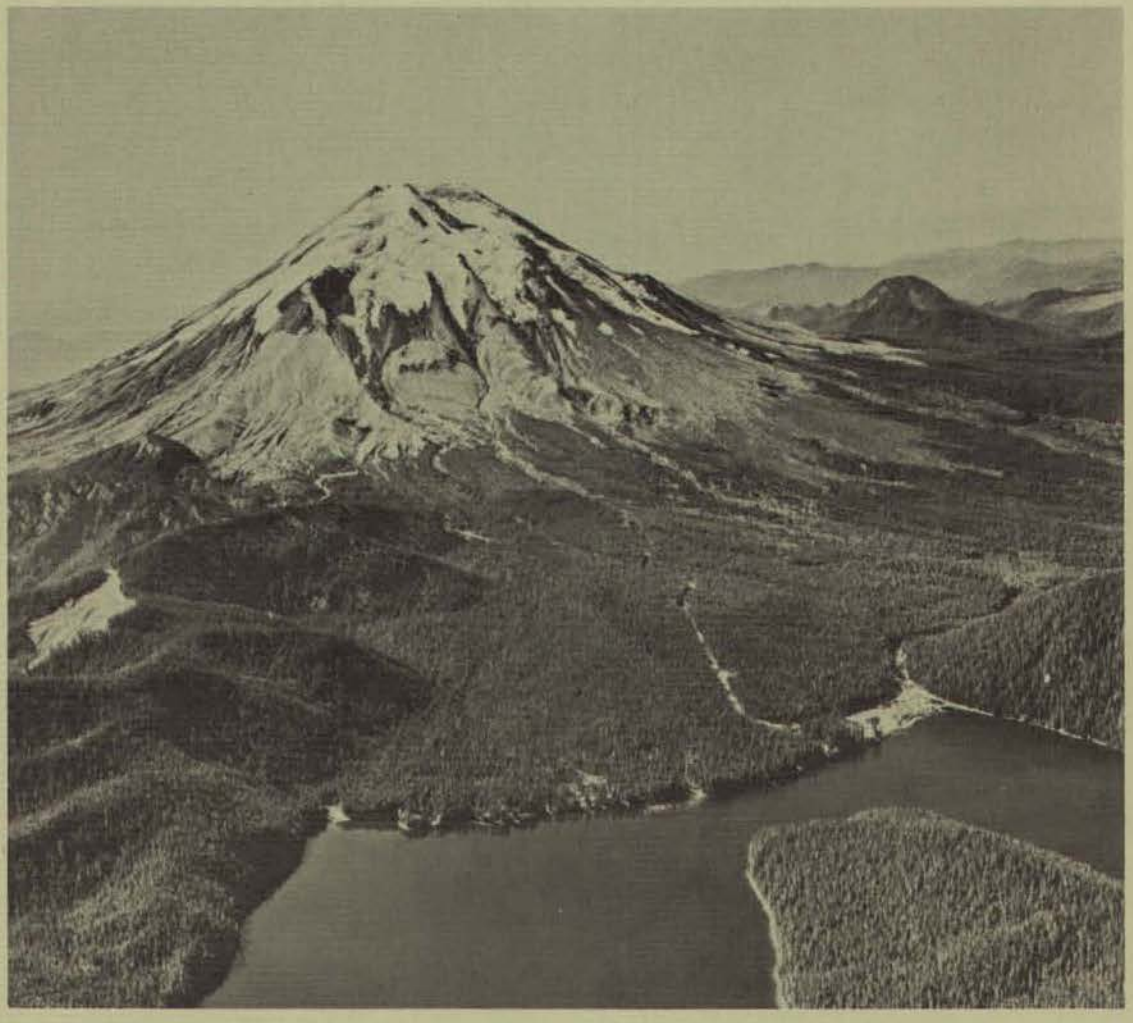
ST. HELENS AND WASHOUGAL MINING DISTRICTS OF THE SOUTHERN CASCADES OF WASHINGTON



BY WAYNE S. MOEN

DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND EARTH RESOURCES
INFORMATION CIRCULAR NO. 60
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STATE OF WASHINGTON

DEPARTMENT OF NATURAL RESOURCES

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Cover Photo

Mount St. Helens, as seen from the vicinity of Norway Pass, rises to an elevation of 9,677 feet. It consists of a dormant volcano composed of lava flows of olivine basalt, pyroxene andesite, and pyroclastic flow deposits. Eruptive material from the volcano filled the valley of the North Fork of the Toutle River and created a natural dam, behind which rests Spirit Lake. Mount St. Helens was named by Captain George Vancouver in October 1792 in honor of Baron St. Helens, British Ambassador at the Court of Madrid.

(Photo courtesy of U.S. Forest Service.)

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PREFACE

In light of recent exploration by major mining companies for copper in the southern Cascades of Washington, numerous requests have been received by Washington Division of Geology and Earth Resources for information on the region's mineral occurrences. This Information Circular presents briefly the mining history, general geology, and descriptions of the mines and prospects of the St. Helens and Washougal mining districts, which are the southernmost mining districts of Washington. The writer hopes that this publication will serve as a guide, and aid in the search for new metal deposits in the southern Cascades.

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ST. HELENS AND WASHOUGAL MINING DISTRICTS OF THE SOUTHERN CASCADES OF WASHINGTON

BY

WAYNE S. MOEN

INTRODUCTION

GENERAL INFORMATION

The majority of the metallic mineral occurrences of southwestern Washington are within the St. Helens and Washougal mining districts; however, these districts have never been major producers of metals in Washington. As early as 1892, mining claims were staked for copper, gold, and silver in the St. Helens district; at the turn of the century discoveries of these metals, as well as lead and zinc, were made in the Washougal district. In the early 1900's many deposits in both districts underwent exploratory and development work, several small shipments of copper ore were made, but no property developed into a major mine. Many mining operations were abruptly halted by devastating forest fires that destroyed much of the virgin timber of the southern Cascades. In the Washougal district, the Yacolt burn of 1902, swept through 290,000 acres of timbered land. Other forest fires, though not as extensive as the Yacolt burn, occurred in 1917, 1918, 1919, 1922, 1927, 1929, and 1936. These fires destroyed the structures at many mines. Some mining operations were resumed, but at many properties mining ceased because capital was no longer available.

In the depression years of the 1930's, renewed interest was shown in the St. Helens district, and minor lode and placer gold was produced from mines on McCoy and Camp Creeks. In the Washougal district, however, mining activity was at a standstill. From 1940 to 1960, both districts were sporadically prospected for copper and gold. Several of the more favorable deposits, discovered at the turn of the century, were investigated but did not prove to be of economic value. Around 1960, several major mining companies undertook geochemical steam-sediment sampling projects in the southern Cascades. Several areas of anomalous copper mineralization were turned up, but subsequent geological investigations proved discouraging.

In 1970, the Ryan Lake area of the St. Helens district received the attention of Duval Corp., a major producer of copper in Arizona. Encouraged by favorable geochemical and geological studies, the company embarked on an extensive drilling program to evaluate a potential low-grade copper deposit. As of 1977, drilling was still being carried out on the property. In the Washougal district, the most favorable area for copper appeared to be in the vicinity of the Miners Queen prospect on Copper Creek. Al-

though this area had been under investigation by several mining companies since the 1950's, it was not until 1975, when Amoco Minerals Company began and extensive drilling program, that serious exploration for large low-grade copper deposits was undertaken. Elsewhere in the southern Cascades, a small shipment of copper ore was made from the Skamania and Last Chance mines on the West Fork of the Washougal River in 1966. In the Wind River area of southeastern Skamania County, gold ore was shipped from the Wind River mine in 1963, 1967, 1972, 1973, and 1974. Currently, no metal mines in the St. Helens and Washougal districts are in production.

To date (1977), metal mines in the southern Cascades have produced a total of $26,538 in gold, copper, silver, and lead. Of this total $22,844 was gold; $1,345, silver; $2,341, copper; and $8, lead (see table 1, p. 10).

ACKNOWLEDGMENTS

I wish to acknowledge the cooperation and assistance of M. M. Suchy and Z. R. Moore, of the U.S. Forest Service, who furnished general information and photographs of the Gifford Pinchot National Forest for use in this report. Victor F. Hollister, of Duval International Corp., and F. Thomas Bourns, of Amoco Minerals Co., were helpful in supplying general information on their copper exploration projects in the southern Cascades. I am also grateful to E. A. Magill & Associates for furnishing data on many prospects of the southern Cascades and for reviewing this report. Thanks are also due to Alan R. Grant for information on the Miners Queen prospect.

LOCATION AND PHYSIOGRAPHY

The St. Helens and Washougal mining districts, the southernmost mining districts in Washington, are on the western slopes of the Cascade Mountains (fig. 1). The Washougal district includes part of southwestern Skamania County and part of eastern Clark County. The St. Helens district is chiefly in northwestern Skamania County, but includes part of northeastern Cowlitz County and part of south-central Lewis County. Mountainous country prevails throughout both districts (fig. 2). Hillsides are steep and the summits of most mountains are rounded. However, several of the highest mountains contain alpine-type summits characterized by talus-covered slopes and craggy summits. Most of the region supports good stands of first- and second-growth timber, consisting mainly of Douglas fir. Because of devastating forest fires in 1902, which burned over 290,000 acres, much of the Washougal district is void of its first-growth timber. On the higher peaks, the forests give way to open grassy meadows, containing some small mountain lakes. In the St. Helens district, elevations range from a low of 600 feet on the Cowlitz River to a high of 5,858 feet on the summit of Mount Margaret. In the Washougal district, elevations range from 200 feet on the Washougal River to a high of 4,390 feet on the summit of Silver Star Mountain. The general summit level for the southern Cascade region is around 4,000 feet. Numerous streams form a dendritic drainage pattern in the region. Major drainage systems include the Green, Cowlitz, Lewis, Toutle, Washougal, Cispus, and Wind Rivers. A network of Forest Service

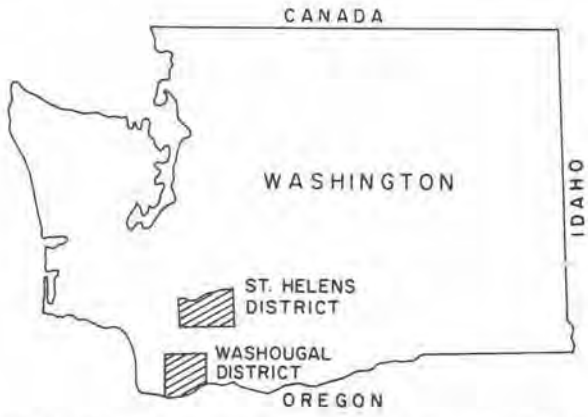
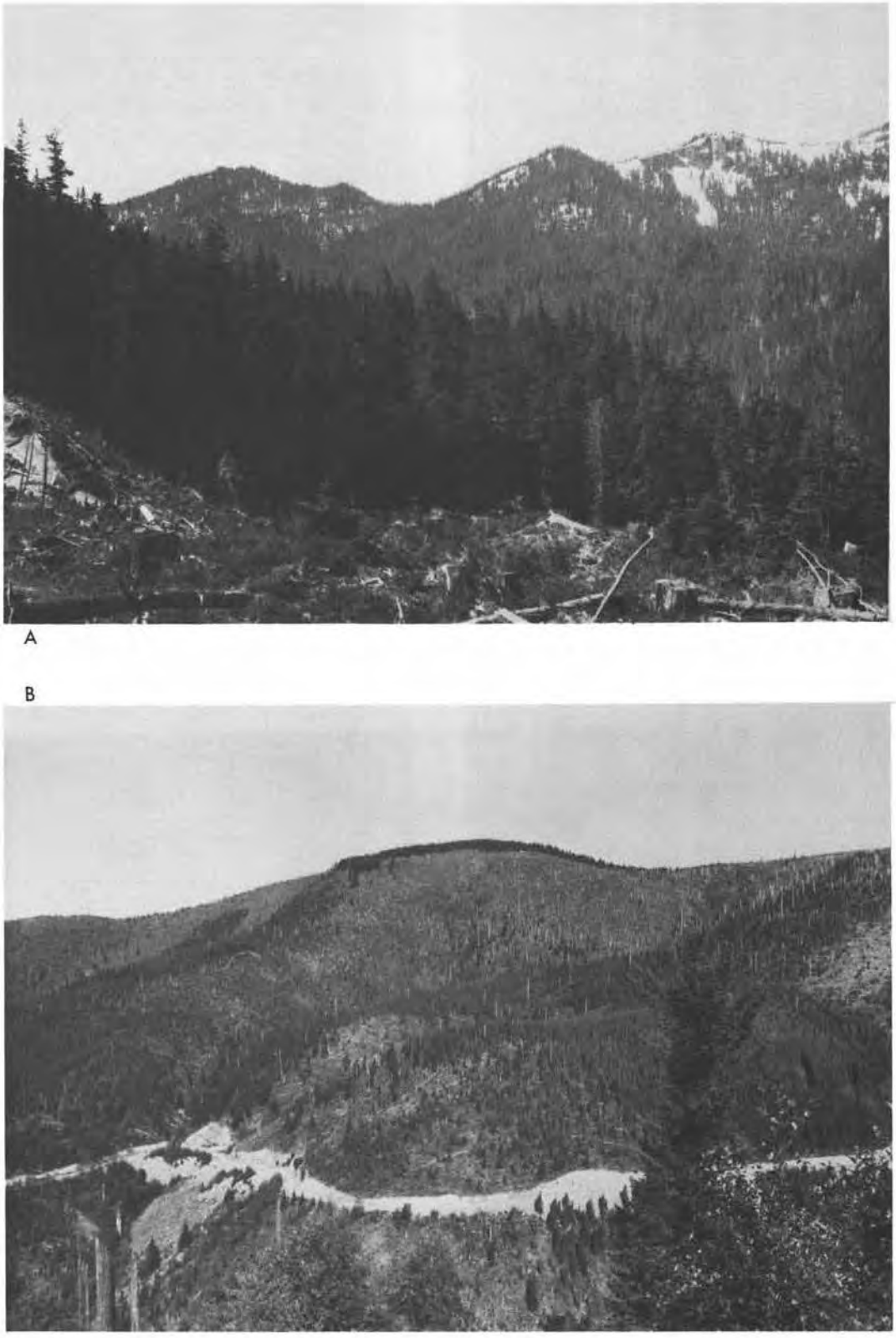


FIGURE 1.—Location map of St. Helens and Washougal mining districts.



A

B

FIGURE 2.—Typical terrain of the southern Cascades. A—Ryan Lake area of the St. Helens district; view looking southwest towards Norway Pass near center of photo. B—Copper Creek area of the Washougal district; view looking north from vicinity of Miners Queen prospect; terrain void of timber because of devastating forest fires in the early 1900's.

and logging roads provide access to much of the region. These roads connect with Interstate 5 on the west, State Route 14 on the south, and U.S. 12 on the north. Most forest service roads are maintained seasonally, whereas many secondary logging roads are not maintained and may be difficult to travel.

GENERAL GEOLOGY

Published material on the geology of the southern Cascades is fragmental and much of the region has yet to be mapped geologically. One of the earliest accounts of the geology of the St. Helens mining district was made by Carl Zapffe in 1912. In "The Geology of the St. Helens Mining District of Washington" Zapffe reported briefly on the geology, as well as on the physiography and topography of the district. In the Washougal district, W. M. Felts (1939) described the geology of Silver Star Mountain in a report entitled "A Granodiorite Stock in the Cascade Mountains of Southwestern Washington." A general discussion of the geology of the Washougal district was presented by E. T. Hodge (1938) in a paper entitled "Geology of the Lower Columbia River." At least two reports describe the geology and mineralogy of areas outside the boundaries of the St. Helens and Washougal mining districts. W. S. Wise (1961) reports on the Wind River area of southeastern Skamania County in "Geology and Mineralogy of the Wind River Area." The Camp Creek area of northeastern Skamania County has been studied by Ruth B. Simon (1972) and described in "Geology of Camp Creek Area, Northern Skamania County."

The general geology of the southern Cascades was presented on the preliminary geologic map of Washington that was published by Washington Division of Geology in 1936. In 1961 (Huntting and others), a new updated version of the geologic map of Washington was published by Washington Division of Mines and Geology. Volcanic rock units of the southern Cascades were shown in greater detail and several intrusive bodies were added to the new map. In the summers of 1972 through 1975, the volcanic rocks of the southern Cascades were studied by Dr. Paul Hammond, of Portland State University, in connection with a study of the geothermal possibilities of the southern Cascades. Preliminary maps of Dr. Hammond's work are on file at Washington Division of Geology and Earth Resources in Olympia. The most recent geological mapping to take place in the southern Cascades is that of the U.S. Geological Survey. In late summer of 1976, the Survey began mapping the Spirit Lake $7\frac{1}{2}$-minute quadrangle.

Geologic studies to date (1977) indicate that the southern Cascades of Washington were derived from vast eugeosynclinal accumulations of volcanic and sedimentary rocks that range from Eocene to Recent age. Volcanic rocks predominate and consist chiefly of basalt, andesite, flow breccia, tuff, and pyroclastics. Tuffaceous and arkosic sandstone and shale are interbedded with volcanic rocks. Volcanic and sedimentary rocks have been folded into open folds with northwest-trending fold axes and intruded by stocks of granodiorite, diorite, and quartz diorite. Hornfels aureoles and breccia zones are associated with some stocks, and alteration of the intrusive rocks is prominent. Above the surface of these rocks rise the volcanic cones of Mount St. Helens, 9,671 feet, and Mount Adams, 12,307 feet, composed chiefly of layers of basalt, andesite, and tephra. Both mountains were formed in comparatively recent times. St. Helens is probably not more than 30,000 years old, and many basalt flows that make up the mountain cannot be more than a few hundred years old. The present cone is the result of a major eruption that occurred around 1800. Heavy ash falls were reported in 1842, and an eruption of basalt occurred as late as 1854. North and northeast of Mount St. Helens for as much as 30 miles, large areas of the surface are mantled by pumice and pumicite from eruptions of St. Helens.

METALLIC MINERAL DEPOSITS

The metal deposits of the southern Cascades are in stockworks or breccia zones and narrow fissure veins, containing only moderate amounts of copper and small amounts of lead, zinc, molybdenum, gold, and silver. Predominant ore minerals are pyrite, magnetite, chalcopyrite, bornite, galena, and sphalerite. At some occurrences these minerals are accompanied by free gold, especially in the oxidized parts of the veins. Common secondary copper minerals associated with chalcopyrite and bornite consist of azurite, malachite, and chrysocolla. Tourmaline is a common accessory mineral at several copper mineralized breccia deposits.

As can be seen in figure 3, the metal deposits of the southern Cascades are confined to certain areas

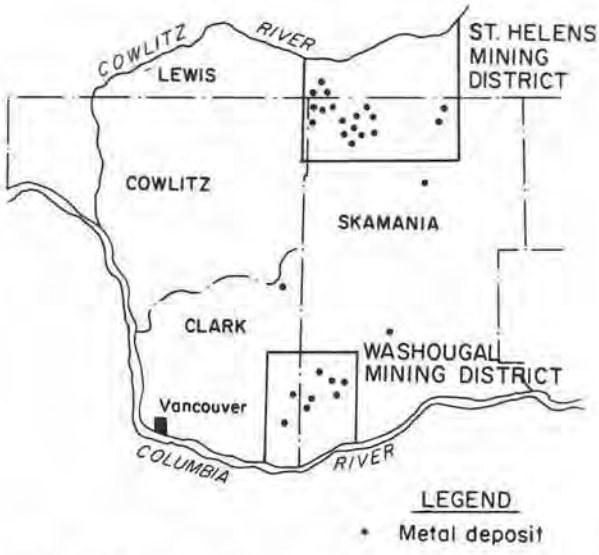


FIGURE 3.—Distribution of metal deposits in the southern Cascades.

in the St. Helens and Washougal mining districts. In the Washougal district the deposits occur chiefly along the eastern edge of the Silver Star Granodiorite. In the St. Helens district the deposits occur chiefly in the southeastern part of the Mount Margaret stock, and along the south-central section of the Goat Mountain stock. Outside the boundaries of the St. Helens and Washougal districts, several copper-gold deposits occur in the Camp Creek area of McCoy Creek in north-central Skamania County, whereas the major gold-producing area of southwestern Washington has been the Wind River area of southeastern Skamania County.

The earliest account of the mines and prospects of the southern Cascades was by L. K. Hodges in 1897. In "Mining in the Pacific Northwest," Hodges briefly described the mining history and mining properties of the St. Helens district. Landes and others (1902) reported on the mineral occurrences of the district; in 1912, H. V. Winchell reported on the general barrenness of the district. In an unpublished report of 1934, H. L. Williams discussed mining activity in the St. Helens and Washougal districts, as well as several prospects in outlying areas. In 1935, Everett Hougland reported on a geologic reconnaissance of the St. Helens mining district. Mineralization in the Silver Star Mountain area of the Washougal district was described by R. H. Howe in 1938 and by M. T. Heath in 1966. In 1957, E. A. Magill and R. N. Appling, Jr. reported on the Miners Queen copper deposit in the Washougal district, and in 1969, A. R. Grant briefly described the geology and mineralization of the Silver Star stock. In mineralized areas outside the boundaries of the Washougal and St. Helens districts, J. D. Scott in 1933 described the geology and mineralization at the Camp Creek mine on McCoy Creek.

MINING HISTORY

Although placer gold had been discovered in the gravels of the Toutle River several years previously, it was not until 1892 that the region north of Mount St. Helens experienced an influx of prospectors. Around 1891, two of the region's farmers, totally inexperienced in prospecting, entered the region on a hunting and fishing trip and discovered occurrences of pyrite, chalcopyrite, arsenopyrite, specular hema-

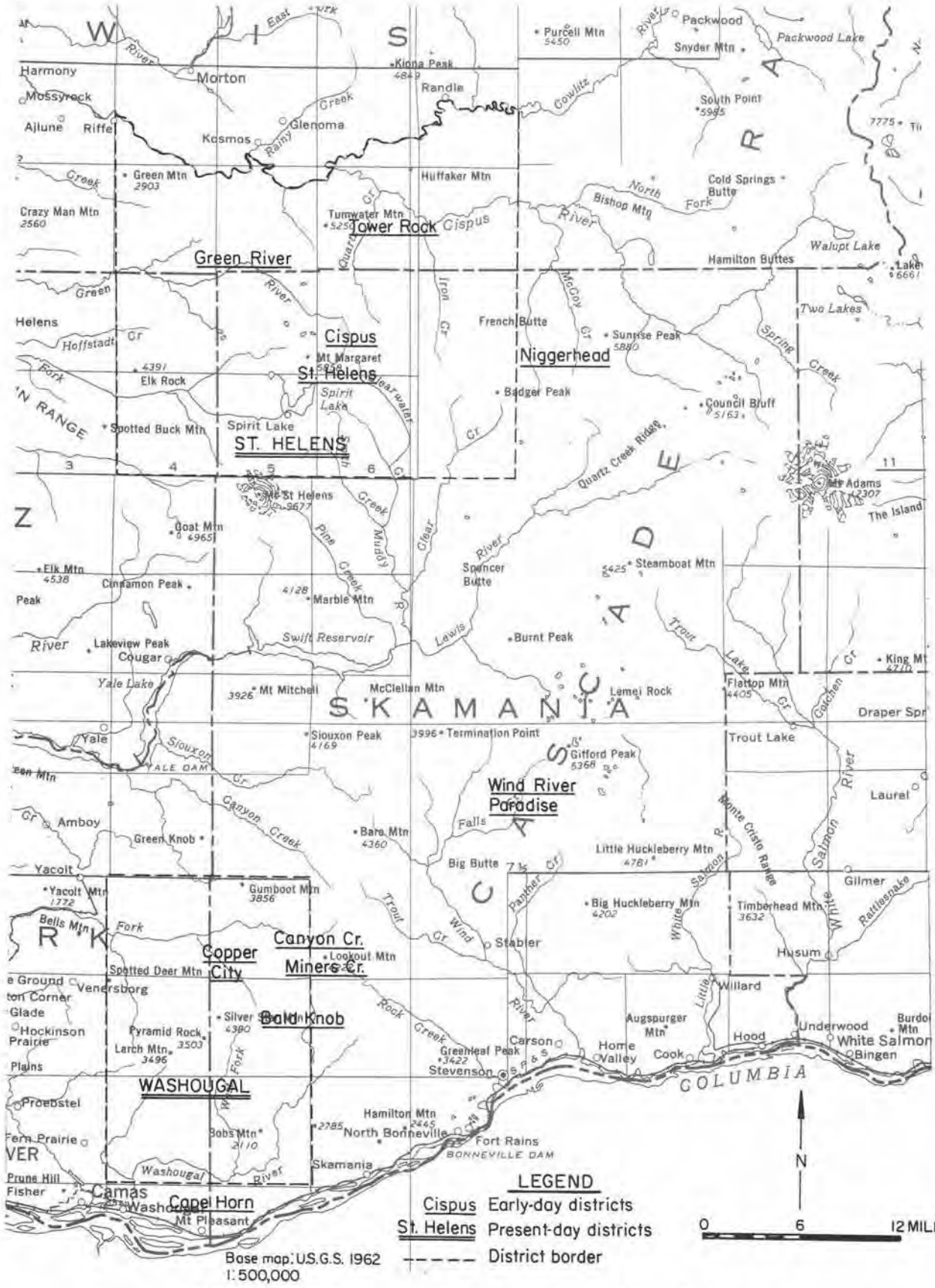


FIGURE 4.—Early-day mining districts of the southern Cascades.

tite, magnetite, galena, sphalerite, and tourmaline. As novices in prospecting, it seemed as if they had discovered a bonanza. When news of their discoveries reached the settlements, prospecting fever spread rapidly. On July 30, 1892, the Cispus mining district, which encompassed north-central Lewis County, northeastern Cowlitz County, and northwestern Skamania County was organized. This was followed in September 1892, by the organization of the Green River mining district, which ". . . shall embrace all lands drained by the Green River and all its tributaries, canyons, and gulches from the mouth to the headwaters and summits of the mountains surrounding the streams." However, because confusion arose between it and the Green River coal district of King County, the name was a short time later changed to the St. Helens district. Early mining districts of the southern Cascades are shown in figure 4.

Following the organization of the St. Helens district in 1892, the district was actively prospected and within 3 years over 500 prospectors had entered the district and staked claims on any outcrop that appeared to be mineralized. Mining companies of large capitalization were organized, and thousands of shares of stock were sold in order to explore and develop the mineral deposits. Placer gold was found in several of the district's streams; however, the deposits proved to be small and unprofitable to mine.

Among the most active companies in the St. Helens district were the Mount St. Helens Consoli-

FIGURE 5.—Polar Star mine (circa 1910) was typical of the many mining properties under development in the southern Cascades at the turn of the century.

FIGURE 6.—Statue of Sacajawea. Unveiled July 7, 1905, at Lewis & Clark Exposition in Portland, Oregon, this statue now stands in Washington Park in Portland. The 20 tons of copper in the statue was donated by Dr. Henry W. Coe and came from copper mines in Oregon and Washington, among which was the Sweden mine in the St. Helens mining district of Washington.

(Photo courtesy of U.S. Forest Service.)

dated Mining Co., Mining Corporation Ltd. of Portland, and Cascadia Mining & Development Co., which under the leadership of Dr. H. W. Coe undertook considerable work at the Norway, Sweden, Polar Star, Minnie Lee, and Last Hope properties (fig. 5). By 1910, thousands of prospect pits had been dug, and over 11,000 feet of underground workings had been driven. Several thousand tons of copper-gold-silver ore had been mined, but most of it remained on the mine dumps. However, in 1905, 14 tons of copper ore from the Sweden mine was laboriously dragged from the mine to Spirit Lake, loaded on a makeshift barge, towed to the western end of the lake, and hauled to the railroad for shipment to the Tacoma smelter. After smelting, the copper is reported to have been cast into a statue of Sacajawea for the Lewis and Clark Exposition in Portland in 1905 (fig. 6). In 1929, a test shipment of three carloads of copper ore was made from the Sweden mine; however, the ore proved to be low grade and mining ceased. Although many thousands of dollars were spent attempting to develop the copper deposits of the St. Helens district, no property became a major producer. For the most part, the veins proved to be narrow and contained only moderate amounts of copper and small amounts of gold and silver. At several properties the veins contained blotchy and scattered bunches of copper minerals that assayed as much as 30 percent copper, but on the average the deposits yielded only several hundred pounds of high-grade copper ore.

East of the St. Helens district, in what was known as the Niggerhead district, claims were staked on deposits of lode and placer gold at the tum of the century. The most productive area proved to be the upper reaches of McCoy Creek, which yielded small amounts of placer gold in the early 1900's and in the depression years of the 1930's. Discovery of placer gold on McCoy Creek led to the discovery of lode gold on Camp Creek, a tributary to McCoy. From 1934 to 1940, the Camp Creek mines produced minor gold from small high-grade deposits that had been discovered in the early 1920's. Since 1940, the McCoy Creek area has been nonproductive. Several streams other than McCoy Creek yielded placer gold; however, all deposits proved to be small and noncommercial.

In the Washougal district of southern Skamania County, discoveries of copper and gold were made in the late 1890's near the headwaters of the East Fork of the Lewis River, and at the headwaters of the Washougal River, as well as at the headwaters of its East Fork. At the turn of the century, mining districts in the southern Cascades consisted of Copper City, Copper Canyon, Miners Creek, Bald Knob, and Cape Horn; around 1930, the districts were consolidated into the Washougal district (fig. 4). Following the initial discoveries, several hundred claims were staked; however, mineralization at most properties was so poor that little in the way of development work took place other than shallow prospect pits and adits. At the more favorable deposits, tunnels up to 3,000 feet in length were driven along the copper veins, and shafts up to 500 feet deep were sunk to test the veins at depth. Properties that underwent extensive exploration and development work for copper and gold in the early 1900's were the Skamania and Last Chance on the West Fork of the Washougal River, and the Maybee mine at the headwaters of the Washougal River. Concentrating mills were built at several properties, but because of the lack of ore, milling operations were short-lived, or because of the devastating forest fires, most mills burned to the ground, never to be rebuilt. Except for minor production from the Maybee in 1917, at the Last Chance and Skamania in 1916, and at the Miners Queen in 1952, production from the Washougal district was insignificant.

MINERAL PRODUCTION

The total recorded metal production, according to the U.S. Bureau of Mines, from the St. Helens

and Washougal mining districts and the McCoy Creek and Wind River areas, from 1903 through 1974, amounts to only $26,538 and is distributed as follows: gold $22,844, silver $1,345, copper $2,341, and lead $8. Prior to 1903, mineral production figures were not broken down by counties. Small amounts of placer gold were produced in Clark and Skamania Counties between 1893 and 1903; however, total production probably did not exceed several thousand dollars. Prior to 1905, no record can be found of any other metal being produced from mines in the southern Cascades, except for a 150-pound test shipment of copper ore from the Norway mine. Mineral production figures for Clark and Skamania Counties are shown in table 1.

PLACER DEPOSITS

Although parts of the St. Helens and Washougal mining districts were mined for placer gold, the production of placer gold from the districts has been in-

TABLE 1.—Production of gold, silver, copper, and lead in Clark and Skamania Counties, 1903-1974

Year	Gold	Silver	Copper	Lead	Total	Source of production
			CLARK COUNTY			
1903	None	None	None	None	....	
1904	$100	.do.	.do.	.do.	$100	Columbia and Lewis Rivers placers
1905	$100	.do.	.do.	.do.	$100	.....Do.....
1906	$100	.do.	.do.	.do.	$100	.....Do.....
1907-1934	None	.do.	.do.	.do.	....	
1935	$182	.do.	.do.	.do.	$182	Columbia and Lewis Rivers placers
1936-1976	None	.do.	.do.	.do.	....	
Total	$482				$482	
			SKAMANIA COUNTY			
1903-1904	None	None	None	None	.....	
1905	$ 98	.do.	$ 287	.do.	$ 385	Sweden mine
1906-1913	None	.do.	None	.do.	.....	
1914	.do.	$ 3	$ 19	.do.	$ 22	Unknown
1915	.do.	None	None	.do.	.....	
1916	.do.	$ 79	$ 315	.do.	$ 394	Skamania and Last Chance mines
1917-1928	.do.	None	None	.do.	.....	
1929	.do.	$ 21	$1,181	.do.	$1,202	Sweden mine
1930-1933	.do.	None	None	.do.	.....	
1934	$290	.do.	.do.	.do.	$ 290	Camp Creek mine and Columbia River placers
1935	$560	.do.	.do.	.do.	$ 560	Camp Creek mines
1936	$140	.do.	.do.	.do.	$ 140	....Do.....
1937	$175	.do.	.do.	.do.	$ 175	....Do.....
1938	$875	$ 2	.do.	.do.	$ 877	....Do.....
1939	$280	None	.do.	.do.	$ 280	....Do.....
1940	$210	.do.	.do.	.do.	$ 210	....Do.....
1941-1951	None	.do.	.do.	.do.	.....	
1952	.do.	.do.	$ 179	.do.	$ 179	Miners Queen mine
1953-1962	.do.	.do.	None	.do.	.....	
1963	$8,120	$403	$ 246	.do.	$8,769	Wind River mine
1964-1965	None	None	None	.do.	.....	
1966	.do.	$ 9	$ 36	.do.	$ 45	Wind River mine
1967	$210	$ 28	None	.do.	$ 238	....Do.....
1968-1971	None	None	.do.	.do.	.....	
1972	$3,106	$142	$ 78	$ 8	$3,334	Wind River mine
1973	$4,304	$258	None	None	$4,562	....Do.....
1974	$3,994	$400	.do.	.do.	$4,394	....Do.....
	$22,362	$1,345	$2,341	$ 8	$26,056	

significant. Production records published by the U.S. Bureau of mines from 1903 to 1976, show less than $1,000 in placer gold from Skamania and Clark Counties. Placer gold was undoubtedly produced prior to 1903, but records were not kept on a county basis until 1903, which makes it impossible to know what share of the state's placer gold production should be credited to the Washougal and St. Helens districts. In addition to unknown amounts of placer gold, 1.5 ounces of platinum was produced prior to 1903 from small-scale placer mining operations on the East Fork of the Lewis River in the Washougal district.

Placer mining for gold was carried out as early as 1889, at the headwaters of the East Fork of the Lewis River in southwestern Skamania County, and as early as 1900, on McCoy Creek in the northeastern part of the county. Also, small amounts of placer gold were recovered from black sand deposits on bars of the Columbia River in Skamania and Clark Counties. At the turn of the century, work at most placer operations ceased. However, because of the presence of platinum, Harvey McMunn continued to work his deposit 4 miles upstream from Moulton on the East Fork of the Lewis River. In 1912, a Portland company engaged in hydraulic mining 1 mile upstream from the McMunn operation, but the operation proved unprofitable and was abandoned. McMunn's operation yielded only 17.5 ounces of gold and 1½ ounces of platinum, whereas the cleanup from the hydraulic operation yielded 1 ton of black sand containing 1 ounce of gold.

In the 1930's, claims on McCoy Creek belonging to McCoy Creek Placer Mining Co. were placered for gold. The gravels reportedly tested out at 75 cents to $1.10 per yard in gold, but no record of production exists for the company. Remains of this operation are still visible at the confluence of McCoy and Camp creeks.

Currently (1977), except for an occasional gold panner, placer mining for gold is not being undertaken in the Washougal and St. Helens mining district.

The presence of placer platinum on the East Fork of the Lewis River deserves further mention because it is one of the few occurrences of platinum in Washington. According to U.S. Geological Survey Bulletin 805-A (Pardee, 1929, p. 8, 9) platinum and gold occur as small particles in black sand consisting chiefly of magnetite.

> The platinum grains are dull tin-white and rather smooth except that some of them show small pits filled with iron oxide. Some are rather flat but not flaky, and others are round as shot. They range in size from fine specks to small pin heads. . . . Most of the platinum is strongly attracted by an ordinary horseshoe magnet . . . . Its rather strong magnetism indicates that the Lewis River platinum probably contains as much as 10 percent of iron.
>
> . . . tests also show that the ratio of gold to platinum ranges between 1 to 7 and 1 to 10 by weight.
>
> . . . there is nothing to suggest that the platinum is of other than local origin. The serpenture reported to occur farther upstream (below the mouth of Copper Creek) is thought to be the probable source. It is rather curious that, so far as known, the platinum is confined to the present channel of the South [now shown as East Fork on maps] Fork. This condition suggests that the platinum-bearing rocks, which are presumably older than the lavas, were not uncovered until the river had cut down nearly to its present level.

OUTLOOK FOR THE DISTRICTS

St. Helens District

Although deposits of gold, silver, copper, lead, and zinc are present in the St. Helens district, the deposits consist chiefly of narrow quartz-sulfide veins that are not sufficiently mineralized to be of economic value. To date (1977), out of 30 vein-type deposits that have been explored, only the Norway-Sweden vein appears to contain copper-bearing ore shoots with tonnages and grades required for a profitable mining venture on a small scale. Exploration and development work at the Sweden mine has established inferred ore reserves of about 20,000 tons of 2.5 percent copper. However, parts of the vein con-

tain as much as 10 percent copper over 5-foot vein widths.

The presence of granitic intrusive rocks, well-developed fractures and shear zones, pyritized and tourmalinized rocks, and anomalous copper mineralization in the St. Helens district provide target areas for porphyry copper prospecting. In the Ryan Lake area, Duval Corp. has been investigating a porphyry copper deposit for the past six years. In the Camp Creek area, conditions appear geologically favorable for porphyry copper; however, target areas have not yet been adequately explored. The area several miles northeast of Spirit Lake is geologically similar to the Ryan Lake area. The area contains at least eight vein-type copper deposits, but target areas for porphyry copper have yet to be delineated.

Unless minable porphyry copper deposits are discovered and developed in the St. Helens district, it is doubtful that the district will ever become a significant metal-producing district of Washington.

Washougal District

The Washougal district contains no less than 13 deposits of gold, silver, copper, lead, and zinc, almost all of which consist of narrow quartz-sulfide veins. Several deposits have been extensively explored, but work to date (1977) indicates that the deposits lack sufficient ore for profitable mining operations. The most persistent copper mineralization of the vein-type deposit appears to be at the Skamania and Last Chance mines. At the Skamania, 1,374 feet of the vein, along its strike, averages around 2 percent copper, over an average vein width of 3.5 feet. At the Last Chance, 936 feet of the vein, along its strike, averages around 2.75 percent copper and 0.71 ounce per ton in silver, over an average vein width of 4 feet. Higher copper prices in the future and selective mining of the Skamania and Last Chance veins could result in minor production from both properties.

To date (1977), only one porphyry copper target area has been delineated. In the Miners Queen area of Miners Creek, Amoco Minerals Company, has over the past 3 years, diligently explored an extensive copper-mineralized fracture system. The company has yet to determine if a minable copper deposit exists; however, the geological environment appears favorable for a significant copper deposit.

As in the case of the St. Helens district, the future of the Washougal district depends upon the discovery of minable porphyry copper deposits. Production from the vein-type deposits of the district, if any at all, will be insignificant.

ST. HELENS MINING DISTRICT

GENERAL INFORMATION

For the purpose of this report, the St. Helens district is confined to northwest Skamania County, the northeast corner of Cowlitz County, and a small part of south-central Lewis County (fig. 4). The south border of T. 9 N. forms the southern boundary of the district, whereas the Cowlitz and Cispus Rivers form the north boundary. From the east edge of R. 3 E., the district extends 24 miles eastward to the east edge of R. 7 E. The district encompasses about 400 square miles (256,000 acres).

The terrain of the St. Helens district is mountainous, but not rugged (fig. 7). Moderately steep slopes support good stands of Douglas fir, with minor hemlock, silver fir, red cedar, and noble fir. Steep slopes are predominantly rocky and support little vegetation; in places, steep, near-vertical cliffs prevail. Elevations range from about 1,600 feet on the Green River in the northwest corner of the district to 5,858 feet on the summit of Mount Margaret north of Spirit Lake, and to a maximum of 6,320 feet at Goat Rocks at the southern edge of the district. About 1.75 miles south of Goat Rocks, snow-clad Mount St. Helens,

FIGURE 7.—Typical terrain of the St. Helens district; view looking west with Goat Mountain in upper right and valley of Green River at left center. Ryan Lake (not visible) at lower right.

with a summit elevation of 9,677 feet, towers over the surrounding landscape (fig. 8).

Numerous streams form a dendritic drainage pattern in the district and discharge into the Cowlitz, Cispus, Toutle, and Green rivers. No fewer than 30 lakes are scattered throughout the district and vary in size from small mountain tarns less than 1 acre in size to Spirit Lake, which covers about 2 square miles. October through April are the rainy months, with snow falling at higher elevations from November through March. As much as 10 feet of snow covers the higher mountains during the winter months, making access to much of the high country difficult until June or early July.

County and Forest Service roads provide good access to much of the district. Forest Service road 115 from Randle provides access to the Ryan Lake area at the headwaters of the Green River, whereas Forest Service Route 100 provides access to several mines of the Spirit Lake area. Many prospects are accessible only by trail from Routes 100 to 115. Both Randle and Spirit Lake are about 50 miles from Interstate 5.

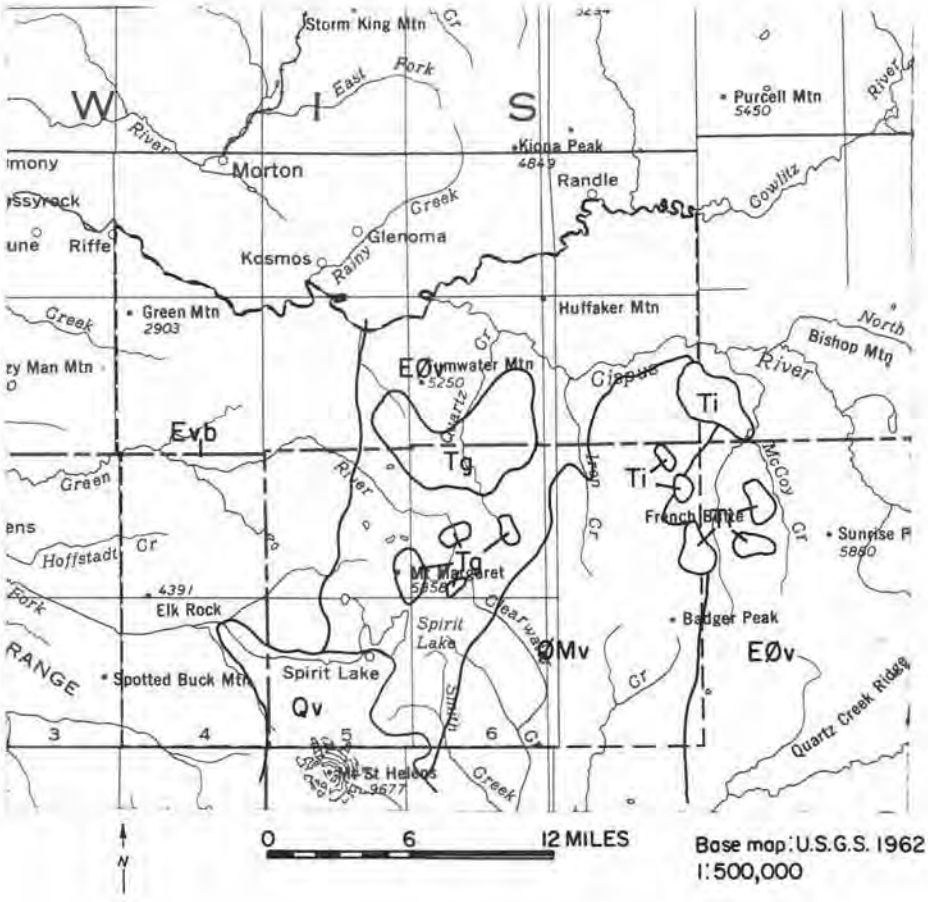
GENERAL GEOLOGY

The rocks of the St. Helens mining district consist chiefly of thick sequences of andesitic flow rocks, breccias, tuffs, and volcanic sandstones and siltstones, which range in age from Eocene to early Miocene (fig. 9). Open north- to northwest-trending folds predominate and dips seldom exceed 30°. On the eastern edge of the district, massive andesite flows predominate and appear to be related to the

FIGURE 8.—Mount St. Helens. View looking west from Forest Service road 100 in vicinity of Independence Pass.

Fifes Peak Formation (Oligocene or Miocene) of Fiske, Hobson, and Waters (1963). In the central part of the district, the rocks consist chiefly of andesite, volcanic breccia, volcanic siltstone and sandstone of the Ohanapecosh Formation (upper Eocene). Along the western edge of the district basaltic lavas and associated pyroclastic rocks of the Goble Volcanics (upper Eocene) predominate.

On the northeastern edge of the district, rocks of the Fifes Peak Formation have been intruded by small stocks, dikes, and sills of andesitic porphyry and dacite. Near the central part of the district several bodies, from less than a quarter square mile in area to as much as 18 square miles, intrude volcanic rocks of the Ohanapecosh Formation. The largest of these bodies crops out in the Goat Mountain-Strawberry Mountain area, 6 miles north of Spirit Lake. The stock consists of medium-grained hornblende granodiorite, which is, in part, quartz monzonitic and dacitic. Near the contact of the stock, propylitic, silicic, sericitic alteration is prominent, and the intruded rocks have been hornfeltized. East-west and north-south trending joints are prominent and some joints have been mineralized with pyrite, chalcopyrite, and tourmaline. Immediately north of the north end of Spirit Lake and east of Mount Margaret, andesites of the Ohanapecosh Formation have been intruded by a stock $2\frac{1}{2}$ square miles in area. The stock is predominantly granodiorite, but contains minor diorite and quartz diorite. Propylitic alteration appears moderate along the border of the stock, whereas the intruded andesites exhibit sericitic alteration. Pyritization of fractures is common both in the stock and the intruded rocks, and some pyrite is



LEGEND

VOLCANIC ROCKS

Qv	Quaternary volcanics of Mount St. Helens. Lava flows of olivine basalt, pyroxene andesite, surrounding summit plug of dacite.
ØMv	Andesite flows, flow breccia, and minor tuff of Fifes Peak Formation
EØv	Andesite breccia with andesite and basalt flows and interbedded sandstone and tuff beds of Ohanapecosh Formation.
Ev_1b	Basalt flows and flow breccia of the Goble Volcanics

INTRUSIVE ROCKS

Tg	Granodiorite, quartz diorite, quartz monzonite, and minor dacite
Ti	Andesite porphyry, dacite porphyry, and quartz diorite

– – – – – St. Helens mining district boundary

FIGURE 9.—Geologic map of the St. Helens district.

accompanied by minor chalcopyrite, sphalerite, and galena. In addition to the above-mentioned stocks, smaller bodies of granodioritic rock crop out between Spirit Lake and Strawberry Mountain (fig. 9). The borders of these bodies have not yet been delineated by geologic mapping, but future mapping will undoubtedly show that the granodioritic intrusive rocks are more extensive than previously thought.

Potassium-argon dating of the Spirit Lake pluton by the U.S. Geological Survey (Engels and others, 1976) indicates an age of 21.4 million years (middle Miocene). The Goat Mountain-Strawberry Mountain stock has been dated at 16.2 million years, whereas the Camp Creek stock on the eastern edge of the district is believed to be 24.0 million years old (Armstrong and others, 1976, p. 242). These ages suggest that the plutons of the St. Helens district and the associated sulfide mineralization are related to the Snoqualmie intrusive episode.

Much of the eastern half of the district is mantled by tephra that ranges from less than 1 inch to as much as 10 feet in thickness. The tephra consists chiefly of pumice and pumicite, but some lithic ash and scoria are present. The tephra originated from Mount St. Helens during eruptive times and was deposited 36,000 to 12,000 years ago. Mount St. Helens, which rises to an elevation of 9,677 feet, consists of lava flows of olivine basalt and pyroxene andesite, as well as great thicknesses of tephra. Valley-fill material adjacent to Mount St. Helens includes pyroclastic flow deposits, lahar, alluvium, tephra, and glacial drift.

MINERALIZATION

Pyrite is a common associate of most volcanic and plutonic rocks of the St. Helens district, whereas other ore minerals appear to be related to intrusive granodioritic rocks. As can be seen in figure 10, areas of significant mineralization are the upper Green River area and the area between Mount Margaret and Bismark Mountain. In both areas, fractures in granodioritic intrusive rocks and the intruded volcanic rocks, near the intrusive contact, are mineralized. The fractures range from less than 1 inch to as much as 4 feet in thickness. Underground mining operations show some fractures to be in excess of 2,000 feet in length, whereas surface expressions suggest lengths in excess of 4,000 feet for some fractures. The depths to which the mineralized fractures extend are unknown; however, mine workings on several persistent fractures indicates depths in excess of 300 feet. The fractures commonly occur in parallel sets, and intersecting sets produce stockworks or breccia zones that are loci for mineral deposition. In the Ryan Lake area, most fractures exhibit northwest and east strikes, whereas in the Spirit Lake area northerly strikes predominate. Most fractures are steeply dipping, with dips that average 70°. Dips of mineralized fractures of less than 40° are uncommon.

Vein material of the fractures consists of quartz, calcite, gouge, and wall rock fragments. Disseminated cubic pyrite grains can be found in most vein material, as well as in the altered wall rocks. In some veins the pyrite is accompanied by chalcopyrite, sphalerite, galena, pyrrhotite, arsenopyrite, and gold, in order of decreasing abundance. These ore minerals commonly occur as small lenses, thin stringers, or as disseminations and appear to favor the silicified parts of the veins. In most veins the ore shoots are small and discontinuous. Only at the Sweden and Norway mines were the ore shoots somewhat persistent along the strike and dip of the veins.

Wall-rock alteration of most veins is intense; outward from the veins it consists of silicic, quartz sericitic, argillitic, and propylitic alteration. Pyrite and pyrrhotite commonly alter to hematite and goethite, whereas chalcopyrite alters to malachite. The surface parts of most veins, as well as the adjoining wall rock, exhibits reddish-brown coloration as a result of the oxidation of pyrite and chalcopyrite. Although the near-surface parts of most veins have been oxidized, it is doubtful that a zone of secondary enrichment

PROPERTY INDEX

Ryan Lake area

1. Big Blue
2. Chicago-Golden Crown
3. Dixie Queen
4. Earl (Sampson)
5. Germania
6. Goat Mountain
7. Golconda
8. Grizzly Creek
9. Independence
10. Index
11. Insurance
12. Last Hope
13. Minnie Lee
14. Morning
15. Mountain Chief
16. Polar Star
17. Rocky Point

Spirit Lake area

18. Bonanza
19. Bronze Monarch
20. Chicago
21. Commonwealth
22. Hercules
23. Kangaroo
24. Norway
25. Sweden
26. United (Mount Fairy)
27. Young America

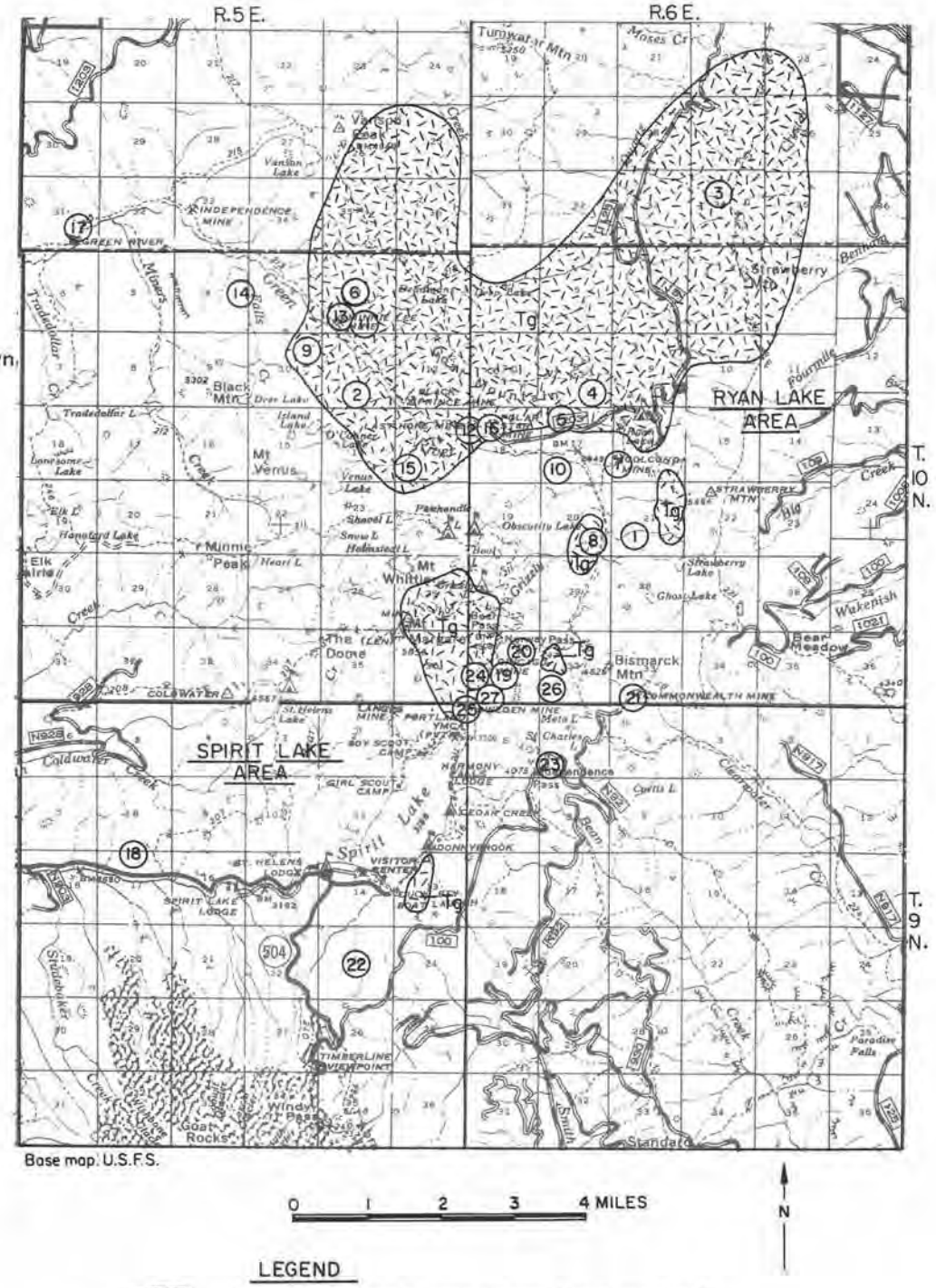


FIGURE 10.—Metal occurrences of the St. Helens district.

with higher copper values will be encountered at depth. The presence of pyrite and chalcopyrite near the surface indicates that oxidation is incomplete and the ground-water table throughout the district is at or very near the surface.

The proximity of the mineralized veins to the granodiorite stocks, as well as silicic, pyritic, and sericitic alteration of the vein's wall rocks suggests a hydrothermal origin for the veins. As such, metalliferous hydrothermal solutions were deposited along fracture zones as a late product of cooling plutons, and are probably middle to late Miocene in age.

Insufficient work has been done at most deposits to establish the tenor of the ore. In the course of the examination of the St. Helens district, the writer was unable to sample any ore shoots because of caved mine workings; however, samples were collected from outcrops of veins and from adit dumps containing small stockpiles of ore. Spectrographic analyses of these samples showed no gold, traces to 0.50 ounce per ton of silver, traces to 3.50 percent copper, traces to 0.27 percent lead and zinc, and traces of molybdenum. A summary of the analyses is shown in table 2. Richer vein material undoubtedly is or was present at several deposits as is shown by analyses of ore shipments and sampling undertaken in the past. Copper ore from the Norway and Sweden mines contained traces to 17.85 percent copper, traces to 1.10 ounces of gold, and nil to 3.80 ounces of silver. Fourteen tons of hand-sorted ore shipped from the Sweden Mine in 1905 averaged 6.6 percent copper, whereas a 76-ton shipment from the mine in 1929 averaged only 0.45 percent copper and 0.53 ounces per ton in silver. At the Polar Star mine, assays showed 0.05 to 30.8 percent copper, nil to 0.70 ounce gold, and nil to 14.56 ounces silver. Additional analyses of vein and dump material from several properties in the St. Helens district are shown in table 2. Please refer to specific properties in the text for other assays.

RYAN LAKE AREA

General Information

Mining properties of the Ryan Lake area (a part of the St. Helens district) comprise 66 patented mining claims and an unknown number of unpatented claims. The claims are on both sides of Green River, from Miners Creek on the west to Grizzly Creek on the southeast, and within an area of about 15 square miles (figs. 10 and 11). The area has experienced little in the way of mining activity since the early 1900's, when most mineral exploration was undertaken in the St. Helens district. Since 1970, exploration and development work has been done chiefly by Duval International Corp. at their Margaret mine project, about 1 mile west of Ryan Lake. Under investigation are the Earl, Germania, Polar Star, and Index groups of claims that were patented in 1910. To date (1977), many core holes have been drilled by Duval to delineate concealed porphyry copper deposits.

Although several thousand feet of adits were driven in the early 1900's in search of ore, most mine workings are caved at their portals and inaccessible. Inasmuch as most adits and prospect pits are no longer discernible, it is difficult to locate many of the prospects of the area.

Mines and Prospects

Polar Star

The Polar Star group of 11 patented mining claims is mainly in the NW¼ sec. 18, T. 10 N., R. 6 E. (fig. 11), and at the end of Forest Service road 1203. Elevations at the property range from 2,800 to 4,000 feet. The main adit is about 3,000 feet north of the end of the road and on the lower southern slope of Goat Mountain. Reddish-brown, iron oxide-stained

TABLE 2.—Analyses of samples and shipments from mines and prospects of the St. Helens and Washougal mining districts

	Copper (percent)	Gold (oz/ton)	Silver (oz/ton)	Remarks
Norway	9.20	1.10	1.40	150 lb test shipment, 1900[1]
	0.16 to 17.85	Tr. to 0.42	1.00 to 19.18	8 samples, 1910[2]
	1.07 to 3.73	.....	.....	5 samples, 1943[3]
Sweden	6.6	.....	.....	14 tons, 1905[1]
	0.45	.....	0.53	76 tons, 1929[4]
	4.5 to 14.2	0.03 to 0.09	0.04 to 2.00	5 samples, 1906[1]
	Tr. to 12.36	0.05 to 0.61	0.98 to 3.80	10 samples, 1910[2]
	1.07 to 8.90	.....	.....	14 samples, 1943[3]
	0.02 to 1.28	Tr.	Nil to 2.88	4 samples, 1959[3]
Polar Star	4.2 to 15.4	0.09 to 0.70	3.59 to 14.56	3 samples, 1909[5]
	4.9 to 30.8	0.02 to 0.08	0.80 to 10.80	10 samples, 1908[1]
	0.05 to 5.13	Tr. to 0.08	Nil to 2.88	4 samples, 1959[3]
Last Hope	Tr. to 11.22	Nil to 0.06	Nil to 7.00	15 samples, 1918[1]
Index	Tr. to 0.70	1.84 to 2.10	1.0 to 1.1	2 samples, 1910[2]
Miners Queen	0.07 to 14.30	Tr. to 0.01	0.05 to 0.24	33 samples, 1957[6]
	Nil to 4.08 (average 0.39)	.....	.....	87 core analyses, 1957[6]
Black Jack	0.28 to 2.92	Tr.	Tr. to 0.40	4 samples, 1955[3]
Silver Star	0.16 to 18.20	0.20 to 1.12	Tr. to 4.4	50 samples, 1930[7]
	Tr. to 2.32	0.08 to 0.24	0.05 to 2.80	4 samples, 1930[7]
Skamania	15.8 to 23.5	0.01 to 0.18	8.7 to 18.5	Sorted ore, 1916[8]
	2.0	.....	1.0	Average for 3.5 ft vein width[9]
	1.05 to 5.54	.....	.....	8 in to 8 ft vein widths[9]
	1.05 to 12.20	Nil to 0.03	0.04 to 11.60	13 samples, east adit[3]
	0.25 to 0.35	.....	.....	2 samples, west adit[3]
Last Chance	2.20 to 3.09	Nil	Nil	6 samples, east adit[9]
	2.75	Nil	0.71	Average for vein[9]
Yellow Jacket	4.73	Tr.	3.47	Average for 5 samples[3]
Maybee	1.3 to 3.10	Tr. to 0.02	2.58 to 5.46	Select dump samples[3]
Blue Bird	0.20	Tr	0.25	Ore stockpile[3]
Wind River	.....	0.12 to 0.59	0.36 to 0.84	Ore shipped[3]
United	6.0	0.21 to 0.63	1.1 to 4.3	2 samples, 1910[1]

Sources of analyses

1/ Gray, 1918
2/ Barker, 1910
3/ Washington Division of Geology files
4/ U.S. Bureau of Mines
5/ Gray, 1917
6/ Magill and Appling, 1957
7/ Riddell, 1930
8/ Brinsmade, 1916
9/ Brerton, 1900

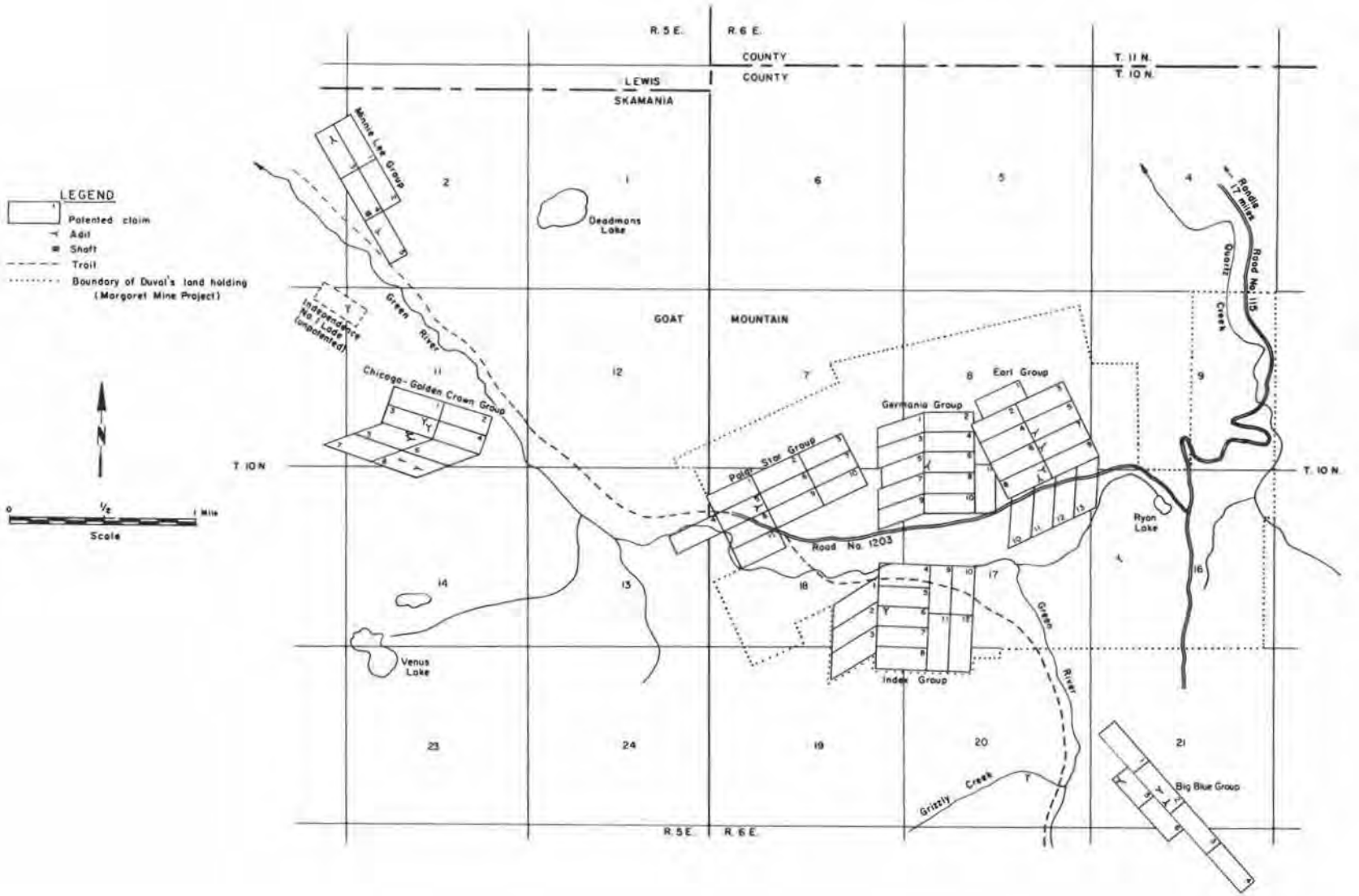


FIGURE 11.—Patented mining claims of the Ryan Lake area.

PATENTED CLAIMS OF THE RYAN LAKE AREA

Polar Star Group

1. Phil Sheridan No. 1
2. Phil Sheridan No. 2
3. Polar Star Jr. No. 2
4. Black Falls No. 2
5. Black Falls No. 1
6. Polar Star No. 2
7. Polar Star No. 1
8. Polar Star No. 3
9. Polar Star Jr. No. 3
10. Polar Star Jr. No. 1
11. Black Hawk

Minnie Lee Group

1. N.C. No. 1
2. N.C. No. 2
3. Minnie Lee No. 3
4. Minnie Lee No. 2
5. Minnie Lee No. 1

Big Blue Group

1. Big Blue No. 1
2. Big Blue No. 3
3. Big Blue No. 4
4. Big Blue No. 5
5. Hiawatha No. 2
6. Hiawatha No. 1

Chicago-Golden Crown Group

1. Silver Bell No. 2
2. Silver Bell No. 1
3. Chicago Golden Crown Jr.
4. Chicago Golden Crown Ext.
5. Chicago Golden Crown No. 2
6. Chicago Golden Crown No. 1
7. El Capitan No. 2
8. El Capitan No. 1

Earl Group

1. Earl No. 9
2. Earl No. 4
3. Earl No. 5
4. Earl No. 3
5. Earl No. 6
6. Earl No. 2
7. Earl No. 7
8. Earl No. 1
9. Earl No. 8
10. Earl No. 13
11. Earl No. 12
12. Earl No. 11
13. Earl No. 10

Germania Group

1. Zenith No. 1
2. Zenith No. 2
3. Ardentine No. 1
4. Ardentine No. 2
5. Germania No. 1
6. Germania No. 2
7. Germania Jr. No. 1
8. Germania Jr. No. 2
9. Germania Secundus No. 1
10. Germania Secundus No. 2
11. Adamantine No. 2

Index Group

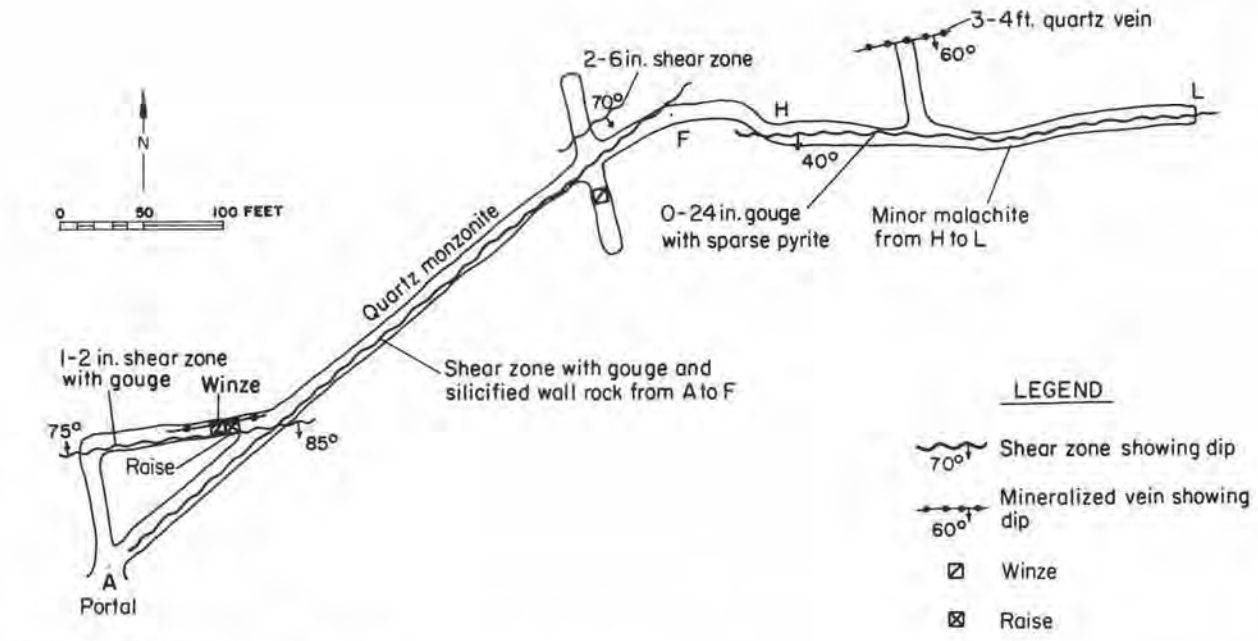
1. Index No. 3
2. Index No. 2
3. Index No. 1
4. Index No. 4
5. Index No. 5
6. Index No. 6
7. Index No. 7
8. Index No. 8
9. Index No. 10
10. Index No. 11
11. Index No. 9
12. Index No. 12

dump material covers much of the area between the road and the adit portal on Black Falls No. 1. In 1958, when the writer examined the property, an estimated 350 tons of ore was stockpiled at the portal of the adit; assays of the stockpile showed 3.45 percent copper, 2.60 ounces per ton silver, and 0.08 ounce of gold. In 1960, the stockpile and other dump material from the mine was used to surface logging roads of the area. The main development work at the Polar Star was undertaken by Cascadia Mining & Development Co. from 1901 through 1905. In 1905, R. E. Hanley examined and reported on the property as follows:

> The principal work from the point of development in the district has been accomplished on the Polar Star group at the point of original discovery of croppings found in bed of creek on the Polar Star claim No. 2. At this discovery point a shaft was sunk on the ore and reached a depth of 37 feet. I was unable to inspect this work, as the shaft has since filled with surface matter, but the result of assays made, taken at different depths at the time work was performed conclusively shows that good values were obtained throughout.
>
> About 50 feet below the shaft, a crosscut tunnel starts to cut the ore body, running a course of about due northwest. In a distance of 90 feet the ore is reached and the tunnel thence follows on its course northeast a distance of 514 feet. For the entire length ore matter has been extracted amounting to some 2,000 tons which is piled at the mouth of the tunnel. The ore is very heavy copper sulphides and from all appearances is admirably adapted for smelting. This is further proven by an analysis made by the Montana Metallurgical Works of Portland, of which mention is made in the prospectus of the Cascadia Mining & Development Co.
>
> In addition to the analysis there is also shown the result of five assays made from average samples taken at different distances along the length of the ore body resulting in a total average value of $89 per ton in copper, gold, and silver. A smelting test from average ore taken from a depth of 10 feet in the shaft and from the entire length of the tunnel giving an average of 17.9 percent copper besides gold and silver, a total of $65.25 per ton. At a distance of 100 feet in on the vein a crosscut through the ore body northwest has been driven 12 feet, showing formation all strongly mineralized with occasional streaks of gray copper. At a further distance of 414 feet in on the vein a second crosscut has been started to crosscut the ore body at right angles and is now in 45 feet, showing formation passed through granite carrying gold percentage of white iron pyrites intermixed with streaks of heavy sulphides.

The Polar Star adit (fig. 12) was driven 775 feet along a persistent fracture zone in quartz monzonite; individual fractures range from several inches to 2 feet in width. The first 450 feet of the adit bears N. 40° E.; the remaining 325 feet bears N. 85° to 90° E. Vein material in the fracture zone consists of quartz, gouge, talc, and wall-rock fragments cemented by quartz. Pyrite and minor chalcopyrite are present in the quartz, whereas pyrite and sparse chalcopyrite are present in the silicified and sericitized wall rock, as are small stringers of tourmaline. J. W. Melrose, geologist for the Division of Geology, examined the mine in 1939 and found little in the way of ore. The fracture followed by the adit contained chiefly gouge and wall-rock fragments, and only minor quartz and chalcopyrite. Only minor malachite was present as stains on the adit walls. The only vein material worthy of mention occurs near the foot of a raise about 125 feet from the portal of the adit. In this area a lens consisting of abundant pyrite, arsenopyrite, and sparse chalcopyrite, several inches to 36 inches in width, can be traced for 60 feet in a drift that heads S. 85° W. from the main drift. Assays of this lens show 0.10 percent copper, traces of gold, and 0.50 ounce per ton in silver. Melrose noted that about 350 feet of the adit was timbered, concealing the vein.

Absence of copper ore in the Polar Star adit conflicts with early reports on the mine. Gray (1918) reported that ore from the mine contained 0.10 to 0.70 ounce of gold, 9.99 to 14.55 ounces of silver,



Mapped by J.W. Melrose, — July, 1939

POLAR STAR ADIT

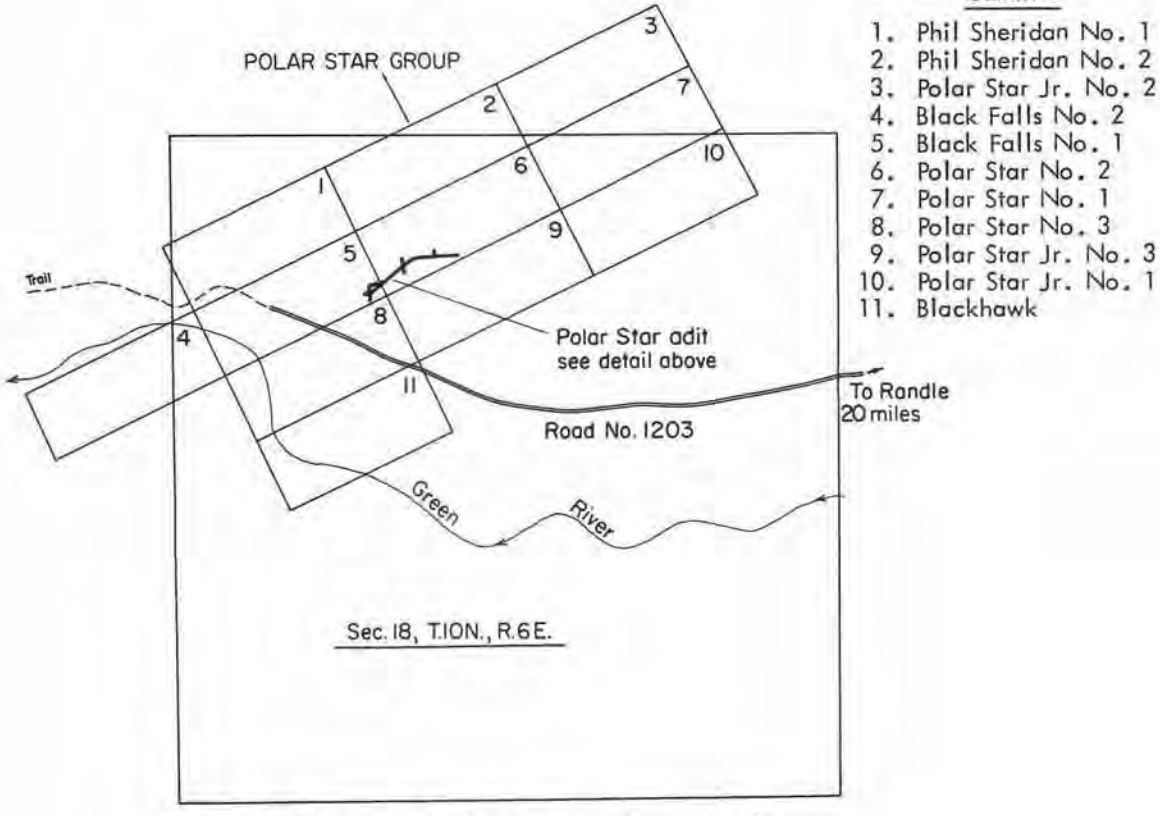


FIGURE 12.—Polar Star group and map of adit.

and 4.28 to 15.48 percent copper, with reserves of 125,000 tons, averaging 7 percent copper. Gray also states that in the bottom of a 100-foot winze a body of chalcocite containing 80 ounces of silver to the ton is exposed. Possibly the 350 tons of 3.45 percent copper that was stockpiled at the portal came from the winze, or from that part of the adit that is timbered and may have been stoped.

Minnie Lee

The Minnie Lee group comprises five patented claims that are in W½ sec. 2, T. 10 N., R. 5 E. (fig. 11). The claims are on the southern slope of Goat Mountain, and at elevations of 2,400 to 3,200 feet. Access to the prospect is by way of 2½ miles of trail from the end of Quartz Creek road (No. 115). No work has been done at the property since 1905 when it was under development by the Cascadia Mining & Development Co.; they were also developing the Polar Star and Last Hope properties. All workings are still (1977) caved and inaccessible as they were when Williams (1934) examined the Minnie Lee. Hanley (1905) reports:

> The croppings were discovered on the Minnie Lee No. 4 claim and can be traced readily on the surface to the Nugget group which joins in the end lines of the Minnie Lee to the west. The development work consists of an open adit 12 feet in length and a shaft 52 feet in depth at point of discovery. The shaft is in ore showing a width of 5½ feet at the bottom. At a point some 600 feet to the southeast of the shaft a crosscut has been started on a course some 6 degrees east to cut the ore body as shown in the shaft. At a point 175 feet in, ledge matter 18 inches wide is encountered and the tunnel follows on its course. At a point 222 feet in, the tunnel cuts the main foot wall of the main fissure, showing a vein filling 4 feet in width carrying a good percentage of iron pyrites. This is followed to the present face of work, a total distance of 297 feet. There is piled at the mouth of the tunnel some 100 tons of ore taken from this work and from all appearances good average-grade concentration ore.

Minnie Lee No. 4 Lode is not shown on the plat of the Minnie Lee group. The plat (fig. 11) shows a 60-foot shaft on Minnie Lee No. 2 Lode, a 100-foot adit on the Minnie Lee No. 3 and a 397-foot adit on the Minnie Lee No. 1, all of which follow a N. 30° W. trending mineralized fracture zone in granodiorite.

Last Hope

The Last Hope group according to Hanley (1905) is situated on the southern slope of Goat Mountain between the Minnie Lee and Polar Star properties (fig. 10). The writer was unable to establish the exact location of the property; however, the claims most likely are in the SW¼ sec. 7, T. 10 N., R. 6 E. and the SE¼ sec. 12, T. 10 N., R. 5 E. The Spirit Lake 15-minute quadrangle shows the Last Hope mine camp in the NW¼NW¼ sec. 18, T. 10 N., R. 6 E., and about 0.4 mile west of the Polar Star mine. According to Gray (1918), pyrite and chalcopyrite occur in a 20- to 30-inch-wide quartz-talc vein in fine-grained granodiorite. Hanley (1905) reports that in addition to the chalcopyrite-mineralized vein, a 2- to 12-inch quartz vein containing galena is present. These veins have been explored by two adits. The upper adit was driven due north for 79 feet, and 40 feet from the portal a drift follows the 2- to 12-inch quartz vein northeast for 30 feet. About 2,000 tons of mineralized rock is stockpiled at the portal of the adit. About 300 feet below the upper adit, a lower adit was driven due north 262 feet, and the last 12 feet of the adit exposes quartz containing abundant pyrite and chalcopyrite (Hanley, 1905). Gray (1918) reported on the analyses of 15 samples from the adits. Assays of the samples showed traces to 11.22 percent copper, nil to 0.06 ounce gold, and nil to 7 ounces silver per ton, with an average of 1.705 percent copper, 2.36 ounces silver, and 0.02 ounce gold.

Earl (Sampson)

The Earl group (fig. 11), which consists of 13 patented mining claims, is about 1 mile northwest of Ryan Lake, and in the SE¼ sec. 8 and NE¼ sec. 17, T. 10 N., R. 6 E. The claims are on the south slope of Goat Mountain and at elevations of 2,848 to 4,000 feet. Access to the property is by way of the Quartz Creek road 115 that passes along the south edge of the claims. Initial exploration work was done on the claims between 1900 and 1904 by Mount St. Helens Consolidated Mining Co. Currently (1977), the Earl group is one of several groups that is under development by Duval Corp. as part of their Margaret mine project.

The area of the claims is underlain by fractured and altered quartz monzonite, quartz diorite, dacite, andesite, and volcanic breccia. The most significant mineralization appears to be confined to areas of closely spaced fractures that form breccia pipes in quartz diorite porphyry. Pyrite, most common ore mineral, is accompanied by minor chalcopyrite and tourmaline and sparse gold and silver. Landes and others (1902) report the presence of a 500- to 1,000-foot-wide ledge that averages not more than $3 per ton in copper, gold, and silver at 1902 metal prices. Alteration of the rocks, outward from mineralized areas, is silicic, quartz sericitic, argillitic, and propylitic. Common alteration products of pyritic rocks consist of hematite, limonite, and goethite, which impart distinct reddish-brown colors to the rocks. Minor malachite and azurite are associated with the oxidized chalcopyrite. Mineralized areas on the Earl group have been explored by eight adits that range from 20 to 475 feet in length, for a total of 1,015 feet. Most adits, which were driven around 1900, are caved at their portals. On the northeast end of Earl No. 1 Lode a 375-foot adit heads N. 17° W., and 345-foot adit heads N. 75° W. from the west bank of Sampson Creek. Along the bank of the creek, for about 1,200 feet north of the 345-foot adit, at least three adits ranging from 30 to 50 feet were driven in search of ore (fig. 11).

Germania

The Germania group of 11 patented mining claims are chiefly in the NW¼ sec. 17 and SW¼ sec. 8, T. 10 N., R. 6 E., about 1 mile west of Ryan Lake (fig. 11). Elevations on the claims range from 2,900 feet near Green River to 4,800 feet near the top of Goat Mountain. Quartz Creek road 115 passes along the southern edge of the claims. Except for core drilling by Duval Corp. from 1970 to 1976, no work has been done at the property since 1905. Hanley (1905) reports a belt of pyritized granodiorite can be traced for 6,000 feet through the Germania group. Near the center of the group, on the Germania No. 2 Lode, an adit was driven 590 feet in the early days at a heading of N. 22° E. to reach the downward extension of sparsely mineralized copper zone; however, it appears that the zone was never intersected.

Independence

This property is one-half mile southwest of the Minnie Lee and centers about the common corner for secs. 2, 3, 10, and 11, T. 10 N., R. 5 E. (fig. 10). It is on the northeast slope of Black Mountain and at elevations of 2,400 to 3,200 feet. About 2.5 miles of trail from the Polar Star mine leads to the northern edge of the property, beyond which point no trail is discernible.

The main vein of the Independence group consists of a northwest-trending quartz vein 14 to 48 inches wide in granodiorite. According to Williams (1934), the vein contains pyrite, chalcopyrite, galena, and bornite. Ore from the property averaged $30 per ton in gold, silver, copper, and lead. The main underground workings consist of a south-trending adit that intersects the vein 125 feet from its portal. At

this point the vein has been followed 215 feet northwest and 60 feet southeast. This adit is possibly the same as the one shown on Independence Lode No. 1 (fig. 11). According to Hanley (1905), 3,000 feet southwest of the adit and at the southwest end of the group, a vein 4 feet in width is exposed in an open cut and can be traced for 3,000 feet on the surface along the side lines of the claims. A shaft was sunk 43 feet on the vein, exposing the same width of vein as is found in the open cut. Thirty tons of ore from the shaft contain pyrite and chalcopyrite and has the appearance of being a good grade of ore (Hanley, 1905).

Index

The Index group of 12 patented mining claims is 1½ miles southwest of Ryan Lake, and chiefly in the SW¼ sec. 17 and the SE¼ sec. 18, T. 10 N., R. 6 E. (fig. 11). The claims are on a north-facing slope of Black Mountain at elevations of 2,840 to 4,400 feet. The northern edge of the claims roughly parallels the Green River, and logging roads from the Quartz Creek road 115 pass within several hundred feet of the group's northern edge. All underground work on the claims was done between 1901 and 1905 by Cascadia Mining & Development Co. Core drilling on the northern part of the claim was undertaken by Duval Corp. in 1973 as part of their Margaret mine project.

Barker (1910) reports that pyrite and minor chalcopyrite occur in faulted and brecciated volcanic rocks as small stringers and pockets. Well-defined veins were not discovered on the property when the original underground work was undertaken. The main adit is about 1,200 feet south of the Green River and on Index No. 6 Lode. The adit heads south 130 feet, at which point it splits into two 50-foot headings, one of which heads southwest, and the other southeast. Barker (1910) reports that two select samples from the adit assays 1.84 and 2.10 ounces per ton in gold, 1.0 and 1.1 ounces in silver, and trace to 0.20 percent copper.

Golconda

This prospect is near the center of the W½ sec. 16, T. 10 N., R. 6 E., and 0.5 miles southwest of Ryan Lake at an elevation of 3,080 feet. About 0.7 miles of trail from Ryan Lake leads to the property (fig. 10). No work has been done at this prospect since the 1930's. Currently (1977), it is held by Duval Corp. as part of their Margaret mine project.

The only underground workings consist of a 40-foot adit that follows a southeast-trending quartz vein in quartz-monzonite. The vein contains mainly pyrite that is accompanied by minor chalcopyrite, sphalerite, and galena. In 1933, about 18 tons of ore was mined and milled at a small three-stamp mill on the property; however, a marketable concentrate was not obtained and operations ceased.

Grizzly Creek

This property, which at one time consisted of 22 unpatented claims, is west of the confluence of Grizzly Creek and Green River, and in the SE¼ sec. 20, T. 10 N., R. 6 E. (fig. 10). From the southern edge of a logged-off area in the SW¼SE¼ of sec. 17, T. 10 N., R. 6 E., 1 mile of trail along the west bank of the Green River leads to Grizzly Creek and the general vicinity of the property. About 1,200 feet up Grizzly Creek from the trail crossing, an adit on the southeast bank of Grizzly Creek heads S. 45° E. for an undetermined distance along a fracture zone in granodiorite. Other than sparse pyrite, no ore minerals were noted in vein material consisting of quartz and altered granodiorite. This is the only mine workings noted on the property by the writer.

Descriptions of the property are given by Gray (1918), Reinhardt (1921), and Williams (1934). Gray and Reinhardt report up to 3 percent copper in altered feldspathic material. According to Reinhardt the adit

is 58 feet in length and 45 feet from the portal. A winze extends to a depth of 33 feet on a vein of plagioclase. The vein is reported to be 3.5 feet wide at the surface and 5 feet wide at the bottom of the winze. This vein material supposedly averaged around 1 percent molybdenite. Reinhardt further states that samples taken from the weathered dump contained 1.51 percent molybdenite. Other mine workings mentioned by Reinhardt consist of a 22-foot adit on the north bank of Grizzly Creek opposite the 58-foot adit, as well as 50- and 500-foot adits 1,100 feet southwesterly from the adits on Grizzly Creek. As much as 7 percent molybdenite is reported in vein material from these adits. Williams (1934) makes no mention of molybdenum but reports between $50 and $60 per ton in gold, silver, and lead at the bottom of the 33-foot winze. The writer's cursory examination of the property on two occasions failed to turn up molybdenite, nor did spectrographic analyses of vein material and stream sediment samples from Grizzley Creek show anomalous molybdenum.

Rocky Point

The Rocky Point group of six unpatented claims is near the confluence of the Green River and Miners Creek (fig. 10). The claims are chiefly in the $SE\frac{1}{4}$ sec. 31, and $SW\frac{1}{4}$ sec. 32, T. 11 N., R. 5 E. at elevations of 2,000 to 2,400 feet. From the end of the Quartz Creek road 115, 6 miles of trail along the north bank of the Green River lead to the property. Williams (1934) reports that a 100-foot adit at river level was driven northward along a 4-foot vein of white quartz that contained $11 to $13 in free milling gold, at $20 per ounce gold prices. Currently (1977) the adit is filled with debris from the river and is inaccessible.

Goat Mountain

This property is in the center of sec. 2, T. 10 N., R. 5 E. and adjoins the north side lines of the Minnie Lee claims (fig. 10). Elevations at the property range from 3,200 to 4,000 feet. According to Hanley (1905), the discovery vein crops out in the gulch of Dead Man's Creek about $\frac{1}{2}$ of a mile north of the Green River trail. At the discovery point a 4-foot-thick quartz vein in granodiorite strikes northeast. The vein, as exposed in a cut, contains abundant pyrite and minor chalcopyrite. About 400 feet below the cut, another adit was driven N. 6° E. for 285 feet to intersect the vein. However, the vein was never intersected by the adit.

Chicago-Golden Crown Group

This group of eight patented mining claims is in the $S\frac{1}{2}$ sec. 11, T. 10 N., R. 5 E. and about $1\frac{1}{2}$ miles west of the end of the Quartz Creek road (fig. 11). Elevations at the property range from 2,800 to 4,000 feet. The writer was unable to find any mineralization on the property and most adits are no longer discernible. Patent plats for this group show at least 10 adits that range from 10 to 92 feet in length (fig. 11). The northwest trend of most adits, as well as the northwest trend of the side lines of the claims, suggests that the claims were staked on several northwest-trending fracture zones.

Big Blue Group

The Big Blue group of seven patented claims is 2 miles south of Ryan Lake and in the $SW\frac{1}{4}$ sec. 21 and $NE\frac{1}{4}$ sec. 28, T. 10 N., R. 6 E. (fig. 11). No road or trail leads to the property, but the Green River trail in the $E\frac{1}{2}$ sec. 20 is within 0.25 mile of the northwest end of the claims. Barker (1910) reports an aggregate of 500 feet of adits was driven to explore mineralization on the property. The largest adits were 165 and 70 feet in length on the Big Blue No. 3 Lode (fig. 11).

Dixie Queen Group

This property consists of the Star King group,

Star Queen group, and Chattanooga group, all of which are on the north end of Strawberry Mountain. The exact location of these groups is unknown to the writer. County records place the claims about 4 miles northeast of the Polar Star mine and in the vicinity of Summit Lake. This location would fall roughly in sec. 34, T. 11 N., R. 6 E., site of the only lake on the north end of Strawberry Mountain. According to Hanley (1905), most of the work was done on the Star King group, which has a "fissure vein" 5 feet in width carrying pyrite and galena. A shaft was sunk 18 feet on the vein. About 400 feet below the shaft a 300-foot adit in "Box Gulch" follows a 12- to 20-inch quartz vein void of ore minerals.

Mountain Chief

The Mountain Chief consists of two unpatented claims that are in the SW¼ sec. 13, T. 10 N., R. 5 E. at elevations of 2,580 to 3,200 feet. Williams (1934) reports that a vein in granite carries copper, silver, and lead. A short adit was driven on the vein in the early 1900's, but the adit has been caved since the 1930's.

Insurance

This property consists of four unpatented claims in the SW¼ sec. 2, T. 10 N., R. 5 E. that were staked on the southeast extension of the Minnie Lee claims (fig. 10). According to Williams (1934) a 165-foot adit was driven in a northerly direction to intersect the extension of the Minnie Lee vein, but the vein was never reached.

Morning

This property is about 0.5 mile up Falls Creek from its confluence with the Green River and is near the E¼ corner of sec. 4, T. 10 N., R. 5 E. A 210-foot adit with a 25-foot drift was driven on a pyrite-chalcopyrite vein in andesite (Williams, 1934).

CAMP CREEK AREA

General Information

The Camp Creek area is 3 miles east of the boundary of the St. Helens mining district. It is in north-central Skamania County and centers about Camp Creek, a tributary of McCoy Creek (fig. 13). The Camp Creek area is mainly in the northeast quarter of T. 10 N., R. 8 E. and is covered by the McCoy Peak 7½-minute quadrangle. The area is mountainous and moderately to sparsely vegetated; throughout most of the area steep, rocky slopes prevail. Elevations range from lows of 2,200 to 2,600 feet along McCoy Creek to a maximum of 5,892 feet at the summit of Sunrise Peak. Forest Service roads 111, 112, and 123 provide access from Randle, a distance of about 20 miles. From December through May, the Camp Creek area is usually covered by 3 to 5 feet of snow.

The area was first prospected around 1895. Mining claims, both placer and lode, were staked, but only minor development work was undertaken, and no claims were patented. The only productive lodes proved to be on Camp Creek; however, production was insignificant. From 1934 to 1940, the total recorded production amounted to 80 ounces of gold, and probably an equal amount of gold or more was never reported.

Placer mining for gold was carried out at the turn of the century along parts of the Cispus River and McCoy Creek, with the latter being the most productive. In the depression years of the 1930's, placer mining was once again undertaken on McCoy Creek, but the total production of placer gold from 1900 through 1940 did not exceed several thousand dollars.

Around 1964, Bear Creek Mining Co. discovered several areas of anomalous copper in the Camp Creek area and staked claims on a quartz diorite intrusion immediately south of Camp Creek. In 1974, Duval Corp. was attracted to the area, and upon

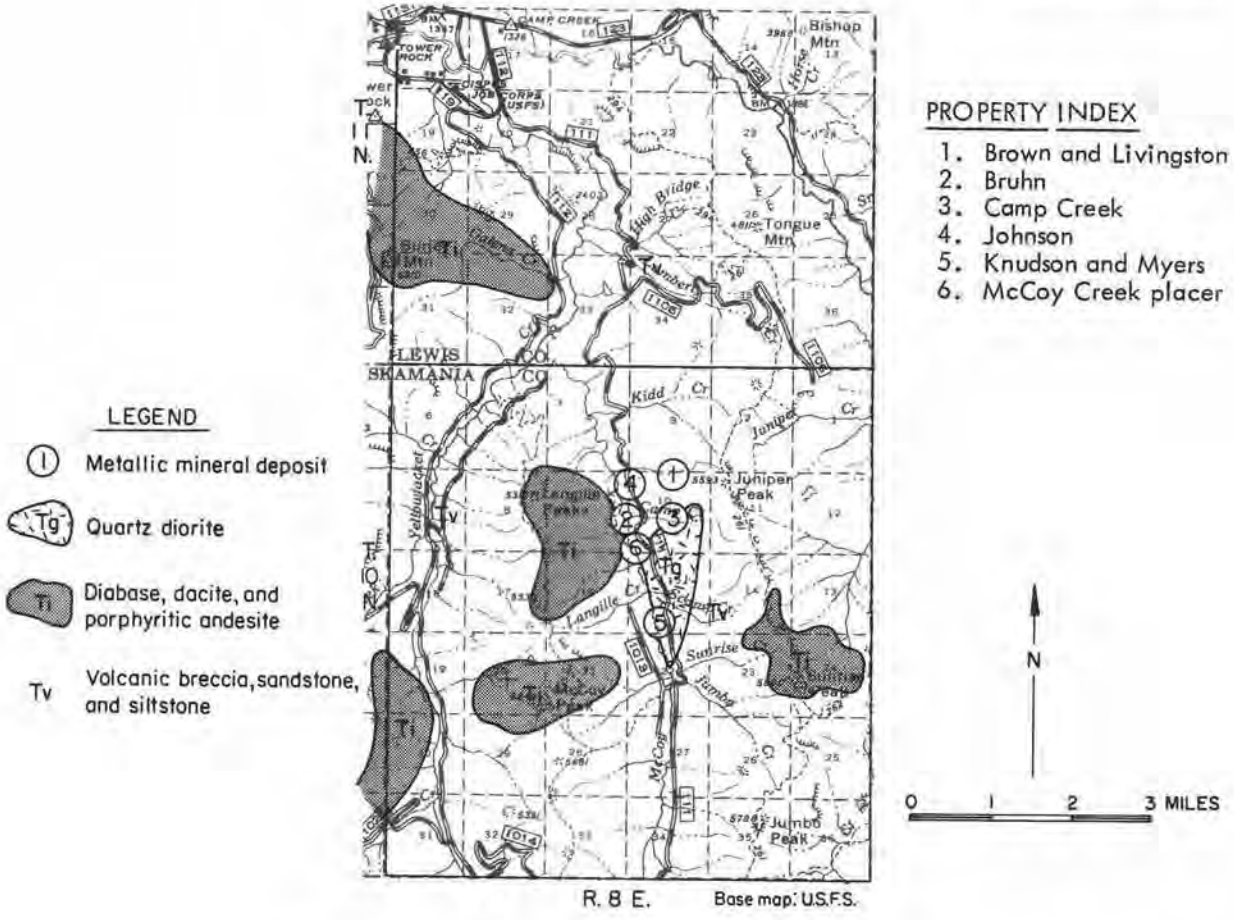


FIGURE 13.—Metal occurrences of the Camp Creek area.

completion of geochemical and geophysical work drilled several core holes in the spring of 1975. In 1976, exploration in the area was at a standstill.

General Geology

The predominant rocks of the Camp Creek area consist of tuff breccias, volcanic breccias, and volcanic sandstones and siltstones of the Ohanapecosh Formation (upper Eocene). These quartz-deficient rocks exhibit well-bedded sequences that strike N. 15° to 30° W. and dip 25° to 30° SW. Two miles south of Camp Creek, rocks of the Ohanapecosh Formation are overlain unconformably by quartz-bearing volcaniclastic rocks of the Stevens Ridge Formation (Oligocene-early Miocene). About 2½ miles southeast of Camp Creek, massive diorite porphyry caps the summit of Sunrise Peak and appears to lie unconformably upon rocks of the Ohanapecosh Formation. Throughout the area, rocks of the Ohanapecosh are intruded by andesite dikes up to 100 feet in width. The dikes strike east to northeast and dip 50° N. to vertical. Immediately south of Camp Creek, rocks of the Ohanapecosh Formation have been intruded by a quartz diorite stock of probable early Miocene age. The stock, which is about 1 mile long in a north-south direction and about 1,500 feet wide, is surrounded by a hornfels halo; an area of propylitic and sericitic alteration coincides with the hornfels. The presence

of disseminated pyrite accompanied by minor chalcopyrite suggests hydrothermal mineralization. Mapping by Simon (1972) indicates that the sericitic altered rocks contain more pyrite than chalcopyrite, whereas the propylitized quartz diorite appears to contain more chalcopyrite than pyrite. Although pyrite most commonly is disseminated in the hornfels and diorite, it is also present in quartz veins and fills fractures up to several inches thick. Gold occurs in the pyritic quartz veins and pyrite-filled fractures, as do sparse galena and sphalerite. Common alteration products of pyrite and chalcopyrite are hematite, goethite, jarasite, and malachite, which impart yellowish reddish-brown colors to the mineralized outcrops.

Mines and Prospects

Camp Creek

The Camp Creek mine is the only mine in the area with a record of production. It is in the $N\frac{1}{2}S\frac{1}{2}$ sec. 10, T. 10 N., R. 8 E. on Camp Creek road. A steep unimproved road 0.4 mile south of Camp Creek can be followed about one-half of a mile east to the mine camp, and another 0.4 mile to the mine's main adit (fig. 14). Elevations range from 3,000 feet at the camp to about 4,000 feet at the highest workings.

Although lode claims were staked on Camp Creek as early as 1903, very little work appears to have been done until the 1930's, at which time the property was under development by Camp Creek Metals Co. and Primary Gold Co. Around 1930, a small water-powered gravity separation mill was constructed on Camp Creek at the site of the Blacksmith adit. Most mining appears to have been done between 1934 and 1940; production was minor, amounting to 70.47 ounces of gold valued at $2,530. Since 1940, several operators have attempted to mine gold at the property, but apparently they were not successful because of the spotty nature of the ore and narrowness of the gold-bearing veins. Currently (1977) the property is idle.

The Camp Creek mine is developed by 10 short adits, none of which is over 100 feet in length; most of them are caved at their portals. The adits are on both sides of Camp Creek at elevations of 2,800 to 3,400 feet (fig. 14). Mineralization appears to be confined to a series of north-trending, steeply-dipping fractures filled with quartz and iron oxides. Common sulfides include pyrite and chalcopyrite accompanied by minor galena, sphalerite, and molybdenite, as well as sparse gold. The ore minerals appear to be localized at the intersection of east-west trending fractures that parallel Camp Creek and north-trending quartz fissure veins that parallel McCoy Creek. Although some gold was mined from pyritic quartz veins, less than 1 foot thick, narrow iron oxide seams adjacent to the quartz veins yielded flakes of gold up to $\frac{1}{2}$ inch across, and masses up to 2 inches in diameter and $\frac{1}{2}$ inch in thickness. Host rocks for the gold-bearing quartz veins and iron oxide seams consist of hornfeltized volcanic breccia, sandstone, and siltstone of the Ohanapecosh Formation, as well as propylitized diorite that intrudes the Ohanapecosh. The most important gold deposits appear to be confined to the north end of the diorite stock where it is in fault contact at Camp Creek with rocks of the Ohanapecosh Formation.

Brown and Livingston

This property is described by Williams (1934) as being on Granite Creek, a tributary to McCoy Creek about one-half mile north of Camp Creek. The property is about 0.5 mile up Granite Creek from its confluence with McCoy Creek and near the $N\frac{1}{4}$ cor. sec. 10, T. 10 N., R. 8 E. (fig. 13). According to Williams the vein consists of five or six heavily oxidized streaks that pan free gold at the surface. The vein material between the streaks consists of soft bluish lime containing fine-grained sulfides. The

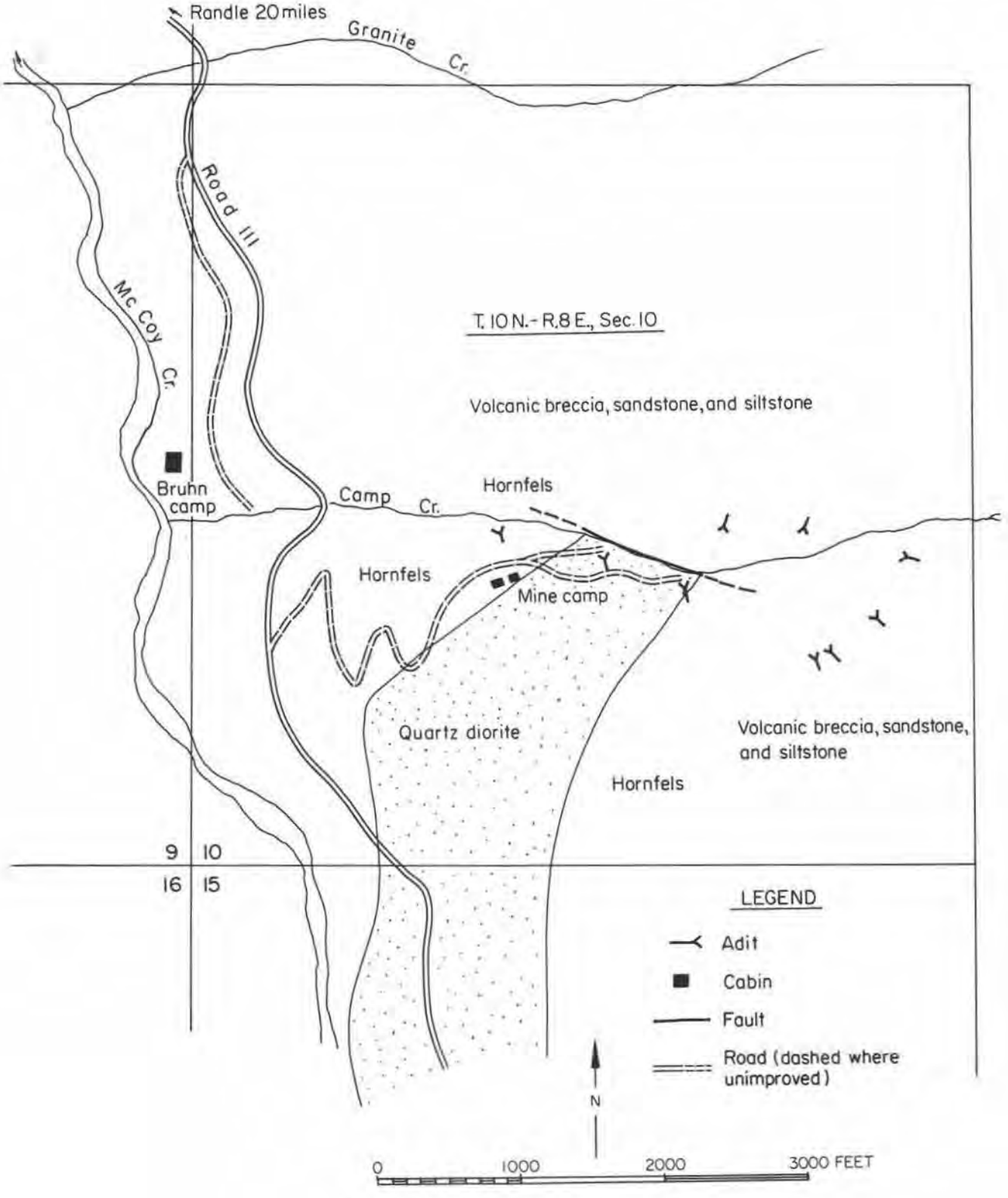


FIGURE 14.—Camp Creek mine.

vein can be traced in a north-south direction and dips 60° E. Assays of the vein range from $6 to $30 per ton in gold, at $20 per ounce gold prices.

Bruhn

This property is at the confluence of Camp and McCoy creeks, and near the W¼ cor. sec. 10, T. 10 N., R. 8 E. Williams (1934) describes the vein as a heavily mineralized 2-foot-thick streak of clay containing sulfides.

Johnson

The Johnson prospect is in the NW¼NW¼ sec. 10, T. 10 N., R. 8 E. at an elevation of about 2,400 feet. It is about 1,800 feet up McCoy Creek from Camp Creek, and about 300 feet east of McCoy Creek. According to Williams (1934) a seam 2 to 3 inches thick carries free gold.

Knudson and Myers

This property is at the confluence of McCoy and Scamp Creeks and in the center of the SW¼ sec. 15, T. 10 N., R. 8 E. Williams (1934) reports the presence of gold-bearing quartz stringers; placer operations in the 1930's recovered unknown amounts of coarse rough gold.

McCoy Creek Placer

Remains of old sluice boxes, flume pipes, and ditches indicate that placer mining operations (E½ sec. 9, T. 10 N., R. 8 E.) were attempted on McCoy Creek in the vicinity of Camp and Scamp Creeks. The caved-in cabins of the Bruhn placer camp are still visible at the confluence of McCoy and Camp Creeks. Scott (1933) visited the area in 1932, and reported that Bruhn tested gravels that ran 75 cents to $1.10 per yard. Another group, which was placer mined on McCoy Creek in the 1930's, reported to have tested gravels that ran 75 cents to the yard. However, large amounts of boulders in the gravels appear to have made it impractical to placer mine the area.

Cispus River Placer

In the early 1900's, small-scale placer mining operations were undertaken along the Cispus River from the confluence of Yellowjacket Creek to the vicinity of Juniper Creek. At least 24 placer claims were staked along the west bank of Cispus River in the W½ sec. 6, T. 10 N., R. 9 E., but no record of production exists for this area. An examination of the area by the writer failed to reveal signs of extensive placer mining operations.

Summary

Although the Camp Creek area has a record of minor gold production, the greatest economic potential appears to be the copper-molybdenum deposits associated with the quartz diorite stock and surrounding hornfels south of Camp Creek. An area of propylitic alteration occurs in the diorite and hornfels, but is more noticeable in the coarser-grained quartz diorite, and is more intense in the fractured rocks; highly fractured rocks are almost totally sericitized. According to Simon (1972), the propylitized quartz diorite contains twice as much chalcopyrite as pyrite, mainly as disseminated grains associated with chloritically altered biotite. Sericitic areas contain more pyrite than chalcopyrite, as well as minor molybdenum. To date (1977), the extent of the copper mineralization has not been determined.

SPIRIT LAKE AREA

General Information

Mining properties of the Spirit Lake area consist of 47 patented mining claims and an unknown number of unpatented claims. As seen in figure 15,

the patented claims are concentrated in a 2.5 square-mile area, the center of which is about 1.5 miles northeast of the north end of Spirit Lake. Little in the way of mining has been done since the early 1900's, when the claims were patented and the underground work at most properties was carried out. Although several thousand feet of crosscuts and drifts were driven in search of copper and gold, very few of the mine workings are accessible; little evidence remains indicating that almost 70 years ago the area experienced a short-lived mining boom. The only producing mine in the area was the Sweden, which in 1905 and 1929 produced a total of 89 tons of copper ore. Since 1929, mines of the area have been inactive, but cursory examinations of the properties have been made at different times by mining companies. In 1976, New Cinch Uranium Ltd. of Toronto, Canada, was rehabilitating the Sweden mine to assess copper potential.

Mines and Prospects

Sweden

The Sweden mine, which is in the extreme NW. cor. sec. 6, T. 9 N., R. 6 E. has experienced more exploration and development work than any other property in the Spirit Lake area. Between 1900 and 1910, Mount St. Helens Consolidated Mining Co. spent around $700,000 in an attempt to make the Sweden a copper-producing mine. In 1905, the mine produced 13 tons of copper ore valued at $286; the copper was donated by Dr. H. W. Coe, president of Mount St. Helens Consolidated Mining Co., for the statue of Sacajawea erected at the 1905 Lewis and Clark fair at Portland (fig. 6). In 1927, California interests shipped 76 tons of copper ore valued at only $1,202 from the mine dump.

The Sweden claim is one of a group of 29 claims that were staked on discoveries made in 1896 and patented by Dr. H. W. Coe in 1905 (fig. 15). The Sweden adit is about 3 miles by trail from the end of the road at the Spirit Lake ranger station, at an elevation of 3,340 feet. The adit, which is the longest mine adit in southwestern Washington, extends northward into the southeastern slope of Mount Margaret for 2,291 feet (fig. 16). The adit contains three crosscuts, which are 142, 127, and 6 feet in length; because of unstable ground, much of the adit is timbered. In its entire length, the Sweden adit follows a persistent fracture zone in fine-grained hornblende granodiorite. The fracture zone, which ranges from several inches to 6 feet in width, consists of gouge, talc, fragments of granodiorite, and quartz; it strikes N. 10° to 20° W. and dips 70° W. to vertical. Ore minerals, which occur in shoots along the vein, consist of pyrite, pyrrhotite, chalcopyrite, and sphalerite, in order of decreasing abundance. In individual shoots, pyrite and chalcopyrite are the predominant ore minerals, and occur as small to medium grains disseminated in the vein material. In parts of the veins the quartz appears to be the most favorable host for chalcopyrite.

The copper, gold, and silver content of the Sweden vein varies considerably along its strike. Numerous assays show 0.02 to 14.2 percent copper, trace to 0.61 ounce gold, and nil to 3.80 ounces per ton in silver (table 2). Fourteen tons of copper ore shipped in 1905 averaged 6.6 percent copper, whereas 76 tons shipped in 1929 averaged only 0.45 percent. Most reports on the value of the ore in the mine are based on the Barker (1910) report, which established the ore reserves at 76,490 tons of ore averaging 5.65 percent copper. However, Barker makes no mention of the number of samples collected to establish these reserves. Eight ore shoots reportedly have an average vein width of 4.68 feet, and reserves are calculated from the adit level to the surface (table 3).

In regard to the procedure Barker used in sampling the Sweden vein Barker (undated letter to Charles Marchand) makes the following statement:

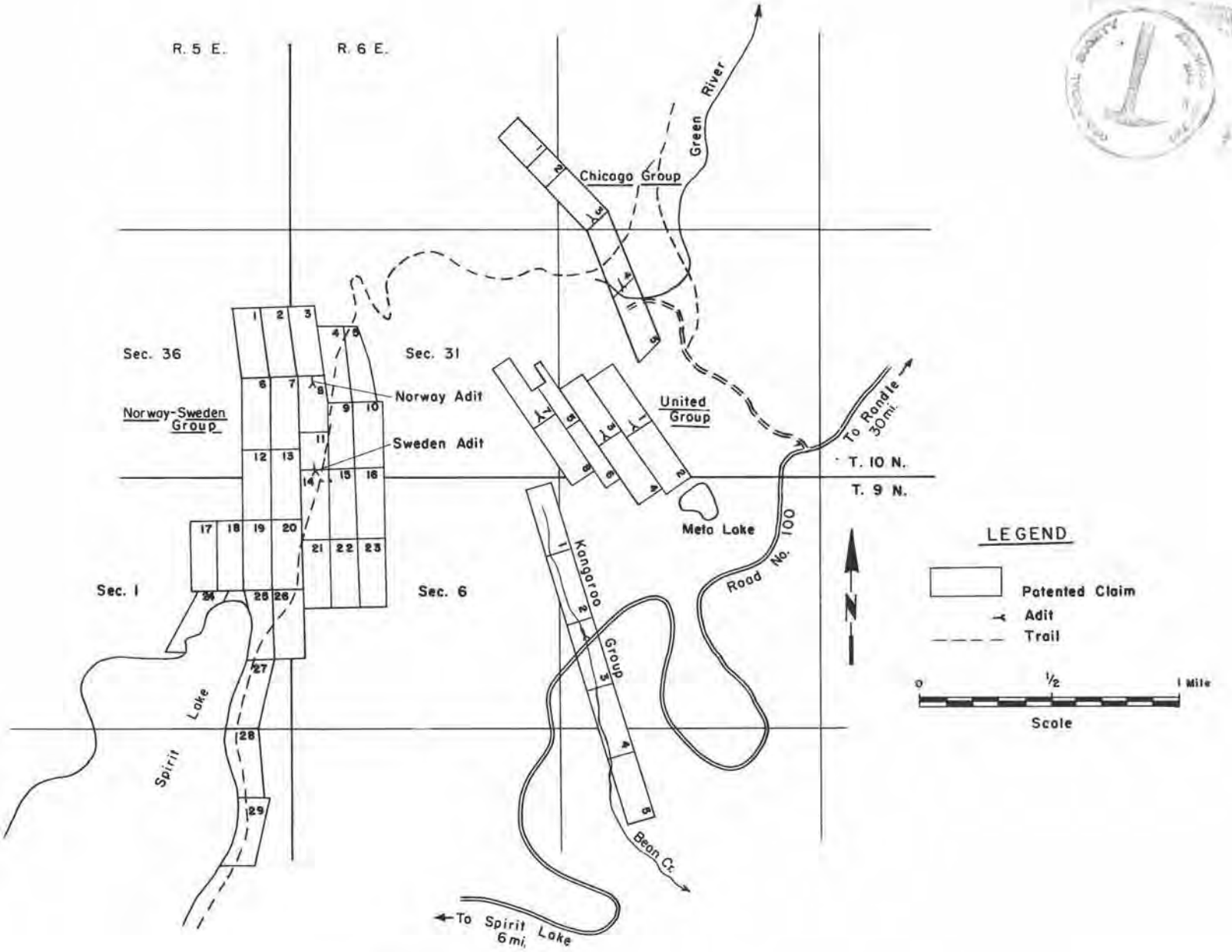


FIGURE 15.—Patented claims of the Spirit Lake area.

PATENTED CLAIMS OF THE SPIRIT LAKE AREA

Norway-Sweden Group

1. Viola First
2. Viola Second
3. Norway Northwest Discovery
4. America No. 1
5. Wilson
6. George
7. Wayne
8. Norway
9. America No. 2
10. Alderman Peak
11. Denmark Discovery
12. Mamie
13. Baby Barnes
14. Sweden No. 1
15. America No. 3
16. Marchand
17. Inez
18. Linnie
19. Ada
20. Mabel
21. Sweden No. 2
22. America No. 4
23. Prince
24. Cena
25. Lakeside
26. Earl
27. Hillside
28. Falls
29. Spirit Lake

Chicago Group

1. Chicago Northwest Discovery No. 2
2. Chicago Northwest Discovery No. 1
3. Chicago Northwest Discovery
4. Chicago No. 1
5. Chicago No. 2

United Group

1. Mount Fairy No. 11
2. Mount Fairy No. 2
3. Mary No. 2
4. Mary No. 1
5. Mary No. 4
6. Mary No. 3
7. Mary No. 6
8. Mary No. 5

Kangaroo Group

1. Kangaroo No. 3
2. Kangaroo No. 2
3. Kangaroo No. 1
4. Kangaroo No. 4
5. Kangaroo No. 5

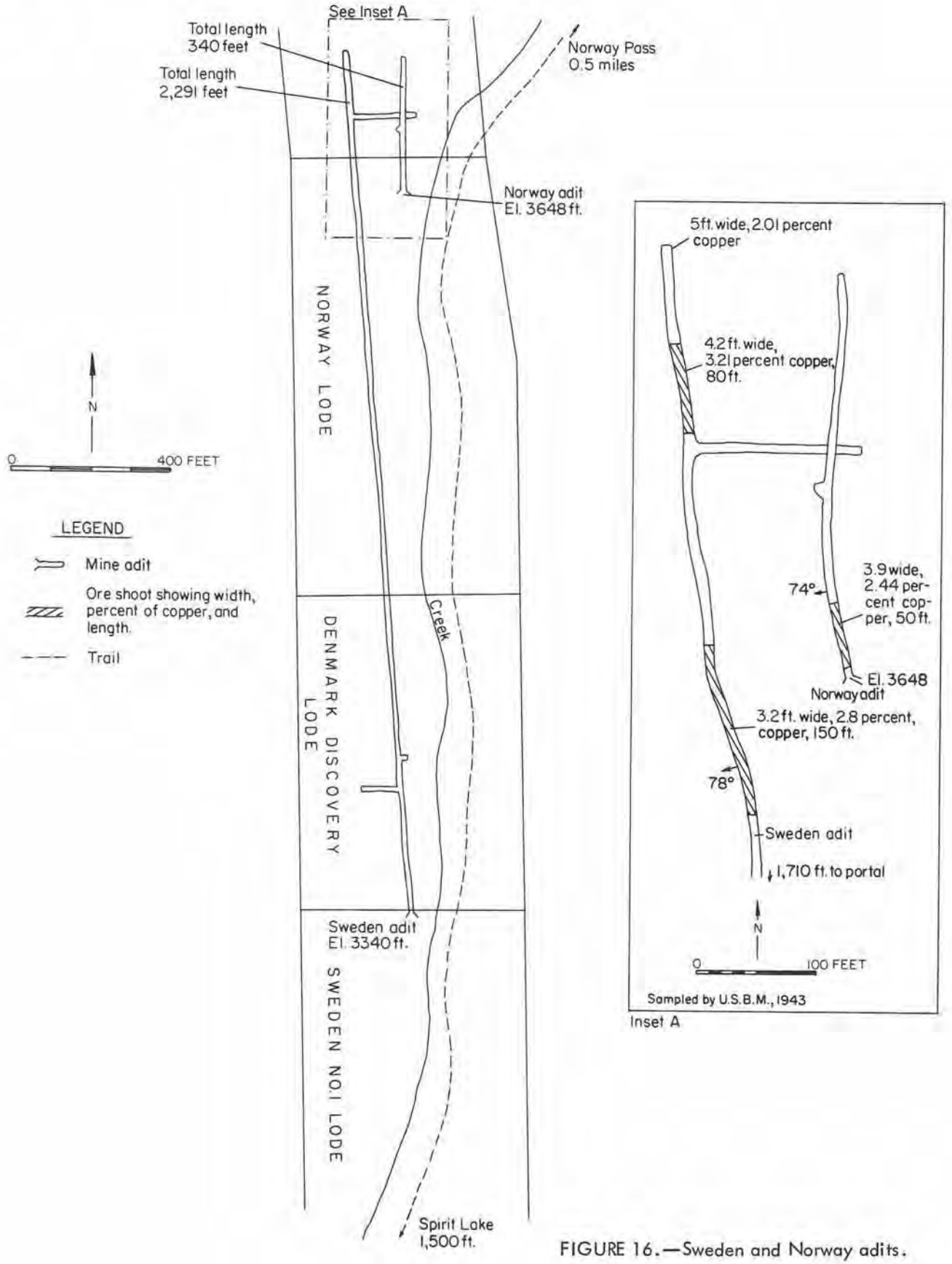


FIGURE 16.—Sweden and Norway adits.

TABLE 3.—Ore reserves of the Sweden mine

Ore shoot no.	Interval in adit from portal (ft)	Adit level to surface (ft)	Length of shoot (ft)	Width of vein (ft)	Copper content (percent)	Reserves (tons)	Samples
				Overall average			
Reserves calculated by Barker (1910)—number of samples unknown							
1	68 to 166	60	89	4.5	1.5	1,360	
2	310 to 412	90	102	5.5	1.77	3,800	
3	691 to 908	150	217	5.0	2.03	12,500	
4	1,191 to 1,342	210	151	4.0	1.5	9,750	
5	1,557 to 1,642	290	85	4.0	7.20	7,580	
6	1,796 to 1,988	350	192	5.0	10.75	20,000	
7	2,077 to 2,207	480	130	4.0	12.36	18,000	
8	2,276 to 2,291	550	15	5.5	8.6	3,500	
				4.68	5.65	76,490	
Reserves calculated by Washington Division of Geology (1956)							
1	387 to 410	90	23	3.5	1.00	480	4
2	1,796 to 1,946	350	150	3.2	2.80	11,120	4
3	2,126 to 2,206	480	80	4.2	3.21	10,750	4
				3.63	2.41	22,350	

> Replying to your enquiry I will say that my samples were taken as follows: The length of the ore chutes had already been marked as the development had progressed. In these ore chutes I had the lagging torn down and the back of the drift thoroughly cleaned and then the vein was channelled the full width, when it was exposed the full width. It was in many cases much wider than the drift, and therefore the sample was taken the width of the drift. These samples were taken at regular intervals in each chute, but each chute did not have the same level. The length of the chute was first checked up and then divided into three, four, or five laterals and the sample taken at each interval.
>
> Inasmuch as no ore is in the technical sense ore positive, I made no assay maps, all the ore must be considered ore possible and its amount is a question which future development must determine.
>
> The averages for each chute were determined by the foot-percent method, although there was little difference in values or width as found.

Sampling of the vein (12 samples) by the U.S. Bureau of Mines in 1943 showed 0.02 to 8.90 percent copper, traces of gold, and nil to 0.64 ounce silver per ton. Three ore shoots were estimated to contain a total of 22,350 tons of ore averaging 2.41 copper over an average vein width of 3.63 feet (table 3). As can be seen in table 3, Bureau of Mine shoots 1, 2, and 3 appear to correspond with shoots 2, 6, and 7 of Barker. However, the average copper content of Bureau of Mines shoots 2 and 3 is only 3.00 percent copper, compared to Barkers' 11.55 percent for these shoots.

Future economic conditions might make it possible to mine several ore shoots in the Sweden mine; however, any mining should be preceded by thorough and careful sampling of the ore shoots. Inasmuch as the ground-water table appears at, or near, the surface there is no reason to expect secondary enrichment on the vein.

Norway

The Norway mine (part of the Norway-Sweden group) is about 1,900 feet north of, and 308 feet higher in elevation, than the Sweden mine (fig. 15). The Norway adit is at an elevation of 3,648 feet and is in the NW¼ sec. 31, T. 10 N., R. 6 E. From the Sweden mine, the trail to Norway Pass can be followed to the property.

The Norway vein was discovered in 1896, and as part of the Sweden group, was patented in 1905. The Norway was the first property to be worked in the

Spirit Lake area, and by 1900, the Norway adit had been driven 330 feet on a vein that assayed about 10 percent copper. About this time the property was acquired by Mount St. Helens Consolidated Mining Co. Work was halted at the Norway and commenced at the Sweden level in order to obtain more depth on the vein.

The Norway vein is a 10-inch- to 4-foot-wide fracture zone in granodiorite and is the upper part of the Sweden vein (fig. 16). The vein, which strikes north and dips 70° to 80° W., consists of gouge, talc, brecciated wall-rock fragments, and quartz. Pyrite and chalcopyrite occur in the vein from sparse amounts to as much as 25 percent. Select samples taken by Barker (1910) contained up to 17.85 percent copper and 19.18 ounces of silver over 4-foot vein widths. A 150-pound sample sent to the Tacoma Smelter in 1900, contained 9.20 percent copper, 1.10 ounces gold, and 1.40 ounces per ton in silver. Barker states that the first 166 feet of vein in the adit averages over 4 feet in width and assays 10.4 percent copper, 0.84 ounce gold, and 1.6 ounces of silver. From 166 feet to the face of the adit at 330 feet, the vein is barren. At the adit's face the vein assays 12.86 percent copper, 0.03 ounce of gold, and 1.2 ounces of silver. Sampling by the Bureau of Mines in 1943 showed that the vein in the first 50 feet of the adit averaged 3.9 feet in width and averaged 2.44 percent copper. From 50 feet to the face, pyrite is persistent, but chalcopyrite is sparse. No samples were taken by the Bureau at the face of the adit, nor did J. W. Melrose (geologist for the Division of Geology) report the presence of copper at the face when he mapped the adit in 1939.

The inferred ore reserves of the Norway vein from adit level to the surface, based on the Barker report, are 3,320 tons of 10 percent copper over a 4-foot vein width. Based on Bureau of Mines data, inferred reserves are 65 tons of 2.44 percent copper over a 3.9-foot vein width.

Bronze Monarch

This property is described as being 0.75 mile north on the Norway Pass trail from the Sweden mine which places the property in the $SW\frac{1}{4}NW\frac{1}{4}$ sec. 31, T. 10 N., R. 6 E. (fig. 10). About 500 feet west of the trail, and at an elevation of about 3,700 feet, an adit heads N. 90° W. for several hundred feet along a fracture zone in granodiorite. The fracture zone averages 3 feet in width, and is composed of gouge, quartz, and brecciated granodiorite. The quartz contains abundant pyrite and minor chalcopyrite; minor malachite and azurite occur as thin coatings on the walls and roof of the adit. Landes (1902, p. 95) reports that the adit is 300 feet in length, with about 1,000 tons of copper ore in the dump at the adit's portal. The Bronze Monarch vein appears to be the northern extension of the Norway-Sweden vein.

Chicago

This property consists of five patented claims that are in the $NW\frac{1}{4}$ sec. 32 and the $SW\frac{1}{4}$ sec. 29, T. 10 N., R. 6 E. (fig. 15). The claims, which are at an elevation of 3,500 to 4,400 feet, are about 1 mile east of trail from Norway Pass, but are more accessible by means of a logging road from Forest Service road 100 near Meta Lake. On the north bank of the headwaters of the Green River and on the south end line of Chicago No. 1 Lode (fig. 15) two caved adits are barely discernible. The upper adit was driven at a heading of N. 25° E. into a 2-foot-wide, iron-oxide-rich gouge zone in andesite. Approximately 5 feet lower in elevation, another adit was driven at the same heading into an 8-foot-wide quartz vein sparsely mineralized with pyrite, chalcopyrite, arsenopyrite, and sphalerite. According to Barker (1910), the first 20 feet of the adit is mineralized, whereas the last 100 feet is barren of ore minerals. A survey plat of the property shows a 125-foot adit, about 1,500 feet north of the above-mentioned adits; examination

of this area did not disclose the adit. Nothing suggests that the Chicago claims have been worked since the early 1900's. There is no record of production from this property.

United Group

This property consists of eight patented mining claims that are chiefly in the SW¼ sec. 32, T. 10 N., R. 6 E. (fig. 15). The claims extend in a northwest direction from the north shore of Meta Lake, and elevations on the claims range from 3,600 to 4,400 feet. Starting from near the center of the S½ sec. 32, a barely discernible trail can be followed west for about one-half mile to the old mine camp.

Rocks of the area are concealed by a cover of pumice and pumicite, except in the bed of Florence Creek that passes over the claims. Along the banks of the creek, iron-oxide-stained, altered, and pyritized andesite crops out for several hundred feet. Around 1904, no fewer than nine adits, ranging from 12 to 75 feet in length, were driven into the south and north banks of the creek. Currently (1977), all adits, with the exception of the one on Mount Fairy No. 1 Lode, are inaccessible because of caved portals. The Mount Fairy No. 1 adit heads N. 55° W. into altered andesite that crops out on the north bank of Florence Creek. About 15 feet from the portal, a 10-foot-deep, underhand stope was sunk on vein quartz that contained up to 10 percent chalcopyrite, 5 percent pyrite, and 1 percent sphalerite. About 45 feet from the portal, a 12-foot drift heads west and a 10-foot drift heads north. In several parts of the adit, the wall rock is covered by thin coatings of malachite. About 650 feet upstream from the adit, chalcopyrite- and pyrite-bearing quartz was noted as float in the creek. In all probability the float came from the dump of a 75-foot adit on the Mary No. 2 Lode. This adit, which has a caved portal, heads N. 34° W. in altered andesite. The old mine workings along the banks of Florence Creek suggest the presence of a series of northwest-trending, copper-mineralized fracture zones.

Commonwealth

This property is in the SW¼ sec. 33, T. 10 N., R. 6 E. and at elevations of 3,360 to 3,520 feet (fig 10). It consists of several unpatented mining claims that are 0.75 mile east by road from the Meta Lake parking area. The main adit is about 150 feet northwest of the road, in a steep narrow ravine that appears to be the surface expression of the mineralized fracture zone in basalt. The presence of the vein over the entire length of the ravine has not been confirmed. The adit, the portal of which is visible from the road, follows N. 25° W. for 350 feet along the vein. Except for the last 30 feet of adit, it is timbered along its entire length. The vein, which dips 75° NE., consists of gouge, brecciated basalt, and glassy white and gray quartz that contains sparse pyrite, arsenopyrite, galena, chalcopyrite, and sphalerite. The vein ranges from less than 1 inch to a maximum of 2 feet in thickness. At the face of the adit it is only 1 foot thick, and consists of white gouge and brecciated basalt. Three assays from the vein in the adit and on the surface showed 0.04 to 0.14 ounce of gold, 0.60 to 3.70 ounces of silver, 0.50 to 1.75 percent copper, 0.25 to 6.00 percent lead, and 0.50 to 5.00 percent zinc. The average copper content of the vein will probably not exceed 1.5 percent.

About 300 feet southeast of the road, and in the same ravine as the adit, a shaft (caved at 8 feet) was sunk 80 feet on a mineralized quartz vein in diorite. The vein is not exposed; however, quartz fragments on the dump of the shaft contain minor disseminated grains of chalcopyrite, pyrite, galena, and sphalerite.

Kangaroo Group

This group of five patented claims is in the

$W\frac{1}{2}W\frac{1}{2}$ sec. 5 and $NW\frac{1}{4}$ sec. 8, T. 9 N., R. 6 E. (fig. 15). The property is about $1\frac{1}{2}$ miles east of Spirit Lake and is accessible from Spirit Lake by way of Forest Service road 100 that crosses the center of the claims at an elevation of about 4,000 feet. Bean Creek falls within the boundaries of the claims and roughly parallels the claim's sidelines. Over most of the claims, bedrock is concealed by pumice and pumicite. About 200 feet upstream from the road crossing of Bean Creek on Kangaroo No. 1 Lode, a 100-foot adit has been driven N. 20° W. along a weakly mineralized fracture zone in basalt. The fracture zone, which dips 60° to 70° E., is 15 to 24 inches wide and consists chiefly of calcite accompanied by minor quartz. Iron oxide and gouge seams parallel the carbonate vein along the hanging walls and footwalls. For the most part, the vein appears barren of ore minerals; however, parts of the vein contain minor pyrite and sparse galena and sphalerite.

Young America Group

This property consists of three patented claims that are part of the Norway-Sweden group. The claims adjoin the Norway and Sweden on the northeast, and are chiefly in the $SW\frac{1}{4}$ sec. 31, T. 10 N., R. 6 E. (fig. 15). The claims are on a steep hillside about 1,000 feet east of the Sweden mine. According to Landes (1902, p. 95), a 12-foot-wide vein can be traced along its outcrop for more than 2,000 feet. An adit 50 feet long has been driven along the vein from an outcrop in the bed of a creek.

Hercules

This prospect is 1 mile south of the Spirit Lake ranger station, and in the $SW\frac{1}{4}NE\frac{1}{4}$ sec. 23, T. 9 N., R. 5 E. at an elevation of about 3,600 feet (fig. 10). Access to the property is by way of trail from State Highway 504. At this site, a 186-foot, eastward-trending adit penetrates pyritized felsite, basalt, and andesite. Other than pyrite, no ore minerals were noted in the adit or on the claim. Much of the pyrite has oxidized to limonite that imparts a yellowish-brown color to pyritized rocks.

Bonanza

The Bonanza prospect is 1.4 miles west of the west end of Spirit Lake and in the $NE\frac{1}{4}NW\frac{1}{4}$ sec. 17, T. 9 N., R. 5 E., at an elevation of about 3,360 feet (fig. 10). A 196-foot, north-trending adit in andesite follows a vertical fracture zone that ranges from less than 1 inch to a maximum of 2 feet in width. The fracture zone consists of rock fragments, gouge, and calcite-cemented breccia; the last 20 feet of the adit follows a 6-inch-wide calcite vein and a 2-foot-wide breccia zone. No ore minerals were noted in the adit or on the property.

WASHOUGAL DISTRICT

General Information

The Washougal district is the southernmost mining district in Washington. It comprises an area of about 3,800 square miles (2,432,000 acres) in eastern Clark County and southwestern Skamania County (fig. 4). The district falls chiefly in Tps. 2, 3, and 4 N. and Rs. 4 and 5 E., Willamette meridian. The southern boundary of the district is 3 to 4 miles north of the Columbia River.

The Washougal district is in the southern part of the Cascade Mountain physiographic province, which consists of a volcanic plateau dissected by numerous streams. The topography of the district is not as rugged as the topography in the St. Helens district to the north; however, in parts of the district steep, rocky mountain

slopes prevail. Elevations in the district average 2,000 feet, with a high of 4,390 feet on the summit of Silver Star Mountain. The East Fork of the Lewis River and its numerous tributaries drain the northern half of the district, whereas the Washougal River and its tributaries provide drainage for the southern half of the district.

Because of extensive forest fires at the turn of the century, much of the Washougal district is void of heavy stands of timber. Small evergreen trees and brush cover much of the burned-over areas, which are marked by the presence of charred snags (fig. 17). Above a general elevation of 3,000 feet, vegetation is sparse, and rocky slopes predominate.

Access to the district is provided by well-maintained state and county roads on the edges of the district, and by a network of Forest Service and logging roads within the district. The northern half of the district is readily accessible from the town of Battleground by way of the East Fork of the Lewis River road. From this road, the Dole Valley-Rock Creek road leads to the west slopes of Silver Star Mountain, whereas Forest Service road 412 provides access to the north and east slopes of Silver Star Mountain, as well as to the Lookout Mountain area east of Silver Star. The southern half of the district is accessible from Washougal by way of State Highway 8B. From 8B, state forest roads and logging roads provide access to the south slopes of Silver Star Mountain and to mining properties on tributaries of the Washougal River.

General Geology

The predominant rocks of the Washougal district consist of andesite flows, tuffs, and volcanic breccia intruded by granodioritic rocks. Most vol-

FIGURE 17.—Typical terrain of the Washougal district. View looking southwest towards Silver Star Mountain; Miners Queen and Black Jack prospects in valley at left center of photo.

canic rocks are of the Skamania volcanics that range in age from late Eocene to early Miocene. Felts (1939) describes the series as andesite flows containing minor intercalated breccia and other pyroclastic material. The upper third of the series consists of nearly horizontal flows, whereas the lower two-thirds have been propylitized and folded. However, the folding was mild, and dips seldom exceed 10 degrees, with a maximum of about 30 degrees noted near the contacts of intrusive rocks. In general, northwest-trending open folds predominate. No major faults have been mapped in the district, but several of the largest valleys may be surface expressions of faults that are concealed by valley fill. Many rocks exhibit two sets of fractures. One set strikes north-northwest, which is roughly parallel to the regional fold axes and the north-south elongation of the Silver Star Granodiorite. The other set exhibits east-west strike that is roughly normal to fold axes. The dominant intrusion of the district is the Silver Star Granodiorite. The stock crops out near the center of the district and is about 10 miles long and 2 miles wide (fig. 18). Near the contact with the Silver Star Granodiorite, rocks of the lower part of the Skamania volcanics have been locally metamorphosed to a siliceous hornfels, whereas the upper flows of the series do not appear to have been affected by the intrusion. Thus, the Silver Star Granodiorite is of probable late Oligocene age. The stock, as described by Felts (1939, p. 302, 306), consists chiefly of granodiorite accompanied by minor quartz diorite and augite diorite near its boundary. The granodiorite is commonly coarse grained and light greenish-gray. The walls of the stock appear to be steep and sharp and contain andesitic zenoliths near the stock's contact with hornfeltized andesite. Some breccia zones and small fractures in the granodiorite contain quartz tourmaline-sericite mineralization, whereas other breccia zones and fractures have been subjected to epithermal quartz-sulfide mineralization. Within 1 mile of the contact of the Silver Star stock, cupolas of granodiorite less than 1 square mile in area crop out on Rock and Copper Creeks, which are northwest of the stock. Felts (1939, p. 303) reports small granodioritic cupolas are present southeast of the stock in Star Canyon and in the canyon of Dougan Creek. An isolated granodiorite cupola crops out in parts of

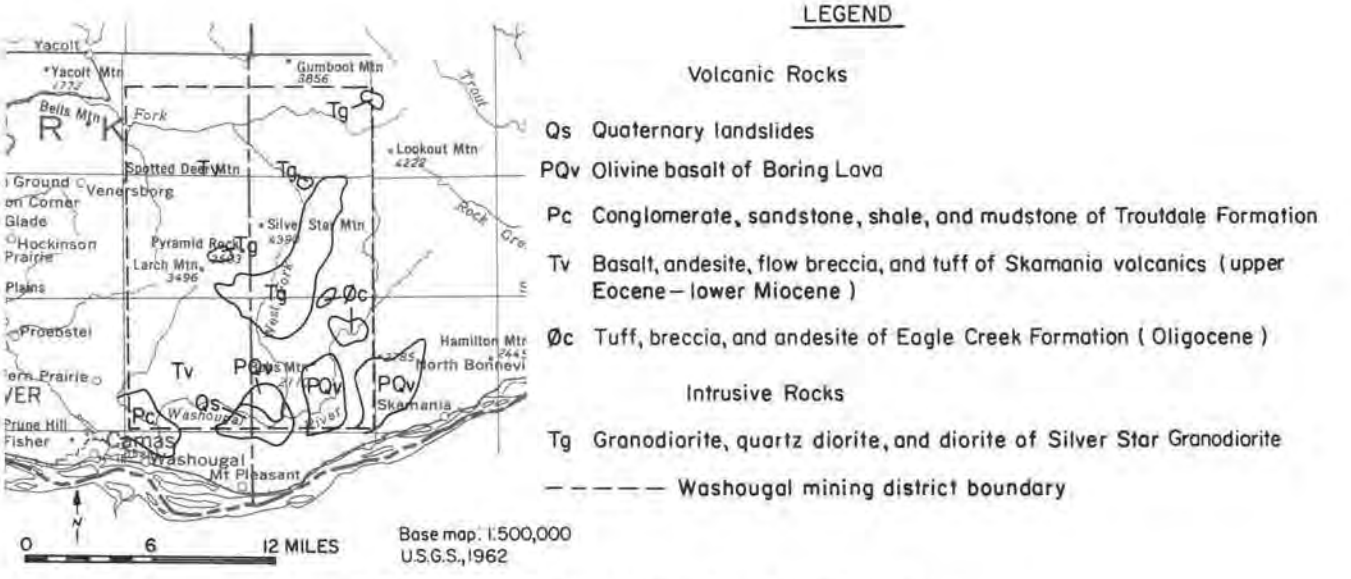


FIGURE 18.—Geologic map of Washougal district.

secs. 11 and 12, T. 4 N., R. 5 E., immediately east of Saturday Rock. The fine-grained granodiorite intrudes andesite of the Skamania volcanics, resulting in pyritization, sericitization, and tourmalinization of rocks of a narrow contact zone that surrounds the cupola.

Mineralization

The mineral deposits of the Washougal district occur within the Silver Star Granodiorite, or in the volcanic rocks at distances not greater than 5 miles from the stock (fig. 19). To date (1977), significant

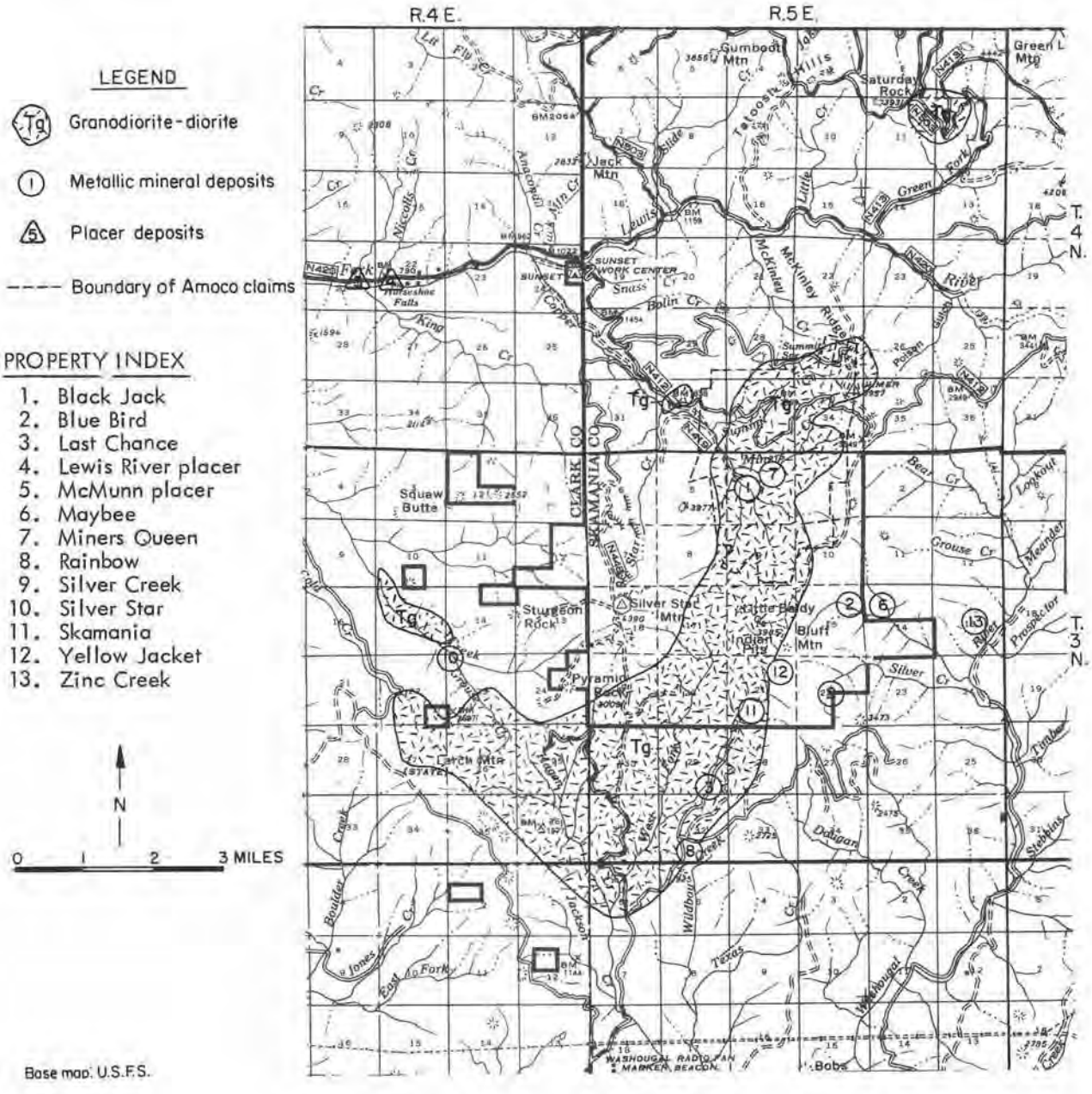


FIGURE 19.—Metal occurrences of the Washougal district.

mineral deposits have not been found in or near the granodioritic intrusion near Saturday Rock, but anomalous amounts of copper occur in stream sediments of the area. The predominant veins of the district consist of quartz fissure veins that fill fractures in granodiorite and volcanic rocks. The veins range from stringers less than 1 inch thick, to massive veins as much as 6 feet thick; west-northwest strikes and near-vertical dips predominate. The strikes of the majority of the veins are normal to the contacts of the Silver Star Granodiorite, which suggests that fractures developed in the stock and overlying and adjoining volcanic rocks during a late phase of the intrusion. The chief ore minerals consist of pyrite, chalcopyrite, bornite, pyrrhotite, magnetite, galena, and sphalerite. Minor ore minerals are molybdenite and descloizite (lead vanadate). Common secondary minerals of most veins include malachite, azurite, chrysocolla, hematite, and limonite. In general, veins within and near the borders of the granodioritic intrusion contain more copper than lead and zinc, whereas veins several miles from the intrusions appear to contain more lead and zinc than copper. Minor amounts of gold and silver occur in most veins, and anomalous amounts of vanadium occur on the West Fork of the Washougal River, at the Rainbow and Last Chance mines.

Rather than a single, well-defined quartz vein, most veins are composed of thin bands of quartz, brecciated and silicified wall rock, and gouge. At most deposits, alteration is minimal in the wall rock, but exhibits some degree of sericitic and propylitic alteration. The ore minerals occur as disseminations, veinlets, and small lenticular masses in the quartz and silicified wall rock that makes up parts of the veins. Metal content of the veins vary considerably. Although as much as 20-percent copper has been reported from narrow parts of some veins, the average copper content of most veins over minable widths is closer to 1 percent. Sampling at the Last Chance and Skamania mines by the U.S. Bureau of Mines showed 3 percent copper over an average width of 3 feet. Gold is generally present only in trace amounts, but assays of 0.1 to several ounces per ton in gold have been obtained from some deposits. The presence of placer gold in Copper Creek and the East Fork of the Lewis River suggests that near-surface parts of some veins contained significant amounts of free gold; however, erosion has subsequently removed the gold-rich parts of the veins. The silver content of most veins is usually less than 1 ounce per ton; however, up to 20 ounces per ton in silver has been reported from select samples. Lead and zinc are generally less than 1 percent each, but at several properties the veins contain small ore shoots with around 3 percent zinc and 3 percent lead. Although vanadium occurs only as trace amounts in most veins, as much as 5 percent has been reported at the Rainbow prospect, and 0.25 to 0.50 vanadium oxide was noted in copper ore from the Last Chance mine.

The maximum horizontal and vertical extent of the mineralized veins is unknown to the writer because of lack of development at most properties. Underground work at the Skamania and Last Chance mines discloses persistent veins for over 1,200 feet along their strikes, and depths in excess of 500 feet.

In addition to vein-type deposits, copper mineralization also occurs in breccia deposits at the north end of the Silver Star Granodiorite. Work by Grant (1969, p. 88-90) indicates that breccia zones occur along northeast-trending fracture zones in diorite and quartz diorite. Possibly these fracture zones intersect regional, northwest-trending fractures of the Copper Creek area to form loci of deposition for copper mineralization. The breccias are discontinuous because of post-mineral faulting; however, outcrop and core-hole data suggest that breccia occurs along a fracture zone that extends over a distance of at least 2 miles. The fracture zones are characterized by en echelon shears, stockwork systems, and breccias. Rocks of the breccia and fracture zones exhibit propylitic and quartz-sericite-tourmaline alteration of variable in-

tensity that is often associated with porphyry copper deposits. Mineralization occurs in the matrix of the breccia and as dissemination in the fragments. In order of decreasing abundance, the ore minerals consist of chalcopyrite, bornite, pyrite, pyrrhotite, and magnetite. The chalcopyrite appears to be directly associated with magnetite. The copper content of the breccia ranges from 0.35 to 0.70 percent, with as much as 1 percent copper in highly brecciated rock. Although most breccia outcrops contain less than 1 percent copper, it is highly probable that breccias in the Miners Queen area may, at depth, exceed 1 percent copper in minable amounts. Most of the rock between breccia zones consists of relatively fresh, slightly fractured diorite that contains less than 0.10 percent copper. Minor gold and silver and traces of molybdenum accompany the copper mineralization. The gold content ranges from a trace to 0.02 ounce per ton; silver ranges from 0.03 to 0.17 ounce. Supergene alteration and sulfide leaching are common over a large part of the mineralized breccia.

Although similar breccias have been noted in the granodioritic rocks of the Saturday Rock cupola, significant copper mineralization is not visible in outcrops.

Mines and Prospects

Miners Queen

This property, which consists of eight unpatented mining claims, is in the center of the NE¼ sec. 4, T. 3 N., R. 5 E., and 2½ miles northeast of Silver Star Mountain (fig. 18).

The mine workings are at an elevation of 1,800 feet on Miners Creek, a tributary to Copper Creek. From Yacolt, which is a small town in east-central Clark County, the property can be reached by 14 miles of well-maintained roads to Sunset campgrounds on the East Fork of the Lewis River. From Sunset, 7 miles of Forest Service road up Copper Creek may be followed to Miners Creek. With the exception of the last 2 miles, the roads are unimproved but fairly well maintained.

Little is known about the early history of the property, the original claims of which were staked in the 1890's. Other than several short adits and shallow shafts, the mineralization was never extensively explored. The only shipment of copper ore from the property was made in 1952, when Fred Weber, lessee, shipped 11 tons of copper ore that averaged 3.4 percent copper to the Tacoma smelter. In 1955, the U.S. Bureau of Mines evaluated mineralization at the Miners Queen. Five diamond drill holes, totaling 628 feet in length, were completed, two 35-foot shafts were dewatered, and all accessible adits were examined. The investigation disclosed a zone of copper mineralization, 225 feet long and 125 feet wide, that contained 0.10 to 0.72 percent copper (Magill and Appling, 1957). Since 1974, the property has been under intensive investigation by Amoco Minerals Co. About 5.5 square miles of claims were staked; geophysical, geochemical, and geological surveys were undertaken; and several thousand feet of core holes were drilled to evaluate the copper potential of the area.

The Miners Queen mine is near the northern edge of Silver Star Granodiorite, a pluton that grades into subordinate diorite and quartz diorite along its periphery. The stock intrudes moderately folded late Eocene to early Miocene andesites, tuffs, and volcanic breccias. The host rocks for copper mineralization consist of breccias and fracture zones, which according to Grant (1971, p. 4) are aligned along a northeast-trending structural system that can be traced from Copper Creek northeasterly for 2 miles to the headwaters of the Summit Creek drainage. Within several breccia zones at the Miners Queen, chalcopyrite, magnetite, pyrite, pyrrhotite, and molybdenite, in order of decreasing abundance, occur as disseminated grains. Highly brecciated areas contain about 1 per-

cent copper, whereas much of the area between the brecciated zones consists of relatively fresh, slightly fractured granodiorite and quartz diorite that contains less than 0.10 percent copper. Assays of outcrops and drill core, as reported by Magill and Appling (1957, p. 7) are shown in figure 20. Of five holes drilled in the vicinity of the mine workings, holes 1, 3, and 5 contain significant copper mineralization, with 170 feet of core averaging 0.67 percent copper. Holes 2 and 3 did not contain appreciable copper below a depth of 9 feet. Sampling of the breccia zones in adits and outcrops showed 0.07 to 14.30 percent copper, with an average of 1.30 percent, as well as traces to 0.02 ounce per ton in gold and 0.03 to 0.17 ounce in silver. Molybdenum is too sparse to be significant and malachite occurs at the surface, but is not present at depth. Titaniferous magnetite and tourmaline are disseminated in the breccia zones and are distinctly abundant in the vicinity of adits 1 and 5. In areas of abundant tourmaline and near concentrations of sulfide minerals, alteration of the coarse-grained quartz diorite is extensive; common alteration products consist of chlorite, sericite, and kaolin.

Underground workings at the Miners Queen consist of a 155-foot adit, with several short laterals, four short adits ranging from 20-85 feet in length, and two 35-foot shafts (fig. 20). Both shafts are filled with water within a few feet of their collars.

Black Jack

This prospect, which consists of 16 unpatented mining claims, is part of Amoco Mineral Co.'s holdings in the Miners and Copper Creeks area (fig. 18).

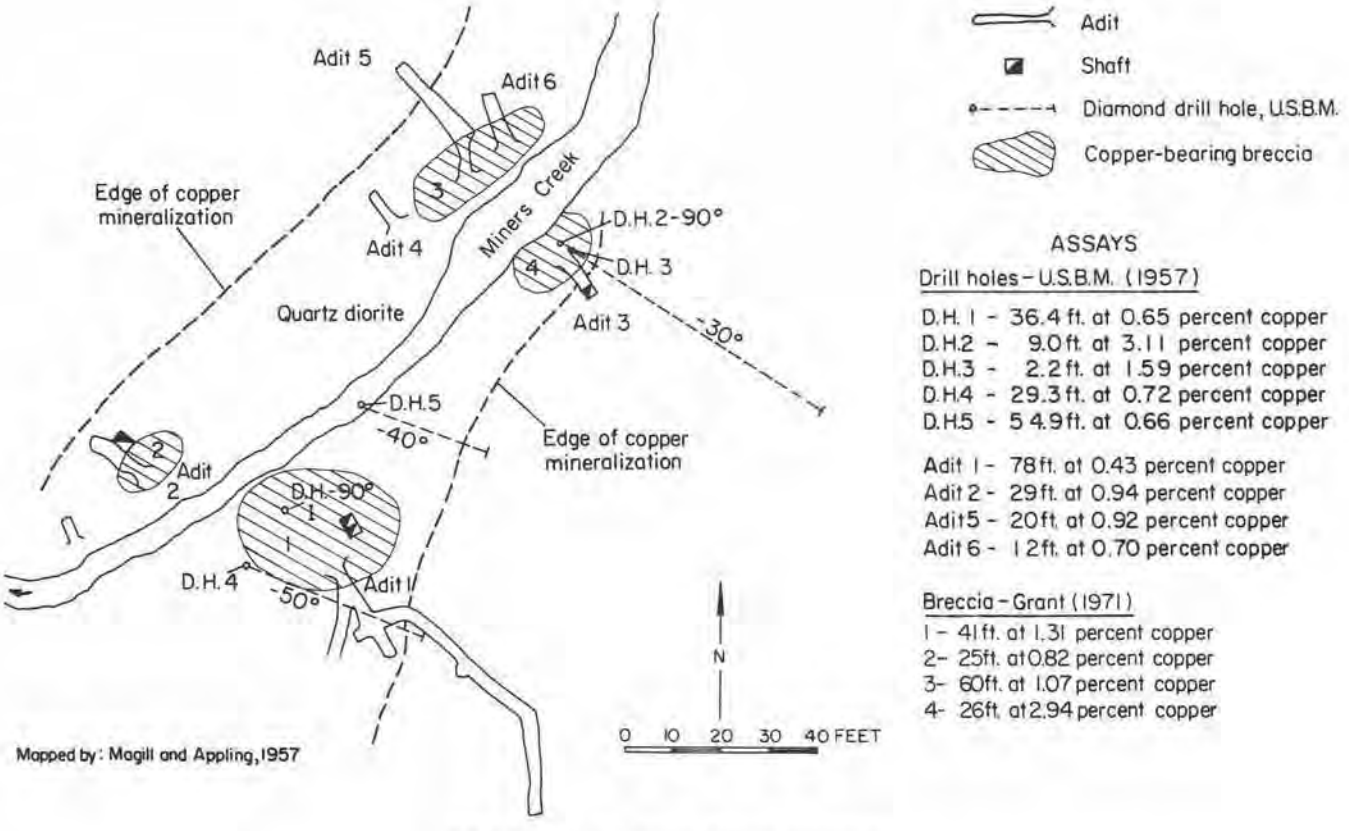


FIGURE 20.—Miners Queen prospect.

The prospect is on the north bank of Copper Creek and in the $S\frac{1}{2}NW\frac{1}{4}$ sec. 4, T. 3 N., R. 5 E. at an elevation of 2,000 feet. Access to the property is by way of a short spur road from the Miners Queen road. Placer gold on Copper Creek led to the discovery of the property in the late 1890's. In the early 1900's, several short adits were driven into the north bank of Copper Creek in search of lode deposits of gold that were sources of placer gold found in Copper Creek. Only minor copper and traces of gold were found, and the claims were abandoned. Around 1970, the property was under investigation for copper by several companies who undertook minor drilling. In 1974, Amoco acquired the property and are currently (1977) evaluating it and the surrounding area for copper.

At the Black Jack prospect, a fracture zone in altered granodiorite is exposed for about 300 feet on the north bank of Copper Creek. The fracture zone, which is about 50 feet in width, strikes north-northwest and exhibits near-vertical dips. Some fractures are filled with several inches of white quartz and tourmaline; the quartz contains minor chalcopyrite, magnetite, pyrite, and molybdenite. Finely brecciated granodiorite within the fracture zone has been hydrothermally altered, tourmalinized, and silicified; granodiorite away from the vein remains unaltered.

The copper content of the fracture zone ranges from 0.28 to 2.92 percent, with the highest values being in the No. 1 adit (see fig. 21). A 3.3-foot chip sample from the adit contains 2.92 percent cop-

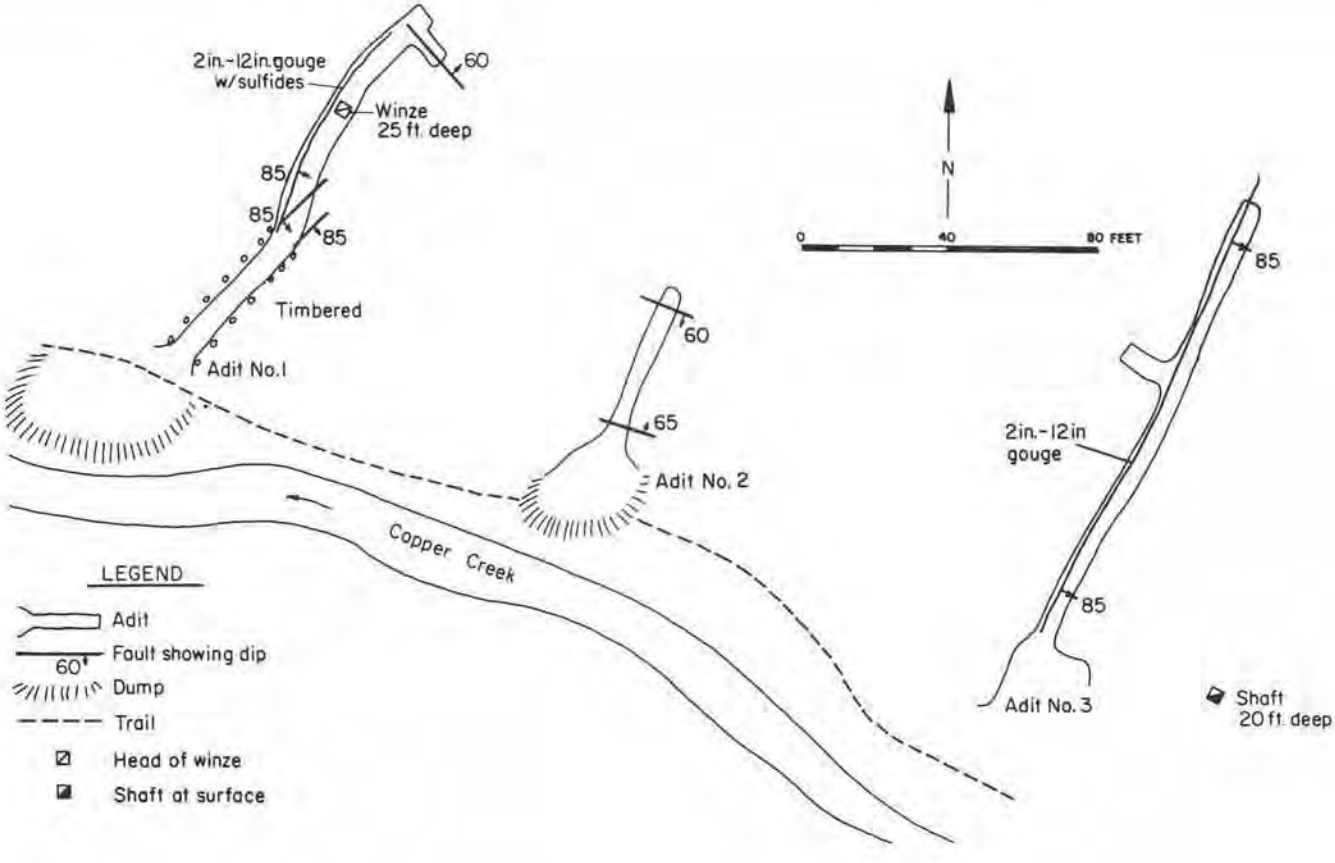


FIGURE 21.—Black Jack adits.

per, as well as traces of gold and silver. Two samples from adits 2 and 3 averaged only 0.30 percent copper.

Underground workings at the Black Jack consist of three adits and a 20-foot shaft. Adit 1 is 115 feet long, with a 25-foot winze 80 feet from the portal. Adit 2 is 40 feet long, and adit 3 is 130 feet long, with a 15-foot crosscut 80 feet from the portal. In adit 1, pyrite and minor chalcopyrite occur as small pods along fracture zones; pyrite is also disseminated in the wall rock. In adits 2 and 3, only disseminated pyrite is present in the wall rock, and the fracture zones are barren of ore minerals. In the writer's opinion, it is highly probable that significant copper mineralization occurs at depth in the general area of the Black Jack prospect. Well-developed, persistent fracture zones appear to intersect in the area and as such could form loci of deposition for copper minerals.

Silver Star

This property is in the W½ sec. 23, T. 3 N., R. 4 E., at the headwaters of Rock Creek (fig. 19). Elevations range from about 1,500 feet at Rock Creek to about 1,800 feet at the uppermost adit, which is on the northeastern slope of Larch Mountain. The property is accessible from Yacolt by 12.5 miles of well-maintained county and logging roads; the last 3 miles follow the southwest bank of Rock Creek.

Nothing is known about the early history of the property. From 1930 to 1944, it was under development by Silver Star Mining Co., of Vancouver, Washington. Numerous open cuts were dug on mineralized fracture zones, and three adits were driven to intersect the fracture zones at depth. Minor amounts of ore were stockpiled at the adit's portals, samples were collected and assayed, several core holes were drilled but no ore shipments were made to smelters. Currently (1977), the property is inactive; adits are caved, mining equipment has been removed, and the old camp building is barely discernible.

Mineralization of the Silver Star is in fractured and altered andesite of the Skamania volcanics. The border of the Silver Star Granodiorite is less than one-half mile south, whereas a small granodiorite cupola adjoins the property on the northwest (fig. 22). Mineralization appears to be confined to several northwest-trending, steeply dipping fracture zones in andesite. The fracture zones contain much brown iron oxide, as well as some black manganese oxide and quartz. Adjacent to the fracture zones, the andesite appears relatively unaltered. The most prominent veins are the Goat, which is near the common corner of secs. 14, 15, 22, and 23, T. 3 N., R. 4 E., and the Oxidized vein, which is S. 24° E. and 1,600 feet from the Goat vein.

C. W. Riddell examined the property in 1930, when excavations on the vein were fresh. Inasmuch as excavations are for the most part no longer discernible, the writer will use Riddell's observations. The Goat vein, as reported by Riddell (1930), is a quartz-filled shear zone in porphyritic andesite. The vein strikes N. 24° W. and dips 80 to 90 degrees. It is 1 to 18 feet thick and contains minor galena, chalcopyrite, pyrite, and sphalerite. Almost all assays show minor gold and silver; free gold was reported in near-surface parts of the vein. Exposures of the vein in Rock Creek, and in excavations along the vein, suggest a length of at least 3,000 feet. The most northerly exposure of the vein is in the bank of Rock Creek, approximately 1,700 feet in a N. 30° W. direction from the northwest corner of sec. 23, T. 30 N., R. 4 E. At this site, the vein is 1 to 3 feet wide and strikes N. 15° E. across the bed of Rock Creek.

The ore minerals occur as disseminated grains within the brecciated rock of the fracture zone, and the average copper content of the vein is estimated at 1 percent. Sampling by Riddell (1930, p. 2) shows 0.08 to 0.24 ounce per ton in gold, 0.05 to 2.8 ounces of silver, traces to 2.32 percent copper, 0.34 to 0.40 percent lead, and 3.6 to 12.80 percent zinc.

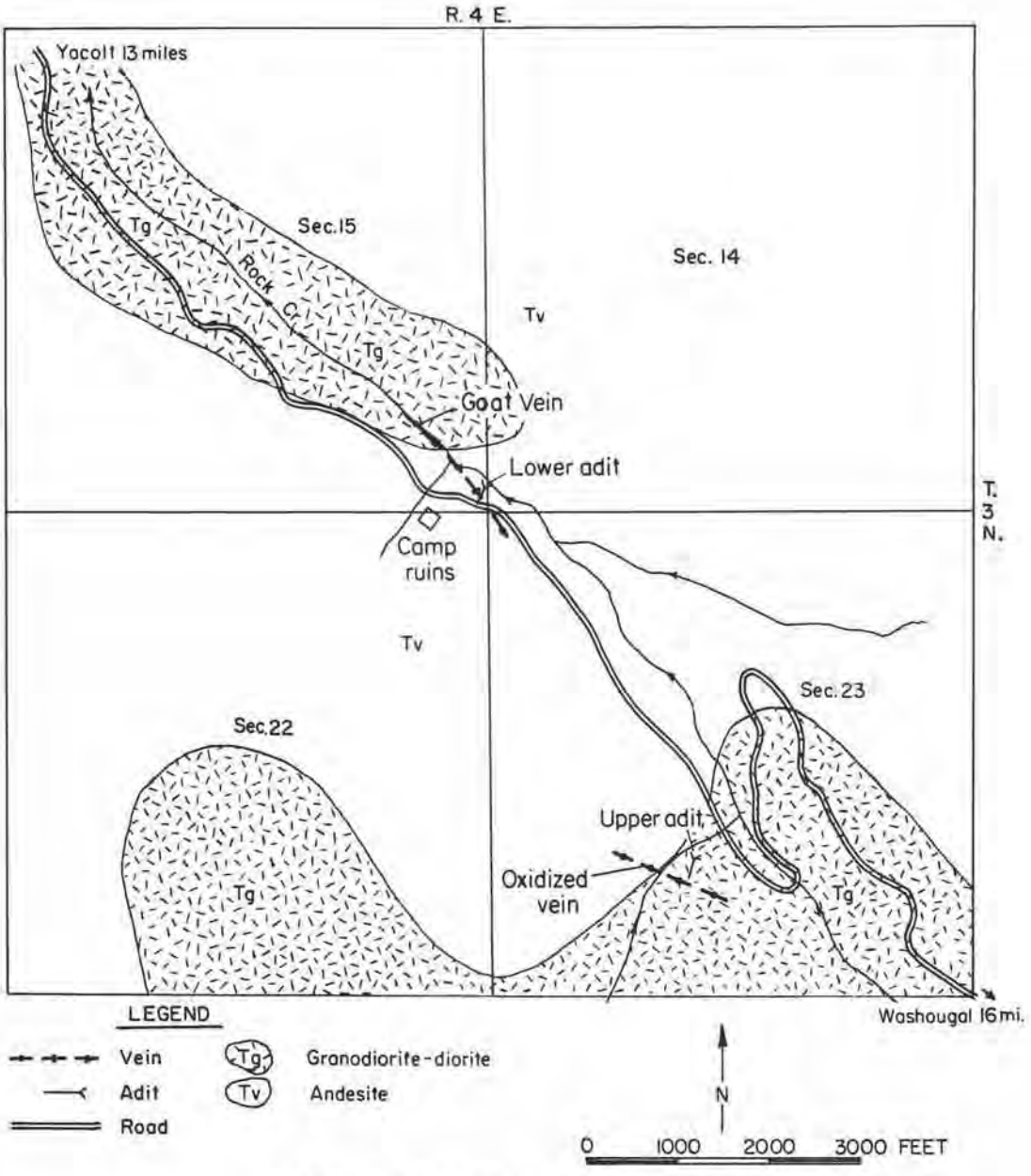


FIGURE 22.—Silver Star prospect.

About 700 feet south of the above-mentioned site, and on the north bank of Rock Creek, the vein was at one time exposed to a depth of 20 feet and showed a thickness of 18 feet. At a bearing of N. 10° W. and 450 feet from the NW. cor. sec. 23, an adit was driven S. 35° W. for 135 feet to intersect the Goat vein at depth. About 15 feet from the face of the adit, a 3-inch shear zone containing minor magnetite, pyrite, and chalcopyrite was followed S. 35° E. for 50 feet. At the end of the drift a 5-foot-wide quartz vein containing minor chalcopyrite, bornite, galena, sphalerite, and pyrite was encountered. The vein was at one time exposed on the surface in open cuts above the adit, and select samples showed 0.28 to 0.30

ounce of gold per ton, 1.80 to 2.80 ounces of silver, 11.08 to 18.20 percent copper, and 10.85 percent zinc. The Oxidized vein, in the southernmost vein on the property, occurs in silicified andesite near its contact with the Silver Star Granodiorite. A small fracture zone has been drifted upon for 115 feet at a heading of S. 15° W. The adit encountered several quartz veins, the largest of which is 1.5 feet thick. The quartz is sparsely mineralized with pyrite, chalcopyrite, sphalerite, specularite, and malachite.

Over 50 samples from adits and open cuts, as well as samples of mineralized float, were collected and assayed by the Silver Star Mining Co. in the 1930's. The gold content of the samples ranged from 0.02 to 46.32 ounces per ton in gold, trace to 22.20 ounces in silver, 0.16 to 18.20 percent copper, and 0.15 to 22.10 percent zinc. The average gold content of these samples was only 0.11 ounce per ton, whereas silver was 0.76 ounce. Disregarding the high-grade samples of copper and zinc, the average copper content of eight samples was 1.01 percent, and the average zinc content of six samples was 1.50 percent.

The northwest trend of Rock Creek suggests erosion of a well-developed, northwest-trending fracture zone concealed by valley fill. Thus, further exploration in the vicinity of the Silver Star property should be directed towards determining if mineralized fracture zones parallel known northwest-trending veins of the area.

Skamania

The Skamania mine is on deeded land in the NE¼SW¼ sec. 21, T. 3 N., R. 5 E. The main adit and shaft are on the east bank of the West Fork of the Washougal River, at an elevation of 1,700 feet (fig. 19). Access to the property is by way of State Highway 8B, County Road 11, and logging roads along the West Fork of the Washougal River, for a total distance of 17 miles from Washougal. The last several miles of road, due to lack of maintenance, are inaccessible to vehicle travel.

At the turn of the century, the area in the vicinity of the Skamania mine was thoroughly prospected. Many claims were staked and considerable development work was undertaken at the more favorable deposits, among which were the Skamania and Last Chance mines of Washougal Consolidated Copper Mining Co. Around 1915, a small concentrating mill was built at the mine and several shipments of concentrates were made to the Tacoma smelter. Brinsmade (1916) reported that assays of hand-sorted ore ran 15.8 to 23.5 percent copper, 0.01 to 0.18 ounce of gold, and 8.7 to 18.5 ounces of silver. In 1966, Northwest Mining Co. of Portland shipped 6 tons of copper ore of unknown value to the smelter. Since 1966, the mine has been idle. Most underground workings are inaccessible because of flooded shafts and caved adits, and all mining and milling equipment has been removed.

The Skamania vein is a quartz fissure vein in quartz diorite of the Silver Star Granodiorite. About 800 feet east of the mine, porphyritic andesite of the Skamania volcanics crops out, and andesite in the mine dump indicates that the quartz diorite-andesite contact was encountered in the mine workings. The vein, which consists of white vuggy quartz, ranges from 1 to 6 feet in thickness. However, some parts of the vein consist of several thin parallel quartz veins separated by brecciated and silicified wall rock and gouge. Several narrow quartz veins parallel the main vein, but these veins appear to be void of ore minerals. The Skamania vein has an average strike of N. 76° W. and dips 80° N. Deviations of up to 10 degrees occur along the strike of the vein, which has been exposed in mine workings for a strike length of 1,374 feet and to a depth of about 500 feet in the main shaft. Near-surface parts of the vein have been leached by ground water and the predominant copper minerals consist of chrysocolla, azurite, and mala-

chite. Slightly leached parts of the vein contain pyrite, bornite, chalcocite, and chalcopyrite containing secondary covellite. The ore minerals occur chiefly as disseminated grains in quartz gangue, but in some parts of the vein ore minerals occur as isolated lenses up to several inches across. The presence of secondary copper mineral in the vein at adit level suggests that the main adit was driven in the zone of oxidation. However, the presence of unoxidized pyrite and chalcopyrite indicates that oxidation was incomplete. Thus, it is doubtful that secondary enrichment will be important because no such zone was encountered in the shaft, which extends almost 500 feet beneath the existing water table near the adit level.

Because of inaccessible mine workings, the writer, as well as the other staff members who have visited the property in the past, was unable to determine the extent of copper mineralization in the mine. Vein quartz on the dump contains traces to 5 percent copper, and Heath (1966, p. 33) reports that sampling by the U.S. Bureau of Mines showed about 2 percent copper and 1 ounce of silver per ton over an average width of 3.5 feet for the length of the adit (1,374 feet). Sampling by Brerton (1930) showed 1.05 to 5.54 percent copper on vein widths of 8 inches to 6 feet. Assays of parts of the Skamania vein as reported by Brerton and others are shown in table 4.

Development work at the Skamania mine consists of a 1,040-foot east adit, a 236-foot west adit,

TABLE 4.—Analyses of Skamania vein

Sampled by Brerton (1930)

Sample location	Vein width (ft)	Length of vein sampled (ft)	Copper (percent)	No. of samples
Sampled by Williams (1930)				
West adit (feet from portal)				
100	3.0		3.38	1
East adit (feet from portal)				
77 to 200	3.0	123	1.80	6
600 to 638	2.75	38	2.11	5
836 to 854	2.5	18	3.00	3
915 to 940	1.5	25	1.82	3
Shaft at 425-foot level	2.33	160	2.32	12

Sample location	Vein width (ft)	Copper (percent)	Gold (oz/ton)	Silver (oz/ton)
Sampled by U.S. Bureau of Mines, 1955				
East adit (feet from portal)				
135	2.2	4.30	0.02	3.70
235	1.2	12.20	0.03	11.60
410	2.7	1.78	Nil	1.30
472	5.0	1.71	0.01	0.90
520	3.5	1.27	0.01	0.50
688	4.0	1.05	Nil	0.50
788	4.2	1.92	Nil	0.40
West adit (feet from portal)				
132	4.0	0.35	Nil	Nil
185	5.0	0.25	Nil	Nil

and a 458-foot shaft (fig. 23). The east adit, which is the mine's main adit, has an average heading of S. 76° E. and follows the vein. About 66 feet from the portal, a winze extends 50 feet below the adit floor; over the length of the adit, six crosscuts from 5 to 10 feet in length have been driven into the north and south walls of the vein. Near the portal of the east adit, a 9- by 5-foot shaft has been sunk 450 feet. The first 100 feet of the shaft is vertical; at the 100-foot level, a drift extends 115 feet east and 50 feet west along the veins. From the 100-foot level to the bottom, the shaft is inclined 77° from horizontal at a bearing of N. 35° E. At the 225-foot level, a drift extends east for 30 feet; at the 325-foot level, a drift extends east for 35 feet. At the 425-foot level, a crosscut extends south for 50 feet and intersects the vein, at which point the vein is followed west for 190 feet and east for 135 feet. The west adit is on the west bank of the West Fork of the Washougal River and 90 feet west of the east adit and follows the eastward extension of the vein (fig. 23). It was driven at a general heading of N. 58° W. for 236 feet. About 70 feet from the portal, a crosscut has been driven south for 30 feet, and at the face of the adit another crosscut extends south for 65 feet. Very little copper mineralization is exposed in the adit. Near the central part of the adit, minor chalcopyrite and malachite are disseminated in the vein over a thick-

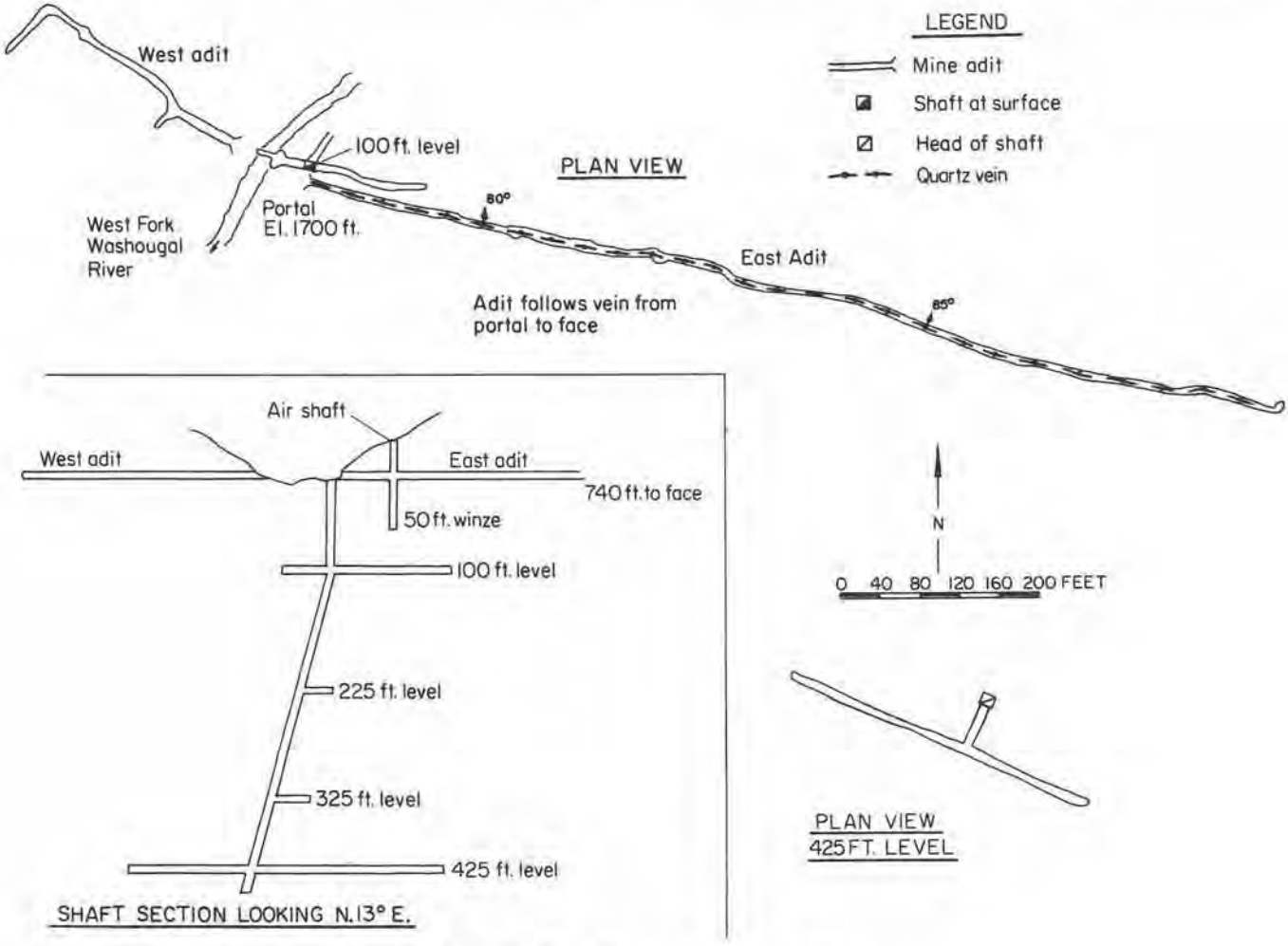


FIGURE 23.—Skamania mine workings

ness of about 4 feet.

Last Chance

The Last Chance mine is on deeded land in the center of S½SE¼ sec. 29, T. 3 N., R. 5 E., and at an elevation of 1,600 feet on the West Fork of the Washougal River (fig. 19). From Washougal, State Highway 8B, County Road 11, and logging roads may be followed for 16 miles to the property. The last 2 miles of the road is not maintained, and is generally inaccessible to vehicle travel. The Last Chance mine was discovered and developed at the same time as the Skamania mine, which is 1.5 miles north of the Last Chance. The properties are often confused with each other because the mine workings are almost identical at both properties. Although Washougal Consolidated Copper Mining Co. undertook considerable development work at the Last Chance in the early 1900's, no shipments of ore were made. Currently (1977), the mine is idle and mining equipment has been removed.

The Last Chance vein is a quartz-filled fissure in a quartz diorite phase of the Silver Star Granodiorite. About 0.5 mile east of the mine, the stock is in contact with andesite of the Skamania volcanics. The vein is from 1 to 10 feet thick, strikes S. 45° to 54° E. and dips 60° to 90° S. and N. Much of the vein consists of 1 to 4 feet of massive white quartz, whereas the thicker parts of the vein consist of several narrow quartz veins alternating with highly brecciated and silicified quartz diorite. Mine workings indicate a strike length in excess of 1,500 feet and a vertical depth of over 800 feet. Brerton (1930) reports that the Last Chance vein can be traced by outcrops for nearly 2 miles. Within parts of the vein, silicification and argillization is extensive; however, quartz diorite wall rock adjacent to the vein is only lightly propylitized and is in sharp contact with the vein.

Common ore minerals of the vein consist of chrysocolla, malachite, bornite, and pyrite. Azurite, chalcocite, and chalcopyrite are less common. The bornite, chalcocite, and chalcopyrite occur as disseminations and blebs in the vein quartz, whereas chrysocolla, malachite, and azurite occur as coatings on fracture surfaces. In a few places, chrysocolla occurs as veins 1 to 6 inches thick. From the portal of the east adit, to about 500 feet within it, the most conspicuous copper mineral is chrysocolla. From 500 feet, to the face of the adit at 936 feet, bornite and chrysocolla are the predominate copper minerals. Near the face of the adit, descloizite (lead vanadate) occurs as thin greenish-yellow coatings on vein surfaces.

The copper content of the Last Chance vein ranges from traces to 6 percent, over vein widths of 1 to 5 feet. In 1942, the deposit was examined by Ward Carithers, former staff member of the Division of Geology and Earth Resources. Carithers reported (field notes) 8 to 10 percent copper over vein widths of up to 1 foot in the east adit. However, the vein as a whole, 500 feet from the portal to the face of the adit, would probably average 1.5 percent copper over widths of 1 to 3 feet. Sampling by Chichester (1953) for the U.S. Bureau of Mines showed 2.75 percent copper and 0.71 ounce of silver for the length of the adit (936 feet) and an average vein width of 4 feet. Sampling by Williams (1934), when all mine workings were accessible, are shown in table 5.

Development work at the Last Chance mine consists of a 936-foot east adit, a 267-foot west adit, and a 540-foot vertical shaft (fig. 24). The east adit is on the east bank of the West Fork of the Washougal River. It bears S. 54° E. for about 500 feet, thence S. 45° E. for 463 feet to its face, which is about 200 feet beneath the surface. Nine crosscuts, ranging from 10 to 40 feet in length, driven into the southwest wall of the vein encountered several quartz veins and stringers that parallel the Last Chance vein. The 540-foot shaft is at the portal of the east adit, and at 64-, 200-, 300-, 400-, and 500-foot levels in the shaft, drifts have been driven along the vein in southeast

TABLE 5.—Copper content of Last Chance vein

Location of ore shoot	Copper (percent)	Vein thickness (ft)	Vein length (ft)
East adit (feet from portal)			
80 to 500	2.92	3.0	430
700 to 800	2.10	2.75	120
In shaft			
64-foot level	3.00	3.5	38
200-foot level	3.09	3.33	120
400-foot level	2.56	2.75	210
500-foot level	2.20	1.95	57

and northwest directions. The drifts range from 30 to 209 feet in length. The west adit is about 280 feet northwest of the east adit, and is on the west bank of the West Fork of the Washougal River. The adit follows the vein N. 60° W. for 267 feet; the copper mineralization of the vein is unknown to the writer.

As in the case of the Skamania mine, there is no reason to expect the Last Chance vein to increase in width with depth, nor is there any reason to expect secondary enrichment of the vein with depth.

Rainbow

The Rainbow prospect is about 1 mile south of the Last Chance mine and in the $S\frac{1}{2}S\frac{1}{2}$ sec. 32, T. 3 N., R. 5 E. (fig. 19). Access to the property is the same as that for the Last Chance.

Currently (1977), little if any mineralization is visible at the prospect. When the property was examined by staff geologists of the Division of Geology and Earth Resources in 1942, two shallow shafts were reported 60 feet east of the road that passes through the center of the property. Vein material on the dumps of the shafts consisted of quartz and minor amethyst. Heath (1966, p. 26) reported the presence of a 3- to 10-inch-wide quartz vein that strikes N. 50° W. and dips 60° NE. Sparsely disseminated galena was observed along the borders of the vein, which occurs in granodiorite.

Yellow Jacket

The Yellow Jacket mine is 0.5 mile north of the Skamania mine and in the $SW\frac{1}{4}NE\frac{1}{4}$ sec. 21, T. 3 N., R. 5 E. (fig. 19). Although a road led to the mine in the 1950's, the road is no longer accessible to vehicle travel. In 1953, $4\frac{1}{2}$ tons of ore, which contained 5.5 percent copper and 3.95 ounces per ton in silver, was shipped to the Tacoma smelter by Copper Canyon Mines of Camas, Washington.

Copper mineralization at the Yellow Jacket occurs in a 1- to 2-foot-wide quartz vein that strikes N. 65° W. and dips 75° to 80° N.; the vein can be traced for at least 400 feet along its strike. The host rock for the vein consists of slightly propylitized granodiorite of the Silver Star Granodiorite. Chalcopyrite and bornite occur as disseminated grains, or in pockets and streaks in banded and vuggy quartz that makes up

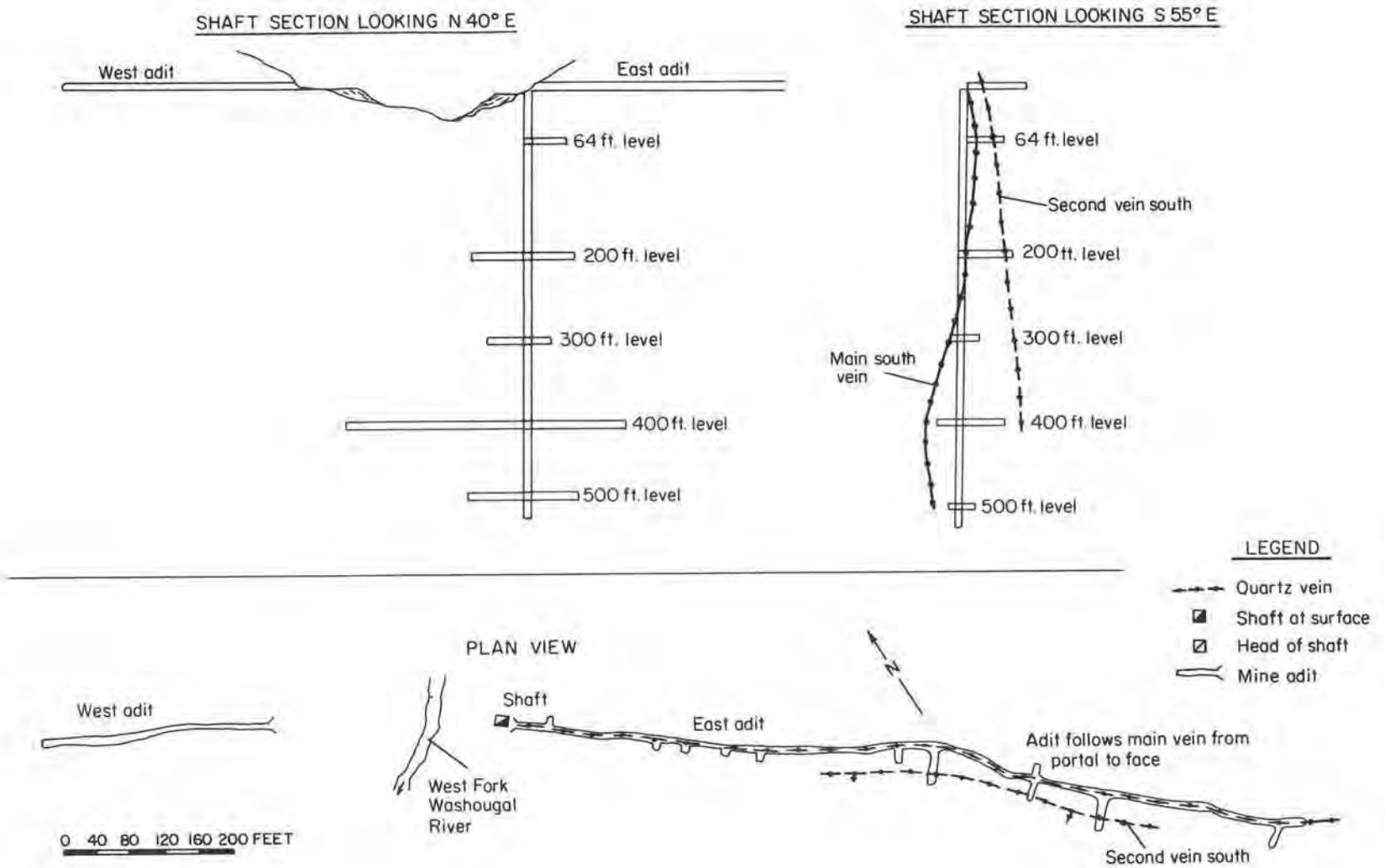


FIGURE 24.—Last Chance mine workings.

the vein. Oxidized parts of the vein contain minor azurite and malachite.

Two adits, one on the east bank of the Washougal River and the other on the west bank, explore the Yellow Jacket vein (fig. 25). The east adit was driven at a heading of S. 65° E. for 120 feet. The first 55 feet of the adit is timbered and conceals the vein; the remaining 65 feet of the adit is untimbered and follows the vein. At 100 feet from the portal, a 7-foot winze has been sunk on the vein. The vein, as exposed in the east adit, is 8 inches to 1.5 feet thick and consists of gouge and quartz containing bornite and malachite. Five channel samples of the vein, ranging from 6 to 18 inches in width, averaged 4.73 percent copper, 3.47 ounces of silver per ton, and traces of gold. The west adit was driven west for 30 feet, at which point it heads N. 65° W. for 77 feet along a 3- to 8-inch-wide quartz vein that dips 70° N. The vein contains minor bornite and azurite and assays up to 2 percent copper, 1.5 ounces per ton in silver, and traces of gold.

Silver Creek

This prospect is near the center of sec. 22, T. 3 N., R. 5 E. and on the northwest and southwest banks of Silver Creek at an elevation of about 2,200 feet (fig. 19). No road leads to the prospect, but a poor trail may be followed for $2\frac{1}{2}$ miles up Silver Creek from its confluence with the Washougal River. To the south, an abandoned logging road in sec. 27 passes within 0.75 mile of the property. The writer did not examine the Silver Creek prospect, and the description that follows has been taken from Heath's report (1966, p. 38).

Mineralization at the prospect occurs in a 5- to 10-foot shear zone in andesite porphyry of the Skamania volcanics. The near-vertical shear zone strikes N. 70° W. and is exposed in tributaries on the northwest and southeast banks of Silver Creek. Adits were driven into the shear zone on both sides of Silver Creek, but the adits are inaccessible because of caved portals. The shear zone on the southeast bank of the creek consists of brecciated andesite in a highly siliceous matrix. The ore minerals, which consist of fine-grained galena, sphalerite, chalcopyrite, and pyrite, occur as disseminated grains and small blebs along the edges of breccia fragments, and in thin veinlets in quartz. Heath (1966, p. 39) estimated the mineral content of the shear zone at 3 percent lead and zinc and less than 1 percent copper.

Mineralization on the northwest bank of Silver Creek is confined to a northwest-trending, vertical cryptocrystalline quartz vein in andesite porphyry. The vein is 2 to 3 feet wide and contains very fine-grained disseminated galena, sphalerite, chalcopyrite, and pyrite. The mineral content of the quartz vein is considerably less than the breccia on the southwest bank of the creek.

Blue Bird

This property is in the $SE\frac{1}{4}NE\frac{1}{4}$ sec. 15, T. 3 N., R. 5 E. at an elevation of about 1,800 feet (fig. 19). It is poorly accessible and can be reached by following the old Maybee mine wagon road to the confluence of Blue Bird and Shirt creeks, thence about 0.5 mile up Blue Bird Creek to caved adits on the property. The remains of a small concentrating mill, which was burned in the 1920's by forest fires, are still visible.

Mineralization at the Blue Bird has been explored by means of two adits of undetermined length. The lower adit was driven N. 40° W. into the bank of the creek and follows narrow quartz stringers in andesite. Although malachite coats fracture surfaces in the adit, no copper sulfide minerals are visible. About 200 feet upstream from the lower adit a 200-foot adit was driven S. 30° E. along a quartz vein in fine-grained granodiorite. In places, the vein is as

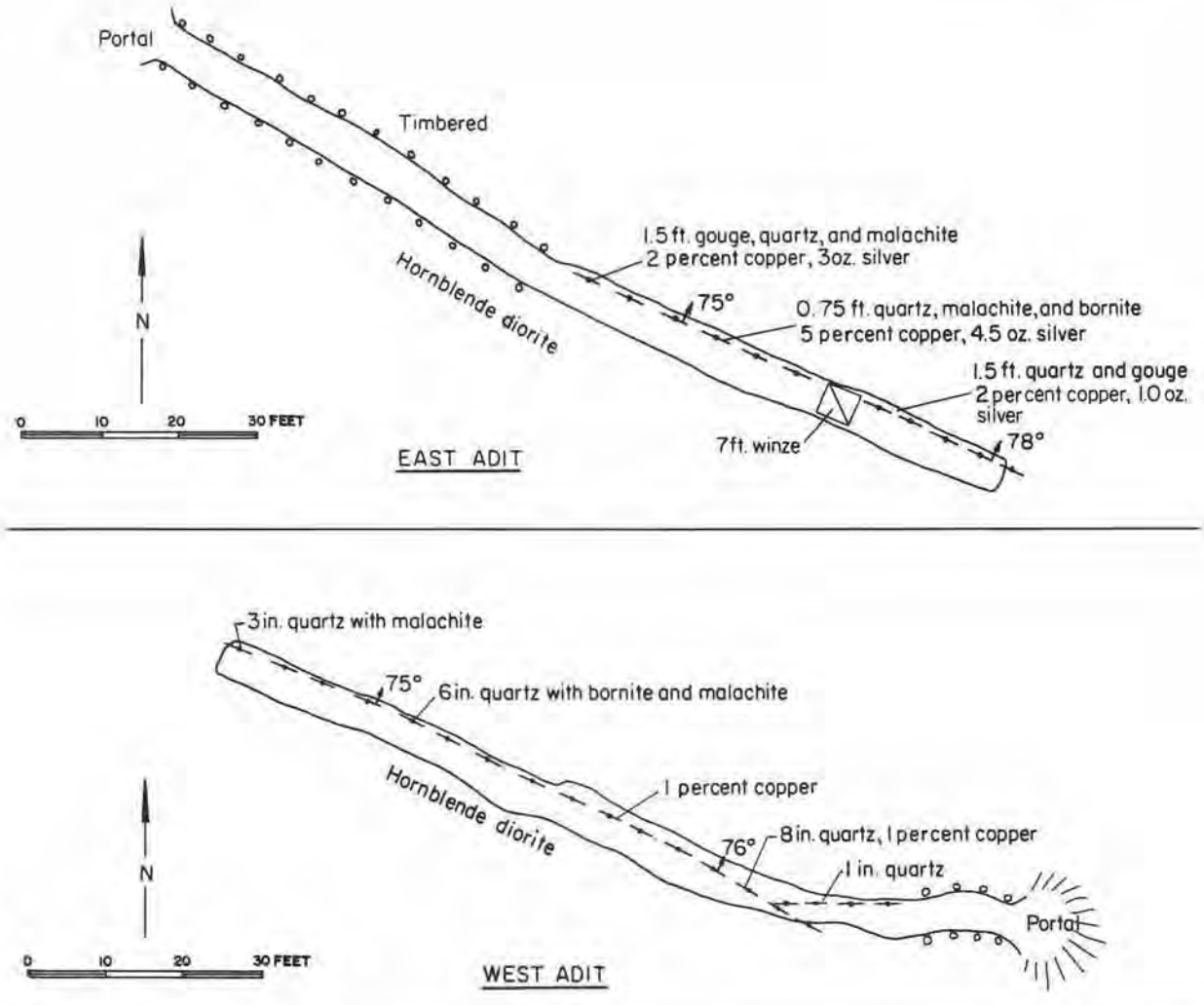


FIGURE 25.—Yellow Jack adits.

much as 2 feet wide, but in many places it pinches to a stringer less than 0.25 inch in width. Much of the quartz contains minor pyrite, chalcopyrite, and malachite. Assays from a small stockpile of the quartz showed 0.20 percent copper, 0.25 ounce silver, and traces of gold.

Maybee

This mine is near the headwaters of Shirt Creek, which is a tributary to the Washougal River in the NE¼ NW¼ sec. 14, T. 3 N., R. 5 E. (fig 19). Elevations at the property range from 1,200 to 2,000 feet. It is one of the oldest mines in the district, having been discovered by F. A. Maybee in 1900. Between 1902 and 1922, the property was under development by Washougal Gold & Copper Mining Co. A 25-ton concentrating mill was built at the property, and in 1917, several wagon loads of concentrate were shipped from the mine (Huntting, 1956, p. 77); however, the mine never became a significant producer of gold and copper, nor can any records of past production from the mine be found. The property has been idle for over 40 years, and all that remains at the mine are caved adits and rusting milling and mining equipment.

The Maybee mine is on state-owned land that is poorly accessible. From near the confluence of Shirt Creek and Washougal River an old, barely discernible wagon road can be followed with great difficulty for 2 miles to the mine camp. The Bluff Mountain road on the south end of McKinley Ridge is about 1 mile northwest of the mine, but no trail leads from the road to the mine.

Predominate rocks in the vicinity of the mine consist of silicified and propylitized andesite, which are traversed by steeply dipping, northwest-trending fracture zones. The fracture zones are up to 6 feet thick and contain quartz veins that have been mineralized with chalcopyrite, bornite, pyrite, and sphalerite. Common alteration products of these minerals include hematite, limonite, azurite, malachite, and cuprite. In general, mineralization along the fracture zone appears to be spotty.

Two mine dumps, on opposite sides of Maybee Creek, indicate that exploration and development work was undertaken on two mineralized parallel fracture zones. The size of the dumps indicates that in excess of 2,000 feet of crosscuts, drifts, and shafts are present in two adits. Abundant white vein quartz on both dumps suggest that most of the vein is barren of ore minerals. Select fragments of mineralized quartz from the dump on the southwest side of the creek assayed 3.10 percent copper, 0.02 ounce per ton in gold, and 5.54 ounces of silver. Select samples from the opposite dump assayed 1.3 percent copper, a trace of gold, and 2.58 ounces of silver.

Currently (1977), all mine workings are inaccessible because of caved portals. However, the following description of the property by Brinsmade (1916, p. 744) provides a description of the mine workings, as well as general data on the nature of the mineralization:

> This is the most extensively developed mine of the district and the only one having a mill. Here are two parallel veins on opposite sides of the narrow gulch of Shirt creek, a branch of the Washougal river. Each vein dips about 70° into the hillside and follows closely the westerly course of the gulch. The veins are strong fissures varying in width from one to six feet but the filling, save in the shoots or chimneys, is only barren country-rock. These chimneys are of quartz, they vary in length from 20 to 40 feet, and contain chalcopyrite, bornite, and sphalerite disseminated in bands of minute dispersed crystals. The sorted ore resembles, in the ratio of its content, the assays given for the Skamania mine, having about 1 ounce of silver to 1 percent of copper, but each unit of copper is here accompanied by 1½ units of zinc.
>
> Each vein is entered by a main adit from the bottom of the gulch, started at 1,700 elevation or some 400 feet below the outcrop. The north, or Dixie, vein is cut by a 400-foot adit, and is then followed to the west for 1,200 feet by a drift. At the north end of the adit is a 130-foot incline-shaft. No underground

communication yet exists with an upper adit and drift that explore the vein at 1,850 feet elevation. The south or Copper King vein is also cut by a 400-foot adit, but here the chimneys are more frequent, so that the drift has been extended west for over 2,000 feet along the vein. Near the west end an incline-shaft has followed the vein down for 130 feet and opened up the best ore in the mine.

Brinsmade's description of mineralization and underground workings points out the fact that extensive exploratory work was undertaken at the Maybee mine. This work appears to have disclosed that veins on the property are poorly mineralized and unprofitable to mine, even at present-day metal prices.

Zinc Creek

This prospect is on Gold Run Creek, which is a minor tributory to the Washougal River in sec. 13, T. 3 N., R. 5 E. (fig. 19). The prospect is at an elevation of 1,450 feet in the SW¼NE¼ and NW¼SE¼ sec. 13. By road the property is about 15 miles from Washougal, but the last 3 miles, a private logging road, is closed to the general public.

In the vicinity of the prospect, the predominate rocks are volcanic breccia and silicified and propylitized andesite that are traversed by N. 30° W. trending fracture zones that dip 50° to 70° SW. The fracture zones average 3 feet in width, but in places are as much as 10 feet wide. Several of the fracture zones have been mineralized with quartz, calcite, and siderite, all of which serve as gangue for minor disseminated sphalerite, galena, chalcopyrite, and pyrite. The main mineralized fracture zone is on the southwest bank of Gold Run Creek, and roughly parallels the creek. Outcrops and trenches along the strike of the fracture zone indicate a strike length in excess of 275 feet. The northwest end of the fracture zone is explored by a 120-foot adit (caved) that heads N. 27° W. into the north bank of the creek. At this site the fracture zone contains a 1- to 3-foot-wide quartz-calcite vein carrying disseminated sphalerite. This vein reportedly contains traces to 5 percent zinc. About 100 feet southeast of the adit and in the bed of Gold Run Creek, the fracture zone is 3 feet wide, strikes N. 35° W., and dips 65° SW. Silicified parts of the fracture zone contains minor sphalerite and chalcopyrite that are accompanied by sparse galena. About 30 feet southeast of the exposure in the creek bed, a shaft has been sunk on a 10-foot-wide quartz-calcite vein that contains up to 5 percent zinc. Vein material on the dump of the shaft shows disseminated grains of pyrite, sphalerite, galena, and chalcopyrite. About 40 feet southeast of the shaft, and on the southwest bank of the creek, the quartz-calcite vein is 3 to 4 feet wide and poorly exposed for 45 feet. At this site the vein strikes N. 30° W. and is vertical. Ore minerals of the vein consist of about 5 percent disseminated sphalerite and less than 2 percent galena and chalcopyrite. The southeasternmost exposure of the mineralized shear zone is about 150 feet southeast of the shaft and on the southwest bank of the creek at an elevation of about 1,385 feet. The fracture zone at this site strikes N. 20° W. and is exposed for about 30 feet. The zone is silicified, but mineralization is sparse and spotty.

WIND RIVER AREA

GENERAL INFORMATION

The Wind River area is not within an organized mining district of Washington. It is about 10 miles northeast of the Washougal district and in T. 5 N., R. 7 E. (fig. 4). The Wind River area is 20 miles north of the town of Carson and encompasses an area of less than 10 square miles near the headwaters of the

Wind River. In the early 1900's, the area underwent prospecting for lode and placer gold deposits; mining claims were staked, but no important discoveries were made. The area was inactive until 1956, at which time Wind River Mining Co. obtained rights to 21 quartz lode claims and explored them for their gold possibilities.

The Wind River area is mountainous and well timbered. Elevations range from around 1,300 to 1,600 feet on the Wind River, to as much as 4,968 feet at the summit of Red Mountain. Access to the area presents few problems because a black-topped road (Forest Service roads 30 and N73) from Carson passes through the center of the area, and logging roads extend into the more remote sections.

GENERAL GEOLOGY

Rocks of the Wind River area are described by Wise (1961, p. 26-48) and consist chiefly of a volcanic sequence of agglomerate, tuff breccias, volcanic sandstone and siltstone, and pumice (Eocene-Oligocene age). These rocks have been intruded by diorite and basalt dikes, sills, and plugs. Red Mountain, a Quaternary shield volcano, is 6½ miles east of the area; and Big Butte, which is an augite-hypersthene diorite plug, is 4 miles south of the area. In most of the larger valleys, flood-plain and stream deposits of gravel, sand, and silt conceal the volcanic rocks, which throughout the area are nearly flat lying. No major faults have been mapped, but the northwest trend of several major valleys may represent surface expression of concealed faults.

Wind River Mine

This mine is the only mining property in the area; however, old adits and prospect pits indicate that other mineral occurrences were investigated in years past. The mine consists of 10 unpatented claims and 1 millsite, which are on a minor tributary to the Wind River in the NE¼ sec. 8, T. 5 N., R. 7 E. (fig. 26). Since 1956, the property has been under the control of Wind River Mining Co.; to date (1977), 831 tons of gold ore valued at $21,462 has been shipped from the mine. This represents about 90 percent of the total metal production of southwestern Washington. Around 1959, a small flotation mill was built by the company to produce gold concentrates from gold-bearing quartz veins; however, milling operations ceased because of poor recoveries. In 1963, around 390 tons of siliceous gold ore was shipped to the Tacoma smelter, and shortly thereafter Wind River Mining Co. ceased operations. In 1967, Baxter Mining Co. acquired the property and shipped 50 tons of gold ore to the smelter. The low gold content of the ore forced mining operations to close. In 1972, Fred Neisler leased the property and shipped 99 tons of ore, which was followed by 169 tons in 1973, and by 123 tons in 1974. In 1975, once again the mine was idle. Currently (1977), the property is under development by Foster Mining Co.

The owners of Wind River mine report at least four mineralized quartz veins in basalt are present on the property. The veins range from 6 inches to 6 feet in width, have general north-northwest strikes, and dip steeply. The vein quartz is white chalcedonic quartz that is commonly banded and vuggy, and the vugs are often partially filled with limonitic clays. In parts of some veins, blade texture is well-developed. Pyrite, although sparse, is the only visible sulfide mineral of the veins; however, patches of realgar were reported in at least one vein (No. 4). Other than the main vein (No. 2) the writer was unable to establish the locations of veins 1, 3, and 4. Vein 1 reportedly is east of vein 2; vein 3 reportedly is in the bottom of the creek that flows through the property and is covered by a log jam; vein 4 crops out on the property but no mention is made of its location.

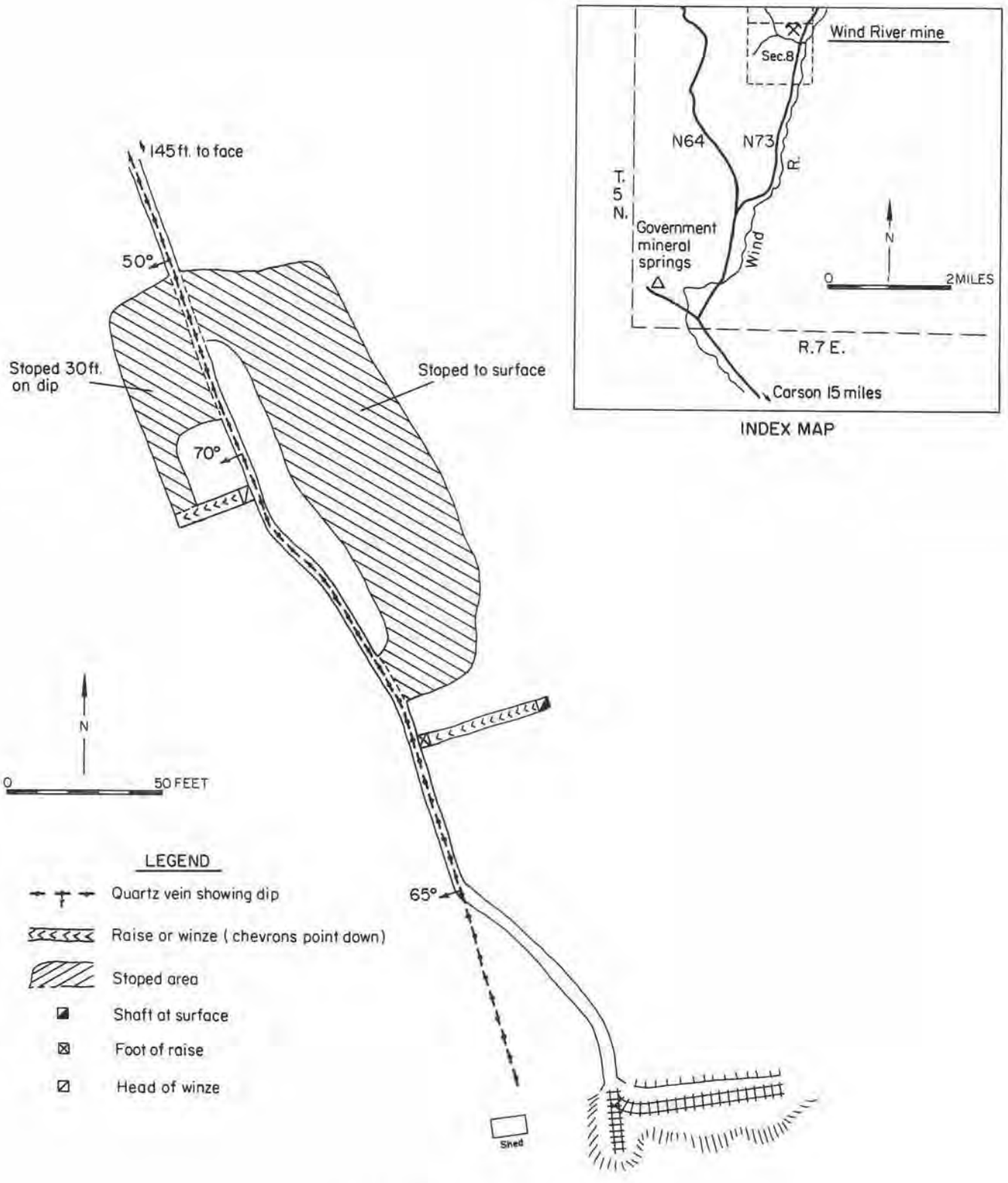


FIGURE 26.—Wind River mine.

The main vein (No. 2) at the Wind River mine is a quartz fissure vein in dense, dark-gray basalt. The vein ranges from 2 to 6 feet in thickness, strikes N. 15° to 40° W. and dips 75° southwest. The quartz of the vein exhibits banding parallel to the walls, and parts of the vein contain elongated vugs lined with drusy quartz. Much of the quartz is chalcedonic, whereas some is porcelanic. Minor calcite accompanies the quartz; pyrite is the common sulfide, and is minor and sporadic. Up to 0.10 percent copper has been reported in ore shipments. However, other than sparse copper staining in the form of malachite, primary minerals do not appear to be present. The gold occurs as minute grains in the vein quartz, and other than assaying the quartz, it is impossible to distinguish ore from barren quartz. Gold-silver mineralization is not uniformly distributed in the vein, but appears to be confined to shoots, the longest of which has been partially mined. Based on past shipments, the gold content of the shoot ranged from 0.12 to 0.59 ounce per ton, whereas the silver content ranged from 0.36 to 0.84 ounce.

Main underground workings at the mine consist of a 485-foot adit (fig. 26). The adit was driven in a general northwest direction for about 85 feet before encountering the vein. About 130 feet from the portal a raise extends to the surface. At this point, the adit follows the vein 400 feet in a general north-northwest direction. From 145 to 305 feet from the portal, most of the vein has been stoped to the surface, whereas from 255 to 305 feet from the portal an underhand stope extends 35 feet down the dip of the vein. About 230 feet from the portal a 30-foot winze connects with the underhand stope. The only other work consists of several shallow prospect pits on the outcrop of the vein.

The main vein (No. 2) is a typical epithermal quartz fissure gold vein, parts of which were sufficiently mineralized to warrant mining. However, exploration to date (1977) has not adequately explored the vein to determine the presence of other ore shoots. As such, the writer feels that the No. 2 vein, as well as all other gold-bearing veins on the property, warrant additional exploratory work.

APPENDIX A

PATENTED MINING CLAIMS OF THE ST. HELENS MINING DISTRICT

Although over 3,000 mining claims were staked from 1890 to 1977 in the St. Helens and Washougal mining districts, only 112 claims were patented, all of which are in the St. Helens district. The patented claims are shown in figure 11 and 15, and appear in tabulated form in Appendix A.

All claims were patented between 1901 and 1912, at which time the patentee received both mineral and surface rights to the claims. However, at later dates the surface rights to most patented claims were deeded back to the U.S. Government by the claim owners. Holders of surface rights to patented claims in the St. Helens district are listed in Appendix A.

Name of claim	Patent no.	Survey no.	General location	Remarks	Surface ownership status
Ada	44060	781A	NE¼ sec. 1, (9-5E)	Part of Norway-Sweden group	U.S.
Admantine No. 2	114944	780	N¼ cor. sec. 17, (10-6E)	Part of Germania group	U.S.
Alderman Peak	44060	781A	SW¼ sec. 31, (10-6E)	Part of Norway-Sweden group	U.S.
America Nos. 1 through 4	44060	781A	NW¼ sec. 6, (9-6E), SW¼ sec. 31, (10-6E)	Part of Norway-Sweden group	U.S.
Ardentine Nos. 1 and 2	114944	780	SW¼ sec. 8, (10-6E)	Part of Germania group	U.S.
Baby Barnes	44060	781A	NW. cor. sec. 6, (9-6E)	Part of Norway-Sweden group	U.S.
Big Blue Nos. 1, 3, 4, and 5	519564	1045	SW¼ sec. 21, (10-6E)	Part of Big Blue group	U.S.
Black Falls Nos. 1 and 2	119770	689A	NW¼ sec. 18, (10-6E)	Part of Polar Star group	Private
Black Hawk	119770	689A	N½ sec. 18, (10-6E)	Part of Polar Star group	Private
Cena	44060	781A	SE¼ sec. 1, (9-5E)	Part of Norway-Sweden group	U.S.
Chicago Nos. 1 and 2	52121	829	NW¼ sec. 32, (10-6E)	Part of Chicago group	Private
Chicago-Golden Crown Nos. 1 and 2	382239	850A	S½ sec. 11, (10-5E)	Part of Chicago-Golden Crown Bell	Private
Chicago Golden Crown Jr.	382239	850A	SW¼ sec. 11, (10-5E)	Part of Chicago-Golden Crown group	Private
Chicago Golden Crown Extension	382239	850A	SE¼ sec. 11, (10-5E)	Part of Chicago-Golden Crown group	Private
Chicago Northwest Discovery	37717	621	SW¼ sec. 29, (10-6E)	Part of Chicago group	U.S.
Chicago Northwest Nos. 1 and 2	37717	621	SE¼ sec. 30, (10-6E)	Part of Chicago group	U.S.
Denmark Discovery	36828	620	SW¼ sec. 31, (10-6E)	Part of Norway-Sweden group	U.S.
Earl	44060	781A	SE¼ sec. 1, (9-5E)	Part of Norway-Sweden group	U.S.

APPENDIX A—Continued

Name of claim	Patent no.	Survey no.	General location	Remarks	Surface ownership status
Earl Nos. 1 through 13	43189	774	SE¼ sec. 8, (10-6E) NE¼ sec. 17, (10-6E)	Part of Lake group	U.S.
El Capitan Nos. 1 and 2	382239	850A	SW. cor. sec. 11, (10-5E)	Part of Chicago-Golden Crown group	Private
Falls	44060	781A	NE¼ sec. 12, (9-5E)	Part of Norway-Sweden group	U.S.
George	44060	781A	SW¼ sec. 36, (10-5E)	Part of Norway-Sweden group	U.S.
Germania Nos. 1 and 2	114944	708	SW¼ sec. 8, (10-6E)	Part of Germania group	U.S.
Germania Jr. Nos. 1 and 2	114944	708	NW¼ sec. 17, (10-6E)	Part of Germania group	U.S.
Germania Secundus Nos. 1 and 2	114944	708	NW¼ sec. 17, (10-6E)	Part of Germania group	U.S.
Hiawatha Nos. 1 and 2	519564	1045	SW¼ sec. 21, (10-6E)	Part of Big Blue group	U.S.
Hillside	44060	781A	SE¼ sec. 1, (9-5E)	Part of Norway-Sweden group	U.S.
Index Nos. 1 through 12	43393	779	SW¼ sec. 17, (10-6E) SE¼ sec. 18, (10-6E)	Index Group	U.S.
Inez	44060	781A	NE¼ sec. 1, (9-5E)	Part of Norway-Sweden group	U.S.
Kangaroo Nos. 1 through 5	245098	801	W½W½ sec. 5, (9-6E)	Kangaroo Group	U.S.
Lakeside	44060	781A	SE¼ sec. 1, (9-5E)	Part of Norway-Sweden group	U.S.
Linnie	44060	781A	NE¼ sec. 1, (9-5E)	Part of Norway-Sweden group	U.S.
Mable	44060	781A	NE¼ sec. 1, (9-5E)	Part of Norway-Sweden group	U.S.
Mamie	44060	781A	NE¼ sec. 1, (9-5E)	Part of Norway-Sweden group	U.S.
Marchand	44060	781A	NW¼ sec. 6, (9-6E)	Part of Norway-Sweden group	U.S.
Mary Nos. 1 through 6	44059	780	SW¼ sec. 32, (10-6E)	Part of United group	U.S.
Minnie Lee Nos. 1, 2, and 3	119770	697A-B	W½ sec. 2, (10-5E)	Part of Minnie Lee group	Private
Mount Fairy Nos. 1 and 2	94288	762	SW¼ sec. 29, (10-6E)	Part of United group	U.S.
Norway	36828	620	SW¼ sec. 31, (10-6E)	Part of Norway-Sweden group	U.S.
N.C. Nos. 1 and 2	119770	697A-B	W½ sec. 2, (10-5E)	Part of Minnie Lee group	Private
Norway Northwest Discovery	36828	620	W½ sec. 31, (10-6E)	Part of Norway-Sweden group	U.S.
Phil Sheridan Nos. 1 and 2	199770	689A	NW¼ sec. 18, (10-6E)	Part of Polar Star group	Private
Polar Star Nos. 1, 2, and 3	199770	689A	N½ sec. 18, (10-6E)	Part of Polar Star group	Private
Polar Star Jr. Nos. 1, 2, and 3	199770	689A	N½ sec. 18, (10-6E)	Part of Polar Star group	Private
Prince	44060	781A	SE¼NW¼ sec. 6, (9-6E)	Part of Norway-Sweden group	U.S.

APPENDIX A—Continued

Name of claim	Patent no.	Survey no.	General location	Remarks	Surface ownership status
Silver Bell Nos. 1 and 2	382239	850A	S½ sec. 11, (10-5E)	Part of Chicago-Golden Crown group	U.S.
Spirit Lake	44060	781A	E½NE¼ sec. 12, (9-5E)	Part of Norway-Sweden group	U.S.
Sweden Nos. 1 and 2	44060	781A	NW¼ sec. 6, (9-6E)	Part of Norway-Sweden group	U.S.
Viola First	44060	781A	E½ sec. 36, (10-5E)	Part of Norway-Sweden group	U.S.
Viola Second	44060	781A	E½ sec. 36, (10-5E)	Part of Norway-Sweden group	U.S.
Wayne	44060	781A	SW¼ sec. 36, (10-5E)	Part of Norway-Sweden group	U.S.
Wilson	44060	781A	SW¼ sec. 31, (10-6E)	Part of Norway-Sweden group	U.S.
Zenith Nos. 1 and 2	114944	708	SW¼ sec. 8, (10-6E)	Part of Germania group	U.S.

APPENDIX B

PROPERTY INDEX—ST. HELENS MINING DISTRICT

Property	Location	Index map page	Property description page
Ryan Lake area			
Big Blue	SW¼ sec. 21, (10-6E)	17	27
Chicago-Golden Crown	S½ sec. 11, (10-5E)	17	27
Dixie Queen	Sec. 34, (11-6E)	17	27
Earl (Sampson)	SE¼ sec. 8, (10-6E)	17	25
Germania	NW¼ sec. 17, (10-6E)	17	25
Goat Mountain	Center of sec. 2, (10-5E)	17	27
Golconda	W½ sec. 16, (10-6E)	17	26
Grizzly Creek	SE¼ sec. 20, (10-6E)	17	26
Independence	Sec. 2, 3, 10, 11, (10-5E)	17	25
Index	SW¼ sec. 17, (10-6E)	17	26
Insurance	SW¼ sec. 22, (10-5E)	17	28
Last Hope	SW¼ sec. 7, (10-6E)	17	24
Minnie Lee	W½ sec. 2, (10-5E)	17	24
Morning	E¼ cor. sec. 4, (10-5E)	17	28
Mountain Chief	SW¼ sec. 13, (10-5E)	17	28
Polar Star	NW¼ sec. 18, (10-6E)	17	18
Rocky Point	SE¼ sec. 31, (11-5E)	17	27
Camp Creek area			
Brown and Livingston	N¼ cor. sec. 10, (10-8E)	29	30
Bruhn	W¼ cor. sec. 10, (10-8E)	29	32
Camp Creek	N½S½ sec. 10, (10-8E)	29	30
Johnson	NW¼NW¼ sec. 10, (10-8E)	29	32
Knudson and Myers	SW¼ sec. 15, (10-8E)	29	32
McCoy Creek placer	E½ sec. 9, (10-8E)	29	32

Property	Location	Index map page	Property description page
Spirit Lake area			
Bonanza	NE¼NW¼ sec. 17, (9-5E)	17	40
Bronze Monarch	SW¼NW¼ sec. 31, (10-6E)	17	38
Chicago	NW¼ sec. 32, (10-6E)	17	38
Commonwealth	SW¼ sec. 33, (10-6E)	17	39
Hercules	SW¼NE½ sec. 23, (9-5E)	17	40
Kangaroo	W½W½ sec. 5, (9-6E)	17	39
Norway	NW¼ sec. 31, (10-6E)	17	37
Sweden	NW cor. sec. 6, (9-6E)	17	33
United (Mount Fairy)	SW¼ sec. 32, (10-6E)	17	39
Young America	SW¼ sec. 31, (10-6E)	17	40

PROPERTY INDEX—WASHOUGAL DISTRICT

Black Jack	S½NW¼ sec. 4, (3-5E)	43	46
Blue Bird	SE¼NE¼ sec. 15, (3-5E)	43	56
Last Chance	S½SE¼ sec. 29, (3-5E)	43	53
Lewis River placer	Sec. 22, 23, (4-4E)	43	11
Maybee	NE¼NW¼ sec. 14, (3-5E)	43	58
McMunn placer	Sec. 21, (4-4E)	43	11
Miners Queen	NE¼ sec. 4, (3-5E)	43	45
Rainbow	S½S½ sec. 32, (3-5E)	43	54
Silver Creek	Center of sec. 22, (3-5E)	43	56
Silver Star	W½ sec. 23, (3-4E)	43	48
Skamania	NE¼SW¼ sec. 21, (3-5E)	43	50
Yellow Jacket	SW¼NE¼ sec. 21, (3-5E)	43	54
Zinc Creek	NW¼SE¼ sec. 13, (3-5E)	43	59
Wind River area			
Wind River	NE¼ sec. 8, (5-7E)	61	60

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