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BULLETIN 73

MYERS CREEK AND WAUCONDA MINING DISTRICTS OF NORTHEASTERN OKANOGAN COUNTY, WASHINGTON

By Wayne S. Moen

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COVER PHOTO

Settlement of Chesaw in the Myers Creek valley of northeastern Okanogan County was the site of the first mining camp of the Myers Creek mining district. The mining camp was established in February 1896, immediately after the opening of the north half of the Colville Indian Reservation to mineral entry, and named after Chee Saw, a Chinese placer miner who had married an Indian maiden. Their ranch was situated at the present site of Chesaw. Within a few years the mining camp had grown into a thriving mining and farming community of several hundred individuals. Over the past 70 years, businesses closed and families moved out; all that remains of the town's business section is a single tavern.

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MYERS CREEK AND WAUCONDA MINING DISTRICTS OF NORTHEASTERN OKANOGAN COUNTY, WASHINGTON

by
Wayne S. Moen

ABSTRACT

Over 84 years ago in February 1896, the north half of the Colville Indian Reservation of northeastern Okanogan County was opened to mineral entry. Within a few weeks, desposits of gold, silver, copper, lead, zinc, and molybdenum were discovered, and the mining districts of Myers Creek and Wauconda were established. Many mineral deposits underwent exploratory and development work but few deposits proved to be large or rich enough to mine. In the early 1900's the Bodie gold mine and the Phil Sheridan and Zalla M silver mines were the district's leading producers; whereas minor production of gold, silver, copper, and lead came from about 20 other mines. Small amounts of placer gold were found in several stream channels, but only on Mary Ann Creek were the placer deposits rich enough to mine. By 1951, mining was at a standstill; total production of the Myers Creek district reached about $100,000, whereas production from the Wauconda district was around $300,000. Since 1951, no mine has operated but gold, silver, iron, and copper mineralization in the districts continue to attract the attention of mining companies. The mineral deposits of the Myers Creek and Wauconda mining districts occur in Permian and(or) Triassic eugeosynclinal metamorphic rocks and in lower Tertiary volcanic rocks. Ore minerals are confined chiefly to narrow quartz fissure veins, breccias, or to skarn deposits of contact metamorphic zones. The most favorable areas of mineralization appear to be the iron-rich skarns of Buckhorn Mountain in the Myers Creek district, and gold-silver veins and breccias of the Bodie and Sheridan areas of the Wauconda district.

INTRODUCTION

The Myers Creek and Wauconda mining districts of north-central Washington lie within the Okanogan Highlands physiographic province. The highlands are mountainous in character and differ sharply from the undulating Columbia Plateau to the south. To the west, the highlands merge with the rugged Cascade Mountains, and to the east, they become part of the Northern Rocky Mountain province of northern Idaho. The Okanogan Highlands has long been known for its mineral wealth, and to date (1979) it remains the most productive part of the state for metallic and industrial minerals. In the past, metal mines of the highlands have produced substantial amounts of gold, silver, copper, lead, zinc, tungsten, and uranium, but currently gold, silver, tungsten, and uranium are the only metals being mined. Industrial minerals produced in the past include limestone, dolomite, marble, magnesite, barite, clay, silica, and quartzite. With the exception of magnesite and barite, pits and quarries of the highlands still produce substantial amounts of these minerals.

The birth of mining in the Myers Creek and Wauconda districts, as well as in most other mining districts of Okanogan County, took place in February 1896 with the opening of the north half of the Colville Indian Reservation to mineral entry. The districts' initial discoveries of gold, silver, and copper were made in the vicinity of the present settlement of Chesaw, but within a few months, other discoveries of these metals were made, 2 miles east of Chesaw, on Buckhorn Mountain, as well as 12 miles east in the Toroda Creek area. Deposits of gold and silver were also discovered in the Wauconda area, which is 14 miles south of Chesaw. Placer gold was discovered in the gravels of several creeks, but only on Mary Ann Creek were the gravels rich enough to mine. Following the initial discoveries, the mining camps of Chesaw, Bodie, Toroda, and Wauconda came into existence, to be followed by the formation of the Myers Creek, Cascade, Ballarat, Sheridan, and Wauconda mining districts. By the turn of the century, small shipments of high-grade gold ore had been made to smelters, and many properties were under development. Several concentrating mills were erected to treat sulfide-rich gold ores, but most mills did not produce enough concentrates to pay for their costs. From 1900 to 1950, no fewer than 12 mines produced minor amounts of gold, silver, copper, and

iron in the Myers Creek district, and at least six mines produced gold and silver in the Wauconda district. In the Myers Creek district the most productive mine was the Magnetic, which produced a total of about 80,000 tons of magnetite between 1918 and 1950.

The bulk of the Wauconda district's production came from the Bodie mine on Toroda Creek that produced around $300,000 in gold from 1902 to 1944. Complete production records for the districts do not exist, but a reasonable estimate for the districts' production of gold, silver, copper, and lead would be about $500,000. Since 1950, neither district has had a producing mine. Although mine production in the Myers Creek and Wauconda districts ceased in 1950, the mineral occurrences of the districts have continued to attract the attention of mining and exploration companies.

The metallic minerals of the districts occur chiefly in quartz fissure veins and in contact-metamorphic deposits. Host rocks for the deposits consist of upper Paleozoic and lower Mesozoic eugeosynclinal metasedimentary rocks, as well as volcanic rocks of Eocene age. In the Chesaw, Wauconda, and Toroda Creek areas, quartz veins containing gold, silver, and copper predominate. On Buckhorn Mountain, occurrences of gold, copper, and iron are associated with skarns of a prominent contact-metamorphic zone. Although many quartz veins are present in the Myers Creek and Wauconda districts, very few appear to be sufficiently mineralized, or large enough in size, to make mining profitable. The presence of a large tonnage of low-grade gold-bearing rock makes the Bodie mine the only property that appears to have economic potential. Silver mineralization is widespread in the Sheridan area, but overall the silver content of the veins, with the exception of the Silver Bell deposit, appears to be too sparse to be of economic value under present (1979) conditions. Although occurrences of gold, copper, lead, tungsten, zinc, and iron occur in tactite zones of contact-metamorphic rocks of Buckhorn Mountain, only the iron deposits appear to be of economic importance because of their grades and sizes. By selective mining of high-grade deposits, minor gold and copper might be produced, but the sparse nature of the tungsten, lead, and zinc mineralization make it doubtful that these occurrences will ever be of value.

In addition to metallic minerals, deposits of limestone, peat, and fluorite occur in the Myers Creek and Wauconda mining districts. Limestone and peat are present in appreciable amounts, but current (1979) existing markets for these materials are too remote to make the deposits valuable. The fluorite-bearing veins and breccias of the Sheridan area of the Wauconda district contain up to 6 percent fluorite, but under present market conditions it is doubtful that sufficient tonnages are present to make the deposits valuable.

LOCATION AND ACCESSIBILITY

The Myers Creek mining district, which is the northernmost and largest of the two districts, extends from the Ferry-Okanogan county line westward 27 miles to the Okanogan River. From the Canadian border, the district extends southward 12 miles to the southern edge of T. 39 N. (fig. 1). The Wauconda district extends from the Ferry County line westward 12 miles to the west edge of R. 30 N.; from the southern border of the Myers Creek district it extends southward 12 miles to the southern edge of T. 37 N. The area of the Myers Creek district is approximately 324 square miles (207,360 acres); the area of the Wauconda district is 144 square miles (92,160 acres).

Access to both districts is good, and provided by well-maintained state, county, and forest service roads. The more remote areas can be reached by way of poorly to unmaintained ranch and logging roads. About 75 percent of the area is within 1 mile of some type of road. No part of the area is more than 3 miles from an existing road; however, many secondary access roads are in a state of disrepair. Chesaw, which is a small settlement in the north-central part of the Myers Creek district, is most readily accessible by way of 20 miles of surfaced county roads from Oroville. Wauconda, which is a small settlement near the central part of the Wauconda district, is 25 miles east of Tonasket on State Highway 20, and 25 miles west of Republic.

TOPOGRAPHY AND DRAINAGE

The Myers Creek and Wauconda districts are in the northwestern part of the Okanogan Highlands, which is a composite group of north-trending mountain ranges. The highlands cover an area in Washington of about 6,750 square miles and are 90 miles long (east-west) and 75 miles wide (north-south). Although the highlands are mountainous, they lack the ruggedness of the Cascade Mountains to the west. The area encompassing Myers Creek and Wauconda districts is characterized by mountains with rounded tops and steep-walled valleys. Most of the area contains a thick cover of overburden, but many slopes are rocky and void of vegetation. In the western half of the Myers Creek district, the countryside is less mountainous and contains large areas of gently rolling, grassy range lands (fig. 2).

The region's average elevation is about 3,500 feet; the average summit elevation for mountains is about

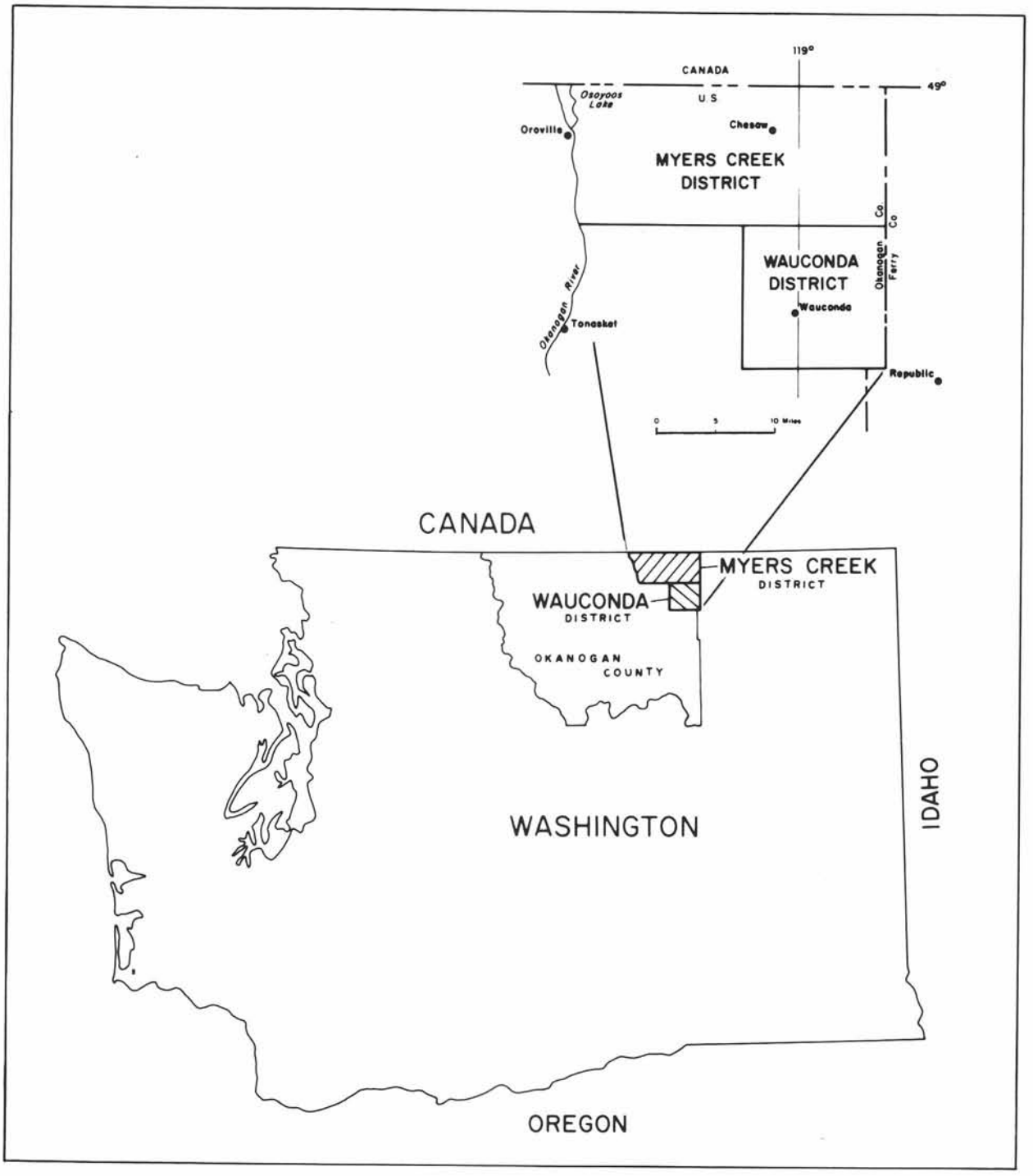


Figure 1.—Index map of the Myers Creek and Wauconda mining districts.

A. Porphyry Peak-Strawberry Mountain region of Chesaw area, Myers Creek district. Nearly 60 percent of the metallic mineral occurrences of the Myers Creek district occur in this area.

B. Forested areas and glaciated terrain of Chesaw area, Myers Creek district. Looking south with Mount Bonaparte on skyline.

Figure 2.—Typical terrain of northeastern Okanogan County.

4,800 feet. Although only eight mountain peaks in the region exceed 5,000 feet in elevation, at least 27 peaks are 4,000 feet or higher in elevation. Mount Bonaparte (7,258 feet) is the highest point in the Wauconda district; Buckhorn Mountain (5,602 feet) is the highest point in the Myers Creek district. The lowest site in the region is at the city of Tonasket with an elevation of 903 feet on the Okanogan River.

The Okanogan Highlands has been dissected by numerous streams, which ultimately discharge into the Columbia River. In the Myers Creek district, Myers, Toroda, and Tonasket Creeks are major streams. West Fork Granite, Toroda, and Bonaparte Creeks are the major streams of the Wauconda district. These creeks, as well as numerous permanent and intermittent tributaries, form a dendritic drainage pattern in the region.

No more than 12 lakes larger than 5 acres of surface area are present in the districts. Bonaparte (167 acres) is the largest lake in the Wauconda district; Sidley (108 acres), and Muskrat (90 acres) are the largest lakes of the Myers Creek district. Most lakes occupy valley bottoms dammed by glacial moraine, or hollows in glacial drift. Bonaparte and Lost are typical of lakes in dammed valleys, whereas Sidley and Muskrat occupy hollows in glacial drift.

VEGETATION AND CLIMATE

Except for the western two-thirds of the Myers Creek district, a thick conifer forest covers most parts of the Myers Creek and Wauconda districts. Most forested areas fall within the boundaries of the Okanogan National Forest. In forested areas, sparsely timbered sections occur mainly on south-facing slopes that contain thin or rocky soil cover. The most common conifers are Douglas fir, western larch, and western yellow pine. Deciduous trees, which commonly grow along moist valley floors, include willow, alder, aspen, cottonwood, and poplar. Areas void of conifers and broadleaf deciduous trees have as groundcover, sagebrush, pine grass, and bunchgrass.

The district's climate is semiarid, but receives more moisture than most other semiarid areas of eastern Washington. The annual mean rainfall is 18 inches, most of which falls between November and June, with the wettest months being May and June. The annual mean temperature is around 45°F (7.2°C). January is generally the coldest month with a mean temperature of about 23°F (–5°C); July and August are the warmest months with a mean temperature of about 60°F (15.6°C). Annual extremes can be as low as –30°F (–1.1°C) and as high as 105°F (40.5°C). The average growing season is about 80 days.

LAND OWNERSHIP

The combined area of the two districts is about 468 square miles (299,520 acres). About 43 percent of the land is federally owned, 6 percent is state owned, and 51 percent is privately owned (fig. 3). A breakdown by district follows:

Mining district	Federal	State (sq. miles)	Private	Total
Myers Creek	132	15	177	324
Wauconda	72	7	65	144
	204	22	242	468

The region is only sparsely populated, and no settlement with a population of more than 100 may be found in either district. Republic, with a population of around 1,059, is 25 miles east of the Wauconda district, while Tonasket, with a population of 985, is about 25 miles west. Oroville, with a population of 1,560, is on the western edge of the Myers Creek district.

FIELD WORK AND ACKNOWLEDGMENTS

Field work, consisting chiefly of property examinations, started in July 1978 and continued sporadically until October of the same year, for a total of 6 weeks. The 1979 field season began in May and continued until July for a total of 5 weeks. During this time the most significant mineral occurrences were examined, existing geochemical and geophysical anomalies were evaluated, and areas of possible mineral occurrences were studied and evaluated. Locations of the district's mines and prospects were established from mineral patent plats, topographic maps, and locations plotted on geologic maps by Fox (1970 and 1978) and Pearson (1967). Examinations of many properties were hindered by lack of accessibility of mine workings because of caved adits and shafts, as well as sloughed-in prospect pits and trenches. The historical background of the Myers Creek district was in part provided by John Thorp of Chesaw, whose father hauled mine equipment by horse team from Republic in the early 1900's. The writer is grateful to E. A. Magill & Associates who furnished geologic data on several mines, and Marion Bumgardner who provided important data on mines and prospects of Buckhorn Mountain. I also wish to acknowledge the help of Stuart Simpson, summer field assistant who ran several radiometric traverses in the Eocene volcanic rocks of the Myers Creek district. All photos were taken by the writer.

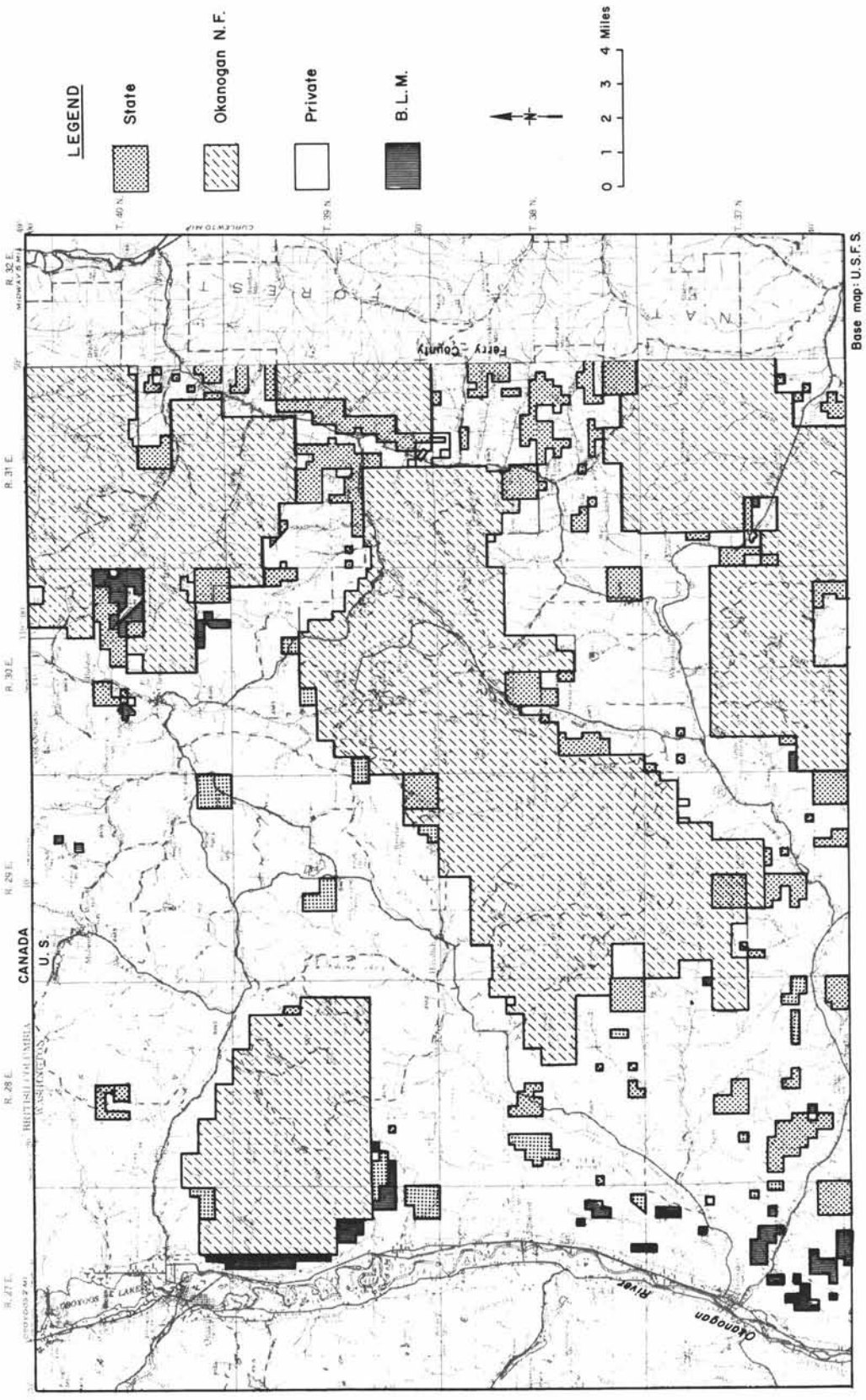


Figure 3.—Land ownership map.

PURPOSE AND SCOPE

The Myers Creek and Wauconda mining districts were organized in February 1896 shortly after the north half of the Colville Indian Reservation was opened to mineral entry. Minor mineral production of base and precious metals has come from both districts; however, for the past 25 years the mines of both districts have been idle. Sporadic mineral exploration by mining companies has been undertaken with the hopes of discovering new ore bodies, but mineralization sufficient to justify mining has yet to be discovered. As part of the continuing investigations of the state's mining districts by Washington Division of Geology and Earth Resources, the writer searched existing literature and examined as many mineral occurrences as possible to determine the future of the districts. An attempt was also made to determine if any area within the two districts has been overlooked or warrants additional exploration based on sound geological evidence for the occurrences of minerals. Another purpose of the report is to place as much existing geologic data as possible under one cover to serve as a starting point for future mineral exploration.

This report covers the geology of the area, as well as the geology of selected mineral properties. It attempts to assess all work done to date in order to determine if mineral deposits of economic value are present. Under specific mineral properties, a discussion of the history, production, geology, and mine development is presented. Whenever possible, sketch maps of mine workings are shown. Published production figures and a chronology of the main mining activities from 1906 to 1953 is also presented.

No attempt was made to map the geology of the two districts because the area has been mapped by the U.S. Geological Survey, at a scale of 1:62,500 (15-minute quadrangles) (fig. 4).

PREVIOUS WORK

The first published report on the mineral properties of the Myers Creek and Wauconda districts was by Henry Landes and others in 1902, when he briefly mentioned several mines and prospects in the "The Metalliferous Resources of Washington, Except Iron." This was followed by "Geology and Ore Deposits of the Myers Creek Mining District" (Umpleby, 1911). Since 1911, several reports on the geology, as well as reports covering the mineral investigations of specific properties and areas within the districts, have been made available as published or open-file reports.

It was not until 1967, however, that geologic maps of sufficient detail and scales were produced by the U.S. Geological Survey. To date (1979), the geology of all of the Myers Creek district and the north half of the Wauconda district, at scales of 1:62,500 and 1:48,000, has been mapped and placed on open-file. Fortunately, the mapping covers almost all mineralized areas of the districts. Mapping of the south half of the Wauconda district has been completed by the U.S. Geological Survey, but has yet to be made available to the public.

As early as 1930, geologists for Washington Division of Geology and Earth Resources have on different occasions examined and mapped underground workings of different properties. Much of this information has never been published, but may be found in the division field notes; most mine maps of past workers appear in this report.

Following is a list of geological and mineral investigation reports in chronological order. Complete entries appear at the end of this report under References.

Geological Maps and Reports

1911—Umpleby, Joseph B., Geology and ore deposits of the Myers Creek mining district.

1912—Daly, R. A., Geology of the North American Cordillera at the forty-ninth parallel.

1938—Krauskopf, K. B., Geology of the northeast quarter of the Osoyoos quadrangle, Washington.

1941—Waters, A. C.; Krauskopf, K. B., Protoclastic border of the Colville batholith.

1954—Phetteplace, T. M., Geology of the Chesaw area, Okanogan County, Washington.

1967—Pearson, R. C., Geologic map of the Bodie Mountain quadrangle, Ferry and Okanogan Counties, Washington.

1970—Fox, Kenneth F., Jr., Geologic map of the Oroville quadrangle, Okanogan County, Washington.

1977—Fox, K. F., Jr.; Rinehart, C. D.; Engels, J. C., Plutonism and orogeny in north-central Washington—Timing and regional context.

1977—Pearson, R. C.; Obradovich, J. D., Eocene rocks in northeast Washington—Radiometric ages and correlation.

1978—Fox, K. F., Jr., Geologic map of the Mount Bonaparte quadrangle.

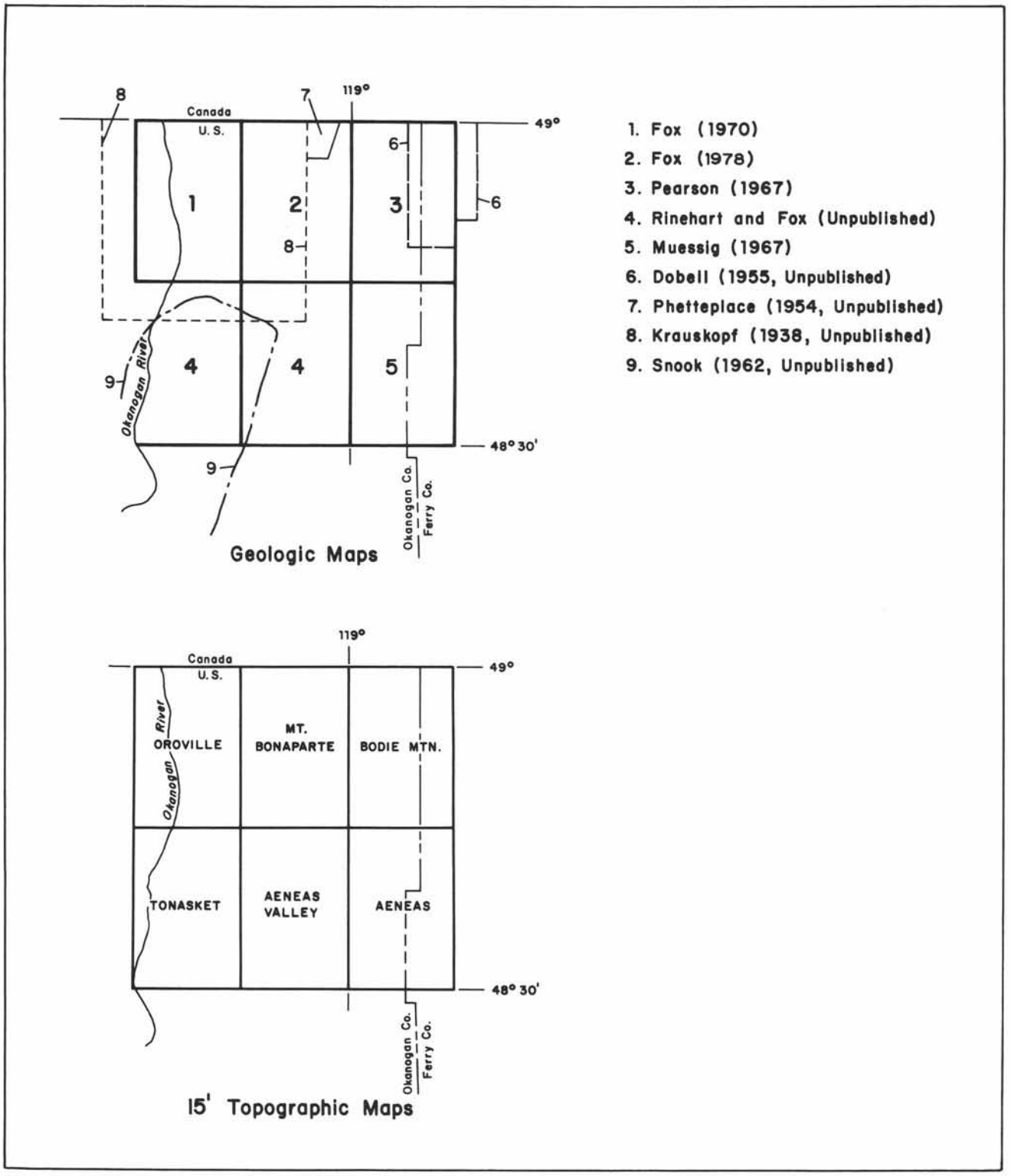


Figure 4.—Index to geologic mapping.

Mineral Investigations

1902—Landes, H.; Thyng, W. S.; Lyon, D. A.; Roberts, Milnor, The metalliferous resources of Washington, except iron.

1916—Handy, F. M., An investigation of the mineral deposits of northern Okanogan County.

1921—Patty, E. N., The metal mines of Washington.

1936—Chamberlain, M. N., Ores of the Bodie mines and their treatment.

1943—Broughton, W. A., The Buckhorn iron deposits of Okanogan County, Washington.

1945—Broughton, W. A., Some magnetite deposits of Stevens and Okanogan Counties, Washington.

1945—Culver, H. E.; Broughton, W. A., Tungsten resources of Washington.

1947—Zoldok, S. W.; Cole, J. W.; Dougherty, E. Y., Iron deposits of Buckhorn Mountain, Myers Creek mining district, Okanogan County, Washington.

1951—Purdy, C. P., Antimony occurrences of Washington.

1954—Purdy, C. P., Molybdenum occurrences of Washington.

1960—Hunting Geophysical Services, Inc., Geological interpretation of airborne magnetometer and scintillation survey—Mount Bonaparte, Bodie Mountain, Curlew, Aeneas, and Republic quadrangles, Okanogan and Ferry Counties, Washington.

1969—Moen, W. S., Analyses of stream sediment samples in Washington for copper, molybdenum, lead, and zinc.

GEOLOGY

GEOLOGIC SETTING

The discussion that follows is based largely on the work of Kenneth Fox, Jr., Dean Rinehart, and Robert Pearson of the U.S. Geological Survey. To date (1979) they have mapped the greater part of northern Okanogan and Ferry Counties and have contributed significantly to unraveling the geologic complexities of the region.

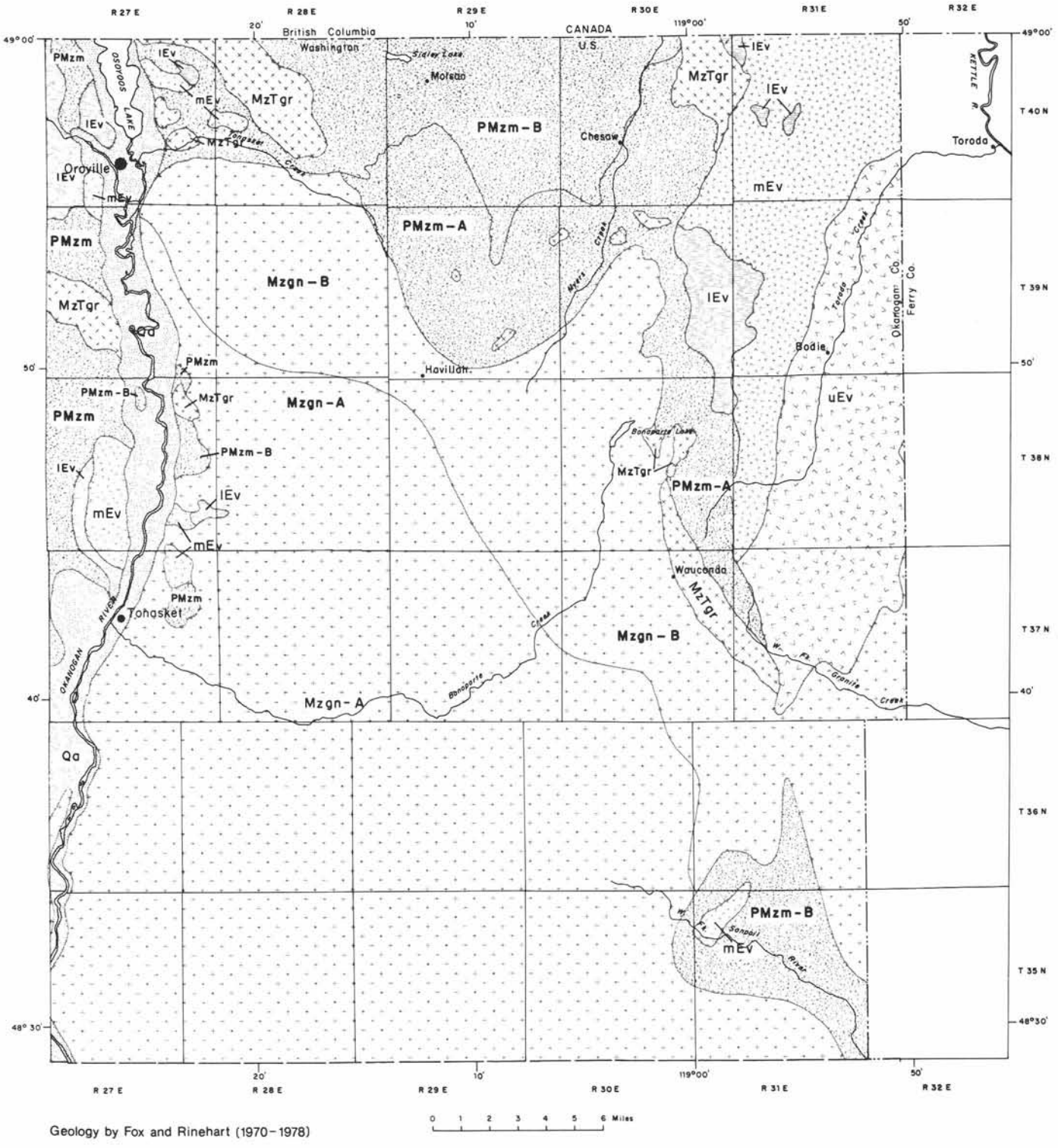
Bedrock of north-central Okanogan County consists of (1) eugeosynclinal rocks of Permian or Triassic age, (2) late Mesozoic high-grade metamorphic rocks consisting of gneiss, schist, and amphibolite, (3) Mesozoic and Cenozoic plutonic rocks, and (4) Cenozoic lavas and continental sedimentary rocks that overlie the older rocks. Surficial deposits consist chiefly of alluvium, which is confined to the largest valleys, and glacial drift which occurs patchily over the entire area (fig. 5).

Orogeny and plutonism began almost simultaneously during Late Triassic with folding of Permian and Triassic rocks and intrusion by several plutons. Plutonism continued sporadically through Jurassic, Cretaceous, and early Tertiary. During late Mesozoic, the Okanogan gneiss dome formed as a result of intense regional deformation and metamorphism. Volcanism began in early Eocene with the deposition of sediments, pyroclastic rocks, and lava flows upon an angular unconformity on older rocks, and continued into Oligocene and possibly early Miocene time. In northeastern Okanogan County and northwestern Ferry County, Eocene deposition was accompanied by penecontemporaneous faulting and subsidence of the north- to northeast-trending Republic and Toroda Creek grabens. Although volcanism continued to the south on the Columbia Plateau, through late Miocene and into early Pliocene, lava flows of this episode are not present in the area covered by this report. With the exception of continental glaciation, which modified the terrain and left extensive glacial deposits throughout the region, major geologic episodes terminated in early Miocene.

EUGEOSYNCLINAL DEPOSITS

These represent the oldest rocks of north-central Okanogan County and consist of weakly to moderately metamorphosed eugeosynclinal rocks of Permian or Triassic age. Geologic studies by Rinehart and Fox (1972) reveal that these rocks represent two mappable units, which are separated by an angular unconformity. The older of these units consists of the Anarchist Group of Permian age, composed of the Bullfrog Mountain and Spectacle Formations. Predominant rocks of the Bullfrog Mountain Formation consist of slate, phyllite, metasharpstone, conglomerate, and fine-grained impure marble. The Spectacle Formation, in addition to the above-mentioned rocks, consists of silicified marble and massive quartzite. The lower member of the formation contains slate, phyllite, greenstone, and amphibolite.

Rocks of the Anarchist Group are overlain by Triassic or Permian rocks of the Kobau Formation

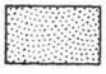


Geology by Fox and Rinehart (1970-1978)

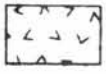
Figure 5.—Regional geologic map of northeastern Okanogan County.

CORRELATION OF MAP UNITS

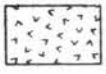
Qal		QUATERNARY
Unconformity		
uEv	upper Eocene	TERTIARY
Unconformity		
mEv	middle Eocene	TERTIARY
lEv	lower Eocene	TERTIARY
Unconformity		
Mzgn		TERTIARY(?), CRETACEOUS, JURASSIC(?), and TRIASSIC(?)
MzTgr		TERTIARY(?), CRETACEOUS, JURASSIC(?), and TRIASSIC(?)
PMzm-B		TRIASSIC or PERMIAN
Unconformity		
PMzm-A		PERMIAN



Qa — Surficial deposits (Quaternary)—Alluvium and glacial drift undifferentiated

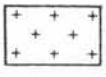


uEv — Volcanic rocks (late Eocene)—Klondike Mountain Formation consisting of lithoidal lava flows and pyroclastic breccias; planar flow structure common. Vitric lava flows and flow breccias; many flows are complexly columnar jointed

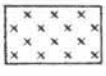


mEv — Volcanic rocks (middle Eocene)—Dacitic, andesitic, and minor trachytic lava flows and hypabyssal intrusive rocks. Includes Sanpoil Volcanics consisting mainly of lithoidal lava flows of quartz latitic to andesitic composition; massive to flow layered. Includes minor tuffaceous rocks and probably some intrusive bodies

lEv — Epiclastic and volcaniclastic rocks (early Eocene)—Sandstone, graywacke, tuff, conglomerate, and shale. Includes O'Brien Creek Formation consisting of well-bedded to massive lapilli tuff, tuffaceous sandstone, siltstone, and shale; carbonaceous siltstone and shale; and conglomerate



Mzgn — Paragneiss, orthogneiss, and associated granitic rocks of the Okanogan gneiss dome (age of metamorphism and mobilization probably Late Mesozoic)—A, paragneiss; B, orthogneiss and associated granitic rocks



MzTgr — Granitic rocks (Triassic to lower Tertiary)—Includes granodiorite, quartz monzonite, quartz diorite, diorite, and monzonite, as well as minor alaskite, pegmatite, aplite, syenite, and hornblendite

PMzm — Eugeosynclinal deposits (Permian to Cretaceous)—Greenstone, greenschist, slate, phyllite, schist, metawacke, quartzite (metachert), limestone, and marble. Siliceous and micaceous hornfels, calc-silicate rocks, and garnet-epidote-magnetite skarn on Buckhorn Mountain. A, chiefly Spectacle Formation (Permian) consisting mainly of metasiltstone, slate, argillite, phyllite, and marble; B, chiefly Kobau Formation (Triassic or Permian) consisting mainly of greenstone, greenschist, metasiltstone, quartzite (metachert), and marble.

and are separated from them by a distinct angular unconformity. Common rocks of the Kobau Formation are greenstone, greenschist, quartzite, metasiltstone, metachert, fine-grained impure marble, phyllite, metadiabase, metagabbro, and siliceous dolomitic magnesite. In the Chesaw area, parts of the Kobau Formation have been intruded by Mesozoic felsite dikes and pipes of quartz porphyry and plagioclase porphyry, which are commonly hydrothermally altered. The Kobau Formation is also the host for most metallic mineral deposits of the Myers Creek mining district.

GRANITIC ROCKS

Plutons of granitic composition occur as small stocks and elongated masses and are Triassic to early Tertiary in age. Common rock types are granodiorite, quartz monzonite, quartz diorite, diorite, and monzonite. Alaskite, nepheline syenite, malignite, pyroxenite, hornblendite, and peridotite are less common. Fox (1970 and 1978) mapped the largest plutons as the Osoyoos, Wauconda, and Buckhorn Mountain plutons and believed them to be of Triassic or Jurassic age. The Osoyoos pluton, 5 miles northeast of Oroville, consists chiefly of gneissic quartz diorite and fine-grained mafic diorite; the Buckhorn Mountain pluton, 5 miles northeast of Chesaw, consists mainly of fine- to medium-grained biotite-hornblende granodiorite with alaskite, quartz monzonite, and other granitic varients; the Wauconda pluton of the Bonaparte Lake area is chiefly granodiorite of variable composition and locally porphyritic, gneissic, or brecciated. The principal mineralized areas of the Myers Creek mining district appear closely associated with granitic rocks, either as contact metamorphic or fissure vein types.

OKANOGAN GNEISS DOME

Rocks of the gneiss dome consist of paragneiss, orthogneiss, and associated granitic rocks that appear in part to have been derived from eugeosynclinal rocks during late Mesozoic metamorphism. As can be seen in figure 6, the gneiss dome is the dominant geologic feature of the area covered by this report. The dome as described by Fox, Rinehart, and Engels (1977) is the southernmost gneiss dome of the Omineca crystalline belt in a north-trending orogenic subprovince in southern British Columbia and north-central Washington. According to Fox and others (1977, p. 18), "The gneiss domes are the regional expression of the widespread deformational and metamorphic events that culminated in the formation to the west of the westward-directed Shuksan thrust, and to the east of the belt of easterly directed Rocky Mountain thrusts and appear to occupy the axial zone between convergent faults." Radiometric ages from within the Okanogan gneiss dome range from Late Cretaceous (56.8 m.y.) to Eocene (46 m.y.) and the discordant ages are attributed to slow cooling of the rocks after the climax of metamorphism in the Late Cretaceous.

Mapping by Fox (1970, 1978) disclosed a wide variety of rocks in the dome, among which are layered granitoid gneiss, schist, augen gneiss, gneissic diorite or gabbro, alaskite, pegmatite, granodiorite, quartz monzonite, monzonite, and amphibolite. In the central part of the dome, layered paragneiss, augen gneiss, and quartz monzonite prevail; the major unit of the paragneiss is the Tonasket Gneiss. As mapped by Fox (1970), this unit consists of cataclastic gneiss composed of individual layers ranging in thickness from less than an inch to several feet, and in composition from alaskite to gabbro with an overall composition of quartz diorite. Individual layers pinch out or grade into other layers within short lateral distances. A major unit of the orthogneiss is the Mount Bonaparte pluton, consisting chiefly of granodiorite and quartz monzonite, which is gneissic and lineated near its contact with Tonasket Gneiss.

Around the edges of the dome several contact features are present. Country rocks adjacent to the gneiss dome along its western, northwestern, and southwestern contacts have been crushed and broken and exhibit little evidence of contact metamorphism. Rocks of the dome at and near its upper surface along its western contact are mylonized. At the north and northeast edge of the dome, Permian or Triassic metasedimentary and metavolcanic rocks of the Kobau Formation contain a garnet-biotite-staurolite metamorphic halo from 100 yards to 1 mile wide (Fox and others, 1977, p. 15).

An outstanding feature of the gneiss dome is the conspicuous absence of metallic mineral deposits. Heavy metals (copper, lead, and zinc) analyses of rocks and stream sediments of the dome indicates that the dome is deficient in these metals, and possibly represents a regional low for metallic mineralization.

TERTIARY VOLCANIC ROCKS

Tertiary volcanic rocks are found chiefly in the northeast part of the study area within a belt about 24 miles long in north-south direction and up to 12 miles wide east and west (see fig. 5). North-flowing Toroda Creek occurs near the center of the belt. Smaller, isolated outcrops of Tertiary volcanic rocks of similar lithology and age also occur along the

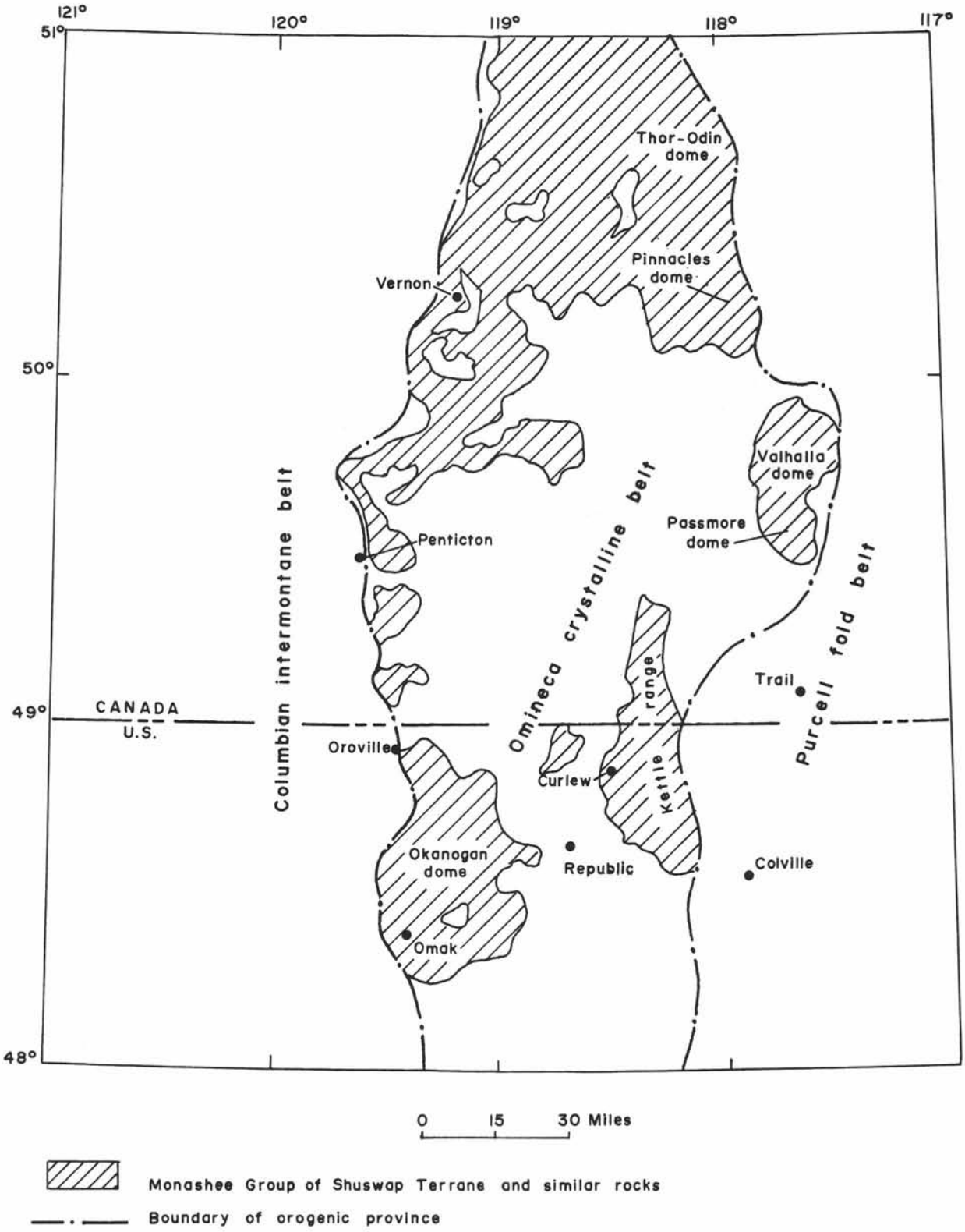


Figure 6.—Gneiss domes of Omineca crystalline belt in parts of north-central Washington and southern British Columbia.

western edge of the study area in Okanogan Valley. The Tertiary volcanic rocks have been mapped as (1) O'Brien Creek Formation (lower Eocene), (2) Sanpoil Volcanics (middle Eocene), and (3) Klondike Mountain Formation (upper Eocene). A discussion of these units follows:

O'Brien Creek Formation

This formation is the oldest Tertiary rock unit in the area covered by this report. Recent work by Pearson and Obradovich (1977, p. 13) place the age of the O'Brien Creek Formation at 53.1 ± 1.5 m.y. (early Eocene). It occurs chiefly in the northeast part of the area, but minor outcrops of similar lithology and age occur along the western edge of the area. The O'Brien Creek Formation of the northeast part of the study area has been mapped and described by Pearson (1967); to the southeast in the Republic quadrangle it has been described by Muessig (1967, p. 45). The formation consists mainly of well-bedded to massive, pale-green cream or buff tuff, tuffaceous sandstone, siltstone, shale, and conglomerate. The rocks are fairly well indurated and appear to be about 400 meters (1,312 feet) thick along Beaver Creek, but the total stratigraphic thickness may be as great as 1,300 meters (4,264 feet). An angular unconformity separates the O'Brien Creek Formation from the older underlying Permian or Triassic metamorphic rocks. The areal trend of the formation is north-northeast and the dip of the beds is seldom over 30 degrees east; however, adjacent to faults, beds may dip as much as 70 degrees. According to Pearson and Obradovich (1977, p. 14), the source of the tuff in the formation appears to be in Canada where volcanic rocks of similar lithology crop out; no source has been found in north-central Washington. Although fine-grained, sparse pyrite occurs sporadically in some rocks of the formation, other metallic minerals do not appear to be present.

Sanpoil Volcanics

The Sanpoil Volcanics are of middle Eocene age and occur chiefly in the same areas as the O'Brien Creek Formation. Recent descriptions of the formation are given by Muessig (1967, p. 50), as well as by Pearson and Obradovich (1977, p. 15-24). An age of 50-51 m.y. has been assigned to the formation by Pearson and Obradovich (1977, p. 22-23). Sanpoil Volcanics are more extensive than the O'Brien Creek Formation, and like the O'Brien Creek Formation the volcanics have general north-northeast strike trends and moderate easterly dips. Mapping by Pearson (1967) in northeastern Okanogan County shows the volcanics to be chiefly lithoidal lava flows of quartz latitic to andesitic composition, and generally porphyritic. The rocks are massive to flow layered and include minor quartz-poor tuffaceous rocks and volcanic breccias, as well as several small intrusive bodies. In the Toroda Creek graben, the formation is over 1,000 meters (3,280 feet) thick; in the Republic area, it may be as much as 1,200 meters (3,936 feet) thick. No source for the Sanpoil Volcanics has been found; Pearson and Obradovich (1977, p. 23) report that it is probably extruded from a large number of volcanic vents rather than from a few large volcanoes, and that intrusive bodies east of the volcanics occur as irregular discordant bodies that may be co-magmatic with the volcanics.

Several buried volcanic vents may occur along a belt of magnetic highs that lie 1 to 2 miles west of Toroda Creek. As can be seen on plate 6, the magnetic highs form an arcuate northeasterly trending pattern over a distance of about 20 miles, and widths of 1 to 3 miles. These magnetic highs fall within the Toroda Creek graben.

As in the case of the O'Brien Creek Formation, rocks of the Sanpoil Volcanics appear void of ore minerals, except for minor pyrite.

Klondike Mountain Formation

The Klondike Mountain Formation crops out extensively in the northeastern part of the study area and has been mapped by Pearson (1967) and Muessig (1967).

It is late Eocene in age and has been radiometrically dated at 41.3 to 49.1 m.y. (Pearson and Obradovich 1977, p. 29), which makes it the youngest formation in the area. Rocks of the formation unconformably overlie the Sanpoil Volcanics, and consist of a wide variety of volcanic and epiclastic deposits which have been divided into three members. The lowest member (Tom Thumb Tuff Member) consists of volcanic breccia, sandstone, conglomerate, and tuffaceous shale. The middle member consists of pale-colored volcanic breccias and lavas. The upper member consists of dark-gray vitric lava flows and flow breccias. Planar flow structure is common to many lava flows of the middle member, and many flows of the upper member are complexly columnar jointed. The formation as a whole strikes north-northeast with low to moderately easterly dips. According to Pearson and Obradovich (1977, p. 27) the Klondike Mountain Formation has a stratigraphic thickness of 1,200 meters (3,936 feet) along Toroda Creek graben. Unlike the O'Brien Creek Formation and the Sanpoil Volcanics, volcanic rocks of the Klondike Mountain Formation act as host rocks for several mineral deposits. Numerous silici-

fied zones are pyritic and contain traces of silver; numerous quartz veins are also present, some of which are mineralized with gold, silver, copper, and fluorite in amounts sufficient to constitute ore.

SURFICIAL DEPOSITS

Surficial deposits of the area consist chiefly of glacial deposits and valley alluvium. Peidmont glaciers, which covered most of the Okanogan Highlands in Wisconsin time, blanketed the entire region with a layer of till, and scattered patches of till remain over many parts of north-central Okanogan County. Only the highest peaks of the region rose above the surface of the glacier, which may have been 4,500 to 5,000 feet thick. In some valleys the till may have been several hundred feet thick, but was much thinner on steep valley walls, and on the summits of high mountains. In waning stages, when ice was melting faster than it was accumulating, much glacial debris formed. In the largest valleys, kame terraces formed between valley walls and ice masses in valley bottoms. These deposits consist of well-sorted but poorly stratified layers of sand and gravel, as well as minor silt. Several till plains contain well-developed kame and kettle topography, and small ponds occupy many kettles. In other areas the hummocky surfaces of the glacial terrain contain lakes as much as 1 mile long. Along the lower reaches of Mary Ann Creek a well-developed network of southeasterly trending eskers and terraces occurs (fig. 7). The bottoms of some of the largest valleys contain unconsolidated, poorly sorted deposits of sand, gravel, and silt of post-glacial age. Upon these deposits rest similar materials of the Recent floodplains. Other minor surficial deposits of the area consist of hillside talus and landslide debris.

Figure 7.—Terraced glacial terrain of lower Mary Ann Creek. Looking northeast toward Strawberry Mountain on skyline near center of photo.

STRUCTURE

The dominant structural feature of the region is the Okanogan gneiss dome. The dome, as described by Fox and others (1977, p. 12), covers about 950 square miles of eastern Okanogan County, almost 750 square miles of which falls within the area of this report (figs. 5, 6). Gneiss, as well as associated granitic rocks of the dome, are foliated and lineated. The western edge of the dome is distinctly layered with well-developed, low-angle dips to the west and northwest. Elsewhere along the edges of the dome, layering is present, but less distinct. Rocks surrounding the dome exhibit all degrees of folding, ranging from intensely folded Permian or Triassic eugeosynclinal rocks to moderately folded Tertiary volcanic rocks, with low-to-moderate easterly dips predominating. The older rocks are distinctly lineated and foliated. Faults occur throughout the region, and appear to be chiefly of Tertiary age. Most major faults occur in the north and east parts of the region, and trend north to northeast; dips of most faults appear steep (70° to 90°).

The structural history of the region began during Late Triassic with folding of Permian and Triassic rocks. Deposition in the area was interrupted in Late Triassic, but deposits were accumulating to the east and west. Through Jurassic and Early Cretaceous the region was positive and the site of continued plutonism, which spread eastward and westward into bordering depositional areas of the Okanogan Highlands province. Late Cretaceous was the time of intense regional deformation and metamorphism as a result of thrusting from the east and west culminating with the formation of the Okanogan and other gneiss domes of the Omineca crystalline belt (Fox and others, 1977, p. 13-15). Early Eocene marked the beginning of several volcanic episodes, which in the study area extended into late Eocene. The Eocene volcanic rocks, as well as contemporaneous sediments and pyroclastics, were deposited upon leveled surfaces of older rocks. Eocene deposition was accompanied by faulting. East of the area in Ferry County subsidence formed a north- to northeast-trending graben (Republic graben), and in the northeast corner of Okanogan County near Toroda Creek the Toroda Creek graben formed. The Eocene rocks of the region were folded and faulted, and partially eroded before renewed volcanism in Oligocene and possibly early Miocene. Following deposition of the volcanics and associated sedimentary rocks, the region underwent mild folding, which resulted in moderate easterly dips, and north- to northeast-trending faults. Faulting continued intermittently until sometime in the Miocene, which marked the end of the development of the major structural features of the area.

MINING HISTORY

Mining activity in the Wauconda and Myers Creek districts began in February 1896, upon the opening of the north half of the Colville Indian Reservation to mineral entry. Prior to this time, except for isolated Indian ranches, northern Okanogan and Ferry Counties had yet to be settled. Near the confluence of the Columbia and Kettle Rivers the settlement of Marcus was established in 1862 and had become a main supply center for parts of northeastern Washington. Sixty-five miles to the west on the banks of the Okanogan River, near the Canadian border, the settlement of Oroville had sprung up in 1891. Upon the opening of the north half of the reservation, prospectors rushed into the region from neighboring mining camps and staked claims on most mineralized outcrops; by summer several hundred lode and placer mining claims had been staked. At the present site of Republic the mining camp of Eureka sprang up, and on Myers Creek, about 4 miles south of the Canadian border, prospectors established the camp of Chesaw near the ranch of a Chinaman named Chee-Saw. Other mining camps included Bolster, which was 2 miles north of Chesaw, Bodie, and Toroda on Toroda Creek, Sheridan, which was 2 miles east of Toroda, and Wauconda, near the headwaters of the West Fork of Granite Creek. Soon after the settlement of the camps, mining districts were established, among which were Myers Creek, Bodie, Sheridan, Cascade, Ballarat, and Wauconda (fig. 8). In the Myers Creek district, by the summer of 1896, the surrounding hillsides were dotted with prospect pits, adits, and shafts; gold placer claims on Myers and Mary Ann Creeks were also being worked. At the present site of Chesaw, V. L. Cuny, Josh Cary, and Major Jim Blaine opened the first general store and saloon. Major Blaine also opened the first assay office (see frontispiece) but concentrated on promoting the mines of the district. Although mining claims had been staked throughout the district, the most promising claims appeared to be north and northwest of Chesaw for about 4 miles, and on the summit of Buckhorn Mountain, which lay 2 miles east of Chesaw. Although high-grade gold ore was stockpiled and shipped to west coast and Canadian smelters,

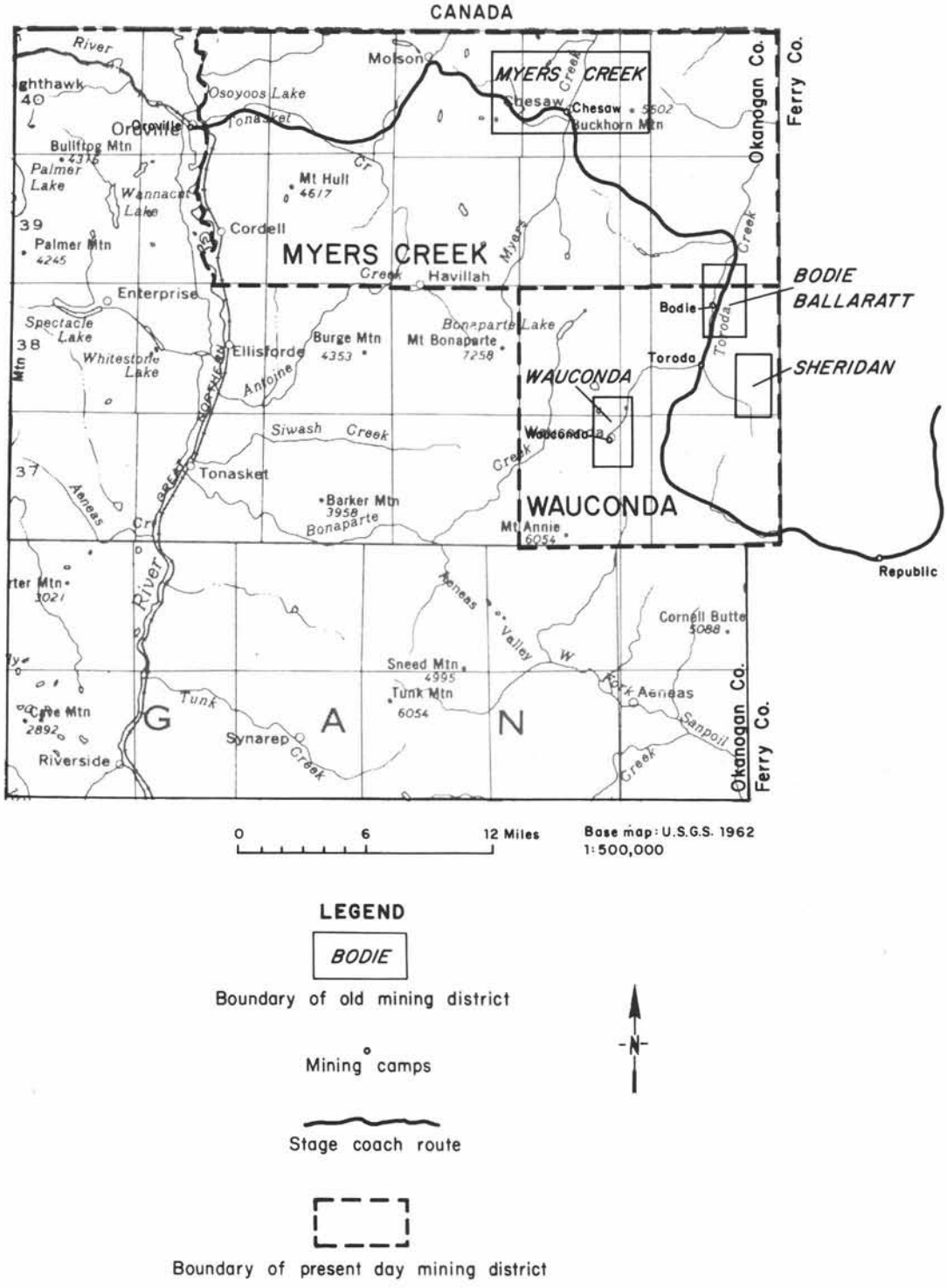


Figure 8.—Mining districts, past and present, of northeastern Okanogan County.

production was not great. Umpleby (1911, p. 28) estimates that production from the Myers Creek district, from 1896 to 1911, at about $100,000; $40,000 of which came from placer deposits on Mary Ann Creek. The amalgamation mills that had been built to treat the district's gold ores proved to be impractical because of the pyritic nature of the ores.

Southeast of Chesaw, at Republic in Ferry County, most gold mines were idle because of the closure of the district's largest custom mill. In the Ruby and Conconully silver districts, which were about 40 miles southwest of Chesaw, most silver mines remained idle because of the silver panic of 1893, when the price of silver dropped from $1.25 per ounce to 90 cents.

After 1910, mining was carried out sporadically at probably no more than a dozen mines in the Myers Creek district, and at only three mines in the Wauconda district. Peak production years for gold and silver in the Myers Creek district were 1910 to 1917, and 1933-1944. In the Wauconda district peak production years were 1910-1933, and 1933-1942 (table 1). In addition to gold and silver, iron ore was shipped from mines on Buckhorn Mountain at different times from 1911 to 1950. The major mines of the districts, as well as their productive years, are shown also in table 1.

After 1951, mining ceased in the Myers Creek and Wauconda districts, and currently (1979) all properties are idle. Mining equipment has been removed at all mines, and the portals of most adits and the collars of most shafts are caved making the underground mine workings inaccessible. Throughout the years mining companies have examined the mines and prospects of the district to determine their economic potential. Properties in the vicinity of Chesaw have received only cursory examinations, while more detailed geologic investigations have been undertaken at copper-iron mineralized acres on Buckhorn Mountain, at silver deposits in the Sheridan area, and at the Bodie gold mine.

Except for several dilapidated buildings, very little remains at the sites of the old mining camps of Wauconda, Bodie, Toroda, and Sheridan. However, at Chesaw enough remains to suggest that it was, in the past, a sizable community. In the spring of 1896, it was a mining camp consisting only of a cluster of tents and log cabins, but within a few years it grew into a thriving community of several hundred individuals. It had several general stores, hotels, saloons, livery stables, and assay offices. It had churches, fraternal lodges, a school, a post office, and a newspaper. However, over the past 70 years, businesses closed and families moved, until all that remains of a town that once served an area of a hundred square miles is a single tavern and a few houses (see fig. 13). Although little remains of the once-thriving town of Chesaw, reddish-brown iron-stained mine dumps may still be seen on the surrounding hillsides—a reminder that in the past the area experienced a short-lived mining boom.

Following is a chronology of mining activities in the Myers Creek and Wauconda mining districts from 1906 to 1953, as extracted from U.S. Geological Survey Mineral Resources and U.S. Bureau of Mines Minerals Yearbook:

CHRONOLOGY OF MINING ACTIVITIES

1906.—The greatest tonnage is from the Bodie, but the greatest production is from the Myers Creek. The principal gold mine is the Butcher Boy at Myers Creek.

1907.—The producing properties are in the districts of Bodie, Chesaw, Methow, Nespelem, and Oroville; the most productive of these districts is Chesaw. The producers in the latter camp are the Butcher Boy, the Grant Consolidated Copper Co., and the Allen Placer Mining Co. This was formerly the Myers Creek district. The Butcher Boy became a shipper in a small way during the year to the extent of about 2 carloads a month. Recently, the Olentangy Mining Co., owning 4 patented claims, installed a hoist, compressor, etc., and will soon be shipping ore.

The Grant Consolidated Mining Co. expended some $60,000 in development work in 1907, after having proved the value of the mine by test shipments. Since the close of the year, the Molson Mining Co. has built a new mill, which is now in operation. So much sulfide ore is being found that an effort will be made to install a smelter at this camp. This is the second year in which there has been copper production from this county. At Bodie, the Bodie Transportation and Mining Co. has a 10-stamp mill and cyanide plant. There are 5 claims in the group being worked by this company.

1908.—The producing deep-mine operators in 1908 were the B. and F. Mining Co., at Bodie; Butcher Boy Gold Mining Co.; Grant Consolidated Copper Co.; and Yakima Gold Mining Co., at Chesaw. The mines of the B. and F. Mining Co., at Bodie, were worked only a short time during the year, and the mill was operated for only a month. This company has a 10-stamp mill with a cyanide plant. In the Chesaw district no new properties were opened during the year. The Butcher Boy Co. has no plant of its own and ships its ores to the Granby Smelter. The property of the Grant Consolidated Copper Co. was developed by about 1,200 feet of underground workings, and is a comparatively new mine, work having commenced only in March, 1907. The ore was hauled 13 miles to the railway and thence shipped to the smelter.

1909.—The deep mines which were productive are at Bodie, Chesaw, Methow, Nespelem, Nighthawk, and Oroville. No single one of the mines in the county produced a total of over $4,000.

1910.—*Myers Creek District:* From three deep mines and one placer the district produced $1,836 in gold and 28 ounces of silver. Development was continued at the Molson property, and tests were made in a 25-ton mill.

Wauconda District: The Duluth-Toroda Mining Co., operating mine and mill at Bodie, marketed considerable bullion and some concentrate.

1911.—*Myers Creek District:* Gold ore was shipped from the Gold Axe mine, near Chesaw.

Wauconda District: The Bodie mine was the source of some bullion recovered by amalgamation.

1912.—*Wauconda District:* Bullion was produced from the Bodie mine.

Myers Creek District: A small placer output came from the creek bed near Molson.

1913.—*Myers Creek District:* The Molson Gold Mining Co. has a plant with six Nissen stamps, but only small tests were made.

1914.—*Myers Creek District:* The region produced 220 tons of ore, $664 in gold, 227 ounces of silver, and 11,500 pounds of copper. The producers were the Molson, Reco, and Western Star, the first two producing gold and the last, copper.

1915.—*Wauconda District:* The Toroda Development Co. is said to have shipped bullion from a mill working ore at the Bodie property. Some rich silver ore was shipped from the Phil Sheridan property, belonging to the Carey Mining Co.

Myers Creek District: Four deep mines and one placer produced 371 tons of ore, $4,086 in gold, 556 ounces of silver, and 11,277 pounds of copper, in all values at $6,341, an average of $16.50 for the ore. Fifty-seven tons were treated in gold mills, and 314 tons shipped directly to smelters contained 158.29 ounces of gold, 542 ounces of silver, and 11,277 pounds of copper. Small placer production came from the Cuba claim, near Molson. A small tonnage of free gold ore from the Reco mine was treated at the Poland China mill. Rich ore containing gold, silver, and copper was shipped from the Gold Axe property. The Western Star mine produced a few shipments of copper ore.

1916.—*Wauconda District:* The Toroda Development Co. operated a 40-ton amalgamation mill at the Bodie mine near Toroda. The mine is developed by a shaft 320 feet deep, 2,100 feet of drifts, and 600 feet of adits. In the same region, the Phil Sheridan property, operated by the Carey Mining & Milling Co., made a small shipment of ore rich in silver.

Myers Creek District: From eight deep mines and three placers, the output was 1,057 tons of ore yielding $14,821 in gold, 1,158 ounces of silver, and 25,916 pounds of copper, valued in all at $21,958, or $19.89 per ton. This represents an increase from 371 tons of ore and a total value of $6,341 in 1915. Only 67 tons were treated in gold and silver mills, the remainder being shipped directly to smelters. A good grade of gold ore was shipped from the Eagle property and the Reco mine at Chesaw, and the Gold Axe property produced gold ore containing some silver and copper. The Caribou property was operated by the British Columbia Copper Co., and several shipments containing gold, silver, and copper were made to Greenwood, British Columbia. Small amounts of gold came from several placer properties, principally the Cuba Line at Molson.

1917.—*Wauconda District:* A shipment of rich silver ore was made from the Phil Sheridan property, operated by the Carey Mining & Milling Co., but only a small clean-up was made from the Bodie mine, formerly a fair producer.

Myers Creek District: Eight deep mines and one placer produced 406 tons of ore, $2,951 in gold, 549 ounces of silver, and 11,378 pounds of copper, having a total value of $6,509. The production in 1916 was valued at $21,958. Nearly all the ore was shipped to smelting plants. The Eagle and Reco properties produced a rich gold ore, and the Neutral and the Caribou properties copper ore.

1918.—*Wauconda District:* Three properties produced 102 tons of ore, containing $216 in gold, 7,820 ounces of silver, and 1,302 pounds of copper, valued in all at $8,358 or an average value per ton of $81.94. A shipment of rich silver ore was made from the Phil Sheridan property of the Carey M. & M. Co., and shipments of lower grade were made as a test from the American Flag mine. A flotation plant is planned for the latter property.

Myers Creek District: A small shipment of copper ore came from the Bi-Metallic property, and the Cuba Line placer produced a few ounces of gold. The Neutral mine, at Chesaw, developed considerable iron ore, which was shipped to Chewelah to be used in the manufacture of ferromagnesite.

1919.—*Wauconda District:* Some ore was milled by the Carey Mining & Milling Co., and a shipment of silver concentrates was made to Tacoma.

Myers Creek District: Many of the mines of the district were idle, but oxidized iron ore was shipped from the Neutral mine to Chewelah to be used in the manufacture of ferromagnesite.

1920.—*Myers Creek District:* A few lots of gold ore were shipped from Chesaw, and iron ore from the Neutral mine was shipped to Chewelah for the manufacture of ferromagnesite.

1921.—*Myers Creek District:* The Eagle mine produced some ore which was treated by amalgamation.

1923.—*Myers Creek Distict:* Lessees operating the Gray Eagle mine shipped one lot of gold ore to the Bunker Hill smelter, at Bradley, Idaho. Ore was tested in a small amalgamation mill for the Mary Ann Creek Mining Co., near Molson, and a little placer gold was marketed from various claims in the district.

1924.—*Myers Creek District:* Four deep mines in the Myers Creek district produced 60 tons of ore that yielded $1,923 in gold and 174 ounces of silver, valued together at $2,040, or $34 a ton. Other than a small lot for an amalgamation test, the product was first-class ore shipped to the smelter; it consisted of gold ore from the Gray Eagle, Eagle, and Rattler properties, near Chesaw. Very rich gold ore was found at the Reco mine, but not enough to warrant the expense of building a mill.

1928.—*Myers Creek District:* Little mining was done in Okanogan County in 1928. One car of gold ore was shipped by lessees from the Gold Axe property, in the Myers Creek district.

1930.—*Myers Creek District:* Placer bullion valued at $2,015 was recovered from the Walker group of claims near Molson, which were active from August to November.

1931.—*Myers Creek District:* The placer output from the Myers Creek district was valued at $619 and came chiefly from the Walker claims 6 miles from Molson.

1933.—*Wauconda District:* Siliceous gold ore of smelting grade from the Gold Axe and Bodie properties was shipped in 1933 to Trail, British Columbia.

Myers Creek District: The Ottia May, Don Mooney, and various small placers in the district yielded bullion valued at $2,090; most of the output came from the Ottia May placer. The Poland China lode mine was also operated in 1933; siliceous gold ore was treated by amalgamation and concentration, and first-class gold ore was shipped to smelters.

1934.—*Waunconda District:* Three cars of gold ore from the Bodie mine and one car from the Gold Axe mine were shipped in 1934 for smelting. A new 75-ton flotation plant was being constructed at the Bodie property late in the year.

Myers Creek District: The Overtop Mining Co. shipped three cars of gold ore in 1934 from the Poland China mine and treated a little ore in a small amalgamation plant; gold ore from the Gray Eagle mine also was treated by amalgamation. The placer output came chiefly from the Ottia May, Johnston, and Spoonamore properties on Mary Ann Creek.

1935.—*Wauconda District:* The Bodie mine near Wauconda, Okanogan County, was the second largest producer of gold in Washington in 1935; the mine was operated by the Northern Gold Corp., and several thousand tons of gold ore were treated by amalgamation and concentration.

1936.—The Northern Gold Corp. was formed in 1935 to operate the Bodie mine 12 miles north of Wauconda. The company rebuilt the milling plant (70-ton amalgamation and gravity-concentration) and in 1935 treated about 9,000 tons of ore, shipping bullion and rich gold concentrates. The production was doubled in 1936 when nearly 19,000 tons of ore were milled. Other producing lode mines in Okanogan County in 1936 included the Golconda mine near Wauconda, the Gray Eagle, and Peterson properties near Chesaw. Placers were operated in 1936 along the Columbia, Similkameen, and Twisp Rivers and on Myers and Mary Ann Creeks.

1937.—The Bodie mine, operated by the Northern Gold Corp., was the most important producer in Okanogan County, in 1937, as usual; the company milled 18,840 tons of gold ore in the 70-ton amalgamation and table-concentration mill, but the output of gold was considerably less than in 1936. Other producing lode mines in Okanogan County included the Mother Lode, Poland China, Gray Eagle, and Peterson mines in the Myers Creek district.

1938.—Suspension of operations by the Northern Gold Corp. at the Bodie mine near Wauconda early in 1938 resulted in a sharp decrease in gold production from Okanogan County. Other producing lode mines in Okanogan County in 1938 included the Whitestone and Golconda mines in the Wauconda district; the Mother Lode, Poland China (Overtop), Gray Eagle, and Peterson mines in the Myers Creek district. Placer production was reported from Myers Creek and Mary Ann Creek.

1939.—*Wauconda District:* The entire output of the Wauconda district in 1939 was gold ore from the Bodie mine north of Wauconda and was treated by amalgamation and concentration; the property was operated part of the year by the Northern Gold Corp. and later by the Toroda Gold Mines Corp.

Myers Creek District: Gold ore was shipped in 1939 for smelting from the Gray Eagle, Mother Lode, Poland China (Overtop), and Harris lode mines. Small-scale sluicing operations were reported at the Ottia May and Davey placers.

1940.—*Wauconda District:* The entire output of the Wauconda district was gold ore from the Bodie group near Wauconda. Over half of the gold and silver from this property was contained in crude ore sent to smelters; the remainder was recovered by amalgamation.

Myers Creek District: A little gold was recovered from gravels along Mary Ann Creek near Chesaw. Small lots of gold ore were shipped crude to the smelter from the Mother Lode and Morning Glory properties.

1941.—*Wauconda District:* The Bodie group near Wauconda, treating gold ore by amalgamation and

concentration, produced the entire output of the Wauconda district in 1941.

Myers Creek District: Gold ore from the Mother Lode property represented the bulk of the output in 1941.

1942.—*Wauconda District:* Metal from crude gold ore shipped direct to the Tacoma smelter from the Bodie group near Wauconda comprised the output from the Wauconda district in 1942.

1944.—*Wauconda District:* A car of gold ore shipped to the Tacoma copper smelter from the Bodie mine comprised the only output from the Wauconda district in 1944.

1950.—*Myers Creek District:* One small lot of gold ore was shipped to a smelter from the Gray Eagle mine which was operated for a short time during the year.

1951.—*Myers Creek District:* A small quantity of gold ore was shipped to a smelter from the Gray Eagle mine, in Myers Creek district.

1953.—*Myers Creek District:* Exploration and development were carried out at the Chesaw gold mine by C. N. Bagwell and H. B. Splawn of Yakima.

MINERAL PRODUCTION

Mineral production figures for the Myers Creek and Wauconda mining districts are incomplete, but figures that are available will serve to point out the most productive years, as well as the districts' most productive mines from 1910 to 1951. According to production figures published in Mineral Resources and Minerals Yearbook, total production of base and precious metals amounted to only $385,969. Not included in this figure is production from 1897 to 1910. Prior to 1910, mineral production figures published by the U.S. Geological Survey and the U.S. Bureau of Mines were reported by county without a breakdown by district. However, Umpleby (1911, p. 28) estimates the production of the Myers Creek district from 1897 to 1910 at around $100,000, $60,000 of which was gold and silver from lode mines, and $40,000 in placer gold. In the Wauconda district the bulk of the production from 1898 to 1903 was from the Zalla M mine, which, according to Patty (1921, p. 198), amounted to $40,000 in silver. Gold was mined at the Bodie property as early as 1902, but production figures are not available. Thus, the total production for the districts from 1897 to 1951 appears to be $535,969. However, it is reasonable to assume that the actual production exceeded this figure as the production from several rich gold mines that operated prior to 1910 was never reported.

As can be seen in table 1, the main producing years of both districts were prior to 1920, and from 1930 to 1944, after which time most mines became idle.

In the depression years of the 1930's, and bolstered by the rise of the price of gold from $20 to $35 per ounce in 1934, the mines once again became productive and continued to operate until the early 1940's, which were the most productive years for the districts. Leading producing mines in the Myers Creek district were the Reco, Gold Axe, Poland China, Mother Lode, and Gray Eagle, as well as several gold placer mines on Mary Ann Creek. In the Wauconda district the leading producing gold and silver mines were the Bodie, Zalla M, and Sheridan. Although the production of gold and silver in both districts ceased around 1944, around 37,000 tons of iron ore, consisting chiefly of magnetite, was shipped from the Magnetite (Neutral) mine from 1944 to 1950. The only other metal that can be credited to the Myers Creek district is 500 pounds of high-grade molybdenum ore that was shipped from the Bi-Metallic mine around 1918 (Huntting, 1956, p. 270).

MINERALIZATION

The Myers Creek and Wauconda mining districts contain deposits of gold, silver, copper, lead, iron, tungsten, molybdenum, fluorite, limestone, and peat. As can be seen in figure 9, the mineral deposits occur chiefly in the east-central part of the Wauconda district and the east half of the Myers Creek district. Host rocks for the deposits of the Myers Creek district are weakly to moderately metamorphosed eugeosynclinal rocks of Permian or Triassic age; in the Wauconda district most deposits are in volcanic rocks of late Eocene age. Although significant amounts of placer gold have been mined from the gravels of upper Mary Ann Creek, all other streams in the districts contain only sparse amounts to no placer gold. The entire area of the Okanogan gneiss dome appears barren of significant metallic mineral deposits.

A variety of ore minerals occur in the Wauconda and Myers Creek districts. Minerals reported to date (1979) include gold, chalcopyrite, galena, sphalerite,

TABLE 1.—*Production of gold, silver, Wauconda mining*

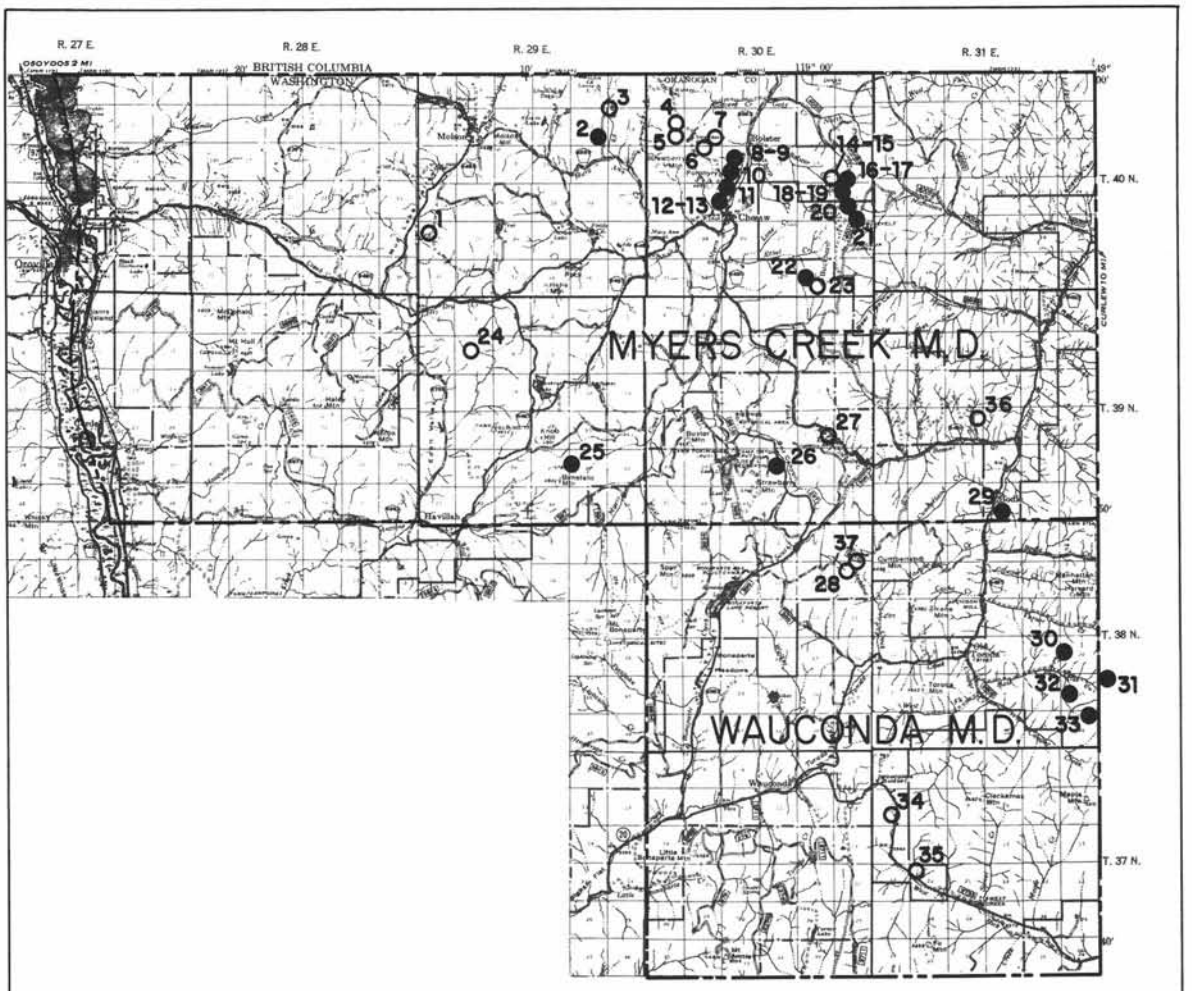
	Myers Creek District						
Year	Gold (oz.)	Silver (oz.)	Copper (lb.)	Lead (lb.)	Total	Principal producing mines	Iron (tons)
1910	91	28			$ 1,890	Gold Axe	
11					4,500	Gold Axe	
12					3,000		
13							
14	33	227	11,500		2,353	Poland China, Reco, Western Star	
15	204	556	11,277		6,341	Gold Axe, Reco, Western Star	
16	740	1,158	25,916		21,958	Eagle, Reco, Gold Axe, American Girl, Caribou	
17	80	549	11,378		6,509	Eagle, Reco, Neutral, Caribou	
18						Bi-Metallic, Neutral	
19						Neutral, Roosevelt	2,000
1920						Neutral, Roosevelt	
21						Eagle	
22							
23						Gray Eagle	
24	96	174			2,040	Gray Eagle, Rattler	
25							
26							
27							
28						Gold Axe	
29							
1930					2,015	Walker (placer)	
31					619	Walker (placer)	
32							
33	134	37			2,690	Gold Axe, Poland China, Mary Ann placers	
34	133	68			4,679	Gold Axe, Poland China, Gray Eagle, Mary Ann placers	
35	165	36			5,787		42,000
36	112	49			3,965	Gray Eagle, Mary Ann placers	
37	290	274			10,386	Mother Lode, Poland China, Gray Eagle, Peterson, Neutral	
38	162	198	10	826	5,837	Gray Eagle, Mother Lode, Peterson, Poland China, Neutral	
39	226	389	10	21	8,176	Gray Eagle, Mother Lode, Peterson, Poland China	
1940						Mother Lode, Morning Glory, Neutral	
41	69	166	200	900	2,608	Mother Lode, Neutral	
42	24	66		600	927	Neutral	
43						"	
44						"	
45						"	
46						"	32,000
47						"	
48							
49							5,000
1950						Gray Eagle	
51						Gray Eagle	
			Total		$ 96,280*		

copper, and lead from Myers Creek and districts, 1910-1944[1]

	Wauconda District					
Year	Gold (oz.)	Silver (oz.)	Copper (lb.)	Lead (lb.)	Total	Principal producing mines
1910						Bodie, Phil Sheridan
11						Bodie
12						Bodie, Phil Sheridan
13						Phil Sheridan
14						Bodie, Phil Sheridan
15						Bodie, Phil Sheridan
16						Bodie, Phil Sheridan
17						Phil Sheridan
18	10	7,820	1,302		$ 8,358	Phil Sheridan, American Flag
19						Phil Sheridan
1920						Phil Sheridan
21						
22						
23						
24						
25						
26						
27						
28						
29						
1930						
31						
32						
33	71	94			1,457	Bodie
34	50	62			1,787	Bodie
35	1,348	1,170	132	2,200	48,120	Bodie
36	2,932	1,929		151	104,128	Bodie
37	1,991	1,598			70,921	Bodie
38	517	628	51	913	18,548	Golconda, Whitestone
39	708	638			25,213	Bodie
1940	134	239			4,860	Bodie, Silver Bell
41	47	38			1,672	Bodie
42	63	128			2,296	Bodie
43	26	45			942	Bodie
44						Bodie
45						
46						
47						
48						
49						
1950						
51						
			Total		$288,302*	

[1]Production figures from Mineral Resource, U.S. Geological Survey to 1924. U.S. Bureau of Mines after 1924. Continued after 1931 as Minerals Yearbook.

*Excluding iron.



PROPERTIES

1. Carlquist
2. Poland China
3. Mary Ann Placer
4. Strawberry Lake
5. Olentangy
6. Ophir
7. Delate
8. Gray Eagle
9. Review
10. Reco
11. Butcher Boy
12. Ben Harrison (Apex)
13. Yakima
14. Rainbow
15. Caribou
16. Aztec
17. Magnetic (Neutral)
18. Western Star
19. Buckhorn
20. Gold Axe
21. Roosevelt (Grant)
22. Crystal Butte (Mother Lode)
23. Crystal Butte Iron
24. Shaw-Bergman
25. Bi-Metallic
26. Whitestone
27. Lake Beth
28. Lupin
29. Bodie
30. Phil Sheridan
31. Zalla M.
32. Silver Belle
33. American Flag
34. Wauconda
35. Umbra and Sundown
36. Ida
37. Lucky Sunday

LEGEND

Mining district boundary

● Mine **○ Prospect**

Figure 9.—Metallic mineral desposits of Myers Creek and Wauconda mining districts.

magnetite, bornite, scheelite, boulangerite, tetrahedrite, hessite, krennerite(?), pyrite, pyrrhotite, and arsenopyrite. Common gangue minerals are quartz, calcite, fluorite, garnet, and epidote.

In the Myers Creek district the ore deposits are of five classes: (1) quartz fissure veins, (2) contact metamorphic deposits, (3) disseminated deposits, (4) breccia deposits, and (5) gold placer deposits. In the Wauconda district the ore deposits are of three classes: (1) quartz fissure veins, (2) disseminated deposits, and (3) breccia deposits.

QUARTZ FISSURE VEINS

The bulk of the gold and silver deposits of both districts occur in quartz fissure veins. Most veins strike north to northeast, are steeply dipping, and are in shear zones that parallel faults of the area. The veins range from several inches to as much as 6 feet in thickness and can seldom be traced continuously for more than 100 feet on the surface, but intermittent exposures of some veins suggest lengths of up to 6,000 feet. Underground at least one vein (Bodie) has been followed for as much as 1,000 feet along its strike and to a maximum depth of about 500 feet along its dip. At all deposits the vein quartz is mostly fine grained and often chalcedonic. It is milky white to light gray in color, though often reddish brown due to iron oxide staining. In addition to quartz, calcite is often present and fluorite occasionally. Many veins have open cavities, crustification, filling, and comb and cockade structure characteristic of low-temperature near-surface epithermal veins. Many quartz veins have been moderately to severely brecciated and fractured; secondary quartz and calcite sometimes fill voids between breccia clasts and openings in fractures. Ore minerals in the veins occur as disseminated grains, or are concentrated into small masses and narrow streaks. Localization of ore minerals into small shoots is common.

CONTACT METAMORPHIC DEPOSITS

Contact metamorphic deposits occur at contacts between Permian or Triassic metasedimentary rocks and Mesozoic granodioritic rocks. These deposits are represented by the Magnetic and Roosevelt iron mines on Buckhorn Mountain, and several smaller deposits in the Myers Creek district. In addition to magnetite, almost all deposits contain moderate amounts of pyrite and pyrrhotite, as well as minor chalcopyrite and sparse scheelite. On Buckhorn Mountain the contact metamorphic zone is at least 2 miles long and up to 2,500 feet wide. Tactite bodies rich in magnetite, garnet, and epidote occur within this contact zone. The largest magnetite deposit (Magnetic mine) is about 750 feet long and 60 to 130 feet wide. Core drilling at this deposit has encountered magnetite to depths of about 1,000 feet. Contact metamorphic deposits other than the Buckhorn Mountain deposits appear to be small.

DISSEMINATED SULFIDE DEPOSITS

Host rocks for these deposits in the Myers Creek district consist of Permian or Triassic metamorphic rocks, and Mesozoic and(or) lower Tertiary granitic rocks. In the Wauconda district disseminated deposits occur in Permian or Triassic metamorphic rocks, as well as in upper Eocene volcanic rocks. In the metamorphic rocks argillite and limy rocks appear to be the most favorable host rocks for mineralization, but in some places quartzite beds are host rocks for ore minerals. Common ore minerals of the disseminated deposits are pyrite, magnetite, and chalcopyrite. At least one deposit (Bi-Metallic) contains minor amounts of molybdenum, and several deposits contain sparse fine-grained scheelite. In the volcanic rocks of the Toroda and Sheridan areas silicified zones contain disseminated pyrite with traces of silver, while the trachyte of the Sheridan area contains disseminated minute particles of an unidentified silver sulfide mineral.

The disseminated deposits in metamorphic rocks, in addition to the above-mentioned ore minerals, contain minor garnet, epidote, and other calc-silicate minerals typical of a contact metamorphic environment. In some cases a definite transition from ore bodies of the contact zone out into the disseminated zone of mineralization exists, but in other cases only the area of disseminated minerals is present. In all probability the disseminated deposits of the metamorphic rocks are related to contact metamorphic deposits, inasmuch as granitic rocks occur within short distances of most deposits, and probably underlie them at shallow depths.

BRECCIA DEPOSITS

These deposits are confined to volcanic rocks, and are linear structures, rather than pipe or cylindrical. They have a tendency to parallel well-developed fissure veins, and most appear to be tectonic in origin rather than volcaniclastic. At the Sheridan and Silver Bell mines in the Sheridan district, mineralized breccias attain a maximum width of 300 feet; at the Bodie mine a persistent breccia ranges from 100 to 300 feet in width with a strike length of over 1,500 feet. The clasts of the breccias are cemented by quartz, calcite, and(or) fluorite that is sometimes

accompanied by fine-grained, minor chalcopyrite, bornite, and sphalerite. Moderate amounts of fine-grained pyrite are almost always present, and in several breccias sparse gold and silver accompany one or several of the above-mentioned ore minerals. The large gold-bearing breccia of the Bodie mine represents the most extensive mineralized breccia of the Myers Creek and Wauconda districts.

PLACER GOLD DEPOSITS

Although sparse amounts of placer gold have been found on many parts of Myers Creek, as well as on several of its tributaries, only the placer gold of Mary Ann Creek, which is a main tributary of Myers Creek, has been productive in the past and is worthy of mention. From its confluence with Myers Creek about 2 miles west of Chesaw, Mary Ann Creek has been mined at widely separated sites northward for about 4 miles to near the head of its north fork. Other than the terrace mining operations at the NW. cor. sec. 12, T. 40 N., R. 29 E. (see fig. 10), all placer mining operations appear to have been small. The placer gold of Mary Ann Creek occurs from grass-root depths down to bedrock. In places, soil and gravels form only a thin veneer on bedrock, but on several parts of the creek, terrace gravel deposits are as much as 35 feet deep. Most gold occurs on or several inches above bedrock. Landes and others (1902, p. 27-28) report that gold-rich gravels also occurred on false bedrock consisting of a 7-inch clay seam 4 feet above bedrock. The gold of Mary Ann Creek is predominantly medium to fine grain, but some coarse nuggets have been found. Much gold is angular indicating that it has not been transported far, and occasionally nuggets are found with vein quartz still attached. It is very likely that the source of much of the placer gold is in the vicinity of Mary Ann Creek, and originated when gold-rich quartz veins similar to the Poland China underwent erosion during glaciation of the area.

Figure 10.—Terrace placer workings at head of north fork of Mary Ann Creek, about 1 mile south of U.S. border.

AGE AND ORIGIN OF MINERALIZATION

At least two ages of mineralization appear to be present in the Myers Creek and Wauconda districts. Some deposits are related to intrusive granodiorite, quartz porphyry, and plagioclase porphyry of probable Late Cretaceous age; other deposits occur in upper Eocene volcanic rocks and are probably of late Eocene or post-Eocene age.

Mineralization in the Eocene volcanic rocks of the Wauconda districts cannot be related to any granitic intrusive rocks of the area, as all deroofed intrusives formed before the veins. In the Myers Creek district the proximity of the mineralized veins to numerous hydrothermally altered granitic dikes and pipes suggests that the veins originated from intrusive sources. The dikes and pipes appear to be offshoots of underlying granitic bodies that could lie within 500 feet of the surface in the mineralized area north and west of Chesaw where most mineralized veins occur (Hunting Geophysical Service, Inc., 1960, p. 23). All contact metamorphic deposits are related to granodiorite intrusive rocks and their derivatives.

TENOR OF ORE

The metal content of ores from Myers Creek and Wauconda districts varies considerably as is shown by numerous assays and past production records of the district's main mines. Near-surface enriched parts of several gold- and silver-bearing quartz fissure veins contained up to 20 ounces per ton in gold, whereas other veins contained as much as 200 ounces per ton in silver. However, as past production records indicate, the gold-silver content of ore mined was in most cases substantially lower. The Au/Ag ratio in the most productive mines (Bodie, Reco, and Poland China) ranged from 1:0.73 to 1:0.97. In the most productive silver mines (Sheridan, and Zalla M) the Ag/Au ratio was from 79:1 and 70:1.

Mine	Tons mined	Gold (average) (oz/ton)	Silver (average) (oz/ton)
Bodie	61,847	0.15	0.11
Zalla M	1,050	0.34	24.42
Reco	887	0.87	0.64
Sheridan	516	1.36	108.12

The silver content of Sheridan ore represents near-surface high-grade ore. At 50 feet beneath the outcrop of the vein the silver content was about 16 ounces per ton and appears to represent the average silver content of the vein. Currently (1979) the only silver mine with known reserves is the Silver Bell where 124,000 tons of fluoritized breccia averages 5.46 ounces per ton in silver and 0.014 ounce in gold. Extensive mining at the Bodie mine illustrates the decreasing gold values on a typical quartz fissure vein with depth. From the surface to a depth of 100 feet the gold content of the vein averaged 1 ounce; from 100 to 200 feet deep it was 0.75 ounces; from 200 to 250 it was 0.40 ounce; from 250 to 300 it was 0.175 ounce. An extensive hydrothermally altered volcanic breccia at the Bodie contains about 0.03 ounces per ton in gold, but some parts have assayed as much as 0.21 ounce. Insufficient work has been done to delineate ore zones within the breccia.

Except for iron, sufficient data is not available to establish the tenor of the ore at other metalliferous deposits within the Myers Creek and Wauconda districts. Select magnetite samples from the Magnetic mine contain 47.3 to 69.3 percent iron, 4.80 to 15.95 percent SiO_2, and 0.03 to 3.24 percent sulfur. The average iron content of the deposit is about 49.08 percent, with 1.97 percent sulfur (see table 2).

OUTLOOK FOR THE DISTRICTS

MYERS CREEK

Although many occurrences of copper, gold, silver, lead, tungsten, iron, zinc, and molybdenum are present in the Myers Creek district, few can be classed as mineral deposits because they are not sufficiently mineralized to be of economic importance under current (1979) market conditions. Mineralized quartz fissure veins mined in the past have been narrow, of limited size, and only near the surface were most veins rich enough to mine. Small amounts of ore still remain at several deposits, but it is doubtful that sufficient ore is present to warrant mining. As such, the known quartz fissure vein deposits are not considered to be of economic value.

The iron occurrences of the contact metamorphic deposits of Buckhorn Mountain appear to be of little value to the iron industry. They are of limited size, high in sulfur, and too remote from existing markets. However, sufficient iron in the form of massive magnetite is present to satisfy regional magnetite markets.

The most favorable areas for the discovery of new metal deposits appear to be intrusive contacts,

especially areas of argillaceous and calcareous rocks. Extensive exploration of these areas could lead to the discovery of contact metamorphic deposits of copper, iron, tungsten, gold, and silver. The most productive gold-bearing veins appear to occur along what the writer calls the Gray Eagle-Ben Harrison gold belt (see Mineralization, Myers Creek Mining District). Detailed prospecting in this area could lead to the discovery of new veins.

Deposits of high-calcium limestone occur in the district but currently (1979) their remoteness to existing markets prevents development.

WAUCONDA

The Wauconda district contains deposits of gold, silver, copper, lead, and zinc, but most deposits lack quality and quantity to be of economic value under present (1979) conditions. Mining has been undertaken in the past at the most favorable deposits, and at most of these deposits little in the way of ore remains. Small-scale mining operations may be justified at the Silver Bell mine where about 124,000 tons of rock averages 5.46 ounces per ton in silver. With rapidly rising gold prices the large sparsely gold-mineralized breccia at the Bodie mine could prove to be of economic value.

The most favorable gold-silver exploration area lies east of Toroda Creek. Large silicified and pyritized zones in brecciated Eocene volcanic rocks of this area could have been the loci of gold and silver deposition.

As in the case of the limestone deposits of the Myers Creek district, the limestone deposits of the Wauconda district are too remote from existing markets to be of economic value. The peat deposits of Bonaparte Meadows are potentially valuable and can satisfy local demands. The fluorite deposits of the Sheridan area are too low grade to be of value.

MYERS CREEK MINING DISTRICT

For the purpose of this report, only that part of the district that falls within townships 39 and 40 north, and ranges 29, 30, and 31 east, is discussed, for it is within this area that almost all mining properties of the district lie (see figs. 9 and 11). This area extends 12 miles south of the international border, and 18 miles west of the Okanogan-Ferry County line. The total area is 216 square miles (138,240 acres).

The terrain of Myers Creek district is mountainous, but not rugged (fig. 2). Elevations along the western edge of the district average about 4,000 feet, are as great as 5,600 feet on the summit of Buckhorn Mountain near the central part, and decrease rapidly to about 2,400 feet along Toroda Creek on the eastern edge of the district. Several miles east of Toroda Creek along the Ferry County line, elevations range from 2,200 to 5,000 feet.

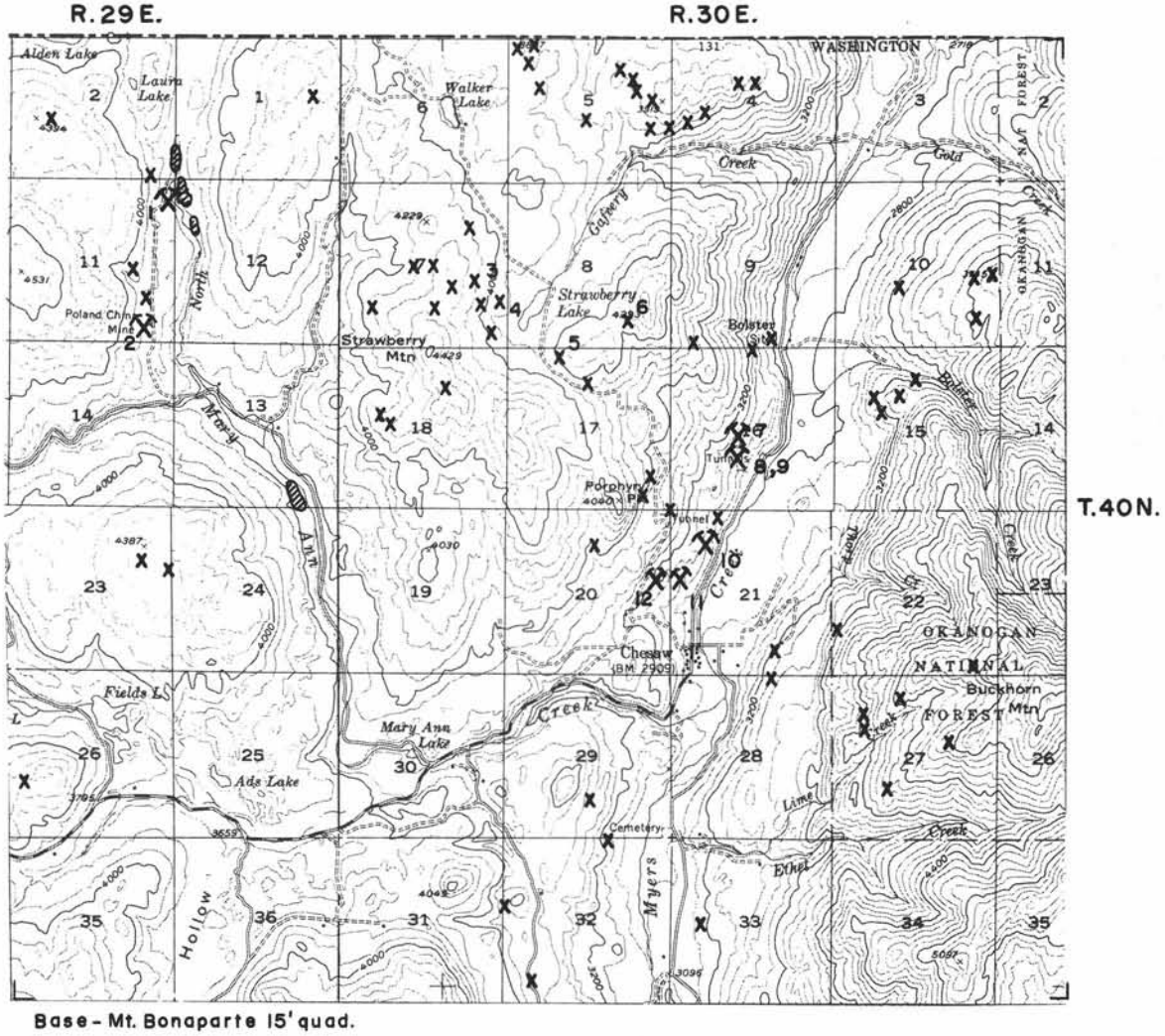
Except for a few south-facing slopes the east half of the district contains dense forest cover of conifers. Common conifers include Douglas fir and ponderosa and lodgepole pine. Western larch, hemlock, and western red cedar constitute a minor part of the conifer growth. Broad-leaved trees are only a minor part of the forests and include quaking aspen, cottonwoods, mountain alder, maples, and mountain ash. The western half of the district is only about 20 percent forested, with conifers growing in scattered stands on north-facing slopes. Most of the area is otherwise covered by pine grass, bunch grass, and sagebrush.

North-flowing Toroda and Myers Creeks are major drainages of the district. Numerous tributaries to these creeks form a dendritic drainage pattern. No fewer than 13 lakes may be found in the rolling uplands of the west half of the district, the largest lake being Sidley Lake (108 acres) near the settlement of Molson. With the exception of Lake Beth (13 acres) and Beaver Lake (30 acres), the east half of the district is void of lakes. Snow generally covers the district between November and April. In the Chesaw area access to mining properties may be hampered by about 2 feet of snow from January to March and at higher elevations on Buckhorn Mountain snow may remain on the ground well into May.

County and Forest Service roads provide good access to much of the district. Mining properties on Buckhorn Mountain can be reached from the east by way of Nicholson Creek road. From Chesaw, the area can be reached from the north by way of the Gold Creek road or by way of the Buckhorn Mountain lookout road, which traverses the southern and eastern slopes of the mountain. Mining properties northwest of Chesaw are accessible only by means of private roads that serve the range lands of local ranchers. The nearest railroad is at Oroville, which is 20 miles west of Chesaw.

GEOLOGY

Bedrock of the Myers Creek district consists of a wide variety of igneous, sedimentary, and metamorphic rocks that range in age from Permian through



Base - Mt. Bonaparte 15' quad.

0 0.5 1 Mile
Scale

PROPERTIES

1. Mary Ann placers
2. Poland China
3. Strawberry Lake
4. Olentangy
5. Ophir
6. Delate
7. Review
8. Gray Eagle
9. Reco
10. Butcher Boy
11. Yakima
12. Ben Harrison

LEGEND

Mine
Prospect
Placer gold workings

Figure 11.—Mines and prospects of Myers Creek mining district.

upper Eocene (plate 1). The oldest rocks are found chiefly in the western part of the district and consist of Permian or Triassic eugeosynclinal metasedimentary and meta-igneous rocks. East of these rocks are thick sequences of Eocene volcanic rocks and associated tuffaceous sedimentary rocks. The granitic rocks of the district appear to be chiefly of Mesozoic age and trend northeast through the center of the district within a belt approximately 4 miles wide and 18 miles long (fig. 12). In the southwestern part of the district, granitic and eugeosynclinal rocks are flanked by plutons of granodiorite and quartz monzonite of the Okanogan gneiss dome (late Mesozoic).

Several episodes of faulting and folding have sheared, foliated, and lineated older rocks. A general strike trend for the older rocks is lacking, but the Eocene rocks have a general north-northeast strike trend, and low to moderate dips to the east as a result of moderate post-Eocene folding. High-angle normal faults occur in the eugeosynclinal rocks, as well as in the Eocene volcanics. The general trend of the faults is north-northeast, roughly parallel to regional fold axes.

As can be seen in plate 1, much of the district is blanketed by surficial deposits of glacial debris and valley alluvium. The glacial debris consists chiefly of drift, terrace deposits, kames, and eskers. Valley alluvium consists of recent stream and flood-plain sand, silt, and gravel in valley bottoms, and talus and fan deposits on the adjoining valley sides. The surficial deposits are much more extensive in the west half of the district, than in the mountainous east half.

Inasmuch as the metallic mineral occurrences of the Myers Creek district occur chiefly in Permian or Triassic eugeosynclinal rocks and Mesozoic granitic rocks, only these rocks are discussed. The Eocene volcanic rocks are host rocks for most mineral occurrences of the Wauconda district (see General Geology, Wauconda Mining District).

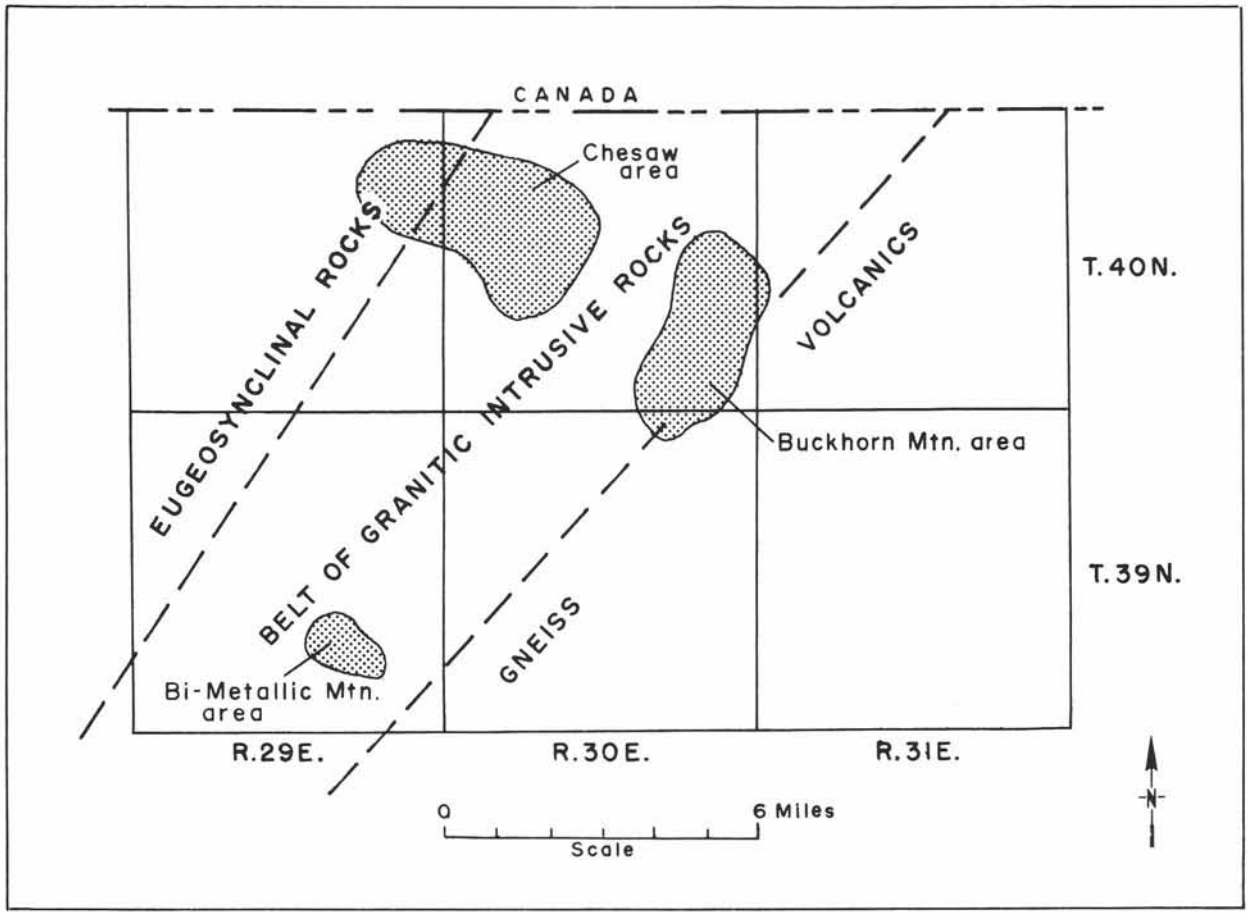


Figure 12.—Chief areas of metallic mineralization in Myers Creek mining district.

Eugeosynclinal Rocks

Fox (1970, 1978), mapped the eugeosynclinal rocks of the district as the Spectacle Formation of the Anarchist Group (Permian), and the Kobau Formation of Permian or Triassic age. The Kobau Formation is composed of a thick sequence of greenstone, greenschist, quartzite (metachert), metasiltstone, siliceous and dolomitic magnesite, and fine-grained impure marble. These rocks crop out chiefly in the northwestern part of the district, and lie unconformably on rocks of the Spectacle Formation. The bulk of the Spectacle Formation consists of metasiltstone, with interlayers of metaconglomerate (chert sharpstone), slate, phyllite, argillite, fine-grained dolomitic marble, greenstone, and amphibolite. These rocks crop out chiefly in the southwestern part of the district. Throughout the district, rocks of the Kobau and Spectacle Formations have been intruded by small discordant bodies of granodiorite, as well as by sill- and dike-like bodies of quartz porphyry and plagioclase porphyry, which are commonly hydrothermally altered.

Granitic Rocks

The granitic rocks of the district appear to be mainly of Mesozoic age, but according to Fox (1978), some granitic rocks may be as old as Triassic, and as young as early Tertiary. Granodiorite appears to predominate; associated rocks include quartz monzonite, quartz diorite, diorite, and monzonite. Minor syenite, alaskite, and hornblendite are also present. The largest granitic pluton is the Buckhorn Mountain stock, with an area of about 6 square miles. Significant mineralization does not appear to be present within the stock, which consists chiefly of biotite-hornblende granodiorite. However, along its southeastern edge contact metamorphism mineralization occurred and formed deposits of iron and copper. Extensive hydrothermal alteration of the largest bodies of granitic rocks is lacking, but as pointed out earlier, most dikes, sills, and pipes are commonly altered, with common alteration products being sericite, chlorite, saussurite, biotite, and epidote. The presence of numerous acidic dikes and sills, as well as near-surface occurrences of contact metamorphic minerals such as epidote, garnet, and magnetite suggests that much of the area in the vicinity of Chesaw is underlain by granitic rocks, which are probably source rocks from which mineralized hydrothermal solutions originated.

MINERALIZATION

Although occurrences of metallic minerals can be found in many parts of the Myers Creek district, the most important occurrences appear to be in the Chesaw and Buckhorn Mountain areas of the northeast part of the district. In the Chesaw area quartz fissure veins predominate. Most veins are only sparsely mineralized with gold, silver, copper, lead and zinc; the ore minerals of these metals are almost always accompanied by pyrite and arsenopyrite. The veins are narrow and seldom exceed 2 feet in width. Most veins pinch and swell and cannot be followed for much more than several hundred feet along their strikes. Of the many veins subjected to exploratory and development work, only the Butcher Boy, Reco, Gray Eagle, and Poland China veins contained minable amounts of gold. Most gold occurred only near the surface and was confined to small shoots assaying up to 17 ounces per ton in gold. Excluding high-grade ore, the average gold content of veins was only around 0.25 ounce per ton.

The Reco, Gray Eagle, Butcher Boy, and Ben Harrison mines lie within the Gray Eagle-Ben Harrison gold belt. The belt is about half of a mile wide and 1½ miles long. It trends northeast and is bounded on the northwest and southeast by steeply dipping, northeasterly trending faults. Within this fault block, Triassic or Permian greenstones of the Kobau Formation predominate and are intruded by small dikes and pipes of Mesozoic hydrothermally altered quartz porphyry and plagioclase porphyry. Because of favorable geology, the presence of gold-bearing quartz veins, and anomalous concentrations of gold and arsenic in soil samples from parts of the gold belt, the area appears favorable for the discovery of new veins.

In the Chesaw area, Cretaceous granitic intrusive rocks in Permian or Triassic metasedimentary rocks provide contact metamorphic environments for mineral occurrences; however, only at the Strawberry Lake prospect is such an occurrence exposed. At this property massive magnetite and sparsely disseminated scheelite occur over an area of several thousand square feet.

In the Buckhorn Mountain area 3 miles northeast of Chesaw, contact metamorphic deposits predominate. The deposits occur in a persistent tactite zone between Permian metasedimentary rocks and Mesozoic granodiorite. Magnetite is the predominate mineral, whereas copper and gold are minor and scheelite is sparse. At the Neutral and Roosevelt mines, bodies of massive magnetite have yielded around 80,000 tons of ore and several million tons remain. Small shipments of copper and gold ore have in the past been made from the Gold Axe, Western Star, Caribou, and Roosevelt mines. The ore came mainly from garnet-epidote skarn bodies within the tactite zone. Although at most of these copper-gold deposits the ore minerals are disseminated in the skarn, core drilling at the Caribou, Aztec, and

Neutral mines disclosed that chalcopyrite also occurs as solid veins up to several inches thick, with little or no gangue minerals; however, magnetite is almost always present as thin veinlets or disseminations. Copper mineralization also persists to depths in excess of 3,000 feet, as was shown by recent diamond core drilling to a maximum depth of 3,300 feet (Marion Bumgardner, oral communication). On the southern end of Buckhorn Mountain at the Crystal Butte mine, quartz fissure veins contain minor amounts of gold, silver, copper, lead, and zinc. Past mining operations have shown that the veins tend to be narrow and pinch and swell along their strikes and dips; the ore is arsenical, as is the case with most gold-bearing veins of the Myers Creek district.

In the Bi-Metallic Mountain area of the Myers Creek district definite quartz viens and contact metamorphic deposits do not appear to be present. At the Bi-Metallic mine, copper and molybdenum minerals occur along several shear zones in hydrothermally altered Mesozoic granitic rocks. The ore minerals are disseminated in the sheared and altered rock and form small discontinuous ore shoots.

CHESAW AREA

Most mineral occurrences of this area are north and northwest of Chesaw (see fig. 11). For the most part they lie within the rolling upland area bordered on the west by the North Fork of Mary Ann Creek and on the east by Myers Creek. It was in this area that the first mineral discoveries of the district were made in the spring of 1896, and where much mining activity took place following the discovery of gold-bearing quartz veins. From 1896 to 1900, the area underwent discovery and development; 1900 to 1918, and 1933 through 1940, were productive years, when mines of the area produced minor gold and silver. Leading producing mines were the Reco, Poland China, Gray Eagle, Ben Harrison, Butcher Boy, and Mary Ann Creek placers. In the years following 1940, very little mining was carried out in the Chesaw area. Futile attempts were made in the 1950's to mine and mill near-surface high-grade gold deposits at the Reco and Gray Eagle mines, and small-scale placer mining operations were undertaken sporadically on Mary Ann Creek. Although several

Figure 13.—Chesaw in center of photo and Ben Harrison mine in lower right. Looking southeast with southwestern end of Buckhorn Mountain at upper left.

mines and prospects in the area have received cursory examinations over the past 25 years from mining companies, they never have followed through with more extensive exploration programs.

Currently (1979), all mining properties are idle. The following discussion of mines and prospects of the Chesaw area covers only properties from which ore was shipped, or properties upon which a reasonable amount of exploration and development work was done. As can be seen in figure 11, this includes only 12 properties.

Ben Harrison (Apex)

The Ben Harrison mine, which is also known as the Apex, is about 0.5 mile north-northwest of Chesaw and in the SE¼NE¼ sec. 20, T. 40 N., R. 30 E., at an elevation of 3,120 feet (see fig. 11). The mine can be reached by way of an unimproved road from the farm of Bill Byers, Jr., which is 0.4 mile northwest of Chesaw. The Ben Harrison claim is one of four patented mining claims (Mineral Survey 1160), Appendix B-1. Other claims of the group are the Ready Peay, Contact, and Gladiator.

In the early 1900's, much work was done at the property by several mining companies, among which were the British Columbia Copper Co., Ben Harrison Gold & Copper Mining Co., and Apex Gold Mining Co. At this time several crosscut adits were driven, and a 286-foot shaft was sunk on the vein. At the north edge of the settlement of Chesaw, a 10-ton concentrating mill was erected to treat gold-copper ore from the mine, but insufficient ore was found to place the mine and mill into production.

Currently (1979), all underground mine workings are caved and inaccessible, but a description of the Ben Harrison vein is given by Umpleby (1911, p. 49). According to him (Umpleby), the vein varies in width, but is as much as 6 feet wide. It consists of gray quartz, fractures of which are filled with fine-grained pyrite and chalcopyrite, that is accompanied by occasional grains of galena and sphalerite. Most gold appears to be tied up in the chalcopyrite, and the silver is contained chiefly in the galena. Hand-sorted ore contained up to 2 ounces per ton in gold.

The vein strikes N. 30° E., and is steeply dipping. Host rocks for the vein are greenstone, quartzite, and magnesite of the Kobau Formation. The magnesite crops out as a conspicuous north-trending, rusty-colored ledge; several open cuts and prospect pits have been dug on the north end of the ledge near the mine shaft. The 286-foot shaft was sunk on a decline of 55° S. At the bottom of the shaft, short drifts extend east and west, and a short crosscut extends south. In addition to the main shaft, two other shafts and two adits are east and at lower elevations on the hillside than the main shaft. No vein material containing ore minerals was noted on the dumps of these workings by the writer.

Butcher Boy

The Butcher Boy mine is 0.85 mile north of Chesaw and in the N½NW¼ sec. 21, T. 40 N., R. 30 E. on public domain (fig. 11). The main adit is about 175 feet west of and about 30 feet higher in elevation than the county road that adjoins the property on the east. From 1906 to 1908, the mine was operated by the Butcher Boy Gold Mining Co., at which time several carloads of high-grade gold ore were shipped to smelters in British Columbia. The peak production year was 1907, when 11 carloads of gold ore were shipped. A carload of ore shipped in 1908, averaged 4 ounces per ton in gold. Operations at the mine ceased in 1909, when a cloudburst filled the mine shaft and stopes with water and surface debris. In 1911, Umpleby (p. 49-50) described the geology of the mine, but made no mention of it being active. In 1938, Jim Miller of Chesaw attempted to clean out the debris-filled stope where most high-grade gold ore was mined, but it is not known if he succeeded.

The Butcher Boy vein is a quartz fissure vein in greenstone of the Kobau Formation. It varies in width from less than 1 inch, to as much as 6 feet; it strikes N. 50° W., and dips 74° NE. The vein quartz is white to cream, and contains fine- to coarse-grained pyrite, pyrrhotite, sphalerite, and galena. Pyrite and pyrrhotite are common, sphalerite is sparse, and galena is rare. Gold is seldom visible, except when high-grade ore shoots are encountered. The gold for the most part appears to favor pyrite-rich parts of the vein, which contained as much as 5 ounces per ton in gold (Umpleby, 1911, p. 50). According to Huntting (1956, p. 137), the vein in the adit assayed 0.35 to 0.75 ounce per ton in gold and 0.77 ounce per ton in silver.

Development work at the mine consists of a 326-foot adit that has been driven west 156 feet and then northwest another 170 feet (fig. 14); only in the last 100 feet of the adit is the vein exposed. Near the face of the adit the vein is offset to the north about 6 feet. About 150 feet west of the adit portal and 50 feet higher in elevation is the shaft where high-grade gold ore was mined in the early 1900's. The shaft does not connect with the adit, but is reported to contain a stope 6 feet wide, 60 feet high, and 60 feet long, from a working level 35 feet below the collar of the shaft.

Delate

This property is about half of a mile east of Strawberry Lake in the SE¼SE¼ sec. 8, T. 40 N., R. 30 E., at an elevation of about 4,200 feet (fig. 11). It is

one of a group of six patented claims owned and operated by Interstate Mining in the early 1900's. Several adits and shafts on the claim suggest as much as 300 feet of underground mine workings, but it appears that the property never reached the production stage. Apparently no work has been done on the claim for over 50 years.

The adits and shafts are on a persistent northeasterly trending shear zone in quartzite and metasiltstone of the Kobau Formation. Vein material on dumps of adits and shafts suggests that quartz and calcite occur as narrow fillings in fractures and fissures, rather than well-defined veins. Some quartz and calcite contains minor to sparse pyrite, bornite, galena, and sphalerite.

The main Delate adit is caved at its portal; the adit as shown on Mineral Survey 646 is 150 feet long. It heads N. 20° E., for 70 feet, then N. 50° W., for an additional 80 feet. About 70 feet from the portal, the adit intersects a 12- to 15-inch-wide quartz vein that strikes N. 60° E. and is vertical. The vein has been drifted upon in an easterly direction for 75 feet, at which point a raise extends to the surface. The quartz vein is iron stained and contains minor galena and pyrite. About 250 feet from the adit and at a bearing of N. 65° W., a shaft about 50 feet deep has been sunk on a bull quartz vein in granodiorite. Except for sparse pyrite, no ore minerals are present.

Gray Eagle (Eagle)

The Gray Eagle mine is near the center sec. 16, T. 40 N., R. 30 E., at elevations of 2,880 to 3,200 feet (see fig. 11). It is immediately north of the Reco mine and is on the Gray Eagle patented claim (Mineral Survey 884). It is one of three contiguous patented claims, the others of which are Bird and Review of Mineral Survey 558 (see fig. 17).

The Gray Eagle claim was staked in 1897, on a quartz vein containing visible grains and stringers of native gold. Small-scale mining operations were carried out on near-surface, high-grade parts of the vein, but insufficient ore was found to make the mine a major gold producer of the Chesaw area. Minor production occurred in 1916, 1921 to 1924, 1937 to 1939, and in 1950 and 1951. The dollar value of mine production is not reported, but is probably not much

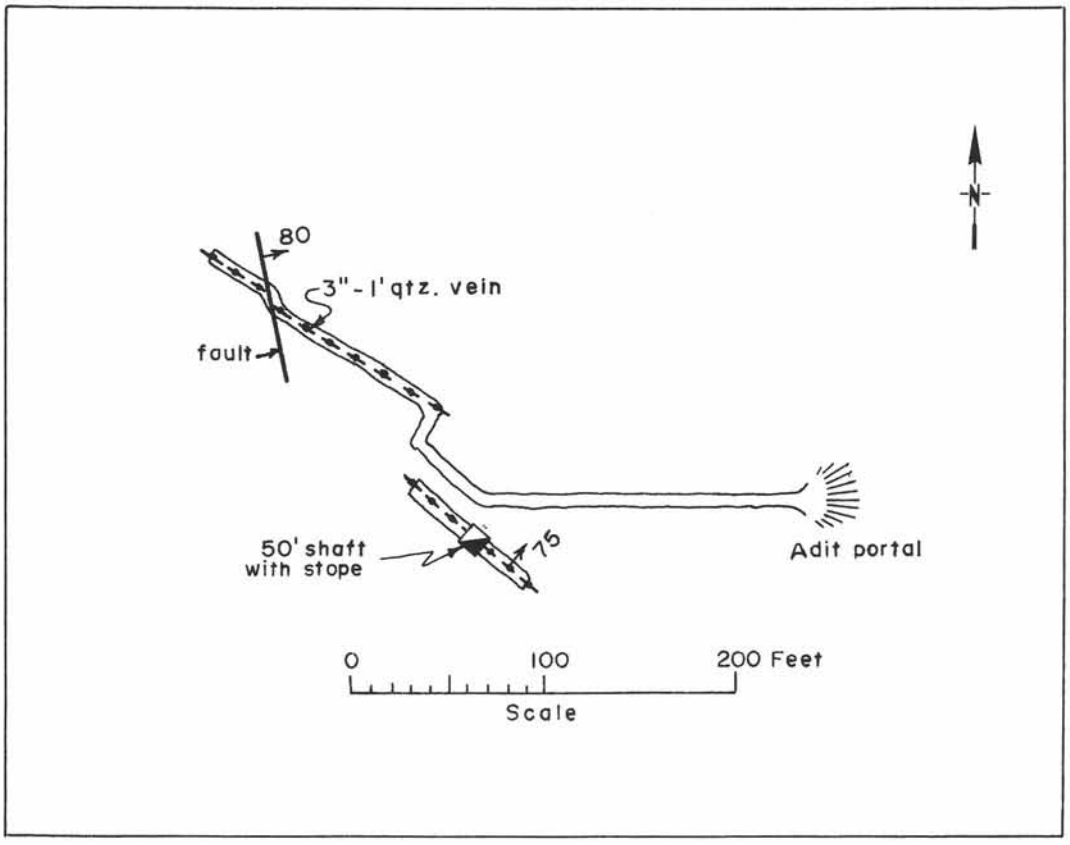


Figure 14.—Butcher Boy adit.

more than $50,000. It appears that most mining was by pick and shovel and wheelbarrow; in some veins the gold content was high enough to mine only 0.5-inch wide stringers.

Mining on the Gray Eagle claim appears to have been carried out on two widely separated veins. In the southeast corner of the claim, that part of the Reco vein that extends northward on the Gray Eagle has been mined along its outcrop for about 100 feet (see fig. 17). The vein has also been stoped from the north drift in the No. 2 adit of the Reco mine. The vein is described in the discussion of the Reco mine and is essentially a north-striking, westerly dipping quartz fissure vein. The vein was mined strictly for its gold content; minor silver accompanied the gold. In 1950 and 1951, a small amalgamation mill was built on the hillside below the outcrop of the vein to extract free-milling gold. Only 8 tons of ore containing 4 ounces of gold and 4 ounces of silver was mined and milled.

In the southwest corner of the Gray Eagle claim, and about 650 feet west of the Reco adits, mining was apparently undertaken on another gold-bearing quartz vein. At this site, an adit heads N. 80° W. into hydrothermally altered granitic rocks, greenstone, and metasiltstone. The adit is caved at its portal, but is reported to be about 70 feet long, with 35 feet of crosscuts. Vein material on the dump of the adit consists of iron-oxide-stained quartz and calcite, both of which contain sparse pyrite. The quartz and calcite occur as stringers and veins 0.5 to 6 inches wide in sheared and brecciated rock. Judging from the size of the mine workings, probably not much more than 100 tons of gold ore was mined at this site.

Olentangy

This property is 0.25 mile southwest of Strawberry Lake and in the SE¼SE¼ sec. 7, and NE¼NE¼ sec. 18, T. 40 N., R. 30 E., at an elevation of about 3,960 feet (see fig. 11). The Olentangy group consists of four contiguous patented mining claims: Colon, Denhor, Korea, and Manchuria lodes (Mineral Survey 832). From 1906 to 1915, the property was under development by Olentangy Mining Co., which explored several mineralized outcrops by sinking shafts and digging prospect pits. The main shaft was sunk to a depth of 160 feet, with drifts on the 100- to 150-foot levels. Insufficient mineralization was encountered to justify mining operations, and apparently no work has been done on the property since the early 1900's.

Most development work was done near the northeast end of the Colon claim, site of the 160-foot vertical shaft. The shaft was sunk on brecciated quartzite, limestone, and metasiltstone of the Kobau Formation; the breccia appears to be associated with a northerly trending near-vertical fault zone. Quartz stringers in the breccia, as well as parts of the breccia, are sparsely mineralized with fine-grained pyrite, arsenopyrite, chalcopyrite, galena, and sphalerite (Umpleby, 1911, p. 51-52). Except for fine-grained pyrite, no ore minerals were noted by the writer in outcrops and dump material.

The presence of quartz porphyry and granodiorite in dump material of the main shaft indicates that intrusive granitic rocks underlie parts of the Olentangy group. These intrusive rocks could represent source rocks for mineralizing agents and possibly contain contact metamorphic mineral deposits, as is the case of the Strawberry Lake iron deposit, which is 0.25 mile north of the Olentangy claims.

Ophir

The Ophir prospect is in the NE¼NW¼ sec. 17, T. 40 N., R. 30 E., and about 0.25 mile southeast of Strawberry Lake (see fig. 11). An unimproved dirt road from Chesaw to the lake passes within 200 feet of the property, which is in the southwest corner of the patented Ophir claim (Mineral Survey 1169). The prospect appears to have been abandoned for many years, with no indications of recent work.

The main workings appear to be a shaft that was sunk on a 1- to 18-inch-wide quartz vein that strikes N. 20° E., and dips 70° SE. The vein is moderately brecciated and iron oxide stained, and occurs in a small quartz porphyry intrusion. Ore minerals of the vein consist of minor galena, bornite, and pyrite which fill fractures in the quartz. The vein occurs along a persistent shear zone, but because of its lenticular nature, the vein cannot be followed for distances much over 50 feet along its strike. Several prospect pits and trenches have been dug along the shear zone in an attempt to follow the vein, but in most pits and cuts only narrow quartz stringers are exposed.

Poland China

The Poland China mine is in the SE¼SE¼ sec. 11, T. 40 N., R. 29 E., which is about 4 miles northwest of Chesaw (see fig. 11). Near the Chesaw-Molson road crossing of the North Fork of Mary Ann Creek a dirt road can be followed 0.4 mile north to several old buildings at the site of the mine. The property is covered by seven patented mining claims of Mineral Survey 1039 (see Appendix B-2).

The initial discovery of a gold-bearing vein was made in 1896 when flakes of gold were discovered at grass-root depths; subsequent digging led to the discovery of the vein. Development work was

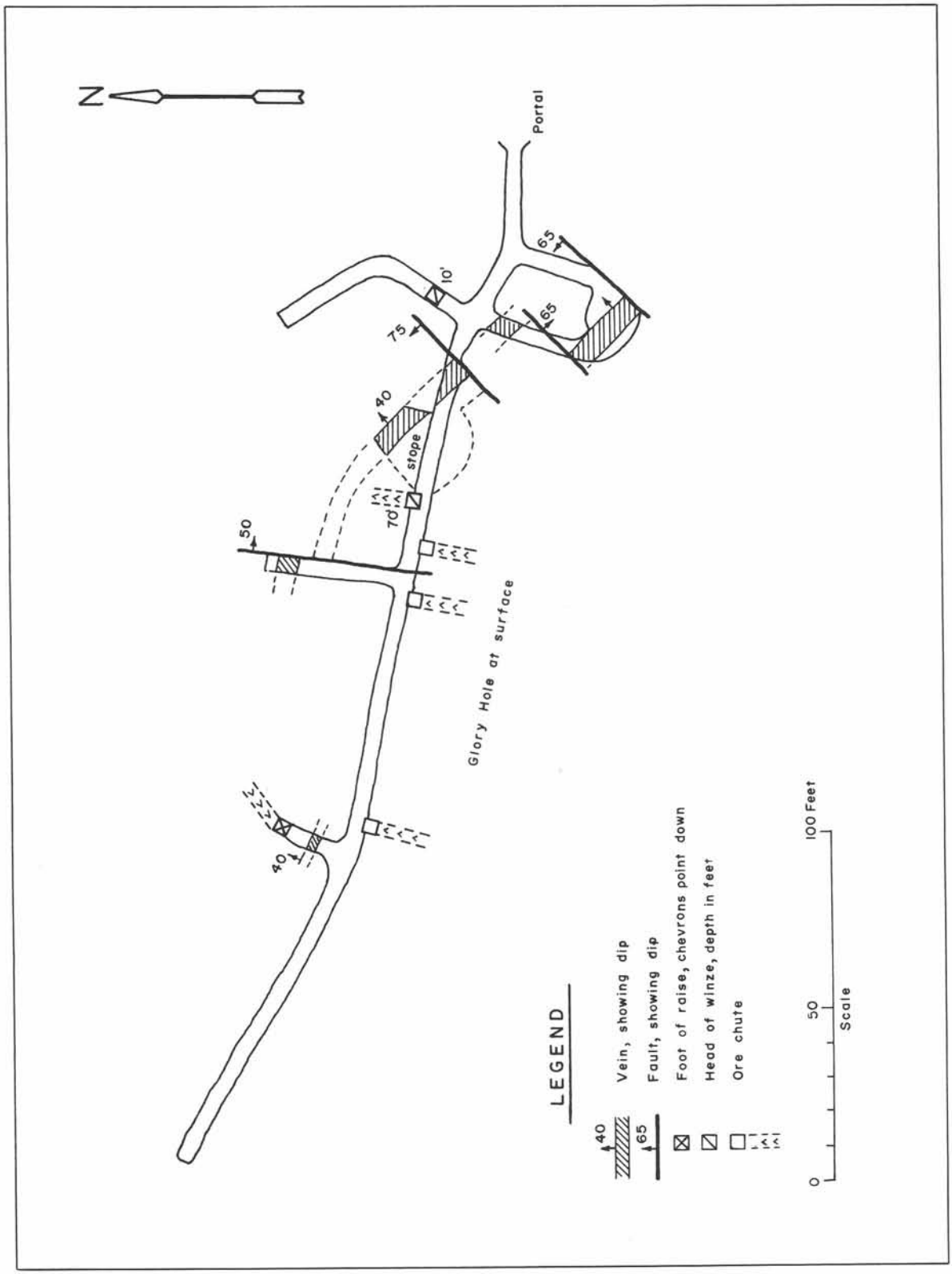


Figure 15.—Poland China adit.

undertaken soon after the discovery of the vein, but it was not until 1907 that an attempt was made to place the mine into production. At this time Molson Gold Mining Co. erected a 25-ton mill consisting of six Nisson stamps, two Wilfley tables, and a barrel amalgamator, all of which were powered by a Fairbank-Morse horizontal steam engine. Other than milling tests on the ore, and a small shipment in 1914, the mine failed to become productive. In 1932, the mine was taken over by Overtop Mining Co. and in 1933 and 1934, a total of 168 tons of concentrate containing 72 ounces of gold and 70 ounces of silver were shipped to a smelter. Milling of the ore proved to be impractical and operations ceased. In 1937, operations resumed, and from 1937 through 1939, a total of 11 carloads of siliceous ore assaying 0.37 ounce per ton in gold were shipped to the Trail smelter in British Columbia. However, mining of the low-grade ore was unprofitable and mining ceased. Since 1939, the property has been idle.

The Poland China vein is a quartz fissure vein in graphitic argillite of the Spectacle Formation (Permian). The vein varies from 2 to 15 feet in width and has an average width of about 7 feet. The general strike of the vein is northwest and its dip is 40° NE. It is white to black in color, and in places contains fragments of argillite wall rock. Most parts of the vein contain well-defined walls, but in several places the vein gradually grades into argillite. Parts of the vein are offset as much as 15 feet by persistent north- and northeast-trending, high-angle faults (fig. 15). Ore minerals of the vein are pyrite, marcasite, and galena, which are moderately to sparsely disseminated in the quartz. In parts of the vein, ore minerals are concentrated into poorly defined ore shoots, but the distribution of ore shoots is sporadic. Although near-surface parts of the vein contained some visible native gold, at deeper depths gold is not visible and occurs chiefly as micron-size particles in pyrite. High-grade near-surface ore contained 0.15 to 30

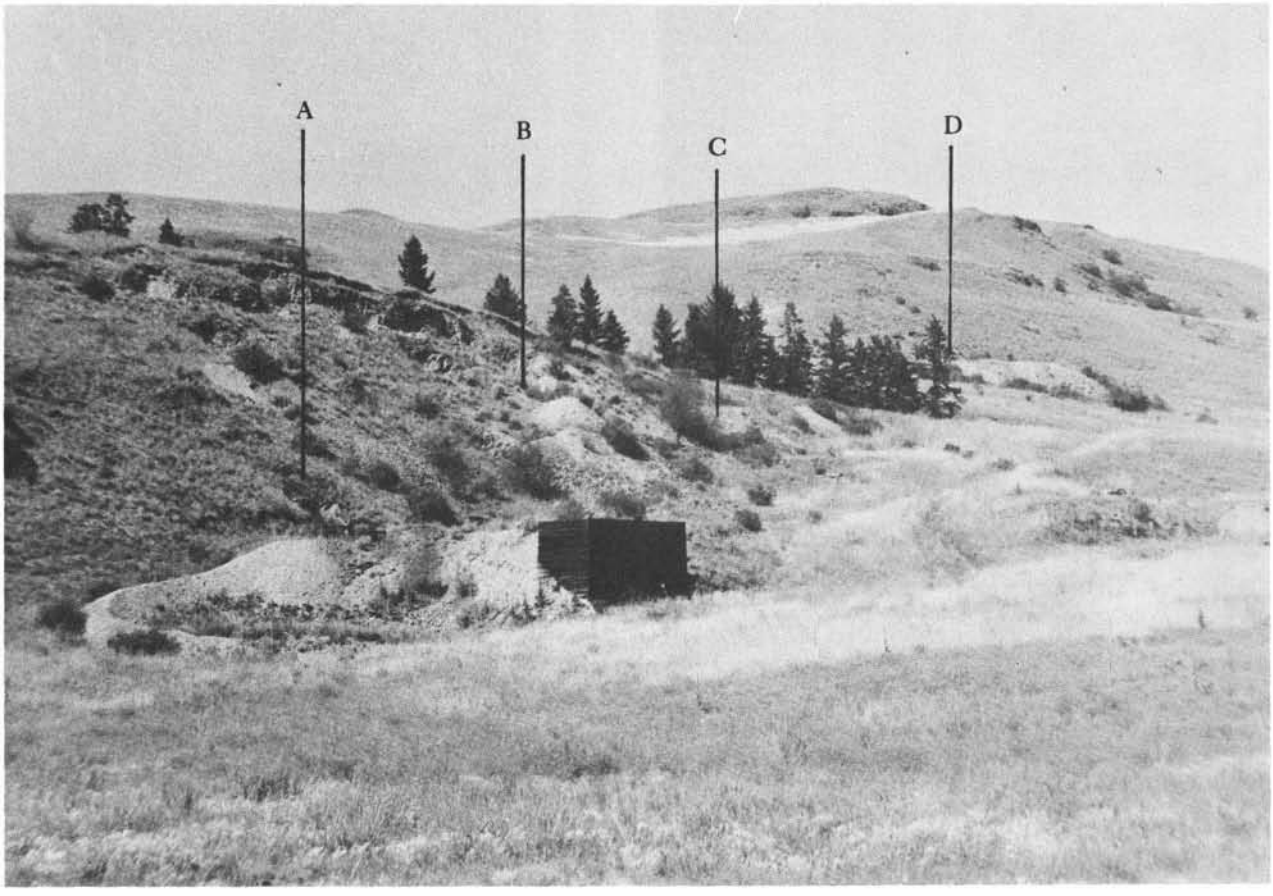


Figure 16.—Reco-Gray Eagle mine workings. Reco adit at A and B; Gray Eagle adit at C; Review adit at D.

ounces per ton in gold; ore that was mined averaged only 0.24 ounce in gold and 0.40 ounce in silver per ton. According to Ray Dart (former president of Overtop Mining Co., now deceased), some wall rock contained from 0.018 to 0.06 ounce per ton in gold.

Development work at the Poland China consists of over 1,500 feet of adits, shafts, and crosscuts, as well as one glory hole. The main adit (fig. 15) was driven at a general heading of west-northwest for around 310 feet. The first part of the adit does not follow the vein but encounters it 75 feet from the portal. The vein is also exposed in three crosscuts, two of which were driven south near the portal, and one of which was driven north from the adit, 135 feet from the portal. About 110 feet from a portal a winze has been sunk to a depth of about 70 feet below the adit level. About midway in the adit, several ore chutes extend upward to the glory hole at the surface. Ore that was mined appears to have come chiefly from a stoped area 65 to 100 feet from the portal.

Reco

The Reco mine is 1.25 miles north of Chesaw, and in the center S½ sec. 16, T. 40 N., R. 30 E., at an elevation of 2,880 feet (see fig. 11). The main adits are about 350 feet west of the county road, and the adit dumps, as well as other mine workings, are plainly visible from the road (figs. 16 and 17). The Reco claim, which was staked in 1897 and patented in 1940 (M.S. 1234), is owned by Reco Mining Co. The property has also been called the Reco-Gray Eagle because the Reco vein extends northward onto the patented Gray Eagle claim. During the first several years after discovery, high-grade free-milling gold ore was mined from near-surface parts of the vein and shipped to smelters in British Columbia. Eventually several crosscut adits were driven to intersect the vein at greater depths; however, at depths greater than 40 feet beneath the surface, the gold and silver content of the vein diminished to the point where

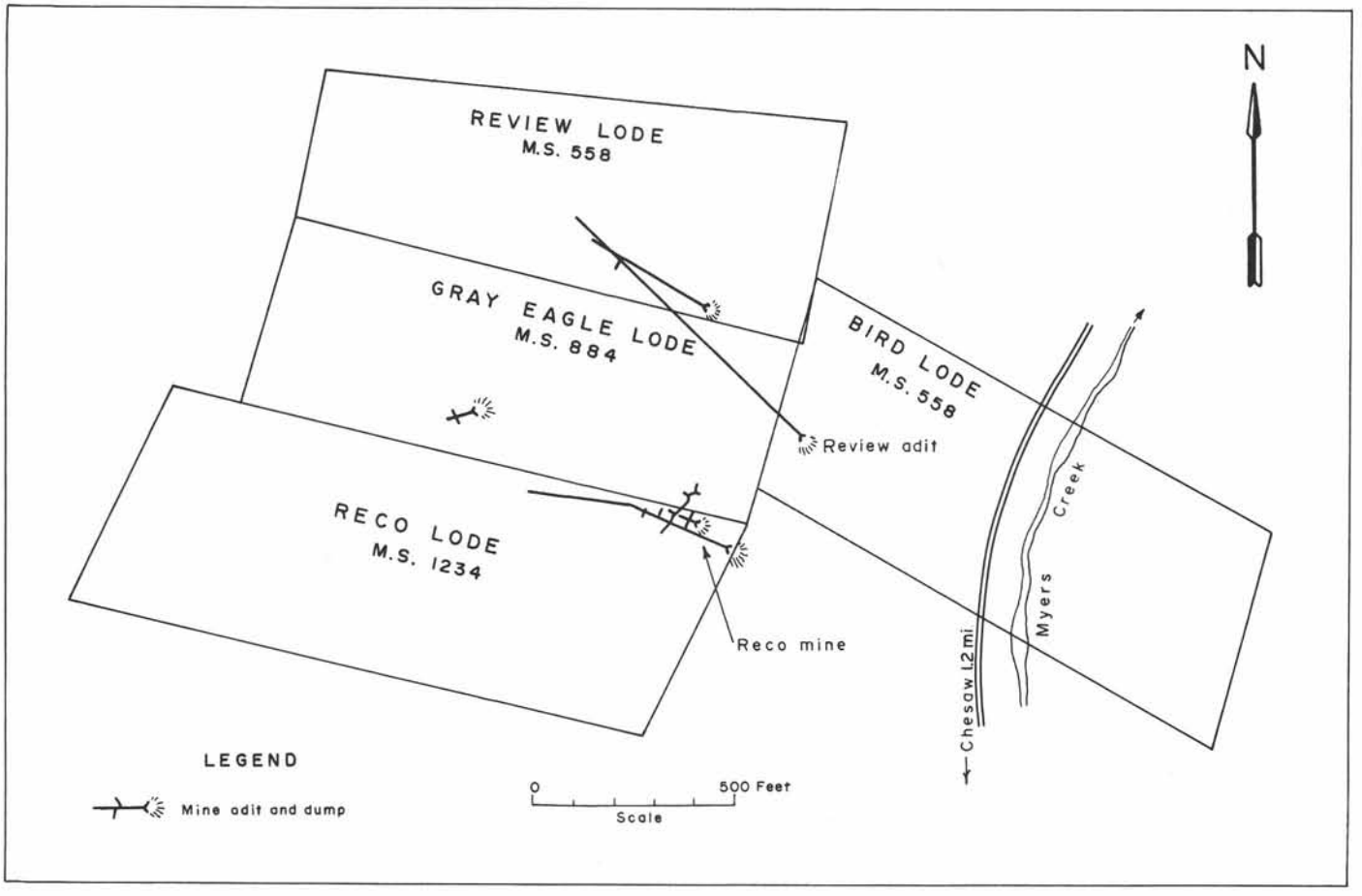


Figure 17.—Claim map for Reco, Gray Eagle, Review, and Bird claims.

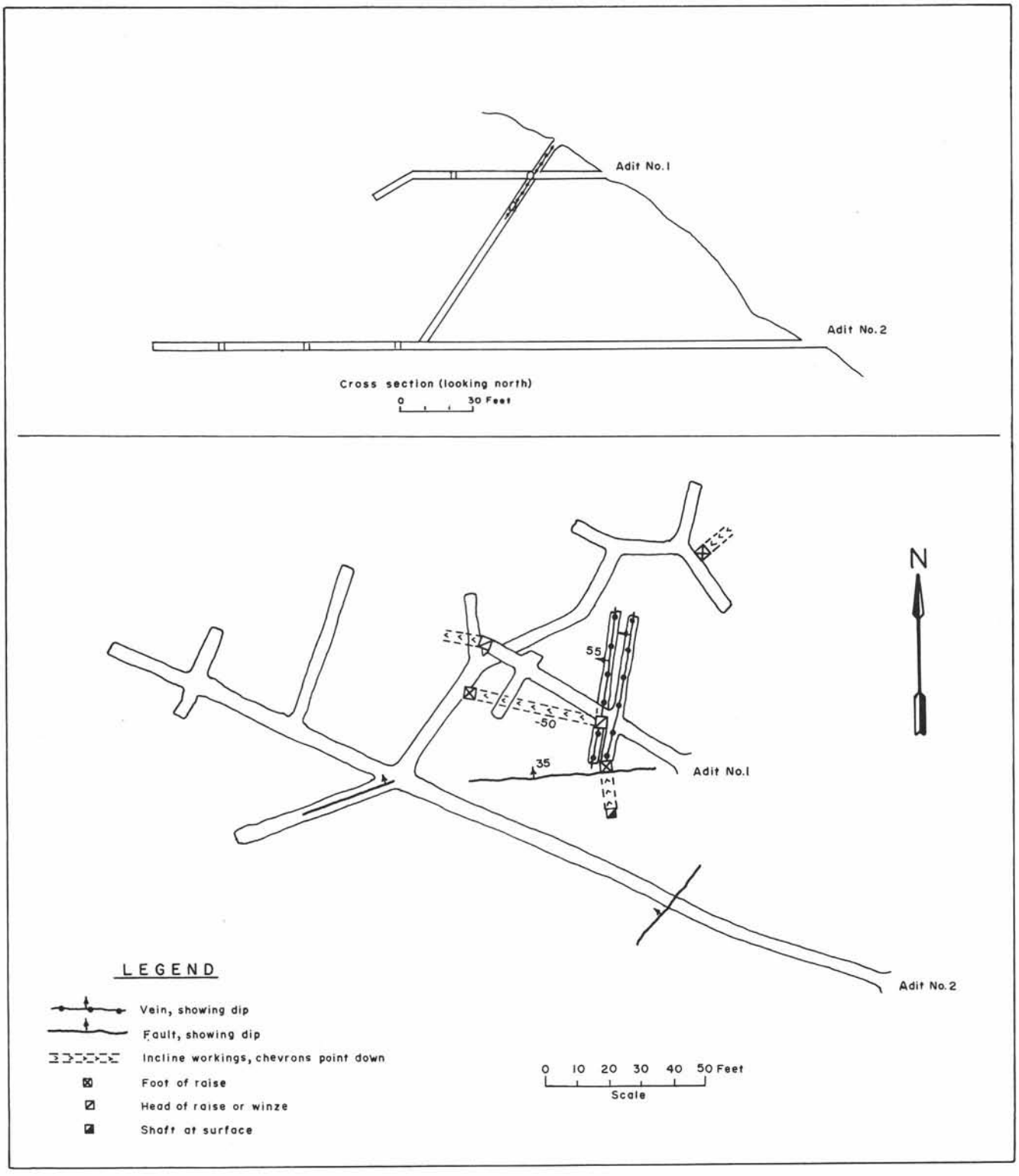


Figure 18.—Reco mine workings.

mining became unprofitable. The bulk of the work undertaken at the mine appears to have been from 1897 to 1900, and sporadically from 1916 to 1953 at which time the mine produced 1,015 tons of ore valued at about $23,000 in gold, and only $365 in silver. This ore contained a total of 887 ounces in gold and 655 ounces of silver. Judging from the size of the mine workings it is doubtful that much more than a total of 1,500 tons of ore was mined from 1897 to 1953. During this interval the most active mining companies were the Reco Mining and Milling Co., and the Reco Gold Mining Co. Since 1953, the mine has been idle, and nothing in the way of mining and milling equipment remains at the property.

Country rock in the vicinity of the mine consists of greenstone, quartzite, and metasiltstone of the Kobau Formation (Permian or Triassic) which is intruded by Mesozoic granitic rocks. The Reco vein strikes roughly north, dips 50° to 70° W., and is 1 to 2 feet wide; based on prospect pits along the outcrop of the vein it cropped out for about 80 feet along its strike. The vein consists of quartz and minor calcite and is sheared and fractured because of recurrent movement along the vein. Ore minerals of the vein are sparse, and consist of fine-grained pyrite, arsenopyrite, bornite, and chalcopyrite. The ore minerals occur as disseminated grains, small blebs, and as thin dark bands in the quartz. Much native gold was visible in high-grade ore mined near the surface, but in deeper parts of the vein gold was rarely visible. The gold-rich parts of the vein were stoped from the surface to a depth of about 30 feet before the vein terminated against a northerly dipping fault. Because of this fault, not much more than 50 feet of the vein is on the Reco claim; the bulk of the vein appears to be on the Gray Eagle claim, which adjoins the Reco claim to the north. The faulted-off segment of the vein is not exposed elsewhere in the mine.

The gold content of the vein varies considerably. Assays of the vein ranged from as low as 0.04 ounce per ton in gold, to as high as 16.8 ounces. Ore mined to date (1979) averaged about 0.87 ounce per ton in gold, and most ore was hand sorted.

Development work at the Reco mine consists of several prospect pits, trenches, short adits, and two main adits (figs. 17 and 18). The No. 2 adit, which is about 10 feet above the valley floor, was driven N. 80° W. for 265 feet. A total of 340 feet of crosscuts were driven north and south in an attempt to intersect the vein, but it was never found. The longest crosscut of Adit No. 2 was driven in a northerly direction for 148 feet onto the Gray Eagle claim without encountering the vein. It appears that the No. 2 adit and its crosscuts are beneath the fault that cuts off the downward extension of the vein. About 35 feet north in the main north crosscut, a raise extends upward for 60 feet to an intermediate level, and 15 feet beyond the intermediate level the raise intersects the No. 2 adit.

No. 1 adit is about 40 feet north of and 55 feet higher in elevation than No. 3. It heads N. 75° W. for 75 feet before intersecting the vein; about 50 feet beyond the vein the adit ends and at this site a 20-foot winze has been sunk. At the intersection of the vein in the No. 2 adit the vein has been drifted upon in a southerly direction for 15 feet, at which point it terminated against a northerly dipping, low-angle fault. The vein was also drifted upon to the north for about 40 feet, and stoped overhead in places to the surface. Most stoping in the mine appears to have been done from the No. 2 adit level to the surface. Also, the richest parts of the outcrop of the vein appears to have been mined from the surface.

Review

This property is immediately north of the Gray Eagle mine. The Review lode (Mineral Survey 558) and the Gray Eagle lode (Mineral Survey 884) share a common side line (see figs. 11 and 17). A county road lies 700 feet east of the property, which is readily accessible from the Reco and Gray Eagle properties to the south. The Review claim was one of the first mining claims in the Chesaw district to be surveyed for patent (1899). In 1901, the property was under Review Gold Mining Co. management; adits 360 feet and 813 feet in length were driven into the hillside to intersect a gold-bearing vein at depth. According to Landes and others (1902, p. 27), a smelter test, consisting of 50 tons of ore, averaged 0.86 ounce per ton in gold; however, no records can be found showing any production from the property. Except for minor rehabilitation work of the portal of the longest adit, no work appears to have been undertaken at the property for many years.

The dumps of two adits are plainly visible; however, both adits are caved at their portals. The longest adit (813 feet), which is also the lowest adit, was driven at a heading of N. 45° W. into sheared greenstone. This adit portal is on the Bird claim, passes through the northeast corner of the Gray Eagle claim, and terminates on the Review claim (fig. 17). About 250 feet, at a bearing of N. 35° W. from this adit, and 70 feet higher in elevation, another adit was driven 360 feet at a heading of N. 60° W. The iron-stained dump of this adit is plainly visible on a barren hillside (fig. 16); this adit also is caved at its portal. According to Landes and others (1902, p. 27), the adits were driven on a vein, which consists of quartz and calcite with minor chalcopyrite, pyrite, and gold.

Strawberry Lake

The Strawberry Lake magnetite deposit is 0.25 mile west of Strawberry Lake in the SE¼ sec. 7, T. 40 N., R. 30 E., at an elevation of about 4,000 feet (see fig. 11). In the 1930's, development work consisting of several shallow prospect shafts and open cuts was undertaken, but no shipments of magnetite were made. In 1944, W. A. Broughton examined the property during an investigation of magnetite deposits in Stevens and Okanogan Counties. Broughton (1945, p. 22-24) reports argillaceous quartzite and siliceous limestone of Triassic or Permian age contain disseminated and high-grade bodies of magnetite. A central core 70 feet long and 50 feet wide contains about 80 percent magnetite, the core grades out into country rock that contains only scattered grains of magnetite. The magnetite is accompanied by minor pyrite and sparse fine-grained garnet and scheelite. A shaft was sunk to a depth of 10 feet on the central core of high-grade magnetite without passing through the magnetite. It is estimated that the core contains at least 4,500 tons of magnetite. According to Broughton (1945, p. 23), detailed magnetic data shows the deposit to be small and confined chiefly to the area where magnetite crops out.

Although granitic rocks do not crop out at the deposit, they are present nearby and could underlie the magnetite deposit at shallow depths. As such, contact metamorphic ore deposits may exist at contacts between granitic rocks and carbonaceous rocks. The presence of sparse scheelite in the iron deposit prompted Culver and Broughton to examine the property in 1944 (Culver and Broughton, 1945, p. 30). According to them, ore-grade scheelite is not present, but geologic conditions are extremely favorable for the occurrence of scheelite deposits. They observed occasional scheelite crystals up to a quarter of an inch across, and the crystals were most abundant along small fractures in limestone.

Yakima

This mine is about 0.4 mile north-northwest of Chesaw and about 500 feet north of the E¼ cor. sec. 20, T. 40 N., R. 30 E. (see fig. 11). The main adit of the mine can be reached by walking 300 feet east from the Ben Harrison shaft. The mine falls within the boundaries of the Yakima Lode (Mineral Survey 615) and was operated briefly from 1900 to 1915, by Yakima Gold Mining Co. and Yakima Mining and Milling Co. At this time one adit and several shafts were driven and sunk on ledges containing base and precious metals. Only in 1908 did the mine produce an unknown amount of ore.

According to Landes and others (1902, p. 27), chalcopyrite, galena, sphalerite, and pyrite occur as disseminated grains in serpentine over widths of several inches to 6 feet. In places the ore minerals form solid bands. The mineralized ledges in the serpentine strike east and dip 25° S. Other rocks on the property consist of greenstone, quartzite, and magnesite of the Kobau Formation.

All mine workings are caved at their collars and portals, but the extent of the underground work is shown on Mineral Survey Plat No. 615 of the Yakima Lode. The plat shows a 75-foot, northeasterly trending adit, a 185- and 145-foot shaft, and two 45-foot shafts, all of which contain short crosscuts.

BUCKHORN MOUNTAIN AREA

The Buckhorn Mountain area of the Myers Creek mining district centers about Buckhorn Mountain, which is 3 miles east of Chesaw (fig. 19). Initial mineral discoveries on the mountain were made in 1896, following discoveries in the Chesaw area. By 1900, claims had been staked on deposits of copper, gold, and silver, and several small shipments of high-grade ore were made to smelters in British Columbia. Among the early producing mines were the Roosevelt, Gold Axe, Western Star, and Caribou. Around 1908, large outcrops of magnetite were discovered on the northern slope of the mountain, and the area was soon covered by mining claims among which was the Neutral, site of the Magnetic iron mine. The presence of copper, gold, and silver on the mountain attracted the attention of the Granby Consolidated Mining, Smelting & Power Co. Ltd., which in 1911, core drilled the most promising occurrences, and also shipped around 12 carloads of copper-gold-silver ore from the Roosevelt mine on the eastern slope of Buckhorn Mountain. In 1918, mining of iron ore at the Magnetic and Roosevelt mines began, with the first shipments being made to Northwest Magnesite Co. at Chewelah. At different times up until 1950, shipments were made to Northwest Magnesite, as well as to west coast ports for ship ballast, and to Keokuk Electro-Metals Corp. at Rock Island for use in the manufacture of ferrosilicon. Mining of copper-gold-silver ore ceased in 1920, but with the increase in the price of gold in 1934, from $20 to $35 an ounce, small shipments of gold ore were made from the Gold Axe and Mother Lode properties until 1942.

Since 1950, when the production of iron ore ceased at the Magnetic mine, no mines have produced in the Buckhorn Mountain area. However, widespread occurrences of copper, gold, and silver, as well as several bodies of high-grade iron ore, have continued to attract mining companies. Geological, geophysical, and geochemical surveys have been undertaken, and

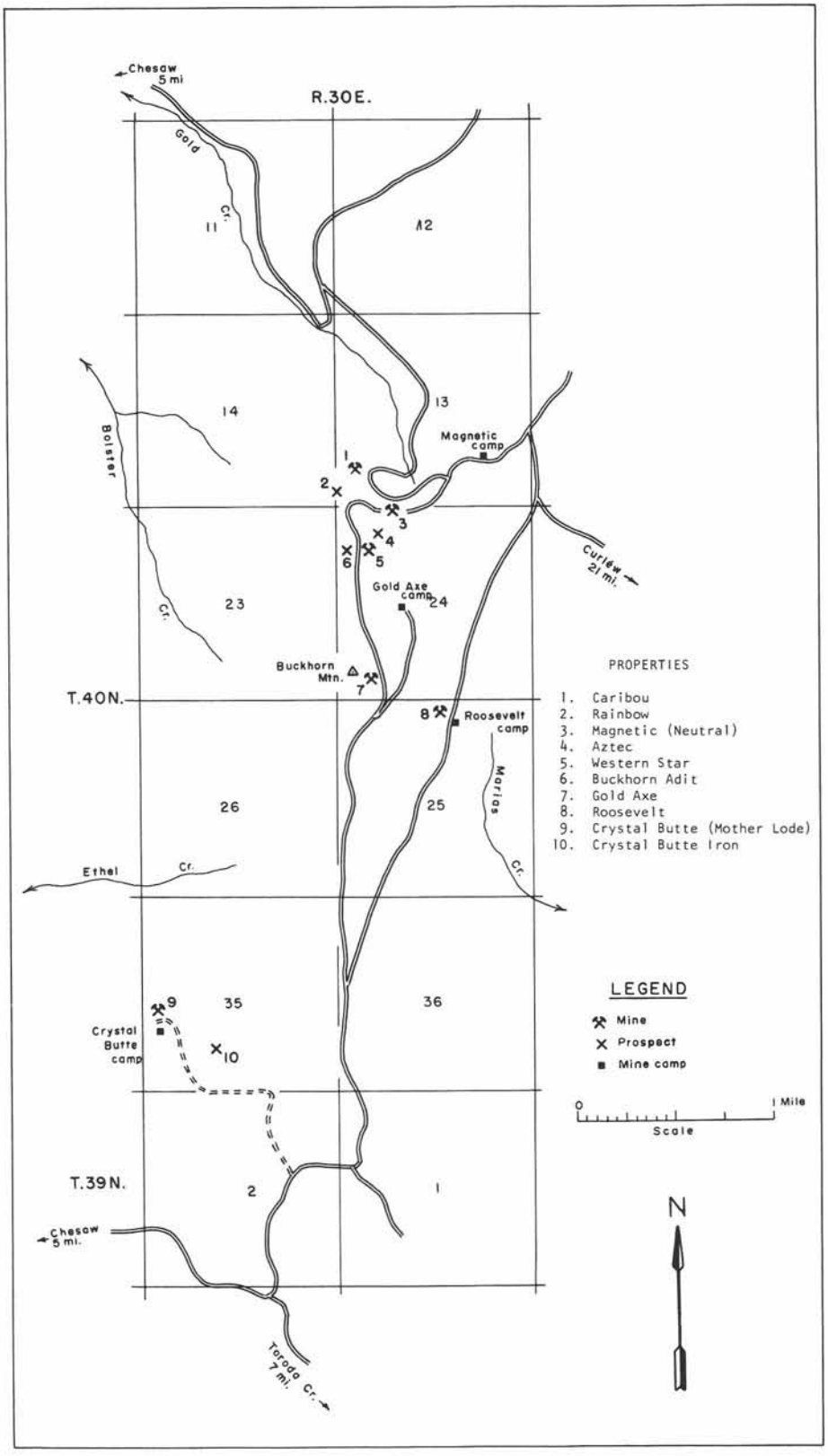


Figure 19.—Buckhorn Mountain mines and prospects.

many core holes have been drilled, but apparently ore bodies of sufficient size and grade to justify a profitable mining venture have yet to be discovered.

Almost all mining claims (27 patented and 68 unpatented) on Buckhorn Mountain have been owned since 1950 by Bumgardner Mining & Investments Co., of Manson, Washington.

The Buckhorn Mountain area is covered by several earlier reports, both published and private. Selected references at the end of this report lists most reports; the pertinent ones follow:

Broughton, W. A., 1943, The Buckhorn iron deposits of Okanogan County, Washington.

Yokota, Tokutaro; Tami, Hiroyuki, 1960, Survey report on Magnetic Mine.

Zapffe, Carl, 1949, A review of iron bearing deposits in Washington, Oregon, and Idaho.

Zoldok, S. W.; Cole, John W.; Dougherty, E. Y., 1947, Iron deposits of Buckhorn Mountain, Meyers Creek Mining District, Okanogan County, Washington.

Aztec

The Aztec claim is in the NE¼NW¼ sec. 24, T. 40 N., R. 30 E., and on the northern slope of Buckhorn Mountain at an elevation of 5,250 feet (see fig. 19). It is one of a group of unpatented mining claims held by Bumgardner Mining & Investments Co., of Manson, Washington. Slightly mineralized contact metamorphic rocks occur on most parts of the claim, but the most highly mineralized area is at the southwestern end of the claim which lies S. 30° W., 700 feet from the No. 1 pit of the Magnetic mine. At this locality several adits and shafts have been dug in garnet-epidote skarn containing massive pyrrhotite and magnetite that is accompanied by moderate amounts of pyrite and chalcopyrite. The pyrrhotite is best exposed in several open cuts; in the face of the uppermost cut an adit has been driven at a heading of S. 20° E. for about 80 feet into the hillside. The adit is mainly in magnetite, with intermixed pyrite and chalcopyrite. About 100 feet south of the adit a 354-foot vertical core hole drilled by Granby Consolidated Mining, Smelting & Power Co. Ltd. in 1911 intersected two 60-foot-wide iron ore bodies that contained 18.6 to 50.6 percent iron, 0.2 to 8.7 percent sulfur, and 11.8 to 25.6 percent silica (Huntting, 1956, p. 198). At the 119- to 324-foot interval in the hole assays of 1.4 to 4.9 percent copper were reported, the 4.9 percent copper being at the 318-320 foot interval. Apparently no mining has ever been done at this property.

Buckhorn Adit

This adit, which is the longest adit on the western slope of Buckhorn Mountain, is about 300 feet west of Western Star mine, and at an elevation of about 5,160 feet. The adit is on the Buckhorn claim (Mineral Survey 673) in the NW¼NW¼ sec. 24, T. 40 N., R. 30 E., and may be reached by way of an abandoned road that joins the upper Buckhorn Mountain road near the NW. cor., sec. 24 (figs. 19 and 20).

The adit heads S. 62° E. for 990 feet into the mountain and apparently was driven in the early 1900's to intersect at depth copper-gold mineralization that occurred at the Western Star mine, which is 140 feet higher in elevation than the adit. However, only sparsely disseminated pyrrhotite and chalcopyrite was encountered in the adit. The portal of the adit begins in granodiorite, but within a few feet it enters limestone and hornfels, which in places contains minor garnet and epidote, as well as sparsely disseminated grains of pyrrhotite and chalcopyrite. At 700 feet from the portal a crosscut heads southwesterly for about 25 feet along a garnetiferous zone containing small blebs and disseminations of chalcopyrite and pyrrhotite. About 766 feet from the portal the adit intersects a 1.5-foot-wide shear zone that strikes N. 35° E. and dips 56° NW. The shear zone contains coarsely crystalline calcite and has been stoped for 10 feet, to a height of 20 feet. No ore shoots are present in the adit, but the presence of several large fragments of intermixed chalcopyrite and pyrrhotite on the dump indicates that localized concentrations of ore minerals were encountered in the adit.

Caribou

The Caribou mine is in the SW¼SW¼ sec. 13, T. 40 N., R. 30 E., and at elevations of 4,700 to 4,800 feet (fig. 19). The property is about 1,800 feet northwest of the Magnetic mine, and can be reached by following a spur road west for 650 feet from the Gold Creek road (fig. 19). Between 1908 and 1916, the mine was operated by British Columbia Copper Co., and eight carloads of gold-silver-copper ore were shipped to smelters in British Columbia.

The area of the Caribou claim is underlain by quartzite and slate of upper Paleozoic age, which are part of a contact metamorphic suite of rocks that occur on Buckhorn Mountain. Within these rocks occur skarn and tactite zones containing disseminated pyrite, pyrrhotite, magnetite, and chalcopyrite. Most mineralized areas are conspicuous by the presence of reddish-brown iron-oxide staining and green malachite coatings on fracture surfaces.

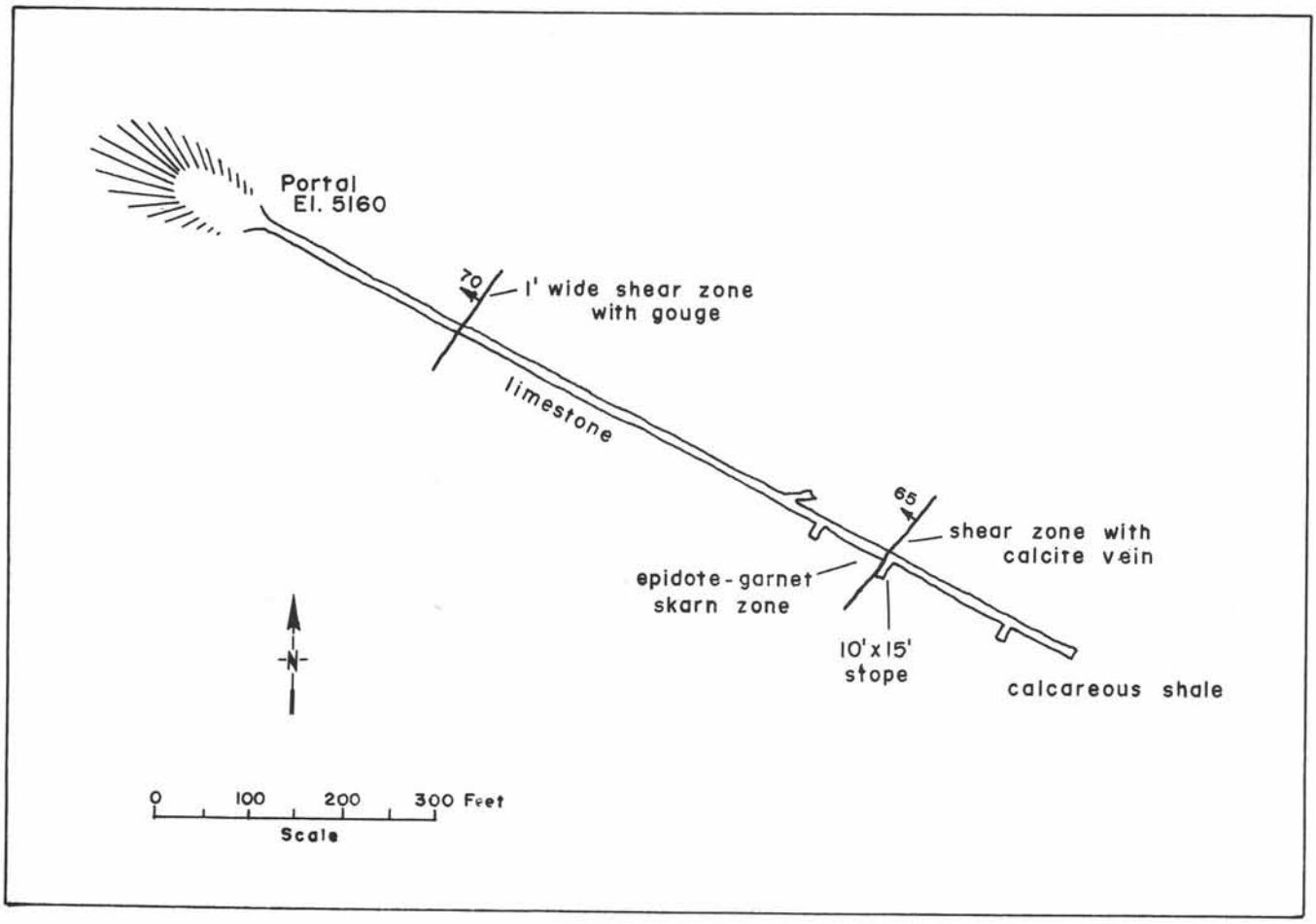


Figure 20.—Buckhorn adit.

Prospect pits, trenches, shafts, and adits have been sunk and driven on the most highly mineralized areas. One shaft is reported to be at least 100 feet deep, and two southerly trending adits are 80 and 90 feet long. Because the mineralization on the Caribou claim appears to be a northwesterly extension of ore bodies at the Magnetic mine, the mineralized areas on the Caribou have been core drilled on several occasions, the earliest of which was in 1911, by Granby. The Granby core hole was 250 feet deep and vertical. Between the surface and 112 feet the core assayed 0.2 to 4.3 percent copper, with 4.3 percent copper at 40 to 60 feet.

Crystal Butte (Mother Lode)

The Crystal Butte mine is in the W½ sec. 35, T. 40 N., R. 30 E., and on the southern slope of Buckhorn Mountain at a general elevation of about 4,800 feet (see fig. 19). From the Buckhorn Mountain lookout road near the center of sec. 2, T. 39 N., R. 30 E., the mine can be reached by following 1 mile of unimproved road, the last 0.5 mile of which has been abandoned. The property consists of five patented mining claims: Reckless, Battleship, Europia, Keystone Fraction, and Keystone Fraction No. 2 of Mineral Surveys 557 and 775A, which were surveyed in 1899 and 1904. Original development work, consisting of two long crosscut adits and several shallow prospect shafts, was done by Interstate Mining Co. between 1902 and 1906. In 1908, Crystal Butte Mining Co. acquired the property and built a small concentrating mill on the east bank of Myers Creek, about 0.75 miles south of Ethel Creek. No records show that the mill produced concentrates. In 1937, R. I. Hirst of Colville acquired the mine and carried out small-scale mining operations until 1941. From 1937 to 1941, several carloads of ore per year were shipped to the Trail smelter in British

Columbia, and to the Bunker Hill smelter in Idaho. A few shipments ran as high as 1 ounce per ton in gold, 33 ounces in silver, and 28 percent lead. Since 1941, the mine has been idle, but on several occasions it has been examined by interested parties.

Ore minerals at the Crystal Butte mine occur in quartz fissure veins in argillaceous limestone, argillite, and quartzite of the Spectacle Formation (Permian), as well as in intrusive quartz and plagioclase porphyries of Mesozoic age. In the main workings of the mine the quartz vein is 8 to 12 inches wide, strikes N. 15° to 80° E., and dips 10° to 35° NW. Persistent gouge zones occur along the hanging walls and footwalls of the vein, and faulting normal to the vein has resulted in minor offsets. Ore minerals include pyrite, arsenopyrite, chalcopyrite, galena, and sphalerite, which occur sparsely disseminated in the vein, or as thin discontinuous bands that roughly parallel the walls of the vein. About 800 feet north of the main adit, and at an elevation of 4,960 feet, another mineralized quartz vein is exposed. This vein is several inches to 12 inches wide and contains minor galena, chalcopyrite, pyrite, and arsenopyrite. A shaft has been sunk on the outcrop of the vein, which strikes N. 50° W. and dips about 50° NE. About 500 feet north of the shaft two south-trending crosscut adits have been driven into the hillside to intersect the vein at depth.

Most underground mine workings at Crystal Butte are on a south-facing slope several hundred feet north of the mine camp, which is in the NW¼SW¼ sec. 35. The main adit, which is about 700 feet northwest of the camp, was driven N. 45° W. for 65 feet before it intersected the vein (fig. 21). At this point the vein has been drifted upon for about 225 feet in a general northeasterly direction. The vein in the first 150 feet of the drift has been stoped above the drift level; from 150 feet to 230 feet in the drift the vein has been stoped above and below the level of the drift. At 222 feet from the portal, an incline was sunk at 16 degrees on the dip of the vein for 80 feet, at which point an intermediate level was established. From this level the shaft extends an additional 90 feet to the lowest level of the mine. The intermediate level contains 210 feet of drifts on the vein; in the lowest level the vein has been drifted upon for only 20 feet. As can be seen by the meandering drifts (fig. 21), the strike of the vein varies considerably; throughout the mine the vein pinches and swells and is continually offset several inches by minor faults. East of the portal of the main adit the outcrop of the vein appears to have been mined from several shallow surface pits.

Several other adits were driven into the hillside at lower elevations than the main adit in attempts to intersect the vein at depth; however, because of the northeasterly dip of the vein it is doubtful that any of the adits intersected it. Several hundred feet east of the camp an adit heads N. 40° E. for 470 feet; about 500 feet west of the camp another adit heads N. 45° W. for 900 feet. Metallized vein material is not present on the dump of either adit.

Crystal Butte Iron

This property is in the SW¼SE¼ and the SE¼SW¼ sec. 35, T. 40 N., R. 30 E. (see fig. 19). It is on the southern slope of Buckhorn Mountain at an elevation of about 4,300 feet. The property can be reached by following an unimproved ranch road north for 0.5 mile from the Buckhorn Mountain lookout road near the center sec. 2, T. 39 N., R. 30 E. At the site of an abandoned ranch a seldom-used road heads west for about 0.2 mile along the south line of section 35 to the Crystal Butte camp. The deposit is about 1,000 feet north of the camp on private land.

According to Broughton (1945, p. 19-22), quartzite and argillite, which have been mapped by Fox (1978) as part of the Spectacle Formation (Permian), contain disseminated grains of pyrite, pyrrhotite, magnetite, chalcopyrite, and scheelite in order of decreasing abundance. Several small ore bodies contain up to 60 percent pyrite and pyrrhotite, and 40 percent magnetite; the chalcopyrite content is always less than 1 percent, and the scheelite content is insignificant. The area of anomalous mineralization is roughly 900 feet long and 300 feet wide, with a N. 20° E. trend. Mineralization of argillite and quartzite beds was incomplete and irregular, but several thin beds have been almost completely replaced by ore minerals. However, it is doubtful that more than a few tons of magnetite are present in the whole deposit. Granitic intrusive rocks do not crop out on the property, but occur less than a quarter of a mile to the west. These intrusive rocks could underlie the Crystal Butte at shallow depths, and provide a contact metamorphic environment at their contact with the overlying argillite and quartzite. Thus, additional mineralization may occur at deeper depths in the areas of anomalous mineralization.

Development work at the property consists of five shallow prospect shafts, a 350-foot adit, and two trenches having a total length of 420 feet. To date (1979), magnetic surveys of the property have not turned up significant magnetic anomalies. Broughton (1945, p. 21) reports that a dip needle survey disclosed several small localized magnetic areas, but large bodies of high-grade magnetite ore cannot be expected. An airborne magnetic survey by Huntting Geophysical Services, Inc. in 1960 did not disclose any anomalies at or in the vicinity of the Crystal Butte iron property.

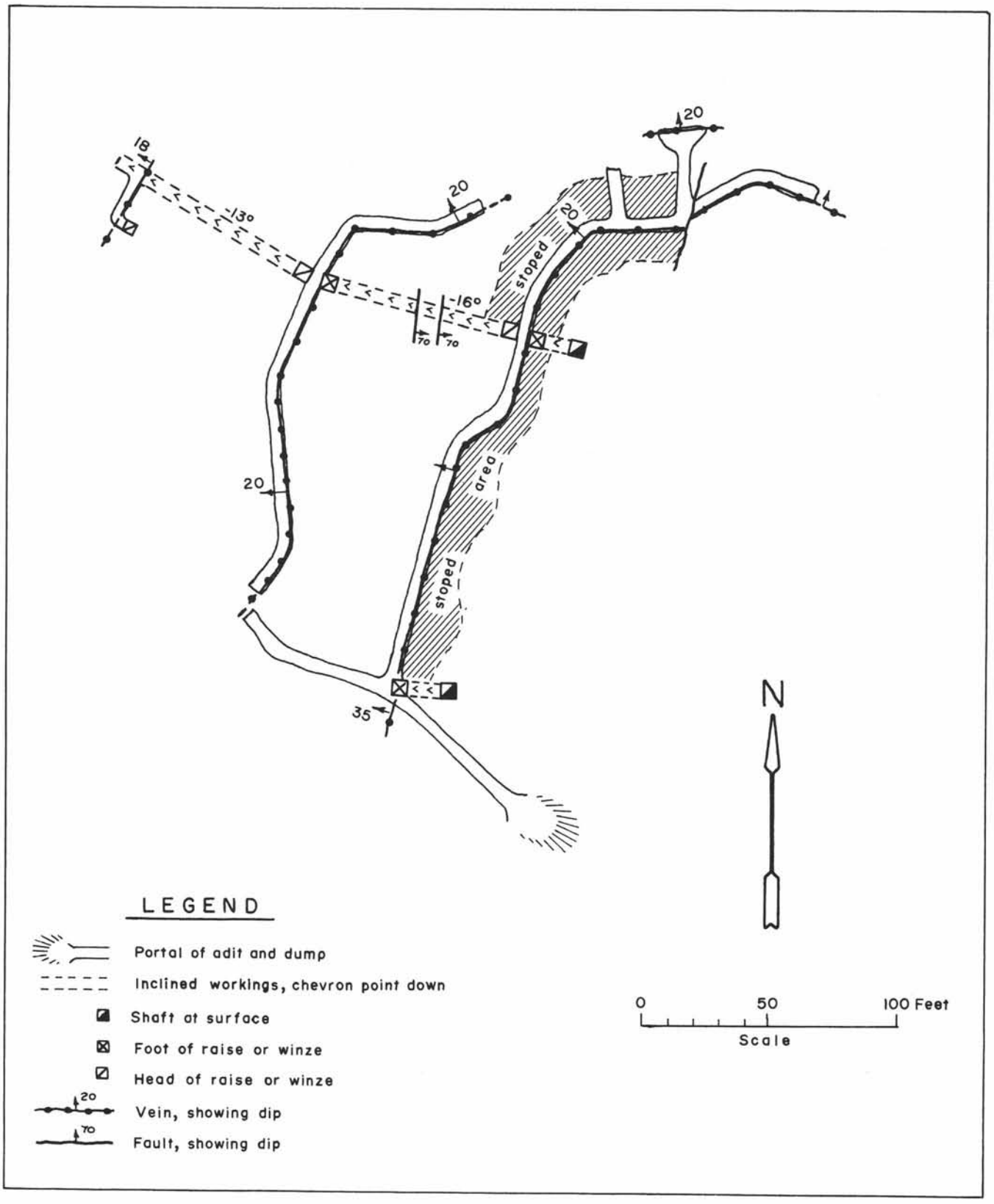


Figure 21.—Crystal Butte (Mother Lode) mine workings.

Gold Axe

The Gold Axe mine is in the SE¼SW¼ sec. 24, T. 40 N., R. 30 E., which is on the east slope of Buckhorn Mountain near its summit (fig. 19). The main workings of the mine are 0.4 mile south of the mine camp and at an elevation of 5,280 feet. The mine has a record of sporadic production of copper and gold from 1910 to 1934, but the total production probably did not exceed 5,000 tons. Handy (1916, p. 8) reports that prior to 1915, six carloads of ore, valued at $10 to $20 per ton in gold and minor silver, were shipped. Huntting (1956, p. 139) reports 16 or 17 carloads of ore were shipped in 1914 and 1915.

The main adit heads N. 34° W. for about 200 feet along a mineralized shear zone in upper Paleozoic limestone. Along the course of the shear zone, which dips 65° SW. to vertical, magnetite and pyrrhotite occur in lens-like bodies, which range from several inches to 1 foot in width. Garnet and epidote accompany the magnetite and pyrite, and gouge of the shear zone is bright reddish yellow as a result of the oxidation of iron minerals. It is not known from which part of the adit the ore that was shipped came from. In addition to the adit, many prospect pits may be found on both sides of the road between the adit and the Gold Axe camp. About 100 feet east of the adit, Cretaceous(?) granodiorite and quartz porphyry crop out, but a well-developed contact metamorphic zone such as the one at the Magnetic mine is not present.

Magnetic (Neutral)

This mine, which is also known as the Buckhorn, Neutral, and Aztec, is in the N½N½ sec. 24, T. 40 N., R. 30 E., on the northern slope of Buckhorn Mountain at elevations of 4,800 to 5,200 feet (see fig. 19). Access to the property from Chesaw is by way of the Gold Creek road, a distance of 7.5 miles. Curlew is 24 miles east of the property by way of roads that follow Nickolson Creek, Toroda Creek, and Kettle River. The chief metal mined in the past has been iron, although small shipments of copper and gold ore were made in the early 1900's. Since 1950, the property has been under the ownership of Bumgardner Mining & Investments Co.

In the late 1890's, Copper Mountain Mining & Milling Co. attempted to develop the property into a copper-gold-silver mine, but were unsuccessful. In 1911, Granby Consolidated Mining, Smelting & Power Co., Ltd. undertook core drilling in search of copper and gold, but mining was not undertaken. In 1917, small shipments of copper ore were made from the Neutral claim to a British Columbia smelter. In 1918, the first shipment of magnetite was made from the claim to Northwest Magnesite Co., at Chewelah, for the manufacture of ferromagnesite. At different times between 1918 and 1950, magnetite was shipped from the Neutral claim; total mine production to date (1979) is estimated at 80,000 tons. Production years were 1918 to 1920, 1937 to 1939, 1940 to 1948, and 1949 to 1950. Companies that operated the mine were Magnetic Mining Co. (1939 to 1949), and Keokuk Electro-Metals Co. (1949 to 1950). All magnetite shipped from the property has come from the unpatented Neutral claim.

Over the past 50 years the property has been examined several times by mining companies to determine if sufficient iron ore is present to justify mining operations. Unfortunately, most examinations have shown that the ore bodies are of limited size. The small size of the ore bodies, as well as high mining costs due to the nature of the deposit, high sulfur content, and the remoteness of the property from iron ore markets makes it doubtful that the property will ever be the source of ore for an iron industry. Fortunately, other markets exist for magnetite, and currently (1979), the possibility of using the magnetite as a heavy media in coal benefication is under consideration.

Geology

The Buckhorn Mountain iron deposit occurs in a contact zone between Mesozoic biotite-hornblende granodiorite and metasedimentary rocks of the Spectacle Formation (Permian) (fig. 22). Common rocks of the Spectacle Formation in the vicinity of the Buckhorn mine include siliceous and micaeous hornfels, calc-silicate rocks, quartzite, limestone, and phyllite. South and west of the Buckhorn mine, dikes of fine-grained hornblende granodiorite and feldspathic porphyry crop out, which suggests that granodiorite is under a relatively thin cover of older metasedimentary rocks on Buckhorn Mountain near the mine. Attitudes of the metasedimentary rocks are highly variable; strikes of beds range from north-south through east-west and dips range from 20 to 35 degrees. No major faults occur in the area, but several minor faults as well as numerous shear zones strike northwest and exhibit moderate to steep dips to the southwest and northeast. Several faults appear to offset the main magnetite body. Some shear zones contain moderate amounts of sulfide minerals, as well as minor gold and silver. Quartz veins, from several inches to several feet in thickness, occur in the granodiorite and metasedimentary rocks, and with the exception of minor pyrite, the veins appear barren of ore minerals.

The magnetite bodies occur in a northwest-trending contact-metamorphic zone between granodiorite on the northeast and limestone lenses and

quartzite on the southwest. The contact zone is about 2 miles long and 1,500 to 2,500 feet wide. Limestone lenses have been totally to partially replaced by tactite zones consisting of grossularite garnet, epidote, zoisite, quartz, and secondary calcite. The tactite in places contains disseminated grains, pods, and pockets of intermixed magnetite, pyrrhotite, pyrite, and chalcopyrite in order of decreasing abundance. In some instances veinlets of pyrite and chalcopyrite cut older pyrite and magnetite. Most magnetite bodies are distributed irregularly through the tactite zone, but in the vicinity of the Magnetic mine the magnetite bodies roughly parallel the northeast-trending tactite contact, which appears to dip about 65° SW.

The magnetite bodies on the north slope of Buckhorn Mountain are the largest on the mountain, and occur within a skarn zone approximately 1,000 feet long and 300 feet wide (fig. 22). Although several large bodies of massive magnetite occur in the tactite

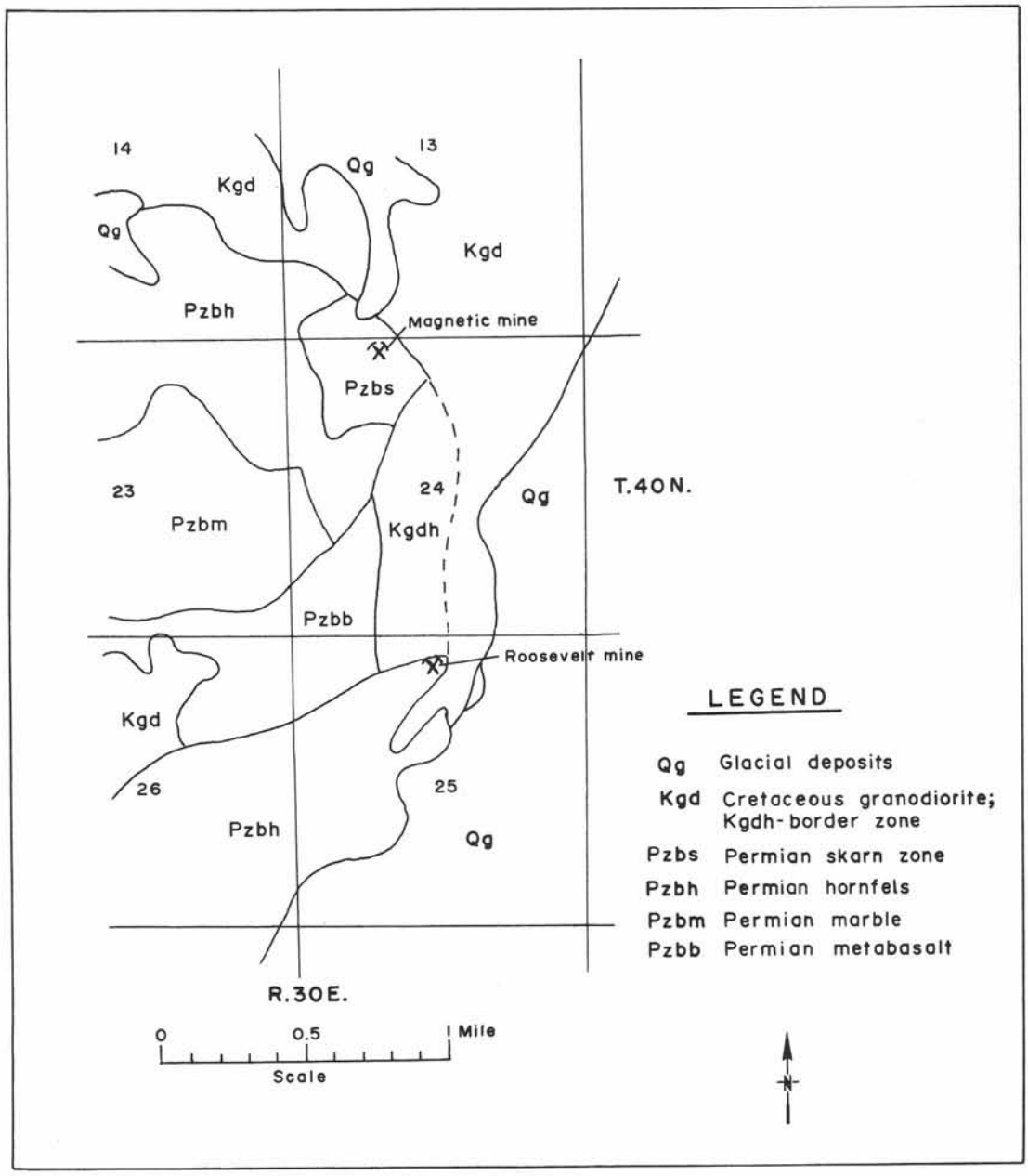


Figure 22.—Geologic map of Buckhorn Mountain area.

zone, much magnetite occurs as disseminations, pods, and lenses. Magnetite is the predominate ore mineral, but minor pyrrhotite, pyrite, and chalcopyrite are present. In garnet and epidote-rich parts of the tactite, sparse fine-grained scheelite is sometimes present.

At the Magnetic mine, magnetite is exposed in three pits (plate 2). The magnetite body in Pit No. 1 is 750 feet long and 65 to 130 feet wide; the magnetite body in Pit No. 2 is 360 feet long and 50 to 100 feet wide; in Pit No. 3 the magnetite body is about 50 feet in diameter. The maximum vertical exposure is in Pit No. 1 where 50 feet of magnetite is exposed. However, based on discontinuous exposures of magnetite in Pits 1 and 3 the magnetite has a total vertical distance of about 200 feet.

The iron content of the ore bodies is highly variable as is shown by numerous assays. Ore consisting of almost pure magnetite contains as much as 68.3 percent iron, 0.2 percent sulfur, and 1.8 percent silica; mixtures of magnetite, skarn, and sulfides contain 27.4 percent iron, 1.5 percent sulfur, and 16.6 percent silica. Work done to date (1979), by several mining companies indicates the presence of high- and low-grade iron ore. Ore classed as high grade contains 57 to 67 percent iron and 0.58 percent sulfur; low-grade ore contains 18.37 percent iron and 7.77 percent sulfur. For comparison purposes several analyses of Magnetic mine iron ore are presented in table 2.

Development

Development work at the mine consists of three open pits, two adits, and numerous open cuts and prospect pits (plate 2). The main pit (No. 1) is 280 feet long, 65 to 130 feet wide, and has a maximum vertical face of 50 feet; the elevation of the pit floor is 5,000 feet. Pit No. 2, which is 150 feet northeast of Pit No. 1 and at the same elevation, is 70 feet long and 45 feet wide. Pit No. 3 is 300 feet northwest of Pit No. 1 and about 150 feet lower in elevation; it is 75 feet long and 45 feet wide. Pit No. 3 is connected to Pit No. 1 by a 485-foot southeasterly trending adit with a 150-foot raise that surfaces at the northwest end of Pit No. 1. Near the center of the southeast half of the main pit a 100-foot adit heads S. 30° W., into the magnetite. This adit was originally 150 feet long, but was partially removed when the pit was excavated.

Core Drilling

At different times since 1911, core drilling has been undertaken on Buckhorn Mountain to determine the extent of iron-copper mineralization. It is not within the scope of this report to discuss all drilling done to date. The drilling, done by the Bureau of Mines in 1945, is discussed in order to shed some light on the nature of the ore bodies at the Magnetic mine. For a full report on the drilling the reader is referred to Zoldok and others (1947). Seven holes from 142 to 957 feet long and totaling 2,877 feet were drilled from the surface (plate 2). The holes were directed to intersect known ore bodies at depth, to intersect lateral extensions of the ore bodies, and to investigate magnetic highs. Hole locations and simplified drill logs are shown on plate 2. Five drill holes intersected the tactite-granodiorite contact, which dips 30 to 65 degrees to the southwest, and all seven holes intersected magnetite bodies containing up to 68.3 percent iron. Nine magnetite bodies contained 50 percent or greater iron, and ranged from 9 to 60 feet in thickness; the average thickness of the bodies is 25 feet. Ten lenses of intermixed magnetite, sulfides, and skarn contained 30 to 50 percent iron, and range from 10 to 62 feet in thickness; the average thickness is 37.5 feet. The main iron-mineralized bodies and lenses intersected by the drill holes are shown on plate 2. Results of the core drilling by the Bureau of Mines disclosed that individual iron-mineralized bodies tend to be lenticular and vary moderately in their iron content. The lenticular nature of the ore bodies indicates that individual bodies are limited in size. In several core holes magnetite bodies were intersected beneath extreme magnetic highs, but not all highs can be expected to indicate the presence of iron ore bodies. Other than iron, the ore bodies contain traces to 0.02 percent copper, traces to 0.15 ounce per ton in gold, and 0.05 to 0.40 ounce in silver.

Reserves

Published iron ore reserves of the Magnetic mine vary considerably due mainly to the lack of data and the extreme irregularity of the mineralization. Broughton (1943, p. 17) estimates that 4,826,000 tons of iron ore occurs within an area roughly 1,000 feet long and 300 feet wide (average) over a vertical distance of 250 feet. The iron ore comprises 25 percent of the volume of this area with the ore averaging 47.3 percent iron, 1.57 percent sulfur, 0.03 percent phosphorous, and 0.03 percent titanium. Another estimate of the iron-ore tonnage is presented by Zapffe (1949, p. 16). According to Zapffe a large tonnage estimate is dependent on the ability to beneficiate the iron-bearing tactite. Based on a depth of 200 feet below Pits No. 2 and 3, and 300 feet below Pit No. 1, the iron ore in the three pits, including beneficiated ore, totals 1,082,667 tons. Adding to this figure undeveloped ore in three fault blocks to comparable depths, the grand total is 1,593,000 tons.

Zapffe makes no mention of the average grade of the ore. He does report that skarn contains 42.11 percent iron and select grade iron ore contains 57.83 percent iron. The reader is referred to table 2, columns 7 through 9 for amounts of other elements. One of the most recent calculations of iron ore reserves is presented by Yokota and Tani (1960, p. 10). According to them, the ore bodies contain a total of 4,575,000 tons of rock averaging 33.8 percent iron. Seventy-five percent of this (3,431,250 tons) is considered minable ore, and upon beneficiation will yield 1,544,100 tons of concentrate with an average iron content of 58 percent. Pits 1 and 3 contain 1,689,000 tons of the ore, while Pit 2 contains 2,886,000 tons of ore. If only high-grade ore is considered, Pits 1 and 3 contain 611,600 tons of ore averaging 55 percent iron, 75 percent of which is minable.

Ore reserves are not reported by the Bureau of Mines, but the ore has been subjected to metallurgical testing. According to Zoldok and others (1947), tests indicate:

> Straight magnetic concentration produced a high-iron, low-silica concentrate with little reduction of the sulfur content. Sintering of this concentrate, however, would reduce the sulfur content to permissible limits for furnace ore. Results of metallurgical testing by magnetic separation of the crude ore and of ore subjected to hydrogen reduction are comparable. Iron recovery was plus 93 percent on all sizes, although grinding to finer than minus 28 mesh was indicated to be necesssary for the production of 69-70 percent iron concentrate. Sulfur elimination was poor at all sizes, owing largely to the presence of the highly magnetic sulfide, pyrrhotite.

Summary

(1) Upward of 4.5 million tons of magnetite-rich ore averaging 33.8 percent iron occurs at the Magnetic mine.

(2) High-grade ore bodies containing 50 percent or more iron can be mined from existing open pit, but the ore bodies are of limited size.

(3) Because of the small size of the ore bodies, large-scale open-pit mining is impractical.

(4) Concentration of most of the ore is necessary because of the intermixed nature of magnetite, sulfide minerals, and skarn.

(5) The total iron content of the ore is low (33.8 percent) and the sulfur content is high (1.97 percent).

(6) The deposit is too remote from coastal ports to be considered for foreign markets.

(7) The magnetite is suitable for such uses as ballast, heavy media, and radiation shielding.

Rainbow

The Rainbow prospect is near the common corner of sections 13, 14, 23, and 24, T. 40 N., R. 30 E., and at an elevation of 5,000 feet (see fig. 19). By driving

TABLE 2.—*Analyses of Magnetic mine iron*

	1	2	3	4	5	6	7	8	9
Fe	55.4	63.4	47.3	52.71	49.08	69.3	55.89	57.83	42.11
SiO_2	7.9	5.7		12.00		4.8	9.30	7.67	15.95
S	1.4	0.5	1.57	3.24	1.97	0.3	2.65	1.62	2.99
P	0.05	0.03	0.03		0.05	0.025	0.025	0.026	0.034
Mn	0.5						0.03	0.112	0.17
TiO_2	nil	0.11	0.03			0.11	0.01	0.048	0.057
Cu	0.06	trace				0.01	0.10	0.049	0.26
Ni	nil		trace						
Cr	nil		trace						
Insol.	14.0								

1. Zoldok, S. W. and others, 1947, 300 lb. sample from Pit No. 1 over 30 ft. width.
2. Zoldok, S. W. and others, 1947, core hole No. 5, 51 ft. of core, average of 10 samples.
3. Broughton, 1943, composite of 3 samples from Pits 1 and 2.
4. Division of Geology and Earth Resources files, 1949, average of 10 samples over 68 ft. interval in 150-foot raise between adit in No. 3 Pit and Pit No. 1.
5. Division of Geology and Earth Resources files, 1960, average of 98 samples from Pits 1, 2, and 3.
6. Zoldok, S. W. and others, 1947, high grade from core hole No. 5 in Pit No. 1.
7. Zapffe, 1949, p. 15, ship ballast shipped in 1942.
8. Zapffe, 1949, p. 15, select grade.
9. Zapffe, 1949, p. 15, skarn.

west 0.3 mile from the Magnetic mine, the section corner can be reached. From the section corner it is only about 200 feet west to the property's adit and shaft (fig. 23). No record of production can be found for this property.

The Rainbow adit was driven 460 feet into garnet-epidote skarn containing sparsely disseminated pyrite, pyrrhotite, chalcopyrite, and scheelite. The first 250 feet of the adit heads S. 65° E; the remaining 210 feet heads S. 25° E. About 250 feet from the portal a 15-foot crosscut extends S. 20° W. At the face of the crosscut, sparsely disseminated scheelite with grains up to 1/16 inch in diameter occur. About 25 feet from the face of the adit a 40-foot crosscut heads N. 55° E. For the first 10 feet of the crosscut the walls contain sparsely disseminated scheelite. At 10 feet in the crosscut a 6-foot wide vein of barren quartz strikes N. 60 E. and dips 40° NE. About 300 feet east of the adit portal a 20-foot shaft has been sunk in skarn containing sparse chalcopyrite, pyrite, and malachite.

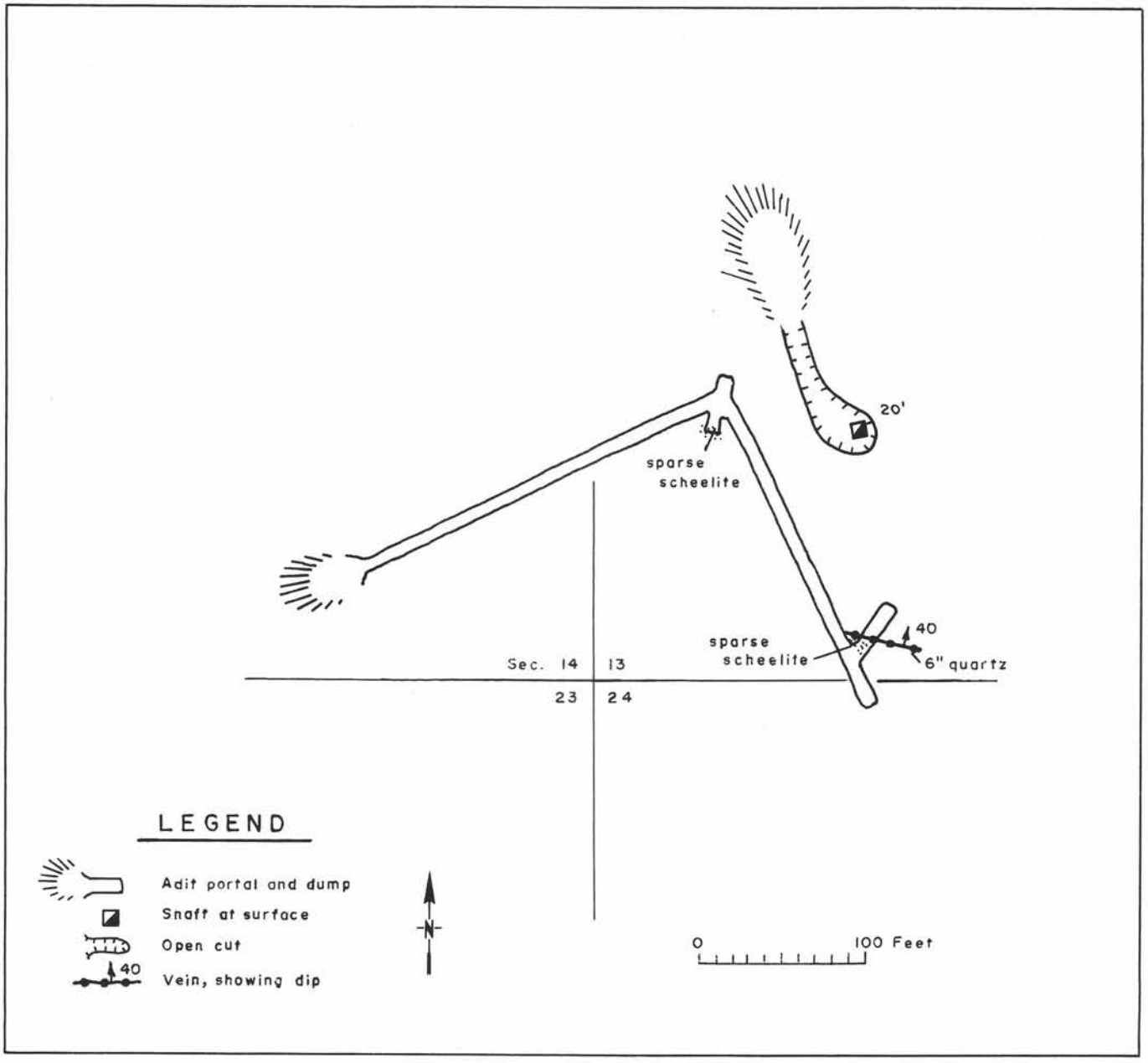


Figure 23.—Rainbow adit.

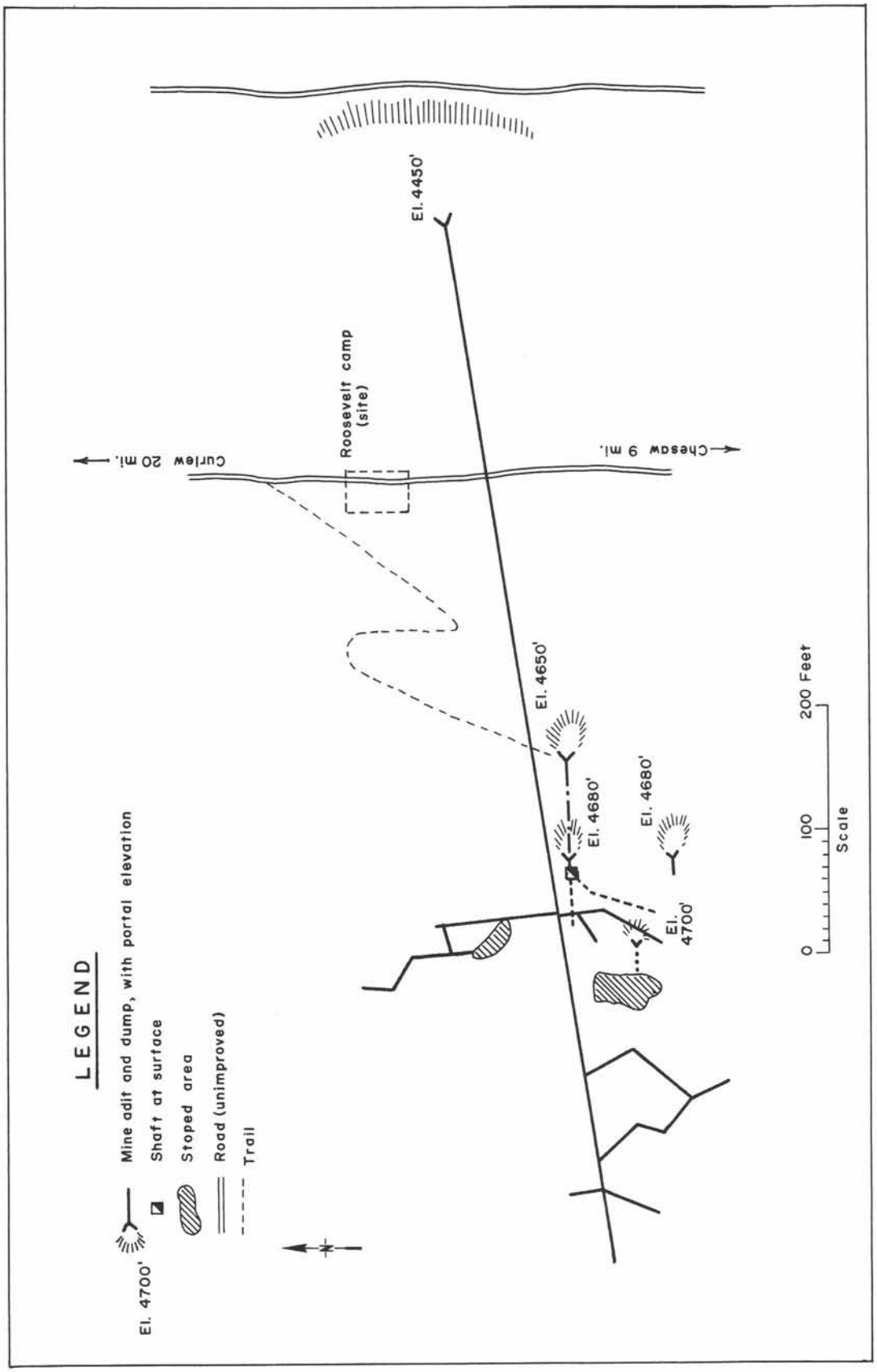


Figure 24.—A, Location map of underground workings, Roosevelt mine.

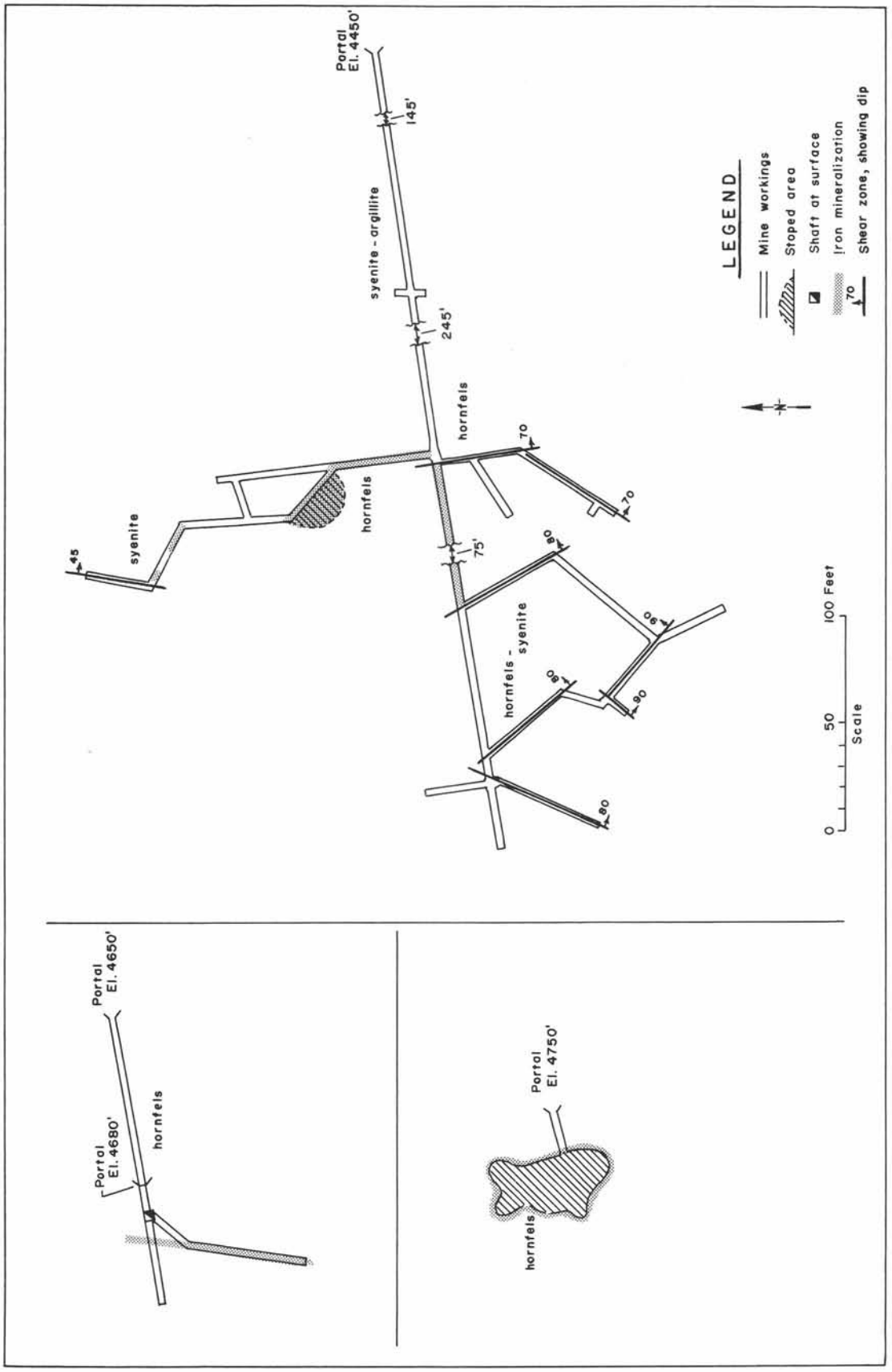


Figure 24.—B, Geology of main adits, Roosevelt mine.

Roosevelt (Grant)

This mine is in the S½ sec. 24, and N½ sec. 25, T. 40 N., R. 30 E., on the eastern slope of Buckhorn Mountain at elevations of 4,400 to 4,750 feet (see fig. 19). Roosevelt mine camp is near the N¼ cor. sec. 25. From near the W¼ cor. sec. 36, T. 40 N., R. 30 E., a spur road from the Buckhorn Mountain lookout road can be followed 1.5 miles north to Roosevelt camp. The lowest adit is about 200 feet east of camp; the upper adits are about 250 feet southwest of camp.

The original claims were staked in 1901 and 1902, among which were the Grant, American Girl, Crystal Light, and Double Standard. Early development work by Grant Consolidated Mining Co. consisted of several adits and open cuts on ore bodies of intermixed magnetite, chalcopyrite, and pyrite. By 1911, 12 carloads of hand-sorted ore had been shipped to smelters. Returns from the shipments ran from $22.00 to $28.00 per ton and contained 7 to 9 percent copper, 0.10 to 0.20 ounce in gold, and 3.75 to 7.5 ounces in silver (Huntting 1956, p. 199). The property remained idle until 1919; in 1919 and 1920, a total of 2,000 tons of iron ore was shipped to Northwest Magnesite Co., at Chewelah, Washington. Since 1920, no mining has taken place.

Ore minerals at the Roosevelt occur in contact metamorphic deposits near the contact between upper Paleozoic metasedimentary rocks and Cretaceous(?) granodiorite (see fig. 22). The ore bodies resemble those of the Magnetic mine, but are considerably smaller. Pearson (1967) mapped the metasedimentary rocks of the contact zone as hornfels and calc-silicate rocks, with minor quartzite, marble, and phyllite. The rocks contain localized areas of garnet-epidote-magnetite skarn. In the vicinity of the adits the most conspicuous rocks are biotite-hornblende granodiorite and pyritic hornfels. Within the skarn zones the ore bodies occur as irregular replacements that apparently favored beds of limestone and calcareous shale. The ore minerals occur as disseminated grains, as well as in pods and lenses. The presence of the iron-rich zones are almost always indicated by abundant reddish-brown iron oxides. At least two moderate-size ore bodies have been mined. In one of the upper adits an ore body attained a maximum size of 35 feet long, 30 feet high, and 25 feet wide. In the lower adit an ore body consisting chiefly of magnetite with minor chalcopyrite and pyrite, was mined from a stope. Other ore bodies in the mine appeared to be too small to mine. Small sparsely disseminated grains of scheelite occur in garnet-epidote-rich areas of the contact zone, but nowhere is the scheelite abundant enough to be of importance.

Main development work at the Roosevelt mine consists of an 855-foot lower adit with about 750 feet of drifts and crosscuts, and a stope 30 feet high, 35 feet long, and 20 feet wide (fig. 24). About 200 feet higher in elevation and 600 feet west of the lower adit are several open cuts and caved adits. The longest of these adits heads S. 80° W. for about 140 feet; near its face a drift heads south for about 76 feet. About 200 feet southwest of this adit and 100 feet higher in elevation a 20-foot adit heads S. 80° W. into a stope 50 feet long, 30 feet high, and 30 feet wide. It appears that these upper adits represent the earliest work at the mine, and at a later date the lower adit was driven in an attempt to intersect the downward extension of ore bodies. Apparently the ore bodies did not extend to the depth of the lower adit, but isolated bodies of magnetite were encountered.

According to Broughton (1943, p. 20-21) the only remaining ore is in the floor of the large stope of the lower adit (fig. 24). Possibly about 2,000 tons of magnetite is present below floor level. Broughton also reports that a surface area of moderately high dip needle readings occurs S. 60° E., 250 feet from the stope. If the high readings represent a body of magnetite, the deposit could contain as much as 62,000 tons of iron ore (Broughton, 1943, p. 21).

Western Star

This mine is in the NW¼NW¼ sec. 24, T. 40 N., R. 30 E. and on the northwestern slope of Buckhorn Mountain at a general elevation of 5,350 feet (fig. 19). About 0.3 mile south of Gold Axe camp, a spur road can be followed 0.8 mile along the western slope of the mountain to the property, which is discernible by many prospect pits, open cuts, shafts, and adits. The Western Star claim was staked around 1900, and in 1914 and 1915, several carloads of ore containing 8 to 10 percent copper, and several dollars per ton in gold and silver were shipped (Huntting, 1956, p. 72). From the appearance of the mine, it appears to have been idle since 1915

The area of the mine is within the garnet-epidote-magnetite contact metamorphic zone of Buckhorn Mountain. At the mine several outcrops contain disseminated pyrite and chalcopyrite accompanied by malachite staining of fracture surfaces. Although the mineralization in general is sparse, it occurs over a 600- by 300-foot area. Most mineralized outcrops have been dug upon, but it is not known from which mine workings the ore that was shipped came from.

Bi-Metallic

This property is 3 miles northeast of Havillah and in the NW¼ sec. 26 and SE¼ sec. 27, T. 39 N., R. 29 E. (see fig. 9). From a county road near the E¼ cor.

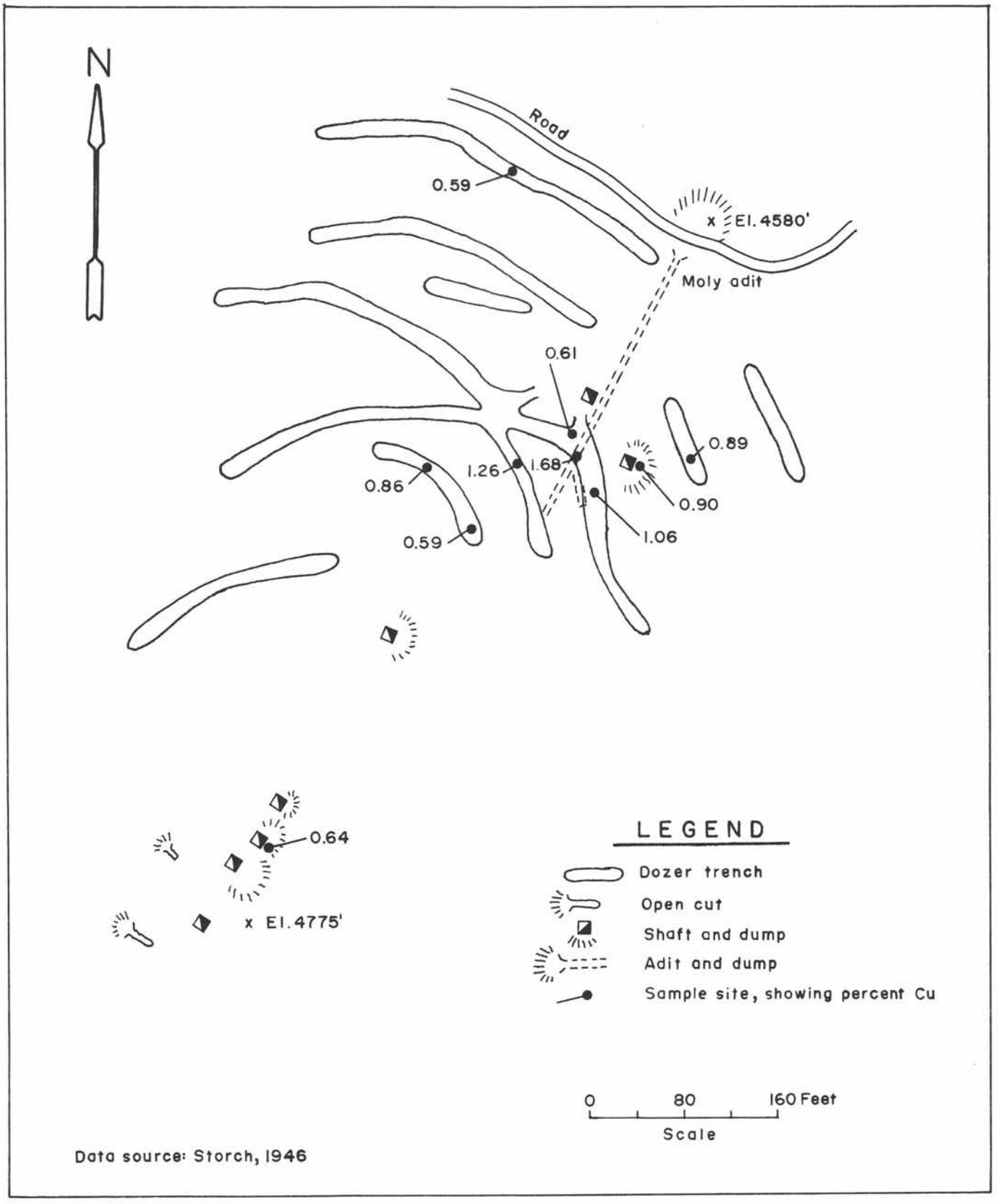


Figure 25.—Bi-Metallic mine workings, showing surface trenching.

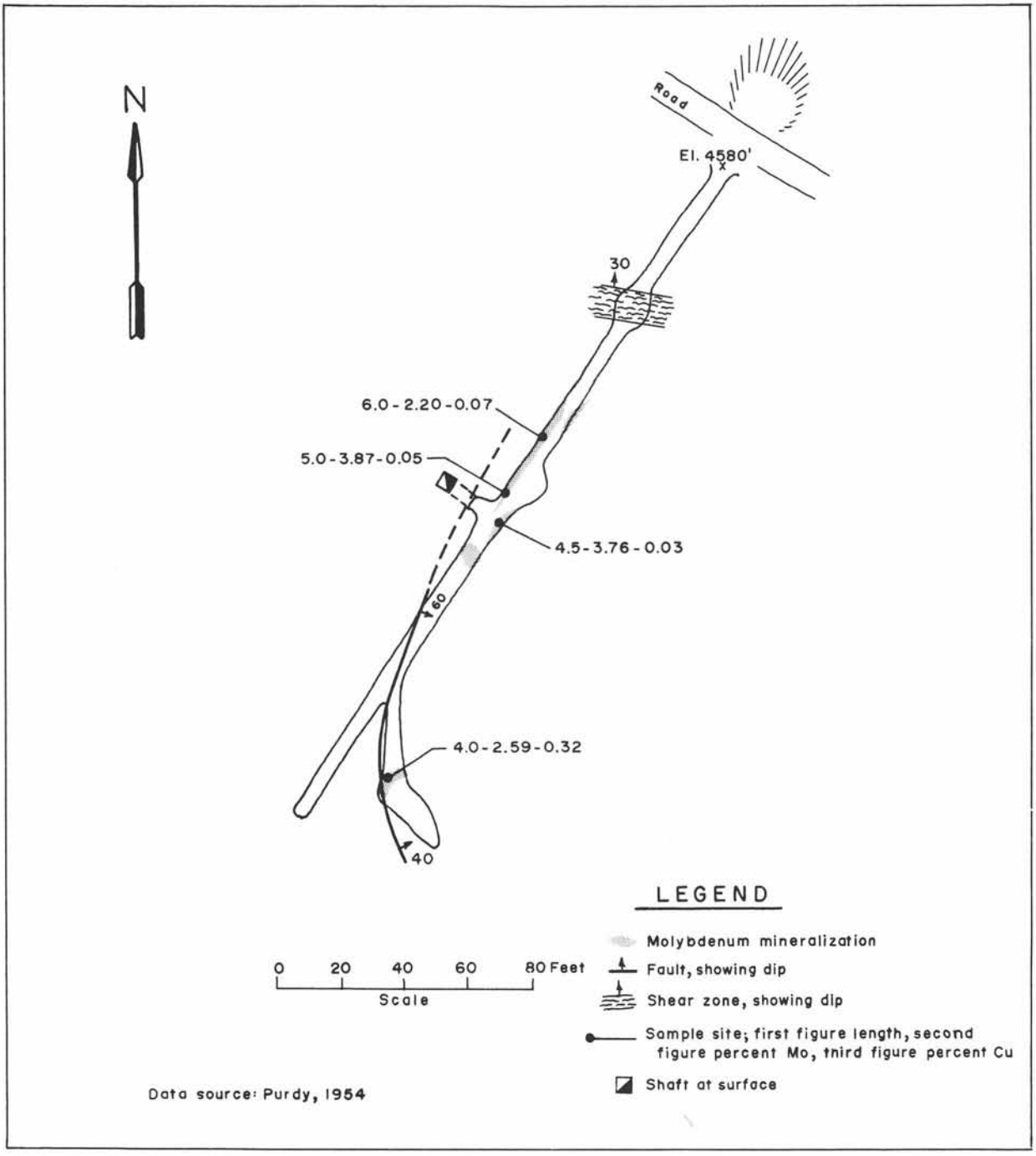


Figure 26.—Bi-Metallic adit.

sec. 22, a single lane unimproved dirt road can be followed south for about 1 mile to the 11 patented claims (Mineral Survey 921) of the property. The claims are on the northeastern slope of Bi-Metallic Mountain and at elevations of 4,100 to 4,800 feet.

The Bi-Metallic mine is one of the oldest mining properties in the area, having been discovered soon after the opening of the Colville Indian Reservation to mineral entry in February 1896. Several shafts were sunk on copper-mineralized rocks that cropped out near the top of the mountain, and from one of these shafts high-grade copper ore was shipped in 1918. Sometime later an adit was driven to intersect copper mineralization at depth; the adit is 650 feet northeast of and about 200 feet lower in elevation than the shafts (fig. 25). After the adit had been driven 250 feet, and about 400 feet short of its objective, work ceased. In the course of driving the adit, several tungsten-molybdenum mineralized areas were encountered. In 1945, the U.S. Bureau of Mines dozer trenched mineralized parts of the property to determine the extent of the mineralization. A total of about 2,200 linear feet of trenching was done, but no significant mineralization was encountered (fig. 25). In 1954, the adit was rehabilitated by M. F. Fowler and Associates, of Okanogan. In 1961, Dawn Mining Co. drilled six core holes, for a total length of 900 feet, to evaluate the uranium potential of the tungsten-molybdenum mineralization; the project was terminated shortly thereafter when no uranium was found.

The geology of the deposit has been described by Purdy (1954, p. 34-44), and as such only a brief summary follows: Mineralization at the Bi-Metallic is localized along several undulating shear zones in hydrothermally altered alaskite, aplite, and monzonite. The shear zones do not appear to be continuous for more than 20 to 30 feet in any direction. Common alteration products of the shear zones are sericite and kaolinite, which are accompanied by disseminated ore minerals consisting of molybdenite, scheelite, chalcopyrite, powellite, and pyrite. Minor malachite staining accompanies the chalcopyrite, especially on surface exposures. The ore minerals are not persistent along the shear zones, but are localized into small ore shoots. In the main adit, molybdenite and minor malachite occur in an area 85 to 140 feet from the portal, as well as 25 feet from the face of the adit (fig. 26). Sampling of these mineralized areas by the Bureau of Mines (Storch, 1946, p. 5) showed 2.20 to 3.87 percent molybdenum, 0.03 to 0.32 percent copper, and traces of gold and silver. In addition to the underground sampling, the Bureau collected 23 samples from trenches on the hillside above the adit with unfavorable results. The average molybdenum content of the samples was 0.01 percent; the copper content ranged from 0.01 to 1.26 percent, and averaged 0.32 percent; gold and silver occurred only in trace amounts in most samples (fig. 26). Sampling to date shows that the highest copper values occur in surface or near-surface rocks, whereas the highest molybdenum values occur in the adit at depths deeper than the copper mineralization.

Development work at the property consists of several shafts and trenches, as well as two adits (fig. 26). The lowest adit, which is caved at its portal, is at an elevation of 4,100 feet and reported to be about 300 feet long. The upper main adit is about 2,000 feet southeast of the lower adit, and at an elevation of 4,580 feet. It heads N. 28° W. for 285 feet, and has a 40-foot crosscut near its face. About 140 feet from the portal in the adit an 80-foot raise extends to the surface, but is inaccessible due to caved ground. The upper shafts are reported to be 50 to 60 feet deep and inaccessible because of caved collars.

Carlquist

The Carlquist prospect is about 0.5 mile east of Mud Lake and in the SE¼ NW¼ sec. 30, T. 40 N., R. 29 E. at an elevation of about 4,000 feet (see fig. 9). Purdy (1951, p. 92) describes the prospect as being in sheared quartzite and schist containing iron-stained quartz veins up to 4 inches thick. One 4-inch quartz vein, which strikes N. 75° E. and dips 73° S., contains sparse arsenopyrite and boulangerite. Mr. Carlquist, the original owner of the property, apparently discovered a high-grade lens of boulangerite at the surface and mined it out after sinking a shaft only 4 feet. The writer was unable to locate the shaft, which appears to have been covered over when the land was farmed.

Lake Beth

This prospect is in the SE¼ sec. 23, T. 39 N., R. 30 E., and on the south shore of Beth Lake (see fig. 9). The adit dump extends out into the lake and is plainly visible from the Beaver Creek road that follows the north shore of the lake.

Tuffs and tuffaceous sandstone, siltstone, and shale of the O'Brien Creek Formation (lower Eocene) predominate in the area, but in the vicinity of the Lake Beth prospect the country rock consists of intrusive breccia and pre-Tertiary metasedimentary rocks. Near the portal, the adit heads S. 45° W. into sheared and brecciated rocks containing numerous stringers of quartz and calcite. A definite vein is not present, and the adit follows a sinuous course for about 400 feet into the mountainside. Except for minor fine-grained pyrite, metallic ore minerals appear to be absent.

Shaw-Bergman

This prospect is 2 miles northwest of Muskrat Lake and in the SE¼NW¼ sec. 8, T. 39 N., R. 29 E., at an elevation of 4,300 feet (see fig. 9). According to Huntting (1956, p. 71), chalcopyrite and pyrite are sparsely disseminated over a width of 3 feet in schist, and assays of up to $25 in gold and silver ($20 gold) have been reported. When the writer examined the property in 1978, a shallow shaft in metasiltite was found, but ore minerals were not noted in rock from the shaft, nor in rocks that crop out in the vicinity of the shaft.

Ida

This prospect is in the NE¼SE¼ sec. 21, T. 39 N., R. 31 E., at an elevation of 2,850 feet (see fig. 9). About 1 mile west of Toroda Creek a spur road can be followed 0.75 mile north from the Beaver Creek road to the prospect. At this site two adits have been driven in a northeasterly direction along an iron-stained, altered, and silicified shear zone. The shear zone occurs between Sanpoil Volcanics on the west and volcanic flow rocks of the Klondike Mountain Formation on the east. The shear zone attains a maximum width of about 10 feet, and except for sparsely disseminated fine-grained pyrite it appears barren of ore minerals. A representative sample of the shear zone assayed 0.20 ounce per ton in silver and contained no gold. The lower adit heads N. 70° E. for about 100 feet into the altered and sheared tuffaceous volcanics. The upper adit, which is about 40 feet higher in elevation than the lower, heads N. 20° E. into the shear zone for a distance, which is unknown due to a caved portal. At the upper adit the shear zone dips 45° SE. The adits are on the Golden Beaver claim of the Ida group of seven unpatented claims belonging to Beaver Mines of Spokane.

WAUCONDA MINING DISTRICT

GENERAL INFORMATION

The Wauconda district lies immediately south of the Myers Creek district (fig. 1), and encompasses townships 37 and 38 north, and ranges 30 and 31 east, for a total area of 144 square miles. At the turn of the century the district consisted of several smaller unorganized mining districts among which were Bodie, Ballaratt, Cascade, Sheridan, and Toroda (see fig. 8). The Wauconda district is only one half as large as the Myers Creek district, but its total mineral production in terms of dollars has been three times as great as the Myers Creek district (table 1).

Access to and within the district is provided by a well-maintained network of state, county, and Forest Service roads. State Highway 20 passes through the south half of the district and provides access to the Wauconda area. The Toroda area is served by an excellent county road between the settlements of Wauconda and Toroda. Mines in the Sheridan area can be reached by following a poor single-lane dirt road along the east fork of Toroda Creek to its headwaters. Although most mining properties can be reached with conventional vehicles, several roads are in very poor condition, making access by vehicles difficult.

The terrain of the Wauconda district is mountainous and most summits are rounded (fig. 27). Major valleys are occupied by north flowing Toroda Creek, easterly flowing West Fork of Granite Creek, and westerly flowing Bonaparte Creek. Elevations range from lows of around 2,700 feet on Toroda Creek, to a maximum of 5,739 feet at the summit of Bodie Mountain; the district's average elevation is about 4,000 feet. Much of the bedrock is covered by a veneer of glacial drift and alluvium, but in many parts of the district bedrock crops out, especially on steep slopes.

About 80 percent of the district contains a dense forest cover of conifers. Common conifers are Douglas fir and ponderosa and lodgepole pine. Western larch (tamarack), hemlock, and western red cedar represent only a small part of the conifer growth. Broad-leaved deciduous trees are only a minor part of the forest cover; they include quaking aspen, cottonwood, mountain alder, mountain ash, poplar, and maple. Unforested areas generally are on south-facing slopes and are covered with pine grass, bunch grass, and sagebrush.

Toroda, Bonaparte, and the west fork of Granite Creek, as well as their numerous tributaries, form a dendritic drainage pattern in the district. The largest creeks flow throughout the year, but many small creeks are dry during summer months. Other than Bonaparte Lake (167 acres) and Walker Lake (20 acres), lakes in the Wauconda district are few.

A. General terrain at headwaters of Toroda Creek, Wauconda district, looking north.

Figure 27.—Valley of Toroda Creek south of Bodie, looking south. Bodie mine at A.

GENERAL GEOLOGY

Bedrock of the Wauconda district consists of igneous, metamorphic, and sedimentary rocks that range from Permian to late Eocene in age (fig. 28). The oldest rocks, which consist of Permian eugeosynclinal metasedimentary and meta-igneous rocks, crop out in a north-northwest trending belt through the center of the district. East of these rocks lie Eocene volcanic rocks and associated sedimentary rocks. West of the eugeosynclinal rocks are Mesozoic gneissic granitic rocks of the Okanogan gneiss dome, as well as intrusive granitic rocks of Triassic to early Eocene age (see fig. 5).

The bedded rocks of the district exhibit various degrees of folding. The Eocene volcanic rocks of the east half of the district dip at low to moderate angles to the east, with general north to north-northeast strikes. The eugeosynclinal rocks of the central part of the district, because of several episodes of folding from Permian through late Eocene time, exhibit diverse strikes and dips, but northeast strikes and moderate dips prevail. In many places foliation of the rocks parallels bedding planes. The faults of the district are predominantly in the east half and are near vertical with north to north-northeast trends; the mineralized veins of the district generally parallel faults. Throughout the district, bedrock is patchily covered by surficial deposits of glacial debris and valley alluvium consisting chiefly of poorly sorted sand, gravel, silt, and clay.

Volcanic Rocks

Eocene volcanic rocks are the most important host rocks for mineral deposits of the Wauconda district. They crop out mainly in the east half of the district and lie unconformably upon folded and sheared Permian or Triassic eugeosynclinal rocks to the west; the volcanics probably exceed 7,500 feet in total thickness. Mapping by Pearson (1967) and Muessig (1967), as well as radiometric ages and correlation by Pearson and Obradovich (1977), show that Eocene volcanics constitute three formations: (1) O'Brien Creek Formation (lower Eocene); (2) Sanpoil Volcanics (middle Eocene); and (3) Klondike Mountain Formation (upper Eocene).

The O'Brien Creek Formation consists of well-bedded to massive, pale-green, cream or buff tuff, lapilli tuff, tuffaceous sandstone, siltstone, and shale, as well as gray carbonaceous siltstone and shale, and conglomerate. In the north-central part of the district these rocks form several outcrops less than one-half square mile in area that are intruded by monzonite and pyroxenite. Folding within the formation has produced diverse strikes accompanied by low to moderate dips. Pearson and Obradovich (1977, p. 14) report that the source of tuff in the formation has not been found in the United States. The nearest sources appear to be in Canada where intrusive bodies of similar lithology crop out. Except for sparsely disseminated fine-grained pyrite, rocks of the O'Brien Creek Formation are barren of ore minerals.

The Sanpoil Volcanics conformably overlie the O'Brien Creek Formation, have a general northerly trend, and dip moderately to the east. Within the Wauconda district the volcanics consist chiefly of lithoidal lava flows of quartz latitic to andesitic composition, and are generally porphyritic. The rocks are massive to flow layered and include minor quartz-poor tuffaceous rocks, as well as some trachytic dikes and sills. According to Pearson and Obradovich (1977, p. 17, 23) the Sanpoil Volcanics in the Toroda Creek graben may be in excess of 3,280 feet thick, and originated from a large number of volcanic vents rather than from a few large volcanoes. As in the case of the O'Brien Creek Formation, rocks of the Sanpoil Volcanics are void of ore minerals, except for minor fine-grained pyrite in parts of some flows.

Rocks of the Sanpoil Volcanics and minor pre-Tertiary rocks are overlain unconformably by volcanic and epiclastic deposits of the Klondike Mountain Formation. Pearson (1967) subdivided the formation into lower, middle, and upper members, but within the Wauconda district only the middle member appears to be present. The middle member consists of light- to medium-gray, green, and brown lithoidal lava flows and pyroclastic breccias. Planar flow structure and bedding have general north to north-northeast strike trends and low to moderate east dips. High-angle faults within the volcanics strike north to northeast. Many shear zones, which parallel the faults of the area, contain mineralized quartz fissure veins accompanied by hydrothermal alteration and silicification of the volcanic rocks. Most gold and silver production of the Wauconda district has come from these veins.

Eugeosynclinal Rocks

Permian eugeosynclinal rocks of the central part of the district are hosts for several mineral deposits, but production from these deposits has been insignificant. These rocks consist of folded and sheared phyllite, metasiltite, metaconglomerate, marble, quartzite, calc-silicate schists, and minor staurolite-garnet schists. The rocks, which are part of the Anarchist Group (Permian) have been mapped as the Spectacle Formation by Fox (1978). Although the rocks exhibit diverse strikes and dips, because of several episodes of folding, the strike of the foliation

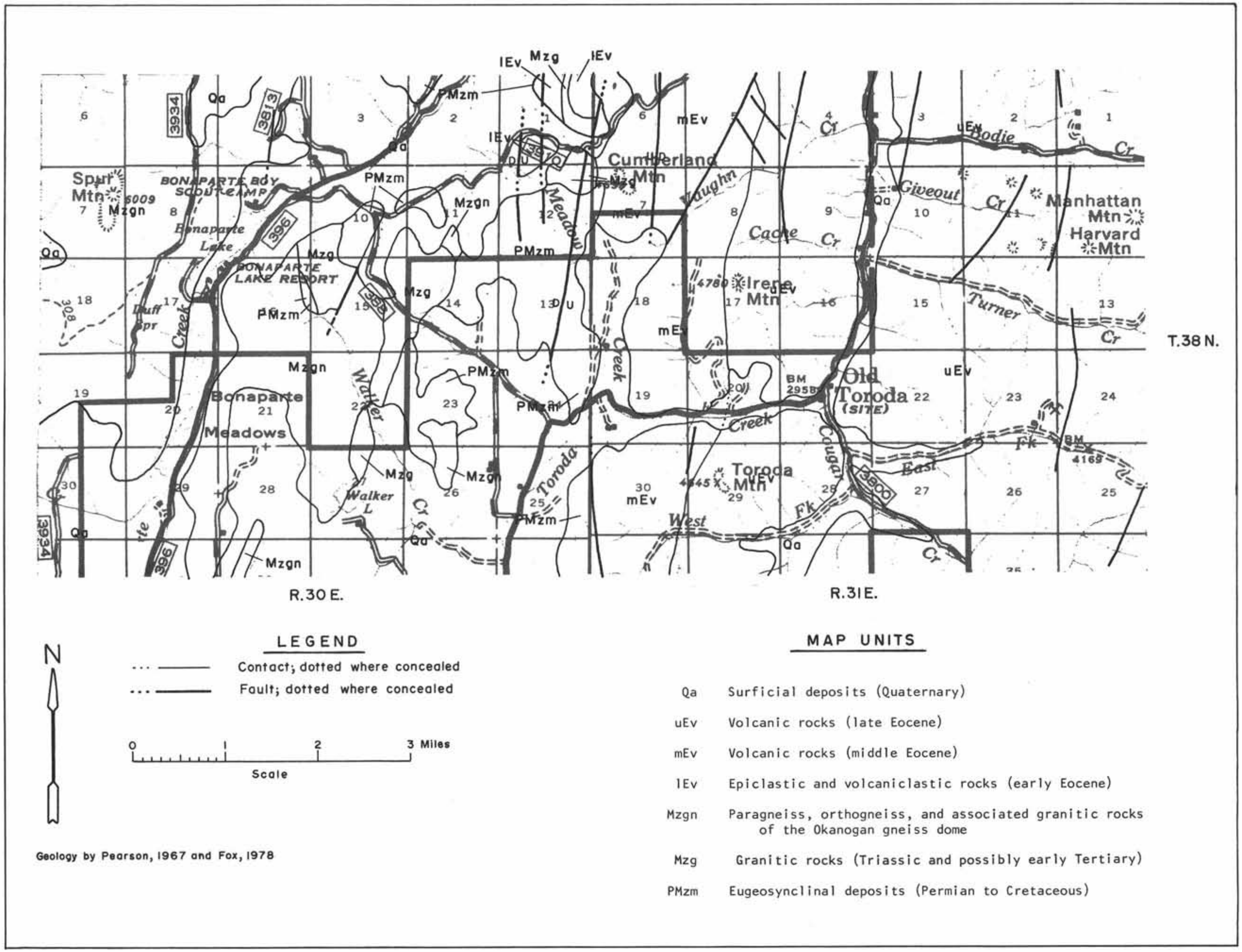


Figure 28.—Geologic map of Wauconda district.

is generally northeast with low to moderate dips to the northwest. Minor high-angle faults are present, with strikes of north to north-northeast. Major offsets are not apparent, nor does mineralization appear to be related to faulting.

Granitic Rocks

The granitic plutons of the district are not known to contain mineral deposits, but disseminated and vein-type deposits of the eugeosynclinal rocks appear to be related to them. The plutons are chiefly of Mesozoic age, but Fox (1978) and Pearson (1967) believe that some plutons may be of Eocene age. They crop out in the central part of the district as small stocks less than 1 square mile in area, and as an elongated discordant body 10 miles long and 1.5 miles wide, which have been mapped by Fox (1978) as the Wauconda pluton (fig. 5). This pluton consists of gneissic to brecciated granodiorite as well as minor alaskite, quartz porphyry, and other varients. The granodiorite is locally porphyritic. The smaller granitic stocks and dikes are generally of monzonitic to syenitic composition; in several granitic bodies minor pyroxenite is present. The intrusion of the granitic rocks into the older eugeosynclinal rocks produced contact metamorphic zones, a few of which contain disseminated ore minerals. These same intrusions were also probably source rocks for metalliferous hydrothermal solutions that formed quartz fissure veins in older eugeosynclinal rocks.

Okanogan Gneiss Dome

This structure, which has been mapped by Fox (1970, 1978) and discussed by Fox and others (1977), is the dominant structure of the western part of the Wauconda district (fig. 5). Although the predominant rocks of the structure are paragneiss and orthogneiss, in the Wauconda district associated granitic rocks prevail. They include gneissic monzonite-syenodiorite border phase rocks of the dome, pegmatites, and pegmatite-alaskite mixtures, and granodiorite and quartz monzonite of the Mount Bonaparte pluton. Although rocks of these types act as host rocks and sources of mineralizing solutions in other mining districts of northeastern Washington, in the Wauconda and Myers Creek mining districts granitic rocks of the gneiss dome appear to be deficient in metallic and nonmetallic ore minerals—such mineral occurrences are rare.

MINERALIZATION

Metallic minerals of the Wauconda district occur chiefly in quartz fissure veins and breccias in Eocene volcanic rocks, as well as in disseminated deposits at and near contacts between Permian eugeosynclinal rocks and Mesozoic and early Tertiary granitic rocks.

Vein Deposits

Quartz fissure veins predominate in the Wauconda district, and the bulk of the district's mineral production has been from them. Most veins have north to northeast strikes, are generally steeply dipping, and roughly parallel faults. The veins range from several inches to as much as 7 feet in width and have a habit of pinching and swelling along their strikes and dips. Common gangue consists of fine-grained white to light-gray quartz that is often chalcedonic. At several properties minor to moderate amounts of calcite and(or) fluorite accompanies the quartz. The fluorite occurrences delineate a distinct mineralized belt in the Klondike Mountain Formation. In this report the writer refers to this structure as the American Flag-Silver Bell-Zalla M mineralized belt. The belt is several hundred feet wide and about 1 mile long, with a general north-northeast trend. It occurs within a half- mile-wide horst structure at the eastern fault contact of the Klondike Mountain Formation and pre-Tertiary granodiorite and gneiss. Rocks of the belt are silicified, fluoritized, pyritized, sheared, and locally brecciated. In the southern two-thirds of the belt sanidine-rich trachyte predominates; at the northern end trachitic andesite is common. Along parts of the belt silver minerals occur in quartz veins, as well as in silicified and fluoritized shear zones up to several feet wide. Up to 100 ounces per ton in silver has been mined from the silver-bearing quartz veins and shear zones. In other parts of the belt, silver mineralization occurs in areas up to 100 feet wide and several hundred feet long, but in these areas the silver content diminishes to only 1 to 3 ounces per ton. The largest area of low-grade silver mineralization is at the Silver Bell mine.

In gold- and silver-bearing veins, fine-grained pyrite, pyrrhotite, and chalcopyrite are usually the only visible sulfides. Gold is rarely visible and silver minerals generally occur as dustlike particles in the quartz. Pyrite is almost always disseminated in the wall rock up to several feet from the veins.

The sulfide ore minerals are generally disseminated in the veins, but in parts of the veins the sulfides occur as small blebs, or as thin black streaks

that parallel the walls of the veins. Wall-rock alteration is almost always present. Silicic, sericitic, pyrititic and porphyritic alteration is common; fluoritic alteration is less common. Pyrite and pyrrhotite commonly alter to jarosite, hematite, or goethite, whereas chalcopyrite alters to malachite and minor azurite. Surface parts of most veins, as well as the adjoining wall rock, exhibit reddish-brown coloration as a result of the oxidation of sulfides. Most veins occupy persistent shear zones and associated breccias related to faults. Clasts of the breccias have been altered and silicified by mineralizing hydrothermal agents. At the American Flag and Silver Bell mines, fluorite accompanies quartz and fills voids in breccia.

The strike and dip lengths of the district's veins are poorly known. The Bodie vein may be as long as 6,000 feet, but most other veins are probably less than 1,000 feet in length. Underground, no single vein has been developed more than 1,000 feet along its strike, and for no more than 500 feet down its dip. At the Bodie mine, the vein exceeds these dimensions as mining operations ceased before the limits of the vein were reached. At no property in the Wauconda district has the limits of veins on their dips been reached, because most mining has not been deeper than 150 feet on the dip of the vein from its outcrop.

Past mining operations provide some data on the metal content of the veins. At the Bodie mine, 61,847 tons of ore yielded 0.15 ounce per ton in gold and 0.11 ounce of silver on heads that averaged 0.21 ounce per ton in gold. At the Phil Sheridan mine, high-grade ore shoots contained as much as 200 ounces per ton in silver, and 3.5 ounces in gold. At the Zalla M hand-sorted ore contained 86 to 118 ounces per ton in silver, 0.17 to 0.25 ounce in gold, and 1.0 percent copper. Sampling by the writer of select dump and vein samples from the Bodie, Sheridan, Zalla M, Silver Bell, American Flag, and Lupin properties showed only traces to 0.20 ounce of gold, traces to 15.2 ounces of silver, traces to 3.15 percent copper, and traces to 1.15 percent lead.

Mineralization is late upper Eocene, or post Eocene as is indicated by the presence of metalliferous veins in upper Eocene volcanic rocks of the Klondike Mountain Formation. Most veins occur along shear zones and formed essentially contemporaneously with faulting that took place after the deposition of the upper Eocene volcanic rocks. The sources of magmatic gases and vapors that formed the mineralized veins are not known but appear to have originated from underlying congealing magmas, which were also sources of the region's youngest volcanic rocks. The presence of gold, silver, fluorite, chalcedonic quartz, and calcite, as well as rhythmic banding of the minerals and comb and cockade vein structure, suggests an upper epithermal zone (100°C to 150°C) of mineral deposition. In many mineral deposits fluorite is generally confined to lower and upper epithermal zones and is usually closer to the surface than sulfide minerals, which may account for the deficiency of sulfides in fluorite-rich veins and breccias. Possibly a zone of sulfide minerals may underlie the fluorite zone.

Disseminated Deposits

Disseminated sulfide deposits, other than disseminated sulfides in veins and shear zones, occur in contact metamorphic zones in Permian eugeosynclinal rocks, and in silicified zones in upper Eocene volcanic rocks. Common eugeosynclinal host rocks are marble, phyllite, and calc-silicate schists. In these rocks, typical contact metamorphic minerals, such as garnet, epidote, and magnetite, are sparse. Sulfides, consisting chiefly of pyrite, pyrrhotite, chalcopyrite, galena, and sphalerite, occur as small to medium-size disseminated grains. In places, the minerals are concentrated into small blebs and bunches along bedding planes in metasedimentary rocks that favored deposition. About 1.25 miles southwest of Cumberland Mountain, hornfels and diorite at the Lupin prospect contain minor disseminated chalcopyrite. This mineralization does not appear extensive, and representative samples from several prospect pits assayed only 0.20 percent copper. Possibly higher copper values may occur at deeper depths along intrusive contacts of underlying granitic rocks.

The disseminated sulfide deposits of silicified zones in upper Eocene volcanic rocks are weakly mineralized. Other than sparse to minor amounts of pyrite, which carry trace amounts of silver, these deposits appear to be barren of other ore minerals and to date (1979) have never been productive.

Breccia Deposits

Apart from minor breccias associated with the vein deposits, at least one persistent tectonically modified volcanogenic breccia occurs in volcanic rocks of the Toroda Creek area and the possibility exists that similar breccias have yet to be discovered. At the Bodie mine a breccia, 100 to 300 feet wide, contains sparse gold and silver; parts of the breccia have assayed up to 0.15 ounce per ton in gold and 0.23 ounce of silver. The wide width of the breccia, its significant gold and silver content, a dip length in excess of 500 feet, and strike length in exess of 1,500 feet offers possibilities of a large low-grade gold deposit. The proximity of the gold-bearing breccia to the Bodie vein suggests that the breccia served as the loci of deposition for minerals, possibly the same time the Bodie vein formed.

WAUCONDA AREA

The Wauconda area (fig. 29) is in the southern part of the Wauconda district and centers about the old mining camp of Wauconda, site of the abandoned Wauconda mine. The area is about 14 miles west of Republic by way of State Highway 20, and about 5 miles east of the settlement of Wauconda. Deposits of gold and silver were discovered in the area in the late 1890's, but most veins proved to be only sparsely mineralized and the mining boom was short lived. The bulk of the work was undertaken at the Wauconda mine where Wauconda Gold Mining Co., between 1900 and 1904, drove over 2,000 feet of crosscut adits and drifts and erected a 60-ton amalgamation mill for the treatment of gold ore. Around 1905, mining activity at the Wauconda ceased and the mining camp of Wauconda soon became deserted. Except for caved portals and grown-over mine dumps, few signs of past mining operations remain.

Sparsely mineralized gold-bearing quartz veins in Permian metasedimentary rocks represent the area's only metallic mineral occurrences and none appear to contain significant amounts of gold and silver. Currently, no mining operations are in progress in the area.

Wauconda

The Wauconda mine, which is near the center of S½ sec. 7, T. 37 N., R. 30 E., is the chief property of the area (see fig. 9). From 1898 to 1904, Wauconda Gold Mining Co. expended large sums of money in the development of the property. Several thousand feet of crosscut adits and drifts were driven, and a 60-ton concentrating mill was built at the portal of the main adit. In spite of the work it appears that the mine never reached production stage as production figures do not exist. The property consists of one patented mining claim (Wauconda No. 3, M.S. 630), but during its active years an additional 32 unpatented claims were part of the property.

The Wauconda adit is about 1 mile south of Wauconda Summit on State Highway 20, and about 400 feet west of the highway. The adit heads almost due west for 1,000 feet into Permian metasiltstone and fine-grained marble. Less than half a mile west, these rocks are intruded by Mesozoic granitic rocks. The adit is caved at its portal, as are other adits on the property, but the nature of the underground workings has been discussed by Landes and others (1902, p. 25-26). According to Landes, a 40-foot-wide gold-bearing quartz vein was encountered in the adit at 700 to 740 feet from the portal. The vein strikes N. 30° W. and dips 60° NE. The gold content of the vein ranges from 0.5 to 1.0 ounce per ton, the average being 0.60 ounce. The vein occurs in the Oregonian ledge, which consists of 200 feet of mixed quartz and slaty rock. The quartz vein has been drifted upon to the south for 50 feet and to the north for 80 feet. Landes and others (p. 26) report that the main adit does not intersect the Wauconda ledge, which was partially developed by an adit 250 feet above the main adit. This adit crosscut the Wauconda ledge for 74 feet without encountering the hanging wall; 215 feet of drifts were driven on the ledge.

The Wauconda mill, as described by Landes (p. 116-118), was a 60-ton stamp mill using pan amalgamation to recover the gold. In conjunction with the mill a sampling mill was built to test mine-run samples. Numerous 50-pound samples gave values of $10 to $18 per ton in gold, with a 95 percent gold recovery.

During the examination of the Wauconda mine the writer could not turn up any evidence to verify the presence of gold-bearing vein quartz as reported by Landes. Only traces of gold were present in quartz samples from mine dumps, and apparently the mill did not operate long enough to produce a tailings pond—if it operated at all. Only by reopening the mine adits or core drilling can the existence of a 40-foot-wide, gold-bearing vein be verified.

Umbra and Sundown

This property consists of five patented mining claims that, around 1906, underwent minor exploration. The claims are in the NE¼ sec. 19, and NW¼ sec. 20, T. 37 N., R. 31 E., and consist of the Umbra, Snetisham, Sundown, Hold Fast, and Nootsack, all of Mineral Survey 862 (see fig. 9). The claims are accessible from State Highway 20, which crosses them 2.75 miles east of Wauconda Summit. The area of the claims is underlain by Permian hornfels and Mesozoic granodiorite. On the Umbra claim a 199-foot adit heads S. 55° W. into a low northwest-trending ridge. On the Sundown claim a 121-foot adit heads N. 70° E. into the same ridge but on the opposite side of the Umbra adit; the adits are about 700 feet apart in a general northeast-southwest direction. The portals of both adits are caved and, except for minor pyrite, no ore minerals were noted in the dump material of either adit.

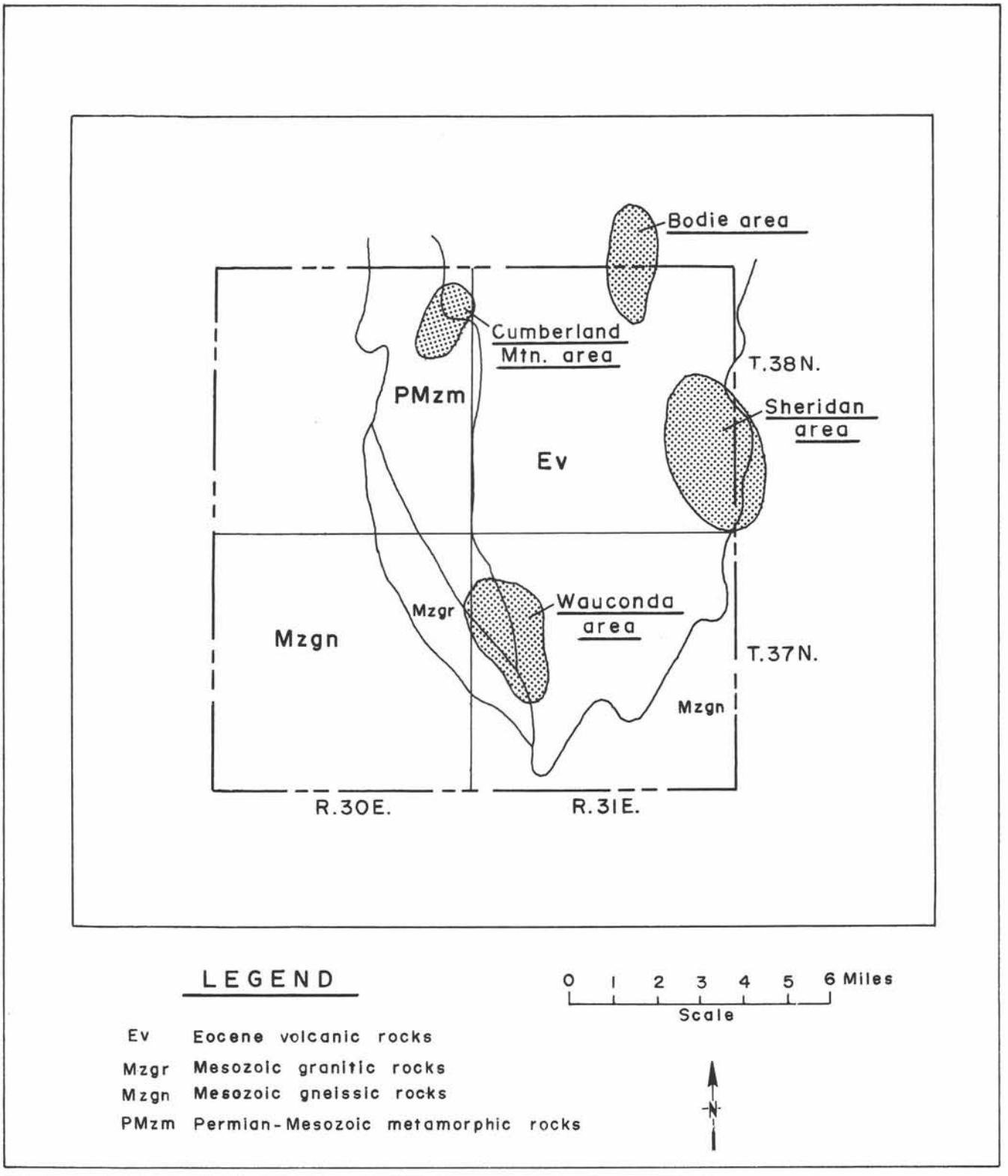


Figure 29.—Chief areas of metallic mineralization in Wauconda mining district.

CUMBERLAND MOUNTAIN AREA

The Cumberland Mountain area is in the north-central part of the Wauconda district and about 2.5 miles east of Bonaparte Lake (fig. 30). Occurrences of copper, lead, zinc, and silver were discovered in the area at the turn of the century, but proved to be small. Based on locations of old prospect pits and caved adits, most mining activity appears to have been undertaken in secs. 12 and 13, T. 38 N., R. 30 E. This area is underlain by Permian metasedimentary rocks, which in part were intruded by alkalic rocks of possible Eocene age. The intrusive rocks were probably sources for mineralizing agents that formed the small disseminated deposits of the area.

No record of production can be found for the area, but a moderate amount of work appears to have been undertaken at the Lupin property. Most underground work at the Lupin appears to have been done in the late 1890's and early 1900's, but some dozer trenching may be as recent as 1950. The presence of survey stakes at the portals of several adits suggests that the property was investigated as recently as 1978 by mining companies.

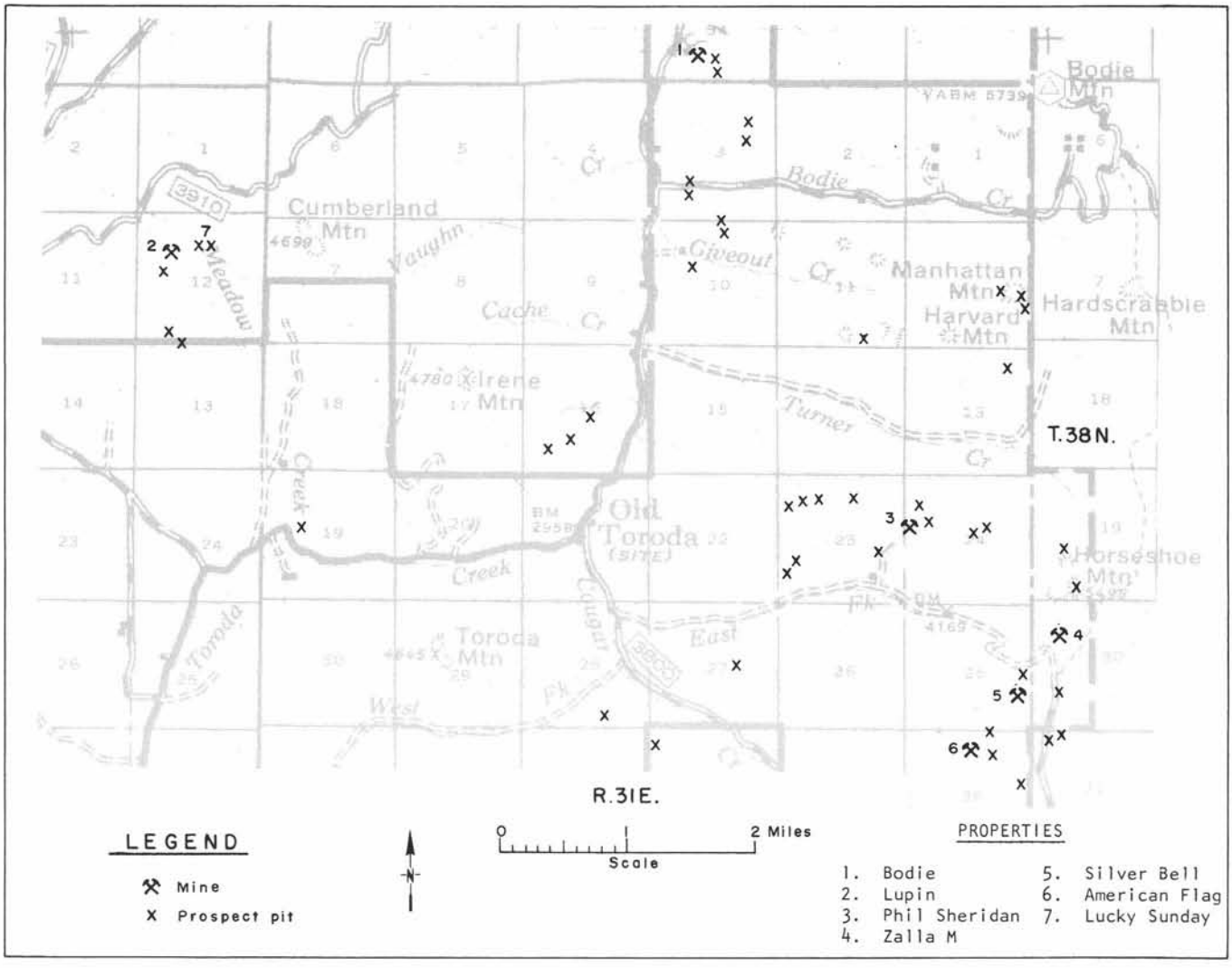


Figure 30.—Mines and prospects of Bodie, Sheridan, Cumberland Mountain, and Wauconda areas of the Wauconda district.

Lupin

This prospect is 3 miles east of Bonaparte Lake and 1.25 miles west of Cumberland Mountain (fig. 30). It is in the NW¼ sec. 12, T. 38 N., R. 30 E., and most readily accessible from the Bonaparte Lake road. About 1.5 miles north of Bonaparte Lake Resort, Forest Service road 388 can be followed 2.6 miles to the SW. cor. sec. 1. At this location an abandoned logging road heads south 0.5 mile to the site of the caved adits and several antiquated log cabins.

Country rock in the area consists of Permian phyllite, calc-silicate schist, and white to gray limestone. Some limestone contains disseminations and blebs of fine-grained galena and sphalerite. Several adits have been driven into mineralized limestone, but only sparse and sporadic mineralization was encountered. On the dump of the lowest adit a select ore sample collected by the writer assayed 85 ounces per ton in silver, 0.12 ounce of gold, and 26.7 percent lead. Small stringers of galena in the adit contained only 5 ounces of silver and traces of gold. This lower adit, at 4,000-foot elevation, heads S. 70° E. into interbedded phyllite and limestone (fig. 31). It is about 140 feet long and does not expose any ore minerals. Near the face of the adit is a 15- by 20-foot room from which the ore on the dump may have been mined. About 60 feet from the portal and in the lower adit, an incline rises 20 feet to an upper level that heads S. 70° E. for 275 feet into phyllite and limestone. This level contains three crosscuts and seven short raises. The crosscuts are 40 to 50 feet long, and except for one 25-foot raise the raises are not over 5 feet long. The only mineralization exposed in the upper level is galena and sphalerite that occur as sparsely disseminated grains or as small pods and blebs. Two channel samples of the mineralized areas contained 0.18 to 3.70 ounces per ton in silver and 0.02 to 0.05 percent lead (fig. 31). Except for about 5 tons of hand-sorted ore on the dump of the lowest adit, other adit and prospect pit dumps appear barren of ore-grade material.

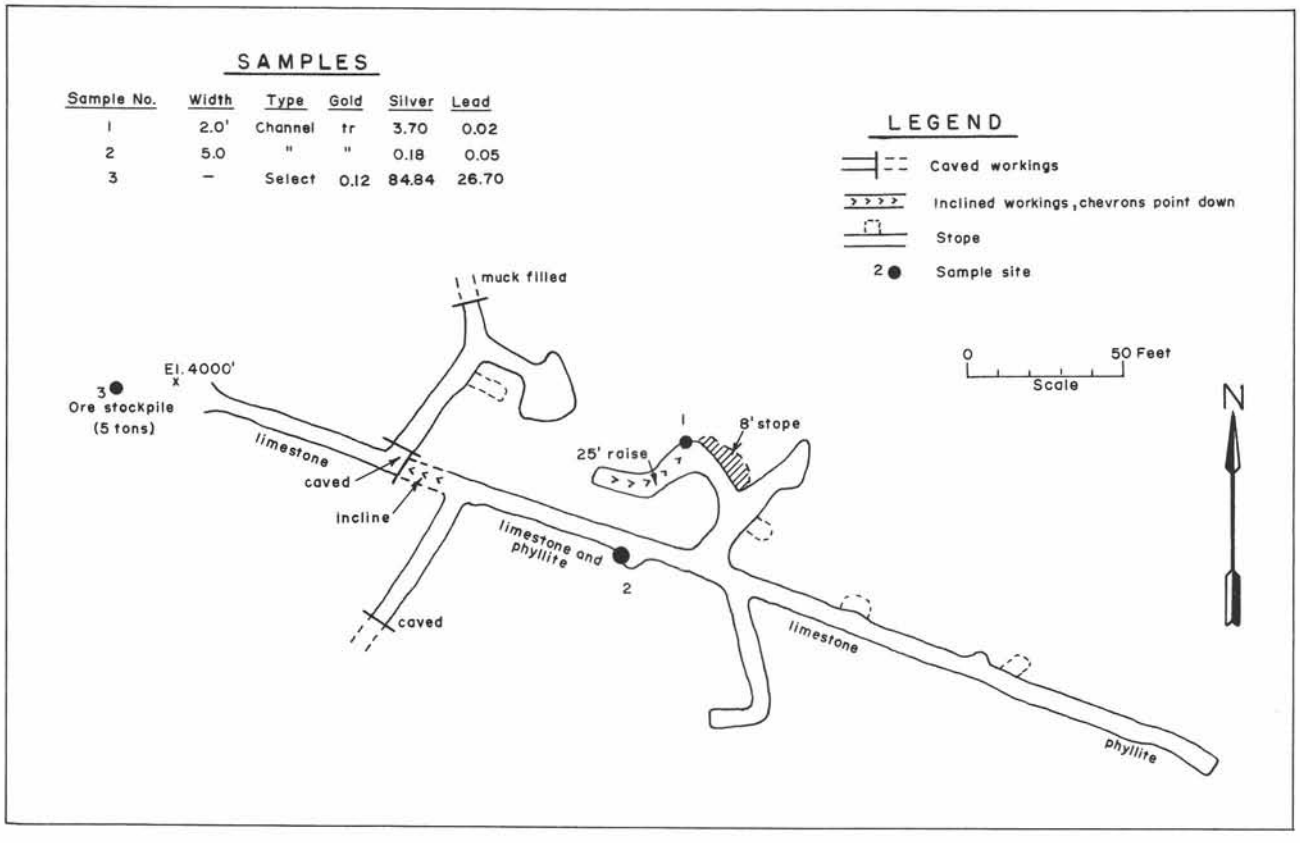


Figure 31.—Lupin adit.

Whitestone

This property is in the N½ sec. 27, T. 39 N., R. 30 E., which is about 0.5 miles northeast of Strawberry Mountain. The writer was unsuccessful in several attempts to locate this property. According to Kenneth Fox, Jr., of the U.S. Geological Survey, several shallow prospect pits occur on a shelf to the west and adjacent to Box Canyon; these could be the Whitestone mine workings.

Small amounts of copper, lead, and zinc ore were mined from 1918 to 1938 (Division of Geology files). The only mention of this property in U.S. Bureau of Mines Minerals Yearbook is for 1938, when Whitestone Mining Company reportedly produced undetermined amounts of ore.

Ore minerals at the Whitestone mine consist of galena, sphalerite, and tetrahedrite that occur on tops and bottoms of low-dipping limestone beds, as well as in stringers cutting the beds (Washington Division of Geology and Earth Resources files).

Lucky Sunday

This prospect is around 1,850 feet east of and 250 feet higher in elevation than the Lupin. It is near the center of the N½ sec. 12, T. 38 N., R. 30 E. Cumberland Mountain is 0.75 mile east of the Lucky Sunday (fig. 30). The prospect can be reached by hiking in an easterly direction from the Lupin mine, or by following a maze of abandoned logging roads one may drive to within 1,000 feet of the main shafts of the prospect. In 1972, the property consisted of eight unpatented claims; the current (1979) status of the claims is unknown to the writer.

Country rocks in the vicinity of the property consist of upper Paleozoic (possibly Permian) metasedimentary rocks; hornfels, phyllite, quartzite, metadiorite, and amphibolite predominate. On the northeast end of the claims the metasedimentary rocks have been intruded by diorite and pyroxenite of early Eocene age. Mineralization at the Lucky Sunday appears to be confined to a poorly exposed, N. 80° E. trending shear zone, site of several shallow shafts, prospect pits, and trenches. The deepest shafts, which are only 60 feet apart, are 30 and 40 feet in depth. At the bottom of the shafts short drifts have been driven along the mineralization shear zone. Rocks of the shear zone contain abundant iron oxide and moderate amounts of malachite. These minerals are accompanied by sparse to moderate amounts of fine- to medium-grained chalcopyrite. Some chalcopyrite also occurs as disseminations in wall rock adjacent to the shear zone. Although parts of the shear zone contain up to 5 percent chalcopyrite, four representative samples of the shear zone and copper-mineralized wall rock averaged only 0.25 percent copper. The same samples averaged only 0.04 ounce per ton in gold and 0.50 ounce in silver.

Most prospect pits, shafts, trenches, and adits at the Lucky Sunday are confined to the crest of a northeasterly trending ridge, for it is along this ridge that most mineralization occurs. However, several short adits have been driven into the southeast slope of the ridge at lower elevations, possibly to intersect the downward extension of the mineralized shear zone. Judging from the size of the adit dumps not one adit was driven far enough to reach the shear zone. All exploratory work at the Lucky Sunday, which includes minor diamond drilling on outcrops in the vicinity of the main shafts, appears to have been done around the early 1900's; no evidence of recent work on the claims was observed by the writer.

BODIE AND SHERIDAN AREAS

Mines and prospects of the Bodie and Sheridan areas are in the northeastern part of the Wauconda district (fig. 30). All properties are east of Toroda Creek and are between Bodie Mountain on the north and Clackamas Mountain on the south. This area encompasses the old mining districts of Bodie, Sheridan, Toroda, Cascade, and Ballarat. The initial mineral discoveries were made in 1897, and in the following year the first shipment of high-grade silver ore was made from the Zalla M mine. By 1900, substantial development work had been completed at the Zalla M, Bodie, and Sheridan mines, and several small shipments of crude ore had been made to west coast smelters. Concentrating mills were built at the Bodie in 1905, and at the Sheridan in 1919, but in 1920, all mining in the area ceased. In 1930, the Bodie mine was reactivated by Northern Gold Corp. Mining and milling were undertaken until 1944, at which time mining operations came to a standstill. During the years the mines of the Bodie and Sheridan area operated, they produced about 95 percent of the metals mined in the Wauconda district. In the years following 1944, little in the way of mining has been carried out, but sporadic exploration for gold and silver has taken place. To date (1979), most exploration work has been done in the Sheridan area on low-grade silver deposits, but in the Bodie area occasional mine evaluations have been carried out at the Bodie mine to evaluate its gold potential.

American Flag

This property, which consists of one patented claim (American Flag, Mineral Survey 1093), is in the NE¼ sec. 36, T. 38 N., R. 31 E., at an elevation of 4,500 feet (fig. 30). Access to the property is by way of

the East Fork of Toroda Creek from the west, or by way of Granite Creek from the east on the Sheridan road. On this road near the NE¼SW¼ sec. 31, T. 38 N., R. 32 E., an abandoned mine road can be followed 1 mile west to the mine workings.

The initial discovery of copper minerals was made in 1898, at which time minor exploratory and development work was undertaken. However, it was not until 1918 and 1919, that two 30-ton shipments of copper ore were made. No record of mining exists after 1919, but the property has been examined on several occasions by mining companies.

The American Flag mine is in the southernmost property of the Zalla M-Silver Bell-American Flag mineralized belt that is about 1 mile long and several hundred feet wide (see page 62 for a description of this belt). Host rock for ore minerals at the American Flag consists of silicified and fluoritized sanidine-rich trachyte of the middle member of the Klondike Mountain Formation (upper Eocene). According to Patty (1921, p. 196-198), the main mineralized structure is a 2- to 8-foot-wide silicified shear zone that strikes N. 45° E. and dips 50° NW. As much as 5 percent purplish to bluish fluorite occurs in sheared and brecciated trachyte. In addition to fluorite, some clasts of the breccia are cemented by sanidine and quartz. Ore minerals consist of chalcopyrite, bornite, sphalerite, galena, and pyrite, which are localized into ore shoots up to 23 feet long. One ore shoot 16 feet long averaged 13 ounces per ton in silver, while another shoot 23 feet long averaged 27 ounces per ton in silver (Patty, 1921, p. 197). Patty also reports that the 60 tons of ore shipped in 1918 and 1919 averaged 36 percent copper, 16 ounces per ton in silver, and 0.10 ounce in gold.

The main adit of the mine is caved at its portal, but according to Patty (1921, p. 197) the adit is 97 feet long and heads N. 45° E. along a mineralized shear zone. About 49 feet from the portal a winze extends 97 feet down the dip of the shear zone. Near the face of the adit a 50-foot raise extends to the surface; this raise is open, but hazardous, and does provide access to the adit. Ore that was shipped came from a small stope; it is not known if ore is present in the winze, which is full of water. On the surface above the adit the silicified and fluoritized breccia appears to be as much as 250 feet in diameter. Prospect pits on the mineralized shear zone reveals that it is as much as 10 feet wide and extends up the hillside for about 500 feet in a N. 45° E. direction from the portal of the adit. For the most part the shear zone appears barren of ore minerals. Several samples collected by the writer along the shear zone contained only traces to 0.20 ounce per ton in silver. Two select mineralized dump samples contained 7.50 and 12.25 ounces per ton in silver.

Silver Bell

The Silver Bell mine is in the NW¼SE¼ sec. 25, T. 38 N., R. 31 E., at elevations of 4,500 to 4,750 feet (fig. 30). It is about 2,000 feet northeast of the American Flag mine, and 3,000 feet southwest of the Zalla M mine. From near the center SW¼ sec. 30, T. 38 N., R. 32 E. on the Sheridan road, spur roads may be followed west for about 0.25 mile to the mine camp and main adit, and another spur road can be followed west 0.20 mile to the main silver-fluorite mineralized outcrop on a rocky ridge above and northeast of the camp. The property is in part on state-owned land and in part covered by eight unpatented mining claims, the mine workings of which are on Silver Bell and Silver Bell No. 2 claims.

Huntting (1956, p. 148) reports that high-grade gold ore was shipped from surface pits prior to 1907. In 1940, Silver Bell Mining Co. shipped 29 tons of ore with a net return of $244.03. Because of significant silver values in prominent outcrops the property has been under investigation by several mining companies in recent years. Currently the property is under development by Rocky Mines of Tacoma.

The Silver Bell mine is near the center of the Zalla M-Silver Bell-American Flag mineralized belt, which is almost a mile long and several hundred feet wide. Host rocks for silver mineralization at the Silver Bell consist of brecciated and silicified alkali trachyte of the middle member of the Klondike Mountain Formation (upper Eocene). The breccia has a general northeast strike and dips about 45° west; it appears to be 50 to 75 feet wide. Quartz of the silicified breccia is accompanied by up to 4 percent purple fluorite, as well as minor amounts of sanidine. The quartz, fluorite, and sanidine fill voids between clasts of the breccia and form thin stringers in shear zones. The silicified breccia forms a prominent outcrop about 800 feet northeast of the mine camp. Much of the breccia is void of vegetation and stained orangish brown due to oxidation of pyrite. Other than sparsely disseminated pyrite, metallic minerals are seldom visible, and only by assaying can the silver content of the breccia be ascertained. X-ray analyses by the writer of select ore specimens revealed the presence of disseminated chalcopyrite, galena, tetrahedrite, and pyrite; no silver mineral could be detected, even in ore that assayed as much as 8.75 ounces per ton in silver.

The silver-bearing siliceous breccia has been sampled and assayed on several occasions by consulting geologists and mining companies. Assays of representative samples have shown from no silver to as much as 30 ounces per ton in silver; gold occurs from traces to 0.02 ounce. As much as 120 feet of the breccia assayed 3.0 ounces per ton in silver, whereas

13 feet of the breccia assayed as much as 26.55 ounces. Jim Moore (property owner) reports that extensive core drilling in the fall of 1978 of the breccia outcrop delineated 124,000 tons of rock having an average value of 5.46 ounces per ton in silver and 0.014 ounces in gold. Further coring will no doubt establish additional reserves as the deposit has not been completely drilled out.

Underground mine workings at the Silver Bell outcrop consist of a 50-foot adit, a 50-foot shaft, and several shallow shafts all on the siliceous silver-bearing breccia (see plate 5). The mine's main adit is about 450 feet southwest and 150 feet lower than the above-mentioned workings (see plate 5). This adit has been driven about 600 feet at a heading of N. 50° E., and at 400 feet intersects the downward extension of the mineralized breccia of the upper workings. In the course of driving the adit, some silver-bearing fluoritic trachyte was encountered. Most samples contained less than 1 ounce per ton in silver; a few samples contained 3 to 8 ounces. Longhole drilling from the adit could intersect enriched parts of the silver-bearing breccia and as such could appreciably increase the ore reserves of the property.

Zalla M

The Zalla M mine is in the S½NW¼ sec. 30, T. 38 N., R. 32 E., and about 3,000 feet northeast of the Silver Bell mine. Although the property is 0.2 mile east of the eastern edge of the Wauconda district and in Ferry County, a discussion of the Zalla M is included in this report because of its proximity and similarity to other silver deposits of the Sheridan area of the Wauconda district (fig. 30).

The Zalla M group consists of five patented mining claims: Zalla M (Mineral Survey 453), Fannie Woodard (M.S. 453), Discovery (M.S. 544), Grand View (M.S. 647), and Kittie Glide (M.S. 1092). These claims are on the southwest slope of Horseshoe Mountain and at elevations of 4,500 to 5,000 feet. Near the W¼ corner sec. 30, T. 38 N., R. 32 E., a spur road off the Sheridan road can be followed 0.2 mile to the main adit of the Zalla M claim.

The first discovery of silver in the Sheridan area was made at the Zalla M in 1898. From 1898 to 1903, ore valued at around $40,000 was shipped to British Columbia smelters. Huntting (1956, p. 295) reports that in 1935, ore was shipped from the mine dump, but the value of the ore is not reported. Except for occasional mine examinations by mining companies and consultants, the property has been idle for many years.

The Zalla M vein is the northernmost vein of the Zalla M-Silver Bell-American Flag mineralized belt (see p. 62 for discussion of belt). The vein consists chiefly of quartz and minor calcite. Host rocks for the vein are silicified and propylitized tachitic andesite and andesite breccia of the middle member of the Klondike Mountain Formation (upper Eocene). The vein, which is 1 to 6 feet wide, strikes N. 25° E., dips 45° to 70° NW., and has been traced on the surface by prospect pits and outcrops for several thousand feet. Wall rock adjacent to the vein has in part been brecciated and sheared. Quartz, calcite, and fluorite act as cementing agents of the breccia and also form veinlets ⅛ to 1 inch wide in sheared wall rock parallel to the vein. Common alteration minerals of wall rock adjacent to the vein are chlorite, silica, epidote, calcite, zoisite, and sericite. Except for minor pyrite, metallic ore minerals are seldom visible in the Zalla M vein. Select ore samples from the main mine dump contained minor chalcopyrite, galena, and pyrite and assayed up to 10 ounces per ton in silver and 0.03 ounce in gold. Pearson (1967, p. 3) reported the presence of hessite (Ag_2Te) and krennerite? $(Au,Ag)Te_2$. The Zalla M vein, as exposed for about 350 feet in the drift of the main adit, ranges from 2 to 12 inches in width. In places it contains scattered grains of pyrite, chalcopyrite, and galena that are accompanied by green malachite staining and rusty iron oxide. Ore mined in the past occurred in ore shoots in a zone of secondary enrichment that extended from the surface to a depth of about 150 feet. This zone is above the level of the main adit.

The main adit heads S. 45° E. for 510 feet before encountering the Zalla M vein. At this point the vein has been drifted upon for 65 feet to the northeast and for 240 feet to the south-southwest (fig. 32). At the point of intersection of the crosscut adit with the vein, a raise follows the vein for about 150 feet to the surface. About 30 feet southwest of the raise, a winze extends 70 feet down the dip of the vein and a raise extends up for an undetermined distance above the level. Southeast of the shaft the vein has been stoped above and below the adit level for as much as 60 feet. The drift follows the vein in a southerly direction for about 175 feet, at which point it narrows to 2 to 6 inches and becomes vuggy. Although quartz veinlets occur in the last 75 feet of the drift, there appears to be no continuity to them. Near the face of the drift the quartz occurs chiefly as scattered euhedral crystals ⅛ to ¼ inch across and up to ½ inch long.

At the outcrop of the vein above the drift the vein has been stoped along its strike for 100 feet and to depth in excess of 50 feet. In the stope the vein is 1.5 to 2.5 feet thick, strikes N. 25° E. and dips 70° W. Much of the vein is vuggy and contains euhedral quartz crystals ⅛ to ½ inch long. Except for minor pyrite, much of the vein appears barren of ore minerals. Patty (1921, p. 200) reports that the richest silver ore assayed 60 to 150 ounces per ton and occurred in a well-defined ore shoot that was about

150 feet long and yielded 5,000 tons of hand-sorted ore; the ore shoot was stoped to the surface. The average silver content of the vein was much lower, as is shown by smelter returns. About 1,000 tons of ore shipped in 1902 and 1903 averaged only 24.42 ounces per ton in silver and 0.34 ounce in gold. Patty also reports that a 1,000-foot crosscut adit was started prior to 1920, 400 feet downslope from the main adit. However, after driving this adit less than 100 feet it was abandoned.

Judging from the appearance of the Zalla M vein in the adit and surface stope it appears that the richest parts of the vein have been mined from the main adit level to the surface. Some ore may remain below the

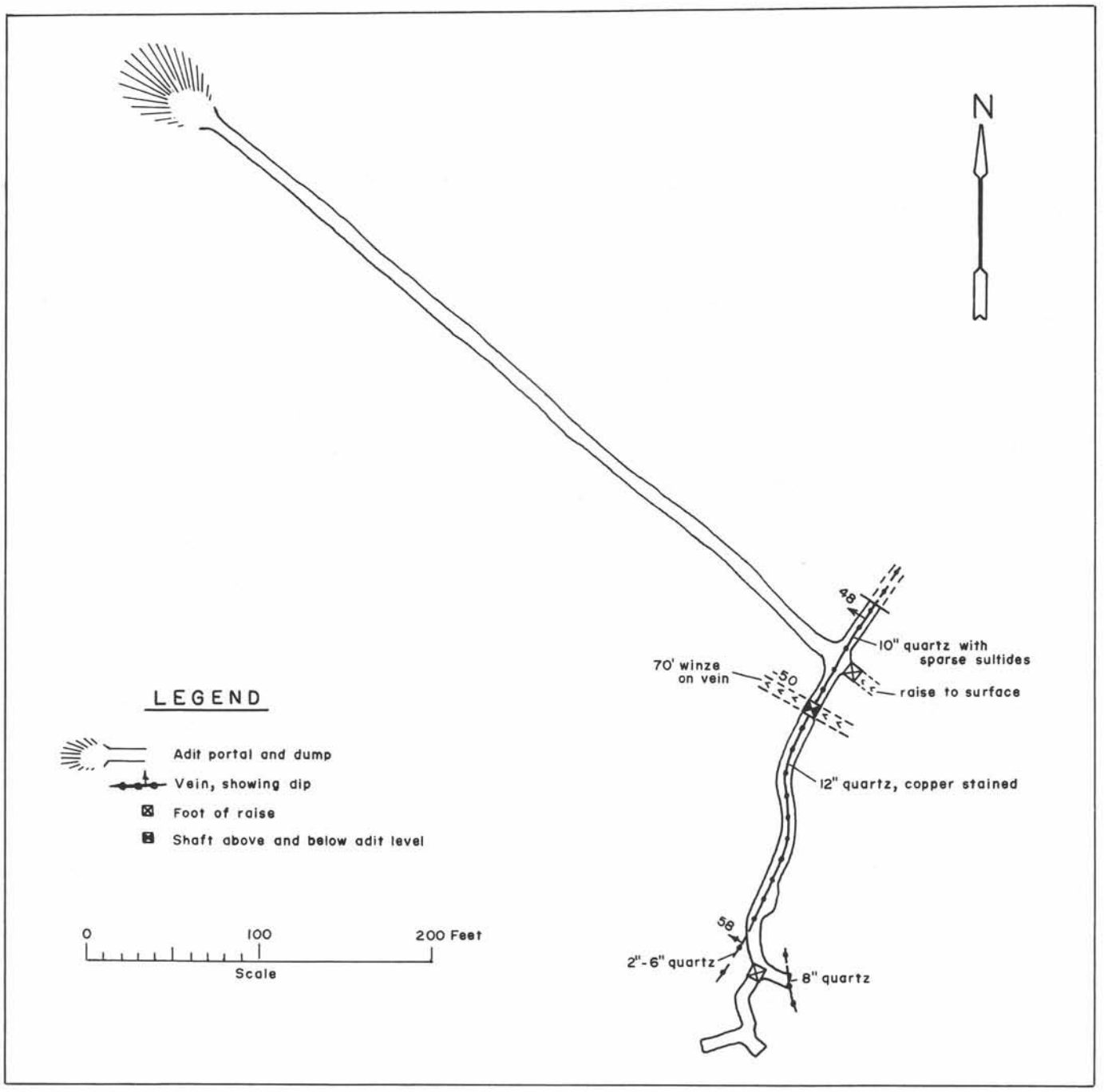


Figure 32.—Zalla M adit.

adit level but the absence of mine workings below the level prevents evaluation of the vein at depth. The southern extension of the vein in the main drift narrows to thin barren stringers, but the northern extension of the vein appears persistent and could contain additional ore shoots. However, the northern end of the drift is inaccessible due to caved ground several feet north of the intersection of the crosscut adit and the vein.

Phil Sheridan

This property is in the SW¼NW¼ sec. 24, T. 38 N., R. 31 E. at an average elevation of 4,500 feet (fig. 30). From near the center of SE¼ sec. 23 on the Sheridan road a spur road may be followed north about 0.5 mile up a gulch to the mine; the last 0.1 mile is accessible only by foot. The mine workings are on deeded land and not covered by mining claims.

The original mineral discovery was made around 1900, at which time several crosscuts, drifts, and shafts were dug to explore silver-bearing veins. From 1906 to 1919, shipments of high-grade gold-silver ore were made to smelters. In 1918, a 50-ton flotation mill was built at the mine, and concentrates averaging as much as 300 ounces per ton in silver were shipped until 1920. Over this period of time, mine production is estimated at $60,000 to $100,000. The mill has succumbed to the ravages of time, and all mine workings are inaccessible because of caved adit portals and shaft collars. Except for recent surface exploratory work by several mining companies, the mine has been idle since 1920.

At the Phil Sheridan, silver minerals occur in a series of closely spaced silicified and pyritized shear zones in andesites and rhyolites of the middle member of the Klondike Mountain Formation (upper Eocene). Brecciation of the rocks accompanied the shearing, and clasts of the breccias have been considerably altered and silicified by hydrothermal solutions. The main silver-bearing zone is 1 to 7 feet in width, strikes N. 20° E., and dips 50° NW. It is on the east side of a northerly trending gulch that appears to be the topographic expression of a major shear zone. The upper part of the mineralized shear zone contains considerable quartz and calcite that carries dustlike particles of unidentified silver minerals, as well as fine-grained pyrite. During mining operations it was necessary to closely assay the vein material in order to establish borders of ore shoots. Patty (1921, p. 195) reports that grab samples from one of the upper dumps contained 16 ounces per ton in silver and mill feed averaged 15 ounces. In the course of the examination of the Phil Sheridan the writer collected 10 samples from widely scattered mine dumps and siliceous outcrops. The silver content of the samples showed a high of 152 ounces per ton in silver on a select sample of ore from a dump, to lows of 0.02 ounce on chip samples of altered andesite. The gold content of the samples ranged from 0.001 to 0.20 ounce per ton. The average silver content for the 10 samples was 1.60 ounce per ton; gold averaged 0.02 ounce. The highest silver values occur in iron-stained siliceous rocks. The average silver content of four siliceous outcrops was 6.75 ounces per ton.

Caved adit portals prevent underground examinations of the vein. According to Patty (1921, p. 195) a width of 3 to 4 feet of the vein was rich enough to mine. The vein was mined from several levels over vertical distance of about 500 feet, and along the strike of the vein for about 400 feet. Most adits have a general heading of about N. 35° E., and in the lowest adit a winze was sunk to a depth of 200 feet on the vein. Several raises connect the different levels of the mine. The lowest adit, which is near the bottom of the main gulch, is reported to be 190 feet long; the middle adit, which is about 70 feet higher in elevation, is 160 feet long and has 390 feet of drifts; the upper adit, which is about 130 feet higher than the middle adit, is 300 feet long. The lowest adit is about 750 feet north of the mill, which is also in the bottom of the main gulch.

Bodie (Northern Gold)

The Bodie gold mine is in the SE¼SW¼ sec. 34, T. 39 N., R. 31 E. on upper Toroda Creek (fig. 30). Access to the property is by way of the Toroda Creek road which passes over the western edge of the claims. East of the road, dumps of several adits can be seen high on the mountainside at elevations of 2,750 to 3,250 feet. The Bodie group consists of five patented claims: Bodie, Bodie No. 2, West Cliff, Crystal Butte, and Little George, all of Mineral Survey No. 721. At one time as many as 10 unpatented claims were part of the Bodie group; the current status of the unpatented claims is unknown to the writer.

The Bodie vein was discovered in 1897, and in 1902, mining was undertaken on rich near-surface parts of the vein, which assayed as much as 20 ounces per ton in gold; in some oxidized parts of the vein much free gold was visible. A 10-stamp amalgamation-cyanide mill was built to recover the gold, and from 1902 to 1916, around 15,000 tons of gold ore was milled. Because of poor gold recovery, as well as mining and management problems, operations ceased in 1916. In the years that followed, several companies were organized to operate the mine, but most were unsuccessful. In 1930, under Northern Gold Corp. management, the mine was reactivated.

The company constructed a 70-ton mill using amalgamation plates and Wilfley tables to recover free gold and gold-bearing sulfides from low-grade ore that contained about 0.65 ounce per ton in gold and 0.60 ounce in silver. In 1938, the capacity of the mill was increased to 125 tons per day and cyanidation and flotation circuits were added. Mining and milling operations were carried out until 1944, with as many as 40 miners working three shifts, and up to $1,500 of gold and silver being produced each day. From 1930 to 1944, around 50,000 tons of ore valued at about $280,000 was mined. Total production from 1902 to 1944 is estimated at about 60,000 tons, which contained $300,000 in gold and silver. Mining companies organized at different times to operate the Bodie include B. and J. Mining Co. (1908-1909); Duluth-Toroda Mining Co. (1910-1912); Toroda Development Co. (1915-1916); Cary Mining and Development Co. (1916-1922); Blue Stem Mining Co. (1921-1926); Northern Gold Corp. (1930-1944). Currently (1979), nothing remains of the Bodie mill and several adits are inaccessible because of caved portals and drifts.

Geology

Rocks in the vicinity of the Bodie mine consist of lithoidal lava flows and pyroclastic breccias of the middle member of the Klondike Mountain Formation (upper Eocene). Although these rocks have general north to north-northeast strikes and low to moderate easterly dips they exhibit diverse strikes and dips at the Bodie mine, especially near faults. Gold-silver mineralization at the Bodie is confined chiefly to a persistent quartz fissure vein, as well as to an extensive breccia that parallels the vein.

The Bodie vein is 2 to 22 feet wide and for the most part consists of many closely spaced parallel quartz veins. Individual quartz veins are several inches to 5 feet in width. The vein strikes north to N. 16° E. and dips 60° to 80° W. Silicified, propylitized, and pyritized andesite and dacite, as well as some gouge, occur between individual veins and wall rock. The vein quartz is white to light gray, fine-grained, and often chalcedonic; colloform vein structure is often present as is banding that parallels the walls of the veins. Calcite is present in the quartz, but only in minor amounts. Much of the vein quartz resembles the gold-bearing vein quartz of the Republic district, and like the Republic veins most likely formed through hydrothermal deposition in the epithermal zone (100° to 200°C). Prospect pits along the vein have exposed it intermittently for about 6,000 feet, whereas underground workings of the mine show the vein to be in excess of 500 feet along its dip.

Ore minerals of the Bodie vein consist of gold, chalcopyrite, pyrite, pyrrhotite, and magnetite. Gold is seldom visible even under high magnification; the sulfides and magnetite are fine grained and disseminated in the quartz. Silver minerals do not appear to be present, and the silver/gold ratio is about 1:1. In parts of the vein the ore minerals occur as thin black streaks, which parallel the vein walls. These streaks, which consist of concentrations of dustlike particles of sulfides and gold, have proven to be the richest parts of the vein. Extensive sampling of the Bodie vein in the past disclosed an erratic distribution of ore minerals; however, parts of the vein were sufficiently mineralized to form definite ore shoots; these shoots were 5 to 10 feet wide and up to 250 feet long. Almost all wall rock adjacent to the vein contains minor disseminated pyrite and pyrrhotite and is hydrothermally altered.

The tenor of the ore of the Bodie vein varied widely as is indicated by past mining operations. Ore from the 100 level to the surface averaged about 1 ounce per ton in gold; ore between the 100 and 200 levels averaged about 0.75 ounce per ton; ore between the 200 and 250 levels averaged about 0.4 ounce per ton; and ore between the 250 and 350 levels averaged about 0.125 ounce per ton. Although this indicates a definite decrease in gold with depth (250 feet), along the strike of the vein for as much as 300 feet the gold content was fairly conistent in each level. Ore milled between 1902 and 1944 assayed from 0.10 to 6.90 ounce per ton in gold, and 0.08 to 2.20 ounce of silver; the ore yielded an average of 0.15 ounce per ton in gold and 0.11 ounce in silver. Selective mining of 302 tons of ore between 1940 and 1944 produced ore that averaged 0.89 ounce per ton in gold and 1.48 ounces in silver (U.S. Bureau of Mines, production records). The Au/Ag ratio was 1:0.73; the fineness of the gold was 631.

In addition to the gold-silver bearing quartz veins that comprise the Bodie vein, gold occurs in a large well-developed breccia in volcanic rocks that adjoin the Bodie vein on the west. Like the Bodie vein the breccia strikes north, but dips west at lower angles (35° to 45°) than the Bodie vein (60° to 80°). In upper levels of the mine the breccia forms the hanging wall of the Bodie vein; in the 400 level it is 60 feet west of the vein; and in the 700 level it is about 250 feet west of the vein (plate 4). All crosscut adits to the Bodie vein expose the breccia. In the 400 and 700 levels of the mine the breccia is about 200 feet thick, whereas in the upper levels it is only 50 feet thick due to faulting and erosion. The breccia extends below the 700 level to an undetermined depth, and in the 300 level it is exposed along its strike for 600 feet. The clasts of the breccia consist of highly to moderately altered volcanic rocks of mixed lithology and minor quartz; the clasts are less than an inch to as much as 1 foot across. Cryptocrystalline silica and

minor gouge act as cementing agents for the breccia. Other than fine-grained pyrite, which makes up less than 5 percent of the breccia, metallic ore minerals are seldom visible. Because of the gold-bearing nature of the breccia and its large size, it has been sampled and assayed for gold and silver on several occasions. Woodbridge (1928) reports that 200 feet of breccia in the 400 level averages 0.002 ounce of gold per ton and 0.045 ounce of silver. In the 200 level the breccia averages 0.21 ounce per ton in gold. Sampling by others around 1970, over a 200-foot section in the 400 level, showed 0.15 ounce of gold and 0.23 ounce of silver. As in the case of the Bodie vein, the gold content of the breccia diminishes rapidly with depth.

Development

Over the past 75 years at least 10,000 feet of underground work consisting of crosscut adits, drifts, and raises has been dug at the Bodie mine (plate 4). Five main crosscut adits penetrate the breccia and intersect the Bodie vein to a maximum depth of 600 feet below the apex of the vein; all levels are connected by raises. At the surface, rich parts of the vein were mined from a glory hole that is about 100 feet long, 75 feet wide, and 75 feet deep. Drifts on the vein range from 180 feet to a maximum of about 1,000 feet. The lengths of the crosscuts and drifts for the different levels of the mine follow:

Level	Length of drift on vein (feet)	Length of crosscut[1] (feet)	Condition of workings
100	280	0	Inaccessible
200	740	30-30	Inacessible
250	400	70-70	Accessible
300	1,000	190-190	Inaccessible
400	180	590-345	Accessible to vein; caved along drift
700	0	750-no vein	Accessible

[1]First figure is total length; second figure is distance from portal of crosscut to vein.

To date (1979) most mining has taken place on the Bodie No. 1 claim (plate 4). On other claims of the Bodie group, especially those along the strike of the Bodie vein, numerous trenches, short adits, and shallow shafts have been dug. Assays of the vein in these workings, as shown in old reports, range from 0.17 to 0.50 ounces of gold per ton.

Several gold recovery tests have been made on Bodie ore over the past 50 years. The ore is not complex but the extremely small size of the gold particles makes fine grinding necessary. When ground to minus 200 mesh, up to 40 percent of the gold can be recovered through amalgamation; up to 77 percent can be recovered by flotation; and as much as 94 percent of the gold and 80 percent of the silver can be recovered by cyanidation (Chamberlain, 1936).

In addition to the gold contained in the Bodie vein and breccia, tailings from past milling operations contain sparse amounts of gold and silver. Recent sampling (1975) of the tailings by consulting metallurgists showed 0.031 ounce per ton in gold and 0.1575 ounce in silver. Cyanidation tests show that 90.1 percent of the gold and 66.8 percent of the silver can be extracted by leaching the tailings for 48 hours. Estimates of the volume of tailings range from 40,000 to 70,000 tons.

Summary

The Bodie vein is a persistent quartz fissure gold-bearing vein that has been partially mined. Although ore has been mined for up to 1,000 feet along the strike of the vein, the vein has yet to be adequately tested over its total length, which is in excess of 6,000 feet. Based on past mining and sampling by mining companies, remaining parts of the vein in existing underground workings will probably average 0.15 ounce per ton in gold and 0.75 ounce in silver, but higher values can be expected in near-surface parts of the vein. The Bodie breccia, which may exceed 50 million tons, is sparsely mineralized with gold and silver. Assays of the breccia in the upper levels of the mine have run as high as 0.23 ounce per ton in gold, but the gold content of the breccia diminishes rapidly with depth. The low gold content of the breccia makes normal sampling techniques impractical, as has been shown by the erratic results of the assays. Only by bulk sampling of the breccia can the true value of the breccia be determined.

NONMETALLIC MINERAL RESOURCES

Nonmetallic mineral resources of the Myers Creek and Wauconda mining districts consist chiefly of limestone and peat. Peat has been mined sporadically on a small scale for over 20 years and sold to local markets. Limestone has never been mined because of the remoteness of the deposits to existing markets. Minor amounts of fluorite occur as a gangue mineral at several mines in the Sheridan area of the Wauconda district, but has never been mined.

LIMESTONE

Limestone deposits occur as pods or lenses in Permian or Triassic eugeosynclinal rocks. Although limestone occurs in many parts of the Myers Creek and Wauconda districts, the largest deposits appear to be concentrated in two distinct areas (fig. 33). In the Myers Creek district limestone occurs in a northeast-trending belt between Havillah on the southwest and Buckhorn Mountain on the northeast. This belt is roughly 4 miles wide and 12 miles long. In the Wauconda district the largest deposits are in the Walker Lake-Cumberland Mountain area, which encompasses about 4 square miles. Most limestone is fine-grained, dolomitic and(or) siliceous, and bluish gray. Some limestone contains alternating bands of gray and white calcite. Lenses of limestone are usually less than 200 feet thick, and several appear to be as much as 1,000 feet thick. Common impurities of the limestone are cryptocrystalline silica, chert, and dolomite. The chert occurs as blebs, nodules, stringers, and layers up to 1 foot thick and several feet long. As much as 10 percent silica is present in some limestone.

TABLE 3.—*High calcium limestone deposits of Myers Creek and Wauconda mining districts*

Deposit	$CaCO_3$	CaO	MgO	SiO_2	R_2O_3	P_2O_5	Tonnage	Remarks
Buckhorn Mountain, SE¼ sec. 28 T. 40 N., R. 30 E.	97.47	54.76	0.46	1.33	0.27	0.005	600,000	150-foot-thick beds; average of 5 samples
Buckhorn Mountain, SE¼ sec. 28, T. 40 N., R. 30 E.	95.25	53.52	0.40	4.48	0.34	0.028	15,000,000	320-foot-thick beds; average of 5 samples
Bunch-Wildermuth, sec. 20, T. 39 N., R. 29 E.	97.15	54.44	0.40	2.01	0.25	0.009	5,000,000	75- and 40-foot-thick beds; average of 4 samples
Havillah, NE¼SE¼ sec. 34, T. 39 N., R. 29 E.	97.53	54.62	trace	1.80	0.60		Less than 100,000	Location uncertain; assay by Hodge, 1944, p. 55
Wauconda, secs. 13, 14, and 25, T. 38 N., R. 30 E.	88.13	49.36	2.38	3.64	2.18		Low	Pure white, finely crystalline. Exact location uncertain. Assay by Shedd, 1913, p. 170
Toroda Creek North, SW¼NW¼ sec. 13, T. 38 N., R. 30 E.	98.77	55.49	0.14	1.56	0.23	0.006	Low	10-foot-thick bed of white coarse-grained limestone
Toroda Creek North, NE¼ sec. 14, T. 38 N., R. 30 E.	98.59	55.39	0.17	1.33	0.29	0.006	Low	57-foot-thick bed of white coarse-grained limestone
Toroda Creek, NW¼ sec. 25, T. 38 N., R. 30 E.	96.31	54.11	0.32	2.84	0.18	0.014	Low	150-foot-thick bed; average of 5 samples

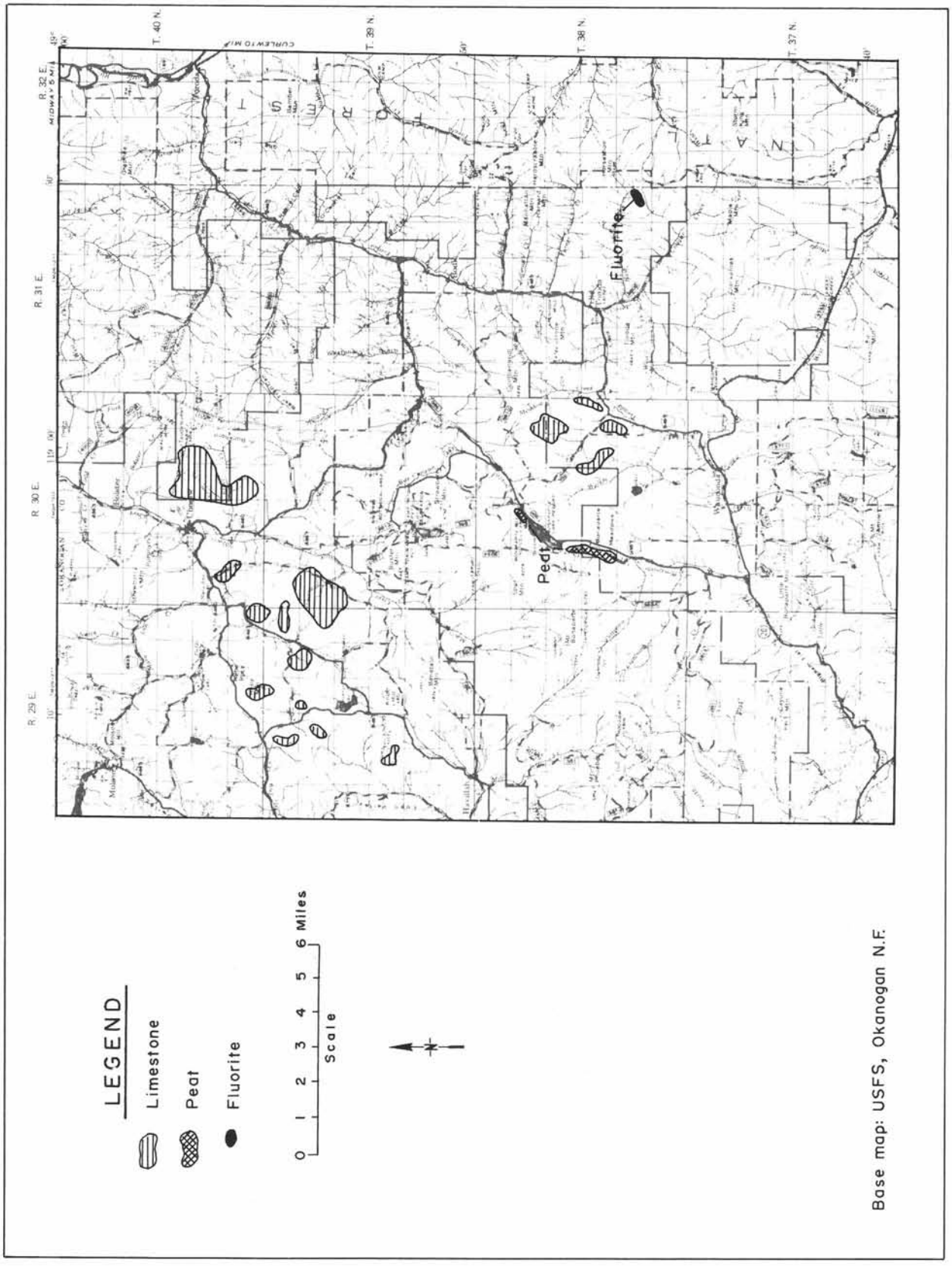


Figure 33.—Areas of limestone, peat, and fluorite in Myers Creek and Wauconda districts.

The high-calcium limestone deposits of the area have been examined by Mills (1962, p. 210-221); however, because of limited time only readily accessible deposits were examined. According to Mills, the deposits are not large enough to support Portland cement industries, but the high-calcium (in excess of 95 percent $CaCO_3$) content of several deposits makes them suitable for such uses as chemical lime, metallurgical lime, builders lime, ceramic whiting, mineral filler, and agriculture lime. Mills (1962, p. 221) points out that careful mapping and sampling of all limestone outcrops may disclose large tonnages of limestone. Deposits mapped and sampled by Mills appear in table 3.

PEAT

Peat deposits of economic importance are confined to the Bonaparte Lake area of the Wauconda district and are the only deposits in Okanogan County that appear to have large reserves (fig. 34). These deposits are in Bonaparte Meadows at the southern end of Bonaparte Lake (secs. 16, 17, 20, 21, and 29, T. 38 N., R. 30 E.). From Wauconda an improved county road may be followed 4 miles north to Bonaparte Meadows. About 280 acres of the meadows is underlain by peat, but only a small amount has been mined to date (1979). For the past several years the deposit has been mined by Bonaparte Peat Co.

Bonaparte Meadows is covered by a dense growth of sedges up to 3 feet tall. Parts of the meadows have been stripped of surface vegetation and several ditches have been dug to drain the meadow. Auger sampling by Rigg (1958, p. 120-121) show the peat to be 15 to 20 feet thick and mostly fibrous; some woody peat, sedimentary peat, and muck is also present. Although Rigg makes no mention of peat reserves, the writer estimates that 250 acres of Bonaparte Meadows contains about 6.5 million cubic yards of peat.

At the north end of Bonaparte Lake about 10 acres is also underlain by peat. The deposit is covered by swamp and aquatic vegetation, and about 2 to 3 feet of water most of the year. Rigg (1958, p. 121) states that the peat is 5 to 12 feet thick and is woody and fibrous. As much as 375,000 cubic yards of peat may be present.

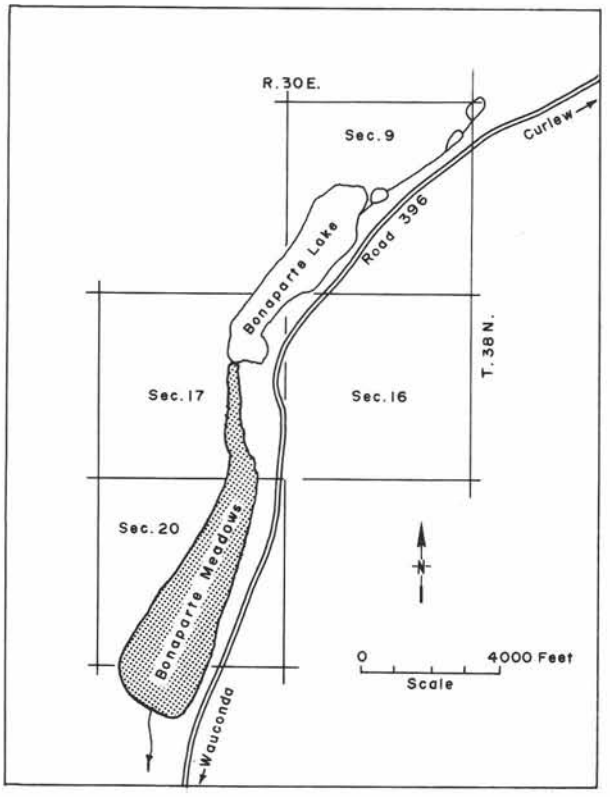


Figure 34.—Bonaparte Meadows peat deposit.

FLUORITE

Fluorite occurs as a gangue mineral at the Zalla M, Silver Bell, and American Flag mines in the Sheridan area of the Wauconda district. Although not of commercial value, its presence offers the possibility that it may occur in larger concentrations that have yet to be discovered. The fluorite is purple to bright blue and occurs as a cementing agent in breccias or shear zones. Select samples contained as much as 6.6 percent fluorite, and a 30-foot channel sample at the upper adit of the Silver Bell mine contained 4.83 percent fluorite (fig. 33). At the Zalla M and American Flag mines the veins contain on an average of less than 2 percent fluorite.

GEOPHYSICAL AND GEOCHEMICAL STUDIES

MAGNETIC

Magnetic ground and air surveys have been conducted over most parts of the Myers Creek and Wauconda districts. Ground surveys have been confined chiefly to the area of the iron deposits on Buckhorn Mountain, whereas an airborne magnetometer survey covered about two thirds of the Myers Creek district and one half of the Wauconda district. The airborne survey includes the 15-minute Mt.

TABLE 4.—*Airborne magnetic anomalies*[1]

Anomaly	Location	Mag intensity (gammas)	Geology
M1	W½SE¼ sec. 1, (40-28E)	58,000	Greenschist
M2	NW¼ sec. 24, (40-28E)	58,400	Greenschist
M6	NW¼SW¼ sec. 26, (39-30E)	58,300	Felsic volcanics
	M1—50 ft ± 250 ft below; surface body width 1,000 ft M2—80 ft ± 100 ft below; surface body width 1,000 ft M6—300 ft ± 100 ft below; surface body width 1,000 ft		
B1	NE¼ sec. 24, (40-30E)	60,000	Intrusive contact skarn (Magnetic mine area)
B2	Center E½ sec. 11, (40-31E)	58,600	Sanpoil Volcanics
B7	Sec. 1, (38-30E)	58,150	Monzonite, O'Brien Creek Formation
	B1—at surface B2—at surface; body width 250 ft B7—120 ft below surface; body width 1,400 ft		

[1]Refer to figure 35 for locations of anomalies.

Bonaparte, Bodie Mountain, and Aeneas quadrangles, which cover most mineralized areas of the two mining districts. Flight lines were spaced at a quarter of a mile intervals and at an average ground clearance of 500 feet, (Hunting Geophysical Services, Inc., 1960). Twenty-eight magnetic anomalies turned up during the course of the survey; nine were in the area covered by the Mt. Bonaparte quadrangle; eight fell within the boundaries of the Aeneas quadrangle. Of these anomalies only six appear to be of interest. At two of the anomalies the causing body of magnetism is at the surface; at the other four, the depths of the causing bodies are 50 to 400 feet beneath the surface. Body widths range from 250 to 1,400 feet. The locations of magnetic anomalies are shown in fig. 35, whereas intensities, geology, and depths are tabulated in table 4.

The presence of massive magnetite bodies on Buckhorn Mountain has resulted in many magnetic surveys to determine the extent of the mineralization, as well as the possibility of discovering new mineral occurrences. To date (1979) most work has been done in the vicinity of the Magnetic mine, as well as at the Caribou mine, which is about 1,800 feet northwest of the Magnetic. Dip needle surveys indicate that areas of moderate to extreme magnetic attractions occur chiefly in the vicinity of the Magnetic mine (plate 3). The area of moderate attraction is about 1,500 feet long in a southeast-trending direction, and about 650 feet wide, and confined to the tactite zone. Several extremely high dip needle readings within the moderately high area are apparently related to known magnetite bodies; other extremely high magnetic areas may indicate faulted segments of known ore bodies or new ore bodies. Plate 3 gives two interpretations of magnetic readings in areas of moderately to extremely high magnetic attractions. Many localized magnetic highs occur elsewhere on Buckhorn Mountain. These highs are linear in shape, being very narrow as compared to their lengths. For the most part these highs appear to be confined to shear zones that contain magnetite, pyrrhotite, pyrite, and chalcopyrite. Pyrrhotite appears to be producing the magnetic highs rather than magnetite (Broughton, 1943, p. 17).

RADIOMETRIC

In conjunction with the airborne magnetometer survey, gamma radiation was measured using an airborne scintillometer, but no significant radiometric anomalies turned up. Only three areas registered radioactivity that exceeded twice background count and field examinations of these areas disclosed no uranium mineralization. The higher than background count of anomalies R1 and R2 (fig. 35 and table 5) occur in andesitic and tuffaceous rocks of the Sanpoil Volcanics (middle Eocene). The area of twice

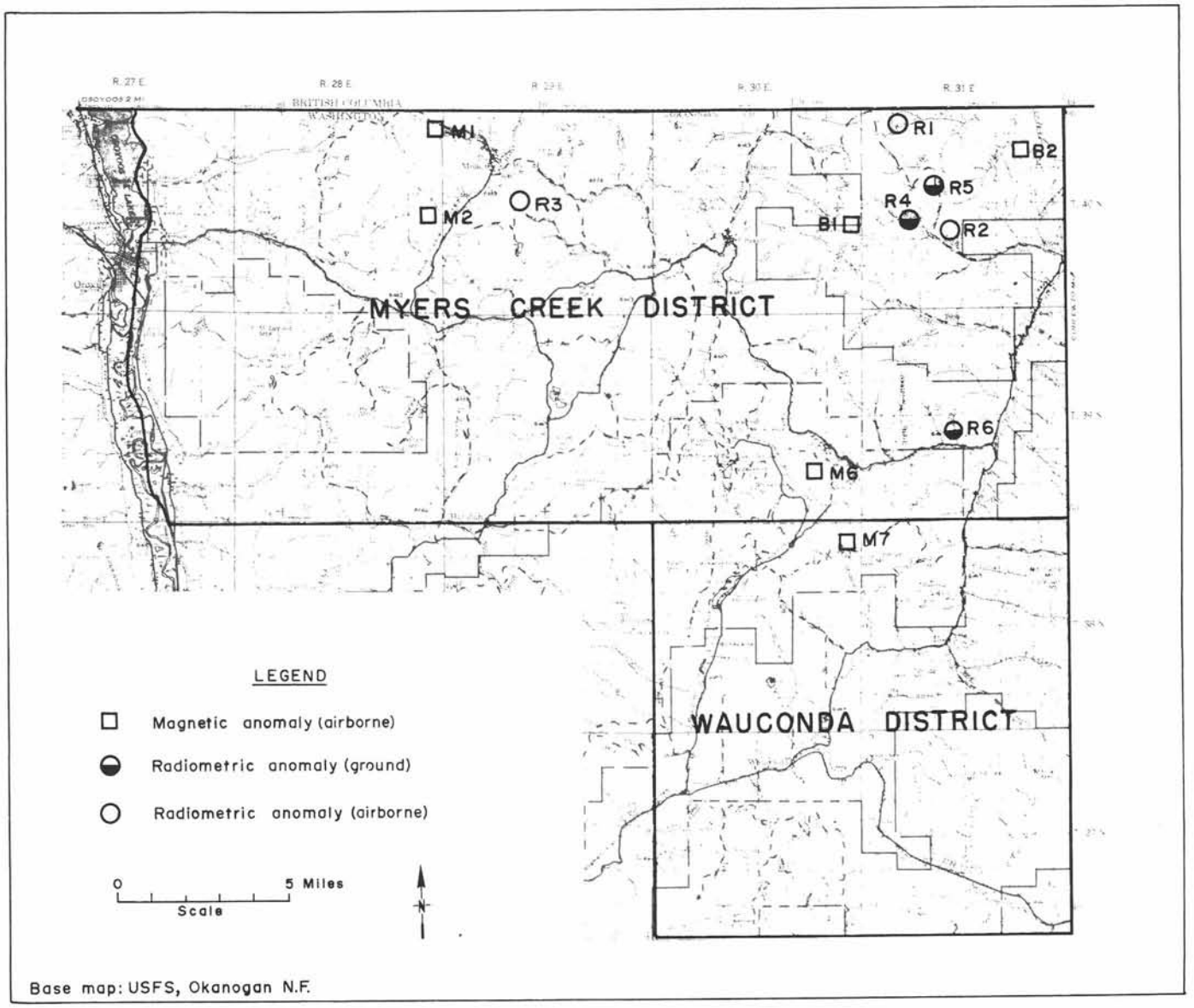


Figure 35.—Radiometric and magnetic anomalies of Myers Creek and Wauconda districts.

background count of anomaly R3 is underlain by Permian or Triassic greenschist. In the course of examining the areas of anomalous airborne radioactivity several traverses were made to establish the background count of the Eocene volcanic rocks. Background count for the O'Brien Creek Formation (lower Eocene) averaged around 85 cps; background for the Sanpoil Volcanics (middle Eocene) is about 100 cps; background for Klondike Mountain Formation is about 75 cps. Two areas of above background count were noted. At ground anomaly R4 (fig. 35 and table 5) granodioritic rocks register 350 cps (2.5 times background). At ground anomaly R5 carbonaceous tuff of the O'Brien Creek Formation registers 963 cps (6 times local background). Based on integrating gamma ray spectrometer readings, the radioactivity is caused by uranium and potassium, but no uranium minerals were noted.

Over the past several years the Eocene volcanic rocks of northeastern Okanogan County, as well as northwestern Ferry County, have been under investigation by uranium exploration companies. However, to date (1979) no significant discoveries have been made.

TABLE 5.—*Radioactive anomalies*[1]

Anomaly	Location	Radioactivity	Geology
		Airborne	
R1	Secs. 5 and 6, (40-30E), 1,000 ft S. of U.S. border on sec. line	3,600 cpm 2 X background	O'Brien Creek Formation and porphyritic dikes and sills
R2	Sec. 24, (40-31E), 600 ft N. of S¼ corner	1,000 cpm 2 X background	Sanpoil Volcanics
R3	Center E½SE¼ sec. 17, (40-29E)	2,500 cpm 2 X background	Greenschist
		Ground	
R4	SE¼NW¼ sec. 20, (40-31E)	350 cps 2.5 X background	Biotite-hornblende granodiorite
R5	S½NW¼ sec. 16, (40-31E)	963 cps 6 X background	O'Brien Creek Formation, carbonaceous tuff
R6	Center NE¼ sec. 21, (39-31E)	450 cps 4.5 X background	Sanpoil Volcanics

[1]Refer to figure 35 for locations of anomalies.

GEOCHEMICAL

Geochemical surveys consisting of water, stream sediment, and soil analysis for base and precious metals have been undertaken by mining companies evaluating mineralized areas and specific mining properties; the results of these studies are not available. In 1969, Washington Division of Geology and Earth Resources undertook a cursory state-wide stream sediment sampling program designed to establish background counts for copper, lead, zinc, and molybdenum for a variety of rocks. Samples collected and analyzed from the Myers Creek and Wauconda mining districts are shown in fig. 36; heavy metal contents of the samples are shown in table 6. In the course of the survey no significant anomalies turned up. All higher than background zinc analyses are most likely caused by contamination from galvanized culverts along stream courses. Slightly anomalous copper contents of stream sediments from Gold Creek on the north slope of Buckhorn Mountain are probably related to copper mineralization of iron-rich skarn zones that contain minor copper. The slightly anomalous copper content of sediments of the North Fork of Beaver Creek (No. 131, fig. 36) and a tributary to Myers Creek (No. 149) are not associated with known copper occurrences and cannot be accounted for.

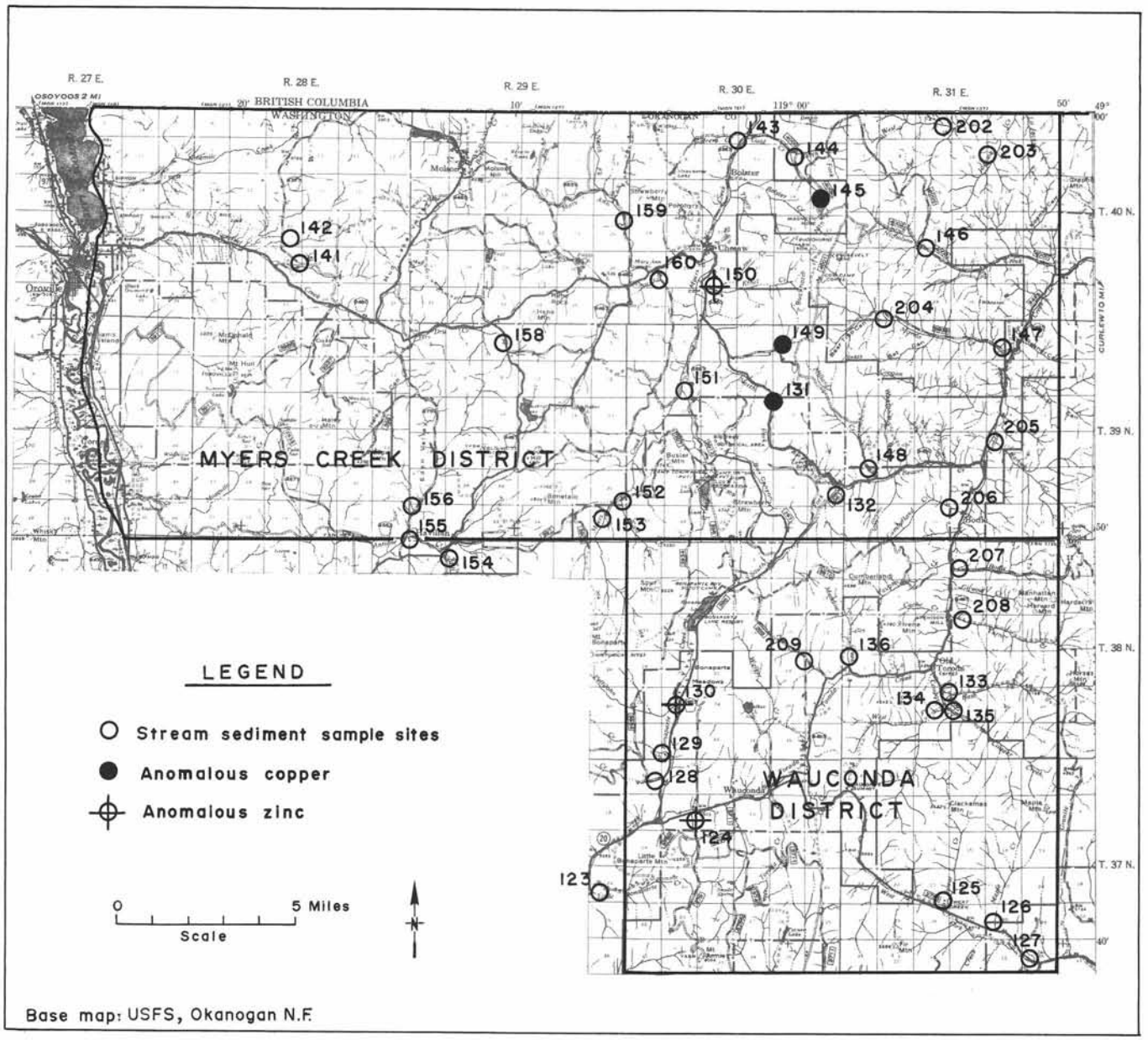


Figure 36.—Stream sediment sample sites in Myers Creek and Wauconda districts.

TABLE 6.—*Analyses for copper, molybdenum, lead, and zinc in stream sediment samples in Myers Creek and Wauconda mining districts*

Sample no.	Stream	Cu	Mo	Pb	Zn	C_xHM
123	Little Bonaparte Creek	10	–5	–25	30	1
124	Tributary to Bonaparte Creek	15	–5	–25	55	2
125	Sweat Creek	15	–5	–25	20	1
126	Maple Creek	10	–5	–25	20	1
127	West Fork of Granite Creek	10	–5	–25	30	2
128	Henderson Creek	5	–5	–25	45	1
129	Lightning Creek	5	–5	–25	20	2
130	Bonaparte Creek	10	–5	–25	45	2
131	North Fork of Beaver Creek	20	–5	–25	65	1
132	South Fork of Beaver Creek	15	–5	–25	35	2
141	Tributary to Tonasket Creek	10	–5	–25	25	1
142	Tributary to Tonasket Creek	10	–5	–25	20	1
143	Myers Creek	10	–5	–25	30	1
144	Tributary to Gold Creek	10	–5	–25	30	2
145	Gold Creek	35	–5	–25	25	2
146	Nicholson Creek	10	–5	–25	25	1
147	Marias Creek	15	–5	–25	35	2
148	Millard Creek	10	–5	–25	35	1
149	Tributary to Myers Creek	25	–5	–25	20	2
150	Ethel Creek	15	–5	–25	50	2
151	Myers Creek	10	–5	–25	35	1
152	Tributary to Myers Creek	10	–5	–25	45	1
153	Myers Creek	10	–5	–25	30	1
154	Mill Creek	5	–5	–25	20	1
155	Antoine Creek	10	–5	–25	35	1
156	Tributary to Antoine Creek	15	–5	–25	35	1
158	Dry Creek	20	–5	–25	80	2
159	Mary Ann Creek	15	–5	–25	65	1
160	Tributary to Mary Ann Creek	20	–5	–25	65	2
202	Cedar Creek	15	–5	–25	60	1
203	Jackson Creek	15	–5	–25	60	1
204	Marias Creek	20	–5	–25	65	2
205	Harvey Creek	15	–5	–25	35	1
206	Cumberland Creek	15	–5	–25	35	1
207	Bodie Creek	15	–5	–25	80	3
208	Turner Creek	10	–5	–25	60	1
209	Meadow Creek	10	–5	–25	65	2

Note: Values for copper, molybdenum, lead, and zinc in parts per million. Cold-extractable heavy metals (C_xHM) values are in milliliters of dithizone required to reach end point.

APPENDIX A

PROPERTY INDEX—MYERS CREEK MINING DISTRICT

Property	*Location*	*Index map page*	*Property description page*
Chesaw area			
Ben Harrison (Apex)	NE¼ sec. 20, (40-30E)	29	33
Butcher Boy	NW¼ sec. 21, (40-30E)	29	33
Delate	SE¼ sec. 8, (40-30E)	29	33
Gray Eagle (Eagle)	Center sec. 16, (40-30E)	29	34
Olentangy	NE¼ sec. 18, (40-30E)	29	35
Ophir	NW¼ sec. 17, (40-30E)	29	35
Poland China	SE¼ sec. 11, (40-29E)	29	35
Reco	Center S½ sec. 16, (40-30E)	29	38
Review	Center sec. 16, (40-30E)	29	40
Strawberry Lake	SE¼ sec. 7, (40-30E)	29	41
Yakima	E¼ sec. 20, (40-30E)	29	41
Buckhorn Mountain area			
Aztec	NW¼ sec. 24, (40-30E)	42	43
Buckhorn adit	NW¼ sec. 24, (40-30E)	42	43
Caribou	SW¼ sec. 13, (40-30E)	42	43
Crystal Butte (Mother Lode)	W½ sec. 35, (40-30E)	42	44
Crystal Butte Iron	S¼ cor. sec. 35, (40-30E)	42	45
Gold Axe	SW¼ sec. 24, (40-30E)	42	47
Magnetic (Neutral)	N½ sec. 24, (40-30E)	42	47
Rainbow	NW. cor. sec. 24, (40-30E)	42	50
Roosevelt (Grant)	S½ sec. 24, (40-30E)	42	54
Western Star	NW¼ sec. 24, (40-30E)	42	54
Bi-Metallic Mountain Area			
Bi-Metallic	W¼ cor. sec. 26, (39-29E)	24	54
Isolated areas			
Carlquist	NW¼ sec. 30, (40-29E)	24	57
Lake Beth	SE¼ sec. 23, (39-30E)	24	57
Shaw-Bergman	NW¼ sec. 8, (39-29E)	24	58
Ida	Sec. 21, (39-31E)	24	58

PROPERTY INDEX—WAUCONDA MINING DISTRICT

Wauconda area			
Wauconda	S½ sec. 7, (37-30E)	24	64
Umbra and Sundown	NE¼ sec. 19, (37-31E)	24	64
Cumberland Mountain area			
Lupin	NW¼ sec. 12, (38-30E)	66	67
Whitestone	N½ sec. 27, (39-30E)	24	68
Bodie and Sheridan areas			
American Flag	NE¼ sec. 36, (38-31E)	66	68
Silver Bell	SE¼ sec. 25, (38-31E)	66	69
Zalla M	NW¼ sec. 30, (38-32E)	66	70
Phil Sheridan	NW¼ sec. 24, (38-31E)	66	72
Bodie (Northern Gold)	SW¼ sec. 34, (39-31E)	66	72

APPENDIX B

PATENTED MINING CLAIMS OF THE MYERS CREEK AND WAUCONDA MINING DISTRICTS

Name of claim	*Patent* no.	*Survey* no.	*General location*[1]
A & R	40677	673	NW¼SW¼ sec. 24, (40-30E)
Adriondack	461871	1086	SE¼SW¼ sec. 24, (38-31E)
American Flag	490578	1093	N½NE¼ sec. 36, (38-31E)
Battleship	44292	775-A	Center NW¼ sec. 35, (40-30E)
Ben Wharton	19486	615	NW¼NW¼ sec. 21, (40-30E)
Ben Harrison	904618	1160	SE¼NE¼ sec. 20, (40-30E)
Bi-Metallic	52907	921	NW¼ sec. 26 and SE¼ sec. 27, (39-29E)
Bird	36870	558	NW¼SE¼ sec. 16, (40-30E)
Blue Diamond	203334	866	SE¼ sec. 7, (40-30E)
Bodie	294489	721	S½ sec. 34, (40-30E)
Bonnie Doon	203334	866	NE¼ sec. 7, (40-30E)
Bouland	43550	787	SE¼SE¼ sec. 8, (40-30E)
Brasher	203334	866	Center E½ sec. 7, (40-30E)
Buckeye Mill Site	43160	776-B	NE¼ sec. 2, (40-29E)
Buckhorn	40277	673	NW¼ sec. 24, (40-30E)
Buckskin	921667	1163	S½NE¼ sec. 3, (38-31E)
Charles F.	605496	1039	SE¼ sec. 11 and NE¼ sec. 14, (40-29E)
Charlotte	916228	1169	NW¼ sec. 17, (40-30E)
Chesaw	34339	543-A	SW¼SW¼ sec. 21, (40-30E)
Clifton	915228	1169	SW¼NW¼ sec. 17, (40-30E)
Colon	120875	832	SE¼SE¼ sec. 7, (40-30E)
Commonwealth Placer	34565	548	NE¼ sec. 16, (40-30E)
Comstock	916228	1169	SE¼ sec. 7, (40-30E)
Contact	904618	1160	NE¼ sec. 20, (40-30E)
Constitution	43550	787	SE¼ sec. 8, (40-30E)
Criterion	43160	776-A	NE¼SW¼ sec. 2, (40-29E)
Crystal Bluff	294389	721	SW¼ sec. 34, (39-31E)
Delate	37396	646	SE¼ sec. 8, (40-30E)
Denhor	170875	832	SE¼SE¼ sec. 7, (40-32E)
Don't Kumtux	45385	848	NW¼NW¼ sec. 17, (40-30E)
Early Dawn	603270	1038	NW¼ sec. 11, (40-29E)
East Side	67627	886	Center N½ sec. 24, (40-30E)
Eldorado	916228	1169	E½NW¼ sec. 17, (40-30E)
Europia	44292	775-A	Center NW¼ sec. 35, (40-30E)
Evening Star	916228	1169	NW¼ sec. 17, (40-30E)
F & A	43550	787	Center SE¼ sec. 8, (40-30E)
Gladiator	904618	1160	NE¼NE¼ sec. 20, (40-30E)
Gold Standard	915228	1169	NE¼NE¼ sec. 18, (40-30E)
Gray Eagle	119771	884	Center SW¼ sec. 16, (40-30E)
Guilbert	43550	787	SW¼SE¼ sec. 8, (40-30E)
Holdfast	250182	862	NE¼ sec. 19 (37-31E)
Interstate Mill Site	44292	775-B	SE¼SE¼ sec. 32, (40-30E)

[1]Locations by legal land descriptions are abbreviated; for example, SE¼NE¼ sec. 24, (40-30E) written in full is southeast quarter of the northeast quarter of section 24, township 40 north, range 30 east, Willamette meridian and base.

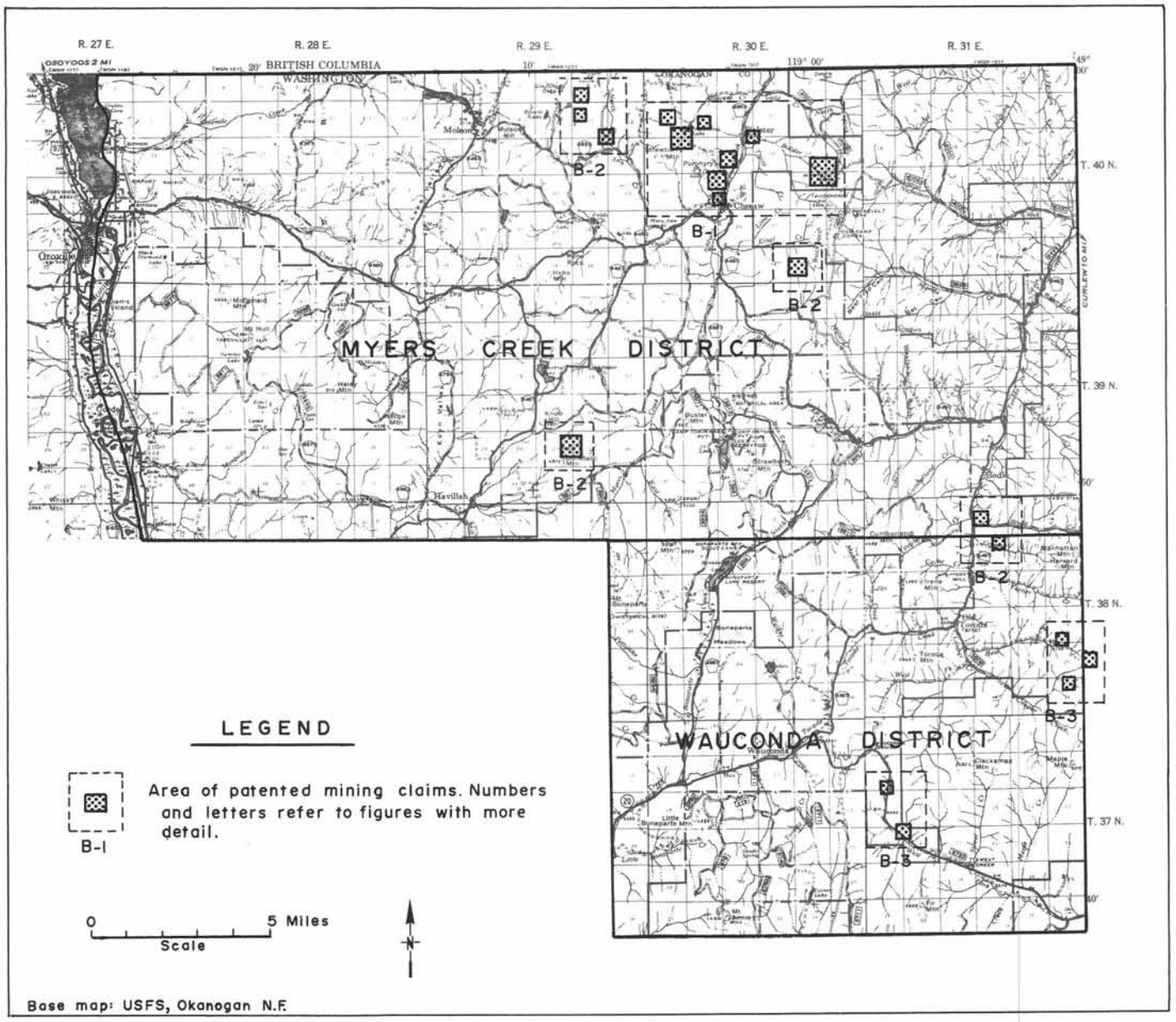
Locations of patented claims within specific sections are shown in Appendixes B-1, B-2, and B-3.

PATENTED MINING CLAIMS OF THE MYERS CREEK AND WAUCONDA MINING DISTRICTS—Continued

Name of claim	*Patent* no.	*Survey* no.	*General location*[1]
Jack Pot	42519	670	Center NE¼ sec. 23, (40-30E)
Jim Hill	34339	543-A	SW¼ sec. 21, (40-30E)
Keno	203334	866	NE¼ sec. 7, (40-30E)
Keystone Fraction	44292	775-A	SW¼ sec. 35, (40-30E)
Kismet	605496	1039	SE¼SE¼ sec. 11, (40-29E)
Korea	120875	832	NW¼NE¼ sec. 18, (40-30E)
Little Alfred	916228	1169	NW¼NW¼ sec. 17, (40-30E)
Little George	294489	721	Center SW¼ sec. 34, (39-31E)
Malabar	43160	776-A	SW¼SW¼ sec. 2, (40-29E)
Manchuria	120875	832	NW¼NE¼ sec. 18, (40-30E)
Mexico Fraction	351012	1035	Center S½ sec. 14, (40-30E)
Missing Link	40277	673	W¼ cor. sec. 24, (40-30E)
National	34339	543	SE. cor. sec. 20, (40-30E)
Nineteen Thirteen	916228	1169	Center sec. 17, (40-30E)
Nip & Tuck	872729	1145	SE¼SE¼ sec. 14, (40-30E)
Northland	605496	1039	Center SE¼ sec. 11 (40-29E)
Nootsack	250182	862	E½NE¼ sec. 19, (37-31E)
Nucleus	42056	673	E½NE¼ sec. 23, (40-30E)
O.K.	36396	615	NE¼SE¼ sec. 20, (40-30E)
O.K. Fraction	36396	615	NW¼SW¼ sec. 21, (40-30E)
Ophir	916228	1169	NE¼NW¼ sec. 17, (40-30E)
Oriental	203334	866	Center NE¼ sec. 7, (40-30E)
Oro Libre	605496	1039	NE¼NE¼ sec. 14, (40-29E)
Overtop	605496	1039	SW¼SE¼ sec. 11, (40-29E)
Palmetto	43160	776	Center SW¼ sec. 2, (40-29E)
Panhandle	40277	673	Center W½ sec. 24, (40-30E)
Peerless	552299	1053	NW. cor. sec. 13, (40-29E)
Pendennis	1109261	1234	SE¼SW¼ sec. 16, (40-30E)
Pilot Hill	43550	787	SE. cor. sec. 8, (40-30E)
Rainbow	342538	1034	SW. cor. sec. 13, (40-30E)
Ready Peay	904618	1160	Center NE¼ sec. 20, (40-30E)
Realty	605496	1039	N½NE¼ sec. 14, (40-29E)
Reckless	35804	557	W¼ cor. sec. 35, (40-30E)
Reco	1109261	1234	Center SW¼ sec. 16, (40-30E)
Reno	33285	547	W½SW¼ sec. 21, (40-30E)
Review	36870	558	NW¼SE¼ sec. 16, (40-30E)
Snetisham	250182	862	SE¼NE¼ sec. 19, (37-31E)
Stratton	42520	673	NE¼NE¼ sec. 23, (40-30E)
Sundown	250182	862	W½NW¼ sec. 20, (37-31E)
Sunset	916228	1169	NE¼NE¼ sec. 18, (40-30E)
Texas Fraction	351012	1035	S½SE¼ sec. 14, (40-30E)
Tenderloin	40277	673	W¼ cor. sec. 24, (40-30E)
Timberland	605496	1039	Center SE¼ sec. 11, (40-30E)
Trenton	36396	615	S½NW¼ sec. 21, (40-30E)
Umatilla Fraction	40277	673	Center NW¼ sec. 24, (40-30E)
Umbra	250182	862	Center NW¼ sec. 20, (37-31E)
Unga	231255	992	NW¼NW¼ sec. 20, (37-31E)

PATENTED MINING CLAIMS OF THE MYERS CREEK AND WAUCONDA MINING DISTRICTS—Continued

Name of claim	*Patent* no.	*Survey* no.	*General location*[1]
Van Dyke	40277	673	SE¼NW¼ sec. 24, (40-30E)
Wallingford	921667	1163	N½NE¼ sec. 3, (38-31E)
War Eagle	40710	722	W½SW¼ sec. 7, (40-30E)
Wauconda No. 3	36827	630	SW¼SE¼ sec. 7, (37-31E)
West Cliff	294489	721	E½SW¼ sec. 34, (39-31E)
Willard Fraction	40277	673	NE¼NW¼ sec. 24, (40-30E)
Yakima	36396	615	SW¼NW¼ sec. 21, (40-30E)
		Ferry County	
Discovery	33284	544	NW¼SW¼ sec. 30, (38-32E)
Fannie Woodard	31517	453	S½NW¼ sec. 30, (38-32E)
Grand View	37088	647	N½SW¼ sec. 30, (38-32E)
Kittie Glide	487590	1092	S½SE¼ sec. 30, (38-32E)
Zalla M	31517	453	SE¼NW¼ sec. 30, (38-32E)



Base map: USFS, Okanogan N.F.

APPENDIX B-1

PATENTED MINING CLAIMS—MYERS CREEK DISTRICT

Mineral Survey 722

1. War Eagle

Mineral Survey 866

2. Oriental
3. Bonnie Doon
4. Keno
5. Blue Diamond No. 3
6. Brasher
7. Blue Diamond No. 1
8. Blue Diamond No. 2

Mineral Survey 832

9. Denhor
10. Colon
11. Manchuria
12. Korea

Mineral Survey 1169

13. Comstock No. 2
14. Comstock No. 1
15. Gold Standard
16. Sunset
18. Evening Star
19. Clifton
20. Nineteen Thirteen
21. Charlotte
22. Eldorado
23. Ophir
24. Little Alfred

Mineral Survey 848

17. Don't Kumtux

Mineral Survey 787

25. Guilbert
26. Constitution
27. F & A
29. Bouland
30. Pilot Hill

Mineral Survey 646

28. Delate

Mineral Survey 548

31. Commonwealth Placer

Mineral Survey 558

32. Review
35. Bird

Mineral Survey 884

33. Gray Eagle

Mineral Survey 1234

34. Reco
36. Pendennis

Mineral Survey 1160

37. Contact
38. Gladiator
42. Ready Peay
43. Ben Harrison

Mineral Survey 615

39. Ben Wharton
40. Yakima
41. Trenton
44. O.K.
44a. O.K. Fraction

Mineral Survey 543-A

45. Jim Hill
48. Chesaw

Mineral Survey 543

47. National

Mineral Survey 547

46. Reno

Mineral Survey 1035

49. Mexico Fraction
50. Texas Fraction

Mineral Survey 1034

53. Rainbow

Mineral Survey 1145

52. Nip & Tuck

Mineral Survey 673

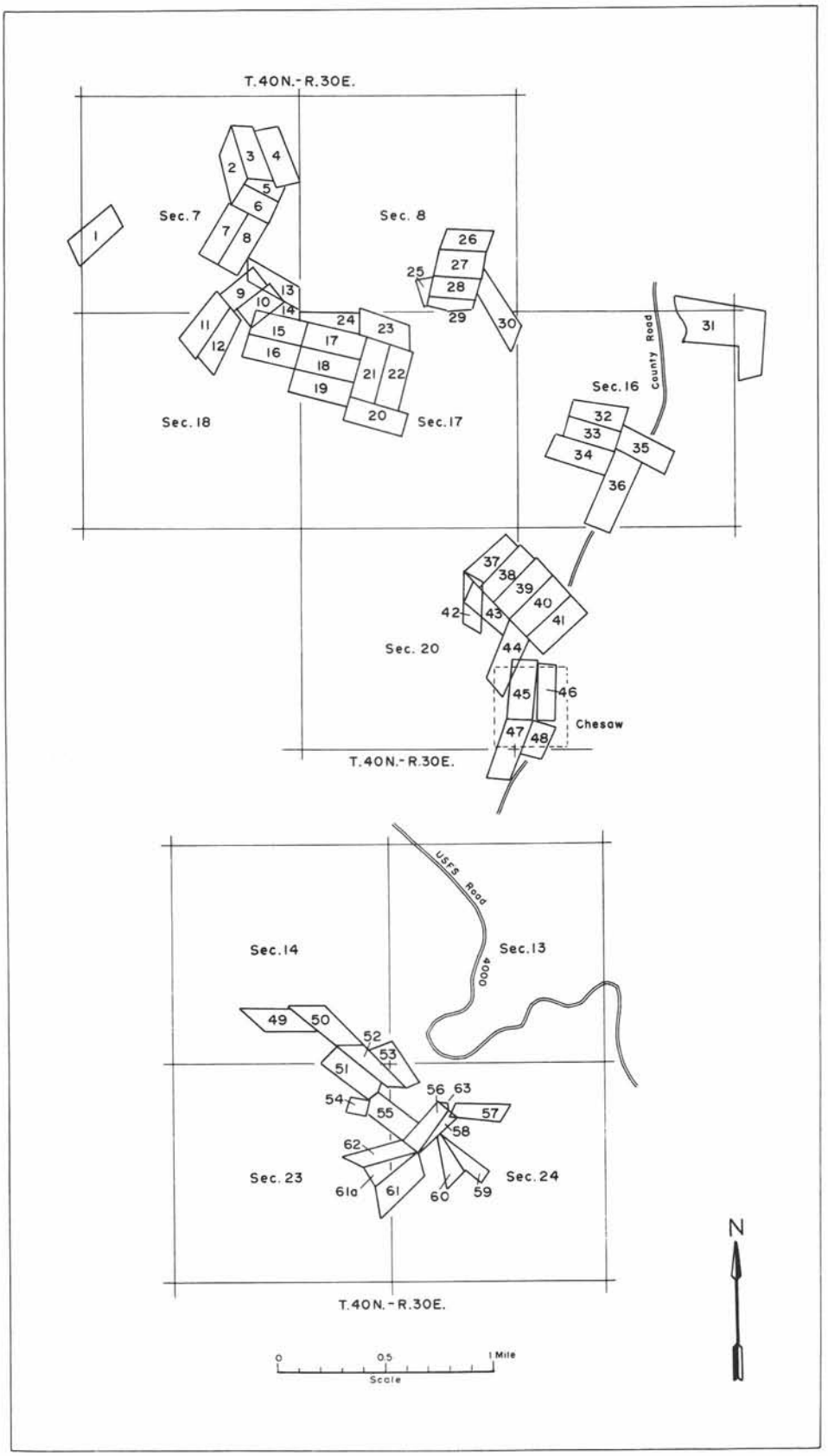
51. Stratton
55. Nucleus
62. Tenderloin
61a. Missing Link
61. A & R
60. Panhandle
59. Van Dyke
56. Buckhorn
58. Umatilla Fraction
63. Willard Fraction

Mineral Survey 886

57. East Side

Mineral Survey 670

54. Jack Pot


T.40N.-R.30E.
Sec. 7
Sec. 8
Sec. 18
Sec. 17
Sec. 16
County Road
Sec. 20
Chesaw
T.40N.-R.30E.
USFS Road
4000
Sec. 14
Sec. 13
Sec. 23
Sec. 24
T.40N.-R.30E.
N
0
0.5
1 Mile
Scale

APPENDIX B-2

PATENTED MINING CLAIMS—MYERS CREEK DISTRICT

Mineral Survey 776-B

1. Buckeye Mill Site

Mineral Survey 776-A

2. Criterion
3. Malabar
4. Palmetto

Mineral Survey 1038

5. Early Dawn No. 3
6. Early Dawn
7. Early Dawn No. 2

Mineral Survey 1039

8. Overtop
9. Timberland
10. Northland
11. Kismet
12. Realty
13. Charles F.
15. Oro Libre

Mineral Survey 1053

14. Peerless Placer

Mineral Survey 921

16. Bi-Metallic No. 11
17. Bi-Metallic No. 9
18. Bi-Metallic No. 4
19. Bi-Metallic No. 6
20. Bi-Metallic No. 7
21. Bi-Metallic No. 2
22. Bi-Metallic No. 8
23. Bi-Metallic No. 3
24. Bi-Metallic No. 1
25. Bi-Metallic No. 5
26. Bi-Metallic No. 10

Mineral Survey 721

27. Little George
28. Crystal Bluff
29. West Cliff
30. Bodie
31. Bodie No. 2

Mineral Survey 1163

32. Wallingford
33. Buckskin

Mineral Survey 775-A

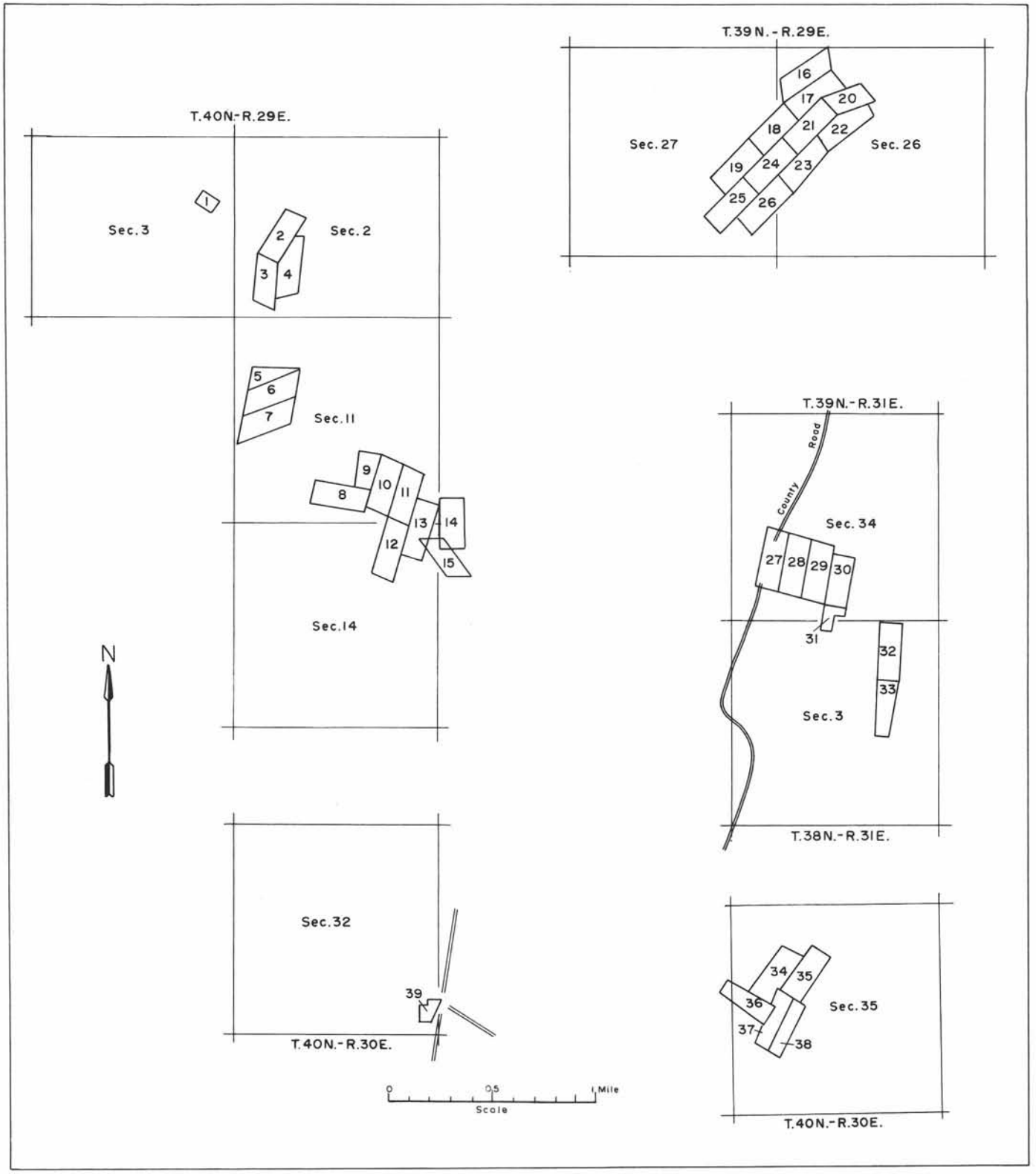
34. Battleship
35. Europia
37. Keystone Fraction No. 2
38. Keystone Fraction

Mineral Survey 557

36. Reckless Quartz

Mineral Survey 775-B

39. Interstate Mill Site


T.39N.-R.29E.
Sec.27
Sec.26
16
17
20
18
21
22
19
24
23
25
26
T.40N-R.29E.
Sec.3
Sec.2
1
2
3
4
5
6
7
Sec.11
9
10
11
8
13
14
12
15
Sec.14
N
T.39N.-R.31E.
County Road
Sec.34
27
28
29
30
31
32
33
Sec.3
T.38N.-R.31E.
Sec.32
39
T.40N.-R.30E.
34
35
36
37
38
Sec.35
T.40N.-R.30E.
0
0.5
1 Mile
Scale

APPENDIX B-3

PATENTED MINING CLAIMS—WAUCONDA DISTRICT

Mineral Survey 630

1. Wauconda No. 3

Mineral Survey 453

2. Fannie Woodard
3. Zalla M

Mineral Survey 544

4. Discovery

Mineral Survey 647

5. Grand View

Mineral Survey 1092

6. Kittie Glide

Mineral Survey 1093

7. American Flag

Mineral Survey 992

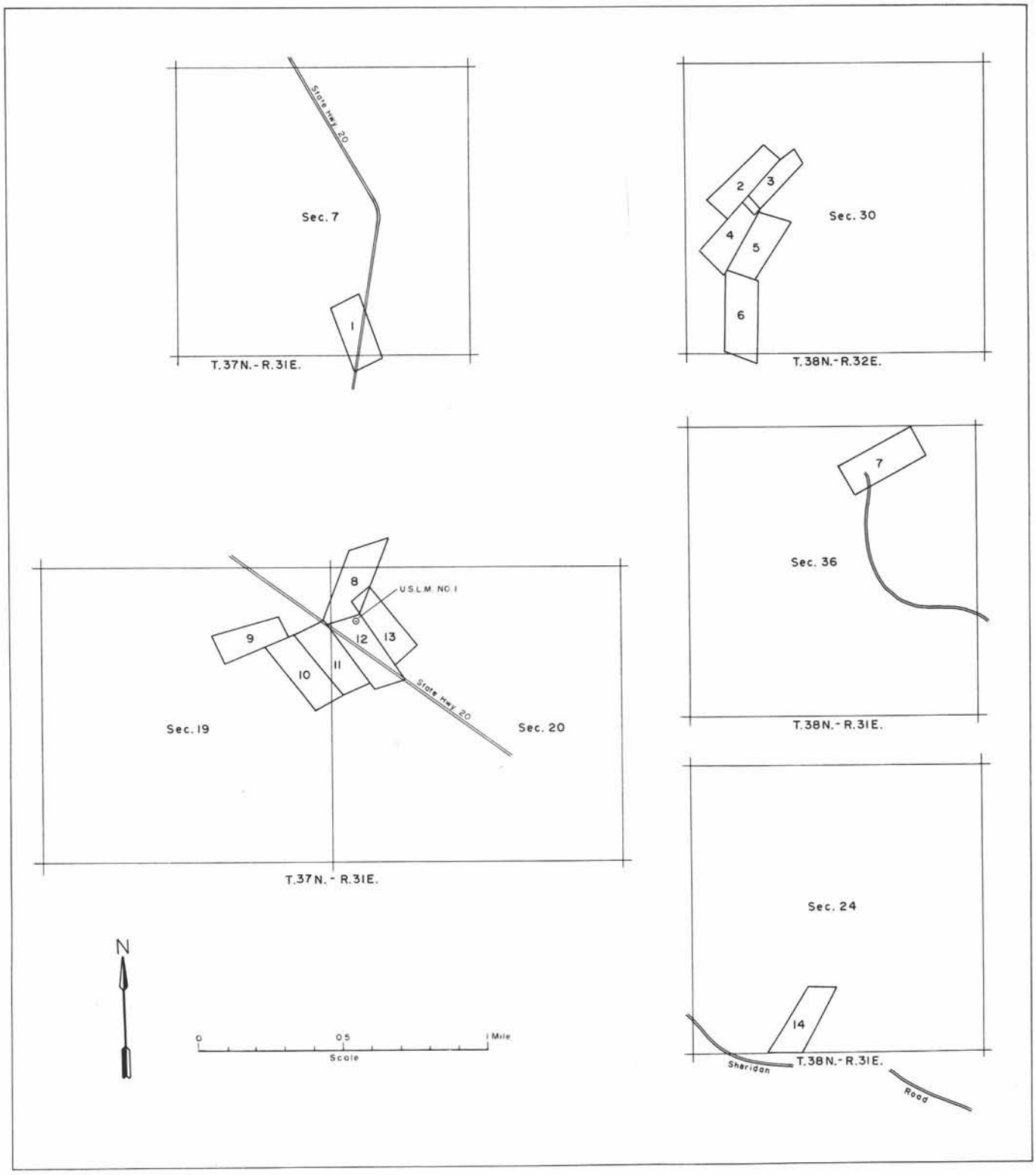
8. Unga

Mineral Survey 862

9. Holdfast
10. Nootsack
11. Snetisham
12. Sundown
13. Umbra

Mineral Survey 1086

14. Adirondack


State Hwy. 20
Sec. 7
1
T.37N.-R.31E.
2
3
4
5
6
Sec. 30
T.38N.-R.32E.
7
Sec. 36
T.38N.-R.31E.
8
U.S.L.M. NO. 1
9
10
11
12
13
State Hwy. 20
Sec. 19
Sec. 20
T.37N.-R.31E.
Sec. 24
14
T.38N.-R.31E.
Sheridan
Road
N
0
0.5
1 Mile
Scale

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Back Pocket

Plate 1. Geologic map of east half of Myers Creek mining district, Okanogan County, Washington

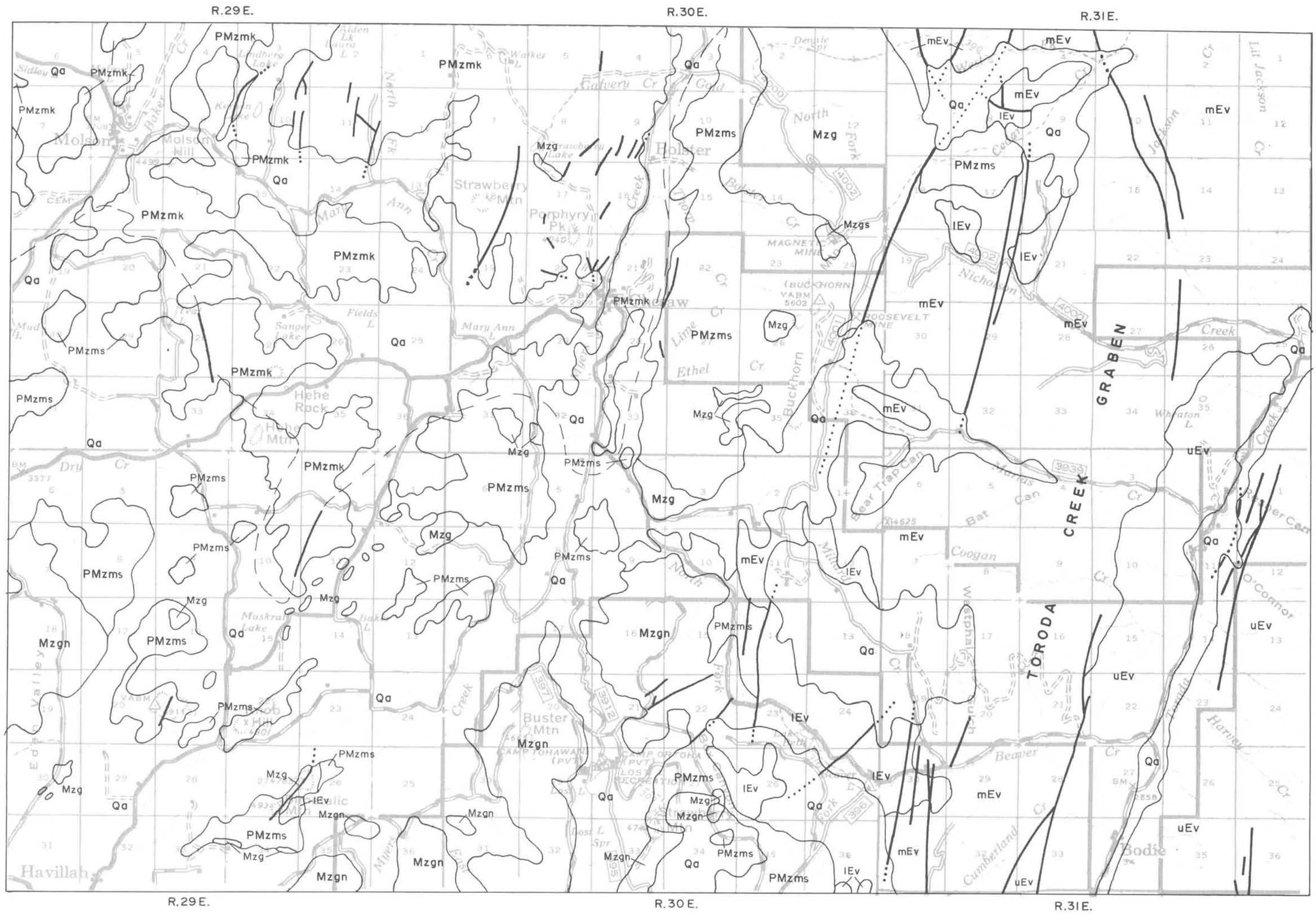
Plate 2. Magnetic mine workings, Okanogan County, Washington

Plate 3. Dip needle and magnetometer surveys of Magnetic mine, Okanogan County, Washington

Plate 4. Bodie mine workings, Okanogan County, Washington

Plate 5. Silver Bell mine workings, Okanogan County, Washington

Plate 6. Generalized aeromagnetic map of parts of Myers Creek and Wauconda mining districts, Okanogan County, Washington



LEGEND

Contact, dotted where concealed

Fault, dotted where concealed

Approximate boundary between Kobau and Spectacle Formations

0 1 2 3 Miles

Scale

Geology by Pearson, 1967 and Fox, 1978

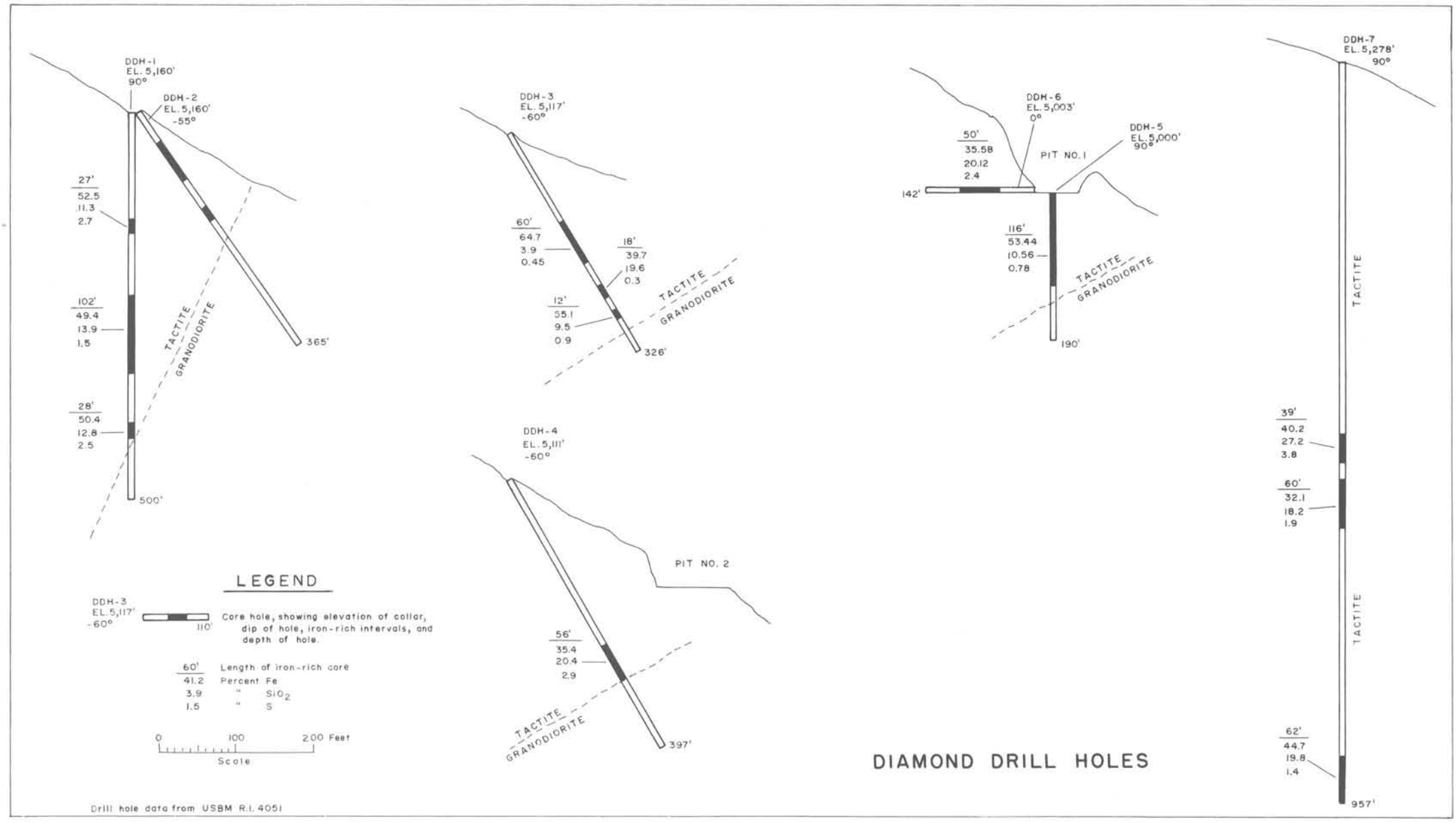
Base map: Bodie and Mt Bonaparte 15' quads

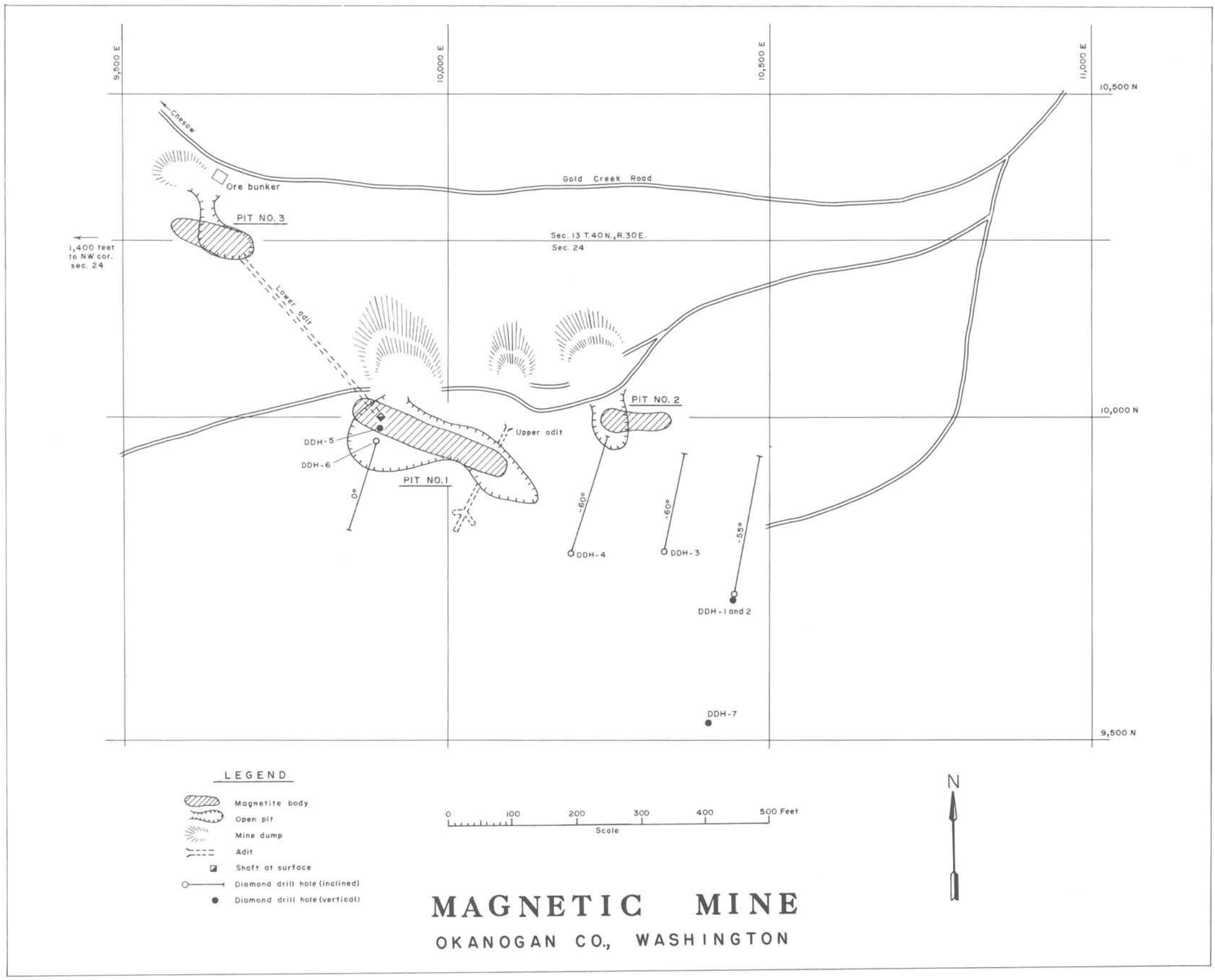
GEOLOGIC MAP OF EAST HALF MYERS CREEK DISTRICT

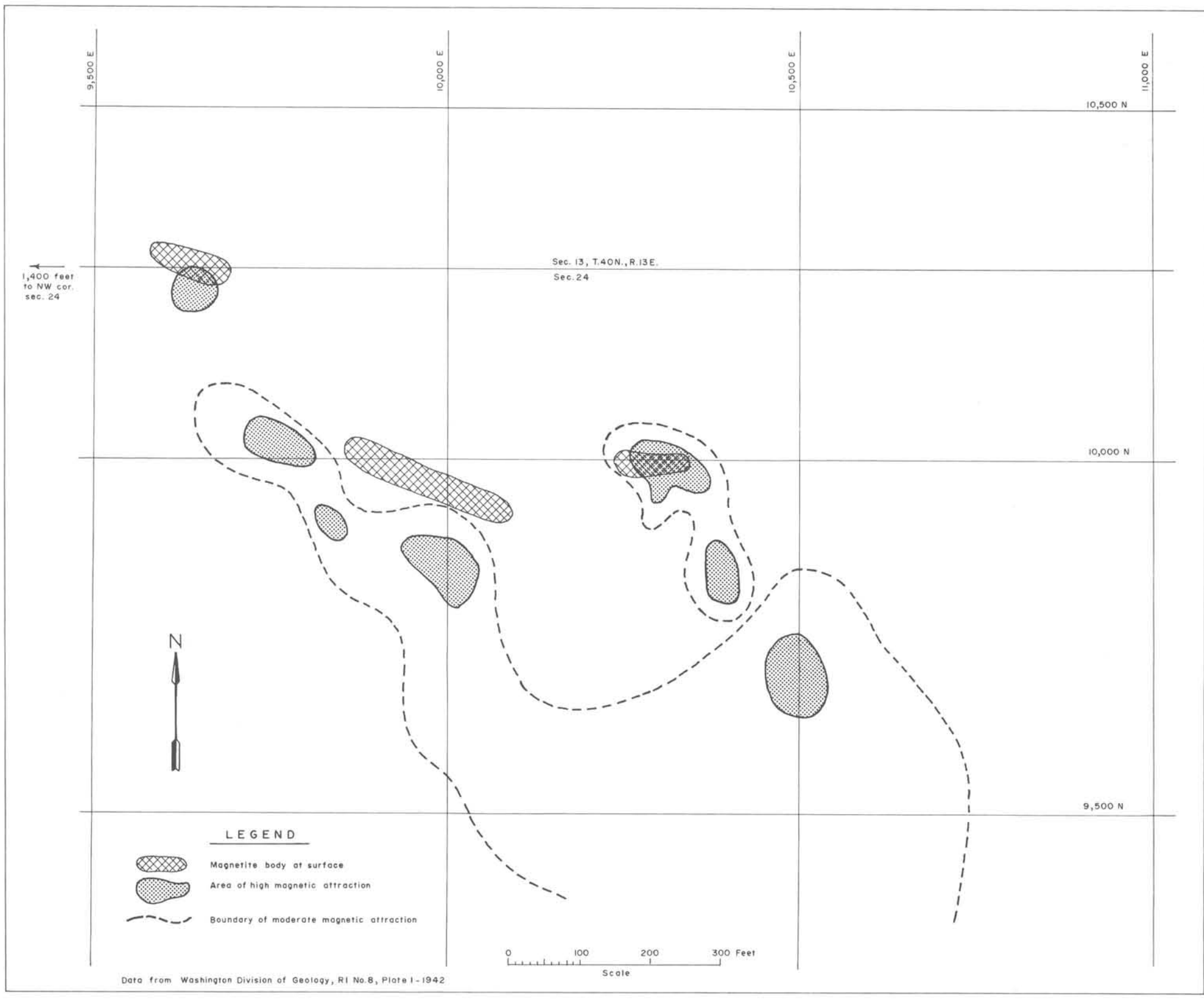
OKANOGAN CO., WASHINGTON

GEOLOGIC UNITS

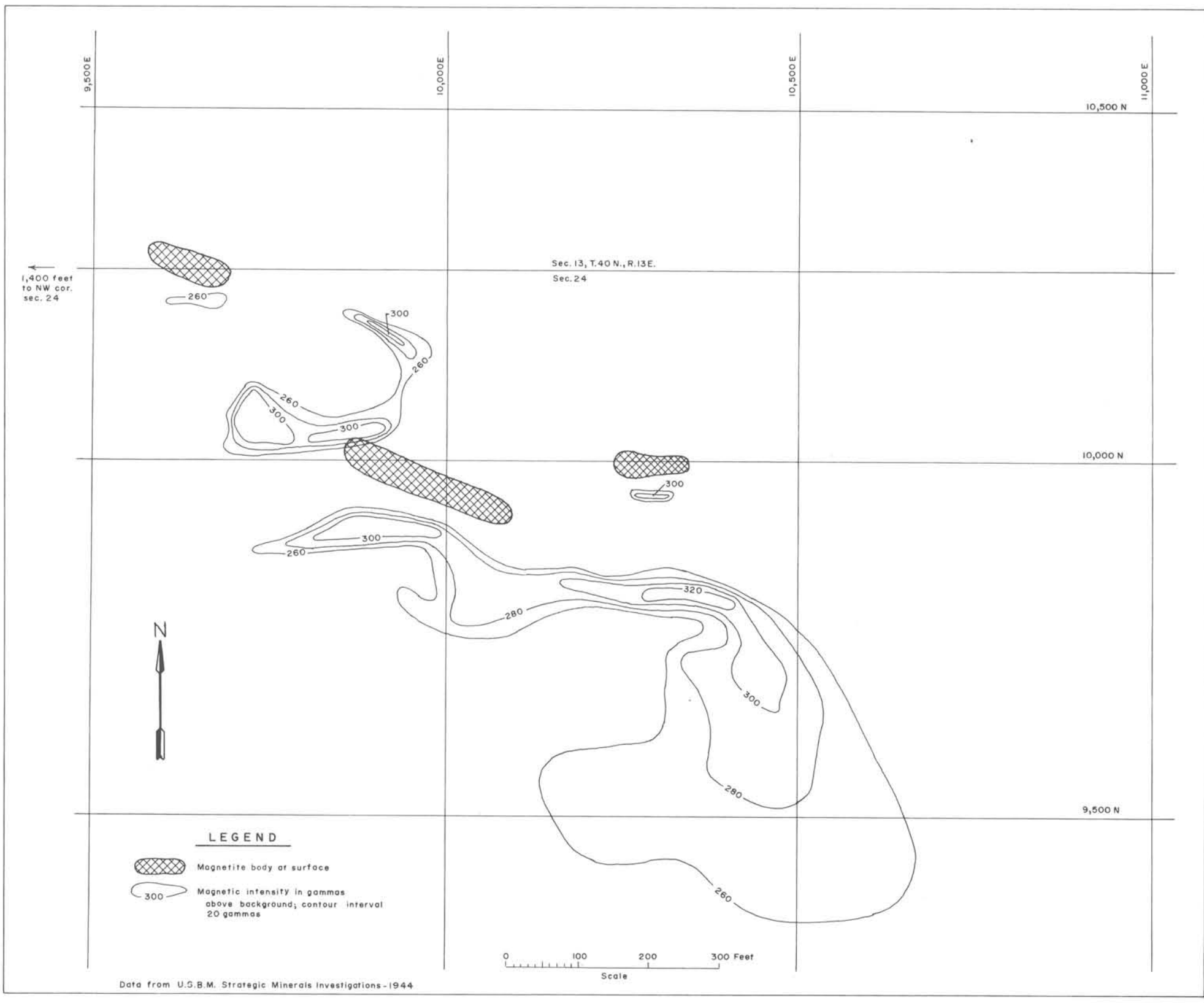
Qa	Surficial deposits (Quaternary) - Alluvium and glacial drift undifferentiated
uEv	Volcanic rocks (late Eocene) - Klondike Mountain Formation, consisting of lithoidal lava flows and pyroclastic breccias; planar flow structure common. Vitric lava flows and flow breccias; many flows are complexly columnar jointed
mEv	Volcanic rocks (middle Eocene) - Sanpoil Volcanics, consisting mainly of lithoidal lava flows of quartz latitic to andesitic composition, massive to flow layered. Includes minor tuffaceous rocks and probably some intrusive bodies
lEv	Epiclastic and volcaniclastic rocks (early Eocene) - O'Brien Creek Formation, consisting of well-bedded to massive lapilli tuff, tuffaceous sandstone, siltstone, and shale; carbonaceous siltstone and shale; and conglomerate
Mzgn	Granodiorite and quartz monzonite (late Mesozoic) - Consists mainly of the Mount Bonaparte pluton of the Okanogan gneiss dome
Mzg	Granitic rocks (Triassic to possibly early Tertiary) - Biotite-hornblende granodiorite of the Buckhorn Mountain pluton; includes border zone of hybrid or mixed rocks. Includes smaller bodies of monzonite, granodiorite, quartz diorite, quartz porphyry, and plagioclase porphyry
Mzgs	Garnet-epidote-magnetite skarn (age uncertain) - Skarn confined to tactite zone on northeastern slope of Buckhorn Mountain
PMzm	Eugeosynclinal deposits (Permian to Cretaceous) - PMzms, chiefly Spectacle Formation (Permian) consisting mainly of metasiltstone, slate, argillite, phyllite, and marble. PMzmk, chiefly Kobau Formation consisting mainly of greenstone, greenschist, metasiltstone, quartzite (metachert), and marble


DDH-1
EL. 5,160'
90°
DDH-2
EL. 5,160'
-55°
27'
52.5
11.3
2.7
102'
49.4
13.9
1.5
28'
50.4
12.8
2.5
TACTITE
GRANODIORITE
365'
500'
DDH-3
EL. 5,117'
-60°
60'
64.7
3.9
0.45
18'
39.7
19.6
0.3
12'
55.1
9.5
0.9
326'
DDH-4
EL. 5,111'
-60°
PIT NO. 2
56'
35.4
20.4
2.9
397'
DDH-6
EL. 5,003'
0°
DDH-5
EL. 5,000'
90°
50'
35.58
20.12
2.4
PIT NO. 1
142'
116'
53.44
10.56
0.78
190'
DDH-7
EL. 5,278'
90°
TACTITE
39'
40.2
27.2
3.8
60'
32.1
18.2
1.9
62'
44.7
19.8
1.4
957'
LEGEND
DDH-3
EL. 5,117'
-60°
110'
Core hole, showing elevation of collar, dip of hole, iron-rich intervals, and depth of hole.
60'
41.2
3.9
1.5
Length of iron-rich core
Percent Fe
" SiO_2
" S
0
100
200 Feet
Scale
DIAMOND DRILL HOLES
Drill hole data from USBM R.I. 4051


9,500 E
10,000 E
10,500 E
11,000 E
10,500 N
10,000 N
9,500 N
Chesaw
Ore bunker
Gold Creek Road
PIT NO. 3
1,400 feet to NW cor. sec. 24
Sec. 13 T.40 N., R.30 E.
Sec. 24
Lower adit
Upper adit
PIT NO. 2
PIT NO. 1
DDH-5
DDH-6
0°
-60°
-60°
-55°
DDH-4
DDH-3
DDH-1 and 2
DDH-7
LEGEND
Magnetite body
Open pit
Mine dump
Adit
Shaft at surface
Diamond drill hole (inclined)
Diamond drill hole (vertical)
0
100
200
300
400
500 Feet
Scale
N
MAGNETIC MINE
OKANOGAN CO., WASHINGTON

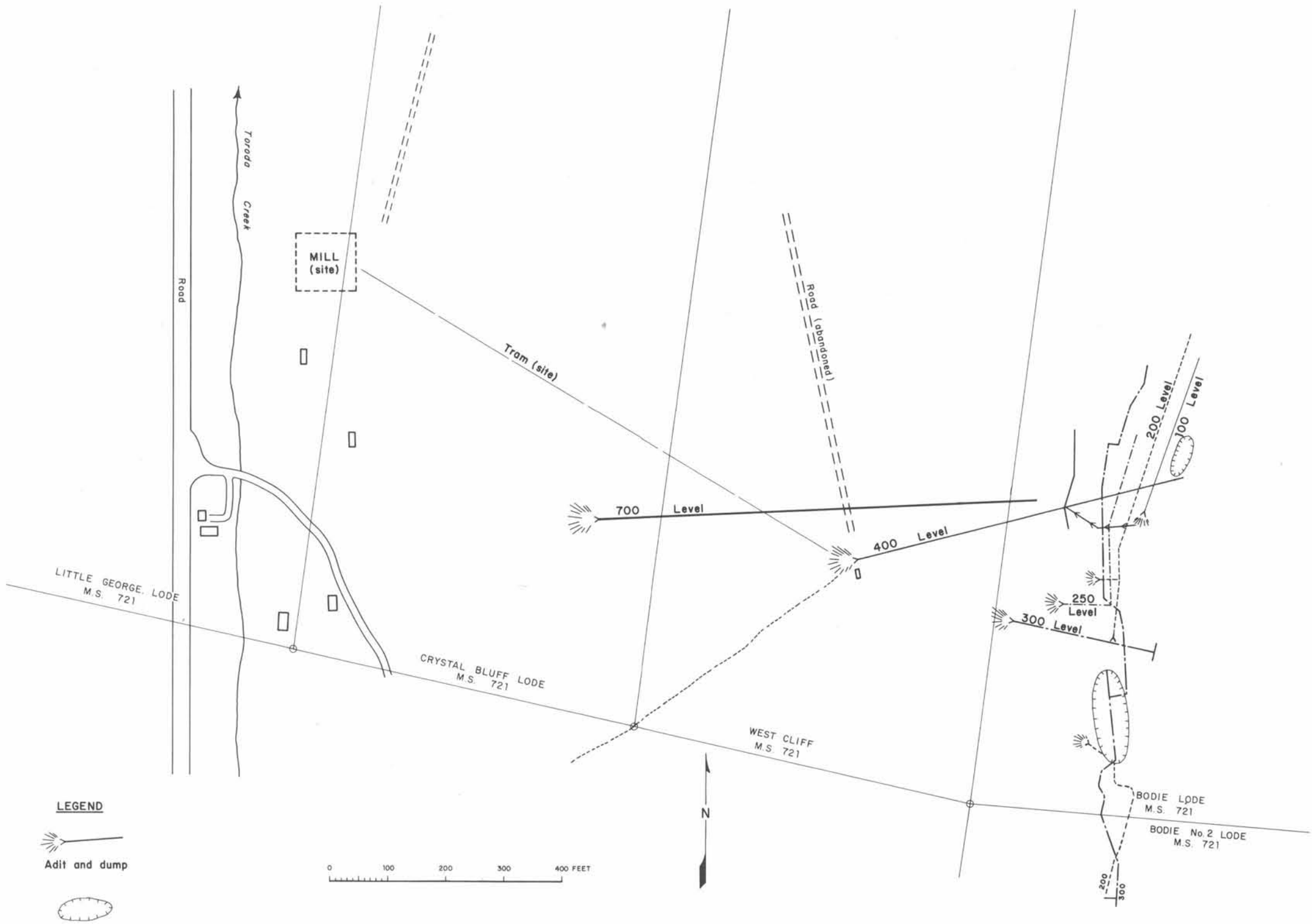


MAGNETIC MINE DIP NEEDLE SURVEY



MAGNETIC MINE MAGNETOMETER SURVEY

OKANOGAN CO., WASHINGTON



LEGEND

Adit and dump

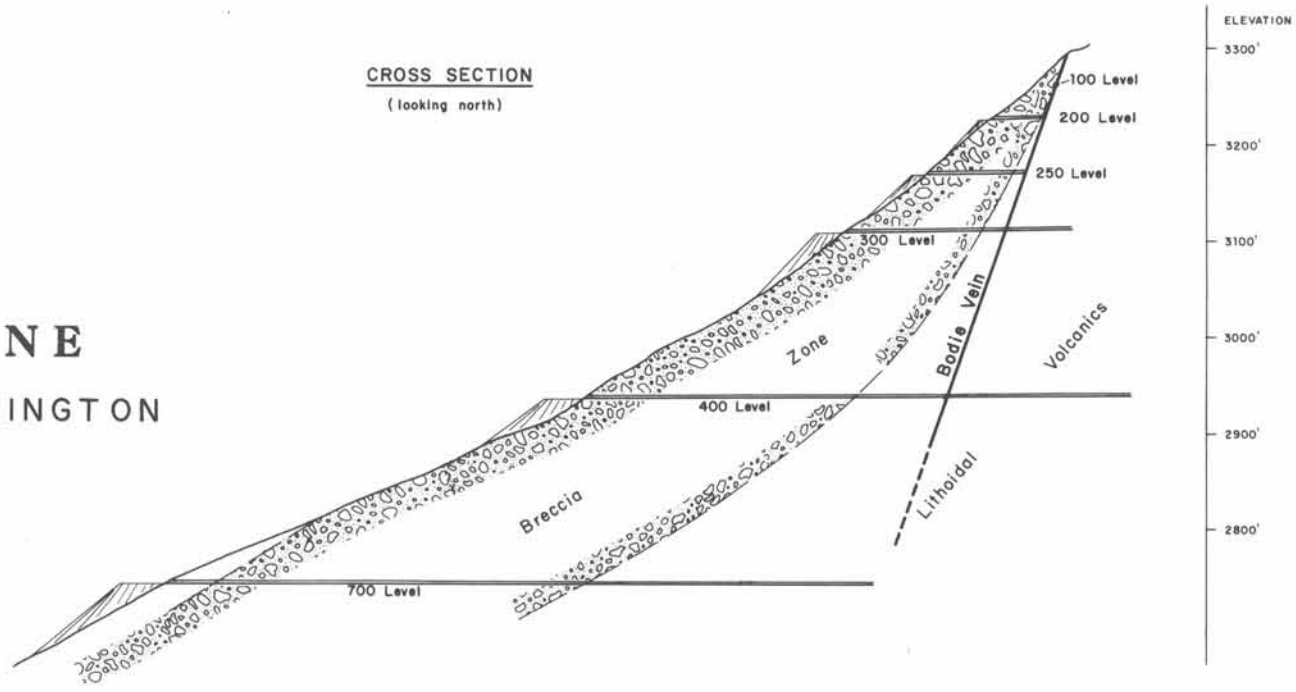
Glory Hole

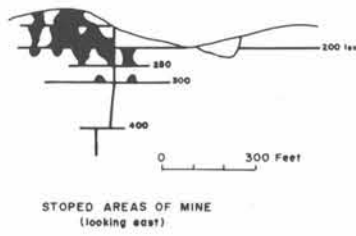
Raise (chevrons point down)

Building or shed

Trail

Claim corner





STOPED AREAS OF MINE
(looking east)

BODIE MINE

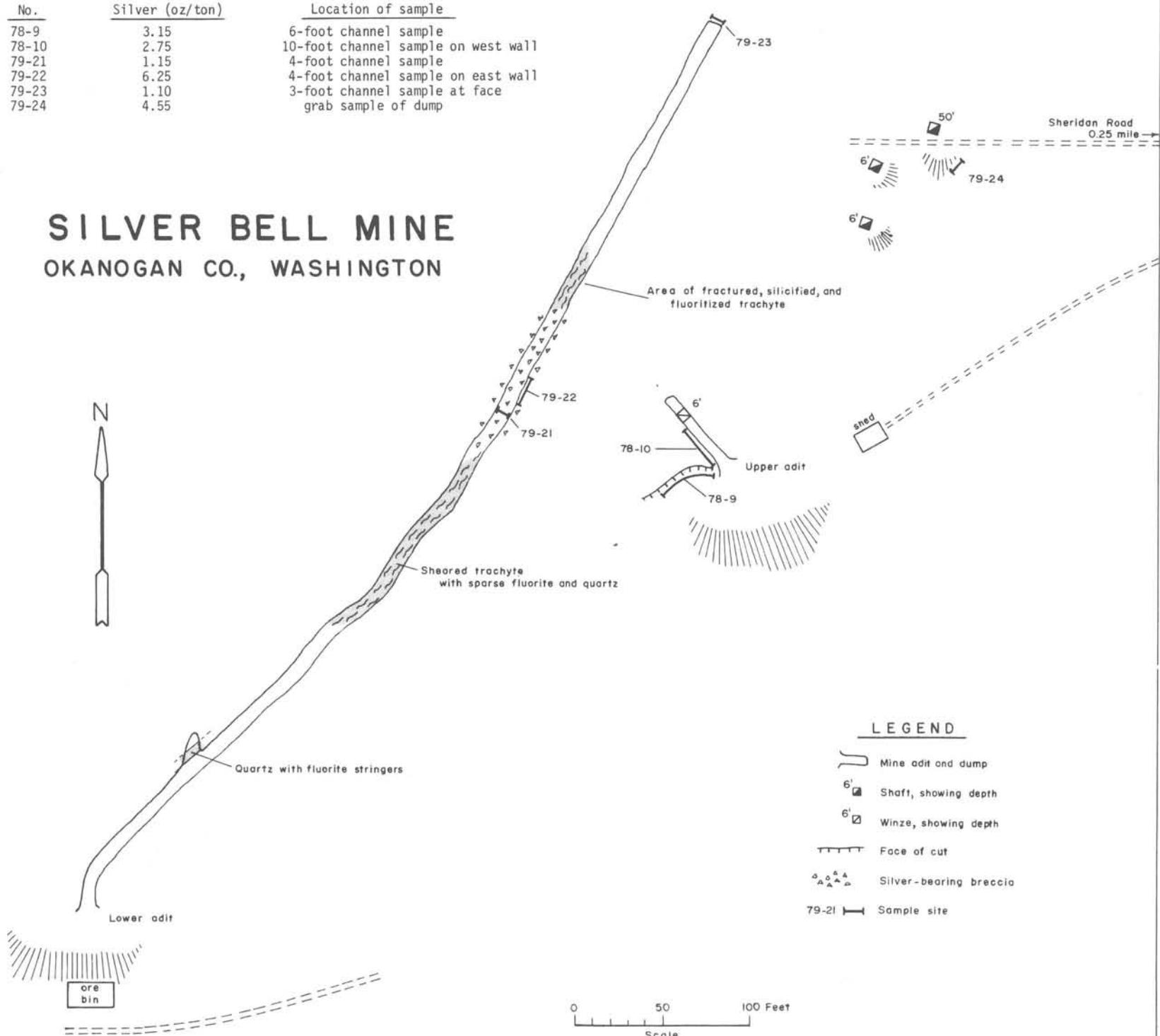
OKANOGAN CO., WASHINGTON

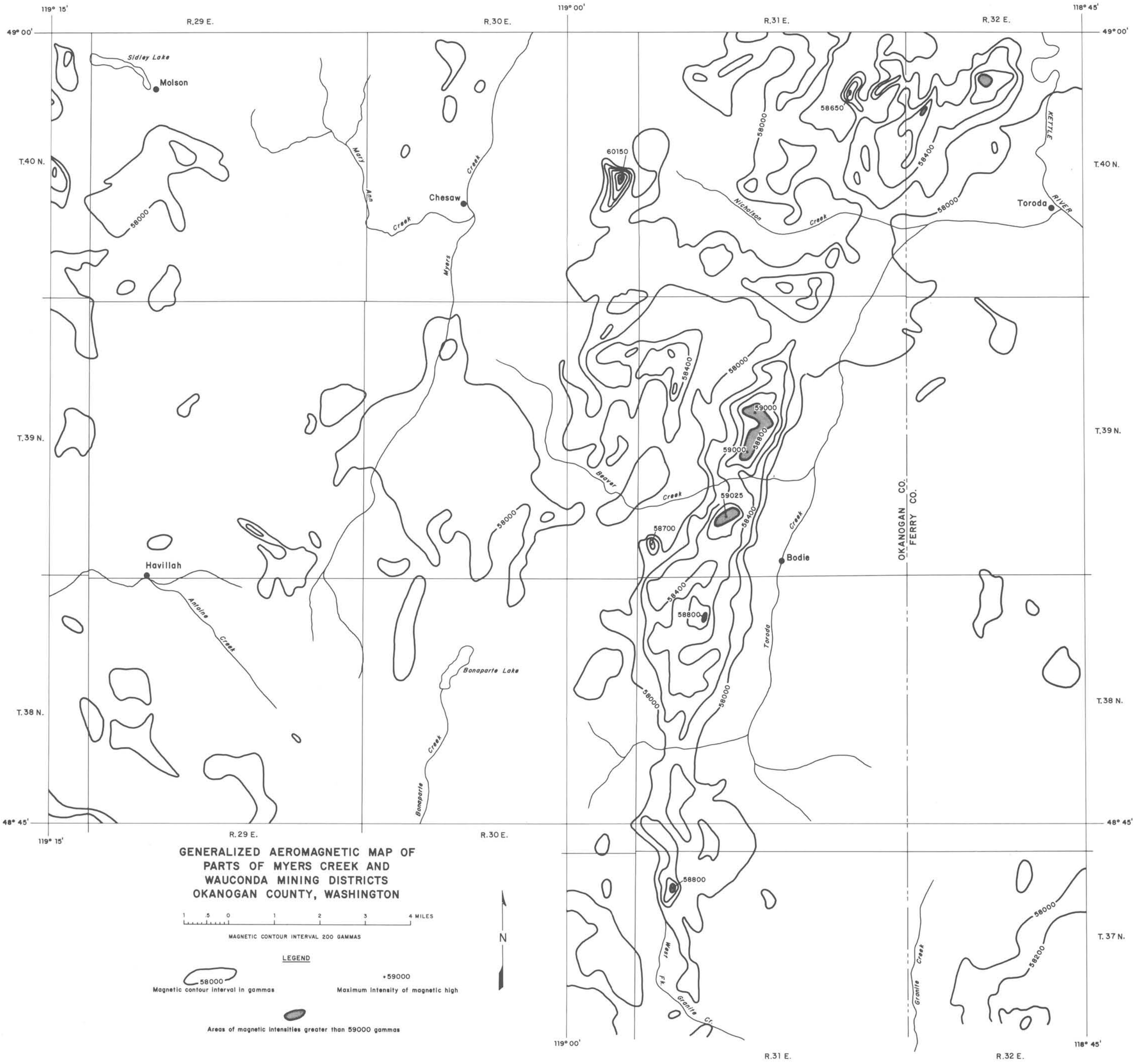
SAMPLES

No.	Silver (oz/ton)	Location of sample
78-9	3.15	6-foot channel sample
78-10	2.75	10-foot channel sample on west wall
79-21	1.15	4-foot channel sample
79-22	6.25	4-foot channel sample on east wall
79-23	1.10	3-foot channel sample at face
79-24	4.55	grab sample of dump

SILVER BELL MINE

OKANOGAN CO., WASHINGTON





GENERALIZED AEROMAGNETIC MAP OF PARTS OF MYERS CREEK AND WAUCONDA MINING DISTRICTS OKANOGAN COUNTY, WASHINGTON

Note: Magnetic values represent total intensities at 500 to 800 feet above land surface, flown on flight-line spacings of ¼ mile (1,320 feet). Isomagnetic lines below 58,000 gammas not shown.
Source of data: Geological Interpretation of Airborne Magnetometer and Scintillometer Survey by Hunting Geophysical Services, Inc.: Washington Division of Geology Report of Investigation No. 20, 1960.