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

BUREAU OF MINES
JAMES BOYD, DIRECTOR

REPORT OF INVESTIGATIONS

TUNGSTEN DEPOSITS IN ALASKA

BY

ROBERT L. THORNE, NEAL M. MUIR, ANER W. ERICKSON,
BRUCE I. THOMAS, HAROLD E. HEIDE, AND WILFORD S. WRIGHT

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By Robert L. Thorne,[2/] Neal M. Muir,[2/] Aner W. Erickson,[2/] Bruce I. Thomas,[2/] Harold E. Heide,[2/] and Wilford S. Wright[2/].

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INTRODUCTION

For many years the domestic production of tungsten has been too small to meet requirements of the United States, and it has been necessary to import about 2 pounds of the metal for every pound produced in this country. The Bureau of Mines and the Federal Geological Survey, cooperating in a program of investigation of strategic and critical minerals, began in 1940 to examine and develop tungsten occurrences in western United States and Alaska. During the years in which the nation was at war, this work was given special impetus to stimulate domestic production. This report is a compilation of results of the tungsten investigations in Alaska supplemented by certain data made available by the Territorial Department of Mines and is designed to include in its scope descriptions of all known tungsten occurrences in the Territory. Two areas in Alaska warranted special investigation - one at Gilmore Dome, 16 miles northeast of Fairbanks, and the other in the Hyder District, at the head of Portland Canal.

Three tungsten properties - the Stepovich, Colbert, and Yellow Pup - are at Gilmore Dome. The Stepovich property, referred to sometimes as the Cleary Hill tungsten deposit, was worked by the Cleary Hill Mines Co. from April 1942 until May 1944 and was first examined by Robert S. Sanford and Norman Ebbley, Jr., engineers of the Bureau of Mines, in September 1942. The Cleary Hill Mines Co. by that time had explored an 800-foot strike length of the ore zone with 10 bulldozer trenches and was sinking an inclined shaft on ore in the central portion of the explored zone. In January 1943, the senior author, in company with Ebbley and Larry C. Doheny, supervising engineer of R.F.C., examined the property. Preliminary work by the Bureau of Mines began in May 1943, but actual exploration did not commence until late in June and continued until the end of October 1943.

The deposit was examined by John B. Mertie, Jr., and William C. Overstreet, of the Federal Geological Survey, in 1942, and this study was continued in 1943 by Frank Byers, who also assisted the Bureau's engineers on geologic problems. A magnetometer survey of this area was undertaken in 1942 by Henry Joesting and Eskil Anderson, engineers of the Territorial Department of Mines, and was completed with Bureau of Mines assistance in 1943.

During 1943 the Bureau completed exploratory projects on the Cleary Hill mine and adjacent Colbert prospect. The field work on the Colbert property was begun early in July 1943 and continued intermittently until the end of October 1943, when it was recessed because of subzero weather. During September 1944, the Bureau of Mines established (by means of a few surface trenches) continuity between the Colbert mineralized zone, high on the dome, and the Yellow Pup vein, the lowest known tungsten mineralization in the area. It is generally recognized that any extensive program to develop the area as a whole logically would be carried out from the lower horizon.

A. F. Buddington, of the Geological Survey, first mentioned the presence of scheelite in the Hyder district at the Riverside, Mountain View, and Monarch properties in 1924. Special attention was called to the district in 1941 by John C. Reed after a reconnaissance examination by the Geological Survey. During the summer of 1942, Neal M. Muir investigated tungsten deposits in the district and in the fall of 1942 and winter of 1942-43 directed a diamond-drilling and underground development program at the

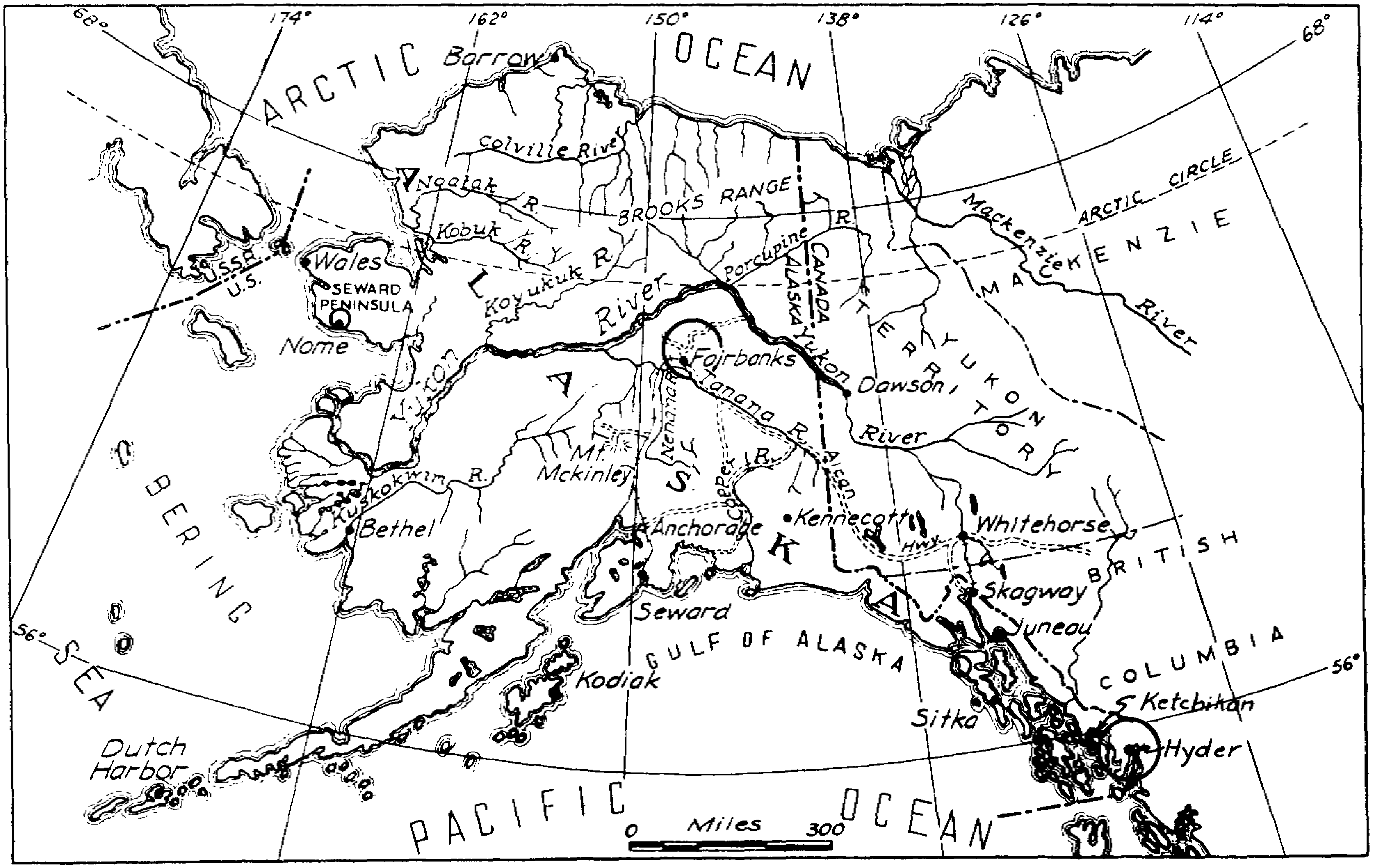


Figure 1. - Index map of Alaska showing location of tungsten deposits.

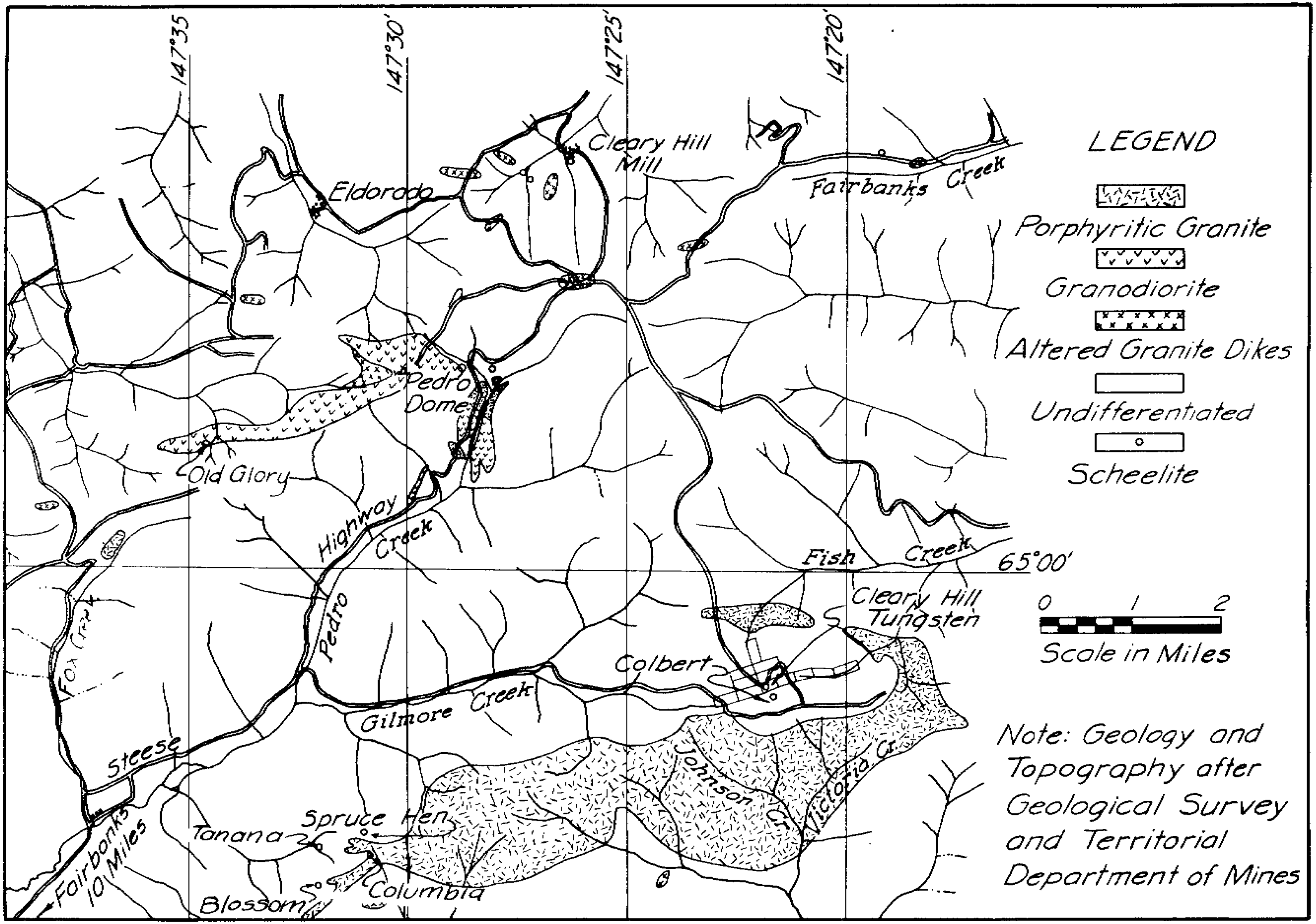


Figure 2. - Location and geology, Fairbanks tungsten area.

Riverside mine. Diamond-drill cores were logged and interpreted by F. M. Byers, Jr., and Clyde Wahrhaftig, Jr., of the Geological Survey. The Geological Survey field party furnished geological, underground, and cross-section maps, which assisted the Bureau's engineers in the diamond-drilling program.

The Bureau of Mines, encouraged by the report of the 1942 preliminary examination of the Mountain View mine, proposed a drifting and sampling project. Work was begun at the property under the direction of Aner W. Erickson May 22, 1944, and was completed October 24, 1944.

In the summer of 1942, Harold E. Heide investigated occurrences of scheelite in placer gravels in the tributaries of Snake River in the Nome area on Seward Peninsula.

Tungsten deposits in the Fairbanks mining district were examined in the winter of 1942 by Henry R. Joesting, mining engineer of the Territorial Department of Mines. The Old Glory prospect at Seattle Creek was examined by Bruce I. Thomas in July 1944.

Tungsten minerals have been found in varying amounts in the concentrates obtained from gold-placer operations in many parts of Alaska. The Apex-El Nido mine on Chichagof Island was examined for scheelite by W. M. Traver, a Bureau engineer, in October 1942.

ACKNOWLEDGMENTS

Special acknowledgment is due the following: Robert S. Sanford, acting chief of the Alaska division of the Bureau of Mines, under whose direction all investigative work was done; Norman E. Ebbley, Jr. who directed exploratory work at the Yellow Pup prospect; Dr. Henry R. Joesting, for his geophysical study of Gilmore Dome deposits; J. S. Kennedy and C. H. Gorski, of the Metallurgical Branch who conducted beneficiation tests on ores from Cleary Hill and Mountain View mines.

Acknowledgment also is extended R. E. Wyer, manager, Cleary Hill Mines Co., for submitting claim maps and other data; to L. D. Colbert for rendering valuable assistance in the investigation of his property; to Arthur O. Moa for contributing historical and production data pertaining to the Mountain View mine, and to Austin H. Merrill, superintendent of the J. H. Scott Co., for imparting general information regarding the Riverside mine.

GILMORE DOME DEPOSIT

Location and Accessibility

Gilmore Dome is in central Alaska at latitude 64° 59' N. and longitude 147° 22' W., 16 airline miles northeast of Fairbanks, as shown in figure 1. The summit elevation of Gilmore Dome is 2,400 feet. The tungsten area, shown in figure 2, is reached from Fairbanks by 24 miles of fair road, part of which is graveled and part unsurfaced. The road is muddy during seasonal thaws and heavy rains.

Fairbanks, a city of about 5,000 population and a major transportation terminal, is the placer-gold mining center of Alaska. The Alaska Railroad, 468 miles in length, links Fairbanks with its Pacific Ocean terminals at Seward and Whittier, Alaska. Alaska Steamship Co. vessels make regular trips at frequent intervals between these ports and Seattle, Wash. Other freight routes to Fairbanks are the Richardson Highway from Valdez and the Alaska Highway from Dawson Creek in Canada.

Pan American World Airways and Canadian Pacific Air Lines make Fairbanks a regular stop, and numerous small air-transportation services have headquarters there. When emergency shipments from Seattle are necessary, they can be sent via air express at approximately $1 a pound. Airplane fare from Seattle to Fairbanks is $149.50, including tax. The steamship fare from Seattle to Seward is $93.38. The railroad fare from Seward to Fairbanks is $32.44, which does not include the cost of an overnight stop at Curry and possible stop-overs in Anchorage or Seward.

Through freight rates from Seattle to Fairbanks by way of the Alaska Steamship Co. and the Alaska Railroad range from $45 a ton to $70 a ton, depending on the nature of the freight. This has been the standard means of transportation and requires from two weeks to more than a month.

A local transportation problem developed when the Cleary Hill Mines Co. decided to use the gold-mine camp and mill rather than construct a new camp and mill at the tungsten mine. Originally the tungsten mine was 19 miles by road from the gold mine, but a new route only 8 miles long was established during the summer of 1943 by constructing 6 miles of new road. The final mile and a half of the new cut-off to the mill has a steep grade. Chains are required during 7 or 8 months of the year when winter conditions prevail. It is estimated that the truck haul costs $2 a ton.

The lack of a permanent camp at the tungsten mine made it necessary to haul most of the workmen to and from the Cleary Hill camp during the winter months. During the summer months two camps were maintained, but these were discontinued toward the end of October. A bus provided transportation for the men. There is telephone communication between the gold mine and Fairbanks.

Three properties are at Gilmore Dome. The Stepovich claims along the strike of the Cleary Hill ore zone extend 3,000 feet southwest and more than 5,900 feet northeast of the summit. Five Stepovich claims are on the north side of Gilmore Dome.

The Colbert prospect is 1,200 feet south of and parallel to the Cleary Hill ore zone.

The Yellow Pup mine property is on the west side of Gilmore Dome near the headwaters of Yellow Pup, a tributary of Fish Creek. The claims are contiguous with the east end line of the Colbert claims and join the south side of the Lucky, Chippewan, and Scheelite No. 3 claims of the Stepovich property.

Physical Features and Climate

Gilmore Dome is one of many nearly flat-topped hills with the rounded contours of mature topography that form the irregular ridge pattern of the country. Most of the mountain tops are about 2,400 feet above sea level, though some are higher or lower by a few hundred feet. Saddles are only slightly lower than summits, except where the ridge chain is terminated by a drainage system. Valley floors range in altitude from 700 to 1,200 feet.

In places trees grow upon the entire slope of the hills, but only on the lower slope do they reach a size adequate for mine timber, fire wood, or lagging. Spruce, birch, poplar, and tamarack grow in the region, but only spruce and birch are found near the mine large enough to be used commercially. Alder, willow, dwarf birch, and huckleberry brush obstruct the work of the prospector. Moss and grass grow on the slopes, but the rounded tops of the domes are carpeted with mossy tundra and several types of berry bushes and vines.

Farm and garden crops mature rapidly in summer, when the sun shines nearly 24 hours a day. Most of the year's precipitation, which is slight, enters the soil during the growing season after the spring thaw. Agricultural land, already productive of farm and truck garden crops, could be made to yield an adequate supply for the local population.

The climate in the Fairbanks area is semi-arctic, with long, cold winters and short, hot summers. The mean temperatures for the 3 winter months is -7° F. and for the 3 summer months 57° F. The temperature is frequently -40° to -60° F. during December, January, and February. The mild months of winter (March, April, and early May) are spent in cross country freighting, placer drilling, and general preparation for the summer's work.

The mature topography of central Alaska, with its many ox-bow lakes, sloughs, and low gradient rivers, plus the water-retaining qualities of the tundra and frozen ground, gives the impression of plentiful precipitation, though this is belied by an average annual rainfall of less than 12 inches, comparable to a semi-arid climate. Average annual snowfall in the area is 49.4 inches. Most of the soil, gravel, and bedrock in the region is perpetually frozen. The seasonal thaw ranges from a few inches where the ground is blanketed by moss to several feet in areas where the moss has been removed.

History and Production

The first work was done on Gilmore Dome in 1915[3/] and consisted of hand-dug pits. After the vein had been traced for a strike length of 200 feet on what is now the Stepovich property, an inclined shaft was sunk 40 feet on the vein.

3/ Brooks, Alfred H., and others, Mineral Resources of Alaska, 1915: Geol. Surv. Bull. 642, pp. 61-62.

In 1916,[4/] two inclined shafts, 75 and 80 feet deep, were sunk on the vein. In 1917, the 75-foot shaft on the Scheelite claim was continued to a depth of 180 feet. Mike Stepovich, the owner, reports that prior to 1918, when operations ceased, production amounted to about 10 tons of concentrate (65 percent WO_3) and 300 tons of sorted mine-run ore averaging 8 percent tungsten trioxide, all of which was shipped to Tacoma, Wash.

A new inclined shaft midway between the two old shafts was begun in 1942. Two levels were driven from the shaft, one 55 feet long at the 50-foot slope level and one 356 feet long at the 150-foot slope level. A tunnel started at a point about 750 feet east of the shaft was driven on the vein for 448 feet towards the shaft. In 1942, 60 tons of mine-run ore averaging 4.55 percent WO_3 was recovered from development work and sold to Metals Reserve Co. at Fairbanks. From October 1943 to May 1944, about 800 tons of ore was concentrated at the Cleary Hill mill, from which 38.3 tons containing 49.7 percent WO_3 was recovered and sold at the Fairbanks depot. (See figs. 3 and 3A.)

The mining at this property from April 1942 until May 1944 was done by the Cleary Hill Mines Co. under lease from Stepovich. The lease was terminated shortly after the operation ceased.

The Colbert discovery was located during the summer of 1941 by L. D. Colbert of Fairbanks. The mineralized structure has a strike parallel to the Stepovich vein system and is 1,200 feet to the south. Colbert sank three test pits indicating a mineralized zone over 1,000 feet in length. Subsequent geophysical exploration by the Territorial Department of Mines indicated a continuous vein structure for over 3,000 feet.

From July until October 1943 the Bureau of Mines explored a 2,000-foot section of the Colbert mineralized zone by excavating 20 bulldozer trenches and 35 hand-dug pits. There has been no production from this property.

The Yellow Pup tungsten property, owned by the Alaska Metals Mining Co. of Fairbanks, was discovered in 1942. By July 1944, several pits designed to trace the mineralization up the hill west of the discovery had been dug without success. A short tunnel from the creek level has been driven on the vein a distance of 12 feet where the vein is cut off by a fault. About 35 tons of ore obtained from the tunnel operation is stockpiled near the portal. An experimental milling operation has produced about 225 pounds of 70 percent tungsten trioxide.

Bulldozer trenches excavated by the Bureau of Mines in September 1944 fulfilled two objectives - first, to locate the continuation of the mineralized zone on the west side of the fault encountered in the tunnel, and, second, to establish continuity between the Colbert mineralized zone and the Yellow Pup vein.

4/ Mertie, J. B. Jr., Mineral Resources of Alaska, 1916: Geol. Surv. Bull. 662, pp. 418-421.

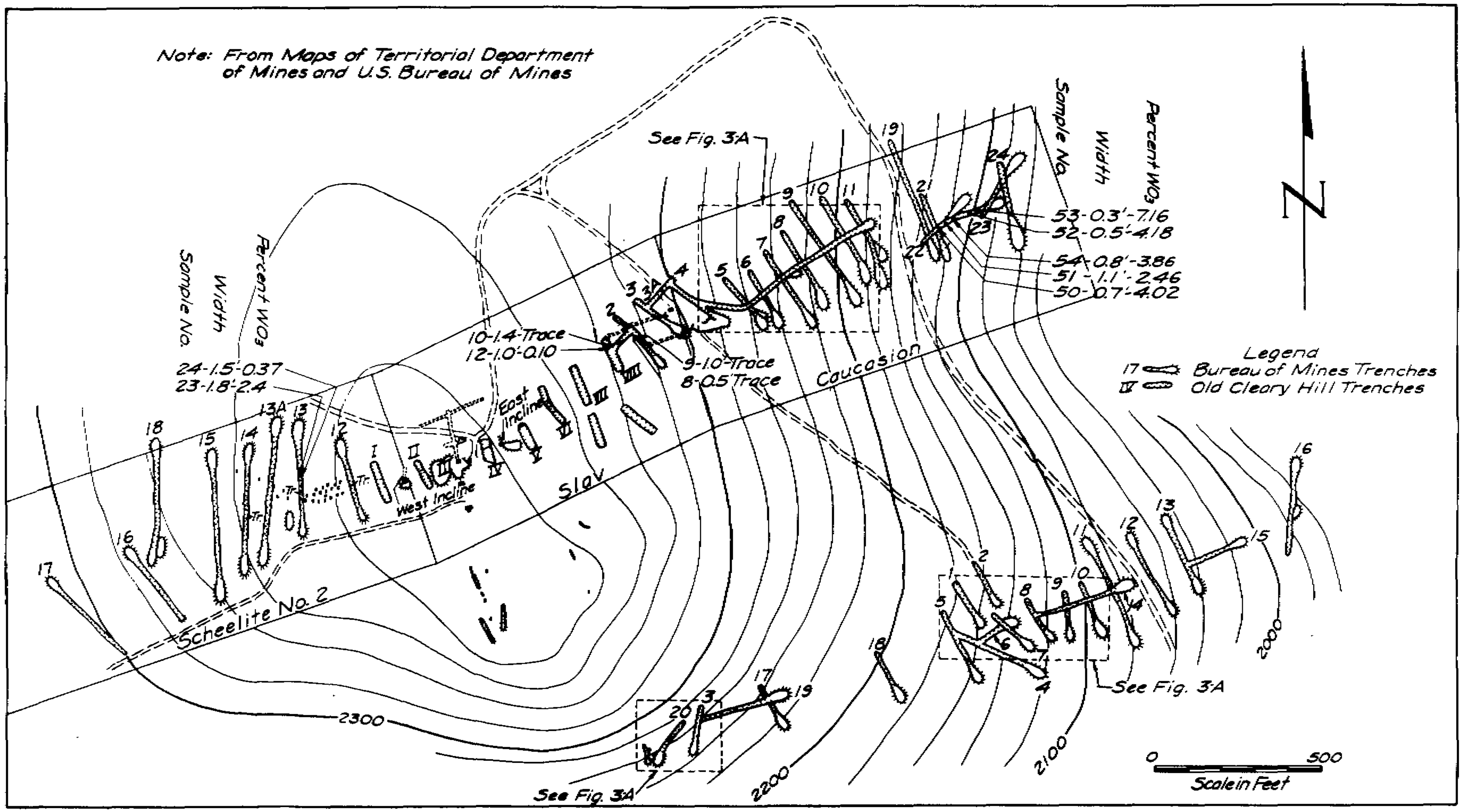


Figure 3. - Surface map of Bureau of Mines exploration work on Cleary Hill and Colbert scheelite zones.

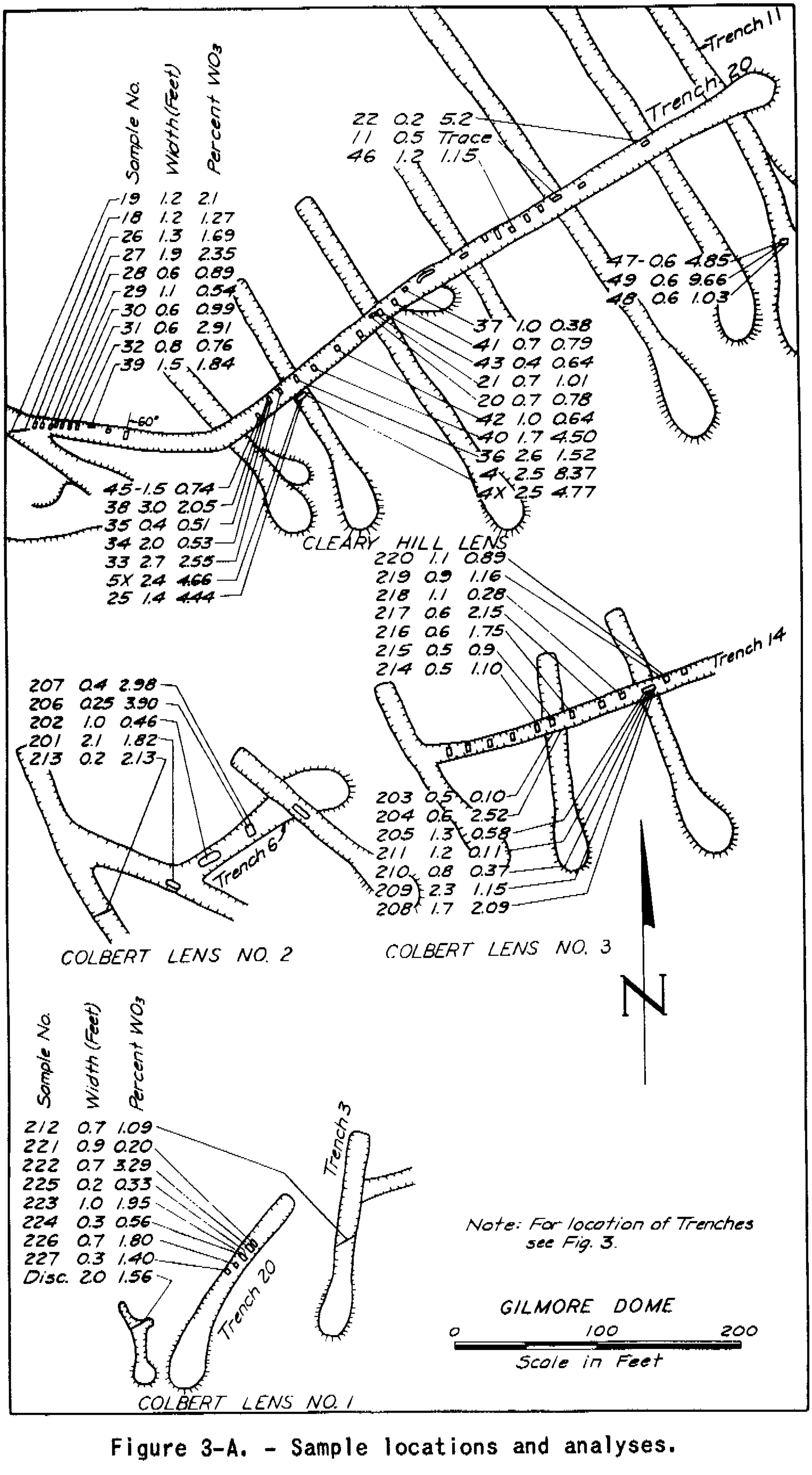


Figure 3-A. - Sample locations and analyses.

Property and Ownership

Figure 4 is a claim map of the Gilmore Dome locality and shows the Stepovich, Colbert, and Yellow Pup properties.

The Stepovich property consists of seven patented and six unpatented claims. The patented claims, covering the apex of the mineralized zone, are, from west to east, the Scheelite, Scheelite No. 2, Slav, Caucasian, Lucky, Chippewan, and Scheelite No. 3. The unpatented claims are on the north slope of Gilmore Dome contiguous to the Scheelite No. 2, Slav, and east half of the Caucasian claims.

Since the death of Mike Stepovich in October 1944, the property has been owned by his two sons.

The 14 unpatented claims covering the Colbert property are on the south slope of Gilmore Dome between the headwaters of Gilmore, Yellow Pup, and Smallwood Creeks. The claims, staked three deep parallel to the patented Stepovich claims, begin at the west end of the Scheelite claim and extend for 5,800 feet easterly. The property is owned by L. D. Colbert of Fairbanks, Alaska.

The Yellow Pup mine property, consisting of six unpatented claims, is owned by the Alaska Metals Mining Co., a partnership formed by M. S. Anderson, William Birklid, and Elmer Stohl, all of Fairbanks.

General Geology

Quartz-mica schist, quartzite schist, and other metamorphic rocks originating mostly from ancient sediments form the country rock of the Fairbanks district.

Small crystalline limestone bodies crop out in two local zones, one on the north side of the Pedro Dome gold belt and the other along the north side of a granite intrusive in the Gilmore belt. Only the limestone of the Gilmore belt appears to have influenced the localization of scheelite.

Two main intrusives have invaded the metamorphic rocks of the area. An elongated body of granodiorite extends from the head of Dome Creek to a point beyond Pedro Dome. The intrusive mass if 3-1/2 miles long and ranges in width from 0.2 mile at its western end to 0.6 mile at its eastern end.

In the Gilmore belt, porphyritic granite extends from the head of Engineer Creek to the head of Pearl Creek, a distance of 7-1/2 miles.

According to a magnetometer survey[5/] the porphyritic granite underlying Gilmore Dome schist is 600 to 1,000 feet beneath the surface. The scheelite mineralization, which generally parallels the cleavage in the schist, has also been found in small amounts disseminated through parts of the granite. No scheelite of commercial grade has been found in the granite.

5/ By Henry R. Joosting, Territorial Department of Mines.

Occurrence of Deposits

The Gilmore Dome scheelite deposits are of the contact metamorphic type. The ore occurs with vein quartz in some places, but more commonly it is found in calcareous zones in the schist. The ore shoots are small, irregular, and discontinuous.

The ore lenses occupy portions of a thin limestone bed that is one member of the Birch Creek schist. The maximum width of the limestone is probably 20 feet. The general strike of the ore zone is N. 67° E., and the average dip is 33° 40' N.

Exploration indicates the existence of a number of small, rich lenses of scheelite ore. The individual lens usually has a downward rake of about 45 degrees to the northeast. The remaining evidence of past and present underground development and surface exploration on the summit of the dome indicates a strong belt of mineralization extending 60 to 90 feet below the outcrops. By the end of October 1943, development on the 150-foot level from the shaft had encountered ore along 204 feet of its 265-foot length. The ore averaged 5.54 percent WO_3 over a 1.4-foot width.

The first four raises started from the 150-foot level and went through the ore into barren rock 15 to 30 feet above the drift. The plan and longitudinal section of the mine are illustrated in figure. 4A. This evidence suggests a narrow barren zone between the surface ore horizon and the one partly developed on the 150-foot level, although several partly developed lenses may continue through to the surface ore horizon.

Strike faulting parallel to the limestone beds and having a slightly steeper dip has been observed. A number of quartz veins follow both the cross faults and the strike faults. These quartz veins have a direct relationship to the scheelite mineralization. Scheelite lenses are often found at the intersection of the quartz veins and limestone beds.

Development has indicated that the maximum dip and strike length of any lens does not greatly exceed 50 feet and that the average ore width is only slightly more than 1 foot. Ore lenses of the maximum sizes thus far encountered may possibly contain 200 ton of minable ore. Ore lenses range from this size down to some containing less than 10 tons of ore. Ore bodies thus far encountered have contained 1.5 to 20.0 percent tungsten trioxide.

The Colbert mineralized zone lies roughly parallel to and 1,200 to 1,500 feet north of the contact of the schist with the granite mass. Scheelite mineralization partly replaces a narrow limestone bed that dips north into Gilmore Dome at a 40-degree angle. The Colbert and the Cleary Hill deposits, both in thin beds of altered limestone, are parallel in strike but appear to diverge slightly in northerly dip.

The limestone bed, possibly 30 feet thick, apparently has been subjected to two periods of silicification. Although both periods may have resulted in some scheelite mineralization, the last period appears to have had the greatest effect upon mineral deposition.

The Colbert, like most deposits occurring in a highly metamorphosed sedimentary bed, has various strikes and dips. Along the partly explored 2,000 feet of vein exposure the average strike is N. 75° E., but local variations were recorded from N. 48° E. to N. 80° E. Individual sections explored by lontitudinal trenching strike a few degrees north of the average. This condition may be a result of a series of faults disclosed by exploration of the parallel Cleary Hill ore zone, which offsets the ore zone to the southeast. A fault was encountered in trench 14 on the Colbert mineralized zone, but the amount and trend of the movement has not been determined.

Narrow veinlets of quartz and thin fractures carrying scheelite mineralization are found across the replacement zone. The larger mineralized zones are usually found on the hanging-wall side parallel to the strike of the main zone. Specks or traces of scheelite mineralization occur in trench 9 over a 40-foot horizontal width, and parallel lenses were noted in other places within the zone of replacement. (See fig. 3.)

In trench 2, a narrow lens of scheelite mineralization was uncovered 130 feet north of the Colbert mineralized zone. Trench 1, 80 feet west of trench 2 and also north of the Colbert, uncovered three barren replacement zones 6 inches to 1 foot wide.

The scheelite lenses along the main Colbert replacement zone range in length from a few feet to 100 feet and in width from 0.5 to 1.2 feet. The WO_3 content of the several lenses is 1.2 to 2.5 percent. The lenses are irregular in shape and distribution.

Although the Yellow Pup vein has been explored intermittently for about 300 feet along the surfact, it appears to conform in occurrence with the two mineralized zones described above. The faulting condition that was observed in the exploration of the Stepovich and the Colbert ore zones apparently is present in the Yellow Pup area, also figure 5 shows the various strikes and dips of the separate vien segments, which is characteristic of the highly metamorphosed schist.

Character of the Ore

The only mineral of commercial value in the three tungsten properties on Gilmore Dome is scheelite ($CaWO_4$), the tungstate of lime. According to Joesting:[6] "Gangue minerals, in the approximate order of their abundance, are quartz, calcite, pyroxene (chiefly diopside and hedenbergite), hornblend,

6/ Joesting, Henry R., associate mining engineer, Territorial Dept. of Mines, Tests Run on Ore of the Cleary Hill Tungsten mine, 1943. Unpublished report. Copy on file in office of Territorial Dept. of Mines, Juneau, Alaska.

garnet, titanite, and apatite. Of these, the first four comprise the bulk of the gangue, although garnet is occasionally found in significant amounts, titanite and apatite are relatively scarce. Pyrite, pyrrhotite and molybdenite are present but are so rare that only a few grains were found in hundreds of specimens of ore."

The gangue minerals in a representative sample of the shaft development ore were separated.[6] A 16.5-pound sample was crushed to minus 1/4 inch and cut to 470 grams. The sample was then ground to minus 35 mesh, and the low specific gravity gangue minerals quartz and calcite, representing 58.2 percent of the sample, were separated in bromoform (specific gravity 2.89). The removal of 34.6 percent of the sample in a gangue containing chiefly hedenbergite, diopside, hornblende, and garnet was effected with a small electromagnet fitted with pole pieces. The remaining 7.2 percent of the sample consisted chiefly of scheelite and assayed 60 percent tungsten trioxide.

Qualitative spectrographic analysis by the Bureau of Mines on representative samples of the ore and concentrate indicated the following elements:

Iron-high plus plus	Titanium-high plus	Tin-trace in concentrate
Magnesium-high plus plus	Manganese-high plus	Molybdenum-trace
Calcium-high plus plus	Sodium-high	Vanadium-trace
Silicon-high plus plus	Bismuth-low in conct.	Copper-trace
Tungsten-high plus	Strontium-very low	Nickel-trace
Aluminum-high plus	Barium-very low	Chromium-trace
		Lithium-trace

Bureau of Mines Work at Stepovich Deposit

The Bureau of Mines excavated and sampled 24 trenches with an aggregate length of 1 mile. Trenches I to VIII, inclusive, shown on figure 3, were excavated by Cleary Hill Mines Co. East of the new shaft the Bureau of Mines continued to explore from trench VIII.

The first 180 feet explored along the strike contained some weak scheelite mineralization but no ore. The Cleary Hill Mines Co. started an adit on ore 750 feet east of the shaft. The site was selected at an elevation suitable for a connection with the 150-foot level. The next 80 feet east, along the strike, was not trenched, as it would have interfered with work on the adit.

Exploration indicates that the ore zone for the first 400 feet east of the adit contains two lenses worthy of underground development as well as several other mineralized sections. The first lens was exposed for a length of 57 feet. It is limited on the east by a fault, but the western limit has not been determined. The explored length averages 1.08 feet in width and contains 1.62 percent tungsten trioxide. The second lens, slightly over 100 feet east, is 60 feet long and averages 3.31 percent tungsten trioxide over a width of 2.3 feet. A fault zone separating the two lenses displaces the eastern section 50 feet to the south. A test pit revealed a fault plane dipping 45 degrees to the east with striations normal to the strike. The southern displacement of a vein dipping to the north indicates that the fault is normal. (See fig. 3A.)

The next 250-foot section to the east contains weak mineralization. East of sample 22, the vein has been faulted and offset 100 feet to the south, as indicated by the location of samples 47, 48, and 49 and as shown on figure 3A. The mine access road prevented exploration for the next 120 feet. Trenches 19 to 24, inclusive, covering 350 feet, completed the exploration to the east. Five samples cut across a vein 0.68 foot wide averaged 3.78 percent tungsten trioxide. Exploration to the east was discontinued after failure to discover additional ore in trenches 23 and 24.

Bureau trenches 12 to 18, inclusive, continued the exploration 1,000 feet west of trench I. All excavations were examined for scheelite with a mineral light. Samples 23 and 24 were cut at the only two scheelite outcrops.

Strike faults parallel to and slightly steeper than the limestone beds have been observed. A number of quartz veins, genetically related to the scheelite mineralization, follow both the cross faults and the strike faults. Scheelite lenses are often found at the intersection of the quartz veins and limestone beds.

Bureau of Mines Work at Colbert Prospect

The Bureau of Mines excavated and sampled 20 trenches with an aggregate length of 3,000 feet. Three nearly equal lenses of scheelite mineralization totaling 300 feet in length were exposed. Figure 3 shows trench locations, and figure 3A shows location of samples and sample analyses for each lens. These lenses are confined to 1,500 feet of the total 2,000-foot strike length prospected. A 600-foot section included in this distance cannot be considered explored.

The original discovery cut exposed a pocket in a small mineralized vein. A sample across its maximum width of 24 inches contained 1.56 percent tungsten trioxide. In trench 3, which is 150 feet east of the Colbert discovery, a band of scheelite mineralization was uncovered containing 1.09 percent tungsten trioxide over a 0.7-foot width. This mineralized band persisted diagonally 15-feet across the trench, its strike of N. 48° E. indicating a projection south of the discovery. A hand-dug trench extending south from the discovery, crossed a replacement zone containing much garnet and scattered grains of scheelite, though it failed to reveal the mineralized band. Trench 20, which, because of the topography, was excavated diagonally to the general strike of the Colbert mineralized zone, exposed for 20 feet two narrow lenses containing scheelite mineralization. These lenses, when projected across the intervening 70 feet, make a reasonable connection with the vein exposed in the discovery cut.

Between trench 3 and the next known lens, which appears in trench 5, 800 feet east, are three trenches that inadequately explore the area. Trench 17 uncovered the replacement zone 200 feet east of trench 3. Trench 19 was excavated obliquely from the hanging wall of the replacement zone in trench 3 to the footwall of the zone in trench 17. Trench 18, on the projected strike 220 feet west of trench 5, exposed a 100-foot section of bedrock but did not encounter the replacement zone. Criteria established by exploratory work on the parallel Cleary Hill replacement zone suggest the possibility that the Colbert replacement zone may be displaced by fault action between trench 17 and trench 5.

The lens of mineralization crosscut by trenches 4, 5, and 7 and followed by trench 6 has been limited to a length of 108 feet.

The replacement zone was uncovered along all but 70 feet of the intervening 220 feet between trench 7 and the next mineralized lens to the east. The section disclosed a zone of intense replacement containing short, narrow seams of scheelite mineralization.

Cross trenches 9 and 10 cut fairly strong scheelite mineralization, and trench 14 uncovered the vein along the strike. Trench 14 was excavated along the replacement zone from trench 8 to a point where the third lens was encountered just west of trench 9. The third lens was exposed from there to a point 15 feet beyond cross trench 10, where it was lost by faulting.

Cross trenches 11 and 12 were bulldozed before the fault had been discovered in trench 14. Each uncovered a 200-foot section of the bedrock but did not encounter the replacement zone. Trench 13 exposed a narrow replacement band containing a thin seam of scheelite. Very similar mineralization was found in trench 2, one hundred thirty feet north of the main mineralized zone cut by trenches 4, 5, 6, and 7. The similarity of the two zones indicates that originally they formed a continuous band. The mineralized zone found in trench 2 could have been faulted to its present position, as indicated by the trend and displacement of faults along the east end of the Cleary Hill zone.

Bureau of Mines Work at the Yellow Pup Prospect

During September 1944, the Bureau of Mines conducted a limited program of bulldozer trenching to establish the continuity between the Colbert mineralized zone high on the dome and the Yellow Pup vein near its base. The vein was explored for about 300 feet by three short trenches near the southwest corner of the Marie claim, as shown in figure 5.

Combined exploration by the Bureau of Mines and local operators on the Gilmore Dome ore zone has disclosed that the tungsten mineralization forms a series of irregular lenses and is erractically distributed horizontally and vertically. In certain areas these scheelite-enriched lenses may comprise a large enough percentage of the replacement zone to be considered commercial. In other areas where the lenses are widely scattered, they could not be considered ore unless found along the course of access or development workings

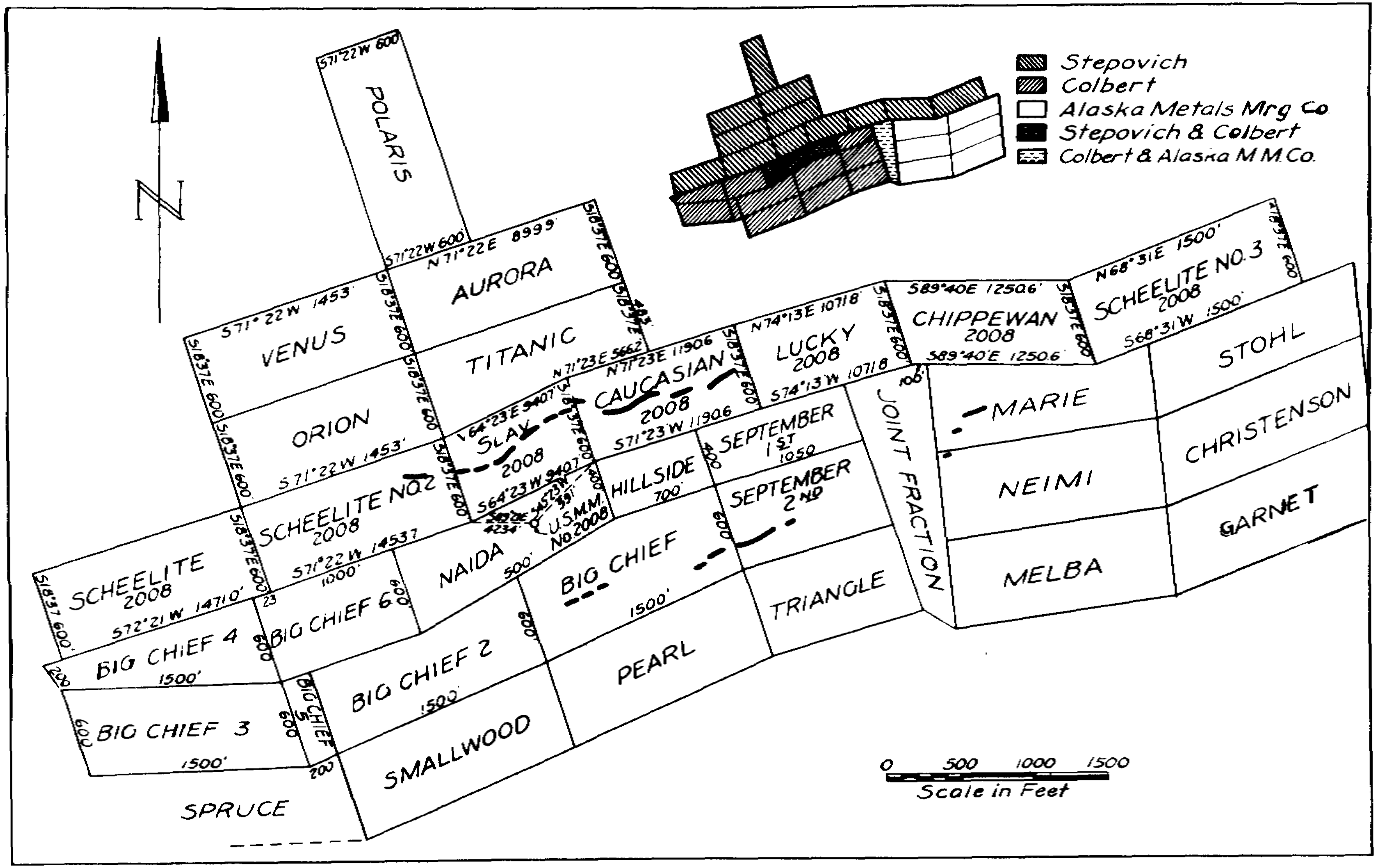


Figure 4. - Claim map of tungsten properties on Gilmore Dome.

The length of the individual lens or the total length of any one zone of deposition has little relation to its depth. The distance to the underlying granite, estimated by magnetometer survey to be 600 to 1,000 feet, is the probable limit of deposition, but irregularities caused by various degrees of resistance to rising magmas along sedimentary beds may have altered this limit.

Sampling and Analysis

Figures 3, 3A, 4A, and 5 show the location and results of 56 surface channel and 26 mine channel samples taken by the Bureau of Mines, 7 surface and 14 mine samples taken by Cleary Hill Mines Co., and 4 mine samples taken by the R.F.C.

The Bureau of Mines channel samples were cut as nearly normal to the dip and strike of the ore lens as possible. All Cleary Hill and R.F.C. samples were reported to be channel cuts.

Surface samples were cut near the bottom of hand-dug pits excavated on veins exposed by bulldozer trenches. Surface samples were cut 3 to 7 feet below the bedrock surface and as much as 15 feet below ground level. The rock in the ore zone has been weathered for a considerable distance below the surface, and in some sections this weathering has continued to an inclined depth of 150 feet.

Samples from this property have been analyzed in the Territorial Department of Mines Assay Office at College, Alaska, and used in this report. Check samples were sent to a commercial analyst in Los Angeles, Calif. The results of duplicates of a number of samples sent to a commercial analyst were generally higher in tungsten trioxide content.

The mineral light was used to determine the limits of individual samples as well as to estimate the content of tungsten trioxide in each sample. In actual practice, the mineral light has proved to be reasonably accurate in estimating the value of the ore in the Cleary Hill mine. Although the estimates of surface samples are usually high, this may be due to the tendency of the scheelite crystals to shatter in the altered surface exposure. Minute particles show distinctly in the fluorescent light. This property undoubtedly increased the error in quantitative comparisons with ores containing large crystals.

Samples 201 to 227, inclusive, were cut from the vein exposures of the Colbert property. In each case the entire channel sample, weighing 10 to 50 pounds, was taken to the Territorial Assay Office at Fairbanks, where it was crushed to approximately 3/16-inch, cut in a riffle divider, and then put through a Braun pulverizer. One cut of each sample was analyzed there, four check samples were sent to a commercial analyst, and one cut of each sample was stored in Fairbanks.

Of the four check analyses, one was identical and the other three were higher in percentage of tungsten trioxide than determined by the Territorial Assay Office.

Figure 5 shows the location and analyses of six samples collected from Bureau trenches on the Yellow Pup property.

Development

A total of 1,262 feet of underground development has been completed at the Stepovich property by the Cleary Hill Mines Co. since 1942. In the shaft area, development along the mineralized zone totals 670 feet. Of this advance, 357 feet were in ore averaging 1.58 feet wide and 5 percent tungsten trioxide. The lower 112 feet of the shaft and 320-foot crosscut were outside the ore zone and are not included in the above figures.

The new inclined shaft was begun in 1942 for exploration and development purposes. It is midway between the two old caved shafts situated 300 feet apart on the summit of Gilmore Dome. The shaft is the present means of access to the two mine working levels which are named for their slope distance below the apex of the vein. The 50-foot level is 55 feet long, and the 150-foot level is 356 feet long. (See fig. 4-B.)

The new adit is 448 feet long and now is 184 feet short of a connection with the shaft 150-foot level. Several small patches of mineralization have been found, but very little ore has been developed.

Alteration of the rocks in the ore zone and lateral postmineral movements parallel to the strike of the zone have resulted in a weak or shattered condition in much of the vein material. For this reason, possibly 80 percent of the underground workings in the ore zone would require timbering if the mine was reopened. The zone of weakness usually extends beyond normal mining widths, and it is doubtful whether much open stoping could be done. The rocks outside of the ore zone consist of tough metamorphosed schist, which does not require support.

The development in the shaft area has encountered several solution cavities in the ore zone. The largest cavity encountered was 20 by 20 feet and had a maximum width of 4 feet. When this cavity was first found, scheelite on its walls could be seen through a 2-inch coating of ice with the aid of a mineral light. In some cavities, scheelite on the walls is covered with a crust of calcite up to 1/4 inch thick. The usual cavity is about 5 by 10 feet in the slope of the vein and about 1 foot in width.

In the fall of 1945, the accessible mine workings were lamped with an ultra-violet light, and the only mineralized portion of the mine is shown in section E_1-E_2, figure 4-G. The assays and thickness of this mineralized segment are shown on the 1946 mine map (fig. 4-B). Between raise 3 and the west heading on the 150-foot level, ore has been included with waste fill and can be seen with the aid of an ultra-violet lamp. Sectional views of the lower workings are shown in figures 4-C, 4-D, 4-E, and 4-F.

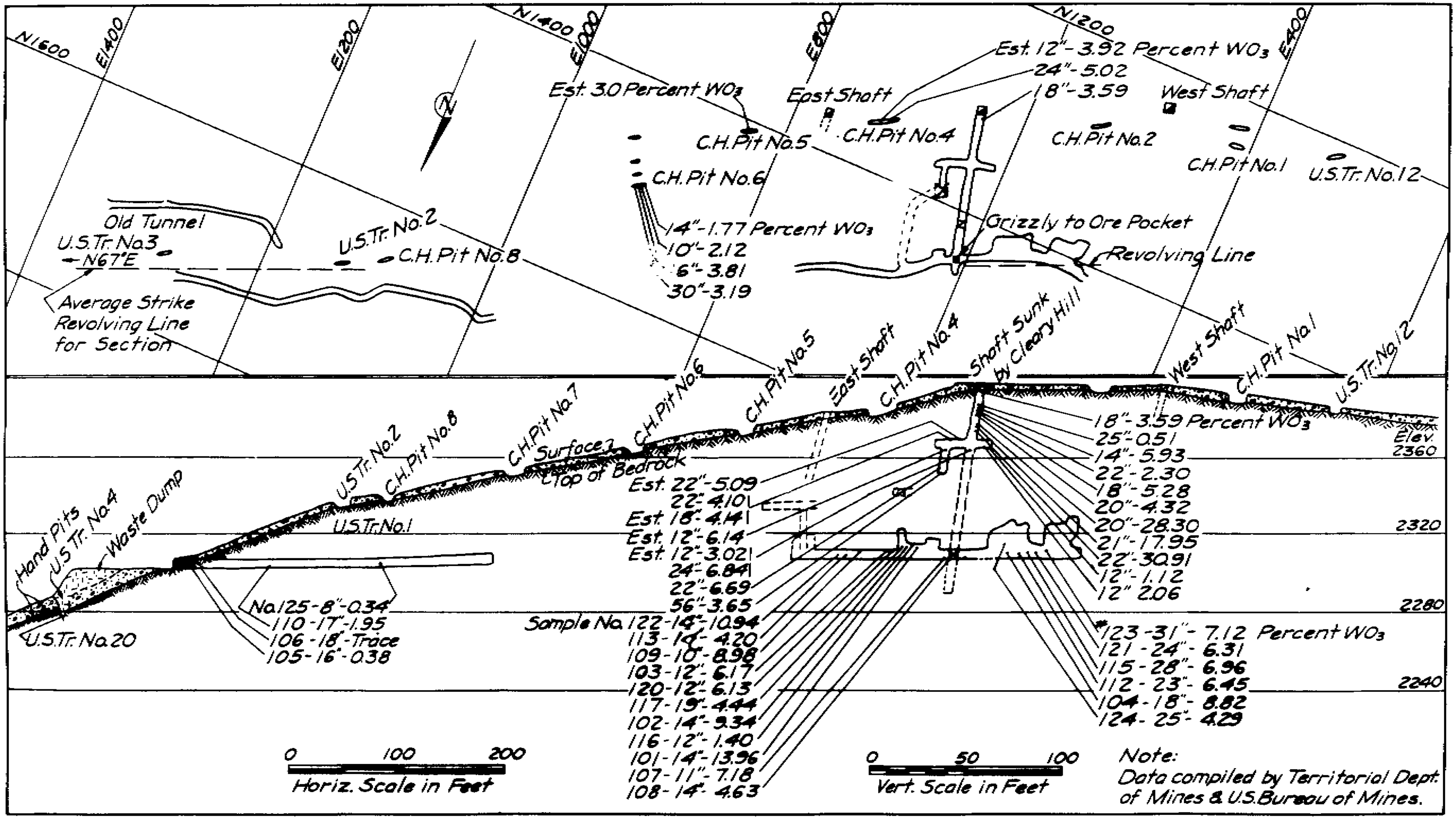


Figure 4-A. - Cleary Hill mine 1942.

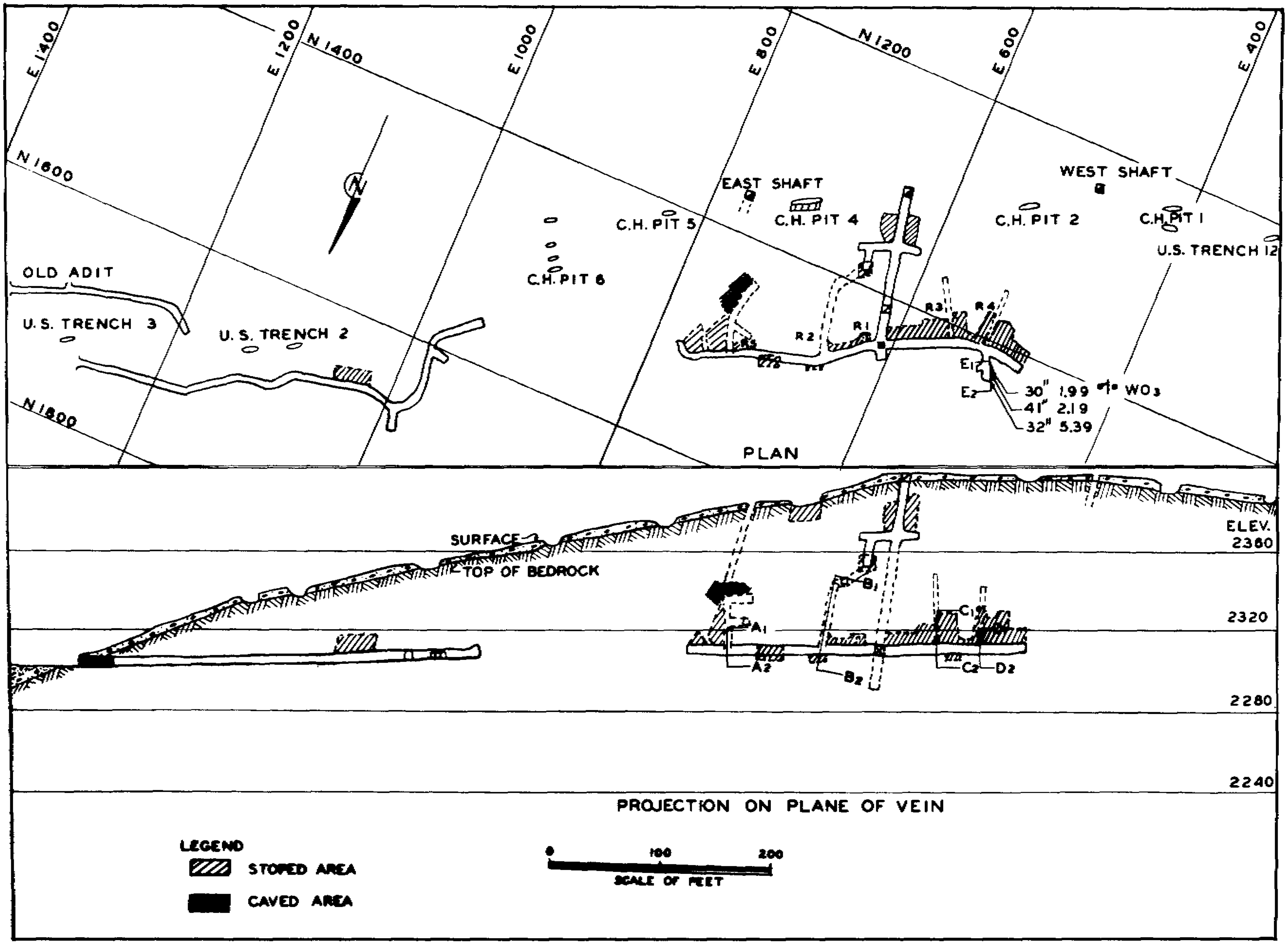


Figure 4-B. - Cleary Hill tungsten mine 1946.

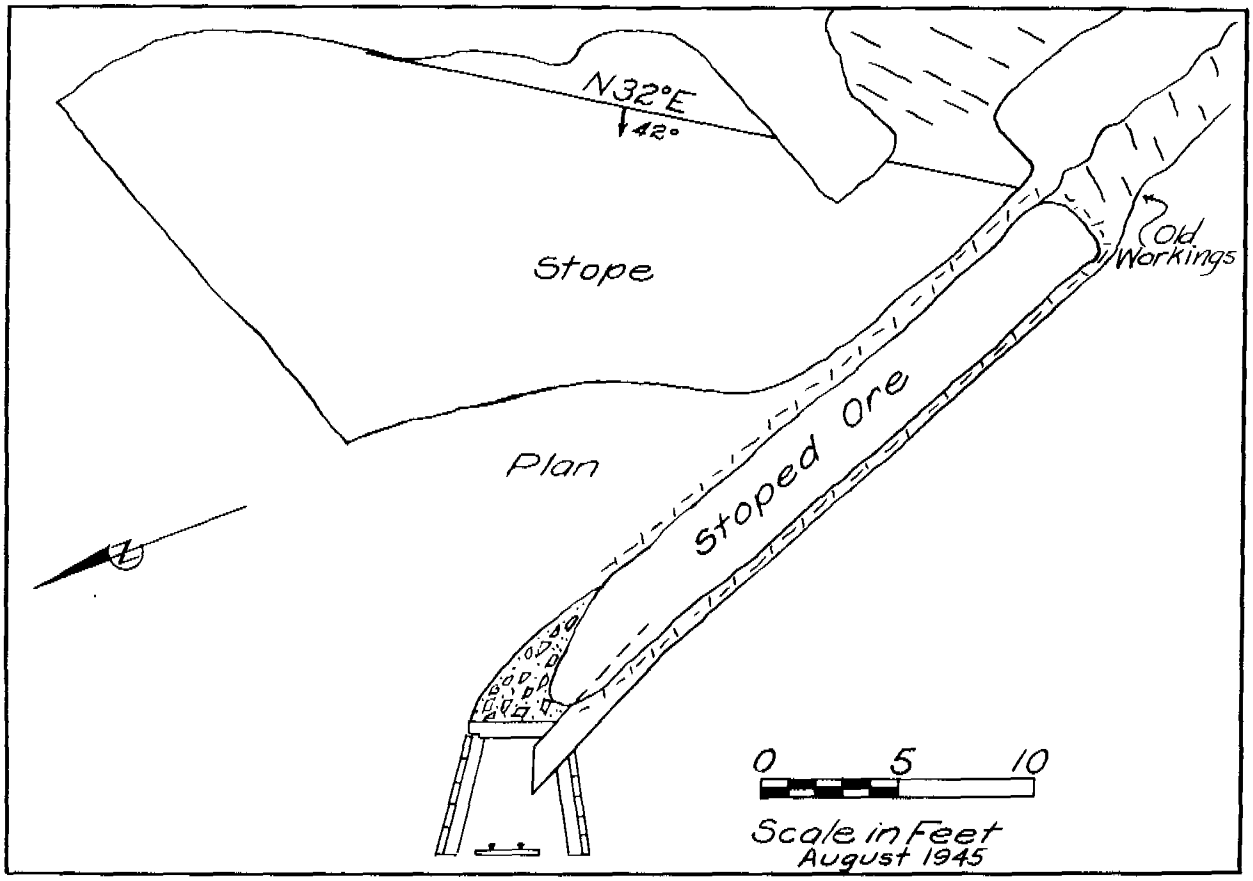


Figure 4-C. - Section A_1-A_2.

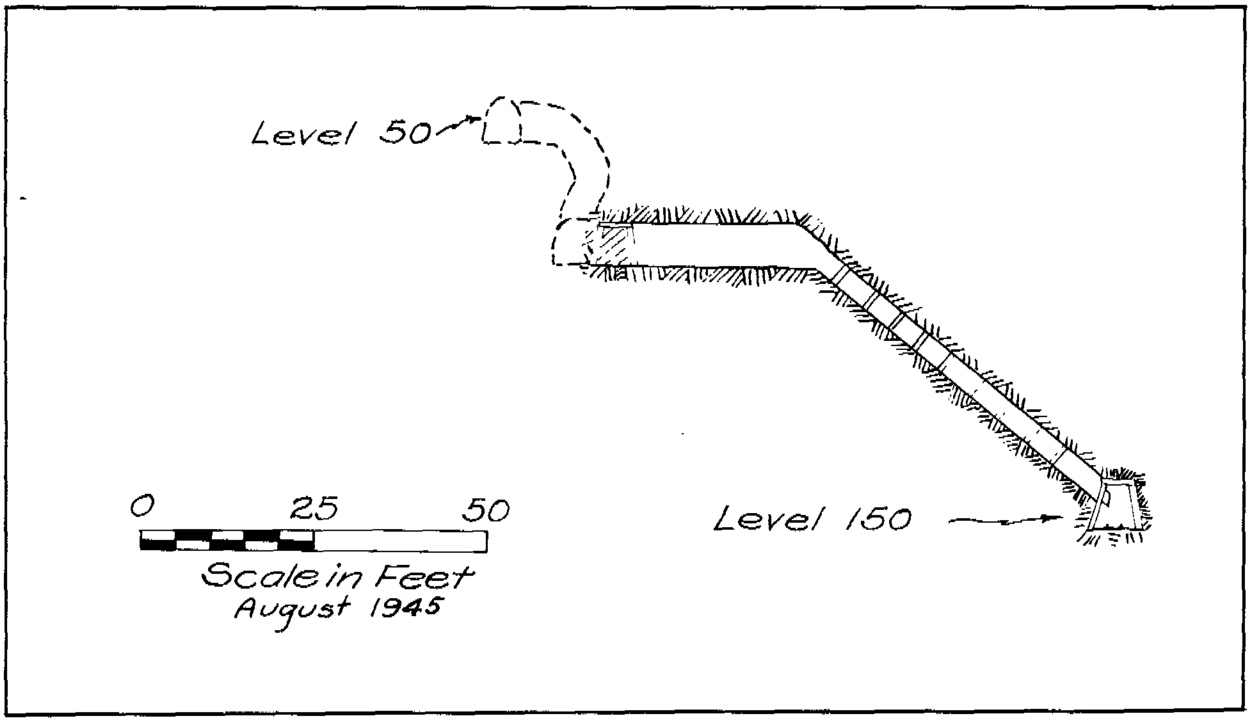


Figure 4-D. - Section B_1-B_2.

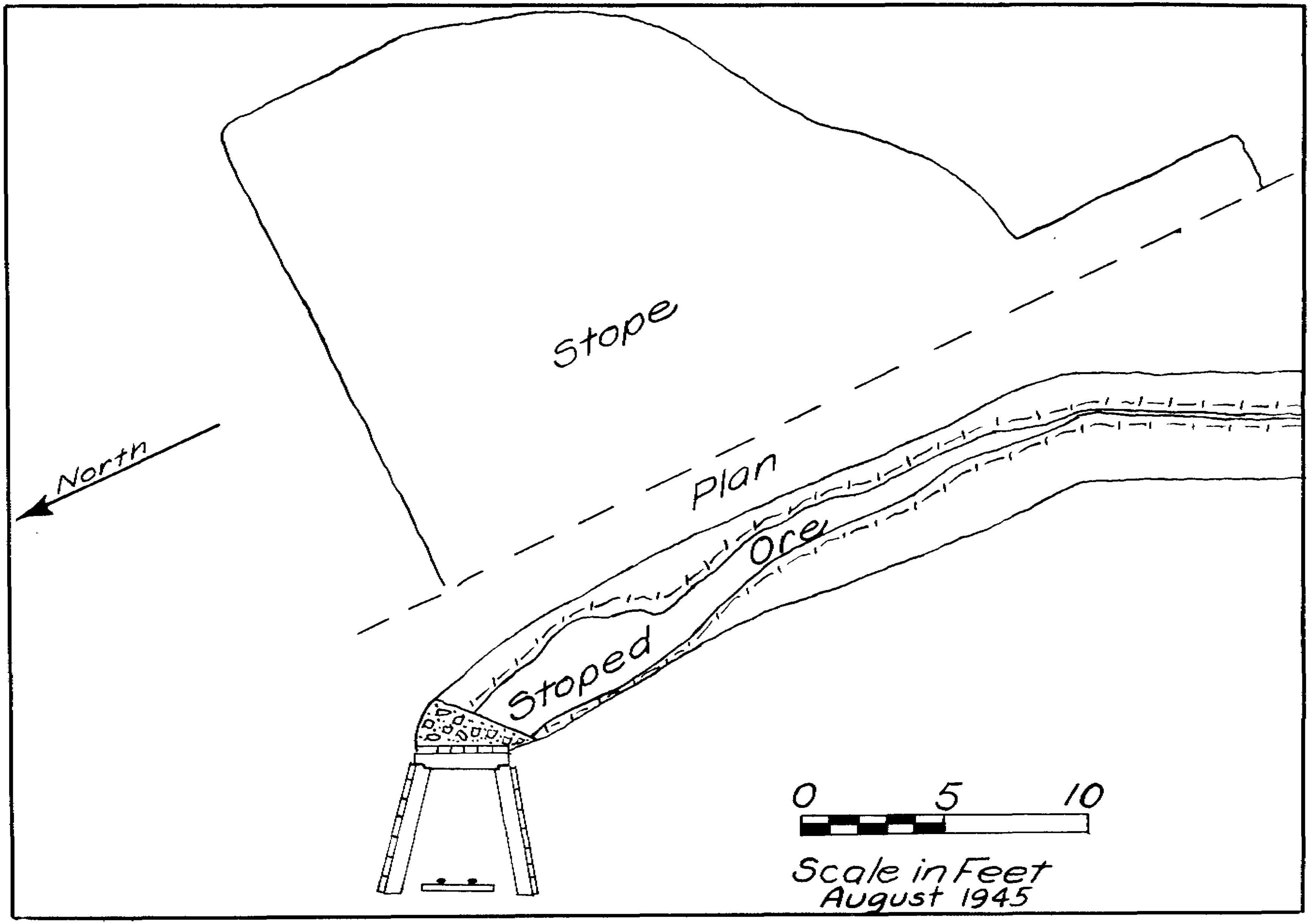


Figure 4-E. - Section C_1-C_2.

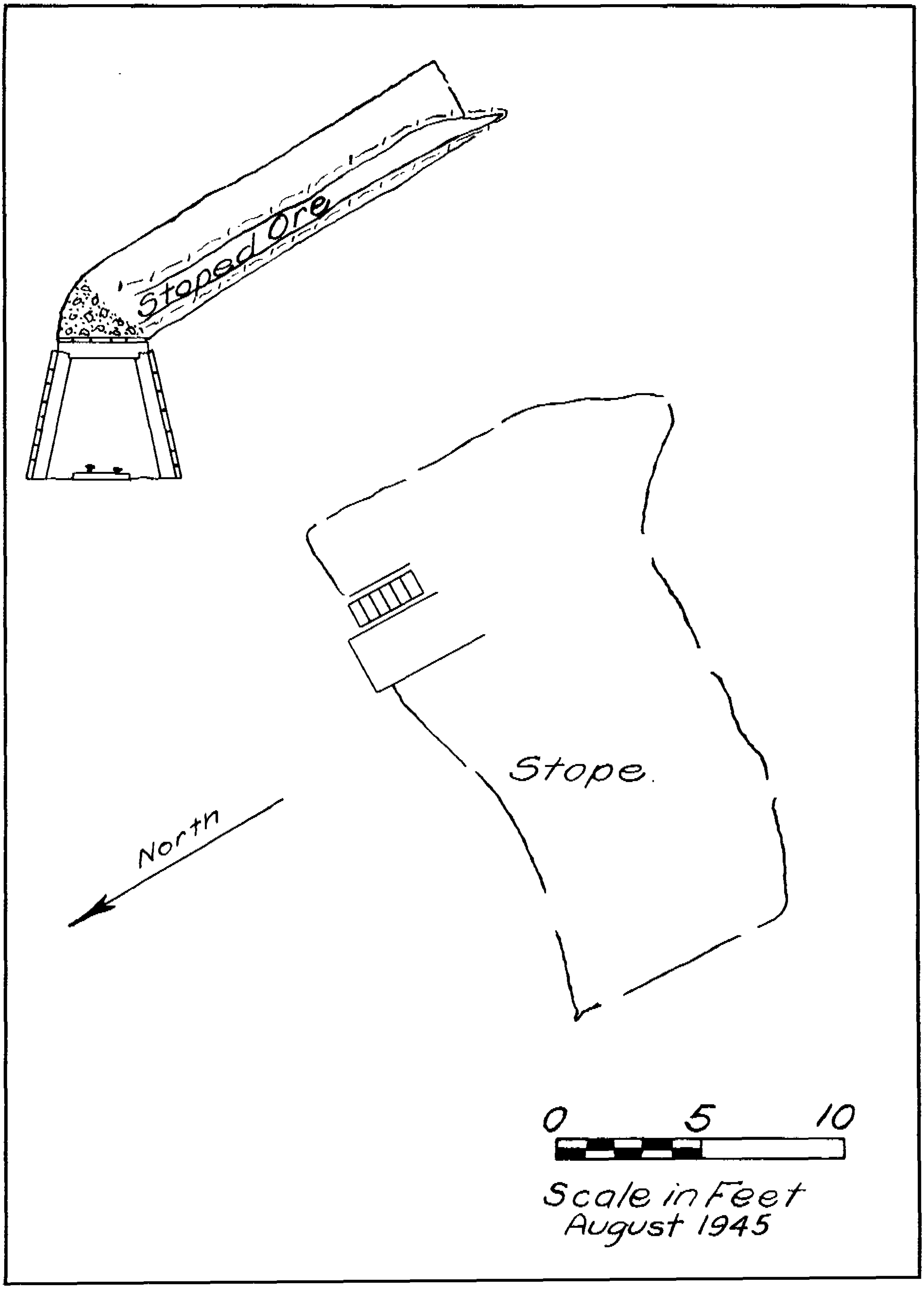


Figure 4-F. - Section D_1-D_2.

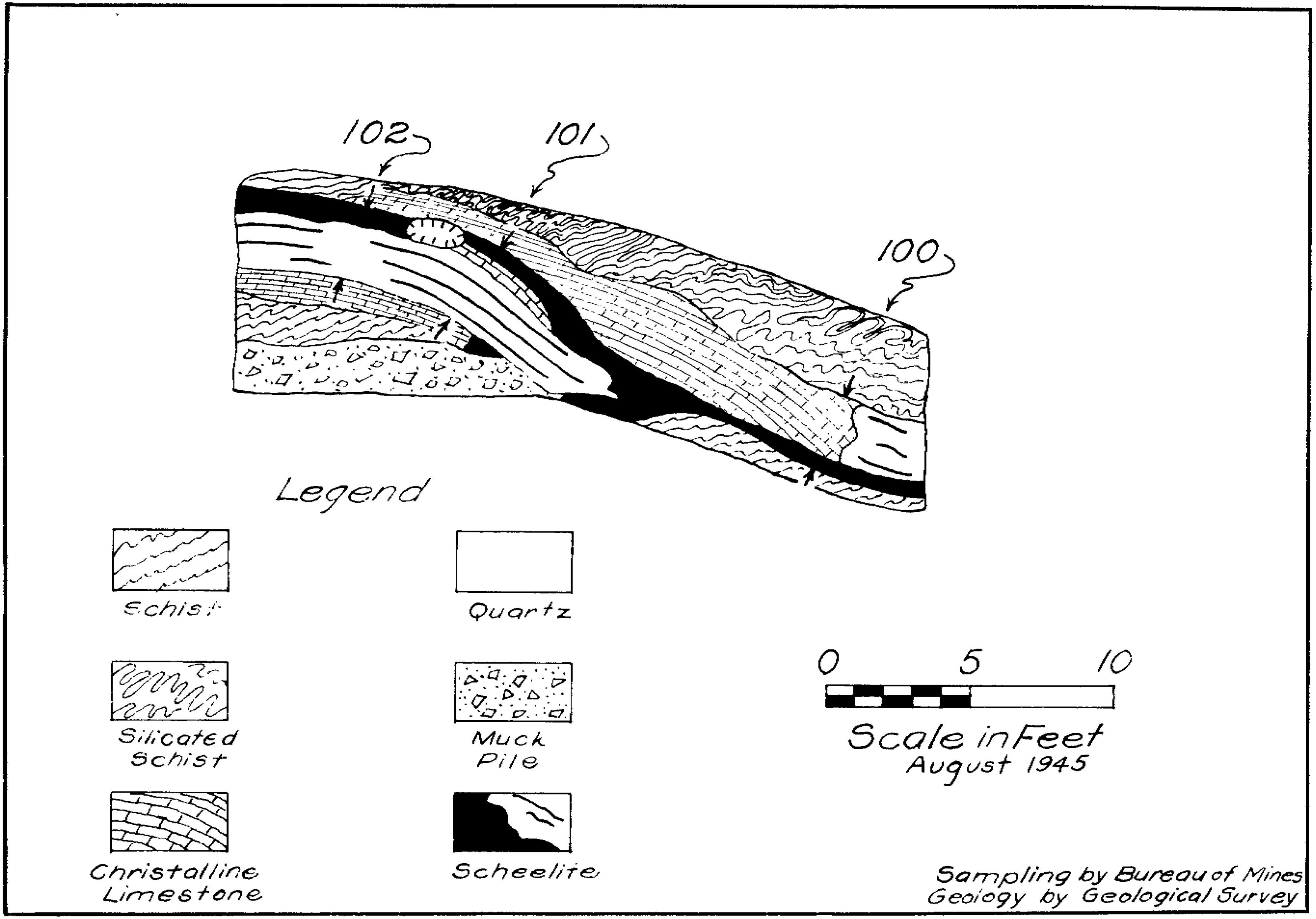


Figure 4-G. - Section E_1-E_2.

The entire mine is in the permafrost zone, and surface water seeping through the old workings in the northeast portion of the mine are icing up the main drift on the 150-foot level. The timbers in the extreme west end of the 150-foot level are ruptured, and it is quite likely that the ore pictured in section E_1-E_2 will be blocked by caves within a short time.

There are no underground workings on the Colbert property.

The nearest source of water for mining and camp use is 2,000 feet west and at an elevation 200 feet below the discovery cut.

Beneficiation Tests by Bureau of Mines

A metallurgical sample was submitted to the Rolla Laboratory by Norman Ebbley, Jr., an engineer of the Bureau of Mines, on October 29, 1942. The report of the metallurgical tests on this ore follows:

> "Ore Dressing Report on Scheelite ore from Cleary Hill Mines Co., Nada Gulch Tungsten Prospect. Fairbanks, Alaska.
>
> "The second sample was from a 30-foot shaft on the property, whereas the first sample, which has been reported previously, was a grab sample from the dump on the property. After having demonstrated that the ore was amenable to concentration, the second sample was submitted to determine the most suitable flowsheet for the ore.
>
> "Physical character
>
> "The tungsten ore consists of scheelite in a gangue of quartz, calcite, and hornblende. Minor amounts of olivine, and biotite and sparing amounts of chlorite and epidote are also present.
>
> "In the highly weathered portions of the rock, the calcite has been removed, and the hornblende has been altered, leaving only a skeleton of limonite with crystals of scheelite.
>
> "A study of the screen size showed that at 48-mesh about 20 percent of the scheelite was locked, whereas at 65-mesh only 2 percent was locked, and all of the scheelite was freed in the minus 65-mesh product.
>
> "Chemical character:

"Analysis of ore, percent

WO_3	S	P	As
5.91	0.05	0.08	0.07

"Treatment procedure:

1. Classification and tabling
2. Flotation of table concentrate
3. Flotation of crude ore
4. Tabling of unclassified feed

"Classification and Tabling

"Although the petrographic examination indicated that grinding through 65-mesh was required to liberate the scheelite completely, table concentration at a coarser size was attempted. The purpose was to reject the bulk of the gangue without excessive slime losses of the scheelite and to recover a low-grade scheelite concentrate for further concentration by flotation.

"Treatment

"The ore was crushed through 10 mesh and classified into four spigot products and an overflow. The four spigot products were tabled separately, and the middling from each tabling operation was crushed, classified, and added to the finer spigot products. The tailings from tabling the two coarsest spigot products also were crushed, classified, and added to the finer spigot products. The combined slime was tabled separately.

"Similar products from each table operation were combined for analysis.

"Results of Classification and Tabling

Products	Weight, percent	Analysis, percent				Percent of total WO_3
		WO_3	S	P	As	
Concentrate	9.7	55.90	0.18	0.04	0.05	94.7
Middling ..	4.6	4.01				3.2
Tailing ...	85.7	0.14				2.1
Heads, cal.	100.0	5.74				100.0

"Remarks

"The concentrate, containing 55.90 percent tungstic oxide, was 9.7 percent of the ore, and the recovery of tungstic oxide was 94.7 percent.

"Flotation of Table Concentrate

"Treatment

"A sample of the table concentrate from the classification and tabling test was wet-ground through 65-mesh in two

5-minute stages. A scheelite rougher concentrate was floated, and the rougher concentrate was cleaned once. Zeolite-softened water was used in both the grinding and flotation. The flotation pulp was 25.0 percent solids and had pH of 8.0.

"Results of Flotation of Table Concentrate

Products	Weight, percent	Analysis, percent				Percent of total WO_3
		WO_3	S	P	As	
Concentrate	76.1	73.96	0.06	0.04	0.0	98.5
Middling ..	4.0	12.73				0.9
Tailing ...	19.9	1.80				0.6
Heads, calculated	100.0	57.16				100.0

Reagent Data

Reagents	Pounds reagents per ton of feed		
	Conditioner	Rougher	Cleaner
"N" sodium silicate ..	1.6		
Soda ash	0.8		
Oleic acid		2.16	0.72
"B-23" Frother1/		0.36	0.18
Time, minutes	10	7	7

1/ E. I. DuPont de Nemours & Co., Inc.

"Remarks

"The recovery was 98.5 percent of the tungstic oxide contained in the flotation feed, and the concentrate contained 73.96 percent tungstic oxide.

"Summary of tabling and flotation of table concentrates

Product	Weight, percent	Analysis, percent				Percent of total
		WO_3	S	P	As	
Flotation Concentrate	7.38	73.96	0.06	0.04	0.0	93.2
Flotation Middling	0.39	12.73				0.9
Flotation Tailing	1.93	1.80				0.6
Table Middling ..	4.60	4.01				3.2
Table Tailing ...	85.70	0.14				2.1
Heads, calculated	100.00	5.85				100.0
Heads, analysis .		5.91				

"Remarks

"The recovery was 93.2 percent of the total tungstic oxide contained in the crude ore. The concentrate was 7.38 percent of the ore and contained 73.96 percent tungstic oxide, 0.18 percent sulfur, 0.04 percent phosphorous, 0.0 percent arsenic.

"Flotation of Crude Ore

"Treatment

"A sample of the ore, crushed through 10-mesh, was wet-ground through 65-mesh in three 5-minute stages and floated. The rougher scheelite concentrate was cleaned twice. Zeolite-softened water was used in grinding and flotation. The pulp was 25 percent solids and had a pH of 8.

"Results of Flotation of Crude Ore

Product	Weight, percent	Analysis, percent				Percent of total
		WO_3	S	P	As	
Concentrate	7.0	65.90	0.09	0.04	0.0	85.6
Middling	5.5	6.85				7.1
Tailing	87.5	0.45				7.3
Heads calculated.	100.0	5.37				100.0

"Reagent Data

	Pounds reagents per ton of feed			
			Cleaner	
	Conditioner	Rougher	1	2
"N" sodium silicate	3.2			
Soda ash	0.8			
Quebracho	0.6			
Oleic acid		0.72		
Frother B-23		0.36		0.18
Time, minutes	10	5	5	4

"Remarks

"The recovery of tungstic oxide was 85.6 percent. The concentrate was 7.0 percent of the ore and contained 65.90 percent tungstic oxide.

"Tabling (Unclassified Feed)

"At the suggestion of the examining engineer, table tests were made on unclassified samples of the ore crushed through 10-mesh and 48-mesh. These tests were made to determine the recovery of a marketable scheelite concentrate that might be expected if the limited equipment available on the property necessitated a simplified flowsheet. Stamps, tables and flotation cells are the only equipment available.

"Results of tabling minus 10-mesh unclassified ore

Product	Weight, percent	Analysis, percent, WO_3	Percent of total, WO_3
Concentrate	5.4	69.90	69.4
Middling	35.0	4.39	28.3
Tailing	59.6	0.21	2.3
Heads calculated	100.0	5.44	100.0

"Results of tabling minus 48-mesh unclassified ore

Product	Weight, percent	Analysis, percent, WO_3	Percent of total, WO_3
Concentrate	5.1	73.48	54.5
Middling	7.7	32.26	36.2
Sand, tailing	85.0	0.68	8.4
Slime, tailing	2.2	2.94	0.9
Heads, calculated	100.0	6.8	100.0

"Remarks

"Tabling of the unclassified crushed ore is not recommended, because the recovery of tungsten trioxide was lower than that obtained by the tabling classified sands and slime.

"Flotation of the table middling would be necessary to increase the recovery of tungsten trioxide.

"The scheelite ore from the Nada Gulch Tungsten Prospect of the Cleary Hills Mines Co., Fairbanks, Alaska, was amenable to concentration by the combined treatment of classification and tabling and flotation of the table concentrate.

"By classification and tabling, 94.7 percent of the total tungsten was recovered. The concentrate was 9.7 percent of the original ore and contained 55.90 percent tungsten oxide.

"In the classification and tabling followed by flotation of the table concentrate 93.2 percent of the total tungsten was recovered as a product that contained 73.96 percent tungstic oxide, 0.06 percent sulfur, 0.04 percent phosphorous, and 0.0 percent arsenic and was 7.38 percent of the ore.

"By flotation of the crude ore, 85.6 percent of the tungstic oxide was recovered in a concentrate that contained 65.90 percent tungstic oxide, 0.09 percent sulfur, 0.04 percent phosphorous, 0.0 percent arsenic, and represented 7.0 percent of the weight of the ore.

"The recovery obtained by tabling the unclassified ore crushed through 10-mesh was 69.4 percent, and the concentrate, which was 5.4 percent of the ore, contained 69.98 percent tungsten trioxide."

Beneficiation Tests by the Cleary Hill Mines Co.

The operators were unable to take full advantage of the Bureau's beneficiation tests because, owing to war demands, very little equipment was available.

Ore was hauled 8 miles from the tungsten mine to the stamp mill at the Cleary Hill gold mine. No provision was made for storage of the crude ore. Upon arrival at the mill the ore was shoveled from the truck onto a sloping grizzly equipped with 2 inch openings. The oversize was shovel-fed to a jaw crusher and was joined by the undersize in the stamp mill feed bin, as shown in flow sheet 1 (fig. 4-H).

The standard five-stamp mill received a feed ranging from fines to ore having a dimension up to 3 inches. The great difference in feed size coming from a bin that holds only slightly more than 10 tons caused the feed for the mill to vary constantly and resulted in the mill being underloaded or overloaded a large part of the time.

The increase in the screen size from 45-mesh to 20-mesh on the stamp-mill discharge screen made necessary a large increase in the water to the stamp battery. Because of an inadequate water supply, low water-to-ore ratio was adopted, which contributed to excessive sliming.

Sources of water are available and could be utilized with additional pumping equipment and approximately 200 feet of winterized pipeline. From May 1 until the middle of October an abundance of creek water is carried to the mill by a long ditch. During the winter months approximately 50 percent of the water used in the mill could be recirculated. A dewatering cone in the tailing circuit and a small centrifugal pump would be required to return the excess water to the mill storage tank.

The crushed minus 20-mesh product of the stamp mill went directly to a three-compartment, rising water classifier. The first two spigot products of the classifier constituted the feed for the Wilfley sand table. In the last arrangement seen in use, the third spigot and the classifier overflow made up the highly diluted feed for the Wilfley slime table. The two rougher tables produced a high-grade (60 percent or better) concentrate, a middling feed, and a final tailing. The middling feed was handled on the Wilfley middling table, which produced a high-grade concentrate, a lower-grade concentrate, and a final tailing.

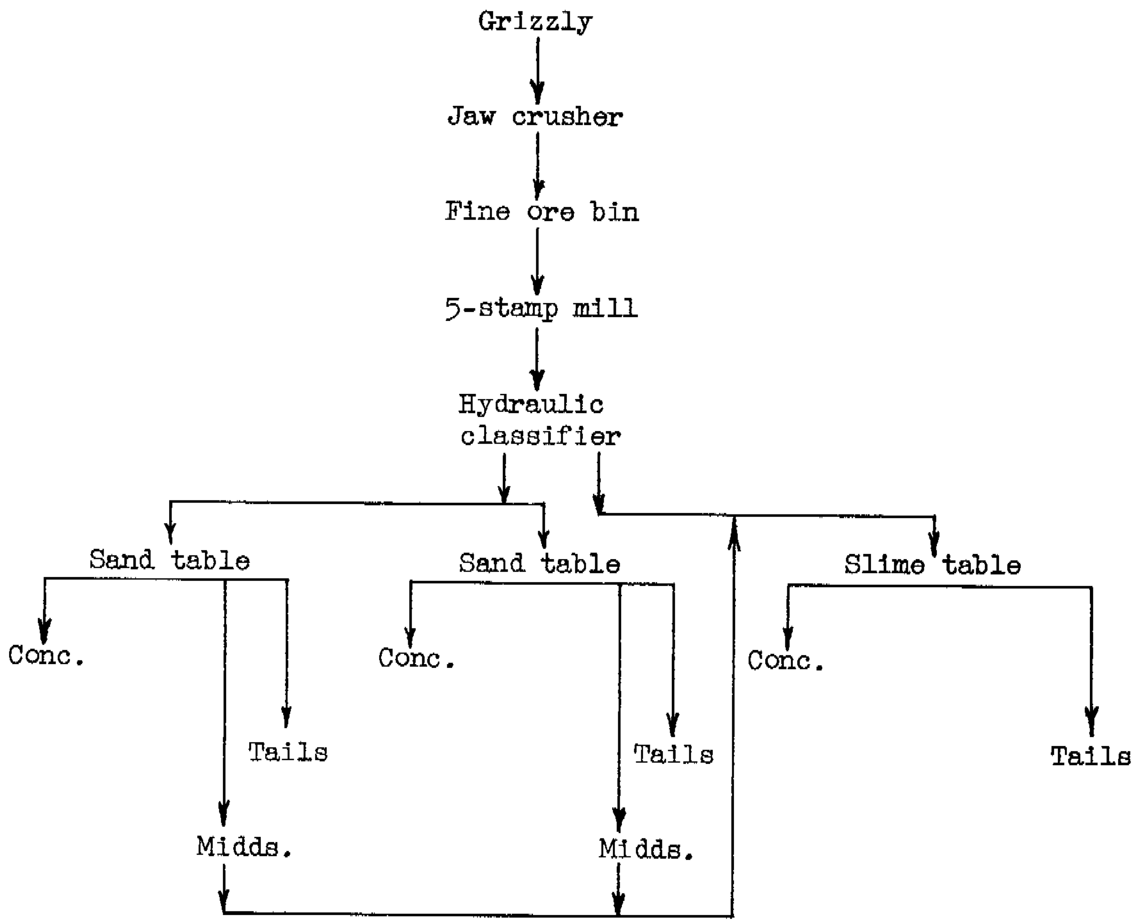


Figure 4-H. - Flow sheet I, Cleary Hill stamp mill, 1943.

The combined tailing usually contained 0.6 percent to 0.8 percent tungsten trioxide. Probably two-thirds of the loss came in the tailing derived from the unclassified feed of the middling table. The major portion of the tailing loss was in free scheelite 200- to 300-mesh in size. Very little scheelite contained in the coarser particles was lost.

LODE DEPOSITS IN THE STEELE CREEK-FIRST CHANCE AREA

Other tungsten deposits in the Fairbanks area were discovered in 1915, and by the summer of 1916 five groups of claims at the heads of First Chance, Steele, and Engineer Creeks had been located. Prospecting continued on them for 2 or 3 years, but the sudden decline in the market price of tungsten ores at the end of 1918 caused a cessation of development. Little more than assessment work has been done since. In 1916, the Geological Survey7/ reported upon these deposits as follows: (See fig. 2)

Tanana Group

"The Tanana group consists of five lode claims along the northeast side of Tungsten Gulch, a headwater tributary of First Chance Creek. The claims are owned by Grant and Hirschberger, and during the summer of 1916 were being actively prospected for scheelite. Six scheelite lodes have been discovered on these five claims, and others are probably present.

"The principal work has been done on the Tanana No. 1 claim. The country rock on this claim is a quartzite schist, the cleavage of which strikes N. 30° E. and dips 35° NW. The lode consists of a mineralized zone 3 feet thick, which lies parallel with the major structure of the country rock. It is the structure of the schist, in fact, which has determined the site of the ore deposition. The scheelite occurs in stringers of soft, decomposed, iron-stained schist 2 to 6 inches wide. Many of these stringers contain little quartz-scheelite veinlets, which are very rich in tungsten and carry also some gold. The stringers of decomposed schist are said to carry both scheelite and gold. The country rock separating the schist stringers in the lode also carries a little scheelite, possibly as much as 1 percent. A specimen of scheelite-bearing pegmatite taken from the bottom of the incline shows the intimate genetic connection of the deposit with granitic rocks.

7/ Mertie, J. B., Jr., Lode Mining in the Fairbanks District. In Mineral Resources of Alaska - Report on Progress of Investigations in 1916: U. S. Geol. Surv. Bull. 662, pp. 422-424.

"A gold quartz vein striking N. 8° W. and dipping 60° E. cuts the schist and the scheelite lode above described. This vein carries gold in about the same amount as the scheelite lode. In view of the fact that gold and scheelite do not appear to have been deposited synchronously at the other properties visited, it is probable that the gold in this scheelite lode is a result of local enrichment by the gold quartz vein. Both structural and mineralogic data, therefore, point to the conclusion that the scheelite mineralization took place before the formation of the gold quartz veins, at least at this particular locality.

"The Discovery lode on the Tanana No. 1 claim consists of 8 feet of scheelite-bearing schist exposed in an open trench. The hanging wall at this place is porphyritic granite.

"The Tanana group of claims, as well as the other claims in this vicinity, including the Spruce Hen group, the Columbia group, the Tungsten Hill group, and the Blossom claim, lie along the western periphery of a large intrusive mass of porphyritic granite. This is the same body of granite that lies north of the Tungsten and Scheelite claims, above described. The granite is intimately associated with the scheelite lodes, being present at the different claims as transverse dikes or wall rock, and in the Tanana No. 1 lode a scheelite-bearing pegmatite occurs. It is quite evident, therefore, that the scheelite deposits at the west end of this intrusive mass are disseminated stringer lodes, much like the lodes at the Scheelite and Tungsten claims. Differences in the form of the deposits are due largely to the differences in the character of the country rock.

Spruce Hen Group

"The Spruce Hen group consists of three claims on the divide between First Chance and Steele creeks. These claims are being prospected by J. F. Zimmerman.

"Five lodes are said to be present on the Spruce Hen claim. These are being prospected by open trenches. One trench has revealed a uniformly mineralized body of schist and metamorphosed basic intrusive rock, without any stringers or veinlets, 3 to 4 feet wide, averaging perhaps 1 to 2 percent of scheelite. This lode carries no gold.

"At another trench, on the same claim, is exposed a 4-foot lode of similar character, which strikes N. 33° E. and dips 40° NW. This strike is conformable with that of the country rock on the Tanana No. 1 claim, and it is not improbable that this trend of the country rock has been determined to some extent by the intrusion of the neighboring granite mass, one tongue of which extends from the main mass in a northeasterly direction along the ridge.

Columbia Group

"The Columbia group, comprising three claims, is at the head of Steele Creek, southeast of the Spruce Hen group. These claims are owned by J. Meier, J. Hoffman, and W. Wallace. At the time of the writer's visit to this property, development work consisted of a short tunnel at one locality and an open cut at another. Since that time, however, the tunnel has been driven 130 feet, and in midwinter the owners were installing a small mining plant.

"The open cut is on the Columbia claim and has exposed a scheelite lode similar to the others previously described, cut by a 1-foot vein of quartz. Considerable wad is associated with the quartz, showing that the vein is to be classed with the gold quartz veins.

"In the tunnel a 3-foot zone of scheelite-bearing rock was exposed. The hanging wall is a porphyritic granite, and the lode material consists of decayed stringers of country rock, rich in scheelite, similar to those at the Tanana No. 1 lode. The strike of the lode system is N. 20° W. and the dip is 30° E.

Tungsten Hill Group

"A group of eight claims, owned by Martin Harrais and known as the Tungsten Hill group, lies on the southwest side of Tungsten Gulch, a tributary to First Chance Creek.

"Four scheelite lodes had been discovered on these claims by August 1916, and it is likely that others are present. On the Grand Duke Nikolas claim a scheelite lode in the schist country rock had been exposed in an open cut. This deposit consists of 6 to 8 feet of decayed schist, carrying scheelite. Vein quartz containing a little gold is also present, cutting the mineralized zone.

"On the Tungsten No. 1 claim another open cut had been made in a country rock of mica schist and quartzite schist. A zone mineralized by scheelite is present, but the width of the lode was not apparent from the work done.

"On the General Joffre claim, a scheelite lode 14 feet wide has been exposed. The lode as a whole was considered low-grade ore, but it contains in the central part an 18-inch stringer of decayed schist, which is of considerably higher grade.

"These claims certainly deserve further prospecting, for they are as advantageously situated with regard to the granite as other scheelite claims in the district on which workable lodes have been developed.

Anderson Claim

"A lode claim adjoining the General Joffre claim, of the Tungsten Hill group, is owned by Charles Anderson. On this claim a quartz stringer striking N. 50° E. and dipping 55° NW. has been exposed in an open cut. The foliation of the country rock, which is largely a mica schist, strikes N. 60° E. and dips 20° NW. Scheelite is reported to be present along the outer edges of this quartz vein, but none is reported either inside the vein or in the adjoining country rock. It is likely that this quartz vein was formed first, and that at some later time the scheelite-bearing solutions percolated upward along the sides of the quartz and deposited scheelite in its present position.

Blossom Group

"The Blossom group consists of several claims belonging to Victor Lundbled and Charles Anderson at the extreme head of Engineer Creek.

"A shaft on the Blossom claim is said to have exposed a rich stringer of scheelite, but this was not visible on account of timbering in the shaft. A granite porphyry dike is present in the bottom of the shaft.

"At another claim of the Blossom group a shaft 20 feet deep has been sunk, opening a scheelite lode 3 to 4 feet in thickness. This is another lode of the stringer type, but a thin quartz veinlet a short distance from the shaft was reported to carry 40 percent of tungsten."

Interest in these claims was revived in 1942, but little was done other than staking new claims. The present (1947) ownership of the groups of claims is not known; however, in 1942, L. D. Colbert, Roy Maddock and Al Goodwin of Fairbanks are reported to have made claim locations in the area.

OLD GLORY PROSPECT

Location

The Old Glory tungsten prospect is in Interior Alaska at latitude 65° 01' 08" north and longitude 147° 34' 36" west as shown on figure 2. It is near the head of Seattle Creek, a headwater tributary of Dome Creek in the Fairbanks Mining District, and it is approximately 15 miles north of

Fairbanks and 2 miles from Elliot Highway. A trail paralleling the U. S. Smelting, Refining & Mining Co., power line, which passes by the head of Seattle Creek, lies within 1,000 feet of the prospect.

The Old Glory Lode claim, which is approximately 600 feet by 1,500 feet, was staked and is held by Robert Leslie of Fairbanks, Alaska.

General Information

The Old Glory prospect is exposed at one place along its strike. A trench has been bulldozed through 7 feet of overburden and into weathered schist bedrock; a small pit sunk at the bottom of the trench exposed a 3-foot zone of finely disseminate scheelite. This zone strikes N. 44° E. and dips 45° to the southeast.

Considerable trenching would be necessary to expose the mineralized zone along the strike. Inasmuch as the mineralized zone was exposed at only one place, sampling was confined to this pit and trench. Three channel samples normal to the strike and dip were cut across the mineralized zone, and two channel samples were cut from the foot and hanging-wall rock. A chemical analysis was not made of the samples, but after an examination with a mineralite it is estimated the zone contains about 0.5 percent tungsten trioxide.

OTHER TUNGSTEN OCCURRENCES IN INTERIOR ALASKA

In 1942 and 1943 the Alaska Department of Mines prepared reports[8/] on strategic mineral occurrences in Interior Alaska. Mention is made of tungsten occurrences as follows:

"Placer Tungsten

"Scheelite probably occurs more commonly in Interior Alaska placers than is generally supposed.-----About a third of the samples of placer concentrates collected during 1942 contained scheelite, as listed in the following table. The terms abundant, common, scarce, and rare indicate the relative amounts of scheelite found in the concentrates and not in the original placers.

"Occurrences of placer scheelite in Interior Alaska

District	Location of occurrence	Relative abundance	Source of information
Bonnifield	Little Moose Creek	Scarce	Dept. of Mines
	Lower Eva Creek	Scarce	Dept. of Mines
Circle ...	Half Dollar Creek	Common	Dept. of Mines
Fairbanks.	Cleary Creek, above Bedrock Creek	Abundant	Dept. of Mines

8/ Joesting, Henry R., Strategic Mineral Occurrences in Interior Alaska, March 1943: Territorial Dept. of Mines, Pamphlet 2, pp. 19-24.

District	Location of occurrence	Relative abundance	Source of information
	Dome Creek, above Seattle Creek	Abundant	Dept. of Mines
	Upper Fox Creek	Abundant	Dept. of Mines
	Willow Creek	Abundant	Dept. of Mines
Fortymile.	Fortyfive Pup, trib. Buckskin Creek	Common	Dept. of Mines
	Jack Wade Creek	Scarce	Dept. of Mines
	Chicken Creek	Scarce	Fred Purdy
	Meyers Fork	Scarce	Fred Purdy
	Stonehouse Creek	Scarce	Fred Purdy
Koyukuk ..	Lake Creek	Rare	Dept. of Mines
Ruby	Midnight Creek	Rare	Dept. of Mines
	Trail Creek		Toivo Rae
Talkeetna.	Dutch Creek	Common	Kenneth Wier

"A sample of jig concentrates submitted by Don Gustafson from the Red Top mine in the Kantishna district consisted mainly of scheelite. Placer scheelite is said to occur in creek gravels in the vicinity.

"Considerable wolframite was found by William Burns, former Territorial assayer, in a sample of placer concentrates from Steele Creek, in the Livengood district. The identification was made a number of years ago."

In describing tungsten lode occurrences in the Fairbanks district Joesting states:

"Tungsten lodes in which scheelite is the chief ore mineral have been found in three areas in the Fairbanks district. They are: (1) The area at the head of Gilmore and Yellow Pup Creeks known locally as Gilmore Dome; (2) the area at the heads of First Chance, Engineer, and Steele Creeks, generally called Tungsten Hill (shown on fig. 2 as the Spruce Hen, Columbia, Tanana and Blossom groups); and (3) the Pedro Dome area.

"Little prospecting has been done in the Tungsten Hill area since about 1918, when a larger number of pits and shafts were sunk. Several years ago a small dragline cut was made by Robert Heath and Louis Colbert, but this has now caved. All of the old pits and shafts are inaccessible, but the locations of mineralized zones may be inferred from material remaining on the dumps. A number of specimens of high-grade ore - one containing 8 percent WO_3 - were found on some of the old dumps. Several shafts were apparently sunk on small quartz veins. Some of these veins carry considerable scheelite, but they are apparently too small to be of

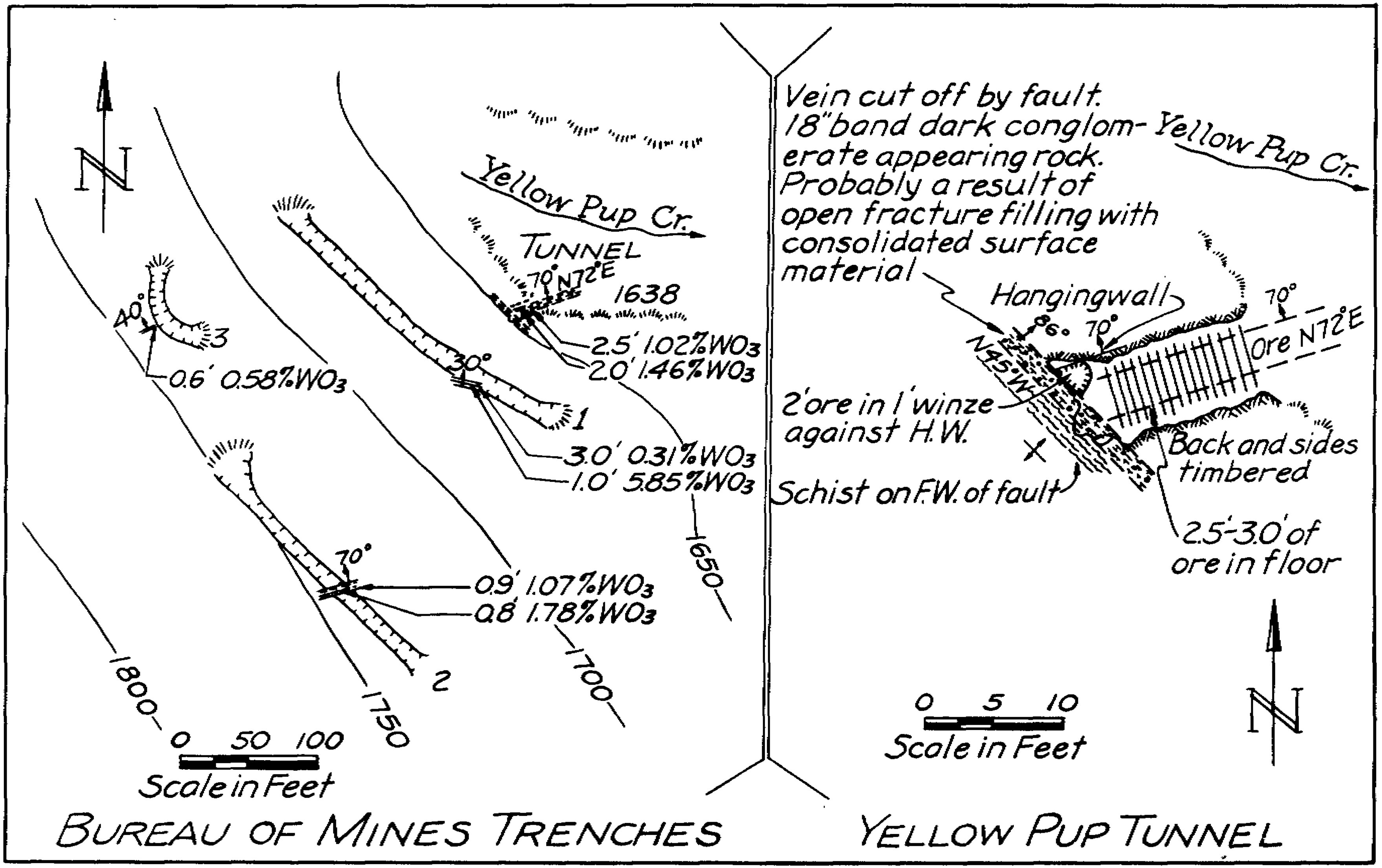


Figure 5. - Yellow Pup surface and underground exploratory work.

commercial importance. Possibly the veins intersect calcareous beds and form larger ore shoots by replacement, as on Gilmore Dome.

"In the Pedro Dome area, several scheelite prospects were found during 1942. One was found by Dan Eagan and associates on the west side of Twen Creek at Mile 18 on the Steese Highway. Scheelite occurs here in several small stockworks of quartz stringers cutting fine-grained quartz diorite. It is also found sparingly in the quartz diorite near the quartz stringers. Some surface work was done during the fall of 1942, and a tunnel was run 30 feet into the hillside during the following winter. Where exposed, the ore in the stockworks is below commercial grade.

"A second prospect was found by Bob Leslie and Frank Hawks at the head of Seattle Creek, and some work was done by Duane Franklin and partner. A trench was bulldozed through several feet of overburden and into the weathered schist bedrock. A small pit was then sunk in the bottom of the trench to a total depth of 8 feet below the surface. Exposed in the trench was a 3-foot zone of finely disseminated scheelite containing a few small, high-grade spots, and with an estimated average WO_3 content of 0.5 to 1 percent. Fine-grained quartz diorite was also exposed in the bottom of the pit. Because it was made when the ground was covered with snow, a thorough examination of the prospect was not possible.

"A third prospect is reported to have been found by Ed Verdin in a placer cut at the head of Fox Creek. It has not been examined by the writer. Bedrock is said to be badly weathered, so that relations are obscure. A sample of placer concentrates obtained from a cut nearby consisted mainly of scheelite of the variety that fluoresces pale yellow, thereby indicating that an appreciable amount of molybdenum is present.

"Geologic Features

"Most of the scheelite deposits of the Fairbanks district are found in calcareous beds in the schist, which is the predominant country rock. Mineralization was apparently effected by tungsten-bearing solutions expelled from underlying granitic rocks; these solutions reacted with the calcareous rocks, replaced much of the calcite, and deposited scheelite and associated gangue minerals. Noncalcareous schists adjacent to the ore were unaffected by the mineralizing solutions, although occasional small scheelite-bearing quartz veins are found in them.

"Several granitic intrusions are known, around which scheelite deposition has taken place. One is the mass of porphyritic granite that outcrops in a 2 by 8 mile area between Pearl Creek on the east and upper First Chance Creek on the west. Near the east end of the granite are the Gilmore Dome deposits, whereas at the west end are those of Tungsten Hill. Other instrusions near which scheelite deposits have been found are in the Pedro Dome area. Quartz diorite is the chief intrusive rock type in this area, but there are also several smaller intrusions of porphyritic granite, as well as a number of granitic dikes. Most of the intrusions are elongated east-west parallel to the regional strike of the schist.

"Although many of the higher-grade deposits are found some distance from the nearest known granitic contacts, the genetic relationship between the scheelite and igneous rock is indicated by the frequent occurrence of sparse disseminations of scheelite in sills and dikes that are offshoots of the main intrusion. Scheelite has also been found in small quartz stringers in the igneous rock."

LODE DEPOSITS OF THE NOME AREA

In 1916, J. B. Mertie, Jr., of the Geological Survey,[9] examined tungsten lode deposits on Seward Peninsula and reported as follows:

Sophie

"The property known as the Sophie lode, on Sophie Gulch, a tributary of Rock Creek, consists of one patented placer claim and two lode claims. Residually weathered tungsten ore was mined here by placer operations in 1916---."

"The country rock at this place is an iron-stained, thin-cleaving, foliated mica schist, the cleavage of which, measured at one place in the pit, strikes north and dips 23° E. It shows, also, a vertical jointing trending N. 35° W. Many well-developed fissures are present, striking N. 45° E. and nearly vertical or dipping steeply to the northwest. These are filled with iron-stained, shattered quartz. Such veins range in thickness from a fraction of an inch to a foot or more. There is great irregularity in these quartz stringers, most of them thickening in places and thinning in others; also, stringers run out into the country rock. Iron-stained fault planes striking N. 18° W. and dipping 54° E. cut both the country rock and the quartz stringers, and along these there is little or no quartz but considerable iron-stained gouge material.

9/ Mertie, J. B. Jr., Lode Mining and Prospecting on Seward Peninsula: U. S. Geol. Surv. Bull. 662, 1918, pp. 436-437.

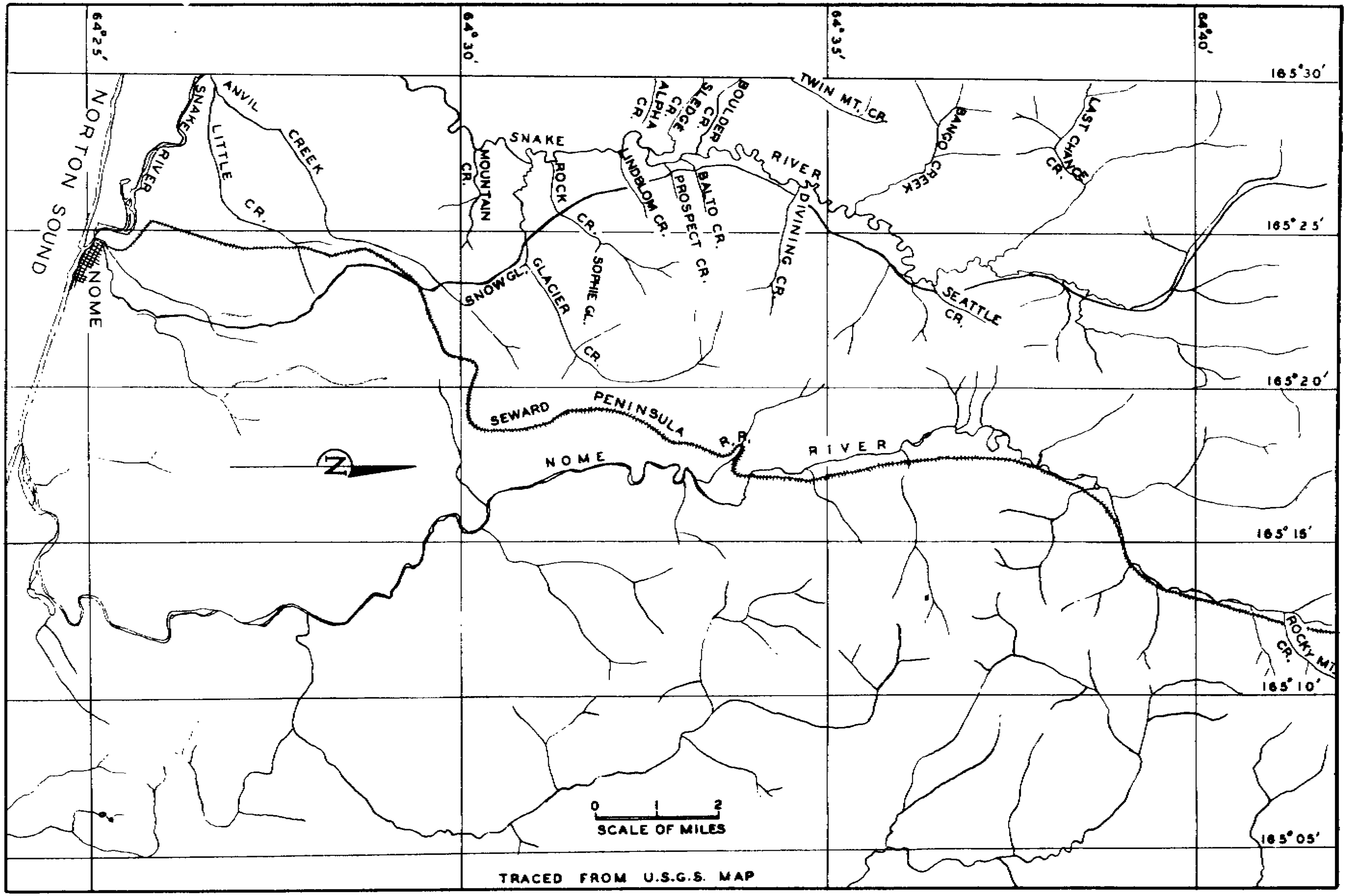


Figure 5-A. - Map of Nome area showing stream location of placer and lode scheelite.

"The scheelite occurs for the most part along the sides of quartz stringers and disseminated in the mica schist. Locally the scheelite is present in the quartz. It is reported that gold occurs in the iron-stained schist outside of the zone of scheelite mineralization, but no gold is reported to have been found in the scheelite-bearing rock. Besides scheelite, however, arsenopyrite, pyrite, and galena are found in the form of later veinlets definitely cutting the quartz.

"It is said by the owners that the belt of scheelite mineralization is about 50 feet wide and has so far been traced about 500 feet in each direction from the open cut. The trend of this zone appears to be that of the iron-stained quartz veins and stringers---that is, about N. 45° E. The northwest side of the lode is reported to carry more scheelite than the other side. Two shafts--one 32 feet deep, northeast of the open cut, and the other 28 feet deep, southwest of the cut-have been driven to ascertain the value of the ore along the lode. It is said that these shafts show a higher content of scheelite in depth than at the surface.

Miscellaneous Localities

"Several other small tungsten lodes in Seward Peninsula have been worked by placer-mining methods. These include the lode on Twin Mountain Creek, the Lynx claim, on the north side of Glacier Creek, and another small lode on the divide between Glacier and Rock Creeks."

Lost River

The Lost River tin mine on Cassiterite Creek, a tributary of Lost River, in the York district, is a potential source of tin and tungsten. Wolframite, an iron-manganese tungstate, and cassiterite are constituents of three types of deposits, as follows: the Cassiterite dike, 0.56 percent Sn and 0.18 percent WO_3; the granite ore zone, 1.27 percent Sn and 0.287 percent WO_3; and a very large contact metamorphic zone, 0.25 percent Sn and 0.03 percent WO_3. The Bureau conducted extensive investigations at Lost River from 1942 to 1944 and reported the results of this work in R. I. 3902, "Investigation of the Lost River Tin Deposit, Seward Peninsula, Alaska."

PLACER DEPOSITS OF THE NOME AREA

Location

The Snake and Nome Rivers in the Nome region on Seward Peninsula are easily accessible from Nome by gravel roads or the Seward Peninsula Railway on Nome River. Figure 5A shows the location of streams from which scheelite-bearing gravels were mined.

History

The presence of scheelite in many of the streams in the Nome region was reported by Moffit[10] in 1905 and 1906. Scheelite remained in the sluice boxes or pans and caused trouble in cleaning the gold.

J. B. Mertie, Jr.,[11] reported that in 1916 the Pioneer Mining Co. on Sophie Gulch mined 4,000 to 5,000 cubic yards and produced a large part of the scheelite mined in Alaska in 1916.

Placer-mining operations for scheelite also were pursued on Rock and Glacier Creeks. In 1916 other gold-placer operators started saving the scheelite recovered from their operations.

Approximately 47 tons of tungsten concentrate, mainly scheelite but including a little wolframite, was produced in Alaska during 1916.

Several prospectors were searching for scheelite in 1942. In recent years no attempt has been made to save scheelite in gold placer operations.

Physical Features

The portion of the Snake River visited by Heide in the summer of 1942 lies in a flat valley about 1-1/2 miles wide, through which the river meanders in a southerly direction. In the vicinity of Glacier Creek, drilling has shown the bedrock to be over 100 feet below the surface. Surface elevation is approximately 100 feet above sea level. Mining the river gravels would require the use of dredges with exceptional digging capacity. Tributaries on both sides of Snake River extend easterly or westerly for a few miles into the hills forming the drainage system.

Ore Deposits

The following tributaries of Snake River have shown notable amounts of scheelite in past gold dredging operations:

Anvil Creek, for three-quarters of a mile near its upper end, was dredged to a width of about 250 feet. Appreciable amounts of scheelite were found in this portion of the stream and were discarded in the tails. Depth of gravel was reported as approximately 14 feet. A stream of water flows all season.

10/ Moffit, F. H., Geology of the Nome and Grand Central Quadrangles, Alaska: U. S. Geol. Surv. Bull. 533, 1913, p. 134.

11/ Mertie, J. B., Jr., Placer Mining on Seward Peninsula: U. S. Geol. Surv. Bull. 662, 1918, p. 457.

Snow Gulch was mined hydraulically for 3,000 feet. It was worked for a width of about 150 feet and a depth of 6 feet. Snow Gulch is dry, but the United States Smelting, Refining & Mining Co. ditch crosses its head.

Glacier Creek was dredged for about 1 mile for a width of 300 feet. Mining depth was reported to average 12 feet. Running water is available throughout the working season.

Rock Creek gravel is known to contain scheelite for a length of 1-1/2 miles. The gravel is 200 to 300 feet wide and about 12 feet deep. A portion of the length has been mined hydraulically. Running water is available throughout the working season.

Between Rock Creek and Balto Creek are two dry gulches - Lindblom and Prospect Creeks - about 1/2 mile long, 25 feet wide, and 4 to 5 feet deep.

Balto Creek gravel is 25 feet wide and 4 to 5 feet deep for half a mile. No information was obtained on whether water flow was constant or intermittent.

Sledge Creek gravel is 50 feet wide and 5 feet deep for a length of half a mile. Running water is available throughout the working season.

Boulder Creek gravel was mined hydraulically for four claim lengths below the mouth of Twin Mountain Creek. At the mouth of Twin Mountain Creek, the Boulder Creek gravel is about 100 feet wide and 10 feet deep. Three claims downstream it is 300 feet wide and 25 feet deep. Virgin gravel remains downstream from the hydraulicked portion, where the gradient was too flat for hydraulicking. Running water is available throughout the working season.

Twin Mountain Creek is tributary to Boulder Creek. The gravel was mined hydraulically for about three claim lengths. A portion of Twin Mountain Creek was worked for scheelite as well as gold. It is uncertain what portion of the gravel may still contain scheelite. Running water is available throughout the working season.

Bangor Creek gravel was dredged for about 1-1/2 miles in 1921. The deposit was dredged for 200 feet to depths of 10 to 18 feet. Running water is available throughout the working season.

Butterfield Creek, at the head of Bangor Creek, also was worked. No other information was obtained on this creek.

Divining Creek gravel is virgin ground for three-quarters of a mile. The width of this deposit is 125 feet and the depth ranges from 5 to 6 feet. Scheelite content and water flow are unknown.

The Ore

Most of the foregoing creeks have already been exploited for gold. Insofar as is known, scheelite is the only other valuable mineral remaining in the tails. Lindblom, Prospect, Balto, and Divining Creek gravels have not been mined and are reported to carry small amounts of gold. During past gold placer operations, scheelite in concentrates was generally considered a nuisance, and few records of its value were kept.

The examining engineer was unable to obtain reliable reports on scheelite content of the gravel. Various conversations were held with officials of the United States Smelting, Refining & Mining Co. and with individuals who were prospecting for scheelite in 1942, as a result of which it appears possible that the scheelite content may range from 1/2 pound to 2 pounds per cubic yard. The lower figure is probably closer to the average. The higher figures were reported from prospects on Prospect and Balto Creeks.

Scheelite concentrates seen by the Bureau of Mines engineer contained 10 to 20 percent impurities, chiefly garnet, magnetite, and other unidentified minerals. Some of the impurities could be removed magnetically, and it is believed that a 60-percent concentrate could be shipped. Scheelite particles in the concentrate were slightly rounded grains ranging in size from about 10-mesh to 1/2 inch diameter. Gravel was commonly composed of schist and quartz. Few boulders over 2 foot in diameter were noted.

WILLOW CREEK DISTRICT

Scheelite in small amounts has been found at the Independence, Gold Cord, and Fern mines, all gold producers in the Willow Creek district, 15 miles northwest of Palmer, Alaska.

Independence Mine

In the Independence mine, the vein is composed of quartz and a "fill" of crushed quartz diorite. Scheelite is present in the quartz as small grains, blebs, and stringers, but it does not occur in the quartz diorite "fill." The mineral is found on the 1,100-, 1,200-, 1,230-, 1,300-, and 1,500-foot levels, but the distribution is spotty; most of the quartz is barren of scheelite.

It is found in greatest abundance in stope 1 on the 1,200-foot level, where the quartz is 18 inches thick and the ore is believed to average a few percent in WO_3. Pockets of ore as large as 8 inches in diameter and containing 50 percent scheelite were found in stoping.

The exposed vein on the 1,100-foot level shows scattered grains and short stringers of scheelite between raises 2 and 3. The mine is worked primarily for the gold, the scheelite alone being too scarce to warrant production. The principal vein minerals are quartz, scheelite, pyrite, galena, and sericite. The scheelite is often readily distinguished without the use of an ultra-violet ray lamp, because its light- to dark-brown color contrasts sharply with the milky quartz.

Gold Cord Mine

Scattered grains of scheelite occur in a quartz vein at the Gold Cord mine. In most places, the scheelite is present in insignificant amounts. The highest-grade occurrence is on the 300-foot level 70 feet from the south face, where a 2-inch quartz stringer shows, for a length of 1 foot, a scheelite content of several percent. The 350- and 400-foot levels appear to be nearly barren of scheelite.

Fern Mine

The Webfoot vein in the Fern mine shows a fairly persistent, though sparse, distribution of tungsten throughout its exposed length on the 200-foot level and in the stope between the 200- and 300-foot levels. At this mine the mineral is creamy in color and occurs in the quartz as scattered grains and stringers. In the first drift south of the 200-adit portal a stringer 8 inches long and 2 inches thick is estimated to contain 15 percent scheelite.

HYDER DISTRICT IN SOUTHEASTERN ALASKA

Location and Accessibility

The Salmon River of Hyder district is in the West Coast Range of Southeastern Alaska. Hyder is at the mouth of the Salmon River and at the head of the Portland Canal, about 135 miles north of Prince Rupert, British Columbia. Prince Rupert is the western terminus of the Grand Trunk Pacific Railroad of the Canadian National System. Hyder is 2 miles southwest of Stewart, British Columbia, which is at the mouth of the Bear River, which flows entirely in British Columbia. The international boundary follows approximately the summit of the Bear River ridge, the divide between the Bear and the Salmon Rivers. The prominent peaks exceed 5,000 feet in altitude; the highest are Mount Dolly and Mount Walker. The principal mines of the Hyder district lie in this region.

A good highway leads from Stewart to Hyder and from Hyder up the Salmon River for 11 miles, then along Cascade Creek to the Premier mine in British Columbia about 15 miles from Hyder. Hyder is a town of about 100 inhabitants. It has postal and steamship service. At present there is weekly service to Stewart by the Union Steamship Co. from Vancouver, where direct connections are made to Seattle. The Canadian boats make the trip from Vancouver to Stewart in three days. A weekly mail boat operated from Ketchikan to Hyder by the McKay Transportation Co. can carry all ordinary freight. Ketchikan is served by the Alaska Steamship Co., Northland Transportation Co., Canadian Pacific Railroad Co., Canadian National Steamship Co., and the Alaska Transportation Co.

Since the discontinuance of the Hyder Radio Co. in January 1943, the only telegraphic service is through Stewart, British Columbia.

There is only one large mine in the area, the Silbak-Premier mine at Premier, British Columbia. This mine is connected to the Stewart dock by an 11-mile aerial tramway. The communities of Hyder and Steward depend largely on the operation of the Premier mine. As a result of this operation there are stores at both Hyder and Stewart from which most ordinary items can be purchased at moderate prices. There are good living conditions in Hyder and Stewart, and during the summer months it is feasible for men to drive back and forth to the Riverside mine; some even drive to the Premier.

The Riverside tungsten mine is 7 miles north of Hyder on the east side of the Salmon River highway at latitude 56° 0' N., longitude 130° 04' W., as shown in figure 6.

The Mountain View property is at latitude 55° 59' N., longitude 130° 03' W., in the Salmon River mining district of southeastern Alaska, about 5 miles in a northwesterly direction from the town of Hyder. Vein outcrops and surface workings occur at an elevation of 950 feet and occupy the west flank of a low ridge between Skookum and Fish Creeks, as shown in figure 6. The portal of the long adit is on Skookum Creek, about 550 feet north of the confluence of Skookum and Fish Creeks.

Access to the property is over a 4-foot-wide trail built and maintained by the U. S. Forest Service. This trail is suitable for pack animals and ample for transportation of supplies and material for exploratory work.

Physical Features and Climate

The topography is characterized by steep mountains, narrow canyons, and rugged peaks. The principal streams in the Hyder district are the Salmon River, Fish Creek, Texas Creek, and the West Fork of Texas Creek. The higher elevations are covered with valley glaciers and a large ice field. The principal glaciers in the area are the Chickamin, Salmon, and Texas.

Vegetation is the dense growth typical of southeastern Alaska. Spruce and hemlock, the principal timber trees, furnish fair wood for heating purposes, but neither yields good lumber. The best fuel comes from alder, which grows in the valleys. Timber line is at 2,500 to 3,000 feet.

Temperature is variable in both summer and winter. The temperature is normally moderate, though subzero weather occurs during some of the winters. The winter of 1942-43 was one of the coldest on record. A temperature of -20° F. was recorded in January at the Riverside mine. From April throughout October the temperature is mild. The rainfall is least from April through June and increases from July through October. Snow falls from November through March and is heaviest during December and January.

The Riverside mine surface plant is 300 feet above sea level.

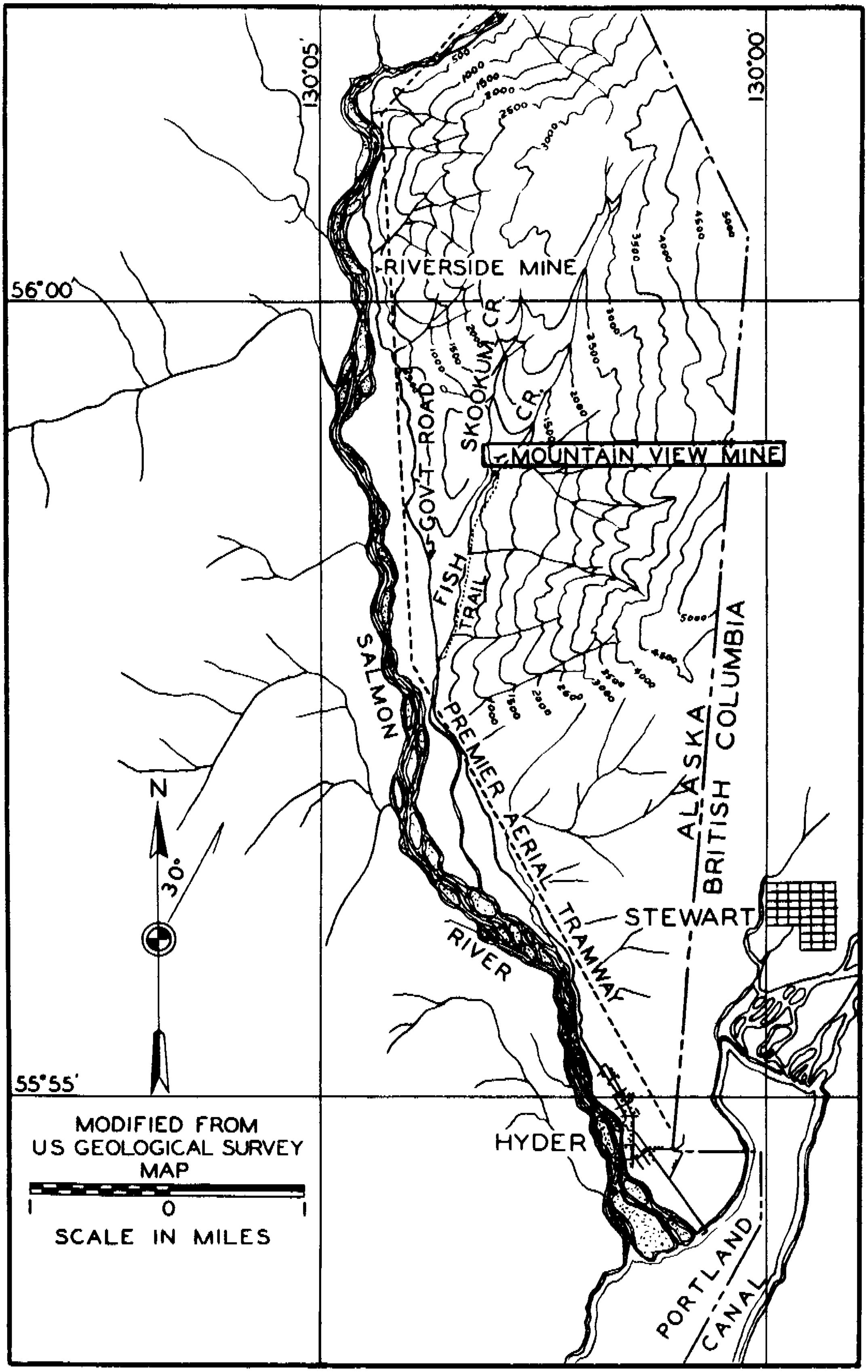


Figure 6. - Hyder and vicinity.

History and Production

The first discovery of mineral in the Salmon River or Hyder district was on the Bear River at Stewart in 1898 by early placer miners. The first record of any mining on the Alaska side was in 1901 on the Salmon River. Mining operations were limited until a small boom occurred in the area during 1909, but real interest in the district did not occur until the opening of the rich gold-silver deposits at Premier, British Columbia, in 1918. Activity was then intensified in both Alaska and British Columbia. In 1923, after a forest trail was built up the West Fork of Texas Creek, a number of claims were staked and considerable development work was done in that area, chiefly for lead, silver, and gold, though some molybdenum claims were staked. The Big Missouri mine was located above the Salmon Glacier in British Columbia.

The Riverside mine and a number of other properties along the Salmon River became active in 1924. By 1925 over 5,000 feet of development work had been completed and a 50-ton mill, with flotation unit and tables, had been erected at the Riverside. It is reported that during this time 218 tons of lead-silver-gold concentrate was shipped. There was a small leasing operation at the Riverside in 1928.

With the drop in the price of silver in that year, activity began to decrease, and by 1932 the camp had almost reached its present status, a nearly abandoned mining community. The only operations to persist have been those of the Silbak-Premier and the Riverside, the latter operating intermittently on a small scale.

The Riverside mine was examined by Durant Hill of San Francisco in 1940 for the J. H. Scott Co., which did some developing during the fall and winter of 1940-41. The flow sheet was changed to adapt the mill for scheelite recovery. During the summer of 1941 the owners reported milling 3,400 tons of ore, which came from the northwest drift stope, the sublevel stopes, intermediate level stopes, and the Nos. 1 and 2 stopes in the upper tunnel level. Thirty tons of scheelite concentrate containing 44 percent WO_3 was produced from this ore. This concentrate was shipped to the General Electric Co. in June 1942. The operators also recovered 49 tons of galena concentrate, which was shipped to the Bunker Hill and Sullivan smelter at Kellogg, Idaho. The reported content of this concentrate was 68 percent lead, 31 ounces silver, and 1.1 ounces gold a ton. From the available data, it is estimated that the ore mined averaged about 1.3 percent WO_3, 1.0 percent lead, 0.5 ounce silver, and 0.01 ounce gold a ton, and sand tailings carried about 0.1 percent WO_3.

About 1,800 tons of slime tailings were impounded during the 1941 operation. Approximately 1,300 tons of these tailings, together with 100 tons of mined ore, were milled during the summer of 1942. Considerable test work was carried on to develop a suitable flow sheet in the mill; however, according to the company's reports, 36.6 tons of 10.15-percent WO_3 concentrate was shipped in October 1942 to the General Electric Co.

During the summer of 1942, the mill operated intermittently and demonstrated a capacity of about 1 ton an hour.

The Mountain View property was discovered in 1917 by John Hovland. In March 1924, a group of Ketchikan businessmen obtained an option on the Hovland group of five claims. On July 15 of that year, the Mountain View Gold Mining Co. was incorporated under the laws of Alaska for the purpose of exploring and developing the property. License fees have been maintained, and the corporation, although almost dormant, is still intact.

From 1924 to November 1, 1928, the property underwent active development. Under the supervision of Arthur O. Moa, general manager, a camp was constructed, a hydraulically operated power plant and compressor were installed, a 4,000-foot aerial tramway to the Salmon River Highway was built, the surface was trenched and mapped, and over 4,000 feet of crosscut and drift were driven. In addition, the original five claims plus two additional claims were patented, and payments on the property were completed. The Gray Copper vein, on which the Bureau of Mines later undertook exploration, was explored by driving the adit in December 1927, but little drifting was done on the vein at that time, as the presence of scheelite was unknown. Operations were suspended November 1, 1928, and, aside from limited repair work, no further development has been carried on by the Mountain View Gold Mining Co.

No ore has been shipped from the property, nor has any appreciable amount of ore been stock-piled on the dump, as most of the development work consisted of crosscuts.

RIVERSIDE MINE

Property and Ownership

The Riverside mine is owned by Strong & Black of Seattle and is under option to J. H. Scott Co., Merchants Exchange Building, San Francisco, Calif. The plant and equipment are owned by the J. H. Scott Co. There are 10 patented claims in the Riverside group.

General Geology

The country rock is the Texas Creek granodiorite of the West Coast Range batholith.[12] Bands of Hazelton rocks are included. The Hazelton group comprises greenstone, tuff, volcanic breccia, graywackes, slate, argillite, quartzite, and occasionally some limestone. The granodiorite and the shear zones are cut by dark malchite, lamprophyre, and monzonite dikes. The dike rocks are post mineral in age and apparently have no bearing on deposition of the ore. These dikes strike in a northerly direction and dip to the west at about 65 degrees. The marked shearing has occurred over a length of several thousand feet and ranges in width from 50 to 100 feet. Folding within the zone has been noted. The principal shear zone is known as the Lindeborg. On the footwall side of the zone a gneissoid granodiorite is first encountered, which passes into gneiss and schist. On the hanging-wall side, granodiorite porphyry is generally encountered.

12/ Buddington, A. F., Geology of Hyder and Vicinity, Southeastern Alaska: Geol. Surv. Bull. 807, 1929, p. 13.

Occurrence of Deposits

Three veins are developed on the Riverside property - the Lindeborg, Riverview, and Cross. These veins are of the quartz fissure-vein type. The Riverview and Cross veins lie in the granodiorite, where the shearing has not been extensive, though considerable movement is shown by gouge and slickensides. The Lindeborg or main vein lies in a shear zone of gneissoid and schistose rock.

There are two types of ore occurrence. One is the narrow pyrite schist vein structure more common along the hanging wall of the shear zone; the other consists of wide, massive, white quartz containing large cream-yellow crystals of scheelite. The quartz type is not as continuous as the pyrite schist mineralization, as it widens or pinches in relatively short distances.

The scheelite is principally of a light brownish-yellow color and is rarely white. Under the ultraviolet ray lamp it fluoresces a creamy white, only occasionally a golden yellow. Very little powellite occurs.

The Riverview vein has a general strike of N. 60° W. It is parallel to the Lindeborg vein and lies about 500 feet east of it. The vein consists of quartz with some galena and pyrite. The quartz is several feet wide at the surface but ranges from 10 inches to small stringers underground for a distance of 250 feet.

The Cross vein lying between the Riverview and Lindeborg veins strikes north-south with a westerly dip of 30 to 50 degrees. Vein widths range from 6 inches to 4.5 feet both along the strike and the dip. The minerals are quartz, galena, and pyrite, with some chalcopyrite, sphalerite, and phrrhotite. The vein is traceable for 650 feet, and a large part of it, where exposed, averages 2 feet in width but pinches out as it approaches the shear zone in which the Lindeborg vein occurs.

The Lindeborg vein occurs more or less in the center of the shear zone, has an average strike of N. 50° W. and an average northeasterly dip of 65 degrees. This vein is traceable underground for 1,000 feet along the strike and for a depth of 300 feet. On the surface, the vein can be traced over 1,500 feet, and the difference in elevation between the two extremities is approximately 700 feet. On the surface and near the west end of the underground workings the quartz vein is 5 feet wide: however, the vein increases in size from a few stringers in the gneissoid and schistose rock to several feet of the mineralized material, the average width being 3 feet.

The principal minerals of the Lindeborg vein are quartz of a milky and vitreous nature, galena and pyrite in varying amounts, with some chalcopyrite, sphalerite, barite, and scheelite. Tetrahedrite has been reported, and in some places galena up to a foot in width has been found. The Lindeborg is the principal scheelite-bearing vein, though there are a few minor occurrences of scheelite in both the Riverview and Cross veins. In a number of places scheelite veinlets are several inches thick and contain large crystals. The scheelite-bearing stringers range in width from seams to as much as 10 inches. The widest occurrence of scheelite is in stope 2 on the upper level, where the quartz vein carried scheelite for a width of 6 feet. The longest ore shoot is on the upper level in what is termed, in this report, the East ore body. In this ore body the scheelite mineralization is 250 feet long; of this, the measured ore shoot is about 160 feet long. This lens extends for nearly 400 feet on the dip, as indicated by the diamond-drill holes. Smaller lenses occur in the upper tunnel level to the east, one about 25 feet in length at stope 3, one about 20 feet in length at crosscut 2, and one 20-foot lens at raise 1. Other scheelite occurrences in the upper tunnel are of minor importance.

The other principal occurrence of scheelite is in the West ore body in the Mill tunnel level. This lens extends along the strike for about 90 feet and on the dip for about 100 feet. This is a narrow ore shoot, but it has possibilities of a downward extension that would justify further exploration.

There are several minor occurrences of scheelite in narrow stringers in the southeast drift of the Mill tunnel level.

Scheelite occurs in the sublevel and in the intermediate level in a divided vein, one on the hanging wall and one on the foot-wall side of the shear zone. Most of the ore in this area has been mined out.

Scattered scheelite occurrences were noted in the upper surface tunnels and the open cuts along the outcrop. Mineralization has been observed over a vertical range of 700 feet and a horizontal range of 1,000 feet. With this wide distribution, there are possibilities of developing other minable ore shoots.

Work Done by the Bureau of Mines

Exploration by the Bureau of Mines began in June 1942 and was completed in March 1943.

Diamond drilling was the major function and the most important part of the work. Four surface holes totaling 1,560 feet and 37 underground holes totaling 3,100.5 feet with an over-all total of 4,660.5 feet were completed.

Underground work by the Bureau of Mines consisted of cross-cutting and raising. Several stations were excavated at underground diamond drill sites. Three full stations were cut for diamond-drill set-ups and seven partial cut-outs for diamond drill set-ups were made. Crosscuts 1 and 2 in the upper tunnel level were driven 42 feet and 24.5 feet, respectively. These crosscuts were driven primarily to obtain favorable sites for diamond-drill exploration above and below the level; but, in addition, important geological information was disclosed. Raise 1 in the upper tunnel level was advanced 15.5 feet to disclose the limited extent of ore above the level. A total of 82 feet of underground developing was done by the Bureau of Mines.

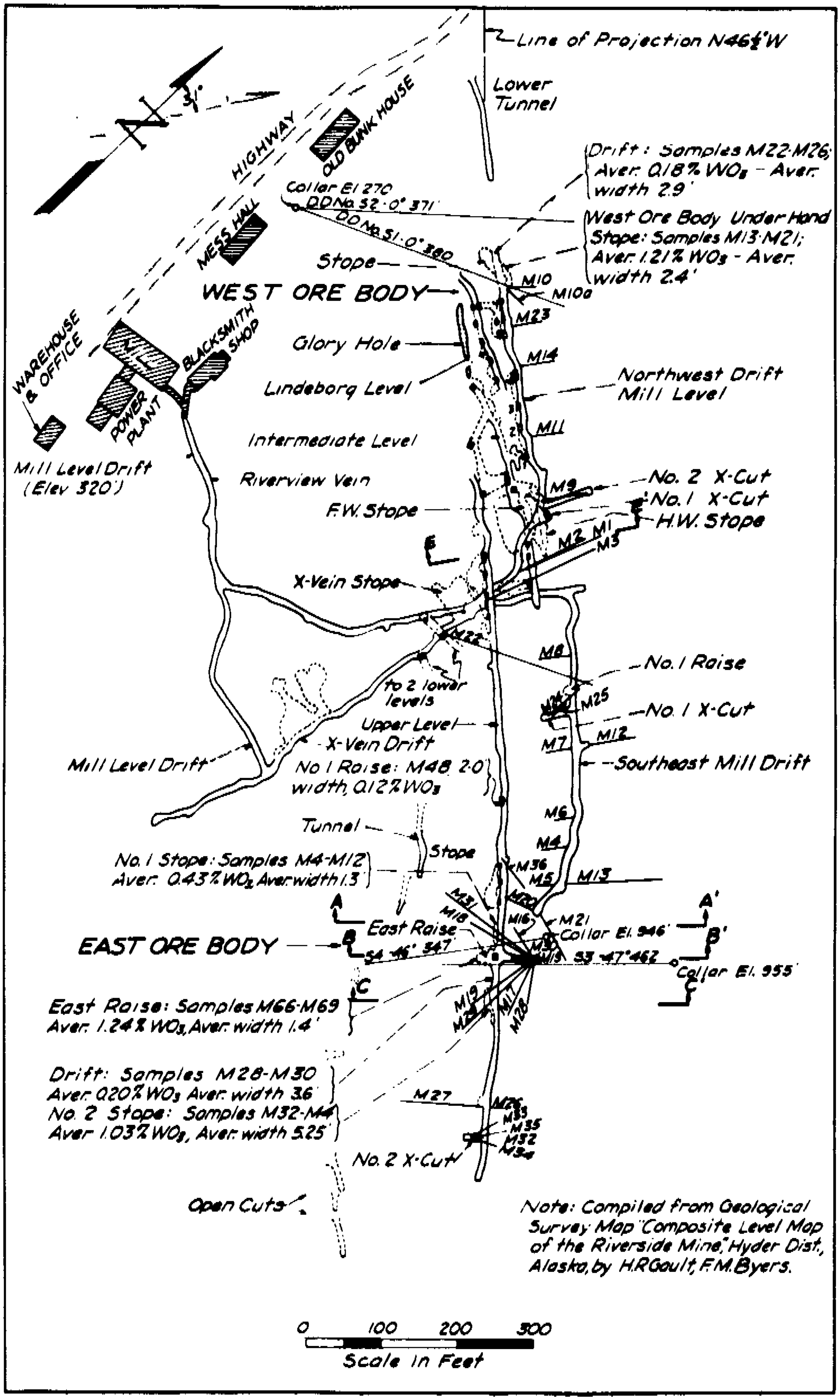


Figure 7. - Plan map of Riverside mine.

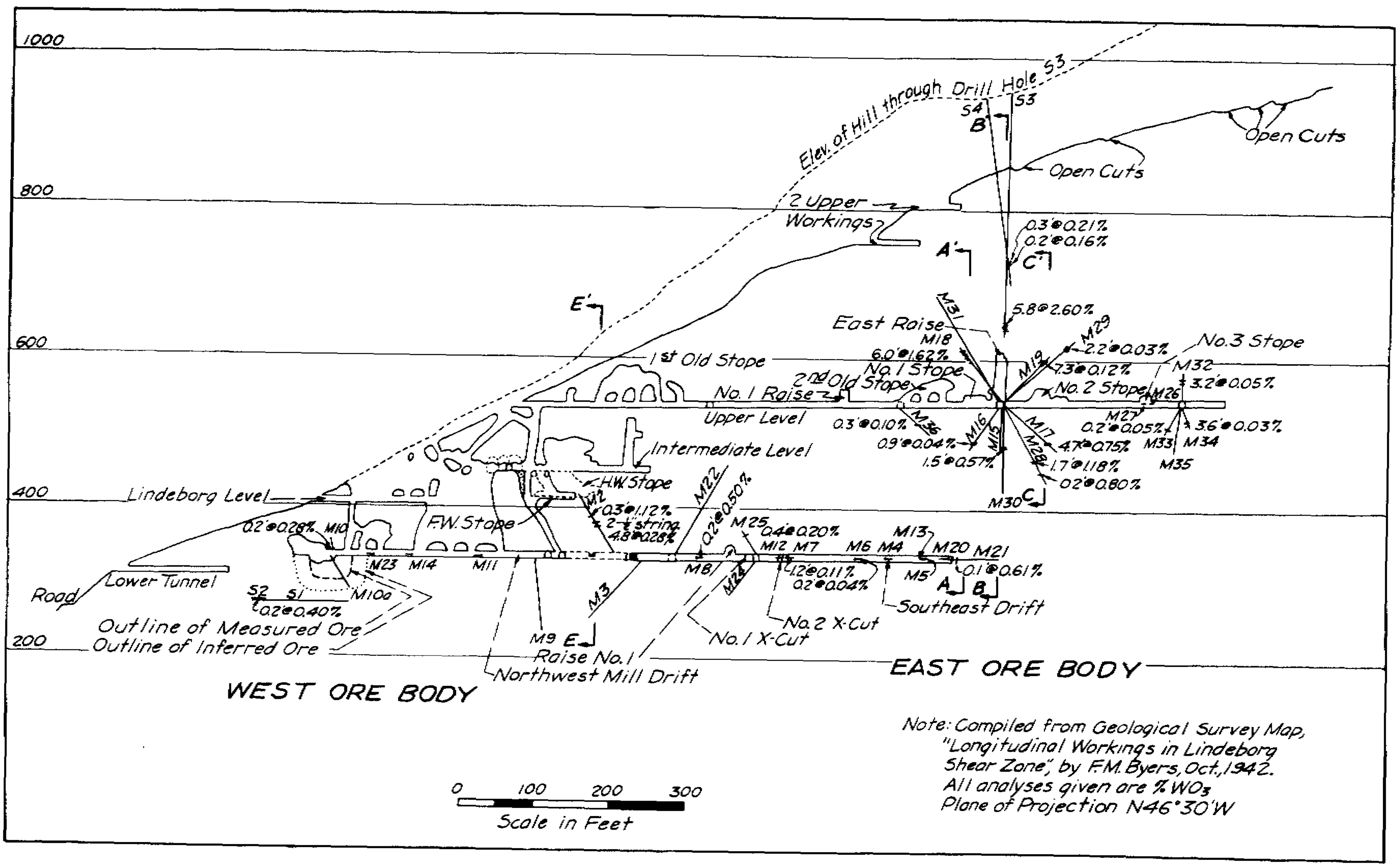


Figure 8. - Vertical projection, Riverside mine.

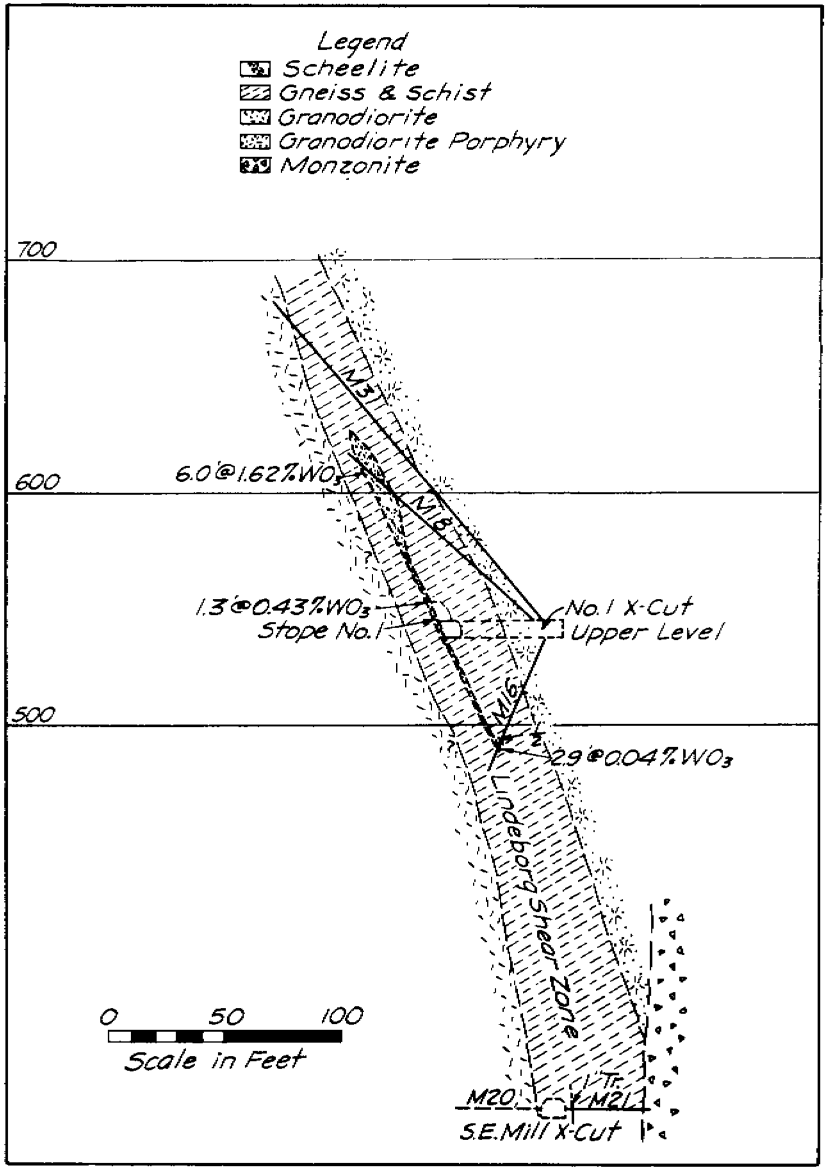


Figure 9. - Section A-A, east ore body, Riverside mine.

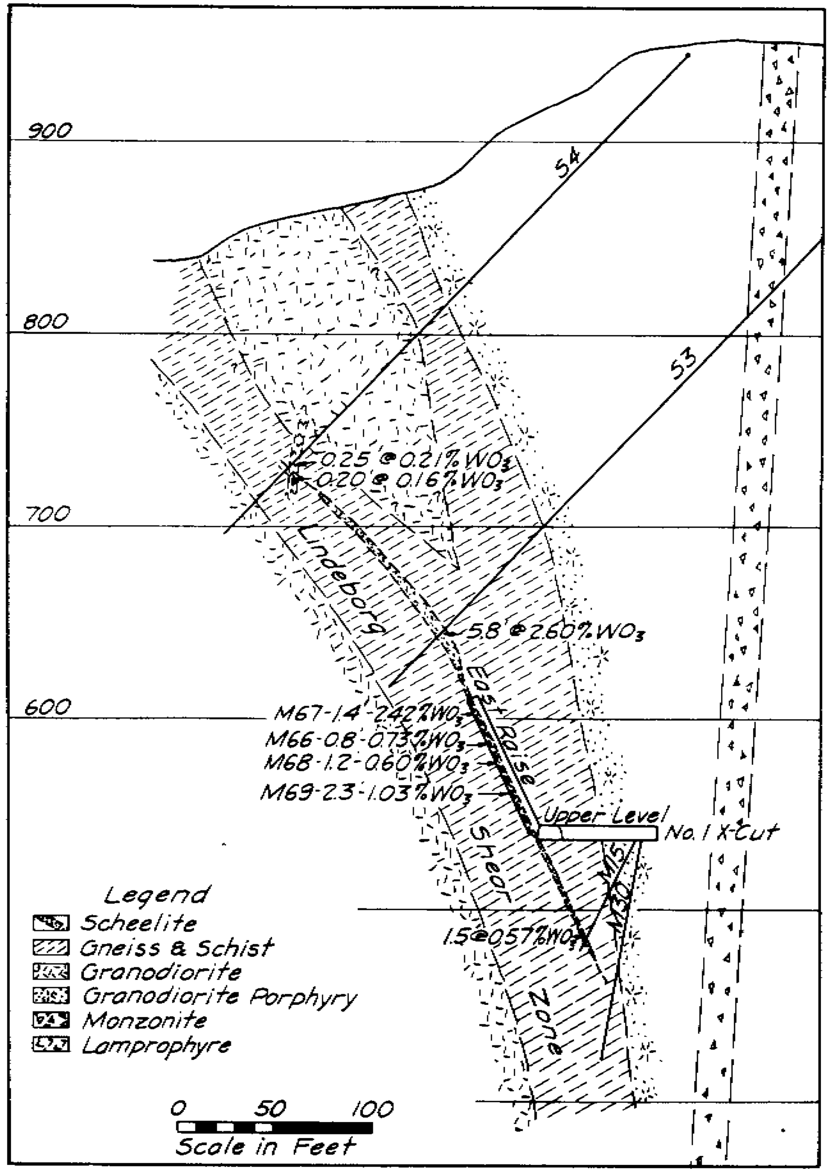


Figure 10. - Section B-B', east ore body, Riverside mine.

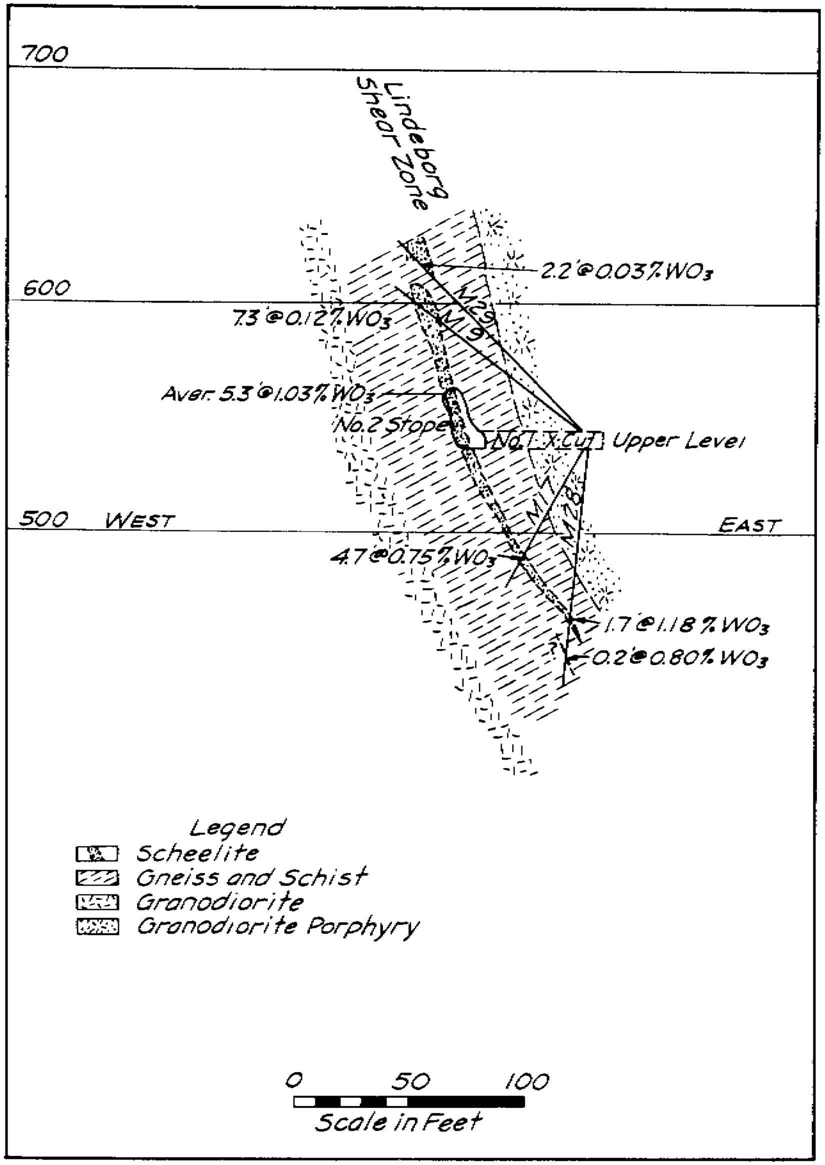


Figure 11. - Section C-C, east ore body, Riverside mine.

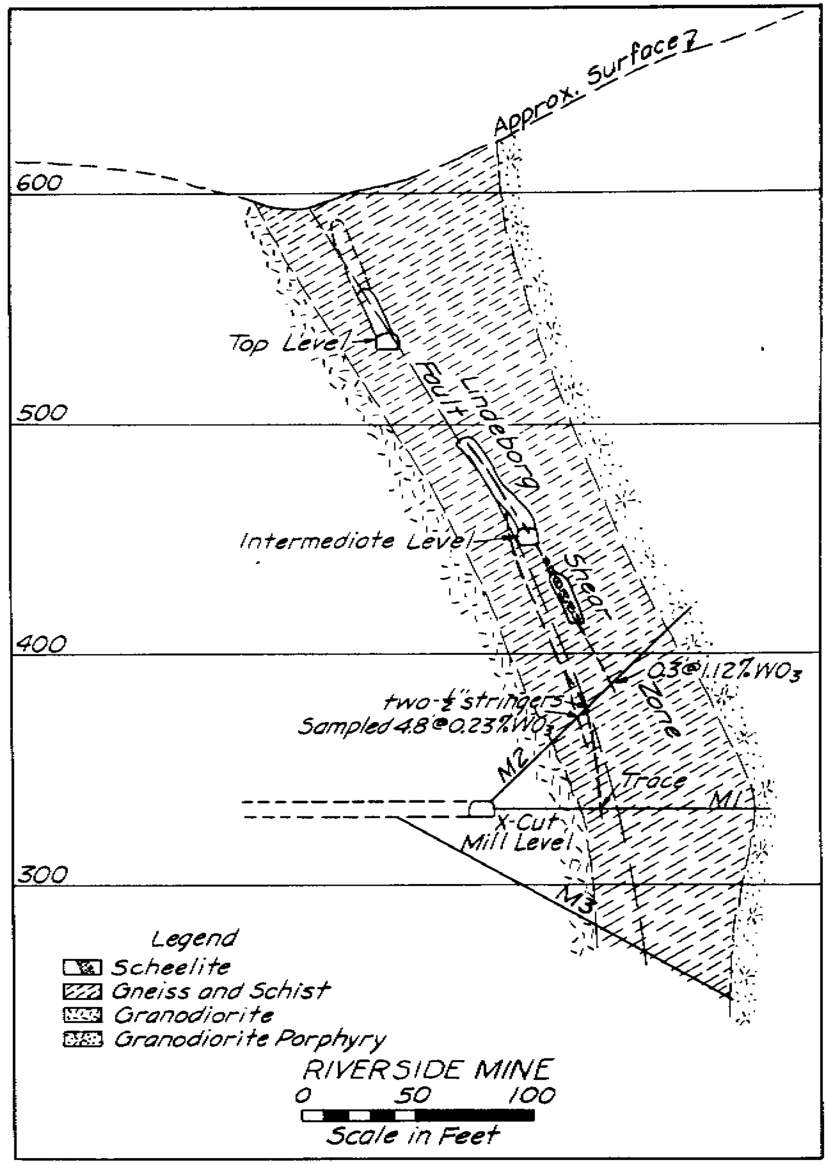


Figure 12. - Section E-E, sublevel ore extension.

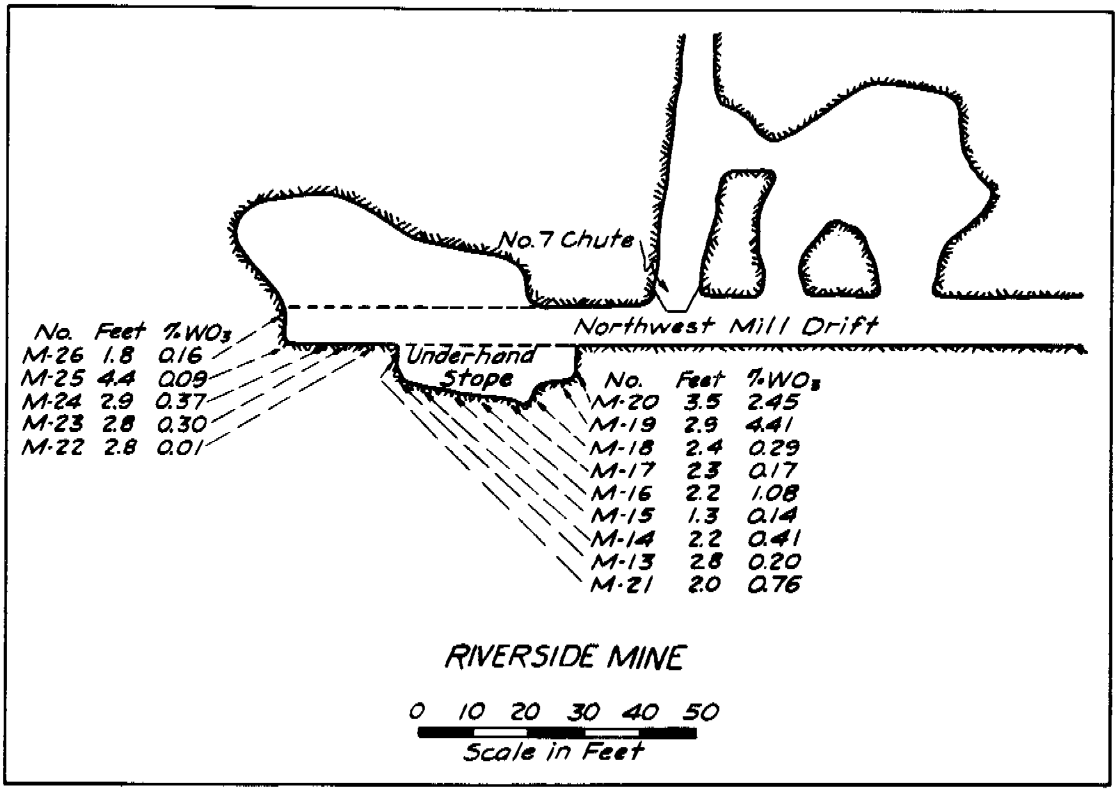


Figure 13. - Analyses, underhand stope, Mill tunnel.

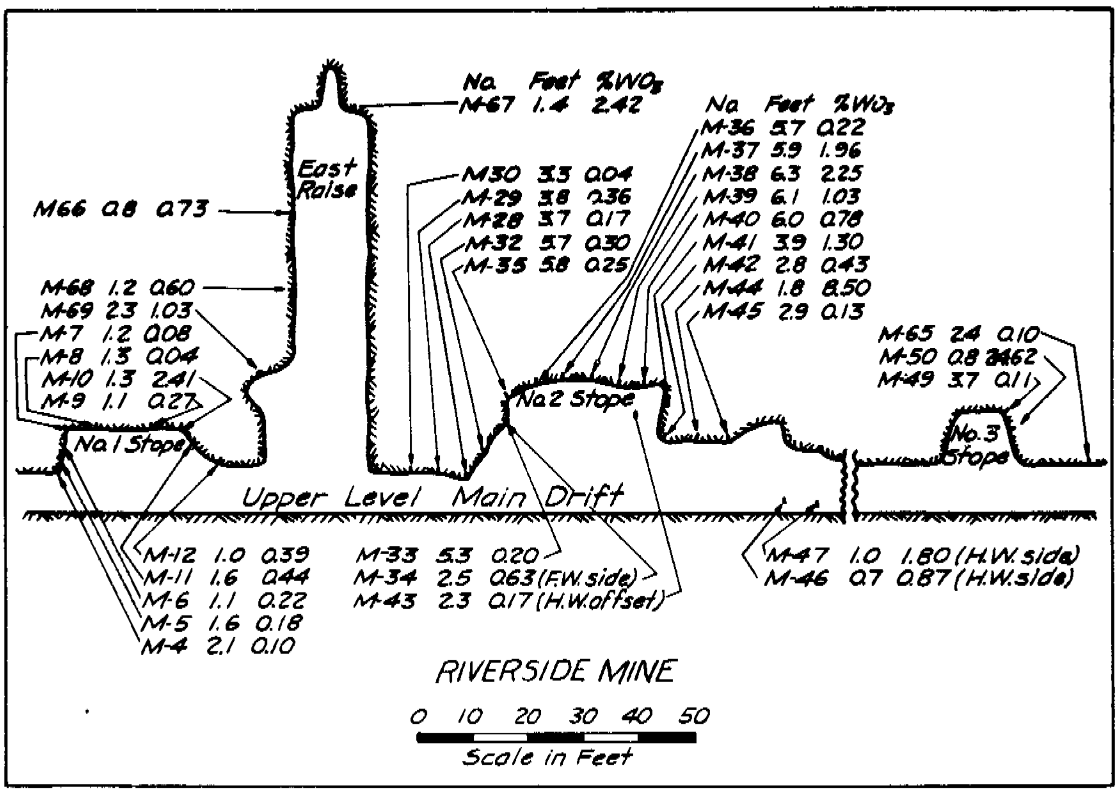


Figure 14. - Analyses, stopes 1, 2, 3, and east raise.

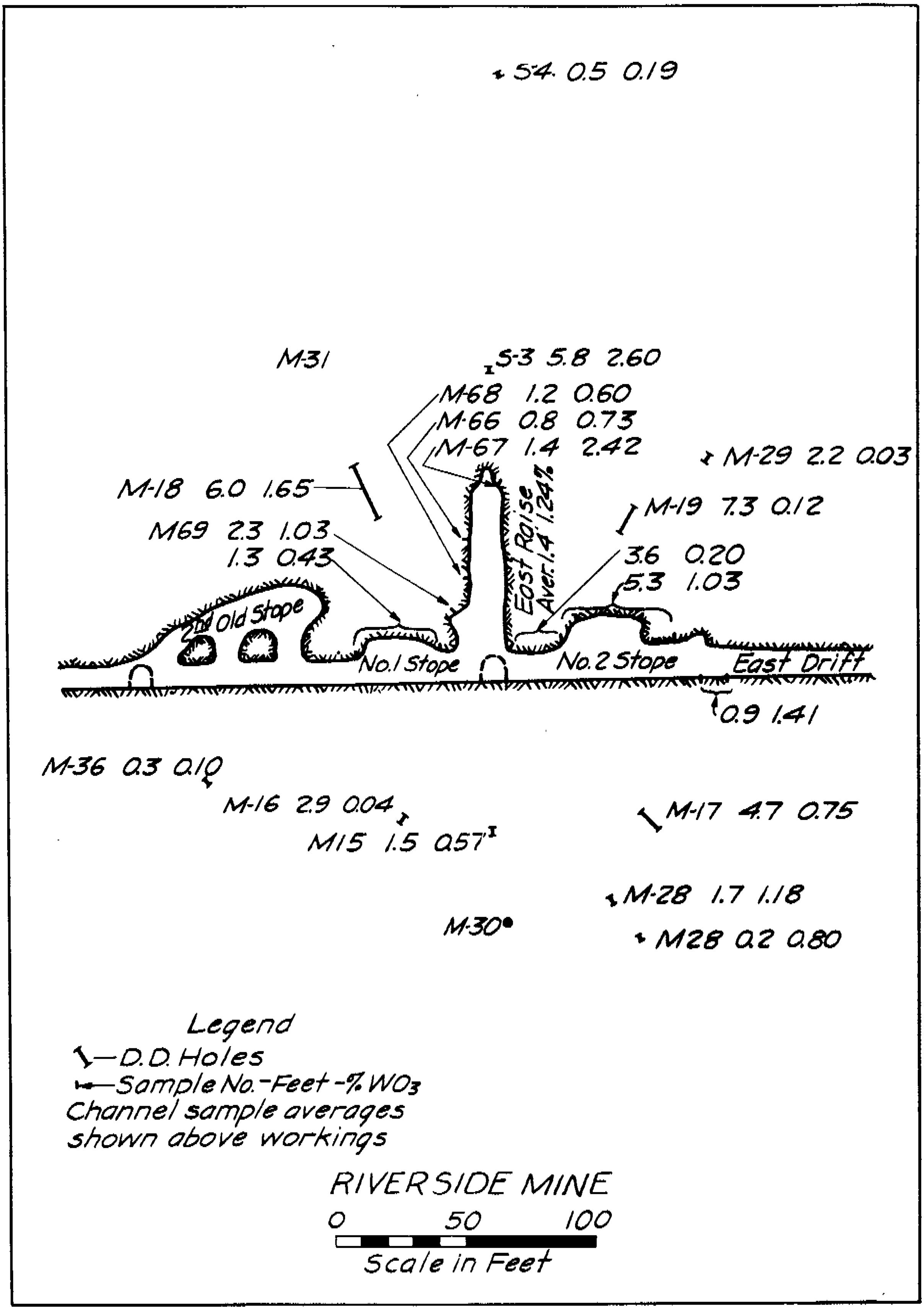


Figure 15. - Section on plane of the vein, east ore body.

In conjunction with exploratory work, it was necessary to repair ladderways, put in stull timbers and staging for channel samples, repair pipe lines, maintain trails, remove snow from roads and around buildings, and repair buildings.

Sampling and Analysis

A plan of the Riverside mine is shown on figure 7, a section through the workings on figure 8. Sections through the drill holes on the East ore body and the sublevel ore extension are shown on figures 9, 10, 11, and 12. Figure 13 shows analyses of samples taken in the underhand stope in the Mill tunnel. Figure 14 shows analyses of samples in stopes 1, 2, and 3 and the East raise. Figure 15 is a section on the plane of the vein in the East ore body.

Fifty-three channel samples were cut at the Riverside mine. Thirty-seven core samples and 47 sludge samples were taken from the diamond-drill work.

Samples of diamond-drill cores were taken only where scheelite was shown by the ultraviolet ray lamp to be present. The entire core of the intervals sampled was analyzed. Core recovery in the scheelite-bearing zone averaged better than 95 percent. Considering the good core recovery, sludge analyses were discounted except in holes M-2 and M-32. In most cases sludge recovery was low.

The true or normal thickness of the vein has been calculated for each core sample, and the weighted WO_3 content has been calculated for each hole.

West ore body. - Nine samples cut in the underhand stope in the northwest drift, Mill tunnel level, over a length of 33 feet and width of 2.4 feet, averaged 1.21 percent WO_3. West of this underhand stope, five samples were cut over a length of 20 feet and an average width of 2.9 feet. The average content of these samples was 0.18 percent WO_3.

East ore body. - In stope 1 an average of nine sample intervals showed a zone 1.3 feet wide and containing 0.43 percent WO_3. In the East raise an average of four samples over a distance of 80 feet shows a width of 1.4 feet containing 1.24 percent WO_3. In the main drift from the East raise to stope 2 an average of three samples over 18 feet shows a width of 3.6 feet containing 0.20 percent WO_3. The best ore in the mine was found in stope 2, where an average of 12 sample intervals over 46 feet shows a width of 5.25 feet of ore containing 1.03 percent WO_3. East of this stope two samples showed a 12-foot zone 0.9 foot in width containing 1.41 percent WO_3. The diamond-drill holes encountered ore in the East ore body as follows:

D. D. H.	Width, feet	Percent WO_3
S-3	5.8	2.60
M-18	6.0	1.65
M-15	1.5	0.57
M-17	4.7	0.75
M-28	1.7	1.18

The tungsten content of ore in the West ore body is close to the average of the East ore body, and an average for measured and indicated ore has been taken at 1.21 percent WO_3.

The study of the analysis values near the limits of the indicated ore body and in the diamond-drill holes outside of the limits of indicated ore demonstrates that 0.5 percent WO_3 can be considered a fair average for inferred ore.

The most pronounced lead-silver occurrence encountered in the diamond drilling was in holes M-18 and S-3. These indicated the possibility of producing a substantial quantity of lead in the East ore body. The following percentages of lead, silver, and gold were obtained from analysis of core samples in holes M-18 and S-3.

D. D. Hole	Sample	Normal thickness of vein interval, feet	Lead, percent	Ounces per ton Silver	Gold
M-18	HC 14	1.8	3.22	2.25	0.075
	HC 15	0.8	1.22	1.20	0.050
	HC 16	0.7	4.78	12.44	0.195
	HC 17	0.8	1.77	4.27	
	HC 18	0.9	6.89	3.80	
S-3	HC 33	1.9	7.00		
	HC 34	1.8	0.15		
	HC 35	2.1	5.00		

Development

The Riverside mine is developed by over 6,000 feet of underground workings. The main or Mill tunnel level is driven on the Riverview vein at an elevation 60 feet above the highway on a level with the top of the mill. Below this level are two short tunnels driven on the Riverview vein and which are now covered by the Mill-tunnel dump.

The Riverview fissure was followed for 500 feet to a point where it intersects the Cross vein. The vein pinches at 200 feet from the mouth of the tunnel and virtually disappears at 250 feet. No ore of economic value was found on this vein.

The Cross vein was developed to a depth of 250 feet below the Mill tunnel level by a winze and two levels at depths of 140 feet and 250 feet. The drifts were driven, according to the reports, north and south from this winze at these levels. The first level is reported to have some 300 feet of drifting. Stoping was carried on from these levels and from two stopes south and two stopes north of the winze above the Mill level. There are no authentic records of the production, but reports indicate that considerable high-grade lead-silver-gold ore was mined from these stopes. The present water level in the Cross vein winze is now 75 feet below the Mill tunnel level.

The Lindeborg vein has been developed by four tunnel levels, an intermediate level, a sublevel, numerous raises, crosscuts, and stopes. The lower tunnel is a 150-foot drift on the vein from a large surface outcrop in the gulch north of the bunkhouse. This tunnel is 20 feet below the elevation of the mill and 70 feet below the Lindeborg tunnel. Near the mouth of the tunnel a 2-foot quartz vein breaks up into quartz stringers and shear-zone seams within a distance of 50 feet. No scheelite was observed.

The Lindeborg vein on the Mill tunnel level is reached by the Cross vein drift and also by a crosscut driven 500 feet easterly from the drift on the Riverview vein at a point 250 feet in from the mouth of the tunnel. The shear zone has been drifted on easterly for 450 feet and west for 375 feet, with about 120 feet of work in four crosscuts. Scattered scheelite was observed in several places in the East drift. Mineralization was more prominent where the main crosscut cuts the shear zone. Several showings of scheelite in the Northwest drift encouraged exploration with the diamond drill, but no parallel veins were developed. The underhand stope of the Northwest drift in the East ore body is the most promising scheelite occurrence on this level.

From the offset crosscut at the east end of the Northwest drift an inclined raise is driven to the intermediate level, a vertical distance of 118 feet. The sublevel is at 80 feet vertically above the Mill tunnel level extending to the east of the raise. The Lindeborg adit tunnel is 76 feet above the Mill tunnel level. The upper tunnel is 202 feet vertically above the Mill level. Two fairly extensive stopes from the West drift of the Mill tunnel level were carried up to the Lindeborg tunnel on the lead-silver-gold ore during the early operations. These were extended to the intermediate level.

The sublevel shows both a footwall and hanging-wall vein from which considerable scheelite ore was stoped to a height of 40 feet above the intermediate level in 1941. This sublevel is about 100 feet in length. The hanging wall and footwall stopes are connected above the intermediate level. A small amount of ore was removed from the hanging wall stope in 1942.

East of the main raise from the Mill tunnel level, scheelite-bearing ore was mined to a height of 40 feet above the intermediate level. Fifty feet east of this stope a raise 75 feet high is in ore containing scattered occurrences of scheelite. West from the main raise on the intermediate level towards the surface are two fair showings of scheelite. However, there is not much unmined ore above these points. It is reported that most of the scheelite ore from the intermediate level stope came from the old pillars left after mining the lead-silver-gold ore in the early operations.

The Lindeborg tunnel is open for 175 feet, at which point it becomes part of the old stope that extends from the Mill level through the Lindeborg tunnel to the surface. This stope was on the largest shoot from which lead-silver-gold ore was removed in the early operations.

The upper tunnel level has been driven east on the Lindeborg vein for 1,000 feet. The quartz-bearing vein in the shear zone is a few inches to 7 feet wide. Galena and pyrite are the principal minerals. In the early operations, two stopes were worked - one, 100 feet east of the tunnel mouth, for a distance of 120 feet to a height of 55 feet, and another, 500 feet east of the tunnel mouth, for a length of 70 feet and a height of 35 feet.

Though pyrite is seen in a number of places throughout the length of the tunnel, there is only one important scheelite ore body on this level, namely, the East ore body in the vicinity of the East raise. The East raise is 640 feet from the mouth of the tunnel and reaches a height of 80 feet. During 1941-42 the present owners removed about 350 tons of ore from what are known as stopes 1 and 2 on the East ore body.

On the outcrop, in line with the face of the upper tunnel and about 400 feet above the upper tunnel, the quartz vein is exposed by an open cut for about 150 feet. Scattered scheelite shows in this cut.

Typical Texas Creek granodiorite is encountered in the various levels. In the main workings the altered granodiorite porphyry, gneissoid granodiorite, gneissoid schist, also aplite, malchite, lamprophyre, and monzonite are exposed by the underground workings and diamond-drill holes.

Beneficiation by the Scott Co.

In 1943, the mill had a capacity of a ton an hour or 25 tons a day.

After making tests with their flow sheet and the use of reagents, in January 1943 the Scott Co. planned to use 0.15 pound of "quebracho" per ton to depress the scheelite in the sulfide circuit and to use "elastoil" at rates of 0.6 to 0.75 pound per ton as a collector instead of soap and oleic acid. Elastoil is a fish-oil product sold by the Industrial Oil Products Co. of Los Angeles. Quebracho is a tannic-acid product developed by the American Cyanamid Co. It is an effective depressant of scheelite at low pH percentages. After the pH is raised in the scheelite circuit, the scheelite floats readily, and quebracho then acts as a depressant for calcite and silicate minerals.

The flow sheet shown in figure 15A was used during the latter part of the summer of 1942.

Scheelite concentrate produced prior to 1943 was sold to the General Electric Co. at Cleveland. The concentrate, being virtually molybdenum free, is a good product for the manufacture of tungsten-filament lamps. The lead concentrate was sold to the Bunkerhill & Sullivan Smelter at Kellogg, Idaho.

The cost of tungsten products at the Riverside mine during 1941 and 1942 was high, owing to the intermittent operation, experimentation, labor conditions, and numerous difficulties encountered. No accurate representative tonnage costs are available.

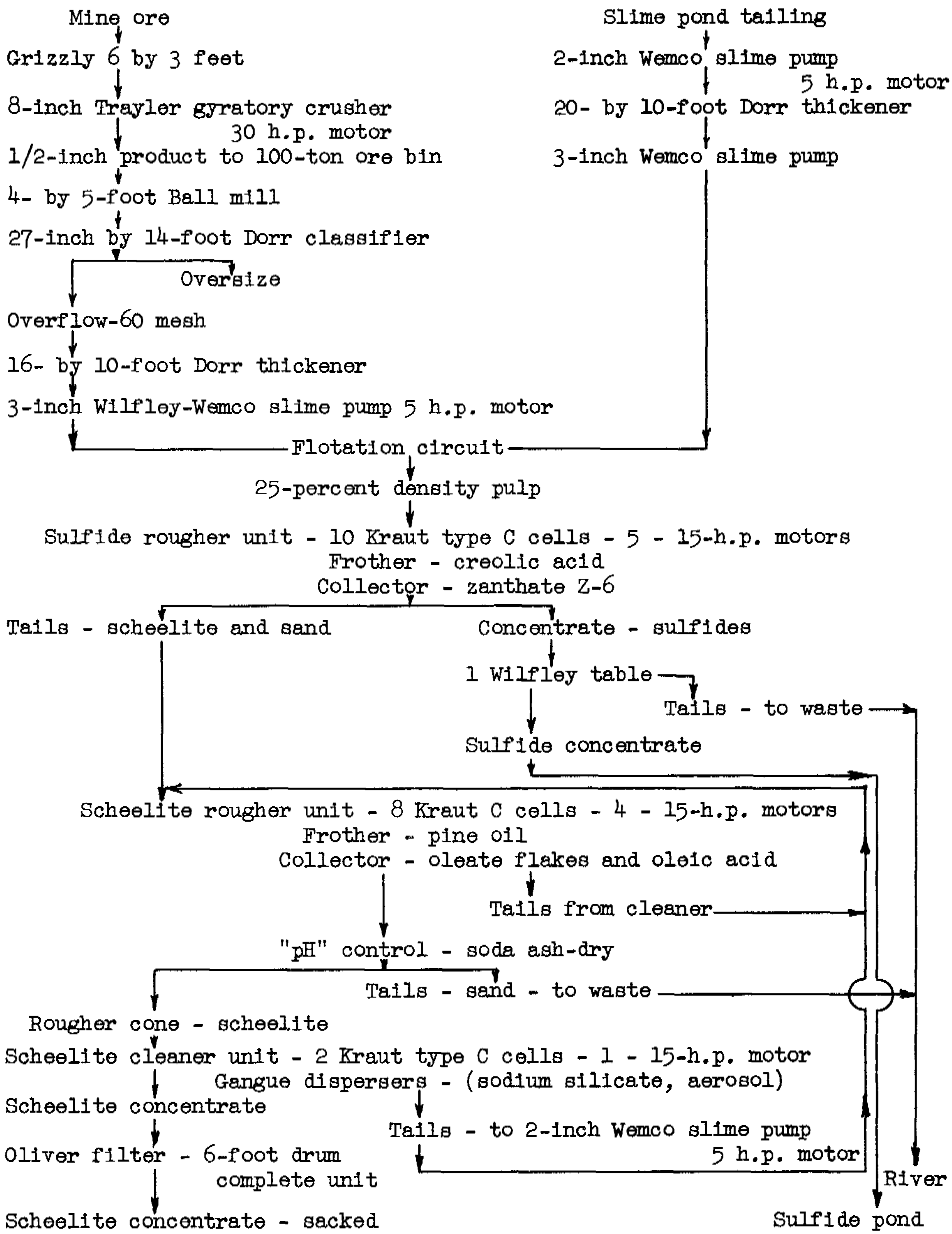


Figure 15-A. - Flow sheet 2, Riverside tungsten mill, July 1942.

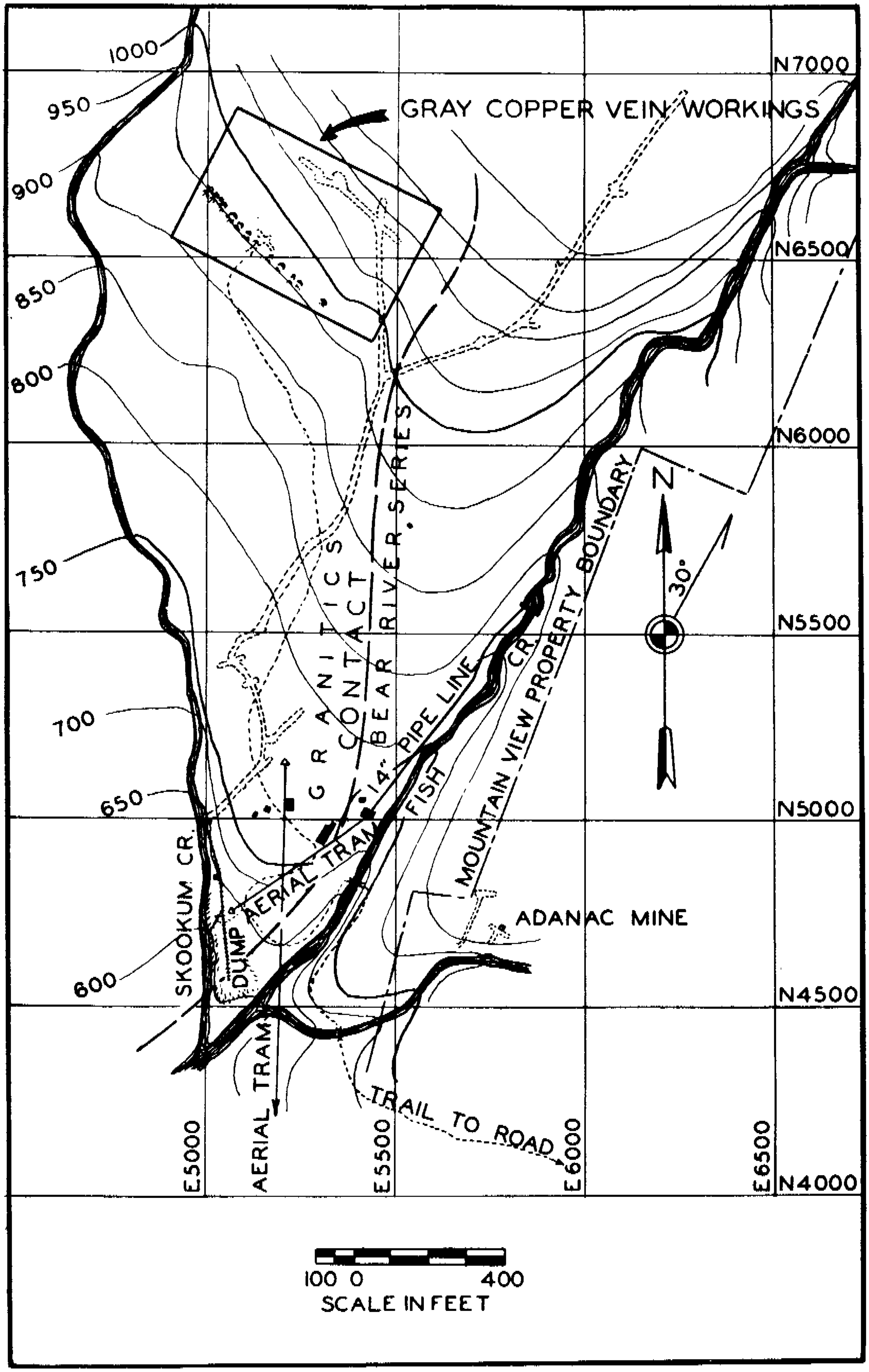


Figure 16. - Mountain View mine and vicinity.

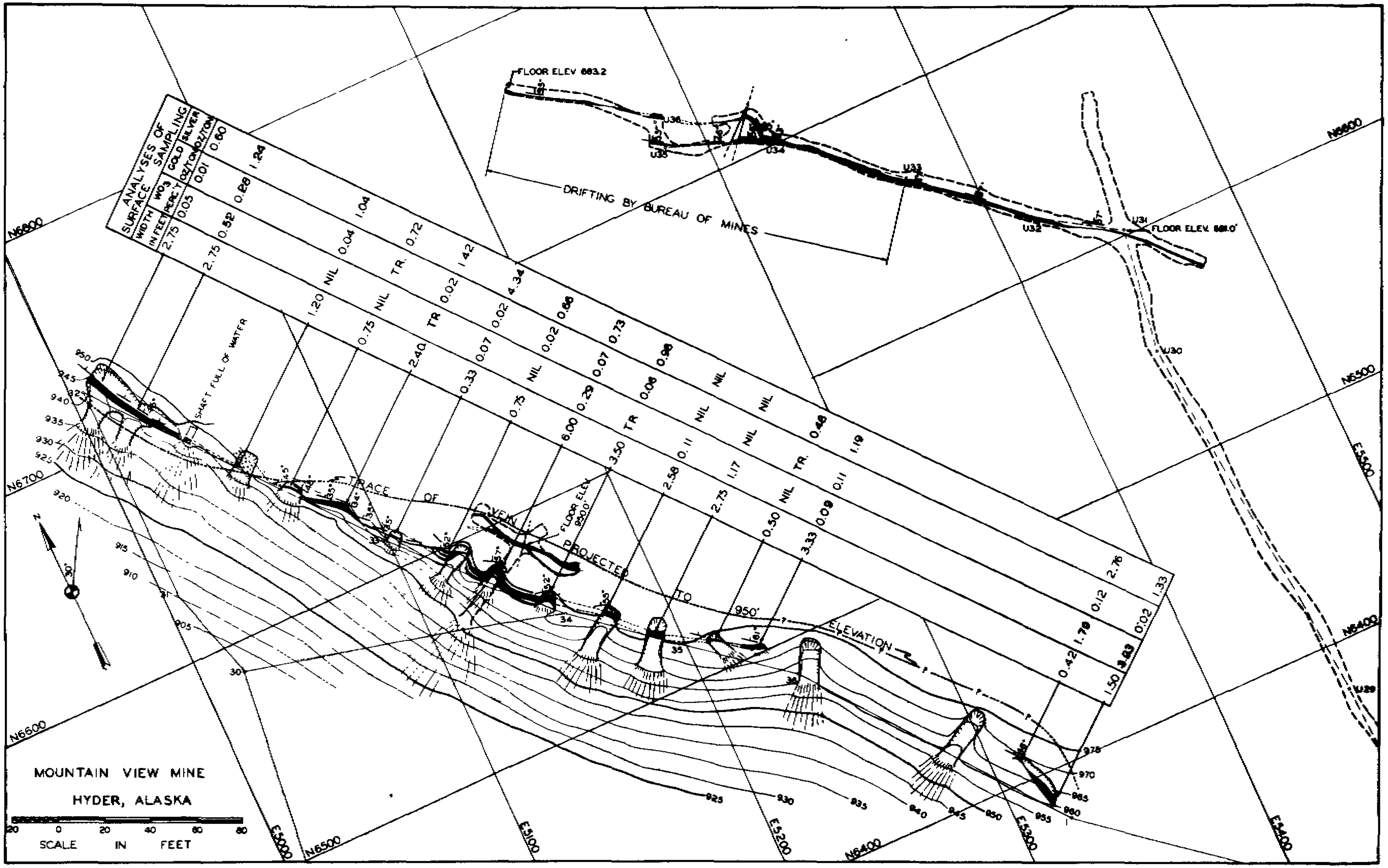


Figure 17. - Workings topography and assay map of surface sampling.

MOUNTAIN VIEW MINE

Property and Ownership

Seven patented claims and two unpatented claims make up the Mountain View property. The patented claims are Fish Creek Nos. 1 to 5, inclusive, Silver Falls, and Silver Falls Fraction; the unpatented claims are Fish Creek No. 6 and Fish Creek Fraction.

The Mountain View Gold Mining Co. has title to the patented ground, and, as far as can be ascertained, its locations of the unpatented claims have not been contested nor invalidated. The company also held a preliminary permit from the Federal Power Commission covering the water-power rights of Fish Creek. Present status of this permit is not known.

General Geology[13]

Portland Canal (fig. 16), at the head of which lies the Salmon River mining district, cuts obliquely across the Coast Range batholith. This batholith, trending northwest, extends 1,100 miles from southern British Columbia into Yukon Territory and ranges from 20 to 110 miles in width. The deposit examined lies near the northeast flank and within the intrusive, which at this point is about 50 miles wide. Outlying dikes, sills, and stocks genetically related to the main batholith further increase the width affected by intrusives to over 100 miles. (See fig. 16.)

Four main groups of rock are present in the district: (1) the Texas Creek granodiorite, a great central intrusive mass; (2) the Hazelton group, of probable Jurassic age, comprised of greenstone, tuff, volcanic breccia, graywacke, slate, argillite, quartzite, and rare limestone; (3) the Hyder quartz monzonite, a pinkish intrusive composing the Hyder batholith; and (4) the Boundary granodiorite, a pink intrusive composing the Boundary stock. Only the Texas Creek granodiorite and the Hazelton group, the Bear River series of which is in contact with the batholith on its northeast flank, are known to carry mineral deposits of economic importance. The contact, which has a northwest trend, is locally irregular in strike.

Occurrence of the Deposits

The deposit occurs as a steeply dipping fissure vein having a general strike of about north 48° west and a dip of 50° northeast, as shown in figure 17. The vein has been exposed by open cuts for a distance of 460 feet along the strike as well as by a crosscut, a drift, and a shaft. Underground drifting, including that done by the Bureau of Mines, exposes the vein for a distance of 315 feet. The distance along the dip between this drift and the outcrop is 360 feet. The exposed part of the vein lies entirely within the Texas Creek granodiorite.

13/ Work cited in footnote 12.

A tentative interpretation of the geological structure of the deposit is shown on figure 18, prepared from observations made during Bureau of Mines exploration. It will be noted that the vein, though continuous, pinches and swells in corresponding lengths both on the surface and underground. Pinched lengths, in both cases, show shattering, thin traces of gouge and poor mineralization. The wider portions of the vein show slight shattering, no gouge, and generally good mineralization. It will also be noted that the strike of the better portions of the vein is, in every case, 5 to 15 degrees nearer north than the pinched segments. From the above it is believed that contemporaneously with or following the establishment of the fissure, slight movement, as indicated by the arrows in figure 18, caused both the formation of openings favorable for deposition and lengths of sheared, tight rock unfavorable for deposition. Movement having a horizontal component of 2 to 3 feet would have been ample for the establishment of this structural control.

Four shoots of mineralization raking approximately north 60° east are shown on figure 18. Shoot 2 has been established from underground and surface exploration, shoot 3 is not well defined underground, shoot 4 is exposed on the surface but not underground, and shoot 1 is exposed partly on the surface and for a few feet underground.

Character of the Ore

Segregation of galena, sphalerite and silver indicates that mineralization took place in two or more stages. Pyrrhotite and scheelite appear to have been deposited contemporaneously, or nearly so, followed by chalcopyrite and pyrite and finally by sphalerite, galena, and quartz. Gold and silver in the native form are present in small but appreciable amounts.

Vein gangue consists of barite, quartz, sericite, chlorite, and small altered inclusions of granodiorite.

Development

Underground development is confined entirely to drifting and crosscutting, of which there is a total of over 4,200 feet, including 226 feet completed by the Bureau of Mines. (See fig. 16.) The Gray Copper vein was encountered 1,823 feet from the portal.

At a point 1,428 feet from the portal a branch crosscut was driven by the Mountain View Gold Mining Co. in a northeasterly direction to cut at depth other veins that apparently are not related to the Gray Copper vein. No positive results were obtained from this work. Several veins were found, but they were of low grade, lacked any apparent continuity, and could not be correlated with surface showings. The Gray Copper vein was not found at or near its projected strike in this crosscut, and it is believed that the deposit extends only a short distance into the Bear River series, it at all.

All underground exploration by the owners took cognizance of the possibility of future full-scale operations. Cross sections of the drifts and

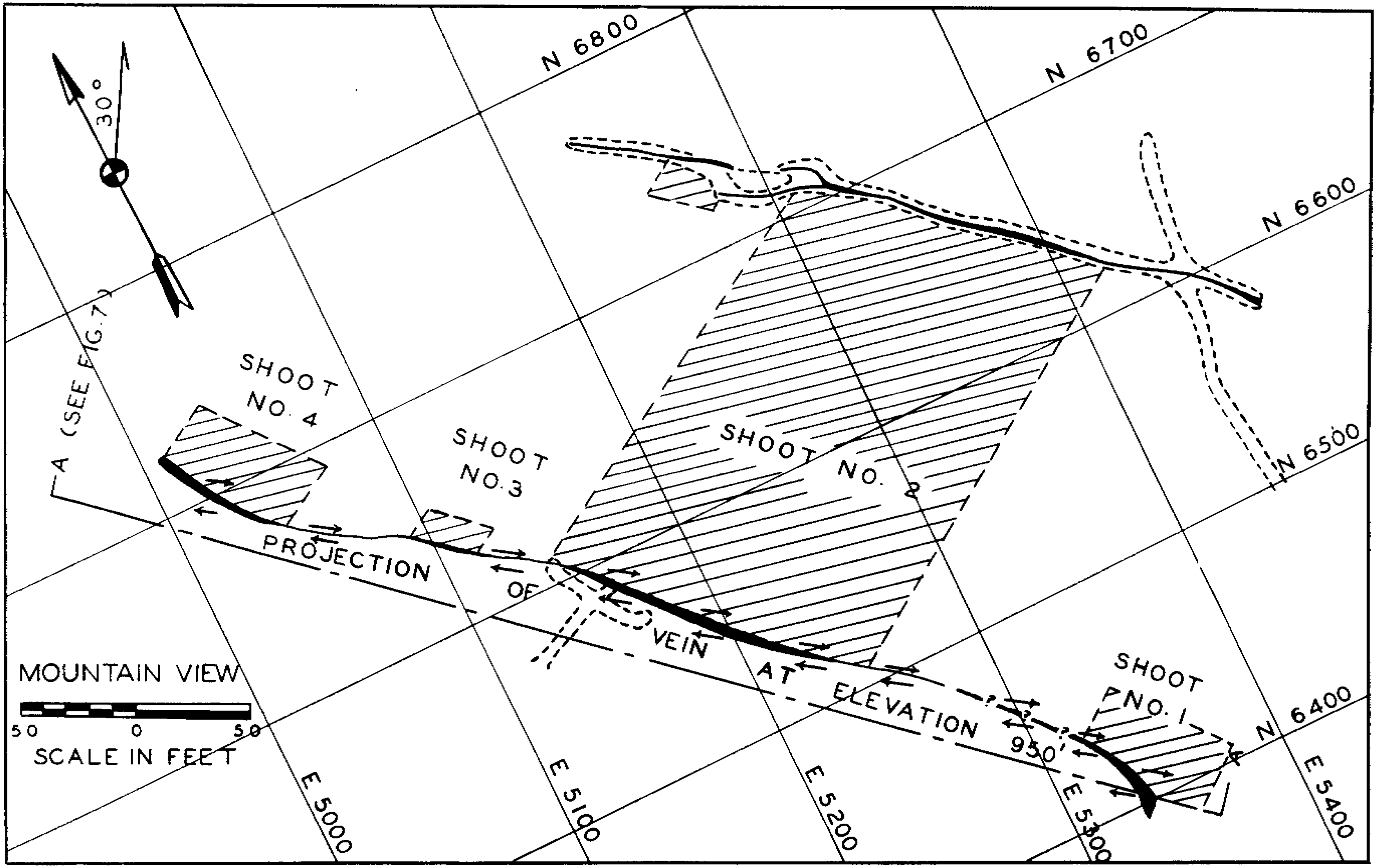
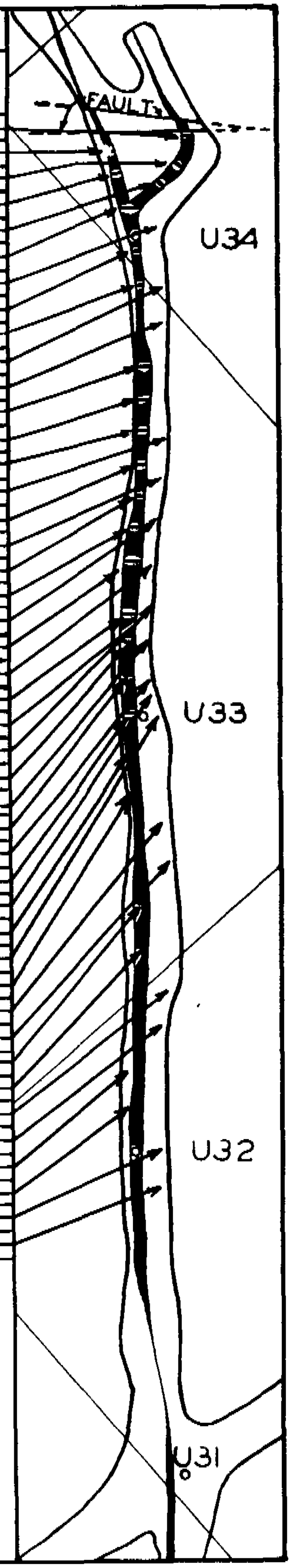


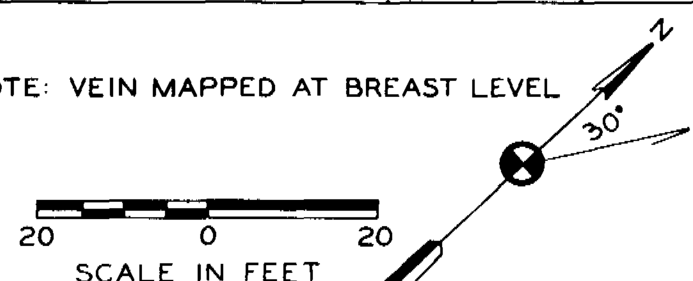
Figure 18. - Plan showing structural control of ore shoots.

ANALYSES OF SAMPLING - LOWER DRIFT

NUMBER OF SAMPLE	WIDTH (FT)	WO_3 PERCT	GOLD OZ/TON	SILVER OZ/TON
14.5B	1.67	1.76	0.45	1.75
72.5	1.08	0.22	0.04	3.20
1.05B	1.50	0.18	0.01	3.16
69.5	1.25	0.22	TRACE	0.72
7.3B	1.17	<0.05	0.72	14.24
65.4	2.92	0.85	0.24	5.26
SILL 60	0.67	<0.05	0.015	0.81
59.3	1.00	NIL	TRACE	1.20
54.7	0.75	0.47	TRACE	0.66
SILL 55.0	1.17	<0.05	0.27	3.15
SILL 50.0	0.83	<0.05	0.02	1.56
44.8	1.75	<0.05	0.03	0.37
40.6	1.25	NIL	0.01	0.80
36.3	1.25	NIL	TRACE	0.80
SILL 35.0	0.00	NO SAMPLE TAKEN		
32.4	1.00	NILL	0.01	1.70
SILL 30.0	1.43	0.19	0.11	6.59
28.5	1.67	NIL	0.0.1	1.20
24.6	1.67	4.11	0.27	2.39
SILL 25.0	2.67	4.52	0.045	19.16
20.0	2.16	0.80	0.02	4.60
SILL 20.0	2.83	4.17	0.21	48.75
13.5	2.16	0.77	TRACE	3.56
SILL 15.0C	0.83	0.06	0.29	42.14
SILL 15.0A	0.50	4.80	0.02	2.28
10.0	1.42	0.06	TRACE	0.40
SILL 10.0	0.92	<0.05	0.02	2.49
5.5	1.17	<0.05	0.03	0.77
SILL 5	1.00	<0.05	0.055	0.67
0.0	1.33	0.16	TRACE	0.36
SILL 3	1.00	1.56	0.03	6.54
205	0.75	1.94	0.015	4.09
SILL 0.0	0.83	0.67	— TRACE —	
210	0.66	0.96	0.02	1.65
215	0.83	1.55	0.04	1.94
220	1.33	2.27	0.04	1.57
225	2.16	1.36	0.02	1.56
230	1.75	3.06	0.04	1.16
235	1.83	1.35	0.01	1.01
240	2.25	1.06	0.10	2.29
245	1.25	0.31	0.07	2.81
250	1.00	0.30	0.035	1.22
255	1.58	1.33	0.21	3.09
260	1.58	3.37	0.31	2.31

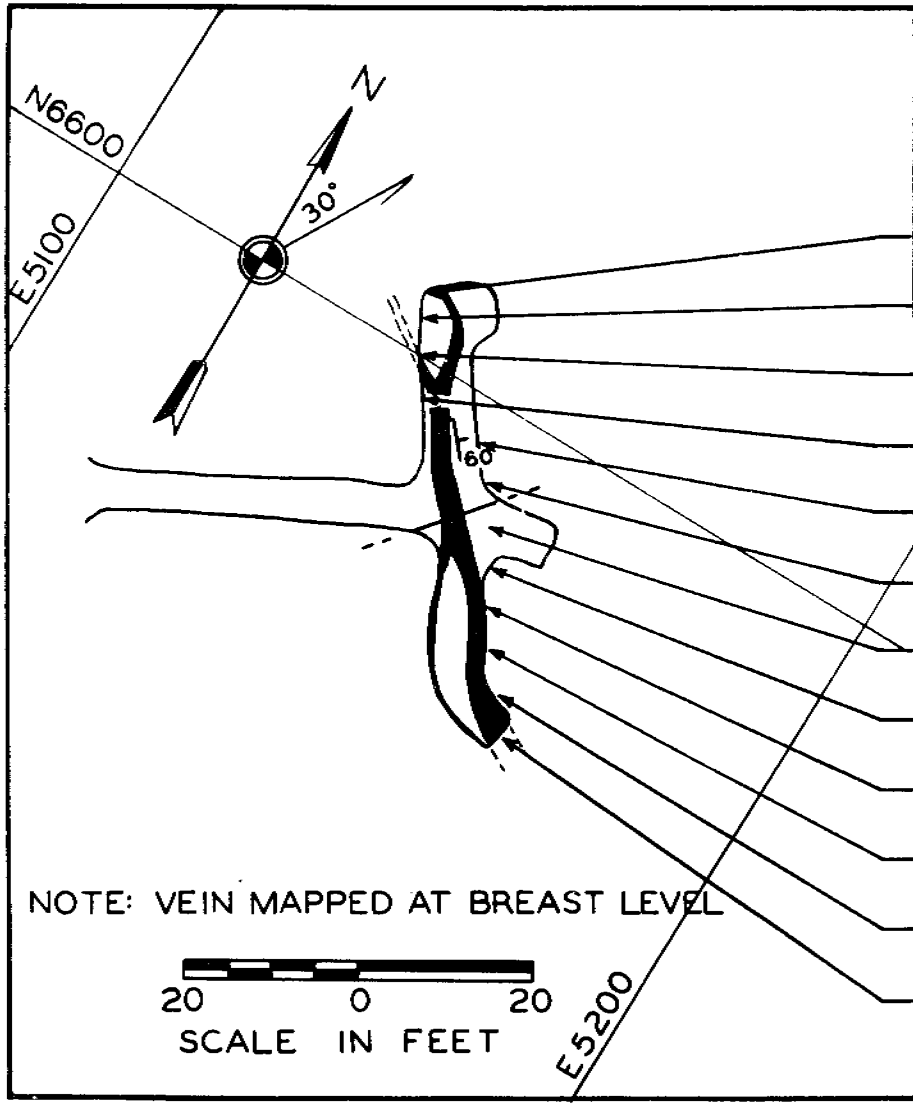


NOTE: VEIN MAPPED AT BREAST LEVEL



MOUNTAIN VIEW - TUNGSTEN

Figure 19. - Assay map - lower drift.



ANALYSES OF SAMPLING - UPPER DRIFT

LOCATION OF SAMPLE	WIDTH IN FEET	WO_3 PERC'T	GOLD OZ/TON	SILVER OZ/TON
WEST WALL, 1 FOOT ABOVE FLOOR	1.75	<0.05	0.01	1.92
WEST WALL, 2 FEET ABOVE FLOOR	1.42	0.67	0.08	1.21
WEST WALL, 4 FEET ABOVE FLOOR	1.33	<0.05	0.04	0.36
WEST WALL, 5 FEET ABOVE FLOOR	1.75	<0.05	0.10	1.05
EAST WALL, 1 FOOT ABOVE FLOOR	0.75	0.15	0.14	1.77
EAST WALL, 1 FOOT ABOVE FLOOR	0.90	0.32	0.02	0.61
CENTER OF CROSSCUT, IN FLOOR	1.33	0.80	0.14	1.10
EAST WALL, 1 FOOT ABOVE FLOOR	1.50	TR.	0.09	0.62
EAST WALL, 2 FEET ABOVE FLOOR	1.75	<0.05	0.06	1.39
EAST WALL, 2 FEET ABOVE FLOOR	1.92	<0.05	0.01	0.47
EAST WALL, 3 FEET ABOVE FLOOR	1.42	<0.05	0.01	0.25
FACE, 4 FEET ABOVE FLOOR	4.00	0.18	0.04	1.72

Figure 20. - Assay map - upper drift, Mountain View mine.

crosscuts range from 5 by 7 feet to 9 by 9 feet. Average tunnel grade is 1.9 percent. Mine track from the portal to the present face on the Gray Copper vein is 12-pound rail.

Roofs and walls stand well throughout the mine without timbers. Water seepage into underground workings presents no problem, as total flow from all rock openings amounts to less than 10 gallons a minute. A drainage ditch has been excavated along the entire length of the tunnel.

Both the granodiorite and the vein material are moderately hard. Properly tempered drill steel generally drills 14 to 20 inches for each sharpening. Breaking qualities of both country rock and vein material are such that holes generally break to the bottom.

Work Done by the Bureau of Mines

An exploratory project at the Mountain View property was begun May 22 and ended October 24, 1944. In the course of this work the camp buildings were rehabilitated; the dam, hydraulic line, and machinery were repaired; 226 feet of drifting was completed; 80 channel samples aggregating 3.9 tons were collected; and the area was mapped in detail. Figure 17 shows the position of the Bureau drifting with respect to the vein outcrop.

Sampling and Analysis

Eighty channel samples 12 inches wide and 6 inches deep were cut from the vein. These were reduced at the project site in accordance with standard procedure by means of a Chipmunk crusher with shims of various sizes and a nest of screens.

A part of the analyses was made by a local assayer in Hyder and a part by assayers in Los Angeles. Samples were tested for tungstic oxide, fold, and silver. Lead, zinc, and copper were present in such small amounts that they were of no economic importance.

The position, width, and grade of all surface samples are shown on figure 17. Similar information for samples from the upper drift is shown on figure 20 and for samples from the lower drift on figure 19. Shoot 2 has an average width of 1.95 feet and contains 0.52 percent WO_3, 0.052 ounce gold per ton, and 2.04 ounces silver per ton.

Beneficiation

During the exploration program at the Mountain View mine, a metallurgical sample was taken from the lower level, which at the time was thought to be representative of the mineralized material. The sample was essentially quartz with some pyrrhotite and pyrite and minor amounts of barite, scheelite, sericite, chalcopyrite, and chlorite. Small amounts of galena and calcite also were present. The sample contained 2.64 percent tungstic oxide, 11.95 percent iron, and had 0.18 ounce of gold and 14.09 ounces of silver to the ton.

Silver was present as native silver in wire form. A qualitative spectrographic analysis of the free silver shows a high gold content, which indicates the gold is alloyed with the silver. The bulk of the scheelite and sulfides was free of gangue at minus 20-mesh, but a small amount of these minerals remained locked to minus 65-mesh.

Detailed sampling of the deposit indicated that the metallurgical sample was of much higher grade than the average tenor of the mineralized material. However, it was thought that the results obtained would be indicative of the recoveries that could be expected from the lower-grade material.

Results of tabling tests indicated that the sample was not amenable to gravity concentration. The scheelite concentrate contained 34.53 percent tungstic oxide, representing a recovery of 64.1 percent. Gold and silver recoveries were 55.1 and 25.8 percent, respectively. The sulfide middlings contained 17.9 percent of the gold and 46.3 percent of the silver and assayed 0.136 ounce gold and 26.96 ounces silver a ton.

The flotation tests evidence further the refractory nature of the sample. The procedures followed in the flotation tests were basically as follows:

The sample was crushed to minus 20-mesh and wet-ground in stages to minus 65-mesh. A sulfide rougher concentrate was floated with Xanthate Z-6, reagent 208, and frother 52. The sulfide rougher concentrate was not cleaned. A scheelite rougher concentrate was then floated with oleic acid, quebracho, and frother 52, and cleaned.

The metallurgical sample consisted of five sacks. For test purposes various combinations of the five sacks were made. Table 1 summarizes the results obtained, giving concentrate grades and percentage recoveries of metals.

The results of the tests illustrated in table 1 indicate that the sample is not amenable to concentration by flotation. Recovery of the scheelite was 43.0 to 79.3 percent, whereas the scheelite concentrates contained 39.85 to 57.52 percent tungstic oxide. The test giving the highest recovery, 79.3 percent, produced the lowest-grade concentrate, 39.85 percent tungstic oxide. In producing a concentrate containing 57.52 percent tungstic oxide, 54.9 percent of the scheelite was recovered.

APEX-EL NIDO MINE

Location

The Apex-El Nido mine is in the northwest part of Chichagof Island near Lisianski Inlet, 115 nautical miles west of Juneau. The property is 2-1/2 miles from Pelican City, a small settlement on the opposite shore of the inlet, as shown in figure 21. A 1-3/4-mile foot trail leads from the beach to the mine, the lower level of which is at an altitude of 1,057 feet.

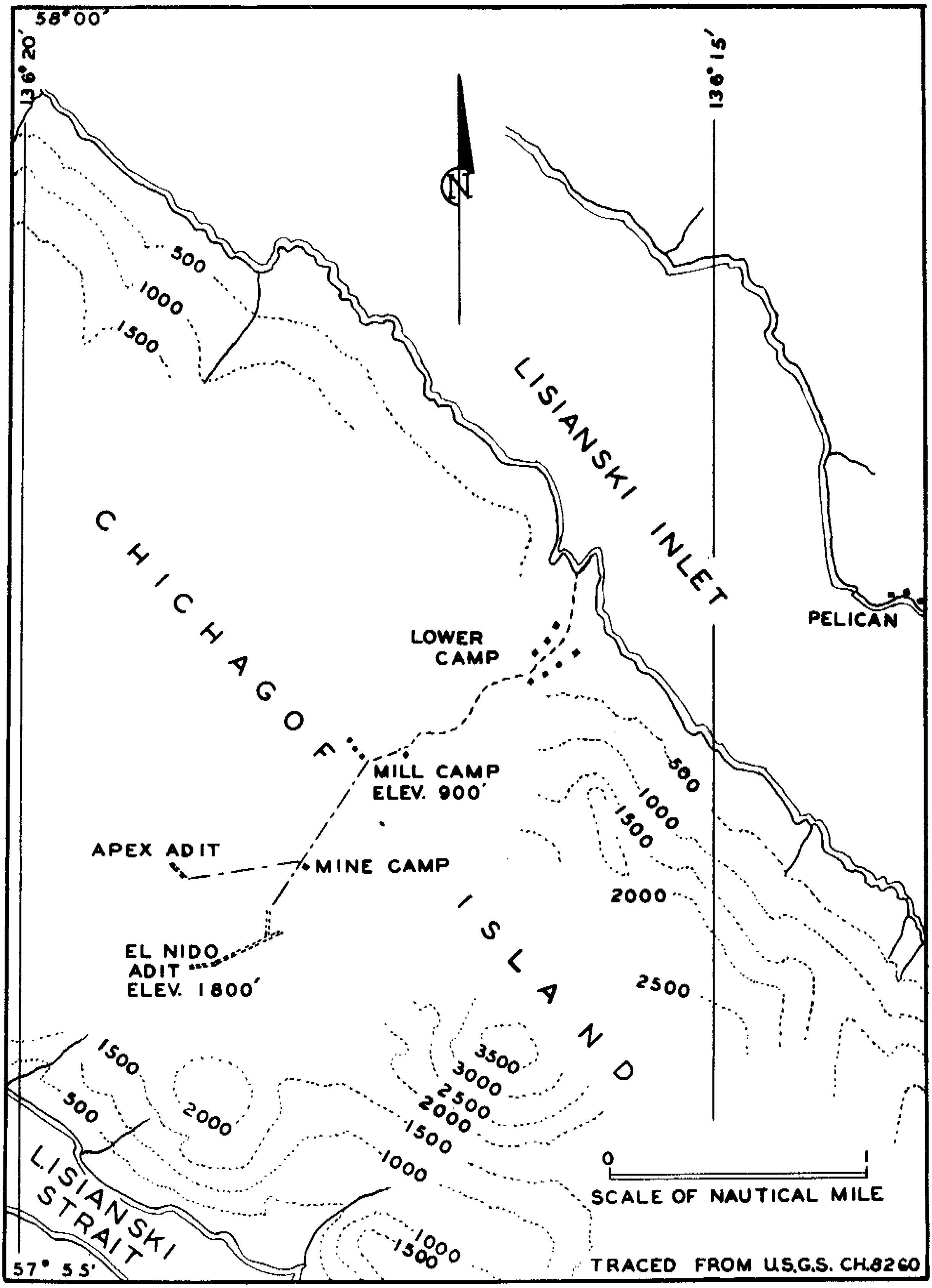


Figure 21. - Location of Apex - El Nido mine.

TABLE 1. - Results of flotation tests, Mountain View mine, Hyder, Alaska

Product	Test A			Test B			Test C			Test D		
	Weight, percent	Analysis, WO_3	Percent of total	Weight, percent	Analysis, WO_3	Percent of total	Weight, percent	Analysis, WO_3	Percent of total	Weight, percent	Analysis, WO_3	Percent of total
Scheelite concentrate..	5.87	39.85	79.3	2.75	53.40	51.0	1.79	57.42	54.9	2.03	55.88	43.0
Sulfide concentrate..	26.30	1.63	14.5	24.88	2.19	18.9	23.62	1.43	18.0	27.97	1.81	19.2
Scheelite middlings....	5.99	1.85	3.7	10.23	5.75	20.4	4.47	7.44	17.8	5.18	5.96	11.7
Rougher tailing......	61.84	0.12	2.5	62.14	0.45	9.7	70.12	0.25	9.3	64.82	1.06	26.1
Composite.....	100.0	2.95	100.0	100.0	2.88	100.0	100.0	1.87	100.0	100.0	2.64	100.0

History

From 1923 to 1928, and again from 1934 to 1935, inclusive, the El Nido mine was worked for its gold content. The presence of scheelite was known as early as 1923, but no effort was made to separate it from the gangue as a marketable concentrate.

Physical Features and Climate

The El Nido and Apex adits are in a rugged area with mountains heavily wooded at the base and rising to barren peaks at 2,500 feet and higher. The mine is situated several hundred feet above a cirque valley, where the formations outcrop prominently in an area void of vegetation. Streams feeding into the valley furnished water for power during operating periods.

The climate is mild, with heavy snowfall in the winter. As much as 12 feet of snow has been recorded on the ground at one time, and snow is likely to remain on the ground from early November until the latter part of April.

Description of the Deposits

Hornblende diorite is the principal country rock in the vicinity of the Apex-El Nido mine. The Apex vein is 5 inches to more than 4 feet wide, and in places it divides into a stockwork of branching veinlets. It strikes N. 60° E. and dips 45° NW.

Fine grains of scheelite are disseminated in the quartz at several places, but the amount of tungsten is low at most of the occurrences. Broken material from stopes on the vein also shows a low tungsten content.

The El Nido vein according to Buddington[14] fills a fracture in an aplite dike which is intrusive into the diorite country rock. The vein has a strike of N. 60° E. to N. 85° E. and a dip of about 60° SE. The width is 5 inches to 5 feet, averaging 10 inches.

The El Nido mine is opened by a lower and an upper adit at altitudes of 1,057 and 1,242 feet, respectively. On the lower level the vein is intersected by an 800-foot crosscut from the surface, whereas the upper level is opened to the surface by a 220-foot crosscut. (See fig. 22.)

Scheelite in small streaks and disseminated grains is found on the lower level between the crosscut and the raise. Scheelite is more abundant near the raise, particularly in the floor of the drift, but it is very sparsely distributed between the raise and a point about 6 feet from the face. A face sample collected from a vein 7 inches wide contained 8.73 percent tungstic oxide. A sample of the best exposure of scheelite contained 56.15 percent tungstic oxide.

14/ Buddington, A. F., Mineral Investigations in Southeastern Alaska: U. S. Geol. Surv. Bull. 773, 1925, p. 119.

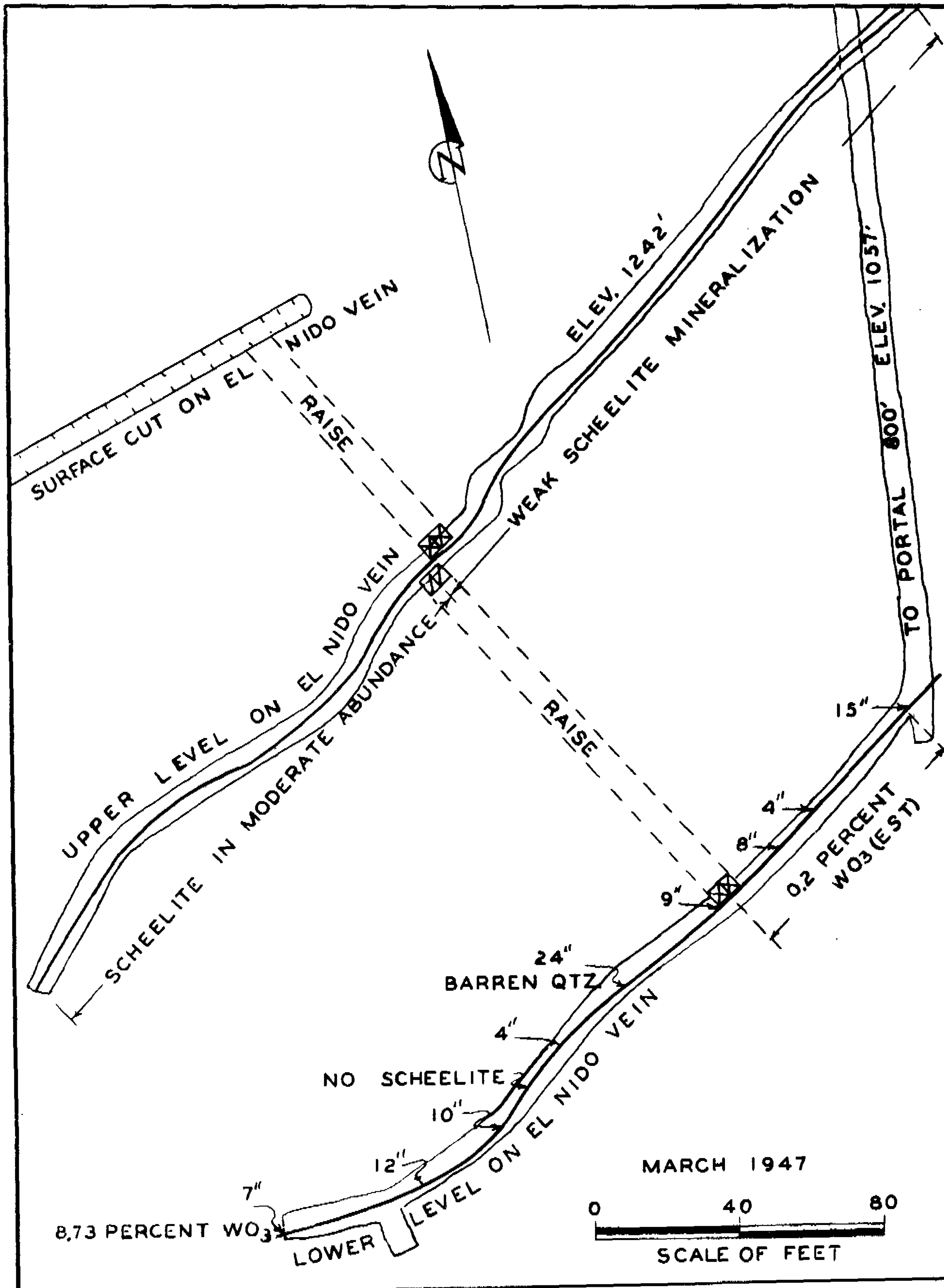


Figure 22. - Map of part of El Nido mine, Chichagof Is.

On the upper level the scheelite content of the vein is very low between the crosscut and the raise to the surface. The portion of the vein between the raise and the face shows more abundant scheelite, most of which occurs as small lenses or pockets. A streak of nearly solid scheelite 2 inches wide and 3 feet long occurs at one place in a veinlet that diverges from the main vein at a slight dip into the hanging wall.

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