

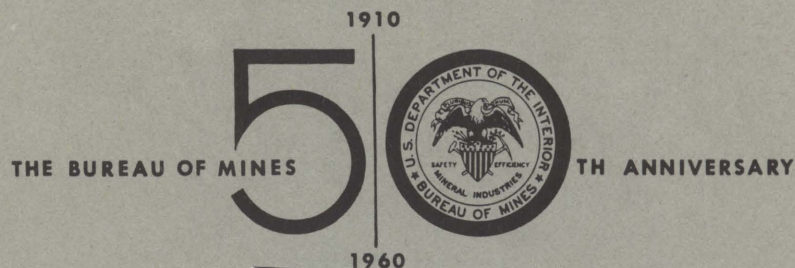
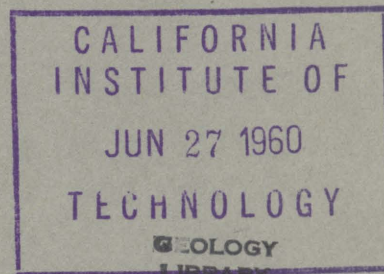
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report of investigations 5612

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TUNGSTEN RESOURCES OF MONTANA:
DEPOSITS OF THE PHILIPSBURG BATHOLITH,
GRANITE AND DEER LODGE COUNTIES

By D. D. Walker



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UNITED STATES DEPARTMENT OF THE INTERIOR

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UNITED STATES DEPARTMENT OF THE INTERIOR
Fred A. Seaton, Secretary

BUREAU OF MINES
Marling J. Ankeny, Director

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TUNGSTEN RESOURCES OF MONTANA: DEPOSITS OF THE
PHILIPSBURG BATHOLITH, GRANITE AND
DEER LODGE COUNTIES^{1/}

by

D. D. Walker^{2 3/}

SUMMARY

Scheelite, the most abundant tungsten mineral in the Philipsburg region of Montana, is found in replacement deposits and along fissures and cracks in limestone at various distances from contacts with acidic igneous rocks. It also occurs at the limestone-igneous contacts, but typical garnet tactites are developed in only a few places in the region. The most favorable host rocks for scheelite mineralization are the Jefferson, Hasmark, and Madison limestones.

Scheelite is exposed in float, outcrops, and surface and mine workings along a 2-mile-wide belt extending southwest from Lost Creek beyond Silver Lake, a distance of 15 miles or more. (See fig. 1.) Some scheelite is found in veins formerly mined for silver. Powellite and molybdenite occasionally are present with the scheelite. Hubnerite occurs in quartz veins in the Black Pine area 10 miles northwest of Philipsburg. These quartz veins occur in the quartzites of the Precambrian Spokane formation.

Tungsten production in the region has come almost exclusively from scheelite deposits, both lode and placer. During a 6-year period beginning in 1943 a total of 142.0 tons of 63-percent WO_3 concentrate was produced by H & H Mines Co. In the early 1950's, the Trigger mine produced 4,000 tons of 1-percent WO_3 ore and the Tip Top 650 tons of 2.0-percent WO_3 ore and 2,906 tons of 2.2-percent ore. There has been sporadic production from some of the smaller properties in the area.

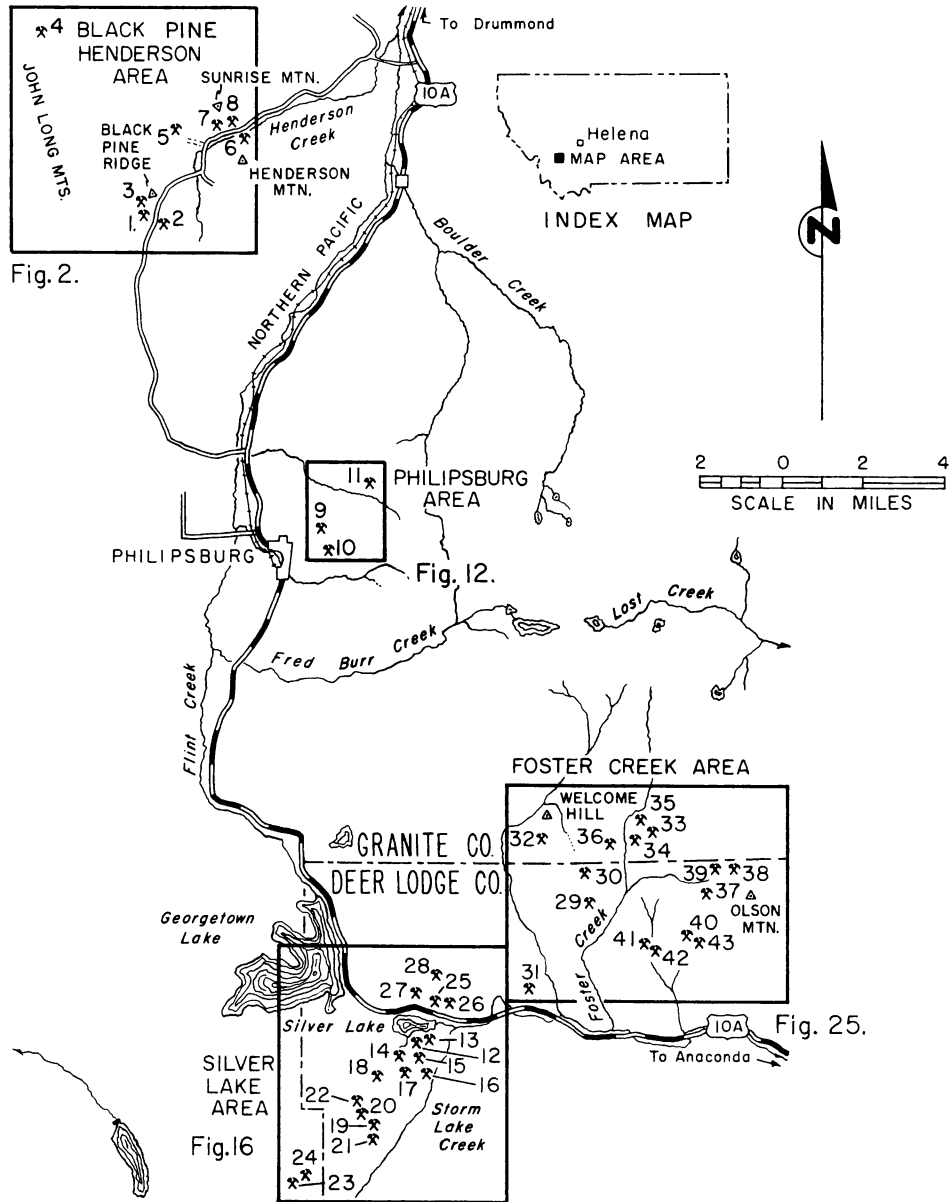
INTRODUCTION

This report is one of a series prepared by the Federal Bureau of Mines on mineral resources of the Nation. The purpose of these studies is to make a comparative appraisal of national mineral resources by individual commodities

^{1/} Work on manuscript completed April 1959.

^{2/} Mining engineer, Bureau of Mines, Region I, Spokane, Wash.

^{3/} Author was assisted by G. T. Krempasky (September 1957) and W. R. Wayment (June 1958), mining engineers, Bureau of Mines, Region I, Spokane, Wash.



PROPERTY LIST

BLACK PINE-HENDERSON AREA

- 1 Black Pine (Combination)
- 2 Bear and Float
- 3 Double Eagle
- 4 Franz
- 5 Deer Hunter
- 6 Henderson Gulch (H & H. mines)
- 7 Sunrise (Copper Queen)
- 8 General Washington group

PHILIPSBURG AREA

- 9 North Star
- 10 Isabelle Queen
- 11 Murphy

SILVER LAKE AREA

- 12 Trigger
- 13 Hanson - Meloy
- 14 Sheila
- 15 Blackshirt
- 16 H L M
- 17 Tommy
- 18 Rising Star
- 19 Sunshine
- 20 Best
- 21 Ceto
- 22 Minnie Lee
- 23 Hilltop
- 24 Headache
- 25 McCabe
- 26 Payoff
- 27 Calcabe
- 28 Gyp

FOSTER CREEK AREA

- 29 Tip Top
- 30 Ben G
- 31 Moonlight
- 32 Porcupine
- 33 Blue Bottle
- 34 Straw Hat
- 35 Fox
- 36 Cliff
- 37 Pay Day
- 38 Big Bear
- 39 Bull Elk
- 40 Smith
- 41 Carbonator
- 42 Rambler
- 43 Bresnahan Fenner

FIGURE 1. - Tungsten Deposits of Philipsburg Batholith.

and regions; to promote development and conservation of the nations resources; and to provide information for long-range and defense planning.

This publication gives information obtained from an investigation of tungsten deposits and a reconnaissance of potential tungsten-bearing areas associated with the Philipsburg Batholith of west-central Montana. It contains maps, assays, and preliminary examination data on 43 tungsten prospects and mines in Granite and Deer Lodge Counties. (See fig. 1.)

Field work was begun in July 1957 and completed in June 1958.

This report is the second of a series on tungsten resources of Montana. The first report was published in March 1960.^{4/} The third and final report will include miscellaneous tungsten deposits and areas and a résumé of tungsten resources in Montana.

ACKNOWLEDGMENTS

The writer acknowledges the cooperation and assistance of owners, operators, and lessees of tungsten prospects and mines.

Data from previous reconnaissance surveys and from Bureau of Mines sampling and exploration work were compiled and integrated. Publications of the Federal Geological Survey and the Federal Bureau of Mines utilized in preparing this report are acknowledged in the bibliography.

Data in the form of maps, assays, and geological reports were obtained from the Office of Minerals Exploration (formerly Defense Minerals Exploration Administration) to aid in preparing the sections on the following properties: Black Pine (Combination) mine, Bear and Float, Double Eagle, Sunshine, and Tip top.

GEOGRAPHY

The Philipsburg Batholith is in west-central Montana. The eastern margin lies in Powell County; the northern half of the remaining area is in Granite County and the southern half in Deer Lodge County.

The batholith is in the Flint Creek Mountain Range with associated stocks in the Anaconda Range to the south. Both ranges are rugged with high, craggy peaks scarred by glacial cirques and mountainsides cut by glacial valleys. Elevations range from 5,000 to more than 10,500 feet above sea level.

TRANSPORTATION

Transportation facilities in the area are excellent. Butte, 49 miles to the east, is the main railroad center and is served by the Union Pacific,

^{4/} Pattee, E. C., Tungsten Resources of Montana: Deposits of the Mount Torrey Batholith, Beaverhead County: Bureau of Mines Rept. of Investigations 5552, 1960, 41 pp.

Great Northern, Northern Pacific, and Chicago, Milwaukee, St. Paul & Pacific Railroads. The last two railroads traverse the Deer Lodge and Clark Fork valleys en route to the west coast. The Butte, Anaconda & Pacific Railroad connects Butte with Anaconda, a town 24 miles east of the batholith. A branch line of the Northern Pacific runs from Drummond to Philipsburg, a town on the western edge of the batholith.

Major auto transportation is by U.S. 10, an east-west transcontinental highway which parallels the railroads. U.S. Highway 10A links Butte, Anaconda, Philipsburg, and Drummond.

County, Forest Service, lumber, and mine-access roads run throughout the area, and it is possible to drive to almost all properties.

CLIMATE

The climate is semiarid and very rigorous. Temperatures range from 90° above zero in summer to 30° below zero in winter, dropping sometimes to 60° below zero. Except for scattered showers, the months of July through September are dry. Snow appears any time after September and stays until April, although in the higher altitudes it may not disappear until late June. Snow depth frequently reaches 6 to 8 feet. From April to July the ground remains moist from melting snow and heavy rainfall.

The area is timbered with several species of conifer, although some willow and cottonwood-poplar trees may be found near streams. Underbrush is scarce and outcrops are plentiful; consequently, prospecting is not too difficult.

INDUSTRIES AND LABOR SUPPLY

Mining, ranching, and lumbering are the principal industries of the area. The Butte copper mines and the Washoe smelter at Anaconda are known throughout the world. Philipsburg, originally a silver camp, is now a manganese mining center. Flint Creek, Clark Fork and Deer Lodge valleys are locations for many fine cattle ranches, while the surrounding hills produce good stands of douglas fir and lodgepole pine for lumber and other types of fir and pine for pulpwood.

The area is one of the more populated regions in Montana, and experienced miners are available.

GENERAL GEOLOGY

The geology of the region has been described in detail by W. H. Emmons and F. C. Calkins (1).^{5/} A brief summary follows.

^{5/} Underlined numbers in parentheses refer to items in the bibliography at the end of this report.

Sedimentary rocks ranging in age from the Precambrian belt series to the Cretaceous Colorado formation have been intensely folded and displaced by faulting. Early thrust faults pushed older rocks over the younger ones, in some instances for thousands of feet. Later, steep normal faults moved younger rocks downward into contact with the older rocks. Several types of igneous rocks intruded and greatly altered the folded and faulted sediments, occasionally completely masking their original characteristics.

The Philipsburg batholith, a granodiorite intrusive just west of Philipsburg, forms a large mass, roughly elliptical in ground plan, extending over an area of approximately 40 square miles. Its upper surface is domelike and in many places the contact follows the bedding. However, most of the mass cuts across the bedding; therefore, it is not a laccolith.

The main mass is very uniform in texture, but near the contacts it varies widely in composition. The intrusive grades from a medium basic granodiorite in the western part to basic in the eastern part. A large mass of muscovite granite lies in the southeast corner. Ultrabasic rocks are present in numerous dikes near the eastern margin of the batholith. Aplitic dikes and pyroxene aplites are common.

The batholith is in contact with Precambrian formations and Paleozoic sediments up to the Madison formation. The sediments have been strongly metamorphosed along the intrusive contact. The granodiorite is cut by occasional fault fissures near Philipsburg.

A major structural feature of the area, the Philipsburg overthrust, is a long west-dipping fault exposed along Flint Creek Valley. It forms the eastern boundary of the Algonkian rocks which override highly folded Paleozoic sediments. Most of the faulting is believed to have accompanied or followed several large granodiorite intrusives of early Tertiary age.

The tungsten deposits of the region are most frequent in limestones altered to marble and more rarely in tactite zones at the contact of limestones and limy shales with granitic intrusions. Tactites range from nearly pure garnet to rocks composed of various mixtures of garnet, amphibole, epidote, pyroxene, vesuvianite, and calcite. Tungsten mineralization, significant in a few places, occurs generally as fine-grained, irregularly disseminated scheelite.

BLACK PINE-HENDERSON AREA

Physical Features

The Black Pine mining district is in the eastern part of the John Long Mountains, which form the divide between Flint Creek and Rock Creek. (See fig. 2.)

The Black Pine district is at an altitude of 6,600 feet, and Black Pine Mountain (highest in the area) rises to 7,900 feet. Heavy growths of lodgepole pine and fir cover the ridgetops. Most slopes are grass covered, but timber extends down the draws and into the creek bottoms.

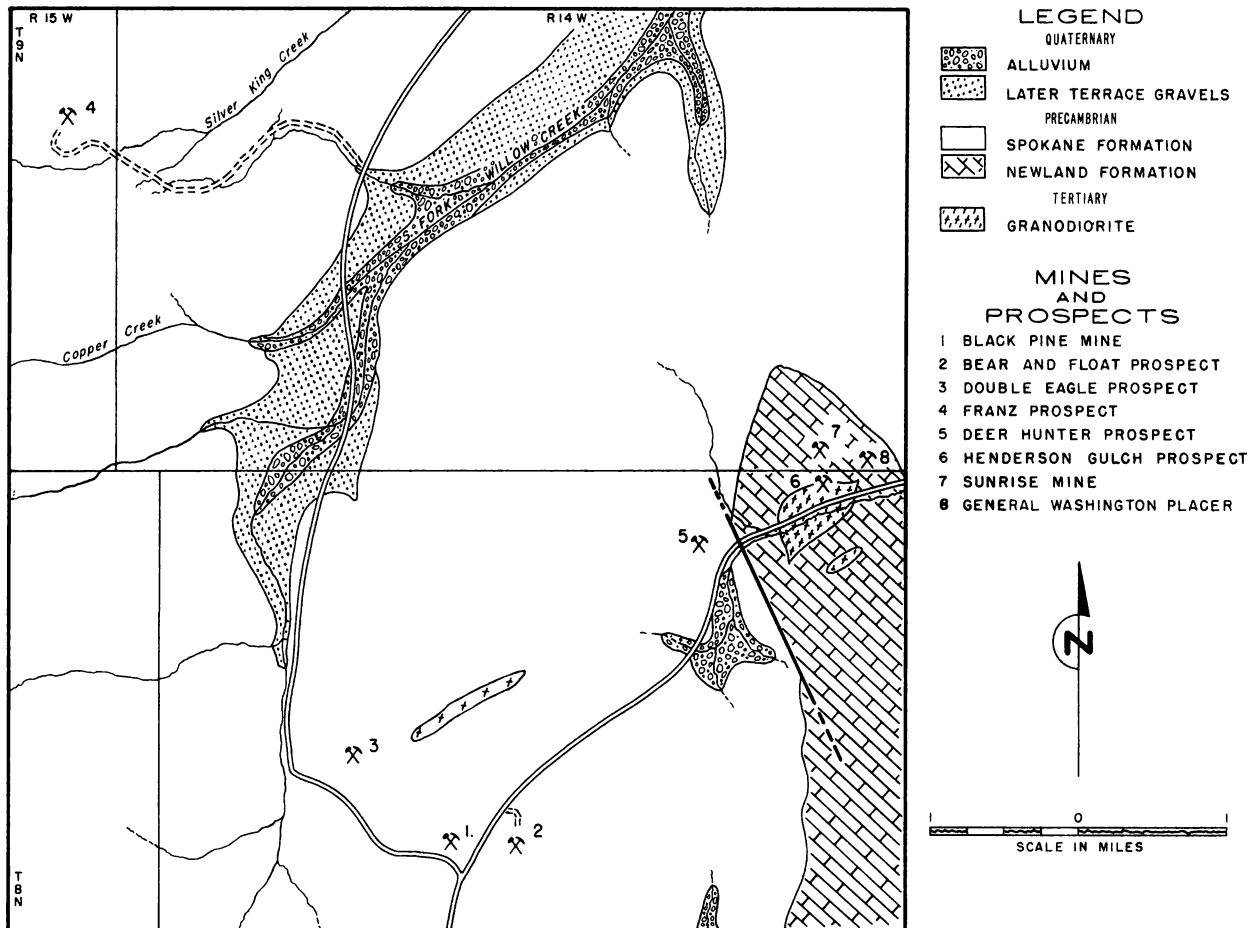


FIGURE 2. - General Geology, Black Pine-Henderson Area, Granite County, Mont.
(Source: Federal Geol. Survey Prof. Paper 78.)

The Henderson district is 4 miles northeast of Black Pine and lies in Henderson Gulch, flanked by Sunrise Mountain on the north and Henderson Mountain on the south. Altitude at gulch level is about 5,400 feet. Sunrise and Henderson Mountains rise rapidly to altitudes of more than 6,600 feet.

Snowfall in the winter months is heavy and may be as great as 6 to 8 feet in the Black Pine area. Melting snow, coupled with considerable rainfall in May and June, causes heavy runoffs, and the mountain streams are high until late July or early August.

Access

The Black Pine area is accessible from Philipsburg by 2 miles on U.S. Highway 10A and 8 miles of good graveled road. (See fig. 1.) Other roads connect the Black Pine area to Henderson Gulch and to Lower Willow Creek. The many Forest Service and logging roads in the area provide access to all properties in summer.

Geology

Sedimentary rocks in the area are of the Precambrian belt series (1, 3). (See fig. 2.) Near Black Pine they consist of thin bedded sandstones and shales of the Spokane formation. Locally, they are altered to quartzites and form the country rock of the Black Pine (Combination) mine. Gray to buff argillaceous limestones of the Newland formation outcrop east of Black Pine Ridge; Sunrise and Henderson Mountains consist of limestone altered to hornfels.

A series of four dike-like masses of granodiorite intrude the Newland limestone. They are aligned in a N. 60° E. direction along a 10-mile zone of weakness and indicate a major crustal break. Granodiorite exposures occur on a hill about a mile north of the Combination mine, in Upper Willow Creek, near the Black Pine lookout tower, and in Henderson Gulch. The outcrop in Henderson Gulch appears to be the top of a great intrusive mass, as evidenced by the extensive metamorphism of the sediments.

The most important structure in the area is the Marshall Creek syncline. The western limb forms the John Long Mountains, and the eastern limb forms Black Pine Ridge. Henderson and Sunrise Mountains were originally one and formed the core of a north-trending anticline. The erosive action of Henderson Creek separated them into two mountains.

Table 1 gives the location, production, and ownership of the Black Pine-Henderson properties.

Deposits

Black Pine (Combination) Mine (3)

The Black Pine-Henderson Gulch road crosses the property.

The mine was discovered in 1882 and from 1885 to 1897 produced 2,135,000 ounces of silver. A depressed silver market forced its closing. Since 1897, sporadic attempts have been made to work the property, and 243,718 ounces of silver, 578 ounces of gold, and about 180 tons of copper have been produced. Tungsten was first produced during World War II, when about 1 ton of hand-cobbed hubnerite ore containing 23 percent WO_3 was sold by lessees to the Metals Reserve Company. Subsequent diamond drilling and sampling by the Federal Bureau of Mines disclosed a large tonnage of submarginal hubnerite-bearing rock (3).

The Combination vein has been mined through seven shafts and three adits. (See fig. 3.) All surface openings are caved, except the Lewis shaft and Combination adit 2. The adit is the only means of entry to the mine. Shafts total 1,000 feet and drifts and inclines 14,000 feet.

Post World War II exploration comprised 10,732 linear feet of bulldozer trenching, 3,119 feet of diamond drilling, and 58 channel samples of old mine pillars (fig. 4) (3). Samples averaged 0.32 percent WO_3 and 15.9 ounces Ag per ton. The weighted average of four drill-hole ore samples was 0.42 percent WO_3 and 15.9 ounces Ag per ton over an average width of 3.3 feet.

TABLE 1. - Location, production, and ownership, Black Pine-Henderson area tungsten properties

Name	Location ^{1/}	Production	Type of property	Owner	Address
Black Pine.....	Secs. 7, 8, 9, 16, 17, 18, 19, 20, 21, T. 8 N., R. 14 W.	Ag 2,378,718 oz., Cu 180 tons, Au 578 oz., and 1 ton 23-percent WO ₃ .	60 claims, 15 millsites.	August Buschman	Seattle, Wash.
Bear and Float....	Sec. 16, T. 8 N., R. 14 W.	None	2 claims.	Wm. McClure	Philipsburg, Mont.
Double Eagle.....	Sec. 8, T. 8 N., R. 14 W.	do.	do.	do.	Do.
Franz.....	Sec. 24, T. 9 N., R. 15 W.	do.	1 claim.	Robert Franz	Do.
Deer Hunter.....	Secs. 3, 14, T. 8 N., R. 14 W.	do.	do.	Wm. McClure	Do.
Henderson Gulch...	Sec. 2, T. 8 N., R. 14 W. and sec. 35, T. 9 N., R. 14 W.	Au and WO ₃ --\$940,000 including 102.0 tons concentrate (63 percent WO ₃).	Placer.	Jake Schneider	Do.
Sunrise.....	Sec. 2, T. 8 N., R. 14 W.	Au \$120,000.	11 claims.	George Lyons and others.	Drummond, Mont.
General Washington	Sec. 2, T. 8 N., R. 14 W. and sec. 35, T. 9 N., R. 14 W.	None	5 claims.	H. L. Maury and others.	Butte, Mont.

^{1/} Montana principal meridian.

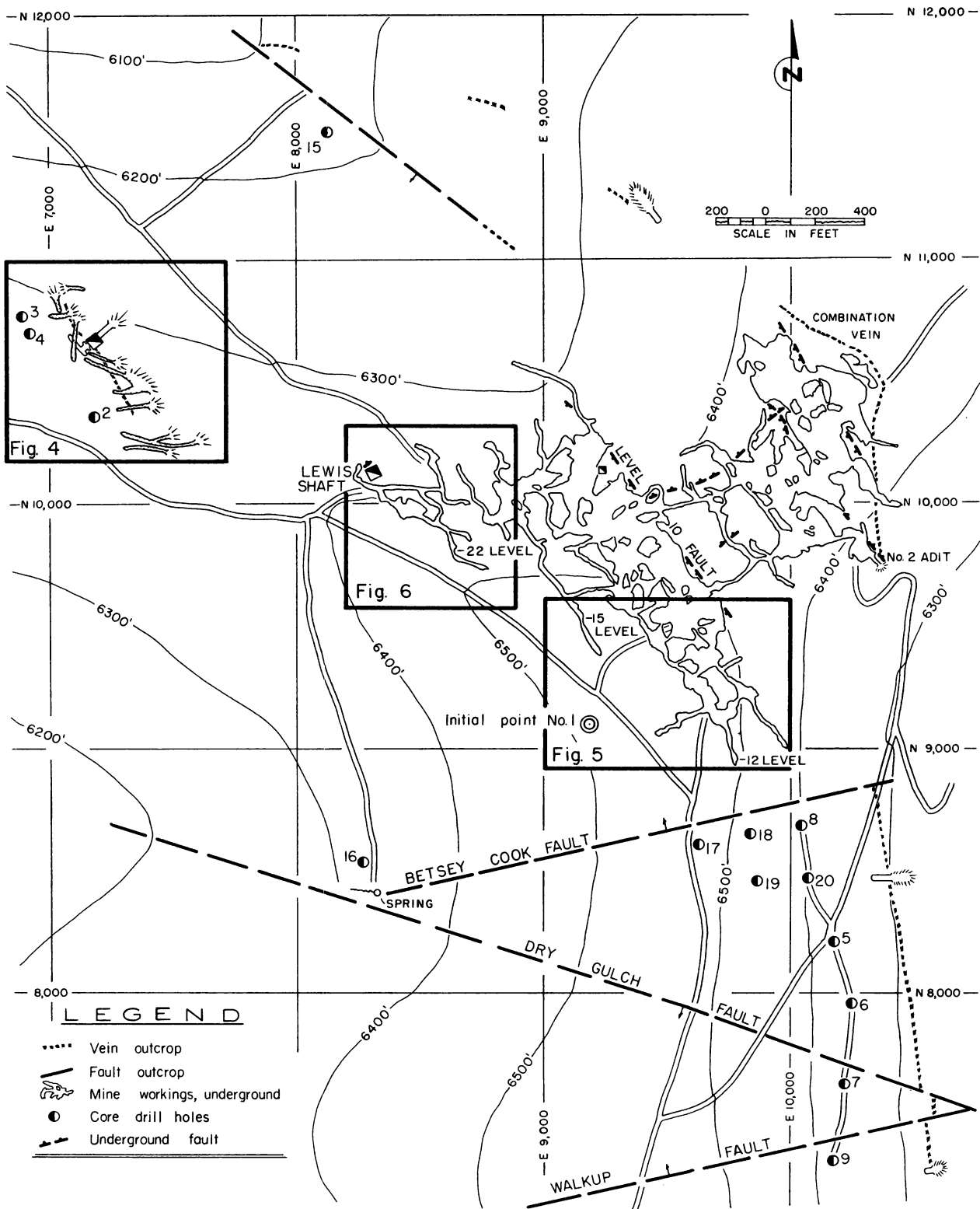


FIGURE 3. - Black Pine Mine, Granite County, Mont.

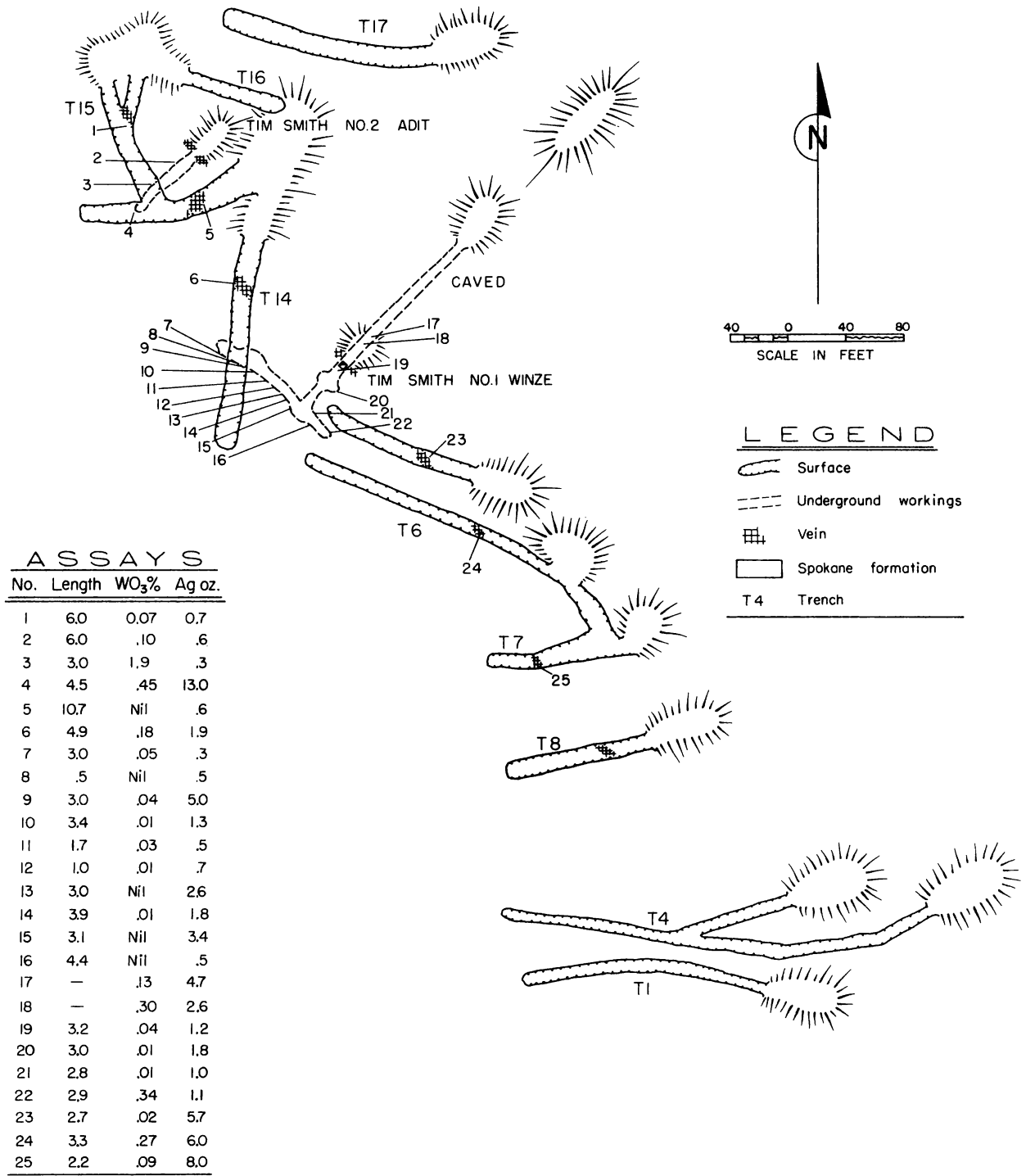


FIGURE 4. - Black Pine Mine, Sample Map Tim Smith Vein, Granite County, Mont.

Exploration in 1951 included unwatering, sampling, and 1,176 feet of further drilling (figs. 5 and 6).

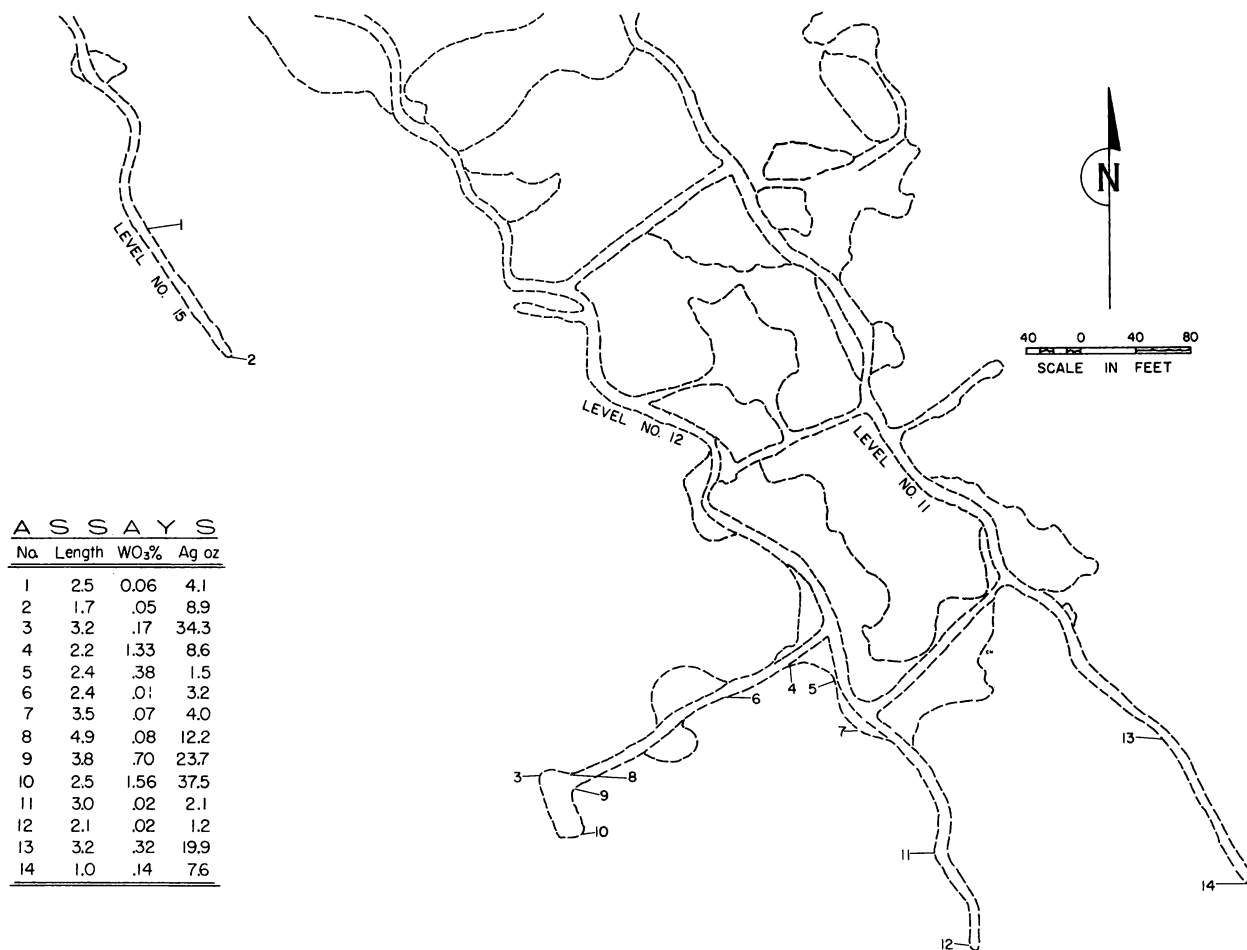


FIGURE 5. - Black Pine Mine, Sample Map Levels 11, 12 and 15, Granite County, Mont.

Four fissure veins occur in the Spokane quartzite. Generally, they conform to the bedding, striking N. 10° to 40° W. and dipping 10° to 30° SW. Dip of veins, however, may range from parallel with the bedding to 30° steeper. The Combination vein was the main producer. Little work was done on the Upper, Tim Smith, and Onyx veins.

The ore in all four veins is similar and consists of white crystalline quartz containing hubnerite, tetrahedrite-tennantite, pyrite, and galena. Hubnerite crystals range in size from fine needles to crystals 2 or 3 inches long. Malachite, pyromorphite, lead and antimony oxides, and native silver, are found in the oxidized part of the veins. Near the water table some secondary enrichment of copper and lead is apparent. Scheelite occurs as an alteration product of hubnerite and as minute particles on hubnerite crystals.

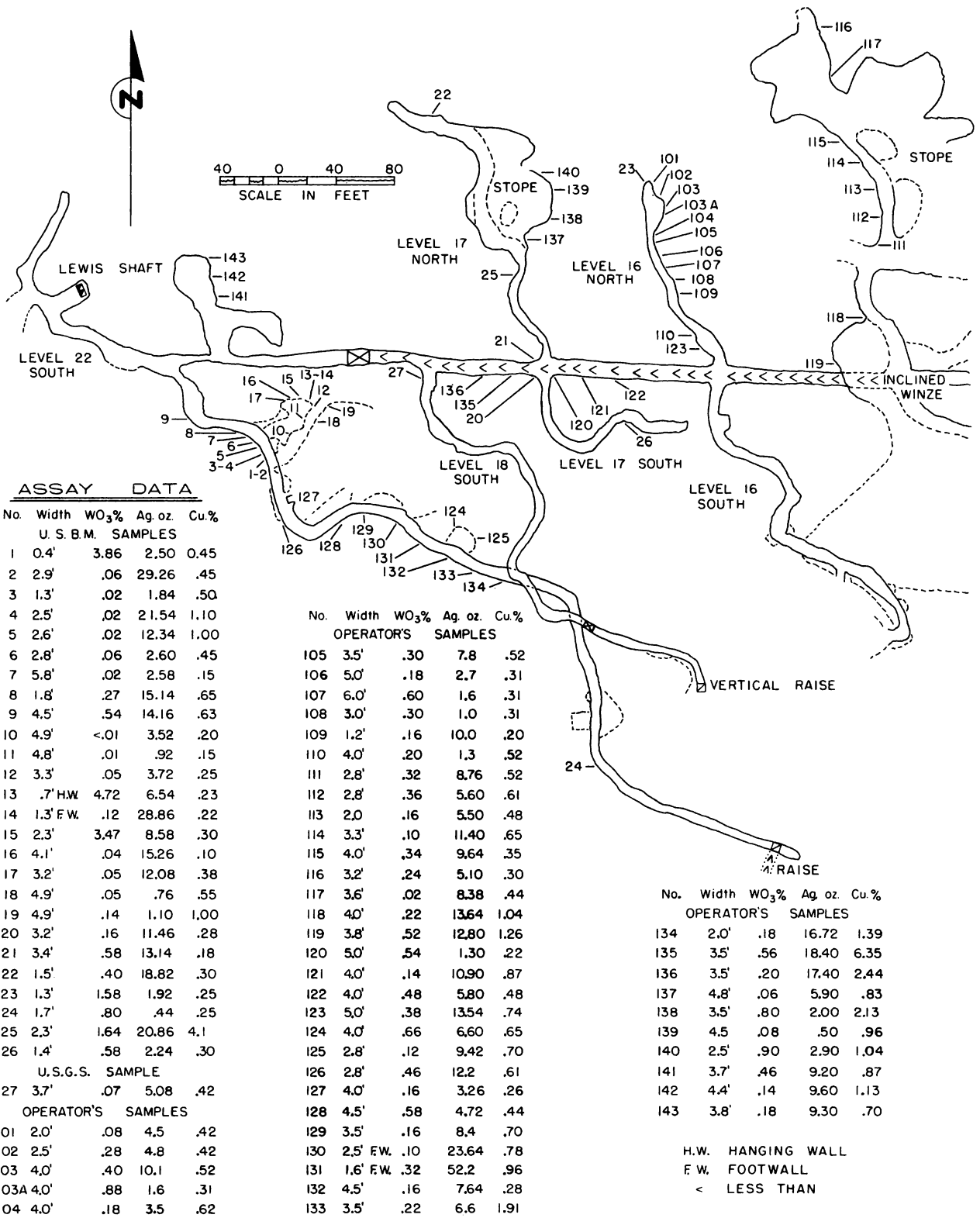


FIGURE 6. - Black Pine Mine, Levels 16-22, Granite County, Mont.
(Source: Federal Geol. Survey.)

The Combination vein ranges in thickness from a few inches to 6 feet, has a proven strike length of more than 1,900 feet, and has been worked downdip for 2,200 feet. Its strike length may exceed 5,500 feet. The vein, a quartz fissure filling with country rock replacement, is cut and offset by a system of normal strike faults.

At the Black Pine mine the principal underground structure comprises a series of normal strike and dip faults generally dipping southwest. Vertical throw ranges from a few inches to 35 feet. Breaks are sharp, and fractures are filled with gangue and breccia; slickensides are common.

On the surface two systems of faulting are indicated. One set including the Betsey Cook and Walkup faults strikes east-southeast and dips north. The other, consisting of the Dry Gulch, Mill Gulch, and Spring faults, strikes east-southeast and dips south. Movement on these faults is apparently small, but a vertical throw of 70 to 90 feet is indicated on the Betsey Cook fault.

Bear and Float Prospect

The Bear and Float prospect is southeast of, and adjacent to, the Black Pine claims. It covers part of the Onyx vein, which reportedly is exposed in the northeast section of the Black Pine mine.

Workings consist of a bulldozed shaft site and a 15° incline sunk in overburden (fig. 7).

Bedrock exposures are poor; generally the Spokane formation strikes N. 30° W. and dips 10° to 20° SW. The Onyx vein is a strong, persistent, relatively unexplored structure. Diamond-drill hole 13 showed that the vein was 3-1/2 feet thick at a depth of 426.5 feet. The vein is indicated on surface only by sporadic float on the east and north slopes of the ridge containing the Combination vein outcrop. The float could also be from the Combination vein.

Double Eagle Prospect

The Double Eagle prospect adjoins the Black Pine claims on the north, as shown in figure 8. Apparently, the Double Eagle vein is the northward extension of the Combination vein. Workings comprise a shallow shaft, a trench, and a few old caved pits.

A limonite-stained quartz vein exposed in the trench is 1.5 feet wide, strikes N. 35° E., and dips 25° NW. In the shaft it is 2.3 feet wide and contains hubnerite with minor specks of pyrite and tetrahedrite. A sample assayed 0.61 percent WO_3 over a 2-foot width, and a high-grade specimen from the dump assayed 7.2 percent WO_3 . The vein in the trench southwest of the shaft is barren. Diamond-drill hole 15, near the south side of the Eagle claim, cut the main vein structure (2.4 feet wide) 188.4 feet below the collar. Two strands of vein material, 1.5 and 1.2 feet thick, and several narrow quartz stringers have been cut in the hanging wall within 10 feet of the vein. Assays range from 0.01 percent to 0.02 percent WO_3 .

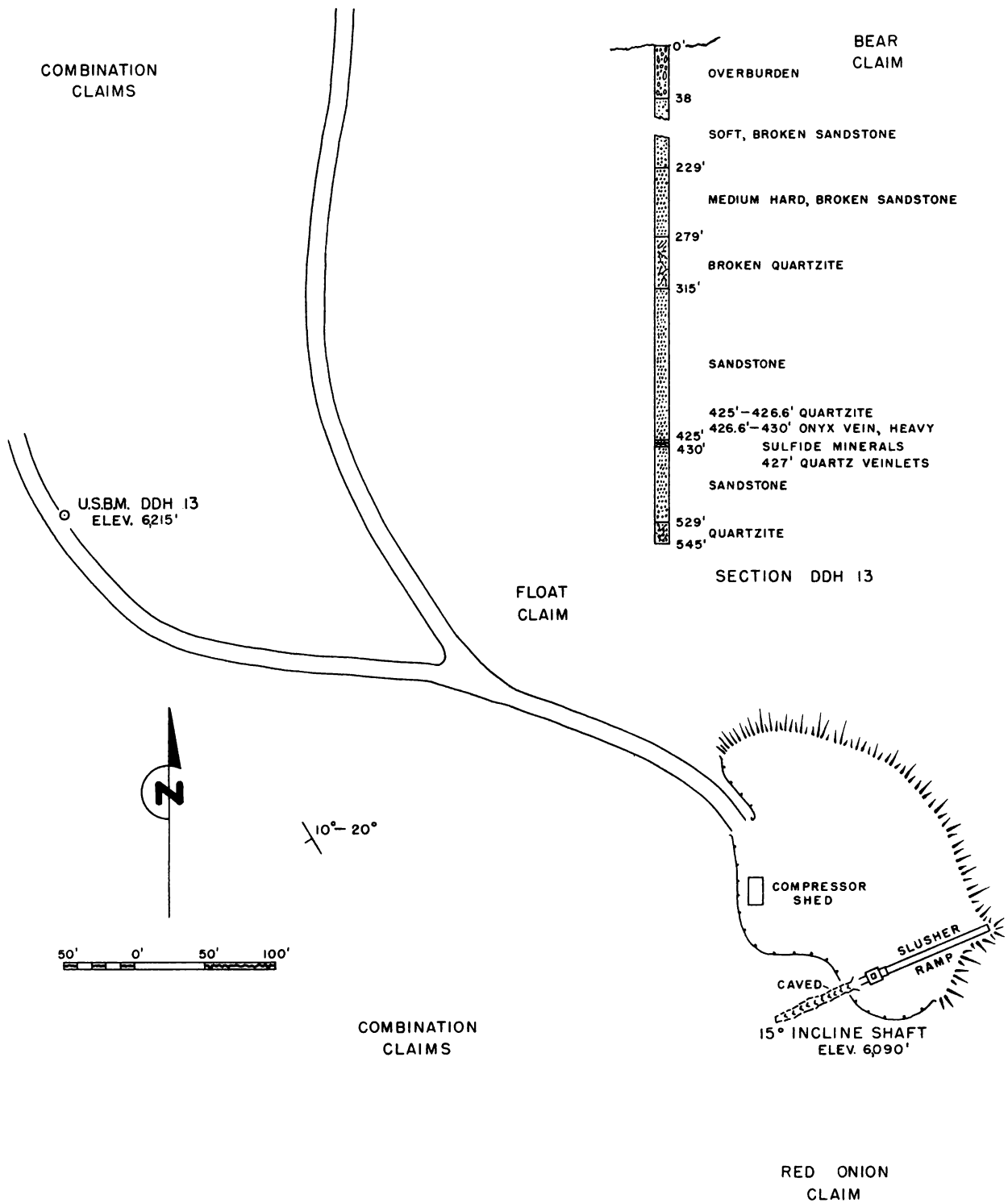
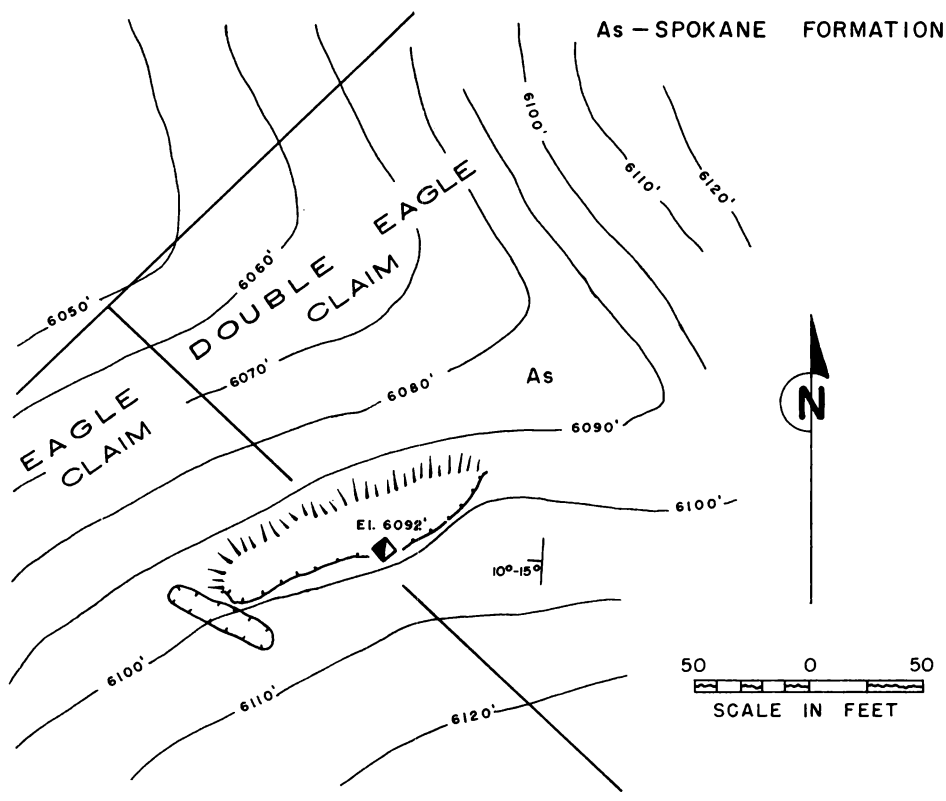


FIGURE 7. - Bear and Float Prospect, Granite County, Mont.
(Source: Federal Geol. Survey.)



The Franz prospect (fig. 9) is at the head of Mead Creek and is accessible from the Black Pine mine by following the Lower Willow Creek road 5 miles, then a poor logging road about 4 miles west.

Relief in the area is moderate, and the hillsides are covered with heavy brush. The property is in a narrow valley; exposure to the sun is limited, and snow remains here long after it has disappeared from the surrounding hills.

Workings consist of a 97-foot adit with a small flat-dipping stope. Little, if any, ore has been shipped; however, about 20 tons is stockpiled

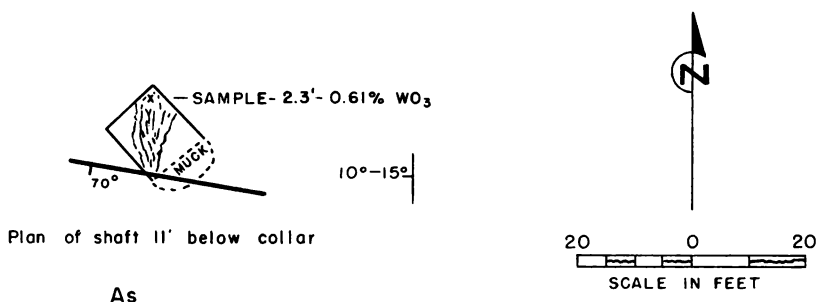


FIGURE 8. - Double Eagle Prospect, Granite County, Mont.

at the property. Past exploration consisted of a long bulldozer cut and several pits. Bulldozing uncovered the vein for approximately 580 feet along the hillside. The country rock is reddish-brown Spokane formation, locally comprising sandstone and quartzite with some zones of intraformational conglomerate. It strikes north and dips 10° to 15° W. No igneous rocks are found near the mine.

The vein, similar to those at Black Pine, is white crystalline quartz containing hubnerite and scheelite in irregularly distributed zones. Generally it parallels the bedding. The width ranges from 6 to 20 inches and averages about 12 inches. Hubnerite crystals are segregated into bunches; scheelite, a minor constituent, occurs as scattered specks along the walls. Ore grade averages 0.4 to 0.6 percent WO₃.

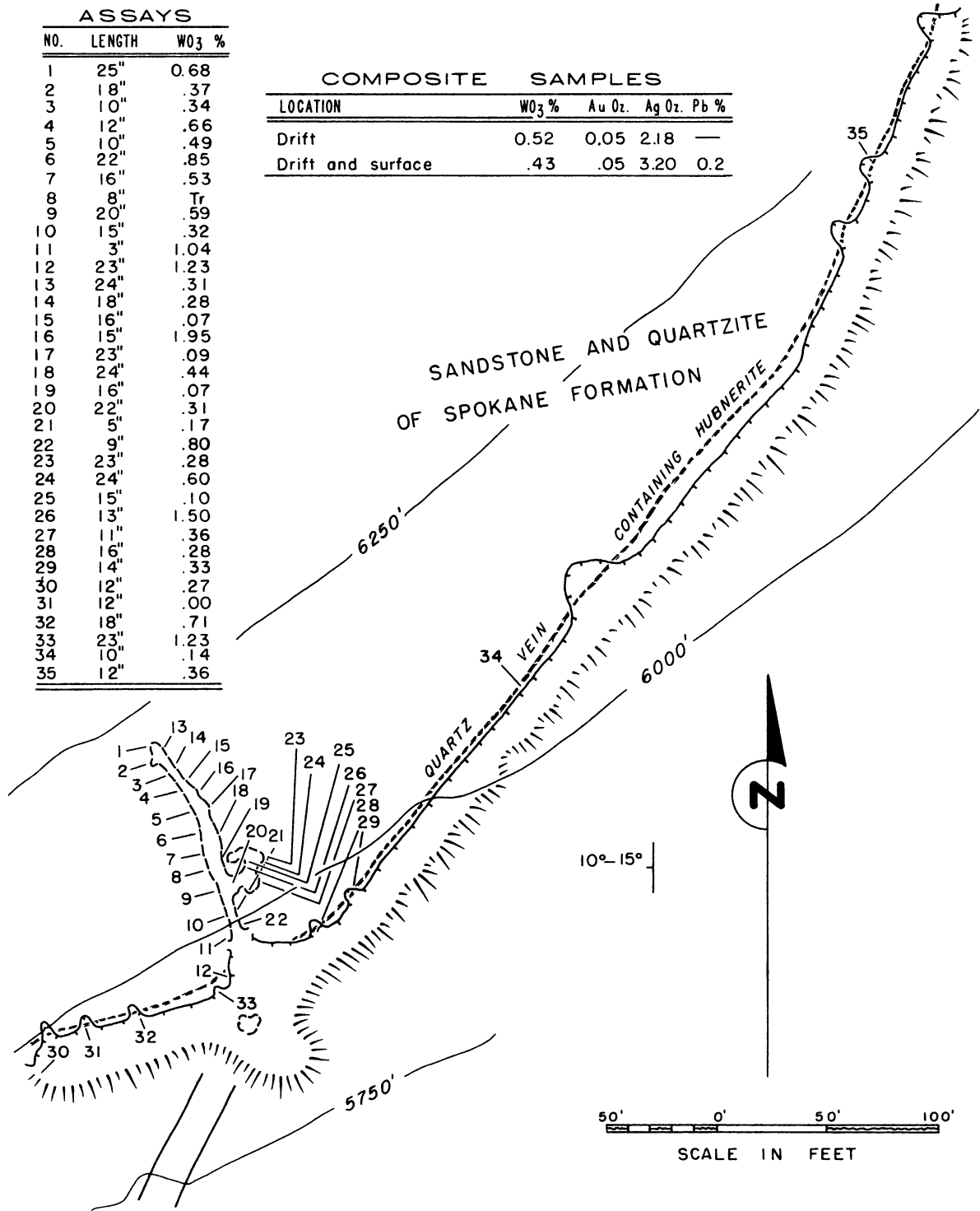


FIGURE 9. - Franz Prospect, Granite County, Mont.

Deer Hunter Prospect

The Deer Hunter prospect is one-half mile west by dirt road from the Black Pine-Henderson road (fig. 2).

Exploration consists of a single small pit in flat-dipping quartzites of the Spokane formation. The pit exposes a hubnerite-bearing quartz vein, 2 to 4 inches wide, striking N. 47° E. and dipping 5° NW., generally parallel to the bedding. A grab sample of vein material from the dump assayed 2.53 percent WO_3 .

Henderson Gulch Deposit

The Henderson Gulch deposit (fig. 10) may be reached from the Black Pine mine or Stone station by the Henderson Gulch road.

Gold was discovered in 1866, and placer operations had yielded \$1,000,000 by 1913. When the Schneider Bros. resumed gold placering on a small scale in 1933, scheelite was identified in the black sand, but attempts to recover it were unsuccessful. In 1942 H & H Mines Co., Portland, Oreg., sampled the property and moved a 4-cubic-foot Yuba dredge onto it. In the next 7 years dredging operations yielded \$940,000 in gold and scheelite from 4,700,000 cubic yards of material. A total of 142 tons of scheelite concentrate containing 63 percent WO_3 was produced (2, 4). The average gold recovery was 15.5 cents per cubic yard and the average tungsten recovery 0.06 pound WO_3 per cubic yard, or 4.5 cents per cubic yard.

The Newland formation forms the core of the anticline from which Sunrise and Henderson mountains were carved. It is about 4,000 feet thick, strikes north, dips 20° W. and consists of impure limestones, calcareous shales, and impure argillites. The sediments have been intruded and intensely metamorphosed by a highly sericitized and decomposed granodiorite. The intrusive is exposed in a triangular outcrop covering about 57 acres.

A strong north-trending and east-dipping mineralized breccia fault zone forms the base of the outcrop. Several ore deposits are found along its strike.

Scheelite is present regularly and persistently in the granodiorite and in the contact-zone sediments (2). Old adits sampled contain different amounts of disseminated scheelite averaging about 0.18 percent WO_3 .

In 1947 the Federal Bureau of Mines trenched and delimited the mineralized zone (2). The work disclosed a large tonnage of submarginal scheelite-bearing rock averaging 0.03 percent WO_3 . The deposit could be mined by open-pit methods.

Sunrise Mine

The Sunrise or Queen mine (fig. 11) is on the south slope of Sunrise Mountain immediately north of the Henderson Gulch deposit.

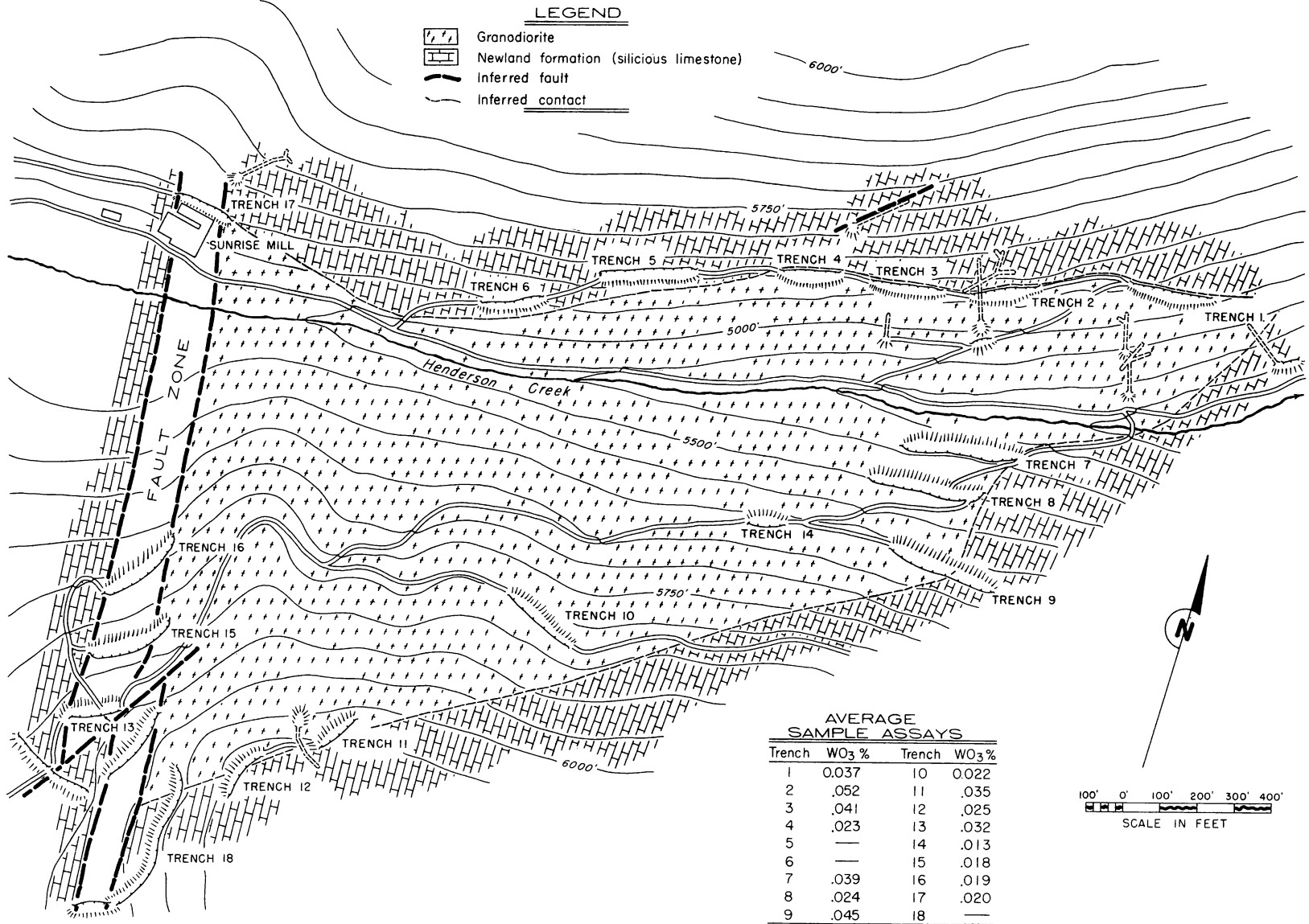


FIGURE 10. - Henderson Gulch Deposit, Granite County, Mont.



FIGURE 11. - Sunrise Mine, Granite County, Mont.

From 1892 to 1903 the Sunrise produced \$120,000 in gold. Later, a small amount of gold was produced from reworked tailings. The Queen workings consist of 7,500 feet of drifts and inclines. The Russel workings, 1,200 feet north of the Queen, consist of 500 feet of drifts and inclines.

The deposit is a quartz vein with considerable replacement on both walls. It occurs in the altered Newland limestone and ranges in thickness from 1 to 10 feet, averaging about 3 feet. The vein strikes N. to N. 10° E. and dips 9° to 40° W., averaging 18° W. It is 1,400 feet long and 1,600 feet deep downdip. Mineralization comprises pyrite, bornite, cuprite, limonite, and free gold. Scheelite occurs as a minor accessory mineral and is very irregular in distribution. The best showing is in the main adit level and the stopes immediately above it, and averages 0.105 percent WO_3 .

General Washington Placer

The General Washington placer is east of the Sunrise mine and adjacent to the Henderson Gulch placer. The deposit, explored by a few surface workings, is a sidehill eluvial placer. The scheelite content is derived from weathering of the granodiorite-contact area.

Overburden ranges from 5 to 20 feet; the thickness and grade of the scheelite-bearing residual material have not been determined. Four grab samples screened through 8-mesh assayed 0.22, 0.26, 0.45, and 0.53 pounds of scheelite per cubic yard in the minus-8-mesh fraction.

In 1953 plans were made to work the General Washington placer along with the remnants of the Henderson Gulch placer. It was proposed to upgrade the material by a washing plant to plus-1.0-percent WO_3 , then to 5.0-percent WO_3 by a jig plant, and finally to plus-60-percent WO_3 by magnetic separation and tables.

PHILIPSBURG AREA

Physical Features

This area in the Flint Creek mining district lies east of, and adjacent to, the town of Philipsburg, a mining and ranching center and the county seat of Granite County. All tungsten prospects are in the western foothills of the Flint Creek Mountain Range. Elevations near the deposits range from 5,500 to 6,500 feet. The mountain crests, 3 miles to the east, attain elevations of more than 8,500 feet. Near the town the slopes are gentle and are covered with bunch grass. Eastward the relief becomes more pronounced, and forests of lodgepole pine and alpine fir are abundant. Snowfall averages about 3 feet in the winter months; summers are dry, and most of the streams cease flowing shortly after the snow melts.

Access

Philipsburg is on U.S. Highway 10A, and nearly all mining activity in the area is within 3 miles of town. All mines and prospects are accessible by a network of good gravel roads.

Geology

Sedimentary rocks of the area range in age from Precambrian to Quaternary; the main structural feature is the Philipsburg anticline (fig. 12). The strike of the anticlinal axis ranges from northwest at the southern extremity to northeast near the nose or northern extremity. The dip on both limbs is about 45°, and the anticline plunges north about 25°. The sediments are intruded on the south and east by the Philipsburg batholith and overlain on the west by alluvium. The area is highly mineralized and has produced considerable silver, lead, zinc, and manganese.

Table 2 gives the location, production, and ownership of the Philipsburg properties.

TABLE 2. - Location, production, and ownership, Philipsburg area tungsten properties

Name	Location	Production	Type of property	Owner	Address
North Star	Sec. 25, T. 7 N., R. 14 W. and sec. 30, T. 7 N., R. 13 W.	86,691 lb. ore, 4.0 to 7.0 per- cent Cu and 1.7 oz. Ag per ton.	3 claims	Wm. F. Flynn.	Anaconda, Mont.
Isabelle Queen....	Sec. 30, T. 7 N., R. 13 W.	None	2 claims	John H. Duthie.	Los Angeles, Calif.
Murphy....	Sec. 17, T. 7 N., R. 14 W.	No record.	do.	Harry A. Murphy	Philipsburg, Mont.

Deposits

North Star Prospect

The North Star prospect is one-half mile east by road from the northeast corner of Philipsburg.

The property has a recorded ore production of 43 tons containing 4.0 to 7.0 percent Cu and 1.7 ounces Ag per ton.

Workings comprise adit 1 (75 feet long), adit 2 (260 feet long), adit 3 (425 feet long), two caved shafts (one as much as 100 feet deep), and a short adit 200 feet north of adit 2. (See fig. 13.) Considerable bulldozer trenching has been done and adit 1 is almost entirely cut away.

The North Star is on the western limb of the Philipsburg anticline; the sediments strike northeast and dip 35° NW. The Maywood and Jefferson formations are exposed near the workings.

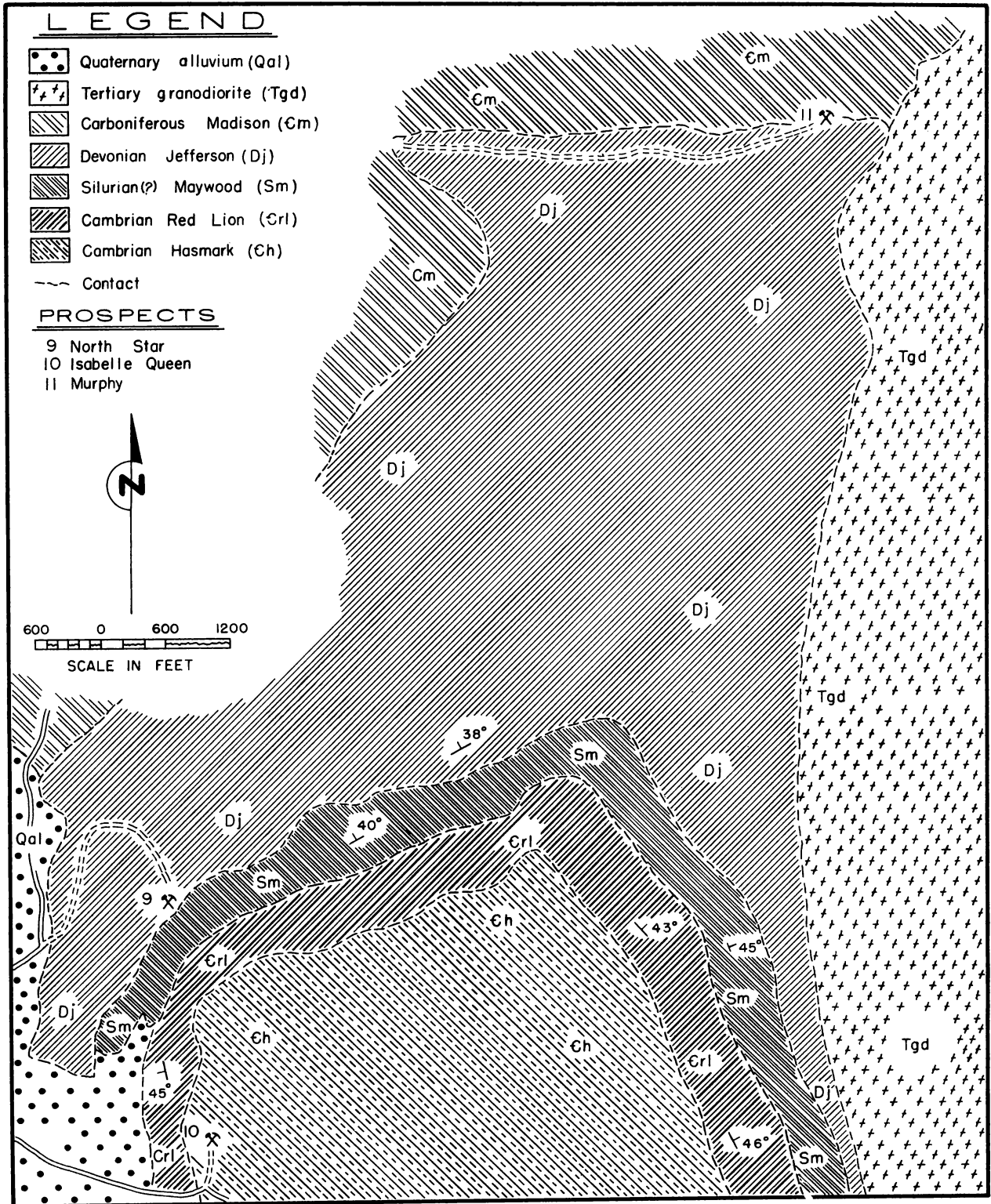


FIGURE 12. - General Geology, Philipsburg Area, Granite County, Mont.
(Source: Federal Geol. Survey Prof. Paper 78.)

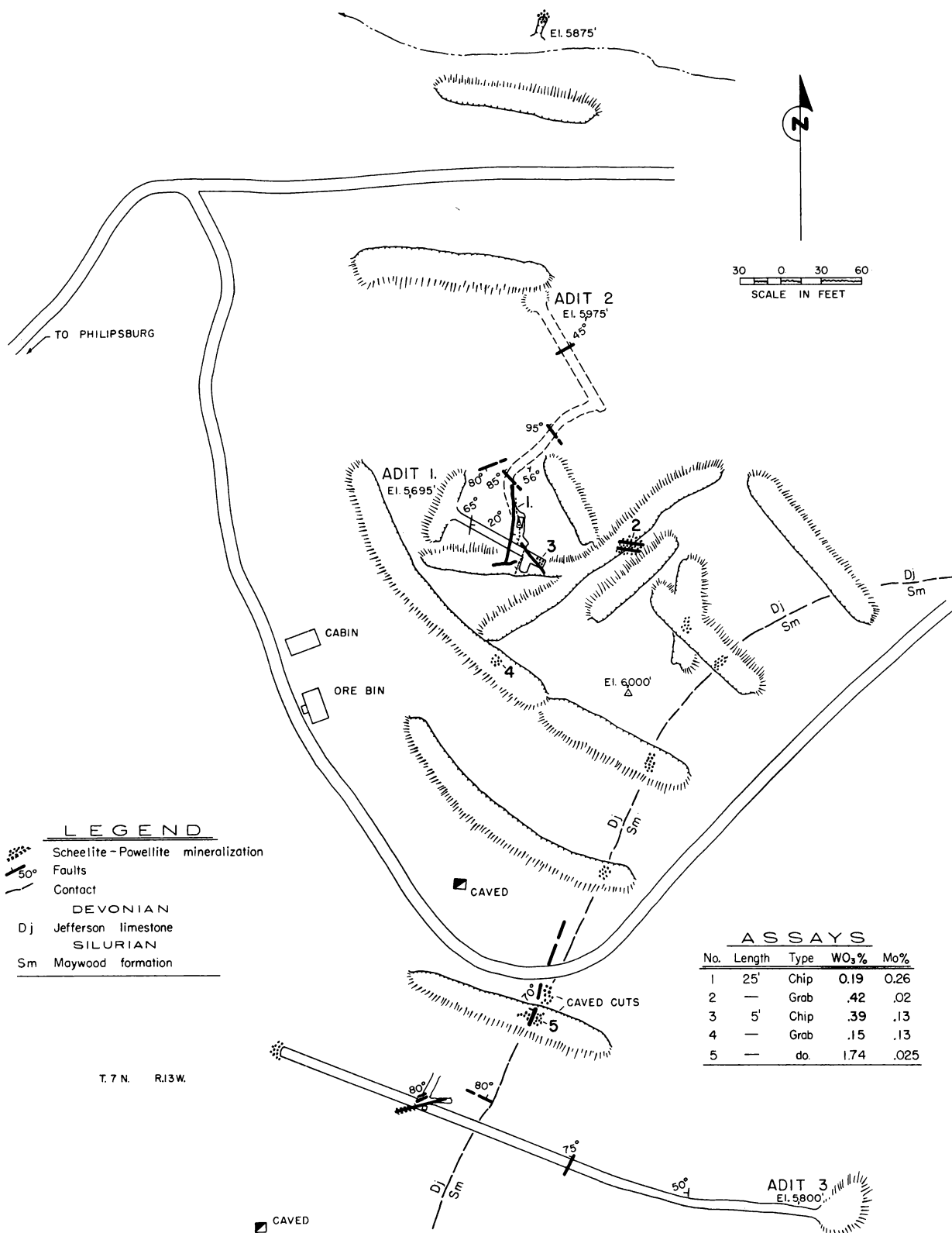


FIGURE 13. - North Star Prospect, Granite County, Mont. (General geology from Federal Geol. Survey Prof. Paper 78.)

Tungsten mineralization is found at scattered points over an area 300 by 600 feet. Scheelite and powellite are disseminated through a gangue of altered sedimentary rock and as small pods erratically distributed in and along fractures in the Jefferson formation. Mineralization may follow the Maywood-Jefferson contact or fractures that intersect it. A 4-foot, vuggy, iron-stained, vertical quartz vein striking west and containing disseminated scheelite, was exposed in the short adit north of adit 2.

Isabelle Queen Prospect

The Isabelle Queen prospect lies on the western limb of the Philipsburg anticline about 1,000 feet south of the North Star (fig. 14). Workings comprise an old caved discovery shaft, a 40-foot accessible adit with a 40-foot winze averaging 8 feet in width, and a number of shallow pits.

Country rock is mainly medium-grained, white, magnesian Hasmark limestone. It strikes north and dips 45° W. The deposit is associated with a shear zone striking N. 20° E. The ore, essentially siliceous silver-manganese mineralization, is a replacement body, and its known dimensions are 50 feet long by 5-1/2 feet wide by 40 feet deep. Scheelite occurs occasionally as an accessory mineral. A 5-foot channel sample across the deposit assayed 0.11 percent WO₃.

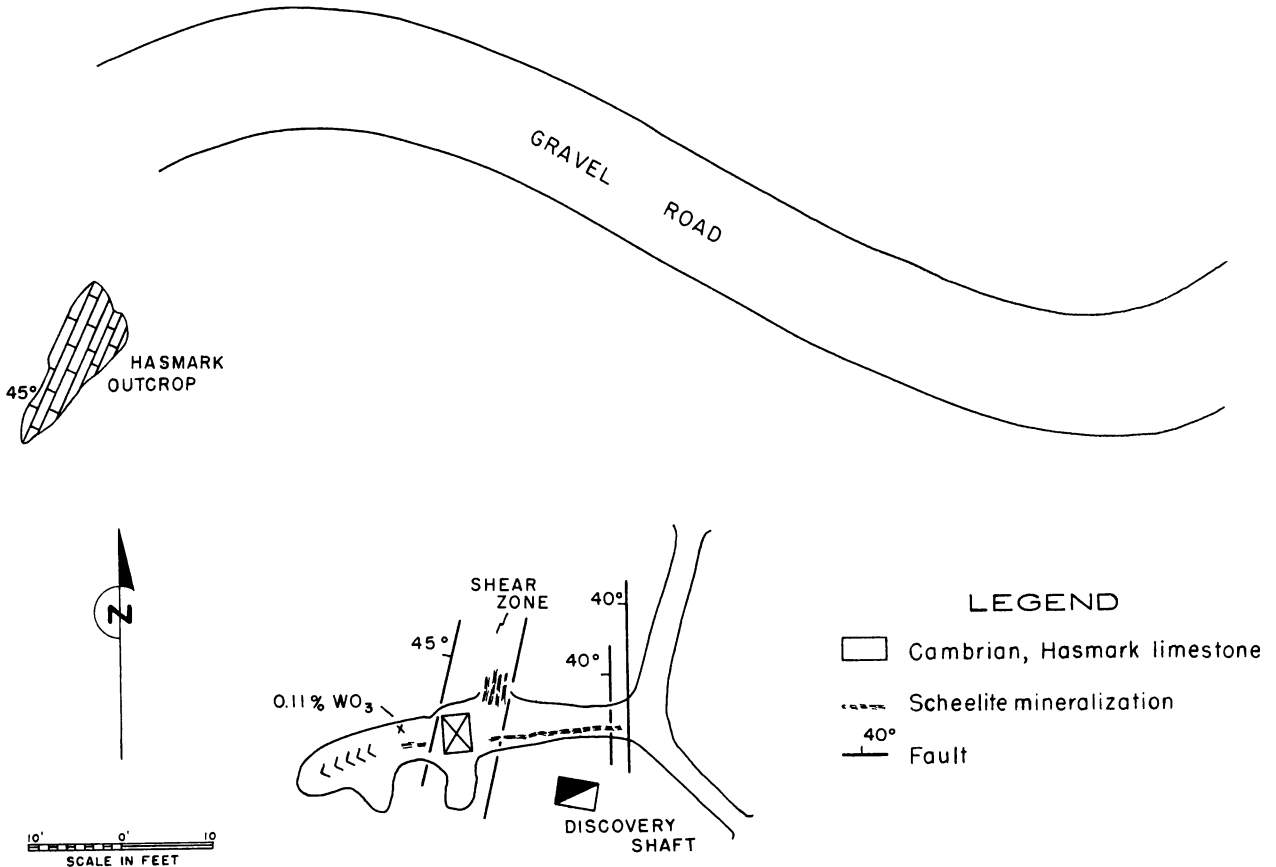


FIGURE 14. - Isabelle Queen Prospect, Granite County, Mont.

Murphy Mine

Access to the Murphy mine is by 1-1/2 miles of road north from the northeast corner of Philipsburg to Steward Gulch and 1-1/2 miles east along the Stewart Creek road. The property is at an elevation of 6,200 feet.

The property comprises the Wilkie and Mr. Bob claims. Mine workings consist of an old caved shaft, two crosscut adits, some drifting (fig. 15), and considerable bulldozing. Underground workings total about 700 linear feet. Some copper-silver ore has been mined, but no production has been recorded.

The deposit is on the western side of the Philipsburg anticline nose and near the contact of the Jefferson and Madison limestone. The formations strike N. 70° E. and dip about 20° NW. Copper-silver lenticular replacement ore bodies contain scheelite in scattered crystals in disseminated bunches. The deposit strikes N. 75° E. and dips 65° NW. to vertical. It is exposed over a strike length of 200 feet and a depth of 50 feet. Width ranges from 1 to 24 inches.

SILVER LAKE AREA

Physical Features

The Silver Lake area (fig. 16) is in Deer Lodge and Granite Counties and is bisected by U.S. Highway 10A. Silver Lake, Georgetown Lake, and Storm Lake serve as reservoirs for the city of Anaconda, 14 miles east of the area.

The Silver Lake shore has a mean elevation of 6,450 feet. Relief ranges from moderate near the lake to rugged a few miles away. The Flint Creek Range to the north rises rapidly to elevations over 8,500 feet and the Anaconda Range to the south towers at elevations over 10,500 feet. Eastward the surface slopes gently into the valley of Warm Springs Creek; westward, beyond Georgetown Lake, the headwaters of Flint Creek have incised a deep valley.

Access

A good gravel road from U.S. Highway 10A extends along the east end of Silver Lake and Storm Lake Creek to Storm Lake (fig. 16). It serves as the main artery for several tungsten properties in the vicinity. Properties north of Silver Lake have access roads to the main highway.

Geology

Rocks of the area range in age from the Precambrian Spokane formation to Mississippian Madison limestone. The major structural feature is the east limb of a gentle syncline with minor folds developed locally. The beds strike northeast and dip 20° to 45° NW.

Although outcrops are plentiful and easily traced, much of the older sediments are covered by Quaternary glacial debris. Further obliteration is caused by accumulations of stream gravels and alluvium.

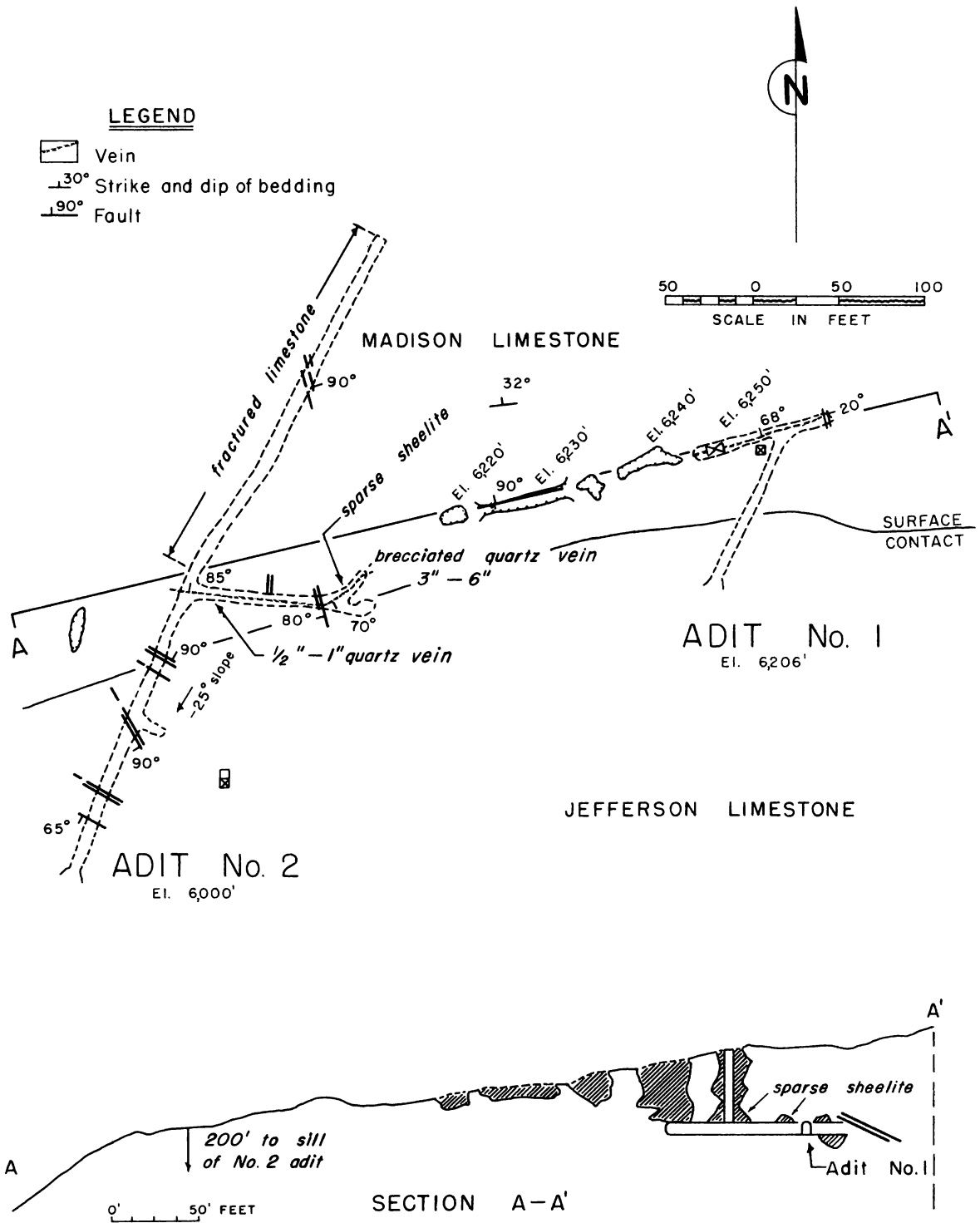


FIGURE 15. - Murphy Prospect, Granite County, Mont.



LEGEND

<p>QUATERNARY</p> <p>Alluvium (Qal)</p> <p>Moraines (Qm)</p> <p>TERTIARY</p> <p>Granodiorite (Tgd)</p> <p>CARBONIFEROUS</p> <p>Quadrant Quartzite (Cq)</p> <p>Madison limestone (Cm)</p> <p>DEVONIAN</p> <p>Jefferson limestone (Dj)</p> <p>SILURIAN</p> <p>Maywood formation (Sm)</p>	<p>CAMBRIAN</p> <p>Red Lion formation (Crl)</p> <p>Hasmark formation (Ch)</p> <p>Silver Hill formation (Csh)</p> <p>Flathead quartzite (Cf)</p> <p>ALGONKIAN</p> <p>Spokane formation (As)</p> <p>Newland formation (Anl)</p> <p>Fault</p> <p>Inferred fault</p> <p>Strike and dip of beds</p>
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PROSPECTS

12	Trigger
13	Hansen-Meloy
14	Sheila
15	Blackshirt
16	HLM
17	Tommy
18	Rising Star
19	Sunshine
20	Best
21	Ceto
22	Minnie Lee
23	Hilltop
24	Headache
25	McCabe
26	Payoff
27	Calcabe
28	Gyp

0 1000 2000 3000 4000 5000
SCALE IN FEET

FIGURE 16. - General Geology, Silver Lake Area, Deer Lodge and Granite Counties, Mont.
(Source: Geol. Survey Prof. Paper 78.)

Several small granodiorite outliers from the Philipsburg batholith intrude the sediments, and a large granodiorite stock lies about a mile north of Silver Lake.

Gold and silver were mined before World War I. Since 1950, prospecting for tungsten has been widespread. Limestone and limy shales of the Jefferson and Hasmark are the most important host formations.

Table 3 gives the location, production, and ownership of the Silver Lake properties.

Deposits

Trigger Mine

The Trigger mine lies on the south shore of Silver Lake at an elevation of 6,450 to 7,100 feet. Access from U.S. Highway 10A is by a good gravel road around the west end of the lake (fig. 16).

Mine workings consist of a 168-foot lower adit, at an elevation of 6,460 feet, and a 125-foot upper adit, at an elevation of 6,507 feet. (See fig. 17.) A north-trending drift 42 feet from the portal of the upper adit intersected ore at one point but otherwise passed under it (fig. 18). Considerable stoping has been done above the upper-adit crosscut. Several bulldozer cuts and 19 diamond-drill holes totaling 3,766 feet complete the workings. Approximately 4,000 tons of ore averaging 1.0 percent WO_3 was mined, concentrated, and sold.

The Trigger is on the east limb of a gentle syncline with minor local folds. The Jefferson limestone, host rock for mineralization, has been metamorphosed into white crystalline marble.

Ore bodies are typical replacement deposits and occur as pipes, chimneys, and lenses. Scheelite is present as very pure crystals in sheared and fractured zones with minor amounts along bedding planes. The largest lens is exposed by outcrops, trenches, and bulldozer cuts for a strike length of more than 400 feet; it is stoped above the upper adit for a length of 100 feet. North of cut 4 the vein splits into stringers and veinlets; little ore is noticeable beyond trench 3. To the south the ore appears to be cut off by a northeast-trending fault. Scheelite float occurs beyond the fault, but no ore is found in place.

Ore is exposed at the portal of the upper adit and in the face of the drift. A lens of ore 2-1/2 feet wide is present at the face of the lower adit (fig. 18). It strikes N. 60° E. and dips 50° NW.

In general, the ore lenses strike N. 20° E. and dip steeply to the west. However, the ore tends to follow local variations in bedding, and in places the dip flattens to nearly 10°.

TABLE 3. - Location, production, and ownership, Silver Lake area tungsten properties

Name	Location	Production	Type of property	Owner	Address
Trigger.....	Sec. 28, T. 5 N., R. 13 W.	4,000 tons, approx. 1 percent WO ₃ .	13 claims	J. J. Meloy. and others.	Anaconda, Mont.
Hansen-Meloy	Sec. 28, T. 5 N., R. 13 W.	None.	8 claims	do.	Do.
Sheila.....	Sec. 28, T. 5 N., R. 13 W.	do.	3 claims	Chas. Cockrell and others.	Do.
Blackshirt..	Sec. 33, T. 5 N., R. 13 W.	do.	do.	J. J. Meloy.	Do.
H. L. M.....	Sec. 33, T. 5 N., R. 13 W.	20 tons, approx. 0.3 percent WO ₃ .	10 claims	Russell Luke and others.	Butte, Mont.
Tommy.....	Sec. 33, T. 5 N., R. 13 W.	None.	7 claims	R. S. McKay	Anaconda, Mont.
Rising Star.	Sec. 32, T. 5 N., R. 13 W.	do.	9 claims	J. J. Meloy	Do.
Sunshine....	Sec. 7, T. 4 N., R. 13 W.	40 tons, 0.5 percent WO ₃ and 5.18 oz. Ag per ton.	7 claims	R. W. Wallace	Do.
Best.....	Sec. 7, T. 4 N., R. 13 W.	None.	4 claims	Harold Best	Do.
Ceto.....	Sec. 7, T. 4 N., R. 13 W.	do.	3 claims	J. J. Meloy and others.	Do.
Minnie Lee..	Sec. 10, T. 4 N., R. 14 W.	do.	3 claims	L. A. Sherrill	Butte, Mont.
Hilltop.....	Sec. 12, T. 4 N., R. 14 W.	do.	8 claims	Burton Colwell	West of Anaconda
Headache....	Sec. 12, T. 4 N., R. 14 W.	do.	9 claims	J. J. Meloy	Anaconda, Mont.
McCabe.....	Sec. 21, T. 5 N., R. 13 W.	do.	3 claims	J. McCabe	Do.
Payoff.....	Sec. 21, T. 5 N., R. 13 W.	do.	1 claim	R. J. Kelly	Do.
Calcabe.....	Sec. 21, T. 5 N., R. 13 W.	do.	2 claims	Eugene McCabe and others.	Butte, Mont.
Gyp.....	Sec. 15, T. 5 N., R. 13 W.	do.	5 claims	Frank Hansen	Do.

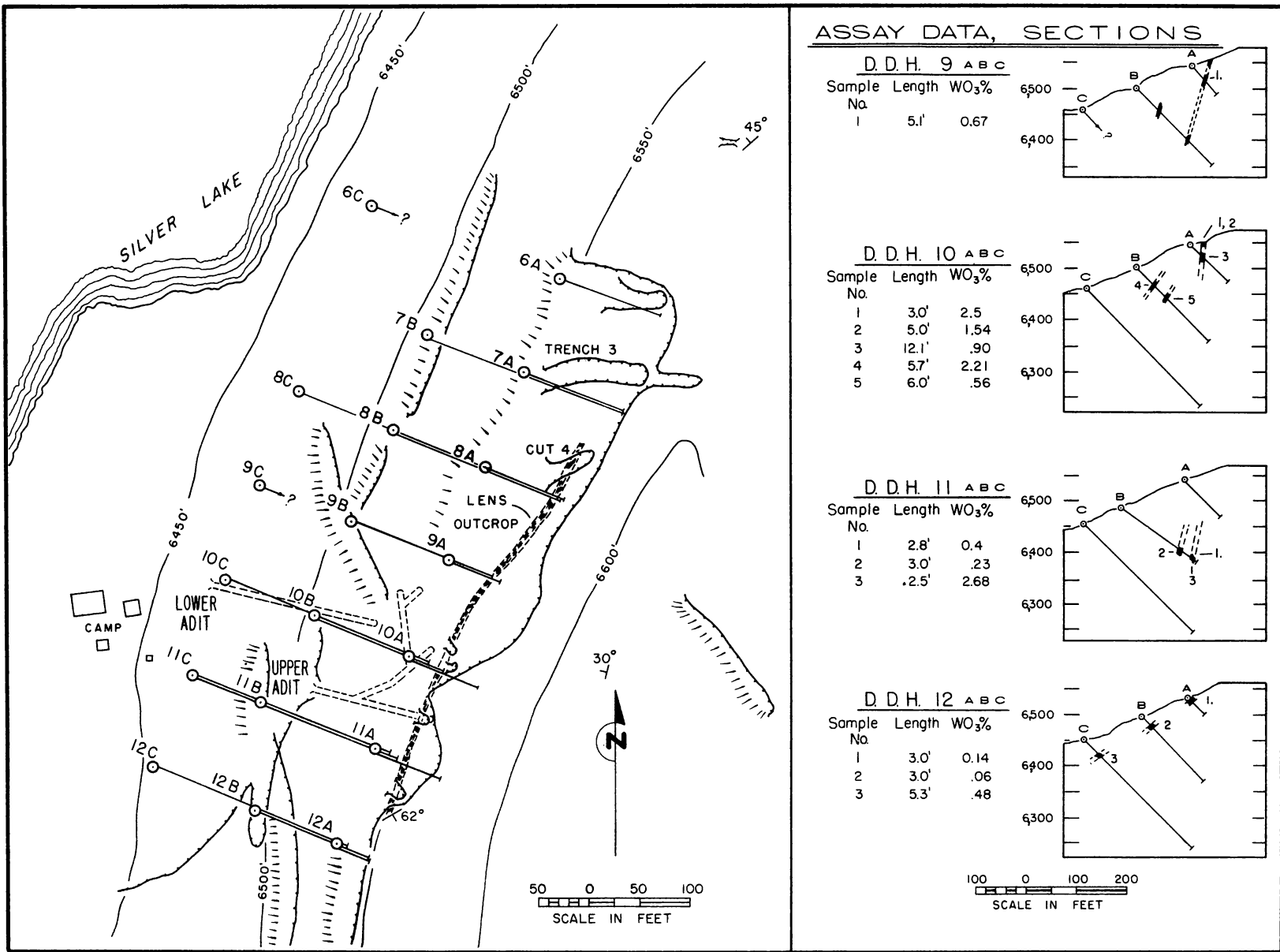


FIGURE 17. - Trigger Mine, Deer Lodge County, Mont. (Source: Owners' map.)

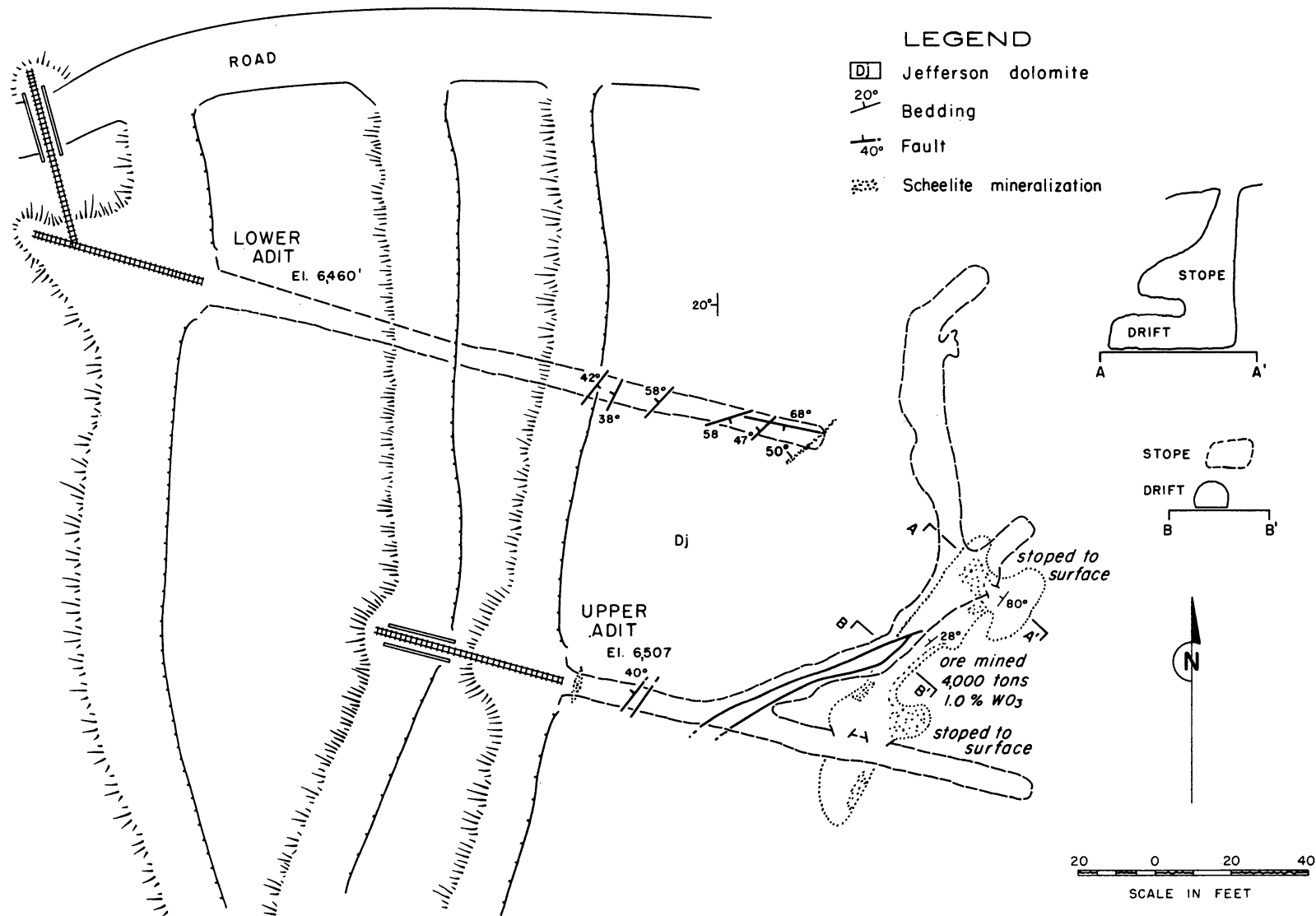


FIGURE 18. - Trigger Mine, Underground Workings, Deer Lodge County, Mont.

Lens width ranges from 6 inches to 6 feet near the surface; occasionally the dip flattens and the lens widens to as much as 12 feet. Values are inconsistent--from 0.05 to 10.0 percent WO_3 . The average grade of the outcrop is slightly over 1.0 percent WO_3 .

According to the present owner, beneficiation tests of a head sample containing 1.8 percent WO_3 gave the following results. Gravity methods produced a concentrate containing 57.4 percent WO_3 with a recovery of 87.4 percent. An additional 7.7 percent was recovered by flotation in a product containing 17.3 percent WO_3 .

Hansen-Meloy Prospect

The Hansen-Meloy prospect is east of, and adjacent to, the Trigger mine. Workings comprise several old caved shafts and adits driven in search of silver. Several random bulldozer cuts in the Hasmark formation comprise the tungsten exploration. Although scheelite float is plentiful the mineral has not been found in place.

Sheila Prospect

The Sheila prospect is approximately one-half mile south of the Trigger mine on the east slope of a narrow gulch.

Two small pits have exposed occasional minute specks of scheelite in Jefferson limestone.

Blackshirt Prospect

The Blackshirt prospect is about one-half mile south of the Trigger mine. Access from U.S. Highway 10A is by the Storm Lake road for approximately 1 mile and westerly by rough mountain road about 1 mile.

An old partly caved 15-foot shaft, sunk originally for silver, and five bulldozer cuts totaling about 900 linear feet, constitute the mine workings (fig. 19). There is no record of production.

The property is on the same major structure as the Trigger, and the workings are in Jefferson limestone. The formation strikes N. 40° E. and dips 40° W. A fracture zone, containing 5 to 6 feet of scheelite mineralization and cutting across the limestone, strikes N. 25° E. and dips 60° NW.

The mineralized zone is exposed by the shaft and a bulldozer cut 10 feet to the southwest. The zone appears to be cut off by an east-west fault in the shaft. The owner reports that scheelite was found in place southwest of other exposures. A sample, taken across 2 feet of the fracture zone exposed in the cut, assayed 0.65 percent WO_3 . Shallow bulldozing northeast of the shaft failed to find ore.

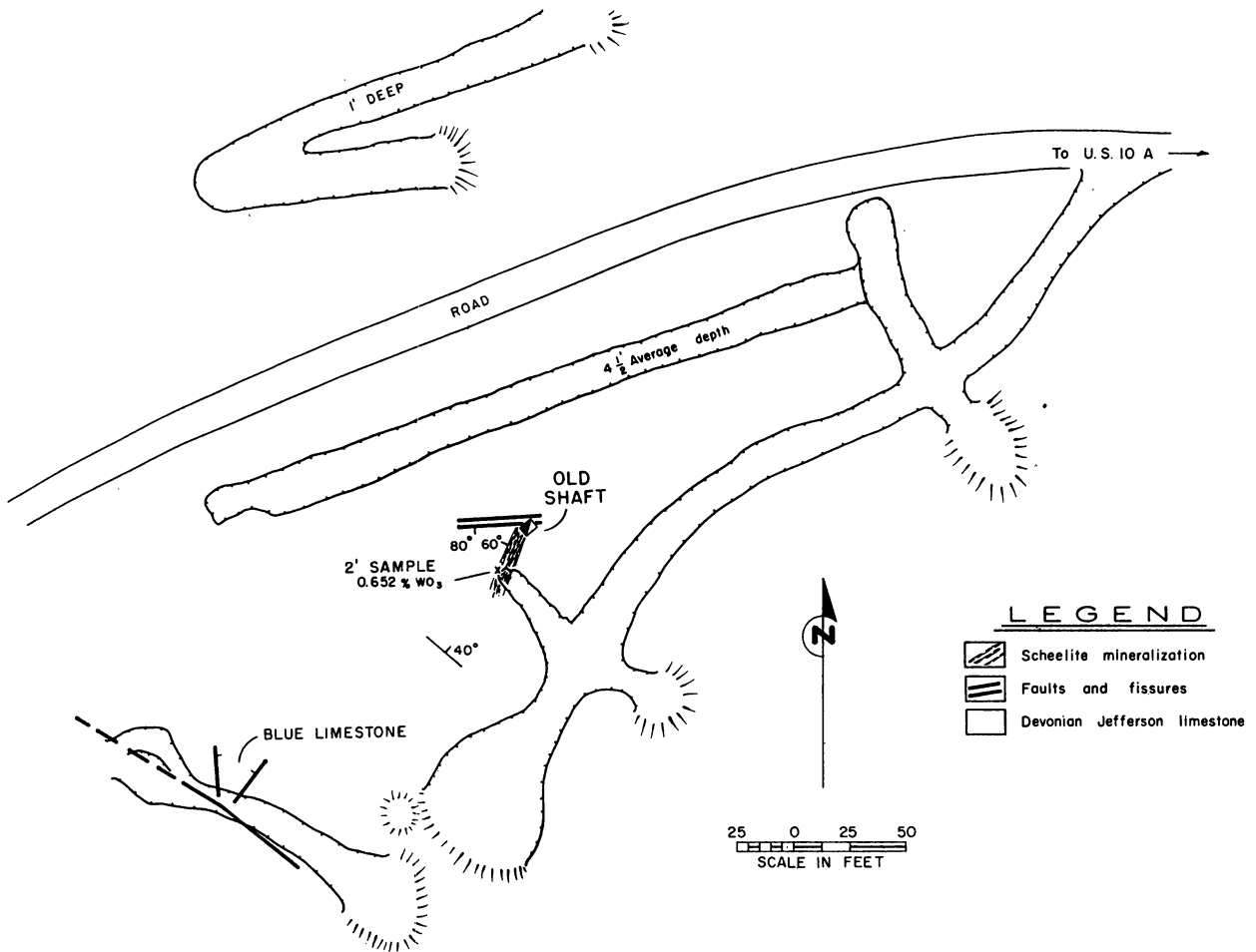


FIGURE 19. - Blackshirt Prospect, Deer Lodge County, Mont.

H. L. M. Prospect

The property is about 1-1/2 miles south of the highway on a steep slope rising above and to the west of Storm Lake Creek. A good road about one-fourth mile long connects the Storm Lake road and the prospect. Workings consist of two adits, a winze, and five bulldozer trenches (fig. 20).

Country rock is predominantly white, metamorphosed Hasmark limestone striking N. 30° E. and dipping 18° to 20° W. Scheelite occurs in an ore shoot 5 to 6 feet wide consisting of fissure-filling quartz with some replacement along the vein. Mineralization is generally low grade, and the best values are in the quartz vein. The ore shoot strikes N. 60° W., dips 60° to 80° SW., and appears on the surface as a prominent outcrop. Two feet of the vein hanging wall is quartz with scattered scheelite; in the footwall of the vein quartz stringers and sparse scheelite are found in limestone. Samples across the outcrop assayed 0.01, 0.02, 0.43, and 1.56 percent WO₃ over widths of 4 feet.

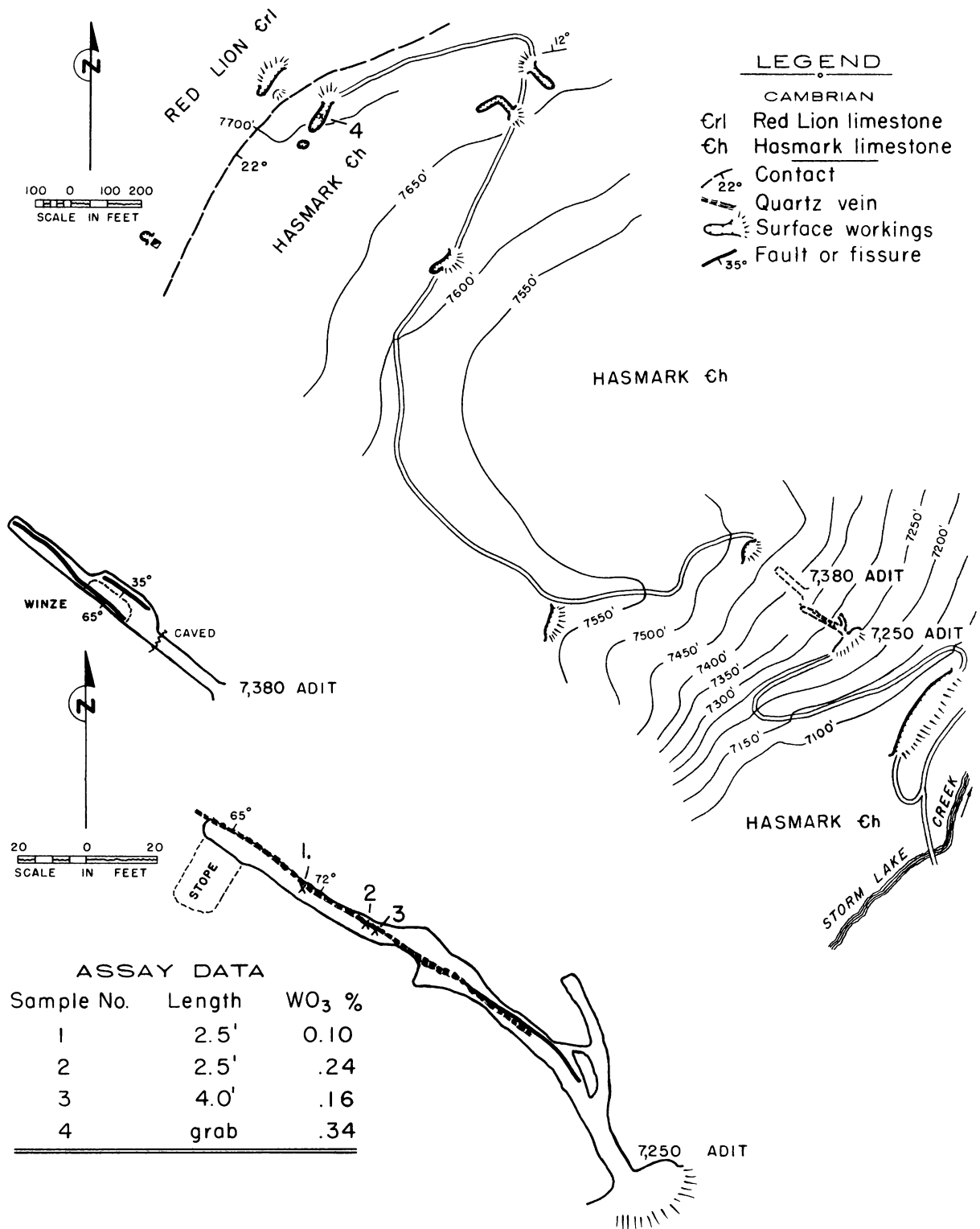


FIGURE 20. - H. L. M. Prospect, Deer Lodge County, Mont. (Source: Owners' map.)

Bulldozer trenches near the ridgetop disclosed no significant mineralization. A shallow trench exposed a shear zone striking N. 50° W., dipping vertically, and cutting across westerly trending flat limestone beds. Weak scheelite mineralization occurs along the shear zone. A 4-foot sample across the most promising area assayed 0.03 percent WO₃. The upper adit, driven by old-time prospectors searching for silver, is about 70 feet long and partly caved at the portal. An 18-inch quartz vein exposed by the adit and an 18-foot winze are devoid of scheelite. The vein strikes N. 50° W. and dips 65° SW.

The lower adit was driven on a quartz vein 2-1/2 feet wide, striking N. 60° W. and dipping 65° to 80° NE. A 30-foot raise contains only weak mineralization. Two small prospect raises were driven on the vein, and the material was shipped for mill tests. Two samples across the vein assayed 0.10 and 0.24 percent WO₃.

Tommy Prospect

The Tommy prospect, on the west side of Silver Hill, is about one-half mile south of the Blackshirt.

Workings include an old 10-foot pit sunk on a quartz vein containing silver mineralization, a narrow bulldozer cut west of the pit, and an area 60 by 80 feet from which the overburden has been stripped.

A quartz-calcite vein, averaging 1 foot wide in the pit and stripped area, cuts across beds of marbleized Jefferson limestone and strikes N. 54° E. with a dip of 30° NW. Scattered crystals of scheelite occur in the vein.

Rising Star Prospect

The Rising Star prospect lies on a bald ridge 1 mile southwest of the Tommy. No road leads to the property.

Exploration consists of several randomly oriented bulldozer cuts and a few old caved prospect pits. Workings are in Madison limestone, striking north-south and dipping 30° W. Although scheelite is present in float, exploration has disclosed no mineralized structure.

Sunshine Prospect

The Sunshine prospect, known also as the Tarlach or Tungstar, is on the east slope of Dry Creek Gulch about 2-1/2 airline miles south of Silver Lake (fig. 16). Access from U.S. Highway 10A is by the Storm Lake road for 3 miles, then west on a good dirt road 1-1/4 miles.

Relief in the immediate vicinity is moderate, and the slopes are heavily covered with timber. It is reported that 40 tons of silver ore was shipped to a smelter in 1910.

The main mine workings are concentrated at the August inclined shaft, 210 feet deep, with drifts on 35-, 50-, and 200-foot levels (fig. 22). The shaft

is sunk on the vein for the first 100 feet and then extends into the footwall. About 40 tons of tungsten ore was removed from a small stope on the 200-foot level. The shaft and lower workings are inaccessible. Other work at the property consisted of bulldozer trenching, diamond drilling, and long-steel drilling.

The prospect is underlain principally by Hasmark, Red Lion, Maywood, and Jefferson formations (fig. 21). In general, they are limy in character and comprise a series of limestone, dolomite, shale, and some sandstone. The beds of the synclinal fold strike about N. 35° E. Diastrophism has further warped the beds into minor north-trending folds, and dips in the area range from 20° to 35° NW. Much of the outcrop area is covered by glacial debris and alluvium.

Sedimentary formations have been intruded and metamorphosed by several small granodiorite stocks, offshoots of the Philipsburg batholith. The Sunshine prospect lies directly between two of these intrusives. The sediments are cut by a number of diorite dikes.

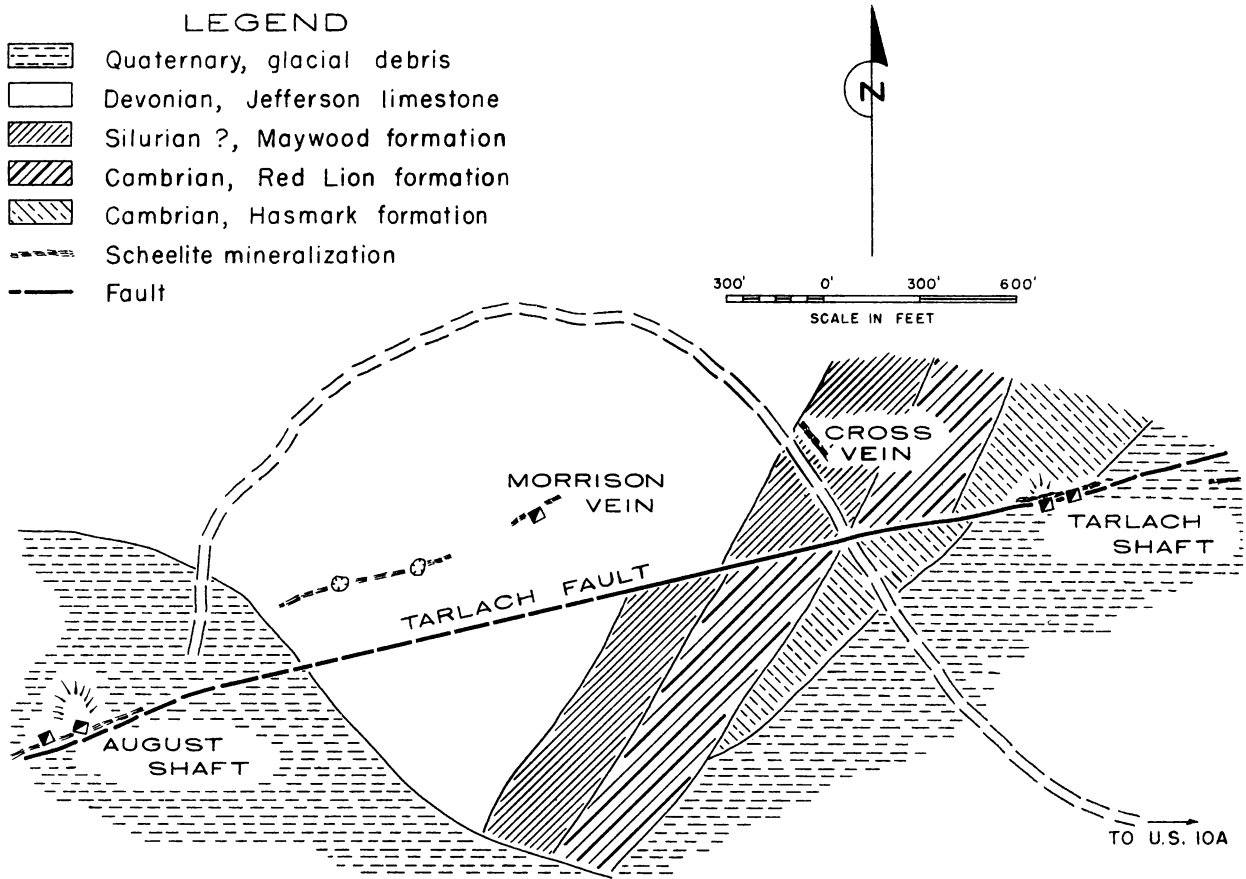


FIGURE 21. - Sunshine Prospect, Areal Geology, Deer Lodge County, Mont.

The most important structural feature is the Tarlach reverse fault, which has 60 to 100 feet of vertical displacement. The fault strikes N. 50° to 70° E. and dips about 70° S. From the August shaft to the Jefferson-Maywood contact the fault is obscured by detritus and overburden. From the contact it may be traced 1,500 feet into Storm Lake valley, where it is obscured by glacial debris. The fault is marked by the outcrop of a massive quartz vein near the Tarlach shaft.

Fine-grained scheelite and tetrahedrite occur in quartz lenses along the Tarlach fault zone and in small quartz veins crossing the structure. The veins also contain small quantities of galena and sphalerite. Scheelite is disseminated as fine grains in limestone in the fault walls.

Four deposits outcrop in rough echelon pattern over a strike length of 4,000 feet; all are in limestone. (See fig. 21.)

The easternmost vein, the Tarlach, outcrops for a length of 150 feet and is 4 to 8 feet wide, averaging 6 feet. It is a bedding plane lens of quartz and calcite with finely disseminated scheelite crystals. The lens dips 60° S.

The Cross vein west of the Tarlach is a limestone replacement deposit exposed only by an outcrop of a high-grade scheelite-bearing quartz lens at least 20 feet long and 3-1/2 to 4 feet wide.

Farther west, the narrow, steeply dipping Morrison vein is poorly exposed by three shallow pits. It is a relatively weak structure containing only a trace of scheelite.

The August vein on the west end of the fault zone is 2-1/2 to 5 feet wide. Scheelite and small quantities of sulfides are found in quartz-calcite veinlets in the fault zone. Mineralization is present as fine, evenly disseminated scheelite crystals; irregular coarse bands and clusters of scheelite; and a thin, dark limestone banding with scattered minute crystals of tetrahedrite. Scheelite is persistently and uniformly distributed on the 35 level. The vein pinches out in the shaft about 100 feet below the collar. On the 200 level the vein is composed of quartz lenses lying along the fault; a diorite dike follows the fault for much of its exposed length.

Two small ore lenses occur on the 200 level; one in the northeast drift is 50 feet long and extends 50 feet above and 20 feet below the level. Scheelite and tetrahedrite are generally confined to a quartz band 12 to 22 inches thick in a limonite shear zone. On the 200 level the vein follows the shear zone northeast of the shaft. Southwest of the shaft it is in the shear-zone footwall. In the raise the vein cuts across the zone, follows the footwall a short distance, and wedges out. A few feet higher another vein with sparse scheelite begins along the shear-zone hanging wall.

The Sunshine property has been drilled, trenched, and sampled extensively. The Jefferson limestone, near the Morrison vein, contained disseminated scheelite crystals a distance of 90 feet into the footwall of the Tarlach fault. Long steel was used to drill several holes 5 to 10 feet long and totaling 68

feet. Analyses of 10 samples showed values ranging from 0.05 to 0.3 percent WO_3 . The August outcrop was sampled, and the weighted average of 16 assays was 0.3 percent WO_3 across an average width of 5.6 feet. Five diamond-drill holes indicated the vein to be similar in grade at depth. Although all cores showed scheelite, only one sample was assayed; it contained 0.3 percent WO_3 over a 5.6-foot length. Grab samples of 142 tons of ore averaged 0.6 percent WO_3 and 5.8 ounces Ag per ton. Samples from the lower 25 feet of the raise and a small stope averaged 0.8 percent WO_3 .

Long steel and diamond-drill holes were used to test the walls of the August workings (fig. 22). Between 18.6 and 23.9 feet, inclined hole 5 (-30°) intersected a vein estimated to contain about 1.0 percent WO_3 . Horizontal hole 6 failed to cut similar structure.

Beneficiation tests of ore averaging 0.5 percent WO_3 and 5.18 ounces Ag per ton gave the following results: Flotation recovered a high-grade silver concentrate averaging 1.88 ounces Au per ton, 314.6 ounces Ag per ton, 5.8 percent Pb, 1.9 percent Cu, and 5.3 percent Zn. The tailings were sized, and the fine fraction was refloatated to recover a low-grade scheelite concentrate averaging 13.2 percent WO_3 and 44.9 ounces Ag per ton. The coarse fraction was tumbled to obtain a high-grade scheelite product averaging 50.7 percent WO_3 , 1.2 ounces Au, and 21.4 ounces Ag per ton.

Overall WO_3 recovery was 89.9 percent.

Best Prospect

The Best prospect is west of the Sunshine. Workings consist of a few scattered pits in Jefferson limestone. Scheelite mineralization is limited to widely scattered minute crystals.

Ceto Prospect

The Ceto prospect is about one-half mile south of the August shaft of the Sunshine prospect. Workings consist of a long bulldozer cut and two small pits in the Jefferson formation. No mineralized structure was exposed, but some scheelite float is present in the overburden.

Minnie Lee Prospect

The Minnie Lee prospect is about one mile northwest of the Sunshine. It was worked for silver in the 1890's. Old workings comprise several adits and pits.

Scheelite occurs persistently in a quartz-calcite vein exposed by an adit and trench in the Jefferson limestone (fig. 23). The vein averages 1 foot in width, is exposed for 100 feet, and has a vertical range of at least 25 feet. Samples taken by the owner assayed 4.2 percent WO_3 in an old adit and 1.8 percent WO_3 in a prospect pit west of the adit. Bureau of Mines samples across a vein width of 1.5 feet in the adit assayed 4.5 percent WO_3 and across a 1-foot vein in the pit, 0.53 percent WO_3 .

A S S A Y S				
No.	Length	Type	WO ₃ %	Ag oz./ton
1	0.7'	Chip	2.2	0.88
2	1.2'	do	0.1	.82
3	4.0'	do	.05	3.70
4	1.5'	do	13.9	.80
5	.5'	do	3.4	8.96
6	.4'	do	4.8	2.14
7	3.0'	do	.1	.10
8	4.5'	do	.1	—
9	1.8'	do	4.6	—
10	1.8'	do	2.6	—
11	1.0'	do	.2	—
12	1.7'	do	nil	—
13	1.9'	do	nil	—
14	5.5'	do	.9	—
15	3.0'	do	.9	—
16	4.0'	do	.6	—
17	2.5'	do	.3	—
18	3.0'	do	.3	—
19	3.5'	do	.6	—
20	3.0'	do	.04	—
21	1.8'	do	13.0	—
22	3.0'	do	.9	—
23	5.5'	do	2.8	—
24	5.5'	do	.3	—
25	3.0'	do	1.0	—
26	3.0'	do	.4	—
27	3.0'	do	.2	—
LONG HOLE ASSAYS				
28	—	0.4	—	—
29	1.28'	.3	—	—
30	1.68'	.3	—	—

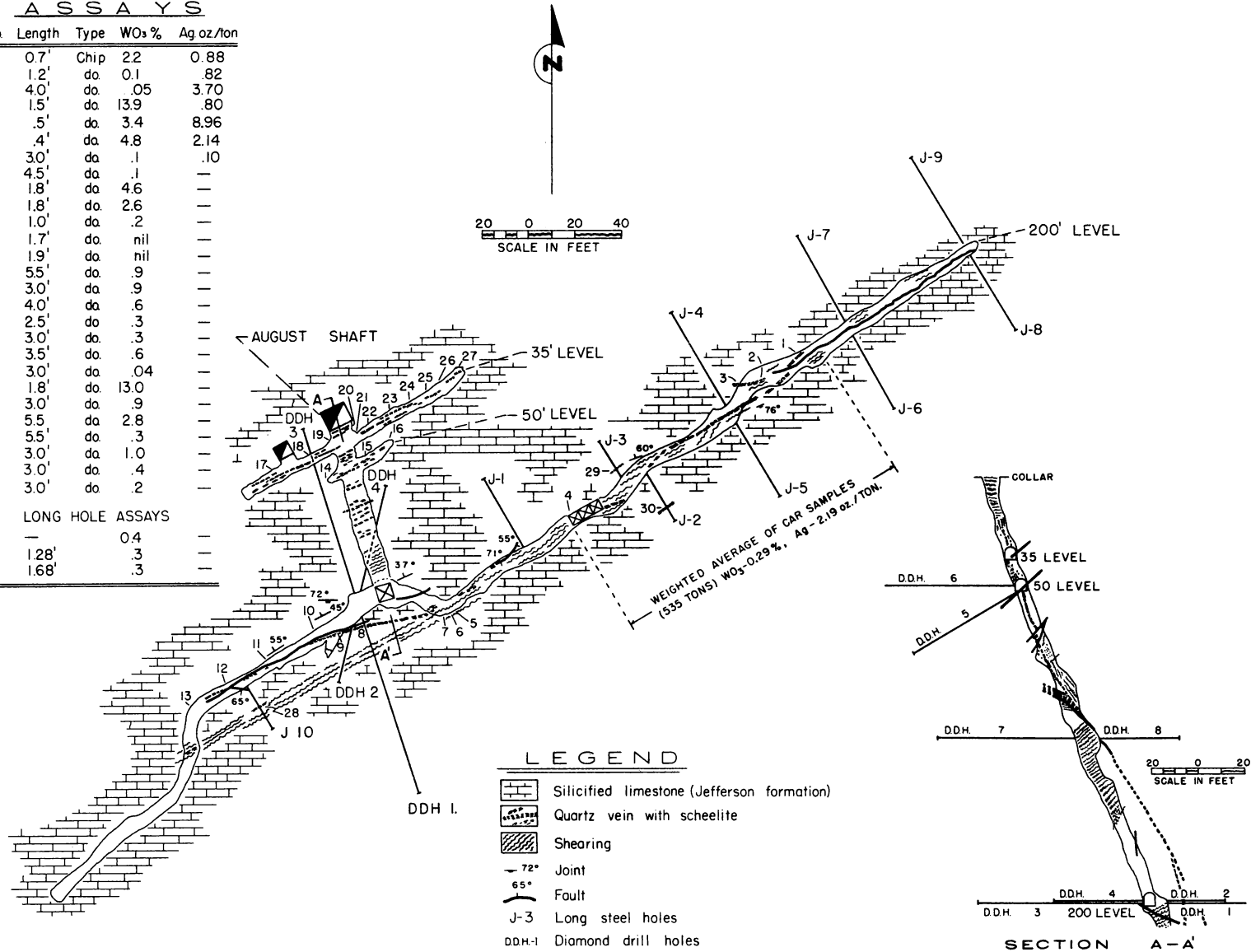


FIGURE 22. - Sunshine Prospect, Deer Lodge County, Mont. (Source: Federal Geol. Survey and Sunshine Mining Co.)

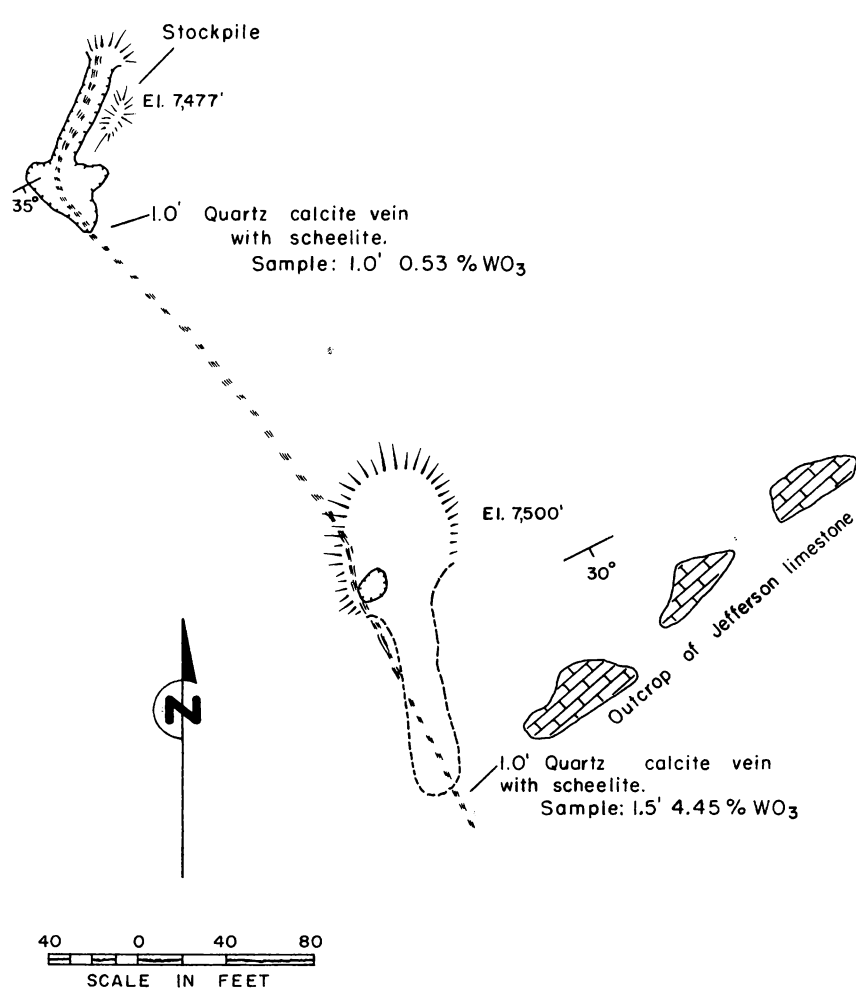
Hilltop Prospect

The Hilltop prospect is accessible from Storm Lake Creek by the Blodgett Creek road. Workings consist of shallow pits in an area stripped of overburden by bulldozing.

A shear zone striking S. 46° E. and dipping vertically cuts beds of massive Madison limestone. A quartz vein, 6 to 24 inches wide, is exposed for 60 feet along the zone. Widely scattered minute specks of scheelite are visible under the ultraviolet lamp, but analysis of a sample across the best area failed to indicate tungsten.

Headache Prospect

The Headache prospect is just north of the Hilltop. Exploration consists of an old caved pit 6 feet deep and a pit 9 feet deep.



A quartz fissure-filling vein with disseminated specks of scheelite occurs in Jefferson limestone. The vein, 2 to 12 inches wide, strikes N. 50° W. and dips 80° SW.

McCabe Prospect

The McCabe prospect is accessible by a short gravel road from U.S. Highway 10A near the east end of Silver Lake (fig. 16).

The geology of the deposit is similar to that of the Trigger mine one-half mile to the south. Mineralization is associated with a quartz vein 16 to 36 inches wide, exposed by trenches over a strike length of 160 feet. (See fig. 24.) The vein strikes N. 5° W. and dips 35° to 45° W. Surface assays range from 0.01 to 0.51 percent WO₃.

FIGURE 23. - Minnie Lee Prospect, Granite County, Mont.

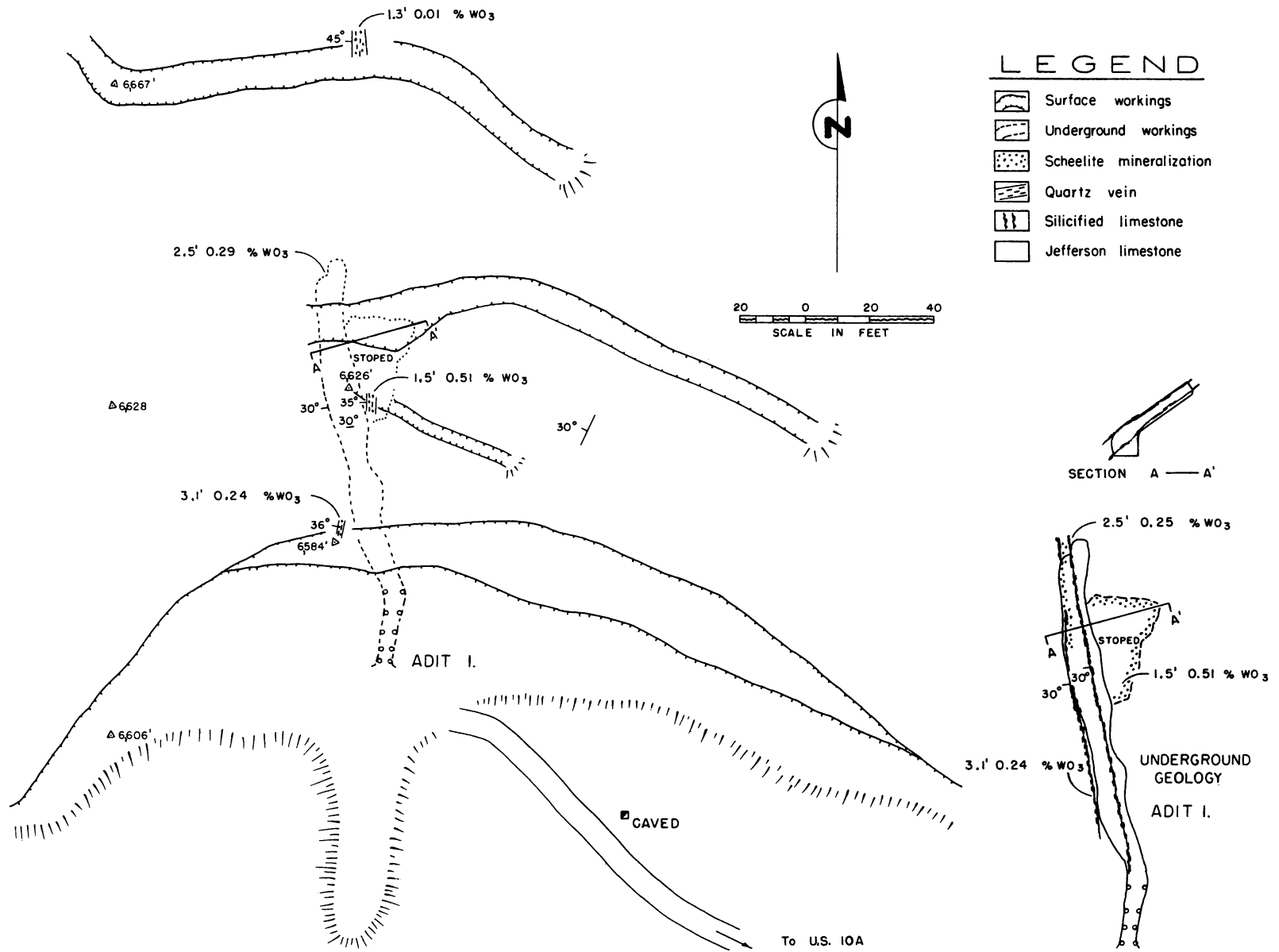


FIGURE 24. - McCabe Prospect, Deer Lodge County, Mont.

A 130-foot adit has exposed a 95-foot zone of limestone between two 6-inch siliceous limestone layers in the Jefferson formation. The zone ranges from 1 to 3 feet in width, strikes N. 12° W., and dips about 30° W. For 50 feet the zone contains scheelite mineralization, and it has been stoped to approximately 25 feet above the adit. A sample across the mineralized structure assayed 0.3 percent WO_3 .

Four short diamond-drill holes and an old caved 35° inclined shaft complete the workings.

Payoff Prospect

The Payoff prospect is on the north shore of Silver Lake immediately east of the McCabe. Workings comprise an old 50-foot inclined shaft, a bulldozer cut south of the shaft, a small pit, and a shallow trench. The country rock is Red Lion limestone. The trench and incline have exposed a quartz calcite vein containing sparsely disseminated specks of scheelite. The vein strikes N. 25° E. and dips 35° NW.

Calcabe Prospect

The Calcabe prospect is on the north shore of Silver Lake, west of and adjacent to the McCabe. Workings consist of an old partly caved 30-foot adit in the Jefferson limestone.

No mineralized structure is apparent.

Gyp Prospect

The Gyp prospect is directly north of the McCabe. Workings comprise an old prospect pit and two bulldozer cuts, all in Jefferson limestone.

A quartz vein averaging 1 foot wide, striking N. 80° E. and dipping vertically, is exposed in the pit. The vein contains occasional specks of fluorescent mineral, probably scheelite.

FOSTER CREEK AREA

Physical Features

The Foster Creek area covers about 42 square miles in Deer Lodge and Granite Counties. (See fig. 25.) It lies on the eastern slopes of the Flint Creek Range approximately 8 miles west of Anaconda and 5 miles northeast of Silver Lake.

The area is one of rugged topography and great relief. Glaciation has carved deep U-shaped valleys and gulches. Remnants of the older sedimentary and igneous rocks appear as high steep cliffs. Welcome Hill and Olson Mountain, the two strongest topographical features, rise to elevations of more than 8,500 feet.



LEGEND

QUATERNARY		DEVONIAN	
	Alluvium		Jefferson limestone
	Moraines	SILURIAN	
	Late terrace gravels		Maywood formation
	Earlier gravels	CAMBRIAN	
TERTIARY			Red Lion formation
	Porphyritic granite		Haskark formation
	Nonporphyritic granite		Silver Hill formation
	Granodiorite		Flathead quartzite
	Basic diorite	ALGONKIAN	
	Basic sills		Spokane formation
CRETACEOUS			Newland formation
	Kootenai formation		Fault
JURASSIC			Fault inferred
	Ellis formation		Strike and dip of beds
CARBONIFEROUS			Contact
	Quadrant quartzite		
	Madison limestone		

PROSPECTS

- 29. Tip Top
- 30. Ben G.
- 31. Moonlight
- 32. Porcupine
- 33. Blue Bottle
- 34. Straw Hat
- 35. Fox
- 36. Cliff
- 37. Pay Day
- 38. Big Bear
- 39. Bull Elk
- 40. Smith
- 41. Carbonator
- 42. Rambler
- 43. Bresnahan and Fenner

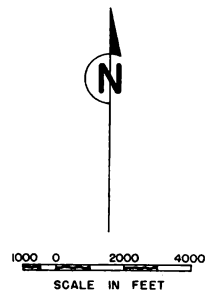


FIGURE 25. - General Geology, Foster Creek Area, Deer Lodge and Granite Counties, Mont. (Source: Federal Geol. Survey Prof. Paper 78.)

The valleys are well timbered with lodgepole pine; ridges and slopes are grass covered with occasional stands of alpine fir; higher slopes are barren.

Access

A good graveled county road extends north into Upper Warm Springs valley from U.S. Highway 10A. Foster Creek, Olson Gulch, and Buck Gulch are served by fair dirt roads from various points on the highway.

Geology

Pre-Tertiary sedimentary rocks of the area range in age from the Precambrian Spokane formation to the Cretaceous Kootenai formation. These sediments have been folded into a series of sharp anticlines and synclines and then intensely faulted and intruded by igneous rocks. The major folds trend and plunge gently to the north.

Large intrusions of basic diorite of upper Cretaceous or lower Eocene age occur on the East Fork of Foster Creek and near the forks of Olson Gulch.

Table 4 gives the location, production, and ownership of the Foster Creek properties.

Deposits

Tip Top Mine (Abbot Tungsten, Bretz Mine, Farmers)

The Tip Top mine is near the head of the West Fork of Foster Creek. The mine is reached by following the Warm Springs road for 1 mile then a mine access road for 3 miles.

Topography is rugged, and the mine is at an elevation of 6,700 to 7,000 feet.

The area was extensively prospected for silver from 1870 to 1900. During this period the Tip Top mine produced several thousand dollars worth of silver, copper, and lead. In 1953 scheelite was found, and 7,650 units of WO_3 were produced from surface workings during the next 2 years (fig. 26). In 1956 an old 70° inclined shaft 180 feet deep was rehabilitated and a drift at the 172 level was driven to explore the vein structure (fig. 27). No scheelite was found. In addition, the main workings consist of an opencut with a 100-foot drift driven easterly from its face. A stope partly open to the surface lies not far beyond the drift collar. Other adits, shafts, cuts, and trenches complete the workings.

The property is underlain by dolomitic Hasmark limestone, locally thin bedded and shaly. Structurally, the limestone is in a long, narrow, north-trending horst, bounded by the Goat Mountain fault on the east and by a lesser fault on the west. Rocks of the Red Lion, Maywood, Jefferson, and Madison formations are in faulted contact with the Hasmark limestone. Small outliers of biotite-granite occur about one-half mile east and west of the deposit.

TABLE 4. - Location, production, and ownership, Foster Creek area tungsten properties

Name	Location	Production	Type of property	Owner	Address
Tip Top....	Secs. 6 and 7, T. 5 N., R. 12 W.	WO ₃ , 7,650 units	8 claims, 2 patented.	C. F. Milkwick	Anaconda, Mont.
Ben G.....	Sec. 6, T. 5 N., R. 12 W.	None	1 claim	J. J. Meloy and others.	Do.
Moonlight..	Sec. 24, T. 5 N., R. 13 W.	No record	3 claims	H. G. and C. B. Nicely.	Do.
Porcupine..	Sec. 32, T. 6 N., R. 12 W.	None	1 claim	J. J. Meloy and others.	Do.
Blue Bottle	Sec. 33, T. 6 N., R. 12 W.	do.	do.	do.	Do.
Straw Hat..	Sec. 33, T. 6 N., R. 12 W.	do.	do.	do.	Do.
Fox.....	Sec. 28, T. 6 N., R. 12 W.	do.	do.	do.	Do.
Cliff.....	Sec. 32, T. 6 N., R. 12 W.	do.	do.	do.	Do.
Pay Day....	Sec. 10, T. 5 N., R. 12 W.	24 tons 1.3-percent WO ₃ .	9 claims	Thomas Moe, and others.	Do.
Big Bear...	Sec. 2, T. 5 N., R. 12 W.	None	11 claims	Frank Hansen, and others.	Do.
Bull Elk...	Sec. 36, T. 6 N., R. 12 W.	do.	4 claims	Russell Luke	Butte, Mont.
Smith.....	Secs. 8, 9, 10, 15, 16, T. 5 N., R. 12 W.	30 tons 0.04-percent WO ₃ for mill test.	15 claims	Cliff Smith	Anaconda, Mont.
Carbonator.	Secs. 9, 16, T. 5 N., R. 12 W.	None	do.	do.	Do.
Rambler....	Secs. 9, 16, T. 5 N., R. 12 W.	do.	5 claims	Frank Hansen, and others.	Do.
Bresnahan and Fenner	Secs. 10, 15, T. 5 N., R. 12 W.	do.	13 claims	R. Bresnahan, and others.	Do.

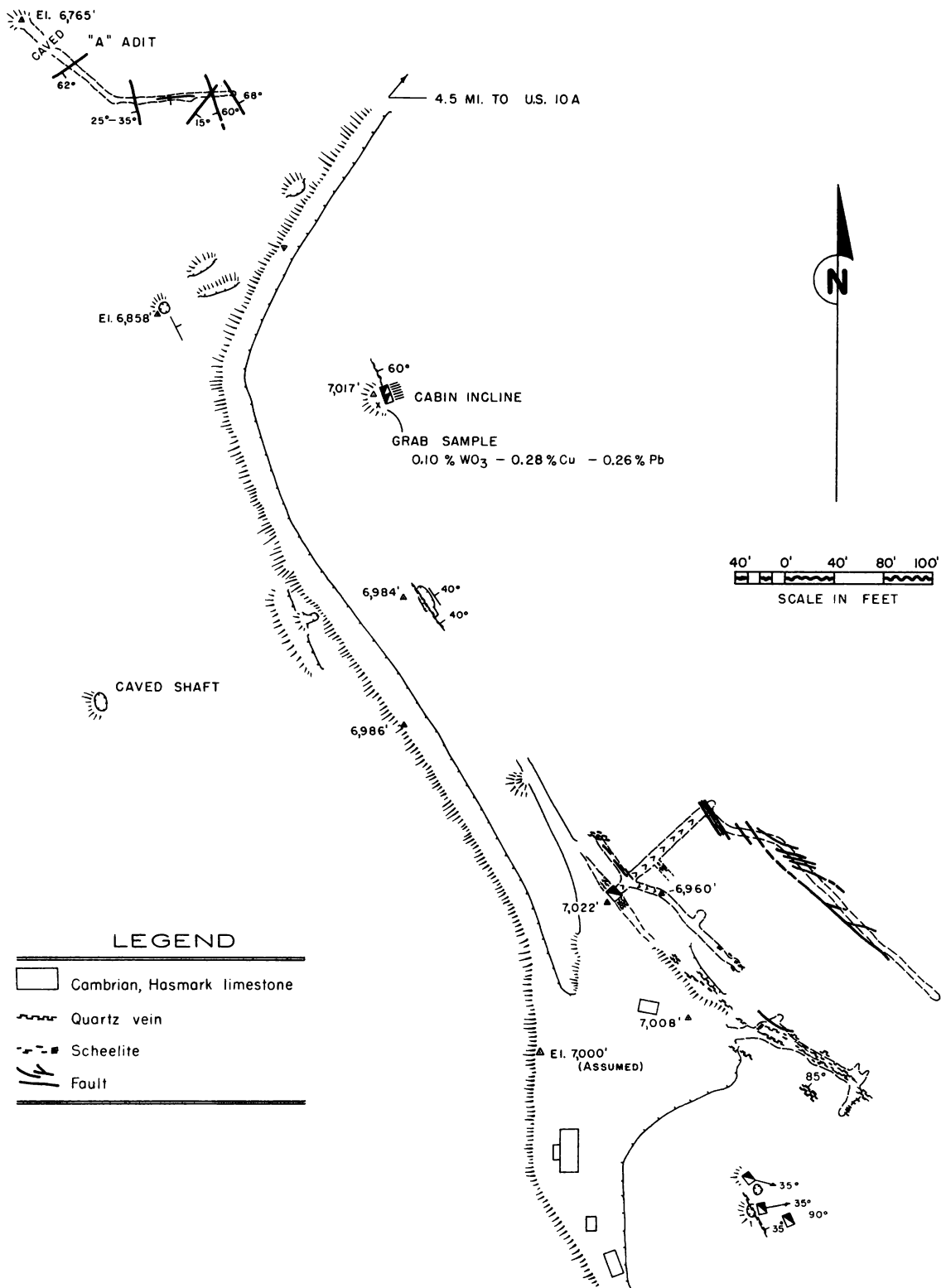







FIGURE 26. - Tip Top Mine, Deer Lodge County, Mont.
(Source: Federal Geol. Survey.)

LEGEND

-  Cambrian, Hasmark limestone
-  Quartz lenses
-  Scheelite
-  Fault
-  Long steel drill holes

ASSAY DATA

Sample	Length	WO ₃ %	Cu %	Pb %	Ag oz.
1	3.4'	0.008	0.49	0.87	14.8
2	3.5'	.747	.19	.74	8.8
3	5.6'	.507	.05	.62	.4

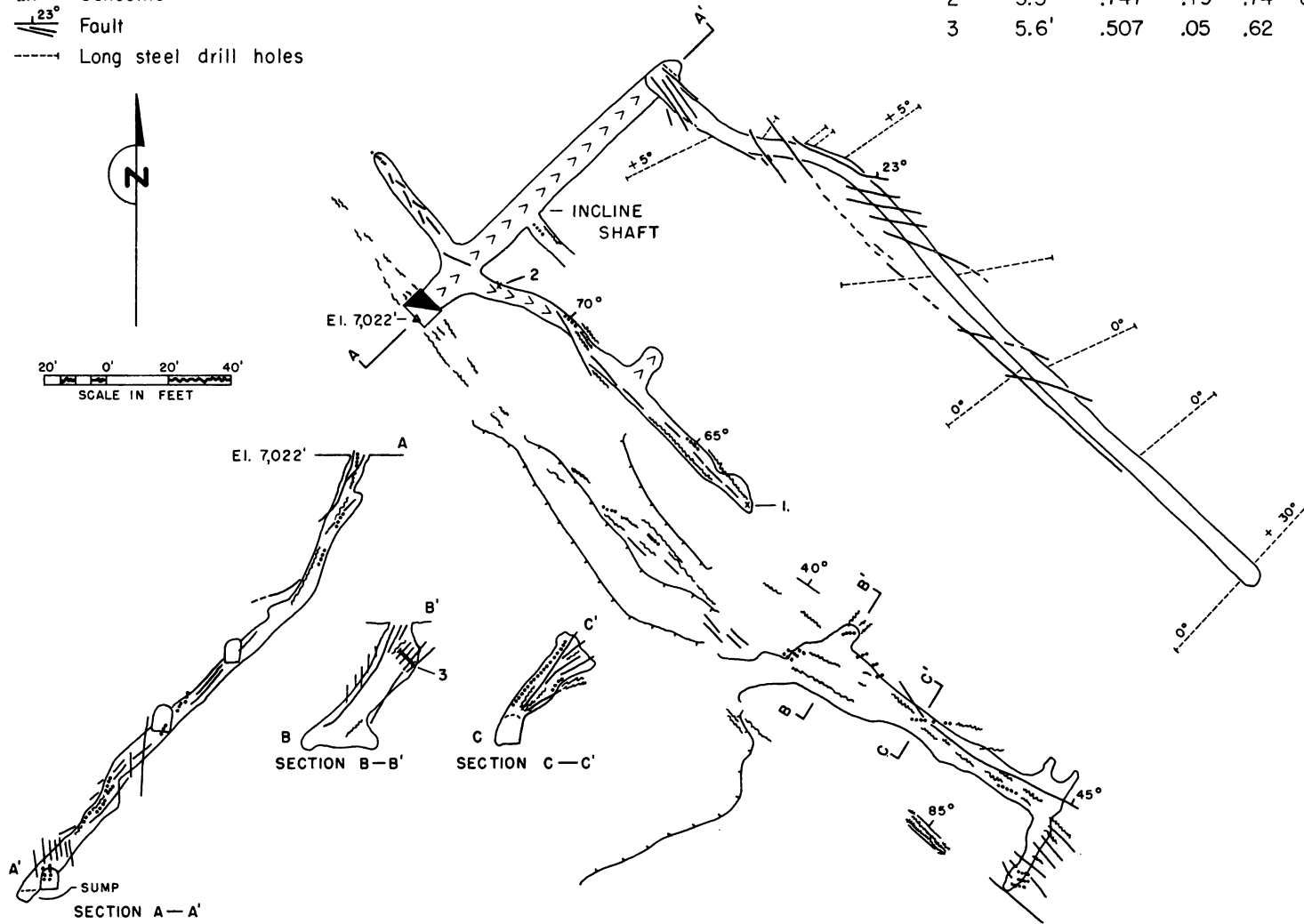


FIGURE 27. - Tip Top Mine Productive Area, Deer Lodge County, Mont.
(Source: Federal Geol. Survey.)

Ore minerals are associated with quartz lenses in a shear zone that strikes generally N. 45° W. and dips 50° to 60° NE. The zone, 5 to 10 feet wide, follows bedding planes of Hasmark dolomite.

Scheelite in the quartz lenses is usually accompanied by tetrahedrite and galena. Shear-zone gangue is composed mostly of quartz, dolomite, and fault gouge material. Minor amounts of scheelite also occur in small quartz stringers that cross the shear zone and as disseminated crystals in quartz-free dolomite. Tungsten production came from two small, near-surface stopes at the southern end of the vein structure.

Ben G. Prospect

The Ben G. prospect is about one-half mile north of the Tip Top; access is by the north fork of the Tip Top road. Elevation at the property is approximately 7,500 feet. The property is explored by two bulldozer cuts and a shallow trench. (See fig. 28).

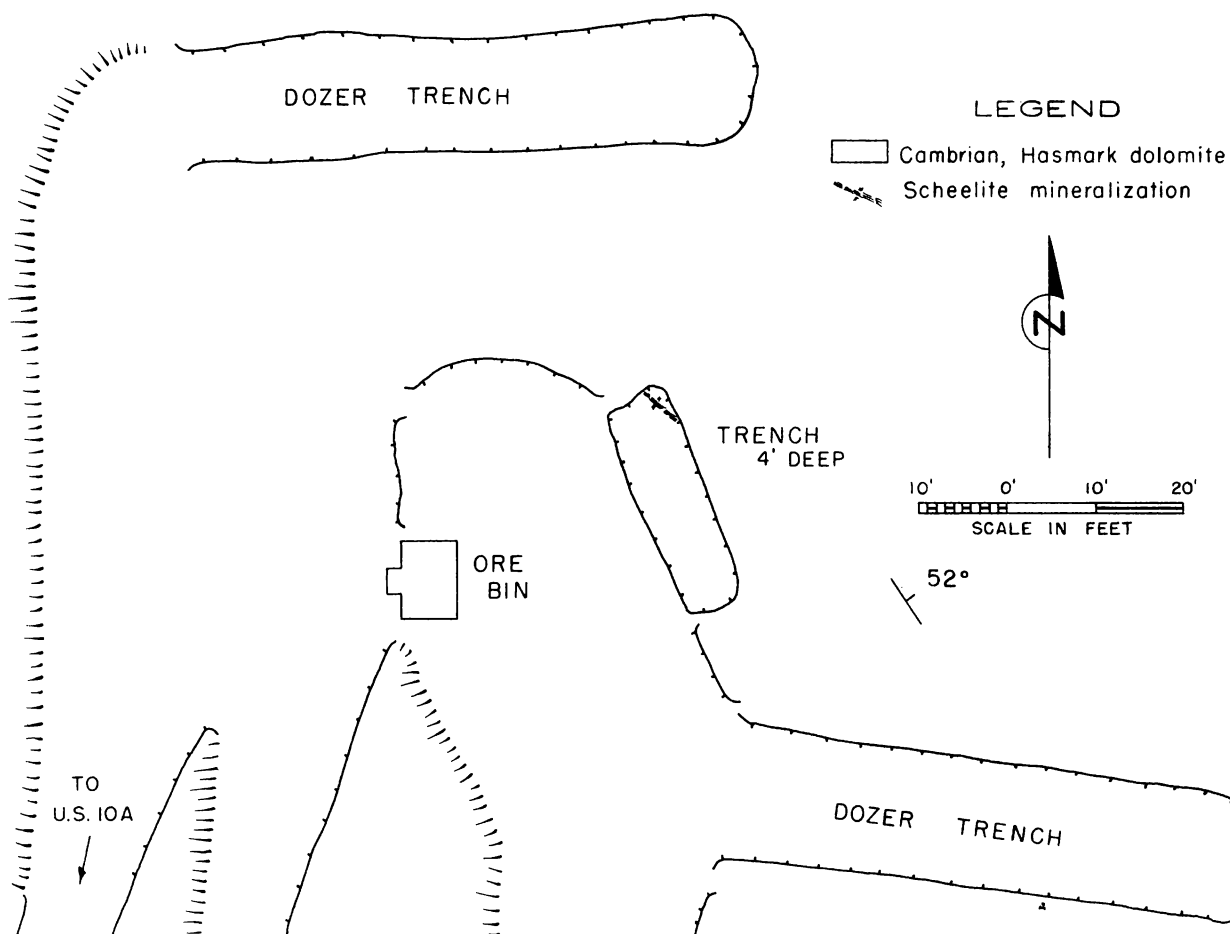
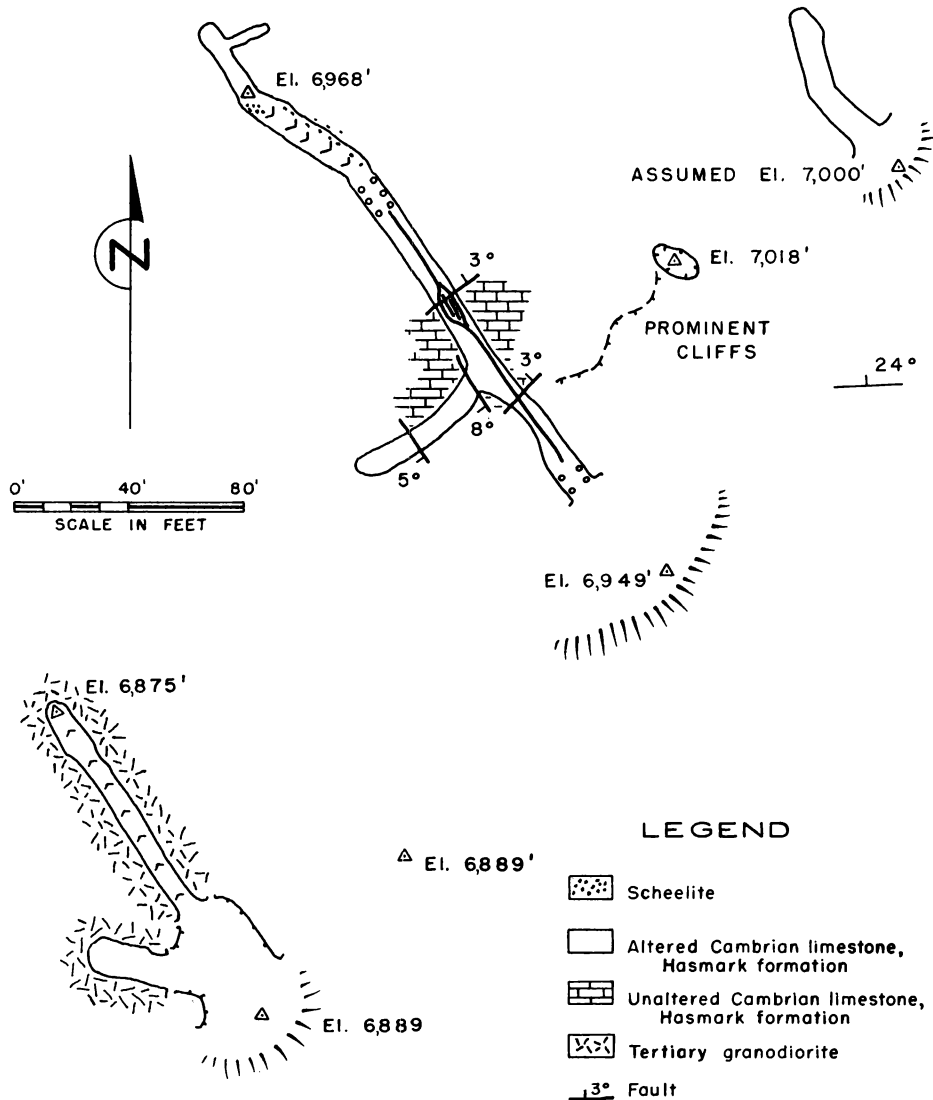


FIGURE 28. - Ben G. Prospect, Deer Lodge County, Mont.

Country rock is Hasmark dolomite metamorphosed to a buff-colored marble that strikes N. 10° E. with a steep westerly dip. Two granodiorite intrusives are near the deposit. Scheelite is found on fracture planes in the dolomite. A small area of scheelite mineralization exposed in the trench strikes about N. 10° W. and dips easterly at a shallow angle. A sample assayed 0.5 percent WO₃ across a 2-foot width. No scheelite was found in the bulldozer cuts.

Moonlight Prospect

The Moonlight prospect is one-fourth mile north of Upper Spring Hill camp ground on U.S. Highway 10A. The deposit is developed by three adits, all accessible (fig. 29).



Mineralization occurs in a fissure-filling vein along a shattered zone in the Hasmark formation. The zone is exposed for 25 feet in length and across an average width of 2 feet in the main adit. It strikes N. 35° W. and has a vertical dip. Scheelite is present in small, sparsely disseminated crystals.

Porcupine Prospect

The Porcupine prospect is on the southeast slope of Welcome Hill and is accessible only by foot. Workings are several old caved prospect pits, one of which has scattered showings of powellite on its dump.

Blue Bottle Prospect

The Blue Bot-tle prospect is in

FIGURE 29. - Moonlight Prospect, Deer Lodge County, Mont.

a rugged, heavily timbered area near the head of the east fork of Foster Creek, at an altitude of 7,300 feet. Access is by dirt road up the east fork of Foster Creek. Near its end the road divides; the east fork leads to the Blue Bottle, the middle fork to the Straw Hat and Fox, and the west fork to the Cliff prospect.

Country rock is partly metamorphosed Jefferson limestone. The property is near the top of a gentle anticlinal fold; beds strike N. 65° E. and dip gently northwest. A small granodiorite intrusive lies northwest of the property, and two larger intrusives lie to the east and west. A large east-west fault passes north of the prospect.

A fissure zone striking S. 69° E. across the limestone and dipping 85° NE. is exposed by old workings and a shallow bulldozer cut. Scheelite occurs as small disseminated crystals in the zone.

Straw Hat Prospect

The Straw Hat lies west of the Blue Bottle at an elevation of about 7,200 feet.

Two old caved shafts are on the east side of a low knob; on the west side of the knob is a bulldozer cut.

The workings are in a biotite-granite which intrudes both sediments and basic diorite. Scheelite is found in fracture planes and narrow bands in the granite.

Fox Prospect

The Fox claim is three-fourths mile beyond the Straw Hat and is on the western side of the ridge separating the headwaters of Flint Creek and Lost Creek. The altitude of the property is about 7,300 feet. Workings consist of a short adit and a vertical shaft, both caved.

Four small granodiorite intrusives are within one-half mile of the prospect. The mine is at or near the contact of the limestone with one of the intrusives.

Mineralization occurs in a shear zone in the Madison limestone. The zone strikes N. 45° W. and has a vertical dip. Scheelite, occasionally in pea-size clusters of crystals, may be found on the dump. Galena, malachite, and quartz are also present.

Cliff Prospect

The Cliff prospect is about a mile west of the Blue Bottle and Straw Hat, at an elevation of 7,250 feet, and is accessible only in the summer months. The workings comprise two caved adits and a bulldozer cut.

The adits are driven on a contact of Jefferson limestone and biotite granite. Scheelite occurs as disseminated crystals in a narrow siliceous band 6 to 12 inches wide at the contact. The band strikes S. 40° W. and dips 78° E. to vertical.

Pay Day Prospect

The Pay Day prospect is near the head of Olson Gulch at an altitude of 8,300 feet (fig. 30).

An outcrop of tactite was discovered in 1954, and approximately 100 tons of rock was mined and stockpiled. Trenching and 595 feet of diamond drilling

failed to locate additional ore. In 1955, 16 wagon drill holes 12 to 120 feet in depth and totaling 887 feet were drilled.

The host rock for tungsten mineralization is highly faulted limestone of the Silver Hill formation. The beds strike N. 68° E. and dip about 25° NW. The outcrop, exposed over a length of 80 feet, consists of a lenticular mineralized structure ranging from 1 to 7 feet in width. Scheelite occurs in a poorly developed tactite containing considerable quartz, clinozoisite, actinolite, and some epidote but no garnet. Scheelite crystals range from pinhead size to more than 1 inch. Generally they are large and easily liberated from the tactite.

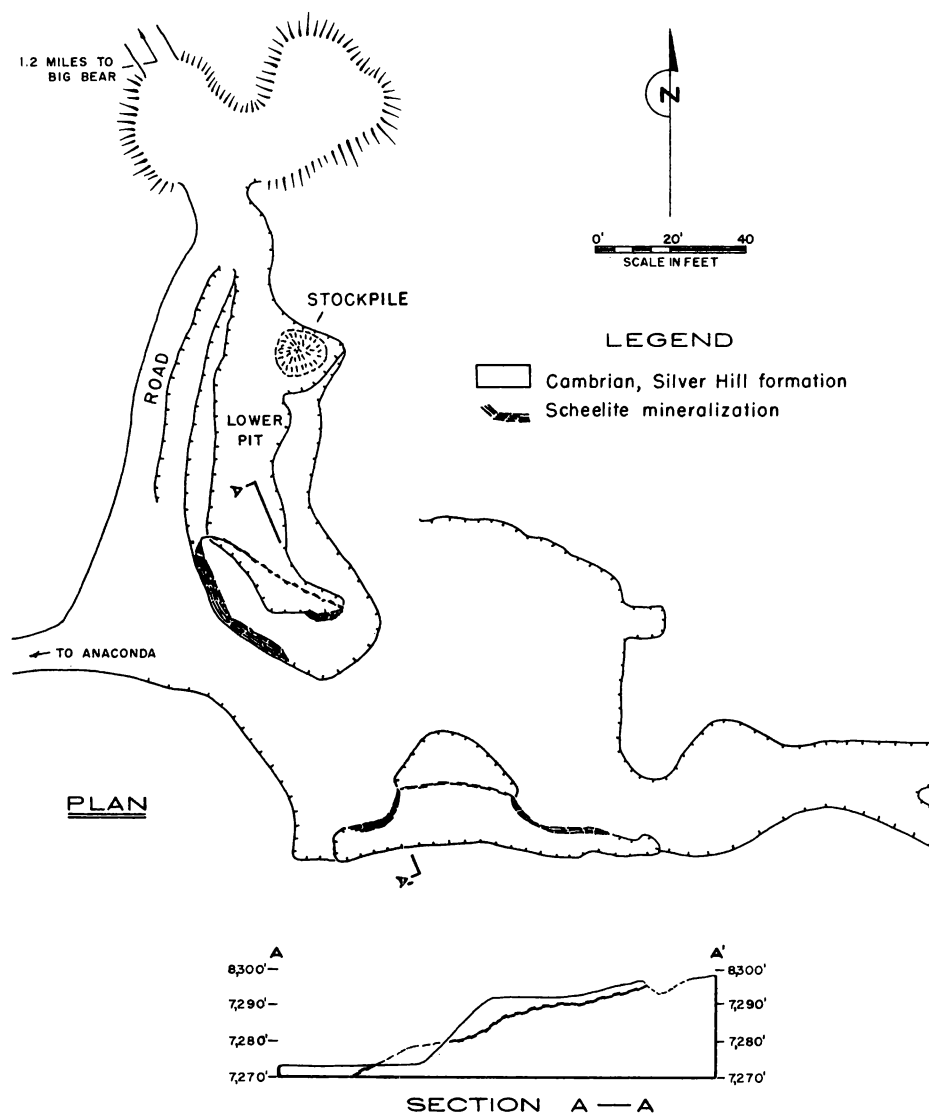


FIGURE 30. - Pay Day Prospect, Deer Lodge County, Mont.
(Source: Map by owner.)

A grab sample of the outcrop assayed 1.03 percent WO_3 and a sample of the stockpile, 3.02 percent WO_3 . A sample of 3.5 tons of stockpile material assayed 1.5 percent WO_3 .

Big Bear Prospect

The Big Bear is about 1 mile northeast of the Pay Day prospect at an altitude of 8,200 feet.

Geology of the Big Bear area is similar to that of the Pay Day area. Scheelite occurs as disseminated crystals in limy shales near the contact of the Hasmark and Silver Hill formations.

Two bulldozer cuts partly exposed a lenticular quartz vein with scheelite; a grab sample assayed 0.45 percent WO_3 . On a cliff overlooking Lost Creek Valley a pit partly exposed the vein. A sample across 1 foot of vein assayed less than 0.1 percent WO_3 .

Bull Elk Prospect

The Bull Elk prospect is west of and adjacent to the Big Bear. A bulldozer cut 60 feet long has exposed the Silver Hill formation. No scheelite or mineralized structure was exposed.

Smith Prospect

The property lies across Olson Gulch and the ridge between Olson and Buck Gulches. Access from U.S. Highway 10 is by the Olson Gulch road and its east fork. The workings are accessible in summer and fall.

Major workings comprise five bulldozer cuts, a caved 30-foot shaft, a 20-foot adit, and several pits. (See fig. 31.) The old shaft was sunk for silver. Thirty short tons of handpicked ore containing 0.4 percent WO_3 was treated in a mill near Hall, Mont.

Country rock is the Hasmark limestone, metamorphosed into a white marble. The formation strikes N. 25° E. Sediments are highly distorted by folding and intense faulting. To the north the Hasmark is in faulted contact with the Madison limestone. A small stock of diorite lies a short distance beyond the contact, and a small intrusion of granodiorite lies about one-half mile south of the claims.

Carbonator Prospect

The Carbonator prospect is in the west fork of Olson Gulch at an elevation of 7,000 feet. Access is approximately 1 mile of dirt road up the west fork of the gulch (fig. 32).

The prospect was developed by a 35-foot shaft and a 150-foot adit; both are accessible. The shaft was sunk on a silver bearing shear zone. No production is recorded.

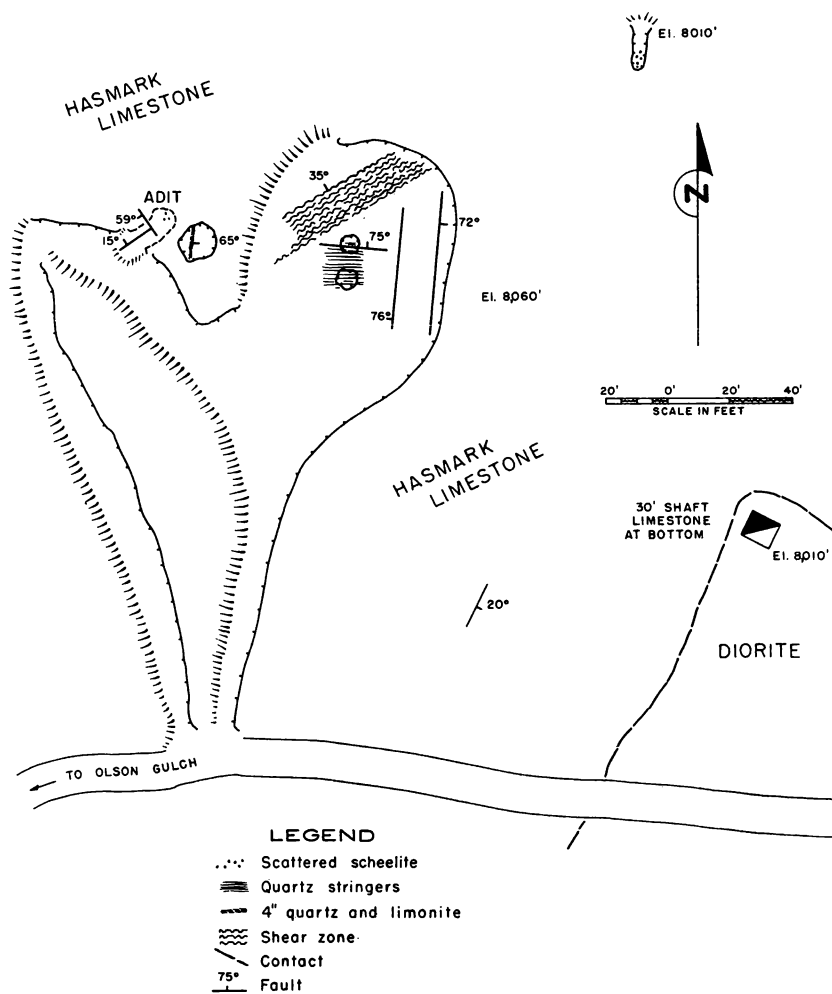


FIGURE 31. - Smith Prospect, Deer Lodge County, Mont.

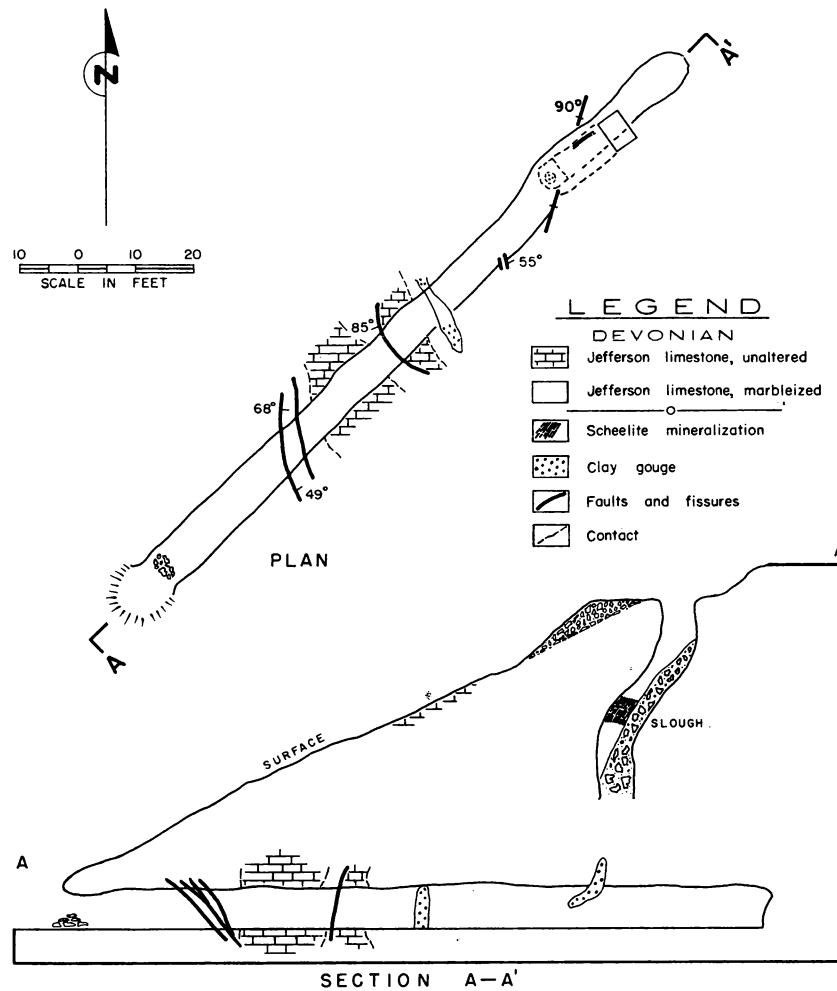


FIGURE 32. - Carbonator Prospect, Deer Lodge County, Mont.

The country rock is Jefferson limestone near its contact with the Hasmark formation. The prospect is near the crest of an anticline, which trends N. 25° E. and dips about 10° E. A small stock of granodiorite lies about one-fourth mile west and a larger stock about three-fourths mile south of the property.

Scheelite mineralization is present as short, discontinuous lenses in a shear zone in limestone. The zone strikes about N. 45° W. and has a vertical dip. A lens 8 to 12 inches wide and 5 feet long is exposed in the west wall of the shaft.

No scheelite is found in the adit; the lens either terminates above the adit or rakes or dips away from it. High-grade scheelite float has been found uphill from the shaft.

Rambler Prospect

The Rambler prospect lies near the valley floor of the west fork of Olson Gulch. It is developed by several old pits and adits and a stope; all are caved and inaccessible. The property was mined for silver in the 1890's.

The stope is on a bedding-plane quartz vein in Jefferson limestone. The vein, striking S. 20° W. and dipping 54° W., is exposed for approximately 100 feet and averages 2 feet in width.

The vein contains a few widely scattered minute specks of scheelite.

Bresnahan and Fenner Prospect

The Bresnahan and Fenner prospect is on the east slope of Buck Gulch about three-fourths mile southeast of the Smith prospect. The prospect is reached from U.S. Highway 10A by traveling about 2 miles on the Buck Gulch road. The only working is a bulldozer cut 55 feet long and 10 feet deep along the hillside.

Country rock is Hasmark, Jefferson, and Madison limestone altered to coarse marble. Generally, the beds strike northerly and are flat lying. The prospect lies between the stocks mentioned in the Smith Prospect.

Scheelite occurs as disseminated grains in a quartz vein 6 to 24 inches wide. The vein strikes N. 20° W., has a vertical dip, and cuts across beds of Jefferson limestone at a slight angle. A sample across the thickest part assayed 0.13 percent WO_3 . A grab sample from a stockpile of sorted ore assayed 0.34 percent WO_3 .

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