery from pegmatite samples 153 and 236. A sulfation procedure extracted over 92% of the tantalum and columbium from this concentrate.

Beryllium

The beryllium in Copper Mountain's pegmatites is not economically competitive with high-tonnage U.S. bertrandite deposits in Utah. No beryl-pegmatite deposits were economic in the U.S. in 1988, although some beryllium is produced from pegmatites as a byproduct (10, p. 158). Bertrandite ore grades fall in the range 0.4 to 0.6% BeO (beryllium oxide) (48, p. 50). Copper Mountain pegmatites average 0.02% BeO (201 samples) and the granitic rocks average 0.004% BeO (63 samples). U.S. pegmatites, when mined for beryllium, required grades of 0.04% to 1% BeO (48, p. 50).

Tungsten

Tungsten content in the alkaline intrusives of the study area is widespread, but it is present in low concentrations. Pegmatite samples did not exceed 0.005% WO_3 and granitic rock samples did not exceed 0.002% WO_3 , contents which are only about 1/100th of ore grade concentrations.

The quartz-scheelite vein occurrences of tungsten, which intruded study area schists prior to the alkaline igneous rocks, were evaluated also to determine if there is a relationship between the presence of tantalum and tungsten in the geologic system. Under some circumstances, tungsten and tantalum mineralization can occur together. However, sample analyses showed that tantalum in Copper Mountain was introduced independently of the quartz-scheelite veins. Sample data are in appendix B.

Gold, Silver, and Copper

Gold, silver, and copper occurrences have been searched for extensively on Copper Mountain, mostly in quartz veins and pods, which apparently are not spatially related to the alkaline igneous intrusions. Samples from these small quartz bodies contained a maximum of 0.001 oz gold/ton; of 23 samples, total, seven contained gold and none contained detectable amounts of silver. Seven samples from the quartz bodies contained copper, with two samples exceeding 0.01% copper (Cu). The maximum concentration detected was 0.06% Cu (sample 41). Sample data are in appendix B.

Concentrations of the metals were low in alkaline intrusive rocks from the study area. Pegmatite samples did not exceed 0.005 oz gold/ton and granitic rock samples did not exceed 0.003 oz gold/ton. Twelve of 201 pegmatite samples contained detectable silver with a maximum 0.6 oz silver/ton. One granitic rock sample contained detectable silver (0.2 oz/ton).

RECOMMENDATIONS FOR FURTHER WORK

Additional field work should be directed towards sampling in greater detail those specific pegmatite bodies with higher tonnages and grades, and towards exploring other alkaline intrusive rocks in the southern part of Copper Mountain, east of the area studied.

To recover the tantalum economically, work should continue to develop and refine a gravity beneficiation and sulfation recovery process because its application may permit nonselective mining and processing of the pegmatite rock, a procedure necessary due to the low tantalum grades.

ECONOMICS OF INVESTIGATED RESOURCES

USES AND ECONOMICS OF TANTALUM

Most tantalum is consumed in electronic capacitor manufacturing; it is also used in a variety of milled metal products and alloys that utilize tantalum's characteristics of high density, ductility, high melting point, corrosion resistance, and its ready alloying tendencies. Tantalum metal is easily fabricated, yet tough and durable (49, pp. 912-913).

The U.S. has been consuming nearly 1 million lbs of Ta_2O_5 per year since 1985 (2, p. 160). Domestic tantalum sources are small and few, with a domestic reserve base of 3.4 to 4.2 million lb Ta_2O_5 . All deposits are currently considered to be non-commercial. The Bear Valley deposit, in Valley County, west-central Idaho, is a placer-type deposit of alluvial material which contains nearly all the domestic reserve base. A second placer deposit, the Dismal Swamp, Elmore County, south-central Idaho, is much smaller. Known domestic pegmatite sources of tantalum are small and scattered; one of the largest recognized is the Harding pegmatite of New Mexico, with about 0.2 million lb of contained Ta_2O_5 (2, p. 161; 43, pp. 450-451).

Traditional Sources

Tantalum is found as a trace element in Asian tin deposits, and is concentrated in the slags formed by tin smelting. Asian tin slags historically have been the source of over half the world's tantalum, with the rest produced as byproduct from mining either alluvial-tin or pegmatite-tin deposits in Thailand, Australia, and Zaire. Residual columbium deposits in Brazil (mined primarily for tin) are another important source of byproduct tantalum. (See 2, pp. 160-161; 4, p. 298; 50, p. 267; 51, pp. 117-118). Depressed tin mining from 1985 to 1989, resulting from the collapse of the tin

cartel, has curtailed the source of tantalum-rich Asian tin slags. Existing slag stocks, which contain 15% to 18% Ta₂O₅, will not last as a tantalum resource through the 1990's (4, p. 298; 51, p. 116; 52; 53), placing emphasis on hardrock mining of tantalum from pegmatites for the future, as well as encouraging development of tantalum-bearing, fine grained alkaline plutons (table 2).

Table 2. - Descriptions of foreign granitic rock-hosted tantalum deposits

Deposit	Grades	Tonnages, grades, notes
<u>Yi Chun,</u> Jiangxi, China	0.017% Ta ₂ O ₅ , 0.009% Cb ₂ O ₅ , 0.012% tin (Sn)	In microlite and columbite-tantalite; about 26.4 million lb recoverable Ta ₂ O ₅ .
<u>Tiger Head Mine,</u> Limu, Guanxi Province, China	0.017% Ta ₂ O ₅ , 0.15% to 0.20% tin (Sn)	13.2 million st of ore.
<u>Pitinga deposit,</u> Amazonas, Brazil	0.03% Ta ₂ O ₅ , 0.3% Cb ₂ O ₅ , 0.3% tin (Sn), 1.5% zirconium oxide	Mining residuum on granitic rock (1988); development of hardrock ores possible in 1989.
<u>Thor Lake</u> <u>deposit,</u> NW Territories, Canada	0.03% Ta ₂ O ₅ , 0.40% Cb ₂ O ₅ , & large amounts of coproduct resources (Be, Zr, REO)	Development property, with 77 million st of rock.
<u>Abu Dabbab</u> <u>deposit,</u> Eastern Desert, Egypt	0.027% Ta ₂ O ₅ , 0.027% Cb ₂ O ₅ , & 0.108% tin (Sn)	Undeveloped, with 52.3 million st.
<u>Nuweibi deposit,</u> Eastern Desert, Egypt	0.0179% Ta ₂ O ₅	Undeveloped, with 32 million st.

Sources: References (54; 55, p. 14; 56, p. 284; 57, p. 93; 58, p. 119).

Grades

Primary hardrock tantalum deposits generally have grades in the range of 0.05% to 0.15% Ta₂O₅; prices in the range of \$35 to \$60/lb are necessary to meet the costs of mining and beneficiating tantalum ores from these deposits (59, p. 6; 60). Operators of pegmatite and other hardrock-types of tantalum mines are responding to increased demand and attendant higher prices.

Operations at the Bernic Lake pegmatite, Manitoba, Canada, were restarted in 1988 by TANCO (Tantalum Mining Corp. of Canada Ltd.) (61, p. 4A) after being idle since 1982 (62, p. 53). The property has 1.3 million st of ore reserves at 0.144% Ta₂O₅ and 0.82 million st of reserves in tailings at 0.065% Ta₂O₅ (63, p. 316). It is a primary tantalum mine.

The Greenbushes pegmatite deposit in Australia has about 0.06% Ta₂O₅ (50, p. 813). A 30% increase in production of tantalum in 1989 was planned (300,000 to 340,000 lb Ta₂O₅ per year), after expansion into underground operations in 1988 (52; 59, p. 6). It is the world's major known tantalum pegmatite and a coproducer tin.

Certain large, fine grained alkaline plutons, at localities such as China, Brazil, and Canada (table 2), may become producers of large amounts of tantalum in the future, though none are being mined currently. Lithologically, they are similar to the granitic pegmatite source rocks on Copper Mountain. Grades of determined resources at these deposits are lower than the economic pegmatite ore grades quoted above, and some are lower than grades of Copper Mountain pegmatites (table 2).

Prices

An oversupply has existed in the world tantalum market beginning about 1980, when production response to \$126/lb prices (up from \$34/lb in 1978)

caused excess stocks to be built up by miners, processors, and fabricators. Prices fell to \$30/lb by 1983, and reached a low of about \$19/lb during part of 1986, in response to oversupply. Not only were prices low, but nearly half the world demand for tantalum was being met through use of existing stocks rather than mining of new ores as recently as 1987 (2, pp. 160-161; 52; 59, p. 1; 64, pp. 1, 8; 65, p. 818). In 1988, prices climbed to about \$48/lb, reflecting a draw down of overstocks (59, p. 6; 66, p. 5).

USES AND ECONOMICS OF COLUMBIUM

Columbium metal's superior alloying characteristics allow small amounts (less than 1%) to significantly strengthen steels. Heat resistance makes columbium important as an alloy in turbine engine parts, and the metal has demonstrated superconductivity properties (7, pp. 222-223; 67, p. 73).

All U.S. columbium feed material is imported, primarily from Brazil and Canada. Since 1984, the U.S. has been consuming about 7.0 to 7.6 million lb of columbium annually, mostly imported in the form of ferrocolumbium, an alloying agent for steelmaking. In 1987, columbium concentrates sold for \$2.60/lb (11, pp. 42-43).

The mineral pyrochlore and lesser amounts of columbite are chief columbium ores. They are mined mostly from the high-tonnage carbonatite sections of alkaline intrusive rock deposits in Brazil, where deeply weathered residuum on top of carbonatites has been concentrated in columbium naturally. Average grade in this soft, readily minable material is 1.57% Cb_2O_5 (67, pp. 73-74).

Some domestic columbium deposits contain resources, although none are in production. Domestic columbium mining has been idle since the end of the Federal government columbium concentrate purchase program (1952-1958), which

arose initially out of raw materials demands during the Korean War (7, p. 215; 68, p. 185). There are about 800 million lb of columbium resources in domestic deposits, mostly occurring in large carbonatites. The Powderhorn (Iron Mountain, or also Iron Hill) carbonatite and the Gem Park carbonatite, both in central Colorado, could each supply about 1.2 million st of ore per year, but the grades (0.21-0.24% Cb_2O_5) do not allow economical mining (11, p. 43; 67, p. 75). Overall, the Powderhorn deposit may contain 24 million st of 0.26% Cb_2O_5 (69, p. 28). Other domestic carbonatite deposits with columbium are in Rocky Boy, MT, and Magnet Cove and Potash Sulfur Springs, AR (43, p. 451).

Numerous pegmatites in the United States have supplied small amounts of columbium as byproduct material in the past, but the amount contained in pegmatites is not significant. Columbium is known in placer deposits at the Bear Valley, Idaho tantalum deposit (43, p. 451).

USES AND ECONOMICS OF BERYLLIUM

Beryllium, one of the lightest of metals, is characterized by high stiffness (exceeding even that of steel) in addition to high strength and heat absorption capabilities. The metal's functions as a neutron moderator, X-ray transmitter, and electrical conductor allow for application in the computer and other electronics fields, radar and other navigation uses, nuclear reactors, and aerospace (67, p. 49; 70, pp. 85-86).

In the U.S., the world's major beryllium metal consumer, domestic mining operations appear capable of supplying 100% of the annual demand if severe market conditions arise, but ore prices have been stable since 1984 in the range of \$4.25 to \$4.40/lb of contained beryllium oxide (BeO). Since 1983, domestic mine production of beryllium metal has been about 0.45 to 0.55

million lb annually, while consumption has been about 0.60 million lb. Brazil is the major import source; imports constitute about 11% of annual consumption. Brush Wellman Inc.'s bertrandite-type deposit, at Spor Mountain, in western Utah, supplies the domestic beryllium need. Other bertrandite deposits known in the U.S. are at Gold Hill, UT, on the Seward Peninsula, AK, and El Paso, TX. (See 6, p. 22; 10, pp. 157-158; 48, p. 50).

CONCLUSIONS

Preliminary work on pegmatites at Copper Mountain suggests additional study is warranted. Reconnaissance-level sampling led to tantalum resource delineation within one area concentrated with outcropping pegmatites. Other pegmatites that outcrop on adjacent land should be examined.

The grades and tonnages of the pegmatite-hosted tantalum resources on Copper Mountain are significant. Grades are 0.02 to 0.03% Ta_2O_5 , or about 50% of ore grade in currently (1988) economic pegmatite tantalum properties. The preliminarily determined resource tonnage for two pegmatites is 1.5 million st, with 0.8 million lb contained Ta_2O_5 , an amount that could increase by 20% the total of tantalum resources currently recognized for the U.S. Byproduct recovery of columbium and beryllium could improve the economic viability of the resources. Contained columbium is estimated at 0.5 million lbs Cb_2O_5 in the preliminarily determined resources; grades are 0.004% to 0.02% Cb_2O_5 . Concentrations of tungsten, copper, gold, and silver within the alkaline igneous rocks are of no economic interest.

Additional tantalum resources may be defined in the Copper Mountain area pegmatites. The pegmatites at sample sites 180-183, 187-190, 195-209, and 320-329 (pl. 1) showed favorable tantalum concentrations in reconnaissance sample assays, and closer-spaced sampling may reveal resource-bearing zones.

Other work is warranted on pegmatites and granitic rocks in the approximately 2 sq mi of public domain land immediately east of the study area.

The economic minerals within the studied part of Copper Mountain are limited to pegmatite occurrences. Small quartz veins in schist within the study area, apparently not spatially related to the pegmatites, have trace amounts of copper, gold, and silver, which are of no economic interest. Larger quartz-scheelite veins in schist, formerly mined for small amounts of tungsten concentrates, do not contain tantalum in detectable amounts.

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APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
PEGMATITE, strikes N. 50° to 70° E. and dips NW. 35° to 50°; thickness is 4 to 6 ft (SAMPLES 2-6)					
2	Chip, 6 ft	0.002	0.005*	0.017	Pegmatite; qtz 90, ksp 5, msc 5; avg mineral gr. 1 in.
3	Chip, 1 ft	.010	.009*	.006	Msc zone in pegmatite; msc >90.
4	Chip, 5 ft	.017	.006*	.020	Pegmatite; ab 50, qtz 45; msc 5, ap, minor; avg mineral gr. >1 in.
5	Chip, 5.7 ft	.005	.009*	.039	Pegmatite, same composition, gr. size as sample 2.
6	Chip, 4.2 ft	.002	.006	.003	Pegmatite, same composition, gr. size as samples 2, 5.
PEGMATITE, strikes N. 8° to 80° E. and dips NW. 15° to 75°; thickness is 2 ft (SAMPLES 8, 9)					
8	Chip, 2 ft	.020	.009	.034	Pegmatite; qtz 50, fsp 50, msc, fap, gar, minor; avg mineral gr. <1 in.
9	Chip, 2 ft	.030	.006	.054	Pegmatite, same composition, gr. size as sample 8.
PEGMATITE, strikes N. 60° E. and dips NW. 50°; thickness is 4.5 ft (SAMPLE 10)					
10	Chip, 4.5 ft	.010	.007*	.015	Pegmatite; bull qtz 50, fine-gr. qtz 25, ab 25, msc, minor.

See explanation of symbols at end of table.
Sample localities shown on plate 1.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
PEGMATITE, strikes N. 55° to 80° E. and dips NW. 19° to 60°; thickness is 2.7 to 10 ft (SAMPLES 12-13, 15-16)					
12	Chip, 2.7 ft	0.007	0.015	0.028	Pegmatite; qtz 60, ksp 25, ab 10, msc 5; avg mineral gr. 1/2 in., range 1/8 to 4 in.
13	Chip, 4 ft	.004	.010	.005	Pegmatite; qtz 50, ab 45, msc 5; msc-rich upper margin, 1 ft thick.
15	Chip, 10 ft	.002	.005	.017	Pegmatite; qtz 60, ab 30, msc 5, ksp 5; msc-rich upper margin, 1 ft thick.
16	Chip, 7 ft	.006	.008*	.014	Pegmatite; qtz 50, ab 40, msc 10, hematite, minor.
PEGMATITES and GRANITIC DIKE outcropping in northern part of section 22 (SAMPLES 18-26, 28)					
18	Chip, 6 ft	.007	.012	.020	Pegmatite, strikes E.-W., dips N. 30°; qtz 45, fsp 45, msc 10; avg mineral gr. 1/4 in.; msc-rich upper margin, 2 ft thick.
19	Chip, 42 ft	.002	.005	.019	Pegmatite pod, up to 42 ft across; qtz 55, fsp 35, msc 10; mineral gr. 1/4 to 2 in.
20	Chip, 30 ft	.002	.006	.021	Pegmatite, strikes N. 30° E., dips 90°; qtz 45, ab 45, msc 10; avg mineral gr. 1/3 in.
21	Chip, 20 ft	.005	.010*	.018	Pegmatite, strikes N. 45° E., dip not apparent; qtz 45, fsp 40, msc 15; avg mineral gr. 1/4 to 3/4 in., qtz up to 2 in.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
22	Chip, 8 ft	0.005	0.013	0.026	Pegmatite; qtz 60, fsp 30, msc 10; mineral gr. coarse at upper margin (up to 8 in.) and finer at lower margin; includes sugary felsite.
23	Chip, 60 ft	.053	.009*	.003	Pegmatite; qtz 40, fsp 40, msc 20, trm pods up to 1 ft across; avg mineral gr. 3/4 to 1 in., up to 2 in.; see also sample 26.
24	Chip, 4 ft	.004	.007	.003	Pegmatite; qtz 45, fsp 40, msc 15; avg mineral gr. 1/3 in., up to 1.5 in.
25	Chip, 8 ft	.006	.008	.024	Pegmatite, similar composition, gr. size as sample 24; minor fine gr. sugary felsite and gar.
26	Chip, 7.5 ft	.012	.016*	.019	Pegmatite, same body as sample 23, strikes N. 75° E., dips NW. 28°; fsp (perthitic) 80, qtz 15, msc 5, lim, gar, biotite, all minor.
28	Chip, 13 ft	.002	.005*	.003	Granitic dike, strikes N. 81° E., dips SE. 70°, locally concordant; fsp 70, qtz 30, msc minor.
PEGMATITE and GRANITIC DIKE in and near unnamed feldspar mine in section 22, NW. 1/4 (SAMPLES 29-31, 33, 37)					
29	Chip, 55 ft	.001	.004*	.004	Pegmatite, strikes N. 78° E., dips NW. 41°; exposed in 90-ft-wide surface cut showing 60 ft approx. true thickness; fsp (perthitic) 80, qtz 15, msc 5; coarse mineral gr.
30	Chip, 35 ft	.002	.004*	.004	Pegmatite, same body as sample 29, minor zones of sugary, fine-gr. felsite.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
31	Chip, 21 ft	0.001	0.003*	0.004	Granitic dike, strikes N. 71° E., dips NW. 45°; fsp (perthitic) 80, qtz 15, msc 5, minor biotite, gar.
33	Chip, 30 ft	.004	.004*	.007	Pegmatite, same body as samples 29-30, strikes N. 40° E., dips NW. 32°; ksp 60, ab 20, qtz 20; see also sample 37.
37	Chip, 50 ft	.004	.003	.005	Pegmatite, pinches out southward; qtz 50, ab 50, msc minor; see also samples 29-30, 33.

GRANITIC DIKES near Quien Sabe feldspar mine
(SAMPLES 38-40, 42)

38	Chip, 35 ft	.001	.006	.001	Granitic dike, strikes N. 51° E., dips SE. 50°; fsp 70, qtz 30, msc minor; perthitic, medium gr., qtz veins up to 5 in. thick.
39	Chip, 15 ft	.002	.007	.004	Granitic dike, upper lens, strikes N. 79° E., dips NW. 32°; fsp (perthitic) 70, qtz 25, msc 5.
40	Chip, 28 ft	.002	.009	.006	Granitic dike, lower lens (see sample 39); fsp 70, qtz 30, msc minor.
42	Chip, 15 ft	.001	.005	.001	Granitic dike, pegmatite lenses, qtz veins up to 14 in. thick; fsp (perthitic) 70, qtz 25, msc 5; see samples 39-40.

PEGMATITES of Quien Sabe feldspar mine
(SAMPLES 45-49)

45	Chip, 9 in.	.005	.010	.008	Pegmatite, chill margin against hornblende schist; ksp 90, msc 5, trm 2, qtz, 3, gar, minor; TANTALITE observed nearby in pit.
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See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
46	Chip, 6 ft	0.001	0.002*	0.002	Pegmatite, vertical chip on highwall; ksp 80, qtz 10, msc 10.
47	Chip, 3 ft	<.001	ND	.003	Pegmatite, probable fsp "ore" (a white-gray ksp).
48	Chip, 3.6 ft	.049	.007	.007	Pegmatite, strikes due N., dips E. 35°; felsite (fsp 2/3, qtz 1/3).
49	Chip, 6 ft	.002	.006*	.002	Pegmatite, same body as Quien Sabe Mine, exposed on blasted outcrop; probably 20 ft+ thick; ksp 70, ab 15, qtz 10, msc 5.

GRANITIC INTRUSIVE, southern boundary of
section 22 (SAMPLE 50)

50	Chip, 6 ft	.002	.006*	.007	Pegmatite zone, reconnaissance sample at study area margin; qtz 80, ab 10 ksp 10, msc minor.
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PEGMATITE and GRANITIC DIKE SYSTEM between Quien Sabe and
Blue Spar Mines (SAMPLES 52-66)

52	Chip, 23 ft	.001	.006	.002	Granitic dike with pegmatite zones, strikes N. 30° E., dips NW. 35°; ab 50, qtz 50.
53	Chip, 25 ft	.001	.007*	.001	Granitic dike, strikes N. 40° E., dips NW. 22°; ksp 60, ab 20, qtz 20.
54	Chip, 2 ft	.001	.006	.001	Pegmatite zone overlying sample 53, strikes N. 55° E., dips NW. 46°; qtz 60, ab 20, ksp 20; avg mineral gr. 1/2 in, up to 3 in.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
55	Chip, 12 ft	0.001	0.006	0.004	Pegmatite; coarse-gr. zones: msc 30, mineral gr. up to 1 in.; finer-gr. zones: qtz 70, fsp 30, msc, minor.
56	Chip, 16 ft	.008	.009*	.030	Pegmatite; fsp 60, qtz 20, msc 20, gar, trm, minor; avg mineral gr. 1-2 in., up to 3 in.
57	Chip, 15 ft	.002	.008*	.006	Pegmatite; fsp 50, qtz 30, msc 20, gar, minor; avg mineral gr. 1/4 in., up to 1 in.
58	Chip, 8 ft	<.001	.002	.001	Granitic dike; fsp 50, qtz 45, msc 5; avg mineral gr. 1/8 in.
59	Chip, 11 ft	.004	.009*	.010	Pegmatite; fsp 40, qtz 40, msc 20; avg mineral gr. 3/4 in., msc up to 5 in., qtz up to 2.5 in.
60	Chip, 17 ft	.015	.005	.006	Pegmatite; qtz 60, fsp 20, msc 20, gar, trm pods, minor; avg mineral gr. 1/3 in., qtz up to 2.5 in.
61	Chip, 42 ft	.003	.011*	.002	Pegmatite; qtz 40, fsp 40, msc 20; avg mineral gr. 3/4 in., qtz up to 2 in.
62	Chip, 60 ft	.002	.006*	.006	Pegmatite, horizontal chip on high-wall base; qtz 40, fsp 40, msc 20, trm disseminated and in pods.
63	Chip, 15 ft	.004	.006*	.016	Pegmatite, vertical sample of exposed highwall; qtz 75, fsp 15, msc 10, trm, minor.
64	Chip, 12 ft	.008	.010*	.074	Pegmatite, vertical sample of exposed highwall; qtz 85, fsp 10, msc 5, trm, minor, in pods up to 3 in. by 5 ft.
65	Chip, 5 ft	ND	.001	.001	Pegmatite; qtz 50, fsp 50, msc, minor.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
66	Chip, 25 ft	0.012	0.013	0.026	Pegmatite; qtz 75, fsp 20, msc 5, gar, minor; avg mineral gr. 1 in., qtz up to 2 in.
PEGMATITES at Blue Spar feldspar mine (SAMPLES 67-88)					
67	Chip, 6 ft	.004	.011*	.003	Pegmatite, vertical sample on high-wall; qtz 45, fsp 45, msc 10, gar, trm, tantalite(?) crystals, minor; avg mineral gr. 1/4 in., up to 3 in.
68	Chip, 6 ft	.005	.014*	.002	Pegmatite from same quarry as sample 67; qtz 40, fsp 40, msc 20, gar, epidote, minor; TANTALITE blades, 1/4 in. long; avg mineral gr. 1 in., up to 2.5 in.
69	Chip, 14 ft	.003	.008*	.009	Pegmatite, vertical sample on high-wall; fsp 60, qtz 20, msc 20, gar, trm, minor; sugary felsite lenses present.
70	Chip, 16 ft	.010	.014	.013	Do.
71	Chip, 14 ft	.006	.014	.020	Pegmatite; fsp 65, qtz 25, msc 10, trm pods, gar, minor; avg mineral gr. small, qtz up to 1 in.
72	Chip, 6 ft	.004	.010*	.005	Pegmatite, vertical sample on high-wall; fsp 50, qtz 30, msc 20, gar, lim, minor; avg mineral gr. 1/2 in., qtz up to 1.5 in.
73	Chip, 6 ft	.003	.006*	.002	Pegmatite, vertical sample on high-wall; fsp 75, qtz 15, msc 10, gar, lim, minor; avg mineral gr. 3/4 in., up to 3 in.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
74	Chip, 14 ft	0.007	0.008*	0.006	Pegmatite, vertical sample from same highwall as samples 72-73; qtz 40, fsp 40, msc 20, gar, minor; avg mineral gr. 1 in, up to 4 in.
[SAMPLES 75-82 and 84-88 represent a NE.-SW. continuous sample across the Blue Spar Mine intrusive.]					
75	Chip, 50 ft	.002	.011*	.006	Pegmatite; qtz 40, fsp 40, msc 20, trm, minor; avg mineral gr. 1/2 in., up to 3 in.
76	Chip, 50 ft	.003	.015*	.005	Pegmatite, adjoins samples 75, 77; qtz 40, fsp 40, msc 20, trm pods in sugary felsite, minor.
77	Chip, 50 ft	.002	.010*	.002	Pegmatite, adjoins samples 76, 78; fsp 55, qtz 35, msc 10, gar, minor; avg mineral gr. 1/3 in., up to 1 in.
78	Chip, 50 ft	.001	.003*	.001	Pegmatite, adjoins samples 77, 79; fsp 55, qtz 40, msc 5, gar, minor; avg mineral gr. 1/2 in., up to 3 in.
79	Chip, 50 ft	.002	.008*	.001	Pegmatite, adjoins samples 78, 80; fsp 70, qtz 30, msc, gar, minor; qtz veinlets; avg mineral gr. 1/3 in., up to 2.5 in.
80	Chip, 50 ft	.002	.007*	.002	Pegmatite, adjoins samples 79, 81; eastern 25 ft same as sample 79, western 25 ft: qtz 75, fsp 20, msc 5; avg mineral gr. 1/3 in., up to 1 in.
81	Chip, 50 ft	.004	.013*	.001	Pegmatite, adjoins samples 80, 82; fsp 40, qtz, 40, msc 20; avg mineral gr. 1/3 in., up to 4 in.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
82	Chip, 38 ft	0.002	0.008*	0.001	Pegmatite, adjoins sample 81; fsp 60, qtz 20, msc 20; avg mineral gr. 1/2 in., up to 3 in.
83	Grab	<.001	ND	.020	Magnetite lens from fsp prospect; 0.03% Mn.
84	Chip, 20 ft	.004	.009	.008	Pegmatite; vertical sample by re-claimed portal; fsp 45, qtz 45, msc 10, trm pods, 1 to 2 in.; avg mineral gr. 1/8 in.
85	Chip, 35 ft	.004	.013	.022	Pegmatite, adjoins samples 84, 86; fsp 45, qtz 45, msc 10, gar, minor; avg mineral gr. 1/4 in.
86	Chip, 50 ft	.004	.011	.016	Pegmatite, adjoins samples 85, 87; qtz 80, fsp 19, msc 1, gar, trm, minor; mostly fine-gr., sugary felsite.
87	Chip, 50 ft	.003	.007	.012	Pegmatite, adjoins samples 86, 88; qtz 65, fsp 25, msc 10, gar, fap, minor; fsp gr. to 4 in.
88	Chip, 50 ft	.001	.003*	.004	Pegmatite, adjoins sample 87; qtz 55, fsp 35, msc 10, trm, minor; avg mineral gr. 1/4 in., up to 2.5 in.

PEGMATITES and GRANITIC INTRUSIVE at Zimmerman Mine
(SAMPLES 90-97)

90	Chip, 4 ft	.004	.006*	.006	Pegmatite; fsp 60, qtz 35, msc 5; avg mineral gr. 1/2 in., up to 1 in.
91	Chip, 72 ft	.005	.013	.006	Pegmatite; fsp 40, qtz 40, msc 20, gar, minor; avg mineral gr. 1/2 in., up to 1 in.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
92	Chip, 100 ft	0.004	0.010	0.005	Granitic intrusive; ksp 60, qtz 40; avg mineral gr. 1/8 to 1/2 in.; adjoins sample 93.
93	Chip, 100 ft	.005	.012	.004	Granitic intrusive, adjoins samples 92, 94.
94	Chip, 100 ft	.004	.012	.004	Granitic intrusive, adjoins samples 93, 95.
95	Chip, 100 ft	.003	.010	.007	Granitic intrusive, adjoins samples 94, 96.
96	Chip, 65 ft	.006	.011	.007	Granitic intrusive, adjoins sample 95.
97	Chip, 50 ft	.005	.013	.012	Pegmatite; fsp 50, qtz 35, msc 15; avg mineral gr. 1/4 to 1/2 in., up to 3 in.

PEGMATITES and GRANITIC INTRUSIVE west and north of
the Blue Spar Mine (SAMPLES 106-134)

106	Chip, 4 ft	.012	.017	.018	Pegmatite; fsp 40, qtz 35, msc 25, gar, minor, beryl up to 3 in., TANTALITE blades up to 1/2 in. long.
107	Chip, 35 ft	.003	.014	.003	Granitic dike, strikes N. 71° E., dips SE. 45°, locally concordant; fsp (perthitic) 70, qtz 25, msc 5; avg mineral gr. mostly medium size, some coarse qtz, fsp.
108	Chip, 60 ft	.002	.002	.001	Granitic dike with pegmatite zones, strikes N. 60° E., dips NW. 50°; qtz, fsp (perthitic), msc, schist xenoliths; see sample 109.
109	Chip, 40 ft	.003	.011*	.002	Granitic dike, adjoins sample 108; has less pegmatite rock.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
110	Chip, 40 ft	0.004	0.012	0.004	Granitic dike; fsp 70, qtz 25, msc 5; qtz veins up to 6 in. thick.
111	Chip, 46 ft	.003	.010	.010	Granitic dike, adjoins sample 110; fsp 70, qtz 25, msc 5, gar, minor; qtz veins up to 10 ft thick with trm, sugary, fine-gr. felsite.
112	Chip, 9 ft	.002	.007*	.005	Pegmatite in granitic dike, strikes N. 53° W., dips 90°; fsp 70, qtz 20, msc 10.
113	Chip, 21 ft	.002	.011	.014	Granitic dike, locally concordant, strikes N. 73° E., dips SE. 64°; composition of sample 114.
114	Chip, 30 ft	.005	.020*	.003	Granitic dike, locally concordant, strikes N. 77° E., dips SE. 66°; fsp 75, qtz 20, msc 5, biotite, minor; in part gneissic texture.
115	Chip, 28 ft	.003	.011*	.002	Granitic dike, locally concordant, strikes N. 80° E., dips SE. 62°; fsp 75, qtz 20, msc 5, lim, biotite, minor.
116	Select	.003	.009	<.014	Granitic dike; ab and gray qtz with FeOx-stained blades (possibly tantalite).
117	Chip, 28 ft	.004	.010	.008	Granitic dike, same site as sample 116, strikes N. 80° E., dips SE. 60°; fsp 75, qtz 20, msc 5, lim, biotite, minor.
118	Select	.004	.008*	.046	Granitic dike; composite sample from dumps of two 8-ft-deep pits, 28 ft apart; fsp 70, qtz 25, rest is msc, trm (in pods up to 7 in.), gar, fap, unidentified black mineral (trm?).

See explanation of symbols at end of table.

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
119	Chip, 3 ft	0.004	0.012	<0.014	Granitic dike; sample from west pit; includes beryl, msc, gar in bands (relict schistosity), trm pods (2 by 3 in.).
120	Chip, 24 ft	.004	.010*	.006	Granitic dike, strikes N. 75° E., dips SE.; across width of sample 118 intrusion.
121	Chip, 28 ft	.001	.004	.008	Granitic dike, strikes N. 72° E., dips SE. 36°; fsp 65, qtz 30, msc 5, trm, gar, lim, minor; medium to coarse-grained; qtz veins up to 10 in.
122	Chip, 72 ft	.004	.012	.019	Pegmatite; qtz 50, fsp 30, msc 20; avg mineral gr. medium, up to 1.5 in.; fine-gr. felsite present.
123	Chip, 7 ft	<.001	.002	.001	Pegmatite; fsp 50, qtz 30, msc 20, disseminated trm; avg mineral gr. 1/3 to 1/2 in., up to 3 in.
124	Chip, 3 ft	<.001	.002	.002	Pegmatite; fsp 65, qtz 25, msc 10, gar, minor; avg mineral gr. 1/4 in.
125	Chip, 16 ft	.004	.012	.013	Pegmatite; qtz 55, fsp 35, msc 10, gar, fine-gr. felsite, minor; mineral gr. up to 2 in.
126	Chip, 22 ft	.003	.010	.006	Pegmatite; qtz 50, fsp 49, msc 1; 5 ft zone of fine-gr. felsite with gar.
127	Chip, 27 ft	.005	.014*	.013	Pegmatite; fsp 70, qtz 30, msc (pods) and trm (near lower margin), minor.
128	Chip, 18 ft	ND	.002	.001	Pegmatite; fsp 50, qtz 50, msc, fine-gr. felsite, minor; mineral gr. up to 3 in.
129	Chip, 8 ft	.005	.008	.019	Pegmatite; fsp 45, qtz, 45, msc 10; avg mineral gr. 1/2 to 1 in., up to 2 in.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
130	Chip, 6 ft	0.004	0.015	0.016	Pegmatite; fsp 45, qtz, 45, msc 10; avg mineral gr. 1/2 to 1 in., up to 2 in.
131	Chip, 35 ft	.003	.015*	.031	Pegmatite; qtz 55, fsp 40, msc 5, gar, minor; avg mineral gr. medium, up to 1 in.
132	Chip, 12 ft	ND	.001	.001	Granitic dike, strikes N. 65° E., dips SE. 70°, locally concordant; probable extension of Bonneville #7 dike; avg mineral gr. 1/4 to 1/2 in., up to 2 in.
133	Chip, 5 ft	.013	.013	.024	Pegmatite, strikes N. 60° E., dips NW. 45°; fine-gr. sugary feldspar 95+, rest is gar, fap.
134	Chip, 6 ft	.028	.018	.039	Pegmatite, strike varies, dips NW. about 70°; fine-gr. sugary feldspar 95+, gar, lepidolite, fap, minor; avg mineral gr. 1/8 in., equant.

PEGMATITES and GRANITIC DIKES on and near the Bonneville #7 and #8 claims (SAMPLES 135-166, 168-171, 174)

135	Chip, 6 ft	.012	.006*	.024	Pegmatite, strikes N. 40° E., dips NW. 20; ab 50, qtz 50; avg mineral gr. 3/4 to 1 in., up to 2 in.
136	Chip, 4 ft	.009	.010	.060	Granitic dike, strikes N. 50° E., dips NW. 25; ab 50, qtz 50.
137	Chip, 16 ft	.011	.010	.019	Pegmatite, strikes N. 70° E., dips SE. 75°, avg 4 ft thick; ab 60, qtz 30, ksp 5, msc 5; avg mineral gr. 1/2 in., up to 4 in.
138	Chip, 1.7 ft	.003	.012*	.013	Pegmatite upper margin; ab 1/3, qtz 1/3, msc 1/3.

See explanation of symbols at end of table.

APPENDIX A.—ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES—CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
139	Chip, 13.7 ft	0.019	0.007	0.014	Pegmatite, adjoins sample 138; mostly qtz core with ab 10; 2 ft of ab at footwall.
140	Chip, 8.2 ft	.005	.012*	.006	Pegmatite upper margin; msc-rich.
141	Chip, 12.6 ft	.011	.010	.022	Pegmatite, adjoins sample 140; qtz 75, ab 25, msc, minor.
142	Chip, 4.9 ft	.020	.014	.023	Pegmatite, fine-gr. felsite zone; 2-3% TANTALITE blades, 1/32 in. thick.
143	Chip, 2.5 ft	.016	.011	.024	Pegmatite, fine-gr. felsite zone; felsite 95+, gar, msc, minor, MnOx stain.
144	Chip, 16 ft	.026	.010	.101	Pegmatite, fine-gr. felsite zone, strikes N. 80° W., dips NE. 20 to 90°.
145	Chip, 35 ft	.079	.010	.014	Pegmatite, composite sample including zones of samples 146-147.
146	Chip, 6 ft	.468	.012	.067	Pegmatite, fine-gr. felsite zone; felsite 95+, TAPIOLITE 1, gar, fap, minor; at 8-ft-deep pit.
147	Chip, 20 ft	.005	.004*	.008	Pegmatite upper margin, adjoins sample 145; fsp, qtz, msc.
148	Chip, 9 ft	.071	.009	.068	Pegmatite, sugary, fine-gr. felsite zone; gar 5, TAPIOLITE in upper 5 in.
149	Chip, 7 ft	.002	.004	.015	Pegmatite, coarse mineral zone overlying sample 148.
150	Chip, 25 ft	.104	.004	<.014	Pegmatite; includes intervals of samples 148-149.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
151	Chip, 6 ft	0.166	0.005*	0.062	Pegmatite, sugary, fine-gr. felsite zone.
152	Chip, 9 ft	.072	.008	.150	Pegmatite at westernmost end of outcrop on #8 claim.
153	Bulk	.101	.003	NT	Bulk metallurgical test sample (632 1b) from area including sample sites 145-152; TAPIOLITE.
154	Chip, 13 ft	.004	ND*	.002	Pegmatite, strikes N. 43° E., dips NW. 32°; ab 60, qtz 30, msc 5, other 5 (includes gar, beryl, TANTALITE, TAPIOLITE); coarse-gr. upper zone.
155	Chip, 16 ft	.058	.011*	.053	Pegmatite, medium-gr. lower margin, adjoins sample 154; ab, qtz, msc (green) major, TANTALITE-COLUMBITE, TAPIOLITE minor.
156	Chip, 5 ft	.017	.013	.027	Pegmatite, sugary, fine-gr. felsite zone; felsite 80, ab 15, msc 5, TANTALITE blades (1/32 in.), fap, minor.
157	Chip, 2 ft	.005	.019*	.028	Pegmatite, coarse-gr. upper margin overlying sample 156; fsp, qtz, msc.
158	Chip, 10 ft	.002	.007	.038	Pegmatite, strikes N. 68° E., dips NW. 43; upper margin is msc 40, qtz 40, fsp 20; main body is fsp 65, qtz 25, msc 10, lim, gar, trm, biotite, minor.
159	Chip, 24 ft	<.001	.001	.002	Granitic dike, strikes N. 67° E., dips SE. 51°; fsp 70, qtz 30, msc, lim, biotite, minor.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
160	Chip, 5 ft	0.011	0.020	0.052	Pegmatite upper margin, strikes N. 60° E., dips NW. 25°; fsp 60, qtz 20, msc 15, other 5 (includes malachite, lim, TAPIOLITE, TANTALITE, fap, gar); near shear in schist.
161	Chip, 6 ft	.026	.015	.005	Pegmatite, msc-rich pod; malachite, Mn stain, fsp inclusions.
162	Chip, 3 ft	.029	.017	.019	Pegmatite; ab 60, qtz 40, msc, TAPIOLITE, TANTALITE, malachite, minor; avg mineral gr. medium.
163	Chip, 37 ft	<.001	.002	.001	Granitic dike, strikes N. 65° E., dips SE. 70°; sample 160-162 pegmatite intersects but excluded from sample 163; avg mineral gr. 1/4 to 1/2 in, up to 2 in.
164	Chip, 75 ft	ND	.001	.001	Granitic dike, strikes N. 60° E., dips SE. 57°; fsp 70, qtz 30, msc, minor; bull qtz zones up to 6 in. thick; sugary felsite at contacts.
165	Chip, 24 ft	<.001	.001	.001	Granitic dike, strikes N. 67° E., dips SE. 51°; fsp 70, qtz 30, msc, lim, minor.
166	Chip, 30 ft	<.001	ND	.001	Pegmatite, interbedded with schist, strikes N. 71° E., dips SE. 76°; fsp 65, qtz 25, msc 10, Mn, biotite gar, trm, minor.
168	Chip, 60 ft	<.001	.002	.001	Granitic dike; similar composition to sample 166.
169	Chip, 28 ft	ND	.002	.001	Granitic dike, strikes N. 65° E., dips SE. 55°; fsp 75, qtz 25, msc, lim, minor; avg mineral gr. medium to coarse.
170	Chip, 22 ft	<.001	.002	.001	Do.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
171	Chip, 68 ft	ND	0.001	0.001	Granitic dike, strikes N. 54° E., dips SE. 39°; fsp 70, qtz 25, msc 5, biotite, gar, minor.
174	Chip, 40 ft	ND	.002	.001	Granitic dike, strikes N. 72° W., dips SW. 65°; fsp 75, qtz 15, msc 5, trm, biotite, lim, minor; avg mineral gr. coarse.
GRANITIC DIKE and PEGMATITES south of the Bonneville #1 and #3 claims (SAMPLES 176-192)					
176	Chip, 43 ft	0.003	.009	.001	Granitic dike, strikes N. 26° E., dips NW. 35°; qtz 75, ksp 20, micas (msc, biotite) 5; avg mineral gr. 1/4 in., up to 4 in.
177	Chip, 76 ft	.003	.010	.002	Do.
178	Chip, 60 ft	.004	.013*	.003	Do.
179	Chip, 100 ft	.004	.013*	.003	Granitic dike; qtz 50, fsp 50, msc, gar, minor; avg mineral gr. 1/4 in., up to 1 in.
180	Chip, 2 ft	.058	.014	.021	Pegmatite, secondary, upper part of outcrop; felsite 95, fap 5, gar, minor.
181	Chip, 15 ft	.003	.003*	.011	Pegmatite, vertical sample; fsp 75, qtz 20, msc 5, gar, fap, minor; mineral gr. up to 6 in.
182	Chip, 10 ft	.006	.007	.029	Pegmatite; felsite (sugary, fine-gr.) and bull qtz 70, fsp 15, msc 15, gar, fap, minor; mineral gr. up to 3 in.
183	Select	.020	.006	.019	Pegmatite; sugary felsite, fap from dump of sample 182 pit.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
184	Chip, 50 ft	0.004	0.010*	0.004	Granitic dike, strikes N. 80° W., dips NE. 35°; fsp 55, qtz 35, msc 10, gar, trm pods, sugary felsite, minor.
185	Chip, 10 ft	.002	.009	.001	Pegmatite exposed on blasted outcrop; interval less than true thickness; fsp 75, qtz 15, msc 10.
186	Select	.007	.046*	.075	Pegmatite, select of coarse msc and qtz (mineral gr. up to 4 in.) from sample site 185.
187	Chip, 6 ft	.004	.008	.013	Pegmatite, vertical sample; qtz 35, fsp 35, msc 30, gar, minor.
188	Chip, 40 ft	.027	.012	.025	Pegmatite, adjoins sample 189; fsp 35, qtz 35, msc 30, gar, fap, minor.
189	Chip, 40 ft	.007	.011*	.083	Pegmatite, adjoins samples 188, 190; fsp 60, qtz 30, msc 10, gar, fap, minor.
190	Chip, 40 ft	.014	.012*	.011	Pegmatite, adjoins sample 189; fsp 35, qtz 35, msc 30, gar, fap, minor.
191	Chip, 45 ft	.006	.009	.021	Pegmatite, strikes N. 25° W, dips SW. 50°; vertical sample on high-wall; fsp 55, qtz 35, msc 10; sugary felsite with gar, fap near lower margin.
192	Chip, 50 ft	ND	ND	.001	Mica schist, baked, overlying sample 191.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
PEGMATITES and GRANITIC DIKES of the Bonneville #1 and #3 claims areas (SAMPLES 194-243)					
194	Chip, 6 ft	0.017	0.017*	0.034	Pegmatite, strikes N. 20° E., dips NW. 80°; ab 60, qtz 30, msc 10; mineral gr. up to 6 in.
195	Chip, 30 ft	.003	.004	.044	Pegmatite, strikes N. 60° E., dips NW. 55°, vertical sample on high-wall; qtz 50, fsp 50, msc, minor; mineral gr. up to 8 ft.
196	Select	.012	.006	.008	Pegmatite, massive trm pods.
197	Select	.013	.008	.022	Mica schist bedrock at pegmatite contact; impregnated with trm.
198	Chip, 14 ft	.016	.004	.013	Pegmatite of samples 196-197, strikes N. 55° E., dips NW. 60 to 70°; fsp 90, qtz 10, trm (at lower margin), gar, minor.
199	Chip, 15 ft	.003	.003	.006	Pegmatite lower margin, strikes N. 70° E., dips NW. 50°; fsp 60, qtz 40, msc, minor.
200	Chip, 2 ft	.021	.008*	.006	Pegmatite upper margin above sample 199; msc 95+, qtz & fsp about 5; mineral gr. up to 3 in.
201	Chip, 3 ft	.014	.018*	.006	Pegmatite, msc zone adjoining qtz core.
202	Chip, 8 ft	.004	.004	.217	Pegmatite upper margin, strikes N. 80° E., dips NW. 43°; fsp 80, qtz 20, msc, minor; see sample 201.
203	Chip, 12 ft	.001	.002	.002	Pegmatite, bull qtz core; see samples 201-202.
204	Chip, 8 ft	.001	.002	.003	Mica schist, baked, at lower margin contact with pegmatite samples 201-203.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
205	Select	0.031	0.018*	0.006	Msc rind on fsp-qtz pegmatite pod; see sample 206.
206	Chip, 22 ft	.002	.002	.002	Pegmatite, strikes N. 70° E., dips NW. 60°; bull qtz on contact margins, qtz-fsp in core.
207	Chip, 5 in.	.014	.010*	.012	Pegmatite upper margin, strikes N. 20° E., dips NW. 25°; msc 50, qtz-fsp 50; see samples 208-209.
208	Chip, 2 ft	<.001	.002	.001	Pegmatite bull qtz zone, adjoins sample 207.
209	Chip, 2.5 ft	.008	.008*	.009	Pegmatite lower margin, adjoins sample 208; fsp 40, qtz 40, msc 20, gar, minor; mineral gr. up to 4 in.
210	Chip, 9 ft	.008	.011	.015	Pegmatite, strikes N. 50° E., dips NW. 35°; ab 80, qtz 20, msc (mostly on upper margin) minor.
211	Chip, 4 ft	.003	.005*	.011	Pegmatite, strikes N. 50° E., dips NW. 48°, same composition as sample 210; avg mineral gr. 1 in., up to 6 in.
212	Chip, 1 ft	.008	.019*	.032	Pegmatite upper margin, msc-rich.
213	Chip, 4 ft	.011	.008	.081	Pegmatite, adjoins sample 212, strikes N. 50° E., dips NW. 20°; ab 60, qtz 30, ksp 5, msc 5; avg 3 ft thick.
214	Chip, 15 in.	.007	.006*	.006	Pegmatite upper margin; ab 1/3, msc 1/3, qtz 1/3.
215	Chip, 5 ft	.047	.004*	.009	Pegmatite, adjoins sample 214; ab 60, ksp 20, qtz 20, lepidolite, minor; ab up to 5 in.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
216	Chip, 16 ft	0.037	0.030*	>0.278	Pegmatite; qtz 95+, msc, fsp, minor, TANTALITE blades up to 1 in. (about 20 observed).
217	Chip, 57 ft	.007	.003*	.009	Pegmatite; fsp (perthitic) 75, qtz 20, msc 5; faulted off.
218	Chip, 25 ft	.035	.001*	.012	Pegmatite, strikes N. 35° E., dips NW. 43°; ab 60, ksp 15, qtz 20, msc 5, gar, fap, TANTALITE, minor.
219	Select	.650	ND*	.004	Pegmatite; select of lepidolite from sorted pile.
220	Chip, 18 ft	.017	.018	.043	Pegmatite, strikes N. 80° E., dips NW. 75°; fsp 40, qtz 40, msc 20 (mostly at upper margin), gar, lim, minor.
221	Chip, 45 ft	.003	.004*	.008	Pegmatite, strikes N. 80° E., dips NW. 55°, composite sample, excluding qtz core; fsp 85, qtz 15, up to 20% msc at schist contact.
222	Chip, 6 in.	.037	.046*	.003	Pegmatite-schist contact; msc-rich; see sample 221.
223	Chip, 12 ft	.018	.009*	>.278	Pegmatite upper margin above qtz core (excluding msc-rich schist contact; fsp 50, qtz 50, msc (in pods) up to 10; mineral gr. up to 4 in.
224	Chip, 8 ft	ND	.001	.001	Pegmatite bull qtz core; see samples 221-223.
225	Chip, 10 ft	.049	.040	.139	Pegmatite upper margin, strikes E.-W., dips N. 48°; qtz 30+, fsp 20+, msc up to 50%, a few crystals of TANTALITE; avg mineral gr. 1/4 to 1/2 in., up to 1 ft.
226	Chip, 10 ft	<.001	.001	.001	Pegmatite qtz core, adjoins sample 225.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
227	Chip, 10 ft	0.038	0.029*	0.031	Pegmatite lower margin, adjoins sample 226; fsp 50, qtz 50, msc, gar, minor.
228	Chip, 7.5 ft	.014	.014	.02	Pegmatite core, vertical sample on east end of open cut; ab 70, qtz 20, msc 10, beryl, trm, tantalite (?), gar, minor.
229	Chip, 15 ft	.021	.007	.02	Pegmatite core, vertical sample, east end of open cut; ab 65, qtz 30, msc 5, gar, minor.
230	Bulk	NT	<.004	<.011	Amphibolite overlying Bonneville #1 pegmatite; 50 lb sample.
231	Bulk	NT	.018	.05	Pegmatite muck from sill of open cut, east end; 50 lb sample.
232	Chip, 6 ft	.004	.006	.39	Pegmatite, vertical sample at face of 10-ft-long cut; msc-rich with qtz, fsp, MnOx; TANTALITE-COLUMBITE crystals up to 3 in. long.
233	Bulk	<.005	<.005	NT	Pegmatite, three-part segregation of sample 232 (see samples 234-235), upper 4 ft of fsp-qtz core (25 ft thick, total); qtz 95, msc 5, MnOx, minor (part of core 70% fsp); avg mineral gr. 3 to 7 in.; 65.6 lb sample.
234	Bulk	.056	.056	NT	Pegmatite, adjoins sample 233, msc- and TANTALITE-rich zone above core; msc 90, ksp 5, qtz 5; 3 ft sample interval; avg mineral gr. 1 to 3 in.; 57 lb sample.
235	Bulk	.005	.005	NT	Pegmatite, adjoins sample 234, upper margin zone; qtz 60, fsp 35, msc 5; 4 ft sample interval; 65 lb.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
236	Bulk	0.147	0.140	NT	Pegmatite, bulk metallurgical sample (1,585 lb) at site of #232; msc-TANTALITE-rich zone.
237	Select	.001	.002	0.001	Pegmatite, MnOx-stained qtz from core at contact with overlying msc-TANTALITE-rich zone.
238	Select	.465	.098	.003	Pegmatite, manganiferous nodules from dump (occur in upper part of core, but are rare).
239	Chip, 5 ft	.018	.023	.39	Pegmatite, west end of msc-TANTALITE-rich zone.
240	Chip, 10 ft	.008	.006	.04	Pegmatite (15 ft thick, total) from central highwall; ab 90, qtz 5, msc 4, other 1 [includes TANTALITE, beryl (green), pyrolusite].
241	Chip, 8 ft	.006	.003	<.01	Pegmatite (12 ft thick, total); ab 85, qtz 10, msc 5, gar, trm, minor.
242	Bulk	.002	.003	<.01	Pegmatite muck, west end of opencut; ab, qtz, TANTALITE; 50 lbs.
243	Chip, 5 ft	.006	.007	.04	Pegmatite; mostly ab, some tantalite (?).

PEGMATITES and GRANITIC INTRUSIVES north and west of Bonneville #1 and #3 claims area (SAMPLES 244-274, 277, 280, 282-285, 287-294, 296-311)

244	Chip, 70 ft	<.001	.001	.001	Granitic intrusive, pendant-shaped; fsp 70, qtz 30, msc, minor; avg mineral gr. medium to coarse.
245	Chip, 4 ft	ND	ND	.001	Pegmatite, locally concordant; fsp 60, qtz 30, msc 10.
246	Chip, 67 ft	ND	.001	.001	Granitic dike, strikes N. 60° E., dips SE. 56°; fsp 65, qtz 25, msc 10.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
247	Chip, 1 ft	0.012	0.009	0.032	Pegmatite in granitic dike, strikes N. 30° E., dips NW. 30°; continues on strike 40 ft; qtz (two phases) 99, msc 1.
248	Chip, 10 ft	<.001	.002	.001	Granitic dike, strikes N. 60° E., dips SE. 60°; fsp 60, qtz 40, msc, minor.
249	Chip, 4.5 ft	<.001	.003	.004	Granitic dike, strikes N. 80° E., dips SE. 66°; fsp 50, qtz 50, msc, minor.
250	Chip, 5 ft	<.001	.003	.002	Granitic dike; fsp 65, qtz 35.
251	Chip, 36 ft	<.001	.002	.002	Granitic dike, strikes E.-W., dips S. 70°; fsp 50, qtz 50.
252	Chip, 40 ft	<.001	.002	.002	Granitic dike; qtz 50, fsp 50, msc, minor; avg mineral gr. 1/4 to 1/2 in., up to 1.5 in.
253	Chip, 45 ft	.001	.002	.001	Do.
254	Chip, 40 ft	<.001	.001	.001	Granitic dike; qtz 50, fsp 50, msc, minor; avg mineral gr. 1/4 to 1/2 in., up to 1.5 in.
255	Chip, 45 ft	<.001	.002	.002	Do.
256	Chip, 9 ft	<.001	.002	.014	Granitic dike; fsp 60, qtz 40, msc, biotite, epidote, minor.
257	Chip, 9 ft	ND	.001	.001	Qtz vein, strikes N. 60° W., dips SW. 60°; msc, minor.
258	Chip, 50 ft	.007	.012*	.010	Pegmatite; fsp 70, qtz 25, msc 5.

See explanation of symbols at end of table.

APPENDIX A.—ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES—CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
259	Chip, 10 ft	0.016	0.010	0.020	Pegmatite, strikes N. 52° E., dips NW. 49°; fsp 60, qtz 30, msc 10, gar, minor.
260	Chip, 7.5 ft	.028	.010	.006	Pegmatite, strikes N. 33° E., dips NW. 33°; fsp 65, qtz 25, msc 10; avg mineral gr. coarse.
261	Chip, 50 ft	.007	.017*	.013	Pegmatite, strikes N. 60° E., dips SE.; fsp (perthitic) 70, qtz 25, msc (pods up to 3 ft) 5, gar, minor.
262	Chip, 15 ft	.008	.014	.022	Pegmatite; fsp 70, qtz 25, msc 5, gar, trm pods, minor.
263	Chip, 37 ft	.005	.011	.025	Pegmatite, strikes N. 57° E., dips SE. 73°; fsp 70, qtz 25, msc 5, gar, lim, minor; granitic texture in zones.
264	Chip, 34 ft	.006	.010*	.048	Pegmatite; fsp 60, qtz 30, msc 10; sugary felsite in core.
265	Chip, 4.5 ft	ND	.001	<.001	Pegmatite, bull qtz core; msc, minor.
266	Chip, 35 ft	.004	.009	.032	Pegmatite, strikes N. 76° E., dips SE. 66°; fsp 70, qtz 25, msc 5, gar, lim, minor; sugary, fine-gr. felsite in core.
267	Chip, 4.5 ft	.010	.014	.033	Pegmatite, strikes N. 36° E., dips NW. 67°; qtz 75, msc 25; core is 90%+ sugary felsite.
268	Chip, 10 ft	.007	.014	.029	Do.
269	Chip, 13 ft	.010	.010	.056	Pegmatite, strikes N. 59° E., dips SE. 56°; fsp 70, qtz 25, msc 5, lim, minor; slightly perthitic.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
270	Chip, 30 ft	0.006	0.005	0.016	Granitic dike, strikes N. 51° E., dips SE. 68°; fsp 70, qtz 25, msc 5, FeOx stain.
271	Chip, 65 ft	.004	.008*	.006	Do.
272	Select	ND	.002	.001	Qtz from vein(?), 18 ft from pegmatite; 2-3% msc, malachite-, lim-stained.
273	Chip, 13 ft	.002	.003*	.010	Pegmatite, strikes N. 30° E., dips NW. 34°; fsp 60, qtz 25, msc 5, other 5 (includes biotite, gar); mineral gr. up to 3 in.
274	Chip, 24 ft	.004	.004*	.015	Pegmatite, strikes N. 55° E., dips NW. 35°; qtz 60, ab 30, msc 10, gar, fap, magnetite, tantalite(?), minor.
277	Chip, 3 ft	.018	.008	.060	Pegmatite, strikes N. 20° E., dips SE. 46° to horizontal, intrudes shear by samples 275-276; qtz 95 (two phases), msc 5.
280	Chip, 6 ft	.020	.008	.011	Pegmatite, strikes N. 50° W., dips SW. 25°, up to 9 ft thick; ab 60, qtz 40, msc, minor; avg mineral gr. 3/4 in.
282	Chip, 5 ft	.025	.012	.034	Pegmatite; qtz 90, ab 10, msc, minor, sugary felsite zones; avg mineral gr. 1/2 in.
283	Chip, 10 ft	.017	.012*	.030	Pegmatite, strikes N. 10° W., dips SW. 18°; qtz 60, fsp 30, msc 10; avg mineral gr. 1/2 to 3/4 in., up to 2.5 in.
284	Chip, 10 ft	<.001	.002	.002	Schist, partially metasomatized.

See explanation of symbols at end of table.

APPENDIX A.—ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES—CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
285	Chip, 12 ft	0.045	0.006*	0.070	Granitic dike; fsp 80, qtz 20, msc, fap, minor; avg mineral gr. coarse, up to 1.5 in.
287	Chip, 9 in.	.018	.010	.028	Qtz-trm vein, largest of several in swarm.
288	Chip, 4 ft	.010	.010	.033	Pegmatite, strikes N. 67° E., dips NW. 30° along 100 ft of exposed strike; sugary felsite core.
289	Chip, 25 ft	.017	.003	.006	Pegmatite, strikes N. 45° E., possibly same dike as sample 288; ab 60, qtz 40, msc, fap, lim, minor.
290	Chip, 3 ft	.010	.011	.018	Pegmatite, strikes N. 50° E., dips NW. 48°, avg 1.5 ft thick; qtz 95, ksp, msc, minor; avg mineral gr. 1/8 to 1/4 in., up to 6 in.
291	Chip, 7 ft	.016	.005	.012	Pegmatite; fsp 65, qtz 25, msc 10; avg mineral gr. 1/2 to 3/4 in., up to 1 in.
292	Chip, 4 ft	.028	.010	.062	Pegmatite; fsp 80, qtz 20, msc, minor but up to 25% at upper margin contact; avg mineral gr. 1/2 in., up to 3/4 in.
293	Chip, 51 ft	.039	.012	.014	Granitic dike; fsp 2/3, qtz 1/3; avg mineral gr. 1/2 in., up to 1 ft.
294	Chip, 12 ft	<.001	.002	.002	Granitic dike; fsp 45, qtz 45, msc 10, biotite, minor.
296	Chip, 6 ft	.047	.004*	.061	Granitic dike with pegmatite zones; fsp 60, qtz 40.
297	Chip, 6 ft	.041	.004*	.036	Granitic dike, strikes N. 65° E., dips SE. 55°; qtz 60, fsp 40, avg mineral gr. 1/4 in., up to 4 in.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
298	Chip, 6 ft	<0.001	0.001	0.001	Pegmatite, strikes N. 10° E., dips NW. 45°, qtz-rich zone.
299	Chip, 4 ft	.002	ND*	.005	Pegmatite of sample 298; fsp 50, qtz 50, msc, minor; mineral gr. up to 6 in.
300	Chip, 20 ft	<.001	.001	.001	Granitic dike, strikes E.-W., dips S. 48°; qtz 60, fsp 40; avg mineral gr. 1/3 in.
301	Chip, 6 ft	.006	.009	.022	Granitic dike, strikes N. 38° E., dips NW. 65°; fsp 50, qtz 50, msc up to 20% on upper margin; avg mineral gr. 1/4 in., up to 3 in.
302	Chip, 20 ft	.006	.010	.036	Pegmatite, strikes N. 20° E., dips NW. 40°; fsp 75, qtz 20, msc 5.
303	Chip, 2 ft	.015	.012	.038	Pegmatite, strikes N. 75° E., dips SE. 55°; fsp 75, qtz 20, msc 5, trm, gar, minor.
304	Chip, 6 ft	<.001	.002	.003	Granitic dike, strikes E.-W., dips S. 60°; fsp 80, qtz 20, includes 2-ft-thick qtz zone.
305	Chip, 6 ft	.008	.008	.018	Pegmatite, strikes N. 30° E., dips NW. 70°; fsp 80, qtz 20, msc, minor; mineral gr. up to 3 in.
306	Chip, 10 ft	.035	.009	.027	Pegmatite; qtz 80, fsp 20, gar, sugary, fine-gr. felsite, minor.
307	Chip, 9 ft	.003	.006*	.009	Pegmatite; ksp 40, qtz 40, ab 20, gar, msc, minor; avg mineral gr. 1/8 to 1/4 in., up to 4 in.
308	Chip, 22 ft	.003	.004	.009	Pegmatite; fsp 70, qtz 30, msc, minor.
309	Chip, 10X9 ft	.001	.004	.043	Pegmatite exposed on blasted outcrop; fsp 75, qtz 20, msc 5.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
310	Chip, 6 ft	0.010	0.007*	0.018	Pegmatite, same body as sample 309, sampled across width.
311	Chip, 11 ft	.002	.006	.006	Pegmatite, vertical sample on high- wall; ab 60, qtz 30, msc 5, ksp 5.
PEGMATITES and GRANITIC INTRUSIVES in the westernmost part of the studied area (SAMPLES 312-329, 331-338, 340-347, 349-354)					
312	Chip, 75 ft	.007	.008	.019	Pegmatite; fsp 45, qtz 40, msc 15; avg mineral gr. 1/2 to 2/3 in., up to 3 in.
313	Chip, 10 ft	.006	.005*	.022	Pegmatite; fsp 65, qtz 25, msc 10; avg mineral gr. 1/3 to 1/2 in., up to 3 in.
314	Chip, 25 ft	<.001	.002	.002	Pegmatite; msc 20, trm, minor; avg mineral gr. 1/3 in.
315	Chip, 6 ft	.013	.008	.008	Pegmatite; fsp 45, qtz 45, msc 10 (up to 30% at upper margin), fap, gar, sugary felsite, minor; mineral gr. up to 2 in.
316	Chip, 25 ft	.002	.004	.019	Pegmatite; qtz 95, msc 3, trm 2, lim, minor.
317	Chip, 4 ft	.006	.009	.032	Pegmatite; fsp 45, qtz 45, msc 10; avg mineral gr. 1/2 in., up to 1 in.
318	Chip, 7 ft	<.001	.002	.001	Granitic dike; fsp 40, qtz 40, msc 20; mineral gr. up to 3/4 in.
319	Chip, 7 ft	<.001	.002	.002	Pegmatite; fsp 50, qtz 45, msc 3, trm 2; avg mineral gr. 1/3 in.

See explanation of symbols at end of table.

APPENDIX A.—ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES—CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
320	Chip, 2 ft	0.003	0.006	0.048	Pegmatite; fsp 60, qtz 30, msc 10 (up to 40% on upper margin); avg mineral gr. 1/3 to 1/2 in., up to 1.5 in.
321	Chip, 15 ft	.010	.010	.012	Pegmatite; fsp 55, qtz 40, msc 5, gar, trm, minor; mineral gr. up to 1.5 in.
322	Chip, 4 ft	.011	.004	.012	Pegmatite; fsp 60, qtz 40, msc, minor; avg mineral gr. 1 in.
323	Chip, 5 ft	.040	.009	.003	Pegmatite, sampled vertically in pit; fsp 45, qtz, 40, msc 15 (up to 95%+ in zones), Mn wad, unidentified black mineral, minor.
324	Chip, 78 ft	ND	.001	.001	Granitic intrusive; fsp 50, qtz 45, msc 5; avg mineral gr. 1/4 in., up to 1 in.
325	Chip, 50 ft	.004	.010	.024	Pegmatite; fsp 55, qtz 35, msc 10; avg mineral gr. 1/2 to 3/4 in., up to 3 in.
326	Chip, 18 ft	.022	.011	.022	Pegmatite, sheared with schist inclusions; fsp 50, qtz 40, msc 10; mineral gr. up to 1 in.
327	Chip, 15 ft	.009	.008	.021	Pegmatite; fsp 70, qtz 30, msc, gar, sugary felsite, minor.
328	Chip, 7 ft	.011	.013*	.005	Pegmatite; fsp 65, qtz 20, msc 15 (enriched on upper margin); avg mineral gr. 3/4 in., up to 1 in.
329	Chip, 10 ft	.002	.008*	.010	Pegmatite, same as sample 328.
331	Chip, 2.1 ft	.039	.004	.014	Pegmatite; fsp 50, qtz 45, msc 5, MnOx stain, minor.
332	Chip, 9 ft	.014	.011	.030	Pegmatite; fsp 45, qtz 45, msc 10; avg mineral gr. 1/2 in., up to 1 in.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
333	Chip, 8 ft	0.007	0.013	0.065	Pegmatite; fsp 45, qtz 35, msc 20; mineral gr. up to 1 in.
334	Chip, 10 ft	.010	.012	.050	Pegmatite; fsp 45, qtz 35, msc 20; mineral gr. up to 1 in.
335	Chip, 11 ft	.011	.007	.028	Pegmatite; fsp 55, qtz 35, msc 10; avg mineral gr. 1/4 to 1/2 in., up to 1.5 in.
336	Chip, 7 ft	.030	.008	.042	Pegmatite; fsp 55, qtz 35, msc 10; avg mineral gr. 1/8 to 1/4 in., up to 2 in.
337	Chip, 17 ft	.004	.008	.022	Pegmatite; fsp 55, qtz 35, msc 10; avg mineral gr. 1/3 to 1/2 in., up to 2.5 in.
338	Chip, 72 ft	.007	.004*	.009	Pegmatite; fsp 45, qtz 45, msc 10; fsp includes blue ksp; avg mineral gr. 1/4 to 1/2 in., up to 2 in.
340	Chip, 12 ft	.003	.012*	.009	Pegmatite; fsp (ab & ksp) 55, qtz 35, msc 10 (up to 25% in pegmatite margins).
341	Chip, 21 ft	.003	.015*	.016	Pegmatite; fsp 45, qtz 45, msc 10; mineral gr. up to 2 in.
342	Chip, 14 ft	.010	.004*	.021	Pegmatite; fsp 60, qtz 25, msc 15; mineral gr. up to 4 in.
343	Chip, 9 ft	.009	.010	.031	Pegmatite; fsp 60, qtz 30, msc 10; mineral gr. up to 1.5 in.
344	Chip, 16 ft	.003	.006*	.014	Pegmatite; fsp 55, qtz 25, msc 20.
345	Chip, 14 ft	.001	.002*	.008	Pegmatite, vertical sample; fsp 60, qtz 20, msc 20; mineral gr. up to 4 in.
346	Chip, 22 ft	<.001	.002	.005	Pegmatite; fsp 50, qtz 45, msc 5; avg mineral gr. 1/3 in., up to 4 in.

See explanation of symbols at end of table.

APPENDIX A.--ASSAYS OF PEGMATITES AND GRANITIC ROCK SAMPLES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)			Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	
347	Chip, 4 ft	0.007	0.012	0.031	Pegmatite; fsp 50, qtz 45, msc 5 (up to 20% on upper margin), gar, minor; avg mineral gr. 1/2 to 3/4 in., up to 1.5 in.
349	Chip, 5 ft	.009	.013	.046	Pegmatite, partially exposed in trench; fap, gar, sugary felsite, minor; mineral gr. up to 2 in.
350	Chip, 7 ft	.024	.005	.036	Pegmatite; fsp 50, qtz 45, msc 5, gar, minor; mineral gr. up to 4 in.
351	Chip, 14 ft	.004	.008	.036	Pegmatite; fsp 65, qtz 30, msc 5; mineral gr. up to 3 in.
352	Chip, 25 ft	.008	.009	.028	Pegmatite; fsp 40, qtz 40, msc 20, fine-gr. sugary felsite, gar, minor; mineral gr. up to 3 in.
353	Chip, 3 ft	.018	.011	.040	Pegmatite; fsp 50, qtz 45, msc 5; mineral gr. up to 1 in.
354	Chip, 4.5 ft	.084	.003*	.009	Do.

ab albite feldspar

ap apatite

avg average

fap fluorapatite

fsp feldspar

gar garnet

gr. grain

ksp potassium feldspar

lim limonite

msc muscovite

ND not detected

NT not tested

qtz quartz

qtz 90 The percentage of a mineral in sample (in this case, quartz), based on field estimation of hand specimen.

trm tourmaline

* Interference noted by assayer due to presence of high rubidium concentration; affects accuracy of columbium concentration measurement.

< Less than

> Greater than

APPENDIX B.--ASSAYS OF SAMPLES FROM QUARTZ VEINS AND TUNGSTEN OCCURRENCES

Sample No.	Type, Length	Analytical data (% unless noted)				Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	Other	
1	Grab	ND	<0.001	0.001	Fe 42	Banded iron formation float in hornblende schist.
7	Grab	<0.001	.003	.001	NAP	Zone rich in actinolite, qtz, strikes N. 85° W., dips SW. 80° in hornblende schist; from sloughed-in pit.
11	Grab	ND	.001	<.001	Au .1 ppm NAP	Qtz pod; lim stain; in 3-ft-deep pit.
14	Grab	ND	.002	<.001	NAP	Qtz pod, 7 by 5 ft; in shallow 9 by 4 ft pit.
17	Select	<.001	.002	.001	NAP	Qtz vein; lim and hematite stain; from dump of caved adit (80 ft long?); pegmatite float nearby.
27	Chip, 2.5 ft	ND	.001	ND	Au 6 ppb	Qtz vein, strikes N. 75° W., dips 90°; heavy lim stain.
32	Grab	ND	.001	.001	Nap	Sillimanite schist, phyllitic; from 32-ft-long cut oriented N. 5° W.
34	Chip, 2.5 ft	ND	.001	.001	WO ₃ 0.08	Qtz vein, locally concordant; strikes N. 82° E., dips SE. 44°; trend same as Comet Mine vein.
35	Chip, 5 ft	ND	.002	.001	WO ₃ 0.04	Shear zone, strikes N. 85° W., dips SW. 44°; lim, scheelite; from raise.
36	Chip, 3 ft	ND	.002	.002	WO ₃ 0.43	Shear zone, strikes N. 82° E., dips SE. 59°; lim, scheelite.

See explanation of symbols at end of table.

APPENDIX B.--ASSAYS OF SAMPLES FROM QUARTZ VEINS AND TUNGSTEN
OCCURRENCES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)				Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	Other	
41	Grab	ND	0.001	ND	Au 11 ppb	Qtz vein, strikes N. 25° W., dips 90°; 4 to 8 in. thick; malachite and Mn stain; from dump of 9-ft-deep pit.
43	Chip, 0.9 ft	ND	.002	ND	NAp	Qtz vein, strikes N. 60° E., dips SE. 59°; lim stain; from 8-ft-deep pit; qtz veinlet swarms nearby.
44	Chip, 3.7 ft	ND	.002	0.001	NAp	Qtz-fsp lens, strikes N. 70° W., dips SW. 61° through hornblende-augite schist; locally concordant; from face of 40-ft-long cut.
51	Grab	<0.001	.002	.001	Au 7 ppb	Qtz vein, strikes N. 45° E., dips SE. 65° in shear zone; 1.5 ft thick; bull qtz, heavy lim stain, phlogopite.
89	Chip, 0.75 ft	ND	.002	<.001	NAp	Qtz vein, strikes N. 80° E., dips SE. 73°; lim stain; from 8-ft-deep pit.
98	Chip, 3 ft	ND	.001	<.001	NAp	Qtz pod in pit; lim stain; adjacent to pegmatite.
99	Chip, 4 ft	<.001	.002	.001	NAp	Hornblende schist adjoining sample 98; baked.
100	Chip, 6 ft	ND	.001	.001	NAp	Shear, strikes N. 82° E., dips SE. 65° through hornblende schist in 8-ft-deep shaft.
101	Chip, 4 ft	ND	.002	.001	NAp	Qtz pod, irregular, in 7-ft-deep pit.

See explanation of symbols at end of table.

APPENDIX B.--ASSAYS OF SAMPLES FROM QUARTZ VEINS AND TUNGSTEN
OCCURRENCES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)				Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	Other	
102	Chip, 4 ft	<0.001	0.002	<0.001	NAp	Shear(?), baked, strikes N. 50° E., dips SE. 65° through hornblende-biotite schist in 10 by 10 ft shallow pit.
103	Chip, 4 ft	ND	.002	.001	NAp	Biotite-hornblende schist, bleached, with sillimanite, in shallow pit.
104	Select	ND	.001	<.001	NAp	Qtz vein, iron-stained, from dump.
105	Grab	ND	.002	.001	NAp	Hornblende schist, iron stained; from same dump as sample 104.
167	Grab	ND	.001	<.001	NAp	Qtz vein from dump; Mn, FeOx stain.
172	Chip, 1 ft	ND	.002	.001	Au 7 ppb	Shear in calcareous phyllite zone, strikes N. 70° E., dips SE. 67°.
173	Chip, 2 ft	ND	.002	.001	NAp	Phyllite surrounding shear of sample 172 (1 ft on both sides of shear).
175	Select	ND	.002	ND	NAp	Qtz vein, strikes N. 72° W., dips SW. 65°, 3 ft thick; qtz 95, mica 5, heavy lim stain.
193	Chip, 10 ft	ND	.001	.003	WO ₃ 0.08	Mica schist with qtz blebs, baked, lim stain; from pit.
275	Chip, 7 ft	.028	.008	.028	NAp	Shear in adit, strikes N. 35° W., dips NE. 85°.
276	Chip, 1 ft	<.001	.003	.001	NAp	Shear, strikes N. 10° W., dips NE. 85° through quartzite, and phyllite.

See explanation of symbols at end of table.

APPENDIX B.--ASSAYS OF SAMPLES FROM QUARTZ VEINS AND TUNGSTEN
OCCURRENCES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)				Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	Other	
278	Grab	ND	0.001	0.002	NAP	Qtz (vein?) material on dump of caved adit (75 ft long?).
279	Chip, 1 ft	ND	.002	.001	NAP	Shear, silicified, strikes N. 60° E., dips SE. 65° in schist; sampled qtz only; at face of 15-ft-long adit.
281	Chip, 1 ft	<0.001	.001	.002	NAP	Qtz vein, strikes N. 35° E., dips SE. 48° in hornblende schist and phyllite; lim, biotite, minor.
286	Chip, 2 ft	ND	.001	.001	Au 12 ppb	Qtz vein, strikes N. 75° E., dips SE. 63°; beryl(?), Cu stain, MnOx stain.
295	Chip, 0.5 ft	ND	.001	.002	NAP	Qtz vein, with 25% phyllitic rock; from adit of Whippet tungsten mine.
330	Chip, 1.5 ft	<.001	.003	.003	WO ₃ 0.18	Sheared quartzite and phyllite at bottom of 30 ft stope in Romur tungsten mine; minor clay gouge, biotite, malachite.
339	Chip, 1 ft	ND	.002	.001	Au 18 ppb WO ₃ 0.04	Qtz vein in 6 by 18 ft, 6-ft-deep pit; cuts schist; malachite, lim stain.
348	Chip, 9 ft	ND	.001	.001	WO ₃ 0.005	Qtz vein set cutting schist at various angles; lim stain; biotite, MnOx, minor.
355	Grab	ND	.001	ND		Qtz vein, at least 1 ft thick, from reclaimed cut; MnOx, magnetite, minor.

See explanation of symbols at end of table.

APPENDIX B.--ASSAYS OF SAMPLES FROM QUARTZ VEINS AND TUNGSTEN OCCURRENCES--CONTINUED

Sample No.	Type, Length	Analytical data (% unless noted)				Description
		Ta ₂ O ₅	Cb ₂ O ₅	BeO	Other	
356	Grab	ND	0.001	0.002		Biotite schist at same cut as sample 355.
357	Grab	ND	.002	.001	Au 16 ppb	Qtz vein by upper reclaimed cut on old Victory tungsten claims; approx. orientation: strikes N. 49° E., dips SE. 47°; malachite, MnOx, FeOx, minor.
358	Grab	ND	.001	.001	Au 48 ppb	Qtz veinlets in biotite schist; from dump; malachite, minor.

lim limonite

NAp not applicable

ND Not detected

qtz quartz

< less than

Note: 1 ppb Au = 0.000029 oz Au/ton.

APPENDIX C.--DATA ON LABORATORY ANALYSES PERFORMED ON COPPER MOUNTAIN
 SAMPLES--Continued

Analyses by Bondar Clegg & Co., Ltd., Vancouver, Canada

Element and chemical symbol	Lower detection limit (ppm unless noted)	Analytical method
Antimony (Sb)	0.2	Neutron activation
Arsenic (As)	1	Do.
Barium (Ba)	100	Do.
Beryllium (Be)	0.5	Atomic absorption
Bromine (Br)	1	Neutron activation
Cadmium (Cd)	10	Do.
Calcium (Ca)	0.05%	ICP
Cesium (Cs)	1	Neutron activation
Cerium (Ce)	10	Do.
Chromium (Cr)	50	Do.
Cobalt (Co)	10	Do.
Columbium [or Niobium] (Cb or Nb)	5	X-ray fluorescence
Copper (Cu)	1	ICP
Europium (Eu)	2	Neutron activation
Gallium (Ga)	5	ICP
Gold (Au)	5 ppb	Neutron activation
Hafnium (Hf)	2	Do.
Iridium (Ir)	100 ppb	Do.
Iron (Fe)	0.5%	Do.
Lanthanum (La)	5	Do.
Lithium (Li)	1	Atomic absorption
Lutetium (Lu)	0.5	Neutron activation
Manganese (Mn)	1	ICP
Molybdenum (Mo)	2	Neutron activation
Nickel (Ni)	50	Do.
Potassium (K)	0.05%	ICP
Rubidium (Rb)	10	Neutron activation
Samarium (Sm)	0.1	Do.
Selenium (Se)	10	Do.
Scandium (Sc)	0.5	Do.
Silver (Ag)	5	Do.
Sodium (Na)	0.05%	Do.
Tantalum (Ta)	1	Do.
Tellurium (Te)	20	Do.
Terbium (Tb)	1	Do.
Thorium (Th)	0.5	Do.

See explanation of symbol at end of table.

APPENDIX C.--DATA ON LABORATORY ANALYSES PERFORMED ON COPPER MOUNTAIN
SAMPLES--Continued

Analyses by Bondar Clegg & Co., Ltd., Vancouver, Canada--Continued

Element and chemical symbol	Lower detection limit (ppm unless noted)	Analytical method
Tin (Sn)	200	Neutron activation
Tungsten (W)	2	Do.
Uranium (U)	0.5	Do.
Vanadium (V)	1	ICP
Ytterbium (Yb)	5	Neutron activation
Zinc (Zn)	200	Do.
Zirconium (Zr)	500	Do.

Analyses by Chemex Labs, Inc., Sparks, NV

(Samples 116, 119, 145, 150, 152; Ta₂O₅ only for samples 239-243)

Element and chemical symbol	Detection limits (ppm)	Analytical method
Beryllium (Be)	10 to 100	Atomic absorption
Columbium [Niobium] (Cb or Nb)	5 to 10,000	X-ray fluorescence
Tantalum (Ta)	2 to 10,000	Neutron activation

Analyses by Bureau of Mines Salt Lake City Research Center, UT

(Samples 153, 228-236; BeO and Cb₂O₅ only on samples 239-243)

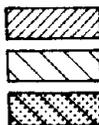
Compound and chemical symbol	Lower detection limit (ppm)	Analytical method
Beryllium oxide (BeO)	100	Atomic absorption
Columbium oxide (Cb ₂ O ₅)	70	X-ray fluorescence
Tantalum oxide (Ta ₂ O ₅)	10	Neutron activation

ICP Inductively coupled plasma-emission spectroscopy analysis.

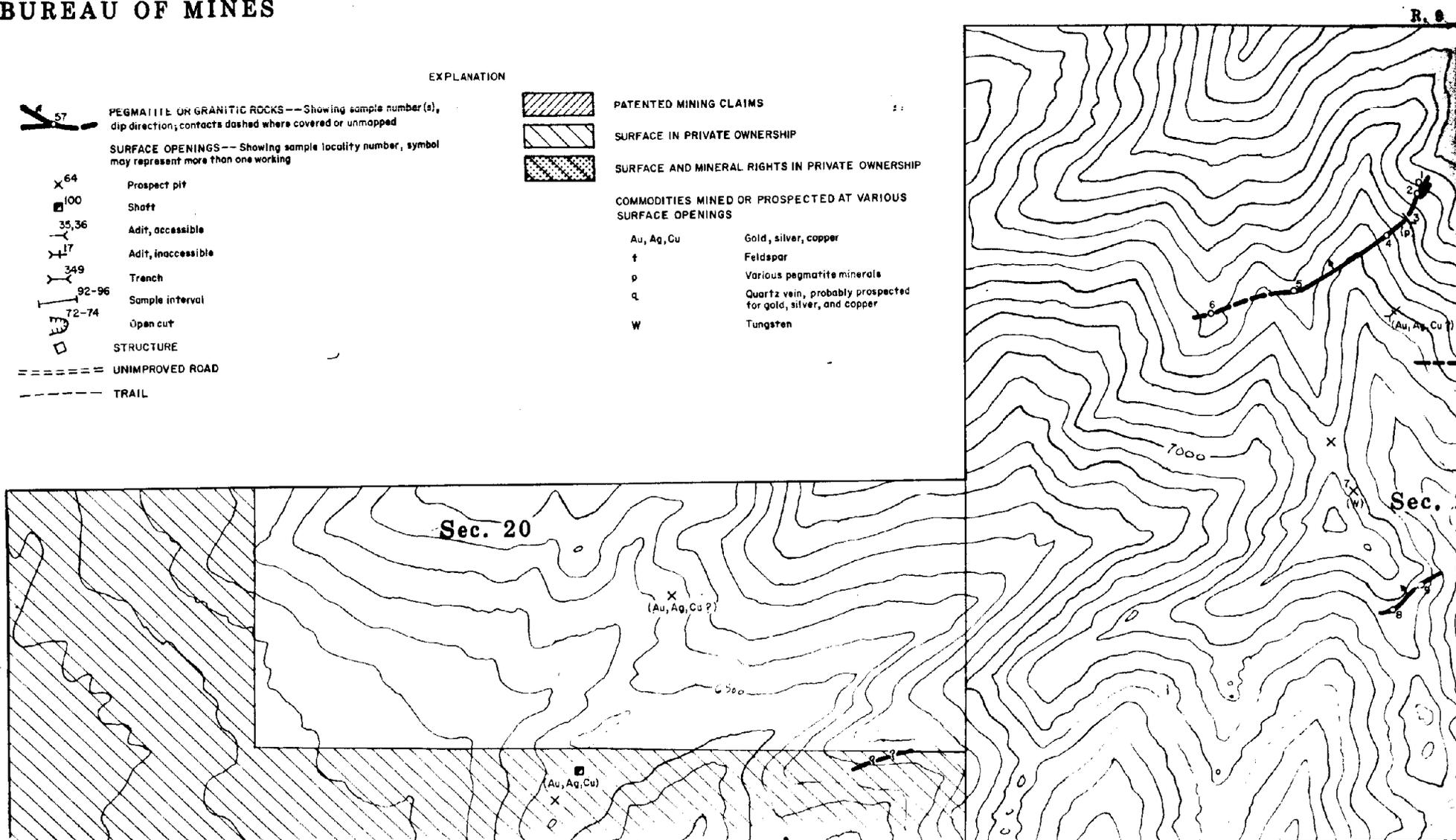
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BUREAU OF MINES

EXPLANATION

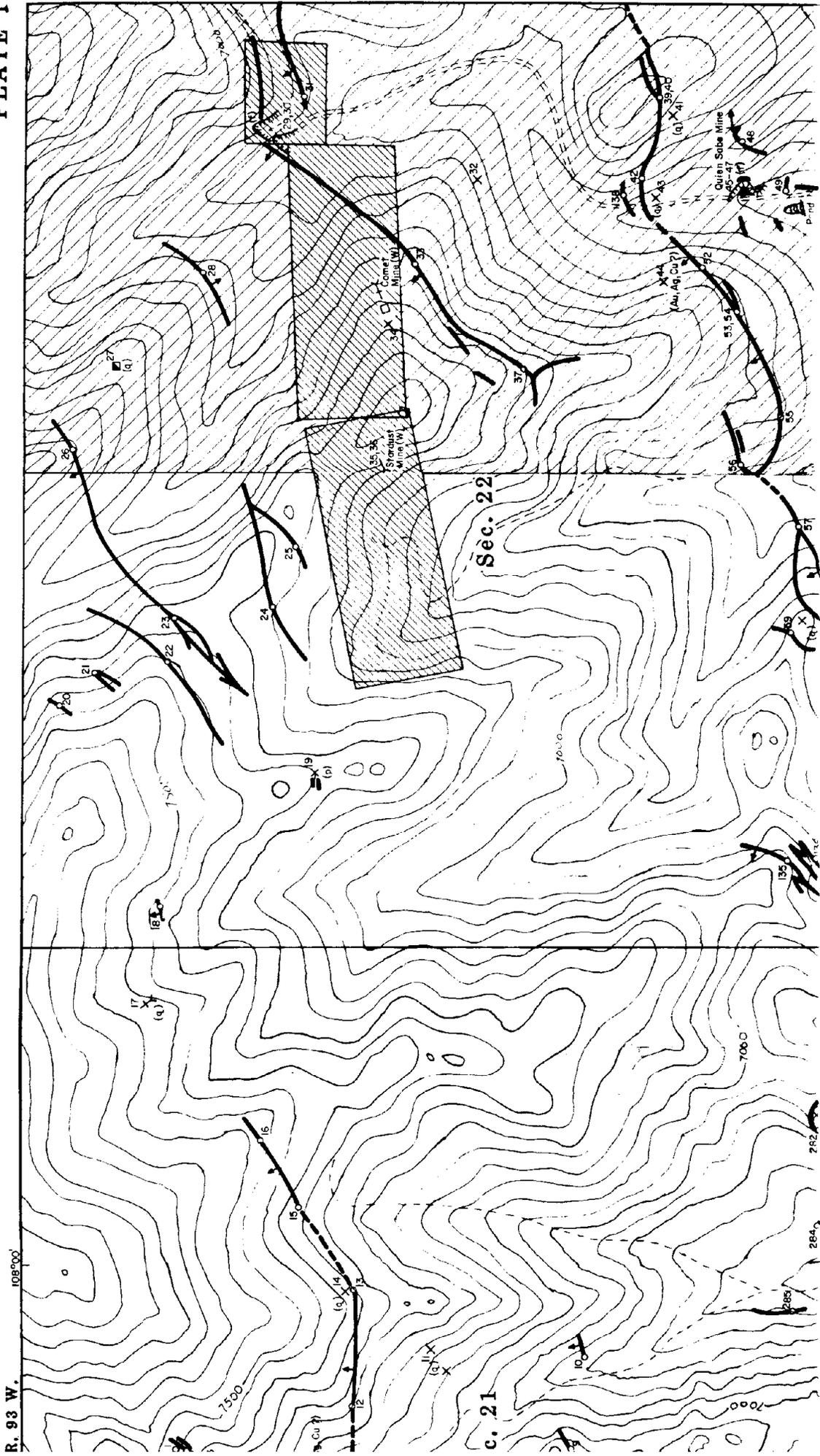
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 SURFACE OPENINGS -- Showing sample locality number, symbol may represent more than one working
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 Shaft (square 100)
 Adit, accessible (line with 35,36)
 Adit, inaccessible (line with 117)
 Trench (line with 349)
 Sample interval (line with 92-96)
 Open cut (line with 72-74)
 STRUCTURE
 UNIMPROVED ROAD (dashed line)
 TRAIL (dotted line)



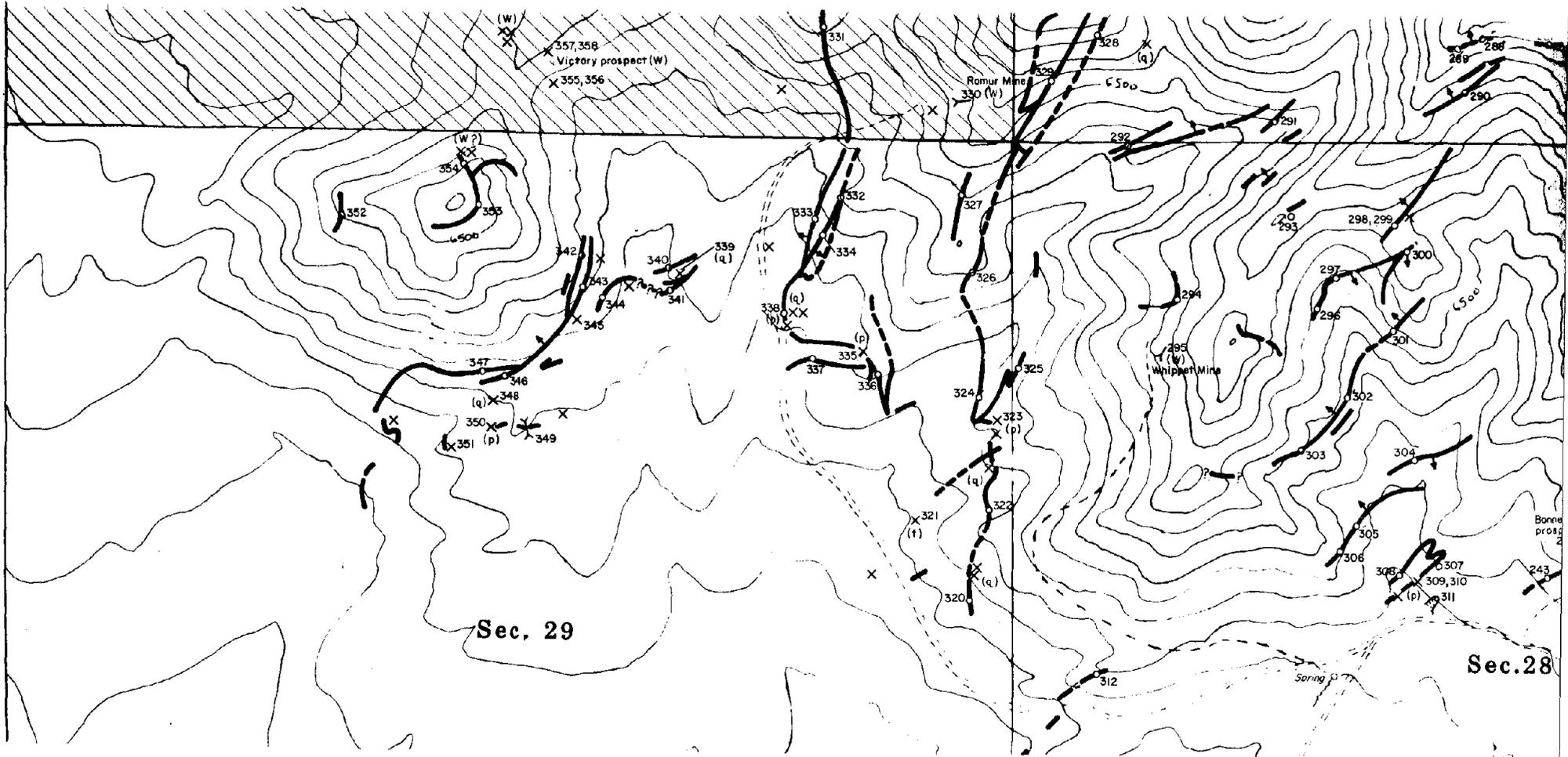
- PATENTED MINING CLAIMS
 SURFACE IN PRIVATE OWNERSHIP
 SURFACE AND MINERAL RIGHTS IN PRIVATE OWNERSHIP
 COMMODITIES MINED OR PROSPECTED AT VARIOUS SURFACE OPENINGS
 Au, Ag, Cu Gold, silver, copper
 f Feldspar
 p Various pegmatite minerals
 q Quartz vein, probably prospected for gold, silver, and copper
 W Tungsten



OPEN FILE REPORT OFR-15-89
PLATE 1

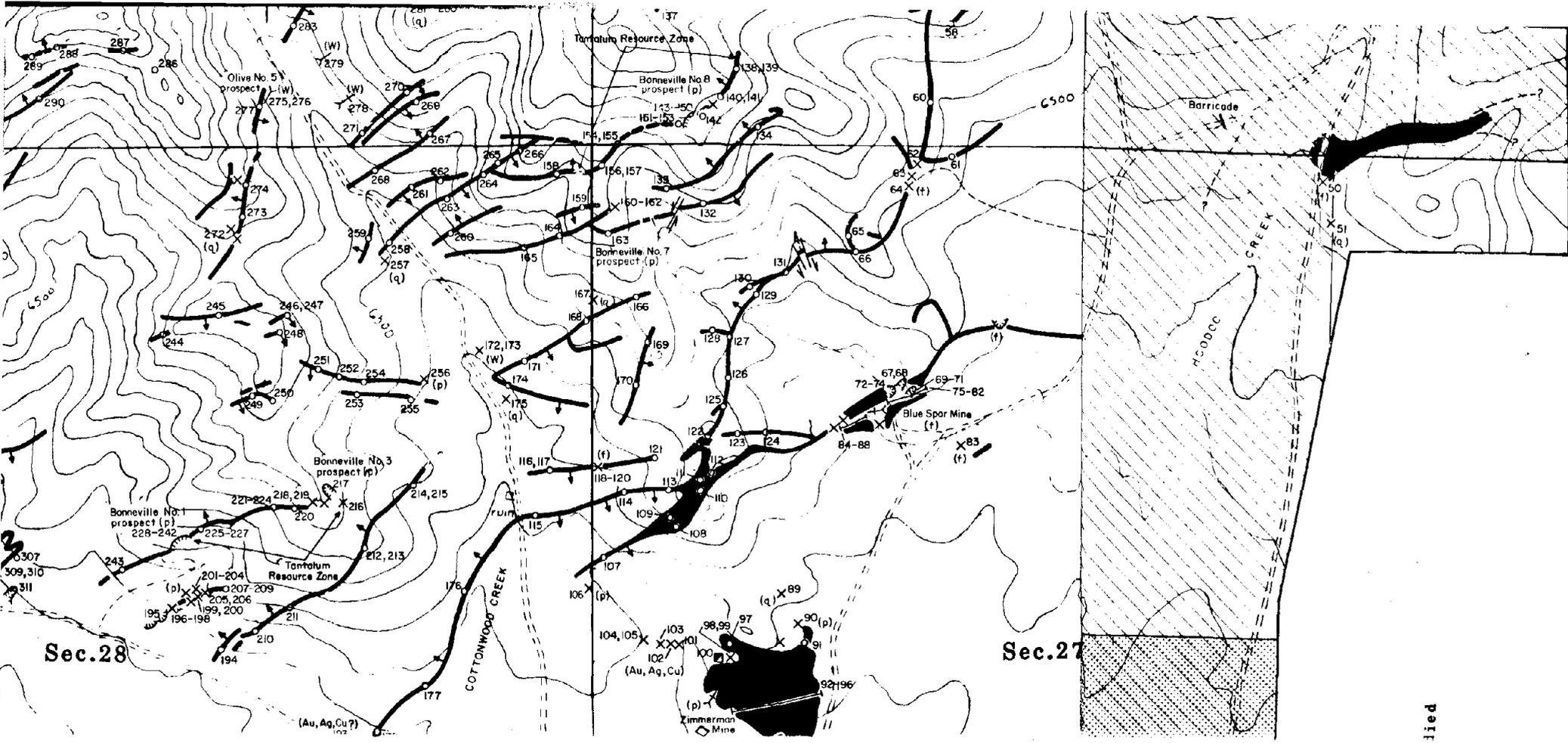


T.
40
N.



Sec. 29

Sec. 28

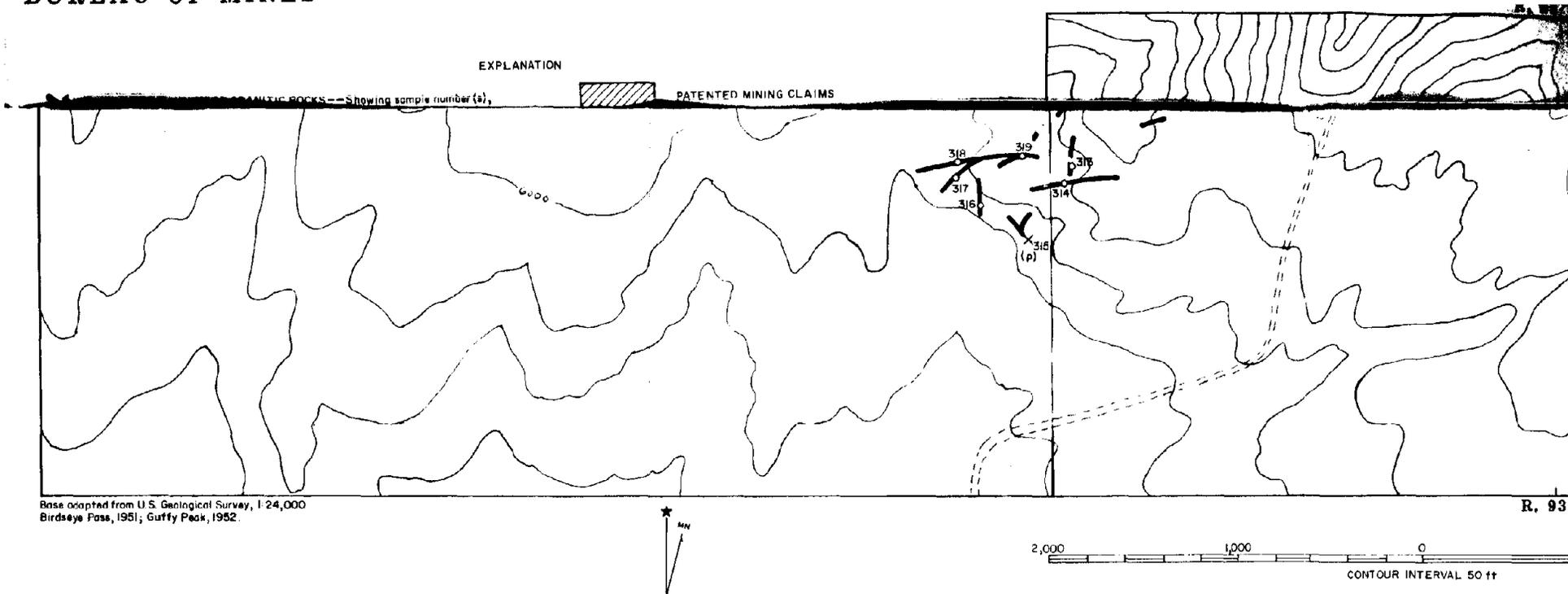


Sec. 28

Sec. 27

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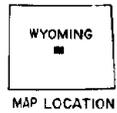
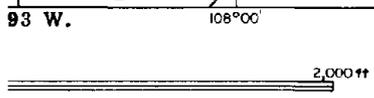
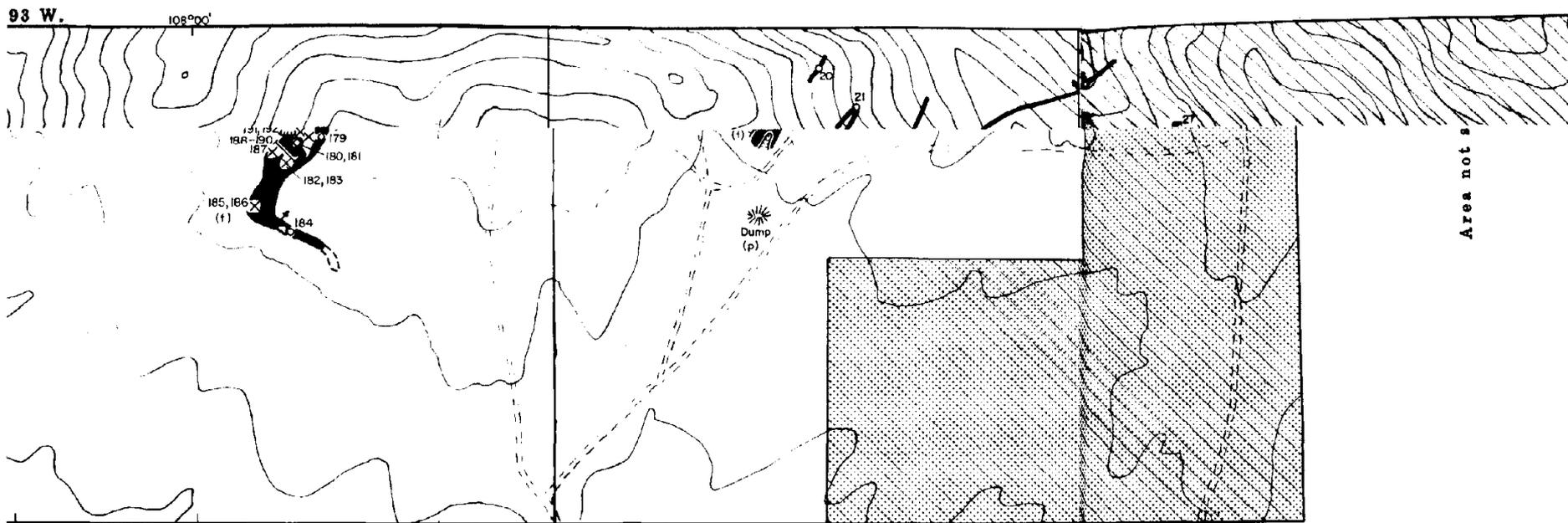
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Base adapted from U.S. Geological Survey, 1:24,000
Birdseye Pass, 1951; Guffy Peak, 1952.

PEGMATITES AND SAMPLE LOCALITIES IN
FREMONT COUNTY, WY
BY MARK L. CHATMAN, U.S. BUREAU OF MINES

1989



Field work completed in 1988 by Mark L. Chatman;
assisted by Brian J. Hannigan, Clay M. Martin,
and Jenne E. Zeltner.

THE COPPER MOUNTAIN AREA,
WYOMING
BUREAU OF MINES