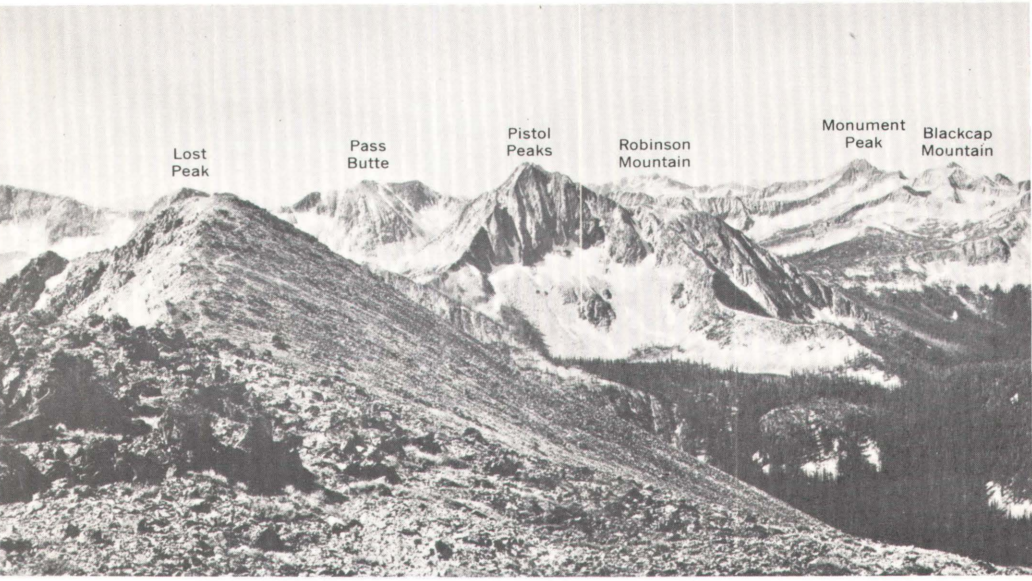
STUDIES RELATED TO WILDERNESS

WILDERNESS AREAS

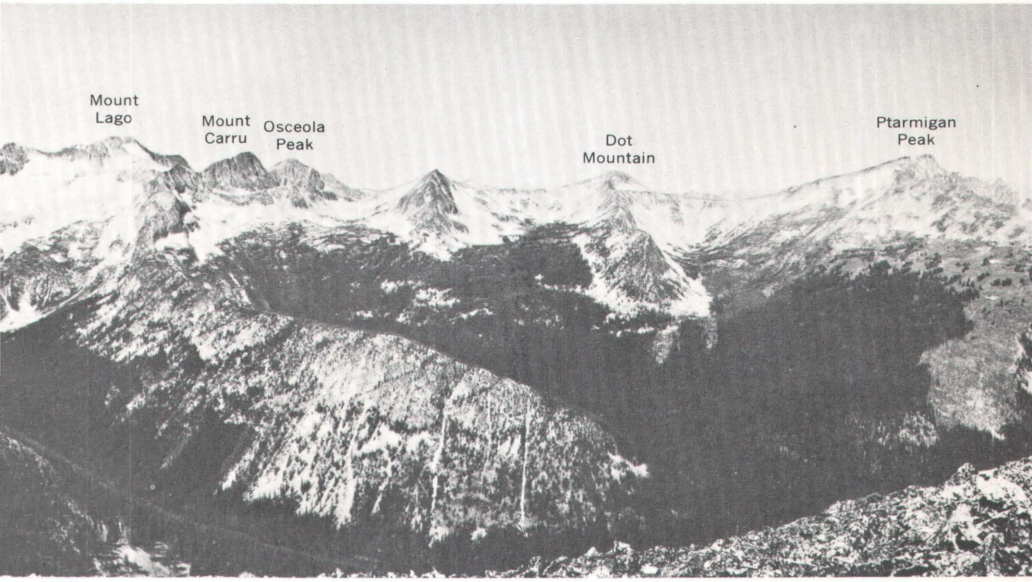
PASAYTEN AREA, WASHINGTON

GEOLOGICAL SURVEY BULLETIN 1325

MINERAL RESOURCES OF THE PASAYTEN WILDERNESS AREA, WASHINGTON



Rugged center of the Pasayten Wilderness Area, viewed across Ptarmigan Creek from Many Trails Peak.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Mineral Resources of the Pasayten Wilderness Area, Washington

By MORTIMER H. STAATZ, PAUL L. WEIS, ROWLAND W. TABOR, *and* JACQUES F. ROBERTSON, U.S. GEOLOGICAL SURVEY, *and* RONALD M. VAN NOY, ELDON C. PATTEE, *and* DEAN C. HOLT, U.S. BUREAU OF MINES

With a section on AEROMAGNETIC INTERPRETATION

By GORDON P. EATON *and* MORTIMER H. STAATZ, U.S. GEOLOGICAL SURVEY

STUDIES RELATED TO WILDERNESS—WILDERNESS AREAS

GEOLOGICAL SURVEY BULLETIN 1325

An evaluation of the mineral potential of the area

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STUDIES RELATED TO WILDERNESS

WILDERNESS AREAS

Under the Wilderness Act (Public Law 88–577, Sept. 3, 1964) certain areas within the National forests previously classified as "wilderness," "wild," or "canoe" were incorporated into the National Wilderness Preservation System as wilderness areas. The act provides that the Geological Survey and the Bureau of Mines survey these wilderness areas to determine the mineral values, if any, that may be present. The act also directs that results of such surveys are to be made available to the public and submitted to the President and Congress.

This bulletin reports the results of a mineral survey of the Pasayten Wilderness, Washington. The area discussed in the report is somewhat larger than the Pasayten Wilderness. This is because work began in the area before the boundaries of the wilderness became established.

This bulletin is the first of a series of reports on wilderness areas.

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MINERAL RESOURCES OF THE PASAYTEN WILDERNESS AREA, WASHINGTON

By MORTIMER H. STAATZ, PAUL L. WEIS, ROWLAND W. TABOR, and JACQUES F. ROBERTSON, U.S. Geological Survey, and RONALD M. VAN NOY, ELDON C. PATTEE, and DEAN C. HOLT, U.S. Bureau of Mines

SUMMARY

The Pasayten Wilderness Area occupies approximately 900 square miles of rugged mountainous terrain in northwestern Washington. It extends for 54½ miles along the International Boundary from Ross Lake eastward to Goodenough Peak. The U.S. Geological Survey and the U.S. Bureau of Mines spent 2 years making a mineral survey of this area.

Geologic mapping, an extensive geochemical sampling program, an aeromagnetic study, and examination of mines, claims, and prospects were carried out as a part of the investigation. During the course of the work, 1,208 stream-sediment samples, 90 panned concentrates, and 681 rock and vein samples were collected for analysis. Areas where anomalous amounts of metals were found were investigated further, known areas of mineralization and rock alteration were sampled, and all known prospects and workings were sampled and mapped. A search was made for all recorded claims. As a part of the geologic investigation, major rock units and structures were mapped in order to associate mineral occurrences with particular rock types.

Geologically, the area is divided into two contrasting parts by the northwesterly trending Eightmile Creek fault, a major structure that crosses the entire width of the wilderness area. The area east of the fault is underlain by igneous and metamorphic rocks that contain few mineral showings.

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West of the fault a broad medial belt of plagioclase arkose and argillite is underlain and overlain on the east by volcanic rocks and faulted on the west against the greenstones and cherts of the Hozomeen Group of Cairnes (1944). In the southwest is a small area of hornblende and biotite gneiss (Custer Gneiss of McTaggart and Thompson, 1967). Numerous bodies of diverse intrusive rock have intruded the rocks west of the fault, and mineral showings are relatively abundant.

Structure in the older metamorphic rocks east of the Eightmile Creek fault has largely been obliterated by large intrusions. West of the fault the rocks are folded about north- or northwest-trending axes and are broken by several large north-trending faults and a few transverse faults.

Since the 1870's, 605 lode and placer claims have been recorded in the Pasayten Wilderness Area. Mineral production has been small, and is limited to only a few areas. Mineral showings can be found in many places, but only four areas appear to have potential for the discovery of economic deposits. These areas are the Monument Peak stock, the Billy Goat Mountain area, a narrow band along the north edge of the Slate Peak mining district, and the drainage basin of Tungsten Creek.

The Monument Peak granite stock underlies an area of about 50 square miles in the south-central part of the study area. No ore deposits are known here, but numerous geochemical anomalies in and around the stock indicate that copper and molybdenum occur in disseminated zones that may have economic potential. Geochemical anomalies around Lake of Woods are particularly encouraging.

Veins near Billy Goat Mountain, at the southeast edge of the study area, contain fairly abundant copper and silver minerals. The veins with greatest apparent potential lie within half a mile of the wilderness area boundary.

Small, discontinuous quartz veins with erratic gold values occur in a band about 1–2½ miles wide along the south boundary of the study area between Beauty Creek and Chancellor. This area comprises the north edge of the Slate Creek mining district. Judged from surface indications, these veins appear submarginal, but new mining techniques and exploration at depth might conceivably permit economic exploitation in the future.

The Tungsten Creek basin, near the Canadian border in the eastern part of the study area, contains tungsten-bearing quartz veins. Attempts to mine these veins in the past apparently proved uneconomic. However, total tungsten resources in the area are probably great enough to warrant further investigation.

INTRODUCTION

Pursuant to the Wilderness Act (Public Law 88–577, Sept. 3, 1964) and the Conference Report on Senate Bill 4, 88th Congress, the U.S. Geological Survey and the U.S. Bureau of Mines began a mineral survey of the North Cascades Primitive Area, Washington, in 1965. The purpose of the survey was to evaluate the mineral resources of the primitive area. Three field seasons were devoted to the work. In the fall of 1968, the eastern part of the North Cascades Primitive Area was incorporated into the National Wilderness Preservation System as the Pasayten Wilderness, through Public Law 90–544 (90th Congress). The present report describes the mineral resources of the Pasayten Wilderness, the eastern part of the Ross Lake National Recreation Area, and certain adjacent lands south and east of the wilderness area.

LOCATION AND GEOGRAPHY

The study area, which comprises the entire Pasayten Wilderness, the eastern part of the Ross Lake National Recreation Area, and certain adjacent lands, occupies about 900 square miles along the north border of the State of Washington (fig. 1; pls. 1, 2). It extends 54½

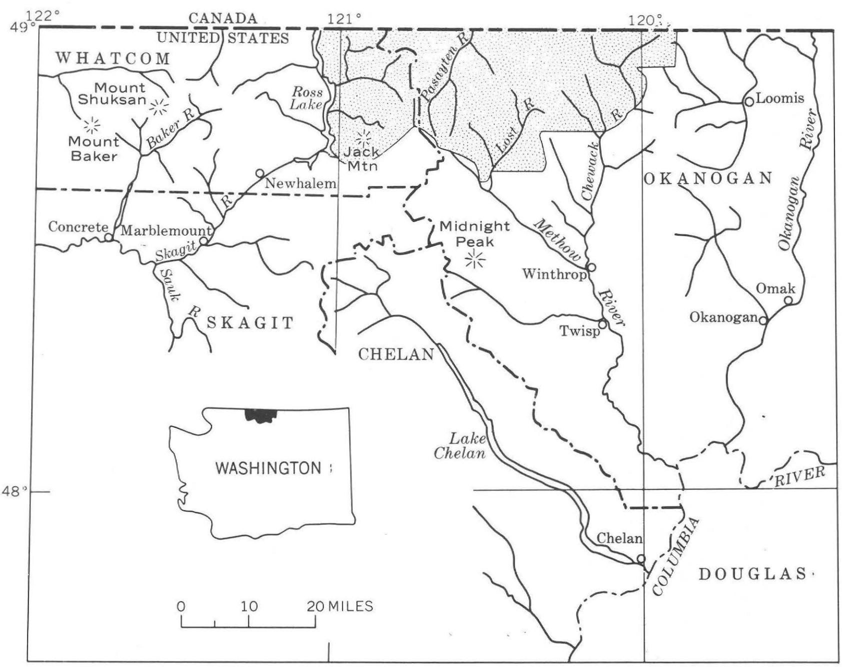

FIGURE 1.—Location of the area considered in this report (stippled).

miles east from Ross Lake, and as much as 23½ miles south from the Canadian border (fig. 1). The Cascade divide runs roughly north-south across the area and splits it into approximately an eastern two-thirds and a western one-third. The divide also forms the boundary between Okanogan and Whatcom Counties, and the boundary between Okanogan National Forest to the east and Mount Baker National Forest to the west.

Rugged mountains and deep, steep-walled canyons form most of the area. Ridge crests commonly have elevations of 7,500 to 8,500 feet above sea level, and adjacent valley bottoms are commonly 4,000 to 5,000 feet lower. The maximum relief is in the southwestern part of the area, where Jack Mountain (elev 8,928 ft) towers 7,328 feet above Ross Lake (elev 1,600 ft), only 3 miles away. Most ridge crests are above timberline, and many are steep, rough, and craggy (figs. 2, 3). Valley sides are also steep. Valley bottoms and lower slopes are mostly densely forested (figs. 4, 5). Many valleys are narrow and V-shaped, such as those of Monument Creek, Three Fools Creek and its tributaries, Devils Creek, and Lost River. Others, such as the Middle and West Forks of the Pasayten River (fig. 16), Cathedral Creek, upper Drake Creek, and Chuchuwanteen Creek, have been

FIGURE 2.—Northeast side of Mount Lago rising above thickly forested Ptarmigan Creek.

FIGURE 3.—Pinnacles on the ridge to the west of Shull Creek tower above virgin forests that cloak the valley sides.

glaciated and now have U-shaped cross sections and broad, nearly flat floors. One of the most rugged parts of the area lies between Eureka Creek and Lost River (frontispiece), where bare, jagged peaks more than 8,000 feet high are bounded by deep valleys with steep to vertical walls. The Jack Mountain–Crater Mountain area and the region around Hozomeen Mountain are also unusually rough country.

The northeasternmost part of the study area, between Ashnola River and Horseshoe Basin, is in marked contrast to the mountainous terrain elsewhere. Here, gently rolling upland lies between scattered high peaks and ridges. Relief in many places is 500 feet or less. Steep slopes or cliffs are found only on the north or northeast sides of the highest ridges.

Glaciers once occupied much of the study area, but today they remain in only four places. Jack Mountain, the highest peak in the

FIGURE 4.—Shull Creek, one of many beautiful streams in a heavily forested valley.

area, has three, the largest more than half a mile across (fig. 17). Nearby Crater Mountain has a glacier on its northwest side. A small glacier lies on the north side of Castle Peak near the Canadian border, and another small glacier clings to the north side of Mount Lago. Elsewhere, the higher peaks may have snowfields in protected areas that persist throughout the summer, but usually the snow disappears in August.

The climate in the western part of the wilderness area is wetter and more temperate than in the eastern part. Average annual precipitation ranges from 75 inches per year near Ross Lake to as little as 16 inches at the east edge of the area. Most of the precipitation falls as snow, which commonly reaches depths of 10 feet in the higher parts of the area, with drifts up to 30 feet deep on the lee sides of ridges. Snow covers most of the area from October to late May, and,

FIGURE 5.—Lake of the Pines, a small tarn high on the south shoulder of Rock Creek. Rocks exposed in foreground and on the north side of Rock Creek belong to the plagioclase arkose and argillite sequence; quartz diorite underlies the forest in the center of the picture.

in most summers, patches remain on north slopes until mid-July. As a result of the prolonged period of snowmelt, the springs, streams, and rivers maintain their flows throughout the relatively dry summer. Although all the area has in summer warm days and cool nights, winter temperatures are as much as 20° colder on the east side.

Roads extend to the edge of the study area at several places (pls. 2, 3). On the northwest, the north end of Ross Lake is at the terminus of a 40-mile secondary road from Hope, British Columbia. Ross Dam and Ruby Creek are accessible from the south by means of Washington State Highway 17. This highway, which runs just south of the wilderness area, connects the Skagit Valley on the west with the Methow Valley on the east. The south margin of the study area can be reached in several places by a road from the Methow Valley that leads to Harts Pass, Slate Peak Lookout, and the old mining town of Chancellor on Canyon Creek. A logging road north of Mazama reaches the south boundary of the area on Goat Creek. One branch of a road north from Winthrop leads to the headwaters of Eightmile Creek, and another branch parallels the area boundary along the Chewack River for about 5 miles southwest from Thirtymile Camp. The easternmost part of the area can be reached via a road up the Middle Fork of Toats Coulee Creek, 21 miles west from Loomis.

Numerous trails provide access within the wilderness area. Several trails east of the Cascade crest are of easy grade and well maintained; trails west of the crest are fewer and generally steeper. Among the better and more extensively used trails are (1) the Cascade Crest trail, which extends along or close to the Cascade crest from the Canadian border south to the Columbia River on the Washington-Oregon border; (2) the trail from Eightmile Creek to Hidden Lakes; (3) the Lake Creek–Ashnola River trail; (4) the Andrews Creek trail to Cathedral Lakes; and (5) the Boundary trail, from Horseshoe Creek to the headwaters of Tungsten Creek, thence westward to Castle Pass and Elbow Basin, and then down Three Fools Creek to Ross Lake. Several other trails, generally less used and not as well maintained, follow other major canyons and ridges.

PREVIOUS STUDIES

Very little geologic work has been done in the Pasayten Wilderness area, and the geology is incompletely known. Russell (1900) made a traverse along part of the south boundary of the area in 1898. This work was followed in 1901 by a geological reconnaissance by Smith and Calkins (1904) across the northern part of the area from its east edge to the Pasayten River and up the Pasayten to the south edge of the area. Between 1901 and 1906 Daly (1912) mapped the geology of a strip across the entire area approximately 4 miles wide centered on the International Boundary. Misch (1952, 1966) has studied the part of this area west of the Cascades and has published two geologic maps at scales of 1:713,940 and 1:533,550. Most of the eastern part of the study area has been studied by J. D. Barksdale. His mapping in this area is shown on the geologic map of Washington at a scale of 1:500,000. In addition, two theses cover the easternmost part of the area: Hibbard (1962) described the crystalline rocks of the township east of longitude 120°00′, and Hawkins (1963, 1968b) described the crystalline rocks from the 120°00′ meridian west to a line along Ashnola River and Lake Creek.

PRESENT STUDY AND ACKNOWLEDGMENTS

The purpose of this study is the evaluation of the mineral resources of the Pasayten Wilderness Area. The study includes the results of the examination and sampling of all known prospects and a detailed geochemical sampling program. More than 1,200 stream-sediment samples were taken; most of the streams of the area were sampled (pls. 2, 3). In addition, samples of panned concentrates were collected along many of the larger streams, and rock samples were taken from all known altered or mineralized zones (pls. 2, 3). A reconnaissance geologic map was prepared (pl. 1) in order to relate rock units and structure to mineral deposits. Ground traverses were made along all the principal ridges and valleys. By use of a helicopter for transportation into working areas and for reconnaissance, this rugged area was covered in a much shorter time than otherwise would have been possible.

Various planimetric and topographic maps of the area, at several different scales, are available. Two topographic maps at a scale of 1:62,500 (the Horseshoe Basin and Mazama quadrangles) cover 45 and 37 square miles, respectively, of the extreme eastern and southeastern parts of this study area. Five topographic maps at a scale of 1:24,000 (Robinson Mountain, Slate Peak, Azurite Peak, Crater Mountain, and Ross Dam quadrangles) encompass 28, 4, 4, 15, and 2 square miles, respectively, of the western part of the south edge of the study area. About 765 square miles is not included in any existing large-scale topographic maps, but is included on the U.S. Geological Survey Concrete sheet at 1:250,000; this map, enlarged to 1:200,000, is the base for the geologic map (pl. 1). The whole area, however, lies within all or parts of 10 U.S. Forest Service planimetric maps at a scale of 1:62,500. These maps were used for plotting sample localities (pls. 2, 3) and for field mapping.

The geological fieldwork was done from July to September 1965, and June to September 1966, by M. H. Staatz, J. F. Robertson, R. W. Tabor, and P. L. Weis. We were assisted in 1965 by B. O. Culp, D. A. McWhorter, E. G. Hasser, and K. Y. Lee, and in 1966 by R. G. Smith, E. E. Loeb, Russell Robinson, Jr., and B. O. Culp. For a month in the latter part of the summer of 1965 we were joined by E. V. Post, W. L. Lehmbeck, and W. P. McKay, who analyzed our stream sediments by colorimetric methods for selected elements in a mobile geochemical laboratory. They also aided us in the collection of sediment samples and made geochemical tests in the field. For a week during this same period we were joined by A. P. Marranzino, G. C. Curtin, and D. J. Grimes, who analyzed panned concentrates, altered and mineralized rock, and selected stream-sediment samples

in a mobile spectrographic laboratory. For most of the summer of 1966 C. L. Whittington and W. H. Raymond, Jr., with the mobile geochemical laboratory analyzed the stream-sediment samples. Mr. Raymond also made geochemical tests in the field. In addition, other spectrographic analyses were made in the Geological Survey's Washington, D. C., laboratories by W. B. Crandell and Joseph Harris, and in the Geological Survey's Denver laboratories by H. G. Neiman, Arnold Farley, Jr., and K. C. Watts, Jr. Samples of vein material were assayed for various metals in the Denver laboratories of the U. S. Geological Survey by O. M. Parker, Claude Huffman, Jr., J. D. Mensik, G. T. Burrow, Luther Dickson, T. A. Roemer, S. K. McDanal, Gary Dounay, George Andrews, and H. H. Lipp.

Rock samples were analyzed for gold by E. E. Martinez, R. L. Miller, T. A. Roemer, J. G. Frisken, J. E. Troxel, and J. A. Thomas.

Fieldwork by the U.S. Bureau of Mines was started during the summer of 1965 and terminated at the end of the summer of 1967. Van Noy, Pattee, and Hole were aided in the field by the following Bureau men: Robert Weldin,[1] Joseph Coffman,[1] William Rice,[2] Errol Kramer,[3] John Johnson,[4] and Joseph M. Roche.[4]

Acknowledgment is made to the Mt. Baker and Okanogan National Forests personnel for providing assistance. Special recognition is given Mr. Paul Schauffer, District Ranger, Winthrop, Washington.

For this investigation, geological mapping, geochemical sampling, and analyses and studies of altered areas were by members of the U.S. Geological Survey. Information on mines, prospects, and mineralized areas were compiled by both the U.S. Geological Survey and the U.S. Bureau of Mines. Examinations of mining claim records and economic appraisals of properties in the area were by the U.S. Bureau of Mines.

GEOLOGY

The geology of the Pasayten Wilderness is diverse and includes a variety of sedimentary, igneous, and metamorphic rocks of several ages. Precise ages are known for only a few of the units. What little is known indicates that most of the rocks are Cretaceous or Tertiary in age, although a few are undoubtedly much older.

The wilderness area is divided into geologically dissimilar parts by the northwest-trending Eightmile Creek fault (pl. 1). The rocks east of this major fault consist principally of intrusive igneous rocks

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[2] Geologist, Spokane Office of Mineral Resources.
[3] Physical Science Technician, Spokane Office of Mineral Resources.
[4] Mining Engineer, formerly assigned to the Spokane Office of Mineral Resources.

with some metamorphic rocks. The rocks west of the fault are more varied. Those in the eastern four-fifths of this western area consist of a thick detrital sedimentary series, some volcanic units, several moderate-sized bodies of intrusive rocks, and numerous dikes. Those in the western one-fifth consist of a thick sequence of slightly metamorphosed volcanics, some highly metamorphosed rocks, and some clastic sedimentary rocks. The rocks on either side of the Eightmile Creek fault are parts of different sequences, and, as their relative ages are unknown, they will be discussed separately.

ROCKS EAST OF THE EIGHTMILE CREEK FAULT

The oldest rocks of the area east of the Eightmile Creek fault are schists, gneisses, and quartzites of sedimentary and volcanic origin. These rocks have been largely engulfed and obliterated by younger intrusive igneous rocks. The metamorphic rocks make up all or the greater part of the three oldest rock units: (1) quartzites, gneisses, and schists of the Horseshoe Basin area, (2) hornblende gneisses of the Sheep Mountain area, and (3) the granodiorite gneiss complex of the Quartz Mountain area. They also occur as isolated pods, layers, and screens in the adjacent igneous rocks. In order of decreasing age, the younger igneous rocks are: (1) gneissic quartz diorite of the Middle Fork of Toats Coulee Creek, (2) Ashnola Gabbro, (3) quartz monzonite, granodiorite, and quartz diorite, and (4) light-colored quartz monzonite dike of the Cathedral Peak area. Small coarse- to fine-grained light- to dark-colored dikes are scattered throughout this area.

QUARTZITES, GNEISSES, AND SCHISTS OF THE HORSESHOE BASIN AREA

Three small areas of older metamorphic rocks (pl. 1; fig. 20) are found in or near Horseshoe Basin in the easternmost part of the study area. These rocks are surrounded and intruded by younger intrusions (fig. 6) and are probably roof pendants, as suggested by Daly (1912, p. 432). Rock types noted are quartzite, feldspathic quartzite, quartz-biotite-orthoclase schist, hornblende-quartz-augite gneiss, and plagioclase-hornblende-biotite gneiss. Except for the quartzites all these rocks are thinly laminated; layers and foliation dip steeply. Some of these rocks were derived from sedimentary rocks, although the hornblende-bearing ones were probably derived from mafic volcanic rocks. Their age is not known, but similar-appearing rocks to the south and east have been dated as Permian and Triassic (Hibbard, 1962, p. 8; U.S. Geological Survey, 1965, p. A96). These rocks were metamorphosed before they were intruded by the gneissic quartz diorite of the Middle Fork of Toats Coulee Creek, which has a minimum age of Early Jurassic according to potassium-argon determinations by J. E. Engels (C. D. Rinehart and K. C. Fox, Jr., unpub. data, 1970).

HORNBLENDE GNEISSES OF THE SHEEP MOUNTAIN AREA

Hornblende-rich gneisses cut by numerous dikes underlie an irregular area of about 4½ square miles along the International Boundary. This unit lies north of Sheep Mountain and extends roughly from Peeve Creek to Ashnola River (pl. 1). These rocks were called the "Basic Complex" by Daly (1912, p. 436–439). The hornblende gneisses are surrounded by rocks of the granodiorite gneiss complex.

The gneisses consist principally of amphibolite, interlayered with less abundant black hornblende-biotite-quartz gneiss and hornblende-augite gneiss. Minor minerals in the gneisses are magnetite, quartz, chlorite, epidote, and apatite. The proportions of these minerals differ greatly from one layer to another. Dark-green gneisses are generally hornblende rich, black layers are biotite rich, and the lighter layers have more plagioclase. Grain size ranges from fine to coarse, both from one layer to the next and within any one layer. The foliation strikes generally N. 65° W. and dips steeply to the northeast, although locally it exhibits tight folds or swirls. A semiquantitative spectrographic analysis of hornblende gneiss (92, table 1; pl. 2) indicates that this rock has the highest iron, magnesium, calcium, and cobalt content of the 39 samples of fresh rock analyzed from the wilderness area.

The hornblende gneisses are cut by numerous crisscrossing fine- to coarse-grained dikes. These dikes are most numerous to the northeast, near a granodiorite stock from which they were probably derived. The gneisses are also cut by other dikes containing olivine, plagioclase, pyroxene, and amphibole. A distinctive 40-foot-thick dike that crops out on the main ridge west of the Ashnola River consists of olivine nodules in a felted matrix of amphibole (Daly, 1912, p. 437–439).

The hornblende gneisses of the Sheep Mountain area are probably among the oldest rocks in the study area and have gone through a period of high-grade metamorphism. Rocks of this composition could have been formed by metamorphism of mafic volcanic rocks.

GRANODIORITE GNEISS COMPLEX OF THE QUARTZ MOUNTAIN AREA

A large irregular mass of gneissic rock lies across the International Boundary from a point three-quarters of a mile east of the Pasayten

River on the west to Cathedral Lake on the east—a distance of 14 miles (pl. 1). This mass extends 3–5¾ miles south from the boundary. It surrounds the hornblende gneisses of the Sheep Mountain area, the Ashnola Gabbro, and a quartz monzonite intrusive, and is surrounded by quartz monzonite, granodiorite, and quartz diorite. Similar gneiss, surrounded by quartz monzonite, granodiorite, and quartz diorite, occurs about 12 miles to the southeast where it extends for 3½ miles along the Chewack River from a point 1 mile north of Andrews Creek.

The granodiorite gneiss complex is a compound rock unit that consists of hornblende gneisses (equivalent to the hornblende gneisses of the Sheep Mountain area) that have been extensively injected and partly replaced by gneissic granodiorite. Thus, the contact between the hornblende gneisses of the Sheep Mountain area and the granodiorite gneiss complex is gradational, and layers of hornblende gneiss extend from one unit into the other. The predominant rock of the complex is gneissic hornblende-biotite granodiorite. The subordinate hornblendic gneisses of the complex are mainly amphibolite, but hornblende-biotite-quartz gneiss, biotite-quartz gneiss, and pyroxene-quartz gneiss are present locally. These rocks, like similar ones in the Sheep Mountain area, probably had a volcanic and sedimentary ancestry. The crosscutting nature of some layers of granodiorite and the presence of hornblende gneiss inclusions in granodiorite indicate that much of the granodiorite is intrusive. Daly (1912, p. 443–448) recognized the predominant intrusive character of this rock and called it the Remmel batholith, but the term "batholith" does not seem apt to indicate this unit's varied rock types.

The hornblende gneisses of the complex commonly show swirling of the foliation and folding of the various layers, which range from thin streaks to zones several hundred feet thick. In the gneissic granodiorite, plagioclase, generally andesine, is the most abundant mineral and commonly makes up about half the rock; quartz content ranges from about 10 to 25 percent, and orthoclase content ranges from 5 to 35 percent although commonly it is about 10 percent. Generally, those rocks containing the greatest proportion of orthoclase contain the smallest proportion of dark minerals, and vice versa. The dark minerals, hornblende and biotite, make up from about 2 to 35 percent of the rock. In a few places muscovite is the principal mica. Accessory minerals are apatite, sphene, magnetite, chlorite, epidote, garnet, and zircon. A semiquantitative spectrographic analysis of a specimen of the granodiorite gneiss (81, table 1; pl. 2) is similar to those of the granodiorite and quartz diorite intrusives west of the

Eightmile Creek fault (183, 194, 195, 289, 315, 316, 402, 433, and 507, table 1), although it contains a little more iron and manganese, possibly reflecting the higher proportion of hornblende and biotite in the gneiss.

The granodiorite gneiss complex is also cut by dikes of pegmatite, aplite, unmetamorphosed quartz monzonite, rhyolite, and andesite.

GNEISSIC QUARTZ DIORITE OF THE MIDDLE FORK OF TOATS COULEE CREEK

An irregular north-trending band of gneissic quartz diorite extends across the eastern part of the area in the vicinity of Horseshoe Basin and the Middle Fork of Toats Coulee Creek (pl. 2). The gneissic quartz diorite is a dark-speckled medium- to coarse-grained rock containing about 25 percent dark minerals. In many places it has a faint to distinct foliation of diverse orientation.

The principal minerals in the gneissic quartz diorite are plagioclase, orthoclase, quartz, hornblende, and biotite. Feldspar makes up about half the rock and plagioclase makes up about nine-tenths of the total feldspar. Quartz occurs in small, inconspicuous grains; hornblende and biotite generally occur in clots, with hornblende being more abundant. Minor amounts of magnetite, sphene, apatite, zircon, and chlorite are also present. A semiquantitative spectrographic analysis of typical quartz diorite gneiss (15, table 1; pl. 2) is similar to that of the gneissic granodiorite of the granodiorite gneiss complex of the Quartz Mountain area.

The gneissic quartz diorite of the Middle Fork of Toats Coulee Creek intruded the quartzites, gneisses, and schists of the Horseshoe Basin area, but it is older than the nonfoliated quartz monzonite, granodiorite, and quartz diorite which surround it. Potassium-argon age determinations by J. E. Engels on hornblende and biotite from this unit southeast of the study area indicate a probable Early Jurassic age (C. D. Rinehart and K. C. Fox, Jr., unpub. data, 1970).

On the east side of Pick Peak the gneissic quartz diorite is cut by a 60-foot-thick north-trending rhyolite dike at least half a mile long.

ASHNOLA GABBRO

A lenticular northwest-trending body of gabbro crosses the International Boundary just east of Beaver Creek, where it forms a prominent ridge (pl. 1). It was named the Ashnola Gabbro by Daly (1906, p. 341) after the Ashnola River. The body, which is 4¾ miles long and as much as half a mile wide (Daly, 1912, p. 434), intrudes the granodiorite gneiss complex of the Quartz Mountain area.

The Ashnola Gabbro is easily distinguished from the surrounding rocks by the distinctive tan color of the weathered rock. Fresh gabbro is dark gray and medium to coarse grained. Faint compositional layering has a consistent northeast strike and a northwest dip (Hawkins, 1963, p. 117). Rock types in the various layers are olivine-hypersthene gabbro, olivine gabbro, hypersthene gabbro, and pyroxene-hornblende gabbro (Hawkins, 1963, p. 120–121). Accessory minerals are rutile, sphene, apatite, zircon, magnetite, and quartz. Some of the primary minerals have altered to serpentine, talc, chlorite, biotite, and sericite.

Primary minerals in the gabbro are conspicuously alined northeasterly in the plane of the compositional layering, which is at right angles to the foliation in the adjacent gneisses. These structures, together with igneous texture, indicate that the Ashnola Gabbro intruded the gneisses after their metamorphism, not before, as concluded by Daly (1912, p. 436). The lineation probably formed by movement of the magma during crystallization. The age of the gabbro relative to the other igneous rocks of this area is not known, but lack of metamorphism suggests this rock is at least as late as Cretaceous.

Streams that drain the area underlain by the Ashnola Gabbro contain relatively high concentrations of magnetite compared with streams draining surrounding rocks.

QUARTZ MONZONITE, GRANODIORITE, AND QUARTZ DIORITE

Intrusive igneous rocks ranging in composition from quartz monzonite to quartz diorite underlie approximately three-quarters of the area east of the Eightmile Creek fault (pl. 1). The intrusion occurred after the regional metamorphism that formed the lineation and foliation in the older metamorphic rocks, which have been cut and replaced (fig. 6).

Several plutons are grouped together in this unit even though they are not all of the same age. Included are rocks in the eastern part of the Horseshoe Basin, which are continuous with the Similkameen batholith of Daly (1912, p. 455–459). Farther west, but also in this group, is a porphyritic quartz monzonite, which along the International Boundary between longitude 119° and 120°10′ was named the Cathedral Peak batholith by Daly (1912, p. 459–464). He correlated the Cathedral Peak batholith with the Similkameen batholith and with the Park stock—an isolated quartz monzonite body west of the Ashnola River. At least some of the Cathedral Peak batholith of Daly, as mapped by Hawkins (1963, pl. 1), has been shown to be much younger than the Similkameen. A potassium-argon date on

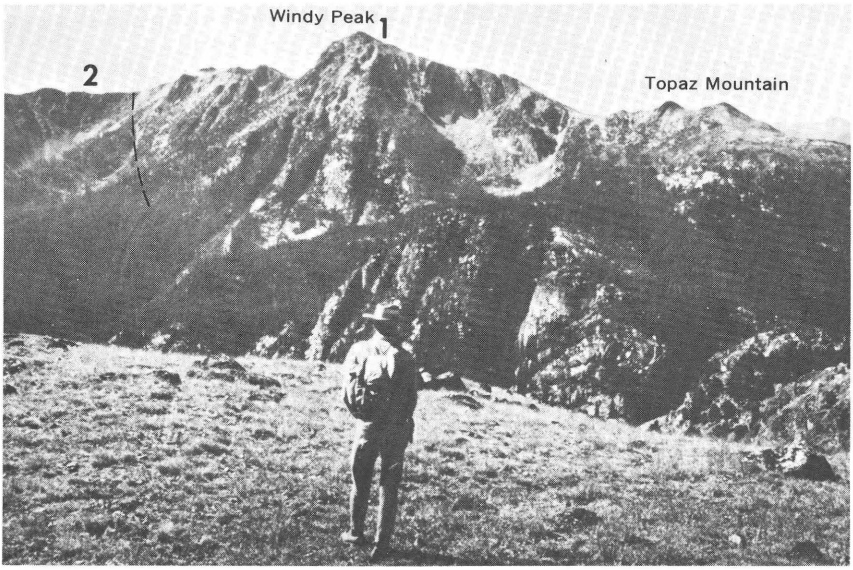

FIGURE 6.—Windy Peak in the easternmost part of the area is made up of granodiorite (1), which on the south side of the peak has intruded quartzites, gneisses, and schists of the Horseshoe Basin area (2).

biotite from granodiorite near Thirtymile Camp (Hawkins, 1968b, p. 1789) is 94.0 ± 2.8 m.y. (million years).

The quartz monzonite and quartz diorite are generally light gray or light pinkish gray, medium to coarse grained, and locally porphyritic. The principal minerals are plagioclase (30–50 percent), quartz (20–40 percent), and perthite (3–40 percent). Biotite (1–10 percent) and muscovite (trace–3 percent) are the most common accessory minerals. Biotite is ubiquitous, but muscovite is common only west of Andrews Creek. Small red garnets are locally abundant. Apatite, magnetite, and chlorite are found in most places in minor amounts, and zircon, epidote, sericite, and sphene are found locally. Four semiquantitative spectrographic analyses (10, 64, 77, and 161, table 1; pl. 2) of specimens ranging from quartz monzonite to quartz diorite indicate that these rocks are less mafic than either the granodiorite gneissic complex of the Quartz Mountain area or the quartz monzonite, granodiorite, and quartz diorite west of the Eightmile Creek fault.

Although most of the rocks are massive, foliation is found locally. Foliation in a zone 1–3 miles wide along the Eightmile Creek fault strikes roughly parallel to the fault and dips steeply. Close to the fault the rock is granulated and veined with calcite, but the foliation gradually dies out to the northeast. This foliation was formed by the deformation of the brittle quartz monzonite, granodiorite, and quartz diorite during faulting. Foliation unrelated to faulting is found in several places in the central part of this unit, where older metamorphic rocks have been incompletely replaced by the younger intrusive rocks and the foliation is inherited from the older rocks. In some places, where replacement is almost complete, faint streaks of darker minerals can be seen; in other places bands of biotite schist and hornblende gneiss are surrounded by the quartz monzonite, granodiorite, and quartz diorite. Partly replaced older rocks can be seen in this unit on the west side of Remmel Mountain, Reed Peak, and along Ram Creek.

Several types of dikes are widely scattered in the quartz monzonite. Most dikes are narrow and fairly short. They are of rhyodacite, andesite, basalt, and granitic pegmatite. The pegmatites in this area consist principally of perthite, quartz, and muscovite with accessory plagioclase, tourmaline, and garnet that have an average grain diameter of about 1 inch. These pegmatites are too small and too fine grained to permit the economic recovery of perthite, quartz, or muscovite. Furthermore, very little if any of the muscovite could be classified as sheet mica.

LIGHT-COLORED QUARTZ MONZONITE DIKE OF THE CATHEDRAL PEAK AREA

A northwesterly trending dikelike body of light-colored quartz monzonite that intruded the older quartz monzonite, granodiorite, and quartz diorite lies across the Canadian border northeast of Cathedral Peak (pl. 1). This dike is about 1,400 feet wide and 3½ miles long (Daly, 1912, p. 461), about 2 miles of its length being south of the border. The light-gray quartz monzonite weathers white. It is bounded by a thin fine-grained border zone that grades inward to a medium-grained porphyritic rock. Phenocrysts of perthite as much as an inch long are set in a finer grained matrix of plagioclase, perthite, and quartz with minor biotite, muscovite, apatite, and magnetite. This rock differs from the older quartz monzonite in being lighter colored, finer grained, and more uniformly porphyritic, and in having a generally higher perthite-to-plagioclase ratio.

The light-colored quartz monzonite may be the youngest major intrusion east of the Eightmile Creek fault, as it intruded the quartz monzonite, granodiorite, and quartz diorite unit, which is partly Late Cretaceous.

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ROCKS WEST OF THE EIGHTMILE CREEK FAULT

Contrasting with the intrusive igneous and metamorphic rocks east of the Eightmile Creek fault are the dominantly sedimentary, volcanic, and low-grade metamorphic rocks west of the fault. The bulk of the area west of the fault is underlain by sedimentary rocks, dominantly plagioclase arkose and argillite of mid-Mesozoic age, that are locally metamorphosed. On the west side along Ross Lake and in the southwest corner of the study area, the Mesozoic sedimentary rocks are in fault contact with two separate sequences of metamorphic rocks. Along the Eightmile Creek fault and in the south-central part of the area volcanic and associated sedimentary rocks underlie, intertongue with, and overlie the arkose-argillite sequence. The youngest unit of the volcanic rocks overlaps the Eightmile Creek fault and is not, itself, faulted.

A variety of igneous rocks in small- to medium-sized bodies, ranging from dunite to granite, have intruded the depositional units west of the fault.

These rock units will be described in order of decreasing age, although the relative age of some units is poorly known. Rock units, in order of description, are: (1) Custer Gneiss of McTaggart and Thompson (1967), (2) Hozomeen Group of Cairnes (1944), (3) volcanics of Billy Goat Mountain, (4) plagioclase arkose and argillite sequence, (5) Midnight Peak Formation, (6) granodiorite, quartz diorite, and quartz monzonite, (7) plagioclase porphyry stock and dikes, (8) dunite and serpentine, (9) hornblende diorite, (10) granodiorite dike and sill complex, (11) granite of Monument Peak, and (12) volcanics of Island Mountain.

CUSTER GNEISS OF McTAGGART AND THOMPSON (1967)

The biotite gneiss exposed on Roland Point and along Ruby Arm near the south end of Ross Lake (pl. 1) is probably the oldest rock west of the Eightmile Creek fault. It occupies only a few square miles of the study area, but is part of a widespread rock unit that extends northwesterly across the North Cascades from the Columbia River to Yale, British Columbia.

The unit was originally named Custer Granite Gneiss by Daly (1912, p. 523–526), but the name was later modified to Custer Gneiss by McTaggart and Thompson (1967, p. 1205–1210). These gneisses can be traced southeastward to the north shore of Lake Chelan, where they have been correlated with the Swakane Biotite Gneiss (Cater and Wright, 1967; Cater and Crowder, 1967). The biotite gneiss in the study area has also been called the Skagit Gneiss (Misch, 1952, p. 12–14), but the name Skagit has previously been used for a sequence of volcanic rocks along the Canadian border on the west side of Ross Lake (Daly, 1912, p. 528–531).

In the study area, the northeast margin of the unit is in fault contact with rocks of the granodiorite dike and sill complex and the phyllite facies of the plagioclase arkose and argillite sequence. Along Ruby Creek, it has been intruded by a small quartz diorite stock.

Within the study area the Custer Gneiss is well foliated, and the foliation has a general northerly strike. In places small folds in the foliation and compositional layering plunge at moderate angles to the south. Although biotite gneiss makes up the greater part of this unit in the study area, there are also layers of hornblende-biotite gneiss, hornblende gneiss, marble, and chlorite schist, particularly south of Ruby Arm. The biotite gneisses are mainly plagioclase-quartz rocks containing 5 to 20 percent biotite and lesser amounts of hornblende, chlorite, apatite, magnetite, and sphene. These layered gneisses are intruded in some places by dikes, sills, and irregular masses of a light-colored quartz diorite which contains less than 1 percent dark minerals.

HOZOMEEN GROUP OF CAIRNES (1944)

From a point about 6 miles east of Ruby Arm a thick sequence of greenstone with minor chert, marble, and shale extends in a northwest-trending belt into Canada (pl. 1). East of Ross Lake this belt is approximately 3½ miles wide and is bounded by faults.

This sequence was originally named the Hozomeen Series by Daly (1912, p. 500). The name was later modified to Hozomeen Group by Cairnes (1944).

The greater part of the Hozomeen Group is made up of slightly metamorphosed mafic lavas (greenstone). These fine-grained rocks are generally dark greenish gray, but locally are light greenish gray, dark purplish gray, reddish gray, or brown, and are made up of plagioclase, actinolite, and hornblende, with lesser amounts of chlorite, epidote, calcite, quartz, ilmenite, and apatite. Prehnite is common in some places, and quartz, calcite, and zeolites fill veinlets. The greenstone is sheared and brecciated. Fracturing, though most common along the borders of this unit, is found even in the center of the mass. Shearing in places has given the rock a streaked appearance. The original volcanic texture is visible in a few places, and near its south end above Canyon Creek well-developed pillow structure indicates that at least some of the lavas were deposited under water.

Further indications of deposition in an aqueous environment are given by discontinuous layers and lenses of banded gray, light-pinkish-gray, and white chert, by lesser amounts of light-gray marble, and by a few bands of black phyllitic argillite that are interlayered throughout the greenstone. The bedding in these less common rock types indicates that the Hozomeen Group has been folded into a broad syncline plunging to the northwest. In the northwestern part of the study area the Hozomeen Group has been intruded by two bodies of quartz diorite that are part of the Chilliwack batholith (fig. 7). The Hozomeen is also cut by many small quartz diorite and diabase dikes.

A minimum age of 30 m.y. for the Hozomeen is provided by a radioactive date from quartz diorite (Misch, 1966, p. 139) that has intruded the Hozomeen south of Silver Creek on the west side of Ross Lake. Aside from this, little is known of the age of the Hozomeen, as no fossils have been found in it and most of its contacts with other rocks are along faults. In the study area the Hozomeen Group is faulted against the surrounding arkose-argillite sequence, and its east contact is marked by intense brecciation and shearing. West of Ross Lake, however, it apparently grades downward into phyllite and metasediments that may be the equivalent of the arkose and argillite sequence to the east. The Hozomeen Group, on the basis

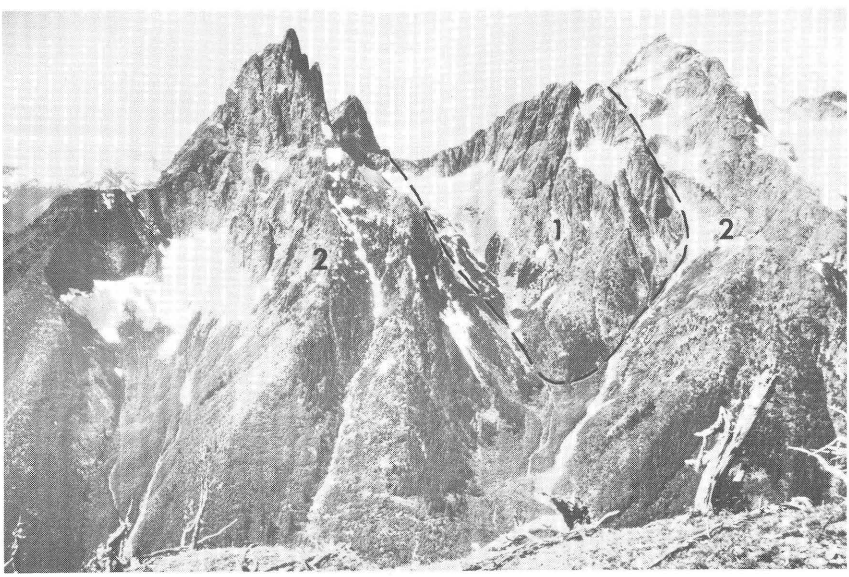


FIGURE 7.—East side of rugged Hozomeen Mountain, showing a small quartz diorite intrusive (1) cutting greenstone (2) of the Hozomeen Group of Cairnes (1944).

of lithologic similarity, has been tentatively correlated with the Cache Creek Series in south-central British Columbia (Smith and Calkins, 1904, p. 23; Daly, 1912, p. 502; Misch, 1966, p. 116) and with the Chilliwack Series of Daly (1912), which crops out about 24 miles west of Ross Lake (Daly, 1912, p. 504; Cairnes, 1924, p. 42). The Cache Creek Series is mostly of Permian age, although the lower part may be Pennsylvanian (Armstrong, 1949, p. 40). Fossils indicate that the Chilliwack Series ranges in age from Middle Devonian to Middle Permian (Danner, 1965; McGugan and others, 1964, p. 109). The overall sinuous contact of the Hozomeen Group suggests that the Hozomeen is separated from the surrounding rocks by a thrust fault, as postulated by Misch (1966, p. 133), and therefore could possibly be older. However, the topographic expression of the sheared east contact suggests a near-vertical fault rather than a thrust. If that is so, the Hozomeen could also be younger than the surrounding Lower Cretaceous rocks. The synclinal form of the Hozomeen above the arkose and argillite sequence and the apparent interbedding with these rocks west of Ross Lake lend support to this hypothesis.

VOLCANICS OF BILLY GOAT MOUNTAIN

A thick sequence of volcanic tuffs and breccias, lava flows, and minor clastic sedimentary rocks forms a northwest-trending belt as much as 3 miles wide along the southwest side of the Eightmile Creek fault (pl. 1). In several these rocks dip steeply to the west beneath the plagioclase arkose and argillite sequence. Graded bedding in some tuff beds indicates that they are right side up. The bottom of the unit is not exposed in the wilderness area. The upper contact is faulted in some places, but in the central part of the area it appears to be depositional. Near the center of the belt a pile of younger volcanic rocks (volcanics of Island Mountain) unconformably overlies the volcanics of Billy Goat Mountain. Dikes ranging from pyroxenite to rhyolite cut these older volcanic rocks.

Total exposed thickness of this unit at its widest part near Billy Goat Mountain is not less than 14,000 feet, but along the Canadian border, where the volcanics have been thinned by faulting, Daly (1912, p. 489) estimated them to be only 1,400 feet thick.

The volcanics of Billy Goat Mountain along the Canadian border were assigned to member *A* of the Pasayten Series by Daly (1912, p. 481). To the south near Twisp, Barksdale's Newby Formation (1948, p. 167–169) is lithologically similar and underlies a thick sequence of plagioclase arkose, black siltstone, and scattered conglomerate beds. Barksdale (1960) traced the Newby Formation northward into marine beds that contained fossils of Early Cretaceous age.

The greater part of the volcanics of Billy Goat Mountain is made up of somber-hued, more or less altered andesitic tuffs and breccias. Andesite and basalt flows are scattered through the section, but are most common in the upper part. Several layers of light-greenish-gray to yellowish-gray rhyolitic or dacitic tuff and breccia occur within the more mafic rocks. Mudflows, made up of a jumble of andesite boulders, are also found in this sequence. Thin lenticular beds of coarse- to fine-grained impure sandstone, reddish-gray to dark-gray siltstone and mudstone, and pebble to boulder conglomerate are interlayered with the volcanic rocks.

Andesitic tuffs, which grade into breccias, range from very fine grained rocks, like the diabase-appearing rock in the Billy Goat mine (loc. 16), to breccias with fragments as much as 8 inches across (fig. 8). Rock fragments are angular to subrounded; most are andesite, although a few are sedimentary rocks or are other kinds of volcanic rocks. Crystal fragments are principally plagioclase and hornblende, with some olivine, apatite, magnetite, and very minor amounts of quartz. These minerals are commonly altered to calcite, chlorite, sericite, clay minerals, zeolites, chalcedony, and iron oxide minerals.

Flows and flow breccias are generally fine-grained massive rocks (fig. 8) that rarely exhibit flow structure. Though dominantly ande-

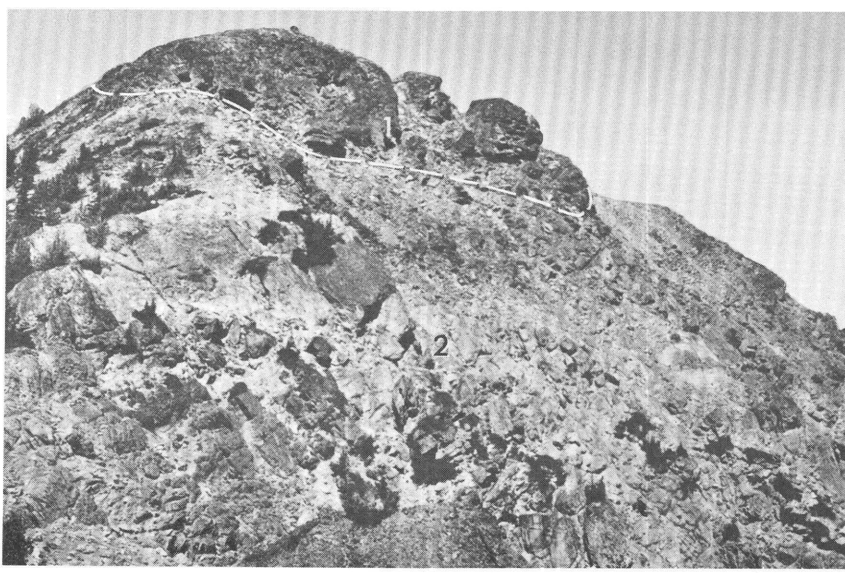


FIGURE 8.—Volcanics of Billy Goat Mountain at the crest of Billy Goat Mountain showing an andesite flow breccia (1) overlying a rhyolite volcanic breccia and tuff (2).

site, these rocks range from olivine basalt to dacite. They contain phenocrysts of plagioclase, hornblende, pyroxene, and olivine, with minor amounts of biotite and apatite. These phenocrysts have largely been altered to secondary minerals that include chlorite, epidote, sericite, magnetite, quartz, albite, and clay minerals.

Rhyolitic or dacitic tuffs and breccias form several lenticular layers, each 100–300 feet thick. These rocks range from moderately well sorted water-deposited crystal-lithic tuff to coarse massive breccia with fragments as much as a foot across. Some of the tuff exhibits graded bedding. These rocks consist mainly of angular fragments of a light-greenish-gray to yellowish-gray fine-grained volcanic rock with sparse quartz phenocrysts set in a matrix of small volcanic rock chips, volcanic ash, and broken crystals of quartz, plagioclase, and altered hornblende. Like the more mafic rocks, these tuffs and breccias have been altered to chlorite, sericite, epidote, albite, calcite, hematite, and clay minerals.

PLAGIOCLASE ARKOSE AND ARGILLITE SEQUENCE

A thick sequence of interlayered clastic rocks, mainly argillite and arkose, underlies the greater part of the area between Ross Lake and the volcanics of Billy Goat Mountain (pl. 1). Argillite is dominant in some parts of the sequence, and plagioclase arkose in others (fig. 9), and in still others both are common (fig. 10). Conglomerate, generally in thin layers, is scattered through parts of the sequence, and at least one thick conglomerate forms a prominent marker (fig. 10*B*). This thick group of sediments is folded about northerly trending axes (fig. 9), and is broken by several large faults.

A similar thick clastic sequence to the south near Twisp has been divided by Barksdale (1948, p. 169–173) into the Virginia Ridge Formation and the Winthrop Sandstone. Along the Canadian border similar rocks were described by Daly (1912, p. 479–489) as members *B* to *L* of his Pasayten Series. Rice (1947, p. 15–24) divided Daly's Pasayten Series into two groups: the Pasayten Group for those rocks east of the fault that crosses the Canadian border along Chuchuwanteen Creek and the Dewdney Creek Group for those rocks west of the fault. The Pasayten Group is of late Early Cretaceous age (Rice, 1947, p. 23; Coates, 1967, p. 57); the Dewdney Creek Group is of Early Jurassic to Early Cretaceous age (Coates, 1967, p. 56; Rice, 1947, p. 18–19). The Dewdney Creek Group at its type area 30 miles north of the Canadian border (Cairnes, 1924, p. 56–66) consists largely of volcanic tuff. Southward the volcanic component decreases, and applicable volcanic material was recognized only in the northern part of the study area; but little was noted in the central and south-

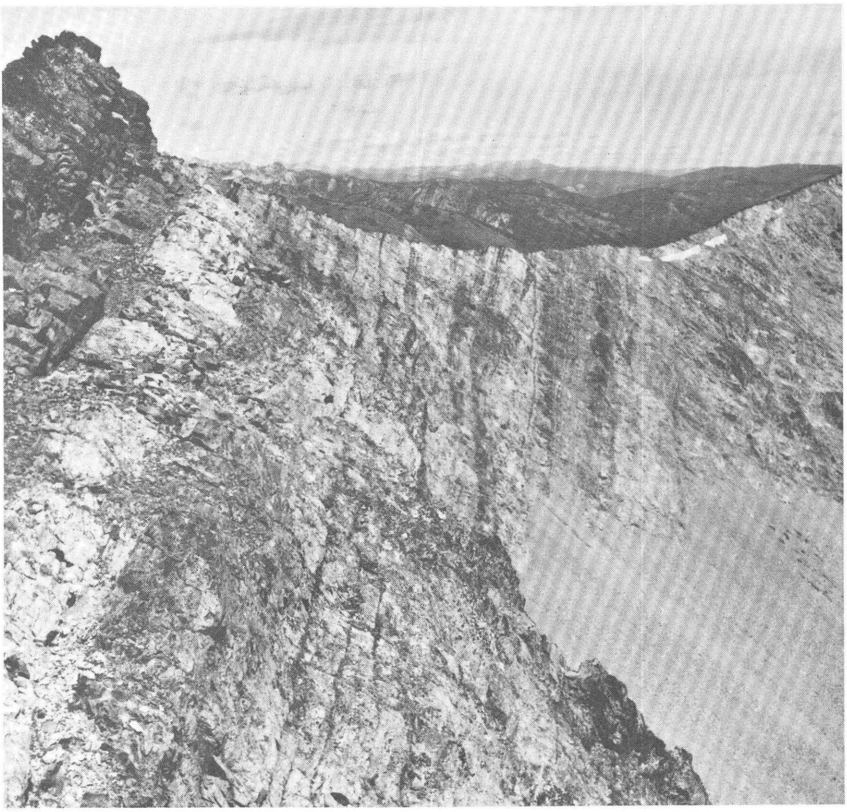


FIGURE 9.—Thin-bedded plagioclase arkose on ridge north of Wildcat Mountain.

ern parts of this area. Our mapping was not sufficiently detailed to permit subdivision of this very thick sequence.

Fossils are rare in the plagioclase arkose and argillite sequence in the study area. We found some poorly preserved fossils in two areas along its south edge, and Rev. Robert Dabritz of Winthrop collected some along the north shore of Dead Lake. The following were identified by D. L. Jones of the U.S. Geological Survey (written commun., 1966):

1. Along roadcut 1/4 mile east of Harts Pass:
   Ammonites—*Melchiorites* (?) sp.
2. Ridgetop 1 mile SSE. of Slate Peak:
   Large Acteonellid gastropods
3. North side of Dead Lake:
   Pelecypod fragments, mainly *Trigonias*

All are of probable latest Early Cretaceous age.

As Coates (1967) identified fossils ranging from Early Jurassic to latest Early Cretaceous in the same sequence in British Columbia, the fossils listed above are evidently from only the upper part of this sequence.

East of the Chuchuwanteen fault the arkose and argillite sequence consists of (fig. 10*A*): (1) thick plagioclase arkose beds with intercalated dark argillite beds, and (2) thin to medium beds of argillite intercalated with about equal amounts of thin to medium beds of arkose and scattered thin to thick beds and lenses of conglomerate. West of the Chuchuwanteen fault the unit consists of the above two assemblages plus (3) black argillite beds with a few thin beds of plagioclase arkose, and (4) massive conglomerate (at least 1,000 ft thick) (fig. 10*B*). In places these rocks contain volcanic debris.

The plagioclase arkose that makes up a large part of the sequence is a distinctive-looking fine- to coarse-grained sandstone consisting of plagioclase and quartz in about a 1- to 20-percent matrix. The rock contains about 20 to 55 percent plagioclase, 15 to 60 percent quartz, 1 to 15 percent orthoclase, and a trace to 30 percent dark minerals. Accessory minerals are chlorite, pyroxene, biotite, muscovite, magnetite, apatite, sphene, garnet, epidote, and calcite. Chlorite generally occurs in the matrix. In addition, a few percent of rock fragments, mainly argillite and volcanic rocks, occur in some of these rocks. The arkose is generally well sorted, and the grains are angular to subangular. Graded bedding and crossbedding are present in some layers. These arkoses range in color from light gray to dark gray, greenish gray, and brownish gray.

The argillite is dark-gray to black carbonaceous rock that commonly weathers to dark brown. In a few layers graded bedding was observed. The argillite is fairly well indurated and has a moderately well developed cleavage.

Conglomerate occurs in layers or lenses from less than an inch to at least 1,000 feet thick (fig. 10*B*). Though mostly poorly sorted, thinner layers are generally made up of small pebbles; thicker layers may have boulders as large as 1½ feet across. Conglomerate commonly forms prominent, generally massive, outcrops. Most conglomerate consists of well-rounded pebbles, cobbles, and boulders of plagioclase arkose, granodiorite, chert, and fine-grained dark volcanic rock embedded in a matrix of greenish-gray feldspathic sand. The layers shown on plate 1 may represent several conglomerate layers or one layer repeated by faulting. A second type of conglomerate is generally finer grained and is composed almost entirely of gray chert pebbles in a finer matrix of chert fragments. In a few places graded bedding was observed. This type of conglomerate is most common in the western part of the area and is especially well exposed west of the Anacortes mine (fig. 53, loc. 59).

Metamorphism of argillite on the southeast side of Ross Lake has produced dark-gray to silvery-gray phyllite. Reconstitution of

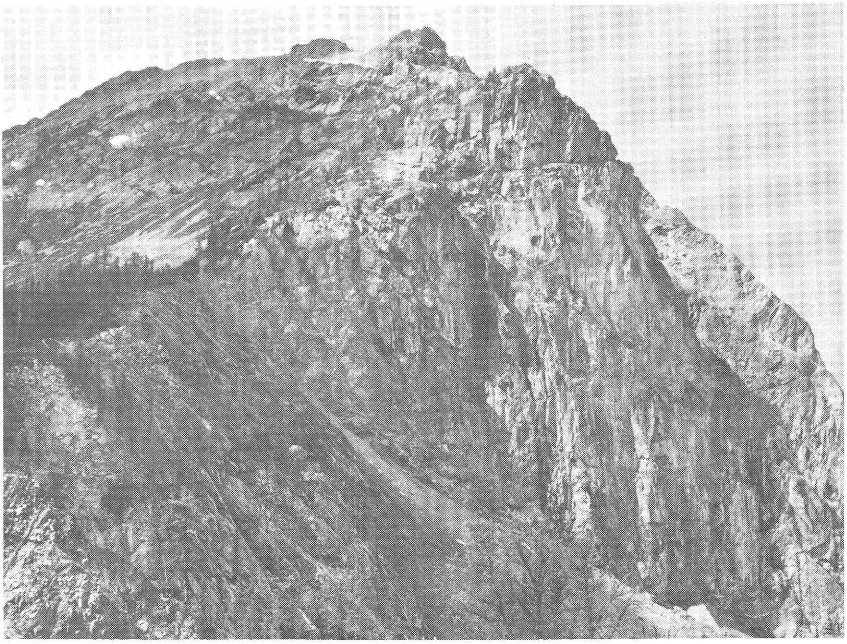
A

FIGURE 10.—Plagioclase arkose and argillite sequence. *A*, Sequence exposed where Grizzly Creek has cut down along strike of beds; view looking south. *B*, Massive thick conglomerate makes up precipitous Holman Peak; view looking southwest. *C*, Contact between plagioclase arkose and argillite sequence (1) and granodiorite (2) on the west side of Many Trails Peak above scenic Dot Lake.

the argillite appears to begin with the growth of sericite in some layers. Where metamorphism has proceeded further, as along Canyon Creek about a mile east of its junction with Granite Creek, layers of phyllite and argillite are interlayered. Farther west most of the argillite has been converted to phyllite. A few thin beds of bleached and foliated arkose are interbedded with the phyllite.

MIDNIGHT PEAK FORMATION

The Midnight Peak Formation is preserved in several major northwest-trending synclines in the Methow River area, where it was named by Barksdale (1948, p. 173–174) for exposures on Midnight Peak 15 miles west-northwest of Twisp. Only the northernmost syn-



B

C

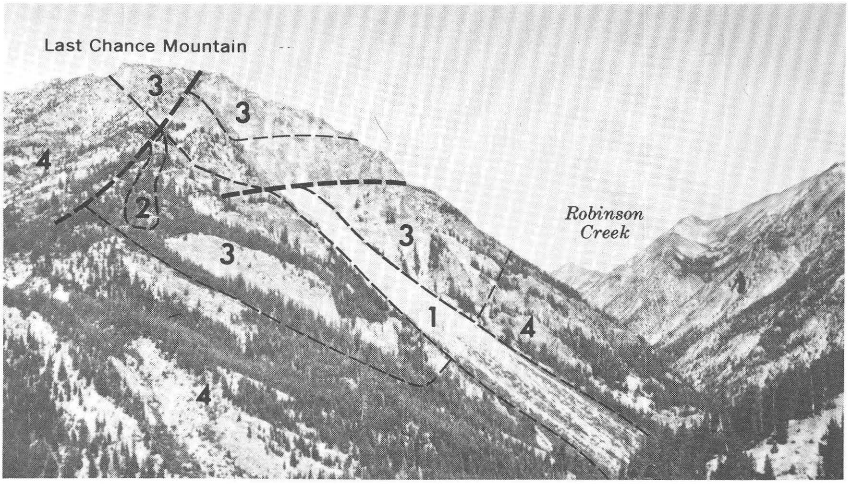


FIGURE 11.—Volcanic rock facies (2) and red-bed facies (3) of the Midnight Peak Formation overlie the plagioclase arkose and argillite sequence (4) and are partly covered by a landslide (1) on Last Chance Mountain. View looking west-northwest.

cline in the vicinity of Robinson Creek is in the study area. The Midnight Peak Formation is generally made up of a lower red-bed unit and an upper volcanic unit (figs. 11, 32). Locally the red beds and the volcanic rocks interfinger near their contact, and isolated layers of either rock occur in the other. The volcanic rocks are more widespread than the underlying red beds, and on the north side of Robinson Mountain red beds are missing. Local unconformities are common beneath the volcanic rocks. The red beds of this area were originally named the Ventura Formation by Russell (1900, p. 113–114), but Barksdale (1948, p. 174) included them in the Midnight Peak Formation.

The red-bed unit in the wilderness area is 0 to about 3,000 feet thick. It is made up of dark-red to purple argillite interbedded with pink to dark-red sandstone and pink to gray conglomerate. The red beds are conformable to, and locally interfinger with, the underlying plagioclase arkose and argillite sequence. Argillite makes up more than 60 percent of the red beds, but the thickest part of the section, on the southwest shoulder of Robinson Mountain (fig. 32), is mostly dark-brown to purple argillite interbedded with purple lava flows at the top. The argillite consists of small angular grains of quartz, plagioclase, altered volcanic rock, chert, and epidote. Cement is mostly hematite, but chlorite, calcite, and sericite are also common. In many places, the argillite is cut by irregular veinlets of chlorite, quartz, and calcite. The sandstone and conglomerate crop out in beds 2 to 15 feet thick. The sandstone consists predominantly of quartz grains but is rich in volcanic and metamorphic rock fragments. It is mainly cemented by hematite, but also by calcite, clinozoisite, and chlorite. The conglomerate consists of well-rounded pebbles, most of which are chert and many of which are about 1 inch in diameter. The rock is cemented mainly by silica, although in places some hematite, chlorite, and calcite are present.

The volcanic unit is made up of mottled dark-greenish-gray massive volcanic breccia and tuff and some flows. These rocks appear to range from dacite to pyroxene andesite. The tuffs consist of tiny fragments of devitrified glass, quartz, feldspar, and a little argillite. Alteration minerals are calcite, clinozoisite, and zeolite. Flows are generally porphyritic, consisting of plagioclase and pyroxene phenocrysts set in a glassy matrix. Most of the original pyroxene, however, is altered to epidote or chlorite.

Semiquantitative spectrographic analysis shows that the tuff (473, table 1; pl. 3) contains about three times as much iron and calcium as the flow (452, table 1; pl. 3).

Numerous quartz porphyry and plagioclase porphyry dikes cut the Midnight Peak Formation.

The Midnight Peak Formation conformably and gradationally overlies the plagioclase arkose and argillite sequence (fig. 11). Inasmuch as the Midnight Peak Formation caps the mountain tops, it seems to be entirely younger than the plagioclase arkose and argillite sequence; another possibility is that it is a local unit in the upper part of this thick clastic sequence. Though no fossils have been found in the Midnight Peak, indirect evidence supports a Cretaceous age. Near Harts Pass, only about 1½ miles northwest of exposures of the Midnight Peak Formation, the plagioclase arkose and argillite sequence contains late Early Cretaceous fossils. A mile northeast of the Midnight Peak Formation (pl. 1), quartz diorite cuts regional folds in the arkose and argillite sequence that also flex the Midnight Peak Formation and, hence, must be younger than the Midnight Peak. The quartz diorite gives a potassium-argon age of 86 ± 2 m.y. (Late Cretaceous).

GRANODIORITE, QUARTZ DIORITE, AND QUARTZ MONZONITE

Five intrusives each, at least a square mile in area and ranging from quartz monzonite to quartz diorite, cut the plagioclase arkose and argillite sequence (fig. 10*C*) or the Hozomeen Group of Cairnes (1944) in the west half of the study area (pl. 1). In addition, there are several smaller stocks and numerous dikes. The five principal

FIGURE 12.—Granodiorite exposed on steep cirque wall rising above small tarn on the east side of Pass Butte.

intrusives, from east to west, are the Lost Peak stock, the Pasayten dike, the Rock Creek stock, the Castle Peak stock, and the Chilliwack batholith.

The Lost Peak stock (figs. 10*C*, 12) is a generally oval shaped body with an area of 12.6 square miles. Lost Peak is near its south end. The south tip of this stock is separated from the main body by an arm of the younger granite of Monument Peak (fig. 19). On the northeast side of Mount Lago, near its southwest end, the Lost Peak stock is cut by many quartz porphyry dikes. On the northeast corner of this stock, however, granitoid dikes derived from the Lost Peak stock cut the surrounding plagioclase arkose and argillite sequence, which has been metamorphosed adjacent to the stock.

The Pasayten dike, the largest of these intrusives (pl. 1; fig. 13), has an area of 16.6 square miles. It is tabular, with an average width of 1.1 miles and a length of 12.4 miles. Its contact is generally sharp,

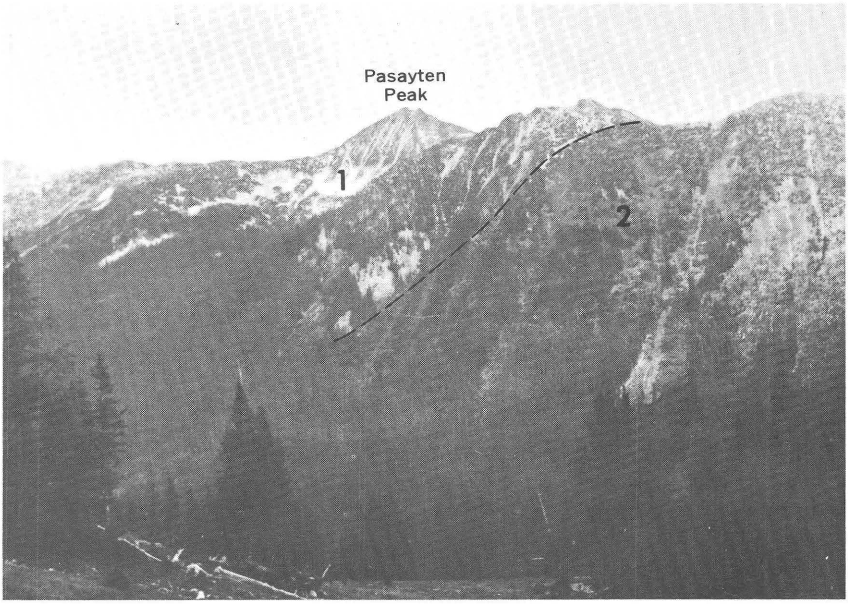


FIGURE 13.—West end of quartz diorite intrusive (1), which cuts plagioclase arkose and argillite sequence (2), is exposed on the east side of the West Fork of the Pasayten River. View looking northeast.

and the arkose and argillite adjacent to it are commonly partly recrystallized by heat from the intrusive. Along Eureka Creek on the south margin of the dike the country rock is cut by numerous small quartz diorite dikes derived from it. In this same area the Pasayten dike contains numerous inclusions of metamorphosed country rock.

The Rock Creek stock (pl. 1) trends northwesterly across Rock Creek and is 5.30 square miles in area. In places this stock contains numerous inclusions of metamorphosed country rock.

The Castle Peak stock (pl. 1) was named and studied by Daly (1912, p. 492–499). It has a generally oval shape and lies across the Canadian border with about three quarters of it—7.4 square miles—lying within the United States. This stock has walls that in general dip steeply outward, and in places dikes extend from it into the country rock. The surrounding sedimentary rocks are recrystallined within several hundred feet of the border of the stock.

Stretched along the east shore of Ross Lake for 4 miles, but exposed over only 1 square mile of the mapped area, is the east margin of the Chilliwack batholith (pl. 1). This body intrudes the Hozomeen Group. Its contacts on the east side of Ross Lake are not well exposed. Smaller stocklike bodies occur on Hozomeen Mountain (fig. 7) and on Ruby Creek. The former is apparently connected at depth with the Chilliwack batholith along Ross Lake (see aeromagnetic contours on pl. 1).

All these intrusives are similar in appearance. In general they are medium-grained gray speckled rock that consist of plagioclase (40–65 percent), orthoclase (1–25 percent), quartz (12–26 percent), and dark minerals (2–25 percent). Dark minerals are principally hornblende and biotite, although in some places these minerals are altered to chlorite. Biotite generally predominates in the Lost Peak and Castle Peak stocks, and hornblende is generally more common in most of the others. Minor accessory minerals include magnetite, ilmenite, apatite, sphene, zircon, and, in the Lost Peak stock, augite and allanite. The Castle Peak and Lost Peak stocks are mainly granodiorite, although some of the Lost Peak stock is a quartz monzonite. The other intrusives are mainly quartz diorite, though some grade into granodiorite.

Eight semiquantitative spectroscopic analyses were made on these rocks: three samples (316, 433, and 507, table 1) from the Pasayten dike, three (194, 195, and 289, table 1) from the Lost Peak stock, and two (315 and 402, table 1) from two small intrusives lying about 1½ miles west of the Lost Peak stock. All eight analyses were similar. This group of analyses is also similar to those made on plagioclase porphyry dikes to be described later (119, 193, 506, and 535, table 1), two volcanic rocks of the Midnight Peak Formation (452 and 473, table 1), and an arkose (439, table 1) from the plagioclase arkose and argillite sequence. They were in most respects similar to the quartz diorite in the quartz diorite gneiss complex except that they contained a little less iron and manganese.

The similarities in mineralogy, texture, minor-element composition, and structural relation to the country rock might suggest that these intrusives formed at the same time, but potassium-argon age determinations on samples from four of them indicate that they were emplaced during at least three different times (Tabor and others, 1968). A sample from the Pasayten dike collected near its center on the ridge just east of the West Fork of the Pasayten River gives ages of 87.7 ± 2.6 m.y. and 85.3 ± 2.6 m.y. on biotite and 86.0 ± 2.6 m.y. on hornblende. A sample from the Rock Creek stock collected in a small cirque northwest of Soda Peak on the south side of Chuchuwanteen Creek gives an age of 86.1 ± 2.6 m.y. on hornblende—the same age as the Pasayten dike. A sample from the Castle Peak stock collected near its center on the ridge three-quarters of a mile northeast of Castle Peak gives ages of 49.8 ± 1.5 m.y. on biotite and 49.5 ± 1.5 m.y.

on hornblende. Hence, these plutons were intruded in Late Cretaceous and Eocene times.

PLAGIOCLASE PORPHYRY STOCK AND DIKES

A small stock of plagioclase porphyry lying across the International Boundary north of Frosty Creek can be traced for 1.1 miles along the boundary and extends south of it for 1 mile (pl. 1). The rock is well jointed and porphyritic; crystals increase in size toward the center of the stock. A thin section of this light-gray rock consists of 63 percent plagioclase, 20 percent orthoclase, 7 percent quartz, 5 percent brown biotite, 3 percent green hornblende, and 2 percent magnetite. Some of the plagioclase has been altered to calcite, chlorite, and magnetite. Compositionally this rock might be a porphyritic quartz diorite or a porphyritic granodiorite. Daly (1912, p. 499–500) referred to this rock as a syenite porphyry, but, as his description is similar to ours, the difference in names appears due to changes in terminology in the intervening years.

Many plagioclase porphyry dikes, which are similar to the stock near Frosty Creek, crop out throughout the area but are commonest near the granodiorite, quartz diorite, and quartz monzonite intrusives, from which the dikes were probably derived. Except near the Monument Peak granite stock (Tabor and others, 1968), these are the most common dikes in the Pasayten Wilderness. In a few places the plagioclase porphyry dikes are so numerous that little is left of the country rock. Dikes are less than a foot to several hundred feet thick and have been traced as far as a mile. They are steeply dipping and have diverse strikes, although northeast trends are most common. In general these gray dikes are spotted with white rectangular plagioclase phenocrysts, one-sixteenth to one-quarter of an inch long, and slightly smaller dark needles of hornblende. Hornblende phenocrysts in many places have been changed to chlorite, and the groundmass commonly contains chlorite and calcite and, in a few places, prehnite.

DUNITE AND SERPENTINE

Dunite, a rock consisting principally of the mineral olivine, forms several narrow intrusives on and around Jack Mountain in the southwestern part of the area. The largest of these is a northwest-trending sill that intruded phyllite on the steep west face of Jack Mountain (pl. 1). The tabular body is about 400 feet thick and more than a mile long. The dunite is dark gray, light-brown weathering, and medium grained. It consists of about 75 percent olivine, numerous branching veinlets of antigorite containing a few specks of limonite and sheaths of chrysotile, and some small pockets of talc and minor scattered

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pyrite. The outer 40 feet of the intrusive along its southwest side has been sheared and altered to serpentine.

Four steeply dipping dunite dikes, each 100 to 200 feet thick (not shown on pl. 1), crop out on the ridge that trends southeast from Jack Mountain at elevations ranging from 5,800 to 7,000 feet. These dikes resemble the large dike just described, and consist of medium-grained dunite that is sheared and partly serpentinized.

A body of serpentine which trends N. 35° W. lies across Canyon Creek just southwest of the mouth of Nickol Creek. On the north side of Canyon Creek this body forms a knoll several hundred feet across. Other serpentine bodies occur on Nickol Creek (loc. 70, pl. 3) and in upper Roland Creek.

HORNBLENDE DIORITE

Hornblende diorite forms numerous dikes or irregular intrusions into the plagioclase arkose and argillite sequence in two places in the western part of the area. The largest body is a small stock, 1 square mile in area, 3 miles east of Hozomeen Mountain and about a mile south of Boundary Creek (pl. 1). This stock has intruded the sedimentary rocks without markedly disturbing them. Satellite dikes, sills, and irregular bodies are separated from the main mass by septa of sedimentary rocks. Many of the smaller satellite bodies lying northwest of the main body are separated by narrow slivers of sedimentary rocks and have not been differentiated from the main body on plate 1; however, the largest along Lightning Creek is shown separately. The diorite near Boundary Creek may be a part of the Chilliwack composite batholith, because similar diorite is common in the batholith west of Ross Lake and because a positive magnetic anomaly (pl. 1) indicates that the diorite is adjacent to a quartz diorite body that is part of the batholith. Hornblende diorite also occurs in a small generally east-trending body between upper Grizzly and Middle Creeks (pl. 1), and about 200 feet north of this small intrusive is a parallel 25-foot-thick hornblende diorite dike.

The hornblende diorite is gray to dark-gray entirely crystalline speckled rock that may be either fine grained or medium grained. It consists mainly of labradorite and hornblende, with less than 2 percent quartz, orthoclase, magnetite, ilmenite, apatite, and sphene. The hornblende is in some places partly altered to chlorite, epidote, and calcite, and the labradorite to sericite. The stock near Boundary Creek has a dark-green hornblende that makes up about 40 percent of most of the rock, but at the contact is a border zone having a higher proportion of hornblende. The small hornblende diorite body between Grizzly and Middle Creeks differs from that just described in having brown hornblende and having layers with varying proportions of hornblende to plagioclase; the hornblende makes up about 20 to 70 percent of the different layers.

GRANODIORITE DIKE AND SILL COMPLEX

Along the southwest side of Jack Mountain a northwest-trending zone is made up of numerous dikes and sills of granodiorite intruded into the phyllite facies of the plagioclase arkose and argillite sequence (pl. 1). The dikes and sills make up at least 70 percent of this zone, and in places the intrusive bodies are separated only by thin septa of phyllite. This zone is 6 miles long and 200 to 4,000 feet wide. Where the zone is thickest, it is entirely granodiorite on the west and grades into a series of 100-foot-thick sills on the east. The granodiorite intrusives have an average trend of about N. 40° W. parallel to the foliation of the phyllite, although in a few places they cut across it.

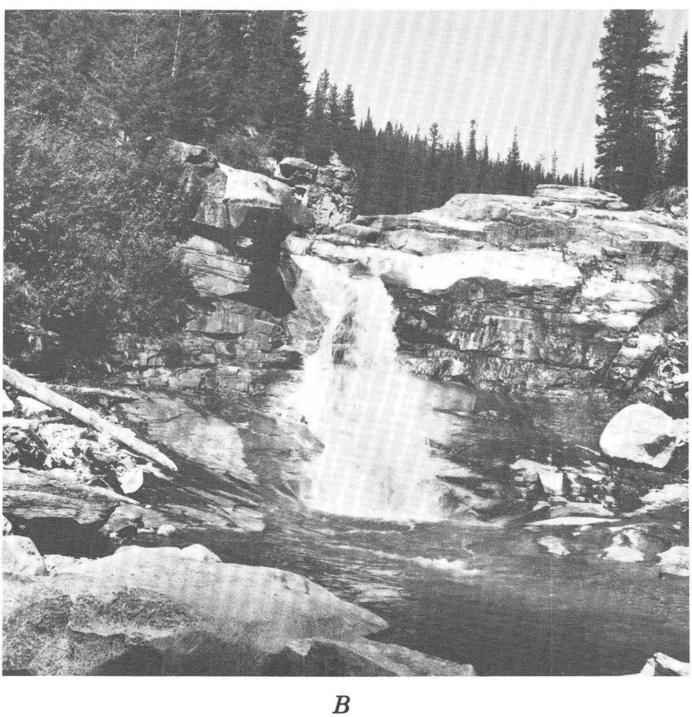
The granodiorite ranges from tan to gray and from porphyritic to equigranular and fine grained. The rock is generally stained by iron oxides and in places is brecciated and sheared. The porphyritic types consist of numerous plagioclase crystals and a few quartz, biotite, and hornblende crystals about one-sixteenth of an inch in diameter set in a fine-grained matrix. In the equigranular types all grains are about one-sixteenth of an inch across. The granodiorite contains about 65 percent plagioclase, 20 percent quartz, 10 percent orthoclase, and 5 percent hornblende, biotite, and chlorite, with trace amounts of magnetite, ilmenite, sphene, and zircon. The dark minerals make up from less than 1 to 15 percent of the rock.

GRANITE OF MONUMENT PEAK

A circular stock about 7 miles in diameter is exposed between Eureka Creek and Lost River in the south-central part of the study area (pl. 1). From the gorge of Lost River to the top of Lake Mountain (fig. 14*A*) this granite is exposed over a vertical distance of 5,100 feet, an exposure which shows clearly the blunt, domed shape of the stock. Along its southeast side the stock is exposed only in the bottoms of the deeper valleys.

The contact of the granite with the adjacent plagioclase arkose and argillite sequence is sharp. Beyond its margin, many granite porphyry sills and dikes intrude the sedimentary rocks, especially along the west border of the stock and in the Lost River gorge. The sedimentary rocks have commonly been metamorphosed by the adjacent granite. Along the north and south borders of the stock the granite cuts granodiorite and quartz diorite.

A



B

FIGURE 14.—Granite of Monument Peak. *A*, Lake Mountain and the adjoining ridge are composed of granite. The source of high copper and molybdenum anomalies near Lake of Woods is concealed by the forest in right center; view looking north-northwest. *B*, Flat jointing in granite at a small falls on Monument Creek; view looking north-northwest.

The granite is for the most part yellowish pink, fine grained, and porphyritic, but in a small area near Monument Peak it is medium grained and nonporphyritic. Platy jointing (fig. 14*B*) subparallel to the contact is ubiquitous. The porphyritic granite consists of 10 to 50 percent phenocrysts of microcline, plagioclase, and quartz set in a finer grained matrix of the same minerals and a few percent biotite. Nine modal analyses indicate that the granite has a uniform composition; it consists of 35 percent quartz, 43 percent microcline, 20 percent plagioclase, and 2 percent accessory minerals. The microcline is commonly perthitic and in places is graphically intergrown with quartz. Plagioclase is mainly oligoclase. Biotite makes up most of the accessory minerals, although small amounts of apatite, sphene, and zircon are present. Fluorite, though sparse, is present in most specimens.

Biotite from granite of Monument Peak collected 0.4 mile northeast of Monument Peak was dated by the potassium-argon method by J. C. Engels (in Tabor and others, 1968) as 47.9 ± 1.4 m.y., which dates this rock as Eocene.

Also seemingly related to the Monument Peak stock, in addition to the granite porphyry dikes and sills that extend out from the margins of the stock, are some quartz veins and quartz porphyry dikes. Vuggy quartz veins are commonly found in the margins of the stock and in the adjacent country rocks. Along the northwest side of Lost River, fluorite is also found in some of these veins. Near Lost River, quartz porphyry dikes extend from the granite into the country rocks (fig. 15). Many similar dikes are found in the older rocks surrounding the stock, but most of them are concentrated southwest of the stock. They generally have a near-vertical dip and a northeast strike, although a few strike north or northwest. The dikes are commonly branched and irregular. In width they range from several feet to several hundred feet, and a few have been traced for more than a mile. The quartz porphyry dikes are generally yellowish pink to cream colored, and consist of clear quartz, white orthoclase, and white plagioclase phenocrysts set in a very fine grained matrix. Dark minerals consist of a few percent of biotite, chlorite, hematite, and magnetite. Fluorite in trace amounts was found in a few dikes.

Two semiquantitative spectrographic analyses of the main intrusive (290, 348, table 1) and four of the quartz porphyry dikes (179, 278, 451, 505, table 1) indicate that their compositions are very similar. They differ from other intrusives in the eastern part of the study area in having the lowest content of titanium, manganese, vanadium, cobalt, chromium, scandium, barium, strontium, iron, and magnesium, and the highest content of beryllium and yttrium.

FIGURE 15.—Many quartz porphyry dikes (underlying the small gullies) cut large granodiorite intrusive on ridge east of Dot Mountain.

VOLCANICS OF ISLAND MOUNTAIN

An oval area of some 7 square miles of younger volcanic rocks overlaps the Eightmile Creek fault in the vicinity of Island Mountain (pl. 1). These rocks also unconformably overlie the volcanics of Billy Goat Mountain, the plagioclase arkose and argillite sequence, and the quartz monzonite, granodiorite, and quartz diorite east of the Eightmile Creek fault. Although they lie in a shallow northwest-trending syncline (pl. 1), as a result either of folding or of original dip, the younger volcanic rocks were deposited after the strong deformation that folded the underlying rocks and after development of the two faults that bound the volcanics of Billy Goat Mountain. They are one of the youngest rock units in the area and probably are only a remnant of a formerly more extensive volcanic field.

The volcanics of Island Mountain consist of a thick series of light-gray to black lava flows, volcanic breccias, and tuffs that range from olivine basalt to dacite or possibly rhyolite. The flows are porphyritic. Phenocrysts are inconspicuous in the darker rocks, but they give the lighter ones a speckled appearance. Where unaltered, the basalts and andesites contain phenocrysts of plagioclase, clinopyroxene, hypersthene, and olivine set in a glassy to fine-grained crystalline matrix. Where altered, the ferromagnesian minerals are commonly changed to calcite and chlorite, and the plagioclase, in part, from andesine to albite. Many of these rocks contain scattered xenocrysts of quartz surrounded by conspicuous dark-colored reaction rims. Vesicles are common and many are filled with calcite or zeolites.

The dacites and other light-colored volcanic rocks consist of phenocrysts of plagioclase, hornblende, biotite, and in some places quartz and potassium feldspar in a fine-grained light-gray matrix. The hornblende in some rocks is altered to calcite, mica, and a clay mineral.

GLACIATION

Most of the Pasayten Wilderness Area has been intensely glaciated. The consistent freshness of exposed glacial features throughout this area suggests that they were formed in late Pleistocene or Holocene time.

The effect of glaciation differs in the eastern and western parts of this area. East of most of the Lost River drainage, three periods of glaciation can be recognized. In the oldest period, probably during middle Pinedale time (15,000–20,000 years ago), most of the area was covered by a broad ice sheet. This was followed by a second period in which large valley glaciers formed—probably in late Pinedale time (8,500–10,000 years ago). During the third period, probably within the last 4,000 years, small glaciers occupied many of the high cirques.

West of the Lost River drainage no large areas were covered by continuous ice sheets, and evidence of different glacial periods cannot easily be recognized. Glaciers here accumulated around high areas, from which they extended downward as large valley glaciers.

The broad ice sheet that covered most of the eastern part of the wilderness area reached elevations as high as about 7,800 feet. Ridges and mountains below this elevation, such as Bauerman Ridge, Coleman Ridge, Kay Peak, and Sheep Mountain, were smoothed and rounded. The ice also scoured and smoothed large areas in between, shaping the beautiful rolling upland meadows in the Remmel Lake–Spanish Creek area. This terrain retains its subdued topography, partly on bare, fresh, unweathered quartz diorite, as evidence of its youth. Peaks that stood above 7,800 feet, such as Cathedral Peak and Remmel Mountain, are sharp and narrow crested, and show none of the gentle sloping surfaces of the lower ridges that surround them. Within the area covered by the massive ice sheet, ice moved both southward and northward, down the gradients of preexisting valleys.

The larger valleys, which carried the most ice, show the greatest change. Such valleys as the southwest-flowing Chewack River, Andrews Creek, and Lake Creek and the northward-flowing Cathedral Creek and Ashnola River were deepened, and their valley walls steepened and smoothed.

Evidence of the second period of glacial activity in this eastern part is found in numerous cirques and local moraines. All the ridges higher than about 6,800 feet are cut by steep cirques on their north, northeast, or east sides. The cirques provide a striking contrast in topography to the many gently sloping, smoothly rounded, south-facing ridges. Most of these ridges have abrupt, nearly vertical north faces that plunge 1,000 to 2,000 feet to the cirque floors below. Glaciers heading in these cirque basins followed the same drainages that were occupied by the thicker ice sheet of the earlier period, and they caused relatively little change in the already ice-sculptured valleys. These later glaciers, however, did not extend as far down the valleys, and formed prominent end moraines in places, as can be seen on the Chewack River a short distance above the Thirtymile Camp on Lake Creek just below Black Lake, and on Andrews Creek just above its mouth.

During the third glacial period, small glaciers formed in most of the higher cirques. Most of these glaciers did not flow far from the cirque basin, as the lower ends of many of these cirques are now blocked partly or completely by low end moraines. Small cirque lakes, such as Glory Lake, Peepsight Lake, Four Point Lake, Kidney Lake, and the lake on the north side of Bauerman Ridge, occur behind these dams (pls. 2, 3).

Other lakes in this area, such as Remmel Lake, Tungsten Lake, and Upper and Lower Cathedral Lakes, owe their existence entirely to ice scour, and occur in rock-rimmed basins formed during the first two periods of glaciation.

West of the Lost River drainage and south of the large ice sheet, ice accumulated around major high areas such as Robinson Mountain, McLeod Mountain, Mount Lago, Shull Mountain, Castle Peak, Hozomeen Mountain, and Jack Mountain. Ice from these major high areas occupied the larger valleys and was joined by smaller glaciers formed along most ridges at elevations above about 6,000 feet. Barksdale (1941, p. 725–726) has shown that ice in the Middle and West Forks of the Pasayten River did not always flow north, as might be expected, but apparently either was joined by southward-flowing Canadian ice or was sufficiently blocked to the north so that a part of the ice flowed southward. Whatever the cause, ice in the upper part of these two drainages crossed divides to the south and southwest, contributing to the glaciers that occupied the valleys of Robinson

Creek, Rattlesnake Creek, Trout Creek, Slate Creek, and Ruby Creek. Passes between these valleys and the Pasayten drainage clearly were occupied by ice, and the distribution of erratics shows that at least for a time ice must have flowed southward and westward from the upper Pasayten. Elsewhere, ice also must have been continuous across low divides between drainages for a time, as at Castle Pass (between Castle Creek and Castle Fork of Three Fools Creek), at Deception Pass (between Shull Creek and the North Fork of Canyon Creek), and at Devils Pass (between Cinnamon Creek and Devils Creek). In these places, however, we can offer no comment as to the probable direction of flow.

Ice from the major centers of accumulation formed wide, deep valleys with prominent U-shaped cross sections. Particularly in areas of relatively less resistant rocks, the effect of glacial erosion was striking, as in the upper Methow Valley, the valleys of the Middle and West Forks of the Pasayten (fig. 16), and the Skagit Valley (Ross Lake). The more effective erosional abilities of the larger glaciers left many hanging tributaries, particularly well shown along part of the Methow Valley and along Ross Lake.

Subsequent erosion of the smaller hanging tributaries has changed their shape but little, and they now enter the larger streams in a

FIGURE 16.—Glaciated U-shaped valley of the West Fork of the Pasayten River. View looking north.

series of cascades. Some of the larger stream valleys were high enough, had their lower courses deglaciated long enough, and had a streamflow great enough to have incised their formerly broad, flat floors and formed steep, narrow canyons. Several examples of this are seen on the east side of the Skagit Valley, where the lower 2 or 3 miles of Lightning Creek, Devils Creek, and Ruby Creek flow through narrow, steep-sided valleys. Similarly, the lower part of Lost River, above its entrance into the broad Methow River valley, has cut a spectacular narrow, steep-sided gorge. Headward erosion will continue to steepen these stream valleys until normal stream gradients are established.

Only four peaks in the area have retained glaciers to the present. Castle Peak, Mount Lago, and Crater Mountain all have small glaciers on their north sides. Jack Mountain, the highest peak in the study area, has three; the largest, on the northwest side, covers more than half a square mile (fig. 17). On all four peaks, the glacier mar-

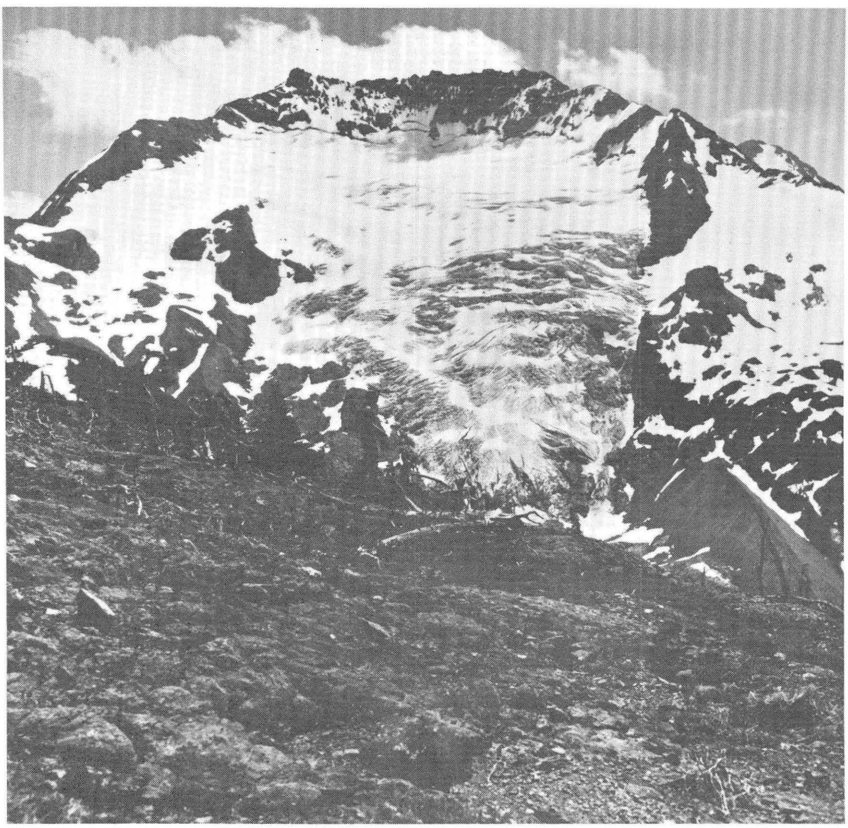


FIGURE 17.—Large glacier on northwest side of Jack Mountain is 0.6 mile wide.

gins lie well inside low fresh moraine, indicating a recession of a few tens to a few hundred feet in the recent past.

STRUCTURE

The structure of the area differs in type and age on opposite sides of the Eightmile Creek fault. Structure of the rocks to the east was formed principally in pre-Early Cretaceous time; that to the west, in post-Early Cretaceous time.

STRUCTURE EAST OF THE EIGHTMILE CREEK FAULT

The metamorphic and igneous rocks east of Eightmile Creek fault do not seem to be deformed by large faults or folds. However, as the rock units are large and the igneous rocks mostly nonfoliated, faults or folds could be easily overlooked in the field. Foliation in the older rocks is locally swirled or tightly folded, generally dips steeply, and strikes parallel to the contact of the major rock units (pl. 1). The foliation in the metamorphic rocks was formed prior to the intrusion of the nonfoliated quartz monzonite, granodiorite, and quartz diorite, which are at least 94 ± 2.8 m.y. old (Hawkins, 1968a). These plutonic rocks are foliated only adjacent to the Eightmile Creek fault; this foliation parallels the fault and was evidently formed at the time of faulting.

STRUCTURE WEST OF THE EIGHTMILE CREEK FAULT

Rocks west of the Eightmile Creek fault are folded and broken by several large north-trending faults and a few transverse faults. Folds in the plagioclase arkose and argillite sequence are easy to discern, but only the larger faults were found because of the similarity of most of the rocks in this sequence. In a few places, however, faults can be distinguished where they cut thick conglomerate beds or intrusive bodies. Most folds trend either north or northwest, although adjacent to Robinson Creek in the southern part of the area two folds trend west-northwest. Fold crests are generally fairly sharp, as the limbs commonly dip 60° to 80°. Although some folds can be traced for only a few thousand feet, several have been traced for at least 12 miles.

Major faults include at least four northerly or northwesterly trending steeply dipping faults and a northeast-trending fault. The easternmost of these northwardly trending faults is the Eightmile Creek fault (pl. 1), which divides the area into geologically dissimilar parts and is one of the major structural features in the State. It averages about N. 30° W. in trend across the entire study area, a distance of nearly 20 miles, continues to the south at least 30 more miles

(Huntting and others, 1961), and extends northward into British Columbia, where it becomes part of the very extensive Frazer River fault system (White, 1966, p. 188, fig. 10–1). Within the wilderness area the fault dips steeply to the west. Rocks on both sides are commonly sheared and brecciated, and on the east side the rocks are foliated in a zone as much as 3 miles wide parallel to the fault. The throw on this fault is unknown but must be large.

The Chuchuwanteen fault in the central part of the area (pl. 1) has been traced into southern British Columbia (Rice, 1947, p. 15), where it separates the Dewdney Creek Group, which contains volcanic debris, from the younger Pasayten Group, which does not. The amount of volcanic debris decreases to the south, and the differences between the two formations are less clear. Hence, south of the Canadian line the position of this fault is located on the basis of topographic expression and the offset of the large Pasayten dike. The west side of the Chuchuwanteen fault moved up and to the north, relative to the east side.

In the western part of the area a north-trending fault in the arkose and argillite sequence crosses both Three Fools and Freezeout Creeks (pl. 1; fig. 18). On the ridge west of Castle Peak, it dips 80° W. Farther south the fault is indicated by bending of beds, topographic depressions, and the abrupt ending of a thick conglom-

FIGURE 18.—Fault on ridge southwest of Freezeout Lake cuts the plagioclase arkose and argillite sequence. View looking southwest.

erate unit. If the thick conglomerate bed to the west of the fault is the same as a similar-appearing conglomerate bed 6 miles to the east, the throw must be large, and the east side moved down.

In the southwest corner of the area a northwest-trending fault separates the Custer Gneiss of McTaggart and Thompson (1967) from the phyllitic facies of the plagioclase arkose and argillite sequence and the granodiorite dike and sill complex (pl. 1). This fault cuts off a smaller crosscutting fault separating the two younger rock units. The presence of entirely different rock suites on opposite sides of this fault suggests a large throw. The west side of this fault moved up relative to the east side.

A large northeast-trending fault (pl. 1) has been inferred to extend southwestward along Chuchuwanteen Creek to Grizzly Creek. Although the fault plane was not observed, we have mapped this fault on the basis of a major disturbed zone, offset fold axes, and the abrupt termination of conglomerate beds and intrusives. The north side of this fault has moved to the northeast.

Faulting that bounds the Hozomeen Group of Cairnes (1944) is subject to various interpretations. The contact was first described as a thrust in British Columbia by Rice (1947, p. 52), and it was similarly interpreted by Misch (1966, pl. 7–1) in the study area. This interpretation was based largely on the overall sinuosity of the contact and on the supposed correlation of the Hozomeen with rocks older than the surrounding arkose and argillite sequence—which were believed to underlie the Hozomeen block.

Despite these lines of evidence, other interpretations are possible. At many places along the east contact of the Hozomeen the fault dips 75°–90° W. over vertical distances of thousands of feet. At one place on the south end, a dike of serpentine has been squeezed in above the contact, suggesting a deep-seated, probably steep fault. Thus, the detailed information does not support the thrust hypothesis.

Regional considerations suggest that the Hozomeen block may be part of the large graben about 25 miles to the southeast (Huntting and others, 1961). The fault marking the west side of the graben trends toward the Hozomeen block and, except where it is obliterated by intervening younger intrusive bodies, may continue as two steep faults—one on each side of the Hozomeen outcrop. Nevertheless, if the Hozomeen is older than the underlying rocks, a thrust is required. If it is younger, as suggested by the lithology on the west side of Ross Lake, existing relationships could be explained without the need of a thrust. In either alternative, steep normal or reverse faults along the east contact are required.

MINERAL RESOURCES AND ECONOMIC APPRAISAL

Metalliferous resources of the Pasayten Wilderness are of two types: placers and lode deposits. Indications of mineralization are widespread in the area, and much of the area is geologically favorable for the occurrence of ore deposits.

A search of mining records at the Okanogan and Whatcom Courthouses revealed that over 605 claims have been recorded since 1891 in the study area; 171 are placer claims. According to county and Bureau of Land Management records, there are no patented claims within the study area.

Most of the claims are in the following areas: Horseshoe Basin, Tungsten Creek, Sheep Mountain, Billy Goat Mountain, Monument Peak stock, northern part of Slate Creek mining district, Hozomeen Mountain, and Lightning Creek–Three Fools Creek drainage.

Recorded mineral production from lode mines in the area has been inconsequential, amounting to only a few carloads of hand-sorted tungsten ore, but production has been recorded from deposits close to the wilderness area. Mines in Allen Basin in the Slate Creek mining district outside but contiguous to the wilderness area have produced at least $1.5 million in gold and silver; placers in the Ruby Creek–Canyon Creek drainage, also just outside but contiguous to the area, may have produced as much as $150,000 in gold at $20.67 per ounce. Most of the gold was recovered before 1910 from gravel near the mouth of Ruby Creek. This area is now covered by water impounded by Ross Dam. Mines in the Copper Mountain–Princeton and Hedly districts in British Columbia only a few miles north of the wilderness area have produced more than 32 million tons of copper, nickel, and gold ores.

Four localities in the wilderness area show particular potential for mineral production: (1) Monument Peak stock, (2) Billy Goat Mountain area, (3) a strip of terrain 1–2½ miles wide along the north edge of the Slate Creek mining district, and (4) Tungsten Creek drainage basin. These four areas are described in detail in later sections of the report.

PLACER DEPOSITS

In most of the study area the steep gradients of the streams and the narrow V-shaped valleys in which they run have precluded the formation of all but very small placer deposits. In the few wider U-shaped valleys such as that of the Pasayten River, recent glaciation has undoubtedly removed nearly all the placer deposits that might have formed. Consequently, the possibility that the study area contains significant deposits of placer gold must be regarded as small, even though 171 placer claims have been located in the area.

LODE DEPOSITS

Lode deposits in the study area are of two types: vein deposits, and zones with sulfide minerals disseminated through the rocks. The first were attractive to the early prospectors, and most of the existing lode claim locations were made on deposits of this type. Deposits of the second type received some attention but are generally too low grade to have been of much interest to the early prospectors. They may, however, prove to be of more significance in the future than the vein deposits. Deposits of this type may have very large tonnages and are the targets of intensive search throughout the world by mineral exploration companies.

DISSEMINATED DEPOSITS

Outcrops of deposits of disseminated sulfides in the study area are characterized by conspicuous iron-oxide-stained rocks, and the presence of sulfide minerals is shown as discrete grains disseminated in the rock. Oxidation is generally shallow, so that the sulfide minerals normally are found within a few feet of the surface. Sulfide minerals are mostly pyrite and pyrrhotite, with a little chalcopyrite or molybdenite and rarely other base-metal sulfides. Iron-oxide-stained zones such as these are exposed in numerous places west of the Eightmile Creek fault. Some are fairly accessible; others are exposed only in steep, nearly unscalable walls or are almost completely covered by talus or glacial debris. Zones of disseminated sulfides are particularly abundant in and around the Monument Peak stock (pl. 1) and probably reflect a genetic relation to the stock. Some may be of potential value. The occurrence with perhaps the greatest promise is indicated by highly anomalous stream-sediment samples from along the west side of Lake of Woods (pl. 2; fig. 19). The source of these anomalous samples is covered by glacial till but must underlie an area at least 1,000 feet long. Other occurrences along Pinnacle Creek and Eureka Creek are better exposed; samples yielded as much as 0.1 percent copper and 0.02 percent molybdenum. These and other iron-oxide-stained sulfide zones from below which anomalous stream-sediment samples have been collected are described in detail in this report. Most are probably too small or contain too little copper or molybdenum to be of interest, but a few, including those in an area along Boundary Creek, may warrant further investigation.

VEIN DEPOSITS

Vein deposits can be found in many places in the study area, but most of them are small; the ore minerals tend to be sporadically distributed within the veins, and the deposits generally are economically unattractive. Three areas which may have some potential for production are:

1. The Billy Goat Mountain area on the south boundary of the study area, where there are lead-zinc-copper veins in volcanics just west of the Eightmile Creek fault (pls. 1, 2; fig. 28).
2. A band 1–2½ miles wide surrounding the Slate Creek mining district on the south border of the study area (pl. 3; figs. 32, 39, 45, 53).
3. The Tungsten Creek drainage basin adjacent to the International Boundary between Cathedral and Horseshoe Creeks (pl. 2; fig. 23).

BILLY GOAT MOUNTAIN AREA

On Billy Goat Mountain, copper minerals occur principally in two areas: on the New Hope property just north of the wilderness area boundary above Billy Goat Pass, and on the Billy Goat property at the end of the Eightmile Creek road (fig. 28).

On the New Hope property an adit, now caved, explored a northeast-trending shear zone in volcanic flow breccia. The zone is made up of several bifurcating shears containing calcite, barite, chalcopyrite, covellite, and bornite. Four of five surface samples taken from shear zones 4 inches to 2 feet wide above the portal yielded from 2.2 to 9.9 ounces of silver per ton and 0.33–4.20 percent copper (fig. 29). Sample RV–66–12A, from a small ore pile at the portal of the adit, contained 10.2 percent copper and 20.6 ounces of silver per ton. This prospect is one that deserves further investigation.

The Billy Goat property has been developed by about 700 feet of underground workings (fig. 31) and is reported to have produced a few tons of copper ore that was sent to the Tacoma smelter for tests. Although it is in the study area, the property is south of the wilderness area boundary. Further exploration might reveal other adjacent areas that contain small workable deposits south of the wilderness area boundary.

BORDER OF THE SLATE CREEK MINING DISTRICT

The boundary of the Pasayten Wilderness excludes most of the Slate Creek mining district. Gold-bearing veins with minor base metals, however, are found within the wilderness area in a broad arc 1–2½ miles wide around the north edge of the district. This arc extends from Beauty Creek west to the junction of Mill Creek and Canyon Creek, an east-west distance of about 10 miles (pl. 3).

The most promising areas appear to be along Beauty Creek, a tributary of Robinson Creek; on Buckskin Ridge between the Middle and West Forks of the Pasayten River between Haystack Mountain and Pasayten Peak; in the Jim Peak–Windy Pass area north of Barron; and near Anacortes Crossing northwest of Chancellor (pl. 3). These areas are described in detail in the text that follows.

Although the known veins bordering the north end of the Slate Creek mining district probably are not minable under present conditions, they outline an area around the north end of the district that appears favorable for exploration for gold.

TUNGSTEN CREEK AREA

In the drainage basin of Tungsten Creek (fig. 23), 1½–3 miles south of the Canadian border, there are several narrow gently dipping wolframite-bearing quartz veins. These veins have an average thickness of between 5 and 10 inches. Wolframite is distributed erratically and ranges in content from a trace to as much as 10 percent in the richer pockets. The average grade of the ore shoots on the two best-developed properties—the Boundary group and the Last Chance claim—is estimated at 0.5 and 0.85 percent WO_3, respectively. A little ore, mostly from rich pockets, has been shipped from the Boundary group, but there has been no production since 1938—not even between 1951 and 1956, when tungsten was at a high price. The flat dip and narrow width of the veins and the occurrence of the tungsten mostly in small widely scattered pockets make mining expensive, and the veins cannot be mined successfully under present conditions. Nevertheless, the overall tungsten content is sufficient for the veins to be considered as a resource.

INDUSTRIAL MINERALS

Two mining claims have been located on fluorite veins near the east edge of the Monument Peak stock, but the small size and low grade of the veins indicate that they have little potential as future producers of fluorspar.

Stone suitable for building stone undoubtedly abounds in the Pasayten Wilderness Area, but equally good material can be found in far more accessible and convenient localities. No deposits of other industrial minerals suitable for exploitation are known within the study area. In general, the rugged terrain precludes the development of industrial minerals, most of which have a low unit value and require cheap transportation if they are to be exploited successfully.

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FOSSIL FUELS

The area seems to hold little promise for the development of deposits of coal, petroleum, or natural gas. The sedimentary rocks there are not of the type generally associated with coal beds, and their low porosity makes them unfavorable for the accumulation of oil or gas.

PROBLEMS OF MINERAL APPRAISAL

Appraisal of the mineral resource potential of any large area is at best a difficult task. The task differs markedly from the appraisal of resources such as timber, which are visible on the surface and can be measured with a high degree of accuracy. Except in rare cases, even the grade and tonnage of an exposed ore body can be determined accurately only after it has been opened to observation by drill holes or mine workings—usually at great expense. Any appraisal should include as a first step a study of the geological environment of the area and examination of all the known mines and prospects and their past production records. A geochemical survey, including panning of streams for their heavy-metal content and collection of stream-sediment samples, may disclose the presence of undiscovered or hidden mineral deposits, as may the application of geophysical methods of prospecting. All these methods were used in evaluating the Pasayten Wilderness.

Appraisal of the mineral potential of the Pasayten Wilderness is thus based on several lines of approach. The general geologic environment has already been discussed under the geology section of this report. The purpose, extent, and methods of taking the geochemical samples, together with a summary of the results of the geochemical sampling, are set forth in the next section; subsequent sections present the results of an aeromagnetic survey and describe the known mines and prospects.

No appraisal can pinpoint all ore bodies within the appraisal area. Nor, without greatly exceeding the scope of the work devoted to this project, is it possible to determine whether occurrences examined during our investigation could be mined profitably under existing conditions or under conditions that might reasonably be expected to pertain in the foreseeable future. Nevertheless, our work has shown that within the study area there are areas where more detailed investigation by mining companies searching for ore bodies might be justified.

GEOCHEMICAL EXPLORATION

Geochemical exploration for minerals may be defined as any method of mineral exploration based on systematic measurement of one or more properties of a naturally occurring material. The property measured is most commonly the trace content of some element or group of elements; the naturally occurring material is rock, soil, gossan, glacial debris, vegetation, stream sediment, or water. The purpose of the measurements is to discover abnormal distribution patterns or geochemical anomalies related to mineralization (Hawkes and Webb, 1962).

Two types of geochemical samples were taken along the streams in the Pasayten Wilderness: heavy-mineral concentrates panned from stream gravels, and stream-sediment samples. The purpose, extent, and methods of taking these samples are discussed below.

HEAVY-MINERAL CONCENTRATIONS FROM STREAM GRAVELS AND SANDS

Ore minerals that have a high specific gravity and are resistant to chemical and mechanical attack can be concentrated with a gold pan from stream sands and gravels. Gold, monazite, and the tungsten minerals, scheelite and wolframite, may be carried many miles downstream. In many places these minerals can be traced back upstream to their source. Metallic sulfide minerals may also be found in the stream gravels, but these minerals tend to disintegrate and are not carried so far by the streams. Under favorable conditions streams may concentrate gold, cassiterite, monazite, and certain other minerals into workable placers.

In our examination, samples for heavy-mineral study were collected from the sand and gravel of stream bars at 2- to 5-mile intervals along many of the major streams (pls. 2, 3). A total of 90 samples were taken and carefully concentrated by panning. Panned concentrates consisted of about 70–95 percent heavy minerals. Semiquantitative spectrographic analyses were run on all these samples. Gold was determined on samples from the western part of the area by the atomic-absorption method (table 1).

Stream sediments throughout the study area contain only a small fraction of heavy minerals. In part, this reflects the low heavy-mineral content of the rocks from which the sediments were derived. Although most of the area is unfavorable for placers, a few occur in protected areas, such as along Canyon Creek, where glaciation occurred long enough ago that sand could accumulate subsequently.

The principal heavy minerals found in panned concentrates are magnetite and hornblende and, in lesser amounts, ilmenite, garnet, sphene, zircon, and epidote. In a few samples tourmaline, monazite, and pyrite occur; gold was not noted. This mineralogy is reflected in the semiquantitative spectrographic analyses (table 1). In comparison with the unpanned stream sediments, the panned concentrates are high in iron and titanium. Many are high in chromium and zirconium, and some are high in vanadium, lanthanum, and yttrium. The mineral content of the panned concentrates varies from one place to another. It was found that an increase of some particular element commonly reflects differences in the mineral content of the rock type drained by the stream from which the sample was taken and does not indicate upstream deposits of that element. However, there were several exceptions, which will be discussed below. A comparison of the elemental content of all 90 panned concentrates with the rock types from which they were derived shows several correlations: (1) most samples containing any detectable tin and all samples containing 100 ppm (parts per million) or more of tin came from streams which drained the granite of Monument Peak; (2) lanthanum and yttrium, which probably occur in the rare-earth mineral monazite, are most abundant in panned concentrates derived from the igneous plutons and are least common in panned samples derived from the plagioclase arkose and argillite sequence of the Hozomeen Group of Cairnes (1944); (3) cobalt content tends to be high in the Midnight Peak Formation; and (4) samples derived at least in part from the Hozomeen Group are high in copper, nickel, cobalt, and vanadium and low in lanthanum, yttrium, molybdenum, and tin.

Most minerals containing copper, lead, zinc, molybdenum, and silver are not resistant to stream wear. Hence, anomalous amounts of these elements in panned samples are likely to occur only fairly near their source. Panned samples proved unreliable in testing for these metals. Of all 90 panned samples, none could be considered anomalous for lead or zinc, only two for molybdenum, three for silver, and 11 for copper. The two anomalous molybdenum samples were from the mouth of Gabril Creek and the headwaters of Lease Creek. Stream-sediment samples collected at these localities also were high in molybdenum. The three anomalous silver samples were also anomalous for copper. Four samples with anomalous copper were taken from Robinson Creek and probably reflect some small copper prospects on the southwest ridge of Robinson Mountain. Two from Freezeout and two from Lightning Creek probably reflect either the prospect on the ridge south of Boundary Creek or several sulfide-bearing altered zones on the ridge to the west. One anomalous sample from the headwaters of Middle Creek lies just below several iron-oxide-stained sulfide-bearing zones on the ridge to the south. The highest anomaly (300 ppm copper) is at the mouth of May Creek, and although part of this high value may be a result of the stream's draining the Hozomeen Group, the copper content is much higher than in other samples taken from the greenstone. Furthermore, the sample is anomalous in silver and gold. A zone of shearing containing short irregular veins of quartz crosses May Creek near its mouth. Some of these small veins contain pyrite, chalcopyrite, and a little gold. This type of occurrence is described in more detail under locality 79. The anomalous copper, silver, and gold content of samples taken at the mouth of May Creek was probably derived from this source. The source of the copper (70 ppm) found in two samples from Frosty Creek and the North Fork of Devils Creek is not known.

In summary, the heavy-mineral content of panned concentrates from stream gravels was only of limited use in our appraisal of the study area. Some areas anomalous in base metals were indicated by this method, but we found that stream-sediment samples are easier to take and show anomalous values at greater distances from the source. In spite of the negative results in this particular study, panning is one of the simplest and most effective methods of prospecting for gold.

STREAM-SEDIMENT SAMPLES

Stream-sediment sampling consists of collecting the finer fraction of the stream sediments and testing it for various metallic elements. These elements can occur as adsorbed materials on fine particles, precipitates of various kinds, or residual mineral particles. After drying and screening, all stream-sediment samples collected in the Pasayten Wilderness that contained enough fines were analyzed for citrate-soluble heavy metals [5] (cxHM) and for cold acid extractable copper (cxCu) by standard methods described by Ward, Lakin, Canney, and others (1963, p. 25–29). These techniques measure only the readily soluble metals and not the total content of the metal in the sample. In both cases this is essentially only the metal content of the adsorbed material. The pattern revealed by these tests, however, is often more significant than the total metal content of the sample.

In this report a stream-sediment anomaly is a stream-sediment sample that contains a higher amount of a metal than samples from most adjacent areas of similar bedrock. A stream-sediment anomaly is but a reflection of unusual concentrations of metals somewhere in the basin drained by the stream. The anomalous values in many of the stream-sediment samples from the study area can be traced to zones of disseminated sulfides; others have been derived from sulfide-bearing veins. The magnitude of a stream-sediment anomaly is controlled by the size and concentration of the metal source, the distance from the source, the amount of water flowing in the stream, and the availability of the metal ions to solution. The anomalies tend to

[5] The heavy-metals test is for combined zinc, cobalt, copper, and lead. It is most sensitive for zinc and less sensitive, in decreasing order, for cobalt, copper, and lead.

decrease in size downstream, and they tend to disappear entirely where a tributary enters a large stream.

Topography somewhat affects the availability of the metal ions. In areas of steep slopes and great relief, as in much of this area, the outcrops are better exposed to oxidation, and water has easy access to the outcrops. Probably the best example of availability of metal ions is a mine dump, where broken rocks from mineralized zones are exposed to ready leaching. Metal content of samples from streams flowing past mine dumps is many times higher than that of samples from streams draining areas of unbroken or poorly exposed mineralized rock. For example, 15 ppm cxCu is in sample 601 (table 1; pl. 3) from the tributary flowing across the dump of the Minnesota mine. On other evidence this area appears to contain only insignificant amounts of copper.

Stream-sediment samples were taken at intervals of about a mile along all the major and many of the smaller streams; we also sampled many of the smaller tributaries coming into these streams (pls. 2, 3,). In all, we took 1,208 stream-sediment samples. Many small tributaries that appear on plates 2 and 3 were not sampled because these are not actually streams, but are steep chutes filled with scree. Because of the large number of samples, only those containing 6 ppm or more of cxHM, cxCu, or molybdenum are listed in table 1. However, all sampling points are shown on plates 2 and 3 as dots. Samples shown in the table are numbered on the two maps. Those samples that have been analyzed for molybdenum have a vertical line above the locality dot. Those that have been qualitatively tested for gold have a horizontal line to the right of the dot. The table also includes all sediment samples on which semiquantitative spectrographic analyses were made.

Semiquantitative spectrographic analyses were made of many of the stream-sediment samples collected during the first year of work in the eastern part of this area to check the chemical analyses, and to insure that metals of potential economic value were not missed. Such analyses were also made in a few instances where not enough fines were present in the sample to be analyzed by the standard geochemical methods. The cold copper content agrees rather well with the total copper content as determined by semiquantitative spectrographic analyses of 193 stream sediments (table 1). As expected, the total copper contents are considerably greater than the cold copper content. The two methods, however, check well in showing the relative abundance of copper in various samples. The greatest percentage variation is generally in those samples in which the copper content is near background. In this range the sensitivities of the two methods are not as good.

A total of 344 samples were analyzed for molybdenum. The total molybdenum content was determined by a carbonate fusion method (Ward and others, 1963, p. 59–61).

Gold was analyzed in some samples by the spectrophotometric method of Lakin and Nakagawa (1965). This method uses 0.5-gram splits of the samples. Checks of second, third, and even fourth splits of the same sample gave widely varying results. Further work showed that only the most complete grinding would disperse the gold evenly through the sample. A positive analysis is indicative of gold in the sample, but the actual amount may be very different from the amount indicated by the analysis. Hence, gold analyses are not shown for stream sediments in table 1. Gold's presence in various areas is discussed at appropriate places in the text.

GEOCHEMICAL RESULTS EAST OF THE EIGHTMILE CREEK FAULT

As previously noted, the mineral potentials of the areas east and west of the Eightmile Creek fault are different. East of the fault only one analysis for cold copper and six for heavy metals show 6 ppm or more. The cold copper analyses and all heavy-metal values over 7 ppm are from the headwaters of Tungsten Creek, and represent minor quantities of zinc and copper in a tungsten vein. All other cold copper and heavy-metal values are negative in this area. Molybdenum, however, shows several small anomalies ranging from 6 to 12 ppm in a belt 5 miles wide lying south of and along the Canadian border. The sources of some of these anomalies are known; others are not. They have probably been derived from small pegmatites with scattered molybdenite similar to the pegmatite in the Horseshoe Basin prospect on Arnold Peak north of Long Draw (loc. 2, fig. 20).

Four anomalous molybdenum samples are from drainages in the headwaters of Tungsten Creek (fig. 23). One containing 12 ppm came from a small tributary that drains the dumps of the Boundary tungsten mine. The molybdenum anomalies in this drainage are believed to be derived from small amounts of molybdenum in the tungsten-bearing quartz veins.

Five other anomalous samples came from tributaries draining Sheep Mountain, where there are several prospects on quartz veins that contain a small amount of molybdenite. Other anomalous analyses from this area are thought to reflect still other small quartz veins or pegmatites. Those near known prospect workings are described in more detail later.

Only three zones of disseminated sulfides were noted east of the Eightmile Creek fault, and the zinc, copper, lead, molybdenum, and silver contents of all three are low (357, 358, 359, table 1; pl. 2).

GEOCHEMICAL RESULTS WEST OF THE EIGHTMILE CREEK FAULT

West of the Eightmile Creek fault, in contrast to the east, many anomalous stream-sediment samples were noted. One hundred eighty-four samples contained 6 ppm or more cold copper; 136 samples contained 6 ppm or more heavy metals; and 41 samples contained 6 ppm or more molybdenum. Furthermore, 25 of these samples contained at least 30 ppm cold copper, 25 contained 30 ppm or more heavy metals, and 15 contained 12 ppm or more molybdenum.

Most of the anomalous values in the samples from this area are derived from one or more zones of disseminated sulfides. Some, such as anomalous heavy-metal values along Jinks Creek, have their source in small veins, and those in the Middle Creek drainage are in part derived from mineralized breccia zones. However, more than 90 percent of anomalously high metal values appear to be derived from zones of disseminated sulfide minerals.

Disseminated sulfide zones are scattered across this whole area west of the Eightmile Creek fault and concentrations of them occur in some localities. Some of these concentrations occur adjacent to the contacts of intrusives with their country rocks. But some concentrations, as along parts of Canyon Creek, could not be related to any particular intrusive. The mineralized areas range in width from less than 1 inch to at least 1,000 feet and in length from a few feet to several thousand feet. They may be either tabular or irregular. Pyrite and pyrrhotite are the most abundant sulfide minerals, but small amounts of copper sulfides are found in some of the disseminated zones. Anomalous amounts of zinc, lead, and molybdenum are also found but are less common than copper. Gold was either not found or found only in trace amounts. Samples taken of the disseminated zones were all far below ore grade, but none of the zones were sampled except on the surface. Most of the disseminated zones are small, but a few are quite extensive.

Three localities having the greatest metal values in stream-sediment samples are of special interest. These localities are on a tributary of Boundary Creek, on the north side of Lightning Creek, and near Lake of Woods. The first, which contained 300 ppm cold copper and 200 ppm heavy metals, is from a very small stream that drains several large zones of disseminated sulfides on the mountain immediately above it (709, table 1; pl. 3). Five rock samples from these zones contained 100 to 500 ppm copper and <200 to 1,000 ppm zinc.

Although the rock-sample analyses are low, at least parts of the zones of disseminated sulfides may contain more copper than these samples indicate. The sources of the material at the other two localities are covered by talus and glacial debris. The stream-sediment sample from Lightning Creek (753, table 1; pl. 3) was probably collected close to the source of the sediment; the anomaly is at least 100 times background, and the area warrants further prospecting. Anomalies at the third locality, which lies west of Lake of Woods (fig. 19), are not quite as large. Three parallel tributary streams gave samples containing 45 to 180 ppm cold copper, 12 to 120 ppm molybdenum, and 40 to >45 ppm heavy metals over a distance of 1,000 feet. This locality is one of several anomalous localities that lie in and adjacent to the Monument Peak stock. Anomalies at other localities around this stock have been traced to disseminated zones containing as much as 0.3 percent copper. As the Lake of Woods anomalies are several times larger than these and occur over a distance of at least 1,000 feet, this area appears to be favorable for further prospecting.

ANOMALOUS AREAS

Many of the geochemical samples gave analytical results high enough to be considered anomalous. In the following discussion these anomalies are explained in light of our knowledge of the geology and the mineral deposits of the area.

Anomalous samples are described by specific areas of collection. Those areas covered by separate maps outlined on plates 2 and 3 are grouped together. Within these general groups the anomalous samples are divided according to separate sources, all the anomalies from one source being grouped together. The areas are discussed in order from east to west across the wilderness area.

HORSESHOE BASIN AREA

Plate 2; figure 20

Three stream-sediment samples (1, 2, and 3) collected along Long Draw and from tributaries draining into it from the north contain anomalous amounts of molybdenum. Other samples from the Long Draw drainage contain <6 ppm molybdenum. The highest value (12 ppm) came from the headwaters of Long Draw south of the Horseshoe Basin prospect (loc. 2, fig. 20), a small irregular molybdenum-bearing pegmatite on Arnold Peak. Similar pegmatites occur in other places on Arnold Peak, and some float therefrom contained molybdenite.

Gold was detected in a qualitative test of stream sediments at localities 1 and 4. Its presence at locality 1 suggests that gold occurs in the molybdenum-bearing pegmatites, though none was found in a sample from the Horseshoe Basin prospect (Huntting, 1956, p. 270).

The prospect at locality 4 (fig. 20) exposes a 4-foot chalcedony vein. A sample (MHS–153–65, table 2) cut across this vein had no gold, but gold may occur in other parts of this vein or in other concealed veins in this area.

TUNGSTEN CREEK AREA

Plate 3; figure 23

Several of the 18 stream-sediment samples that were taken from the drainage of Tungsten Creek are anomalous. Quartz veins that contain tungsten minerals, pyrite, and sphalerite are the source of the anomalies. One sample (19, table 1) of sediment from a stream issuing from the main adit on the Boundary group contains 12 ppm molybdenum, 17 ppm heavy metals, and 6 ppm cold copper. The molybdenum content of this and other samples (17, 18, 23, 24, 26) from this area suggests that molybdenum minerals occur in the tungsten veins, even though none have been reported to date. The anomalous content of heavy metals in several of the samples was probably derived from sparse, widely scattered sphalerite in the quartz-tungsten veins. Of special interest are the two samples taken from the small tributary that drains Little Tungsten Lake (fig. 23). One sample (22, table 1; pl. 3) taken just below the lake contained 2 ppm molybdenum and 9 ppm heavy metals, and the second sample (23), taken just above the tributary's junction with Tungsten Creek, contained 12 ppm molybdenum and 27 ppm heavy metals. The known veins on Apex Mountain lie above Little Tungsten Lake. Hence, this larger anomaly near the mouth of the creek suggests that there may be another vein on the slope between the two samples.

CATHEDRAL CREEK AREA

Plate 2

Of seven samples taken along Cathedral Creek, which flows off the west side of Apex Mountain, two contained anomalous amounts of molybdenum (table 1). One of the anomalous samples (29) is from the main stream and contains 6 ppm molybdenum, the other (31) is from the east tributary draining Apex Mountain and contains 16 ppm. As in the Tungsten Creek area, the source of the anomalous molybdenum is believed to be the quartz-tungsten veins on Apex Mountain.

SHEEP MOUNTAIN AREA

Plate 2

Five samples collected from the area that drains the east and south sides of Sheep Mountain have anomalous amounts of molybdenum. The three highest molybdenum values (12 ppm each in samples 89, 90 and 91, table 1; pl. 2) come from the headwaters of Martina Creek, which drains the cirque on the east side of Sheep Mountain. In this cirque (fig. 27) pits and trenches of the Sheep Mountain prospects expose several quartz veins containing sparsely scattered molybdenite. The prospects extend in a S. 40° E. direction across the cirque and down on the south side of Sheep Mountain. Two samples (104, 105, table 1), which were collected on tributaries that drain this side of Sheep Mountain, contained 6 ppm molybdenum. All five anomalies reflect the metal content of the veins, which are described in the section on veins and shear zones.

BILLY GOAT MOUNTAIN AREA

Plate 2; figure 28

Forty-seven stream-sediment samples and four samples of rock containing disseminated sulfides were collected in the Billy Goat Mountain area. Eight localities containing veins or shear zones occur in andesitic volcanic rocks along the west side of the Eightmile Creek fault. Copper is the principal metal in the veins and shears in the southern part of this area; lead is dominant north of this point.

Stream-sediment samples were collected along Eightmile, Jinks, Pat, and Drake Creeks. The first two drain the heart of the area; the latter two, the flanks. Four stream-sediment samples were taken from the small tributaries that enter Eightmile Creek within half a mile of Eightmile Pass, and from scattered points farther south along the creek. The four samples (113, 114, 115, 120, table 1) near Eightmile Pass are from tributaries that drain the area in which the Lead Horse deposit is found. These samples all contain more than 45 ppm heavy metals but are low in cold copper and molybdenum. The high heavy-metal values are probably due mainly to lead, but also to zinc. The samples taken farther south on tributaries of Eightmile Creek have 3–5 ppm heavy metals, indicating that the anomalous lead area does not extend that far south. One sample (121, table 1) that was taken on Eightmile Creek, 1.2 miles south of the end of the road, had 7 ppm heavy metals, reflecting downstream dilution. Cold copper content of these low-grade heavy-metal samples varies from 0.5 ppm for sample 121 to 11 ppm for two samples—one from high on a tributary draining Isabella Ridge (117) and one from a tributary on the Billy Goat mine ridge (118). The latter value is surprisingly low, in view of the amount of chalcopyrite found scattered in various shears on that ridge. In general, the geochemical analyses from Eightmile Creek conform to the mineralogy of the known deposits, lead being dominant to the north and copper to the south.

Eleven stream-sediment samples were taken on Jinks Creek. The sample taken at the mouth of this creek (144) contained 14 ppm heavy metals. This anomaly was traced headward, and in the upper part several tributaries showed high heavy-metal values. The highest values came from a north-flowing tributary that drains the north end of Isabella Ridge. Anomalous sediments were found to its upper end, where the tributary emerged from under large rubble blocks that fill a high cirque. The source of the anomaly is hidden under the rubble but is probably caused by small lead veins similar to those that occur at the head of Eightmile Creek. Only one sample (141) from the Jinks Creek drainage shows more than background in copper. It was collected near Eightmile Pass, and the source of this copper is not known. Six samples from Jinks Creek were analyzed for molybdenum; all were low.

Seven stream-sediment samples were collected from Pat Creek along the southwest side of the Billy Goat Mountain area. They all had a low heavy-metal content, and the highest copper value (6 ppm) came from a small south tributary. Hence, the southwest edge of the lead and copper mineralization appears to be somewhere along Isabella Ridge.

Seventeen stream-sediment samples were collected from along Drake Creek and its tributaries, which bound the northwest, north, and northeast sides of the Billy Goat Mountain area (pl. 2). Only two contained as much as 7 ppm heavy metals. One of these samples (155) came from Drake Creek, below its junction with Jinks Creek, and represents heavy-metal values derived from the latter creek. The other (151) came from a small tributary that drains the north side of a ridge to the east of Billy Goat Pass. None of the cold copper values are above background. These samples indicate that the north edge of the lead mineralization is probably along the south side of Billy Goat Mountain.

Samples (112a, 112b, 145, 147, table 1; pl. 2) of iron-oxide-stained rock from four zones of disseminated sulfides were analyzed spectrographically. Two (112a, 112b), which were collected near a prospect pit (loc. 13), contained 1 ppm and 15 ppm silver, and 100 ppm and 150 ppm lead, respectively. Their content of copper, zinc, and molybdenum, however, was not anomalous. The other two samples (145, 147) gave negative results on all five metals, demonstrating that not all iron-oxide-stained zones contain anomalous amounts of base and precious metals.

GOAT CREEK AREA

Plate 2

Fifteen stream-sediment samples and two samples of iron-oxide-stained rock with disseminated sulfides were collected on Goat Creek. None of the stream-sediment samples contained anomalous amounts of cold copper, and only one (128) contained anomalous heavy metals. This sample, which was the farthest downstream of those collected, contained 11 ppm heavy metals. We attempted to trace this anomaly upstream with a field kit but were unable to find any other anomalous values. Furthermore, a spectrographic analysis of sample 128 did not show anomalous amounts of lead, zinc, or copper. If the heavy-metals analysis is not faulty, then the high heavy-metal content is probably due to zinc, as its limit of sensitivity in the spectrographic analysis is 200 ppm.

About half a mile upstream from sample 128, two samples of iron-oxide-stained rock with disseminated sulfides were collected, one (126) of arkose and the other (125) of a quartz porphyry dike. Spectrographic analyses were made of both rocks (table 1). The quartz porphyry (125) contained 70 ppm of lead, which is slightly anomalous for this type of rock. The lead content for the arkose was not high, nor was the copper, zinc, or silver content of either rock significant. A qualitative gold test showed small amounts in both rocks.

LITTLE WILLY CREEK

Plate 2

Little Willy Creek flows eastward into Ptarmigan Creek just south of First Hidden Lake. A sample (177, table 1) taken at the mouth of this stream contained 15 ppm cold copper. Seven additional samples collected upstream indicate that the anomaly disappears above sample 178, which contained 20 ppm cold copper. One hundred feet above this sample a 15-foot-wide zone of iron-oxide-stained arkose is exposed along the south bank of the stream. This rock contains considerable disseminated pyrite and a little chalcopyrite. A chip sample (178a, table 1) taken across this zone contains 150 ppm copper by spectrographic analysis. This zone of disseminated sulfides is probably too small and contains too little copper to be significant.

MONUMENT PEAK STOCK

Plate 2; figure 19

The Monument Peak stock is a roughly circular granite body of Tertiary age that intruded the plagioclase arkose and argillite sequence and older intrusive rocks. The center of the stock is about 8 miles west of Eightmile Pass. Many sediment samples from streams that drain the stock were anomalous in cold copper and some in heavy metals and molybdenum. The sources of most of these anomalous samples are zones of disseminated sulfides that contain some copper and, locally, some molybdenum. Some of these zones are in the granite, and some are in the intruded sedimentary rocks. Samples from these copper-bearing zones contain 0.01–0.3 percent total copper, except for one that contains >0.5 percent copper. However, the source of the copper found in the most anomalous samples is covered by glacial debris. The source is probably a disseminated

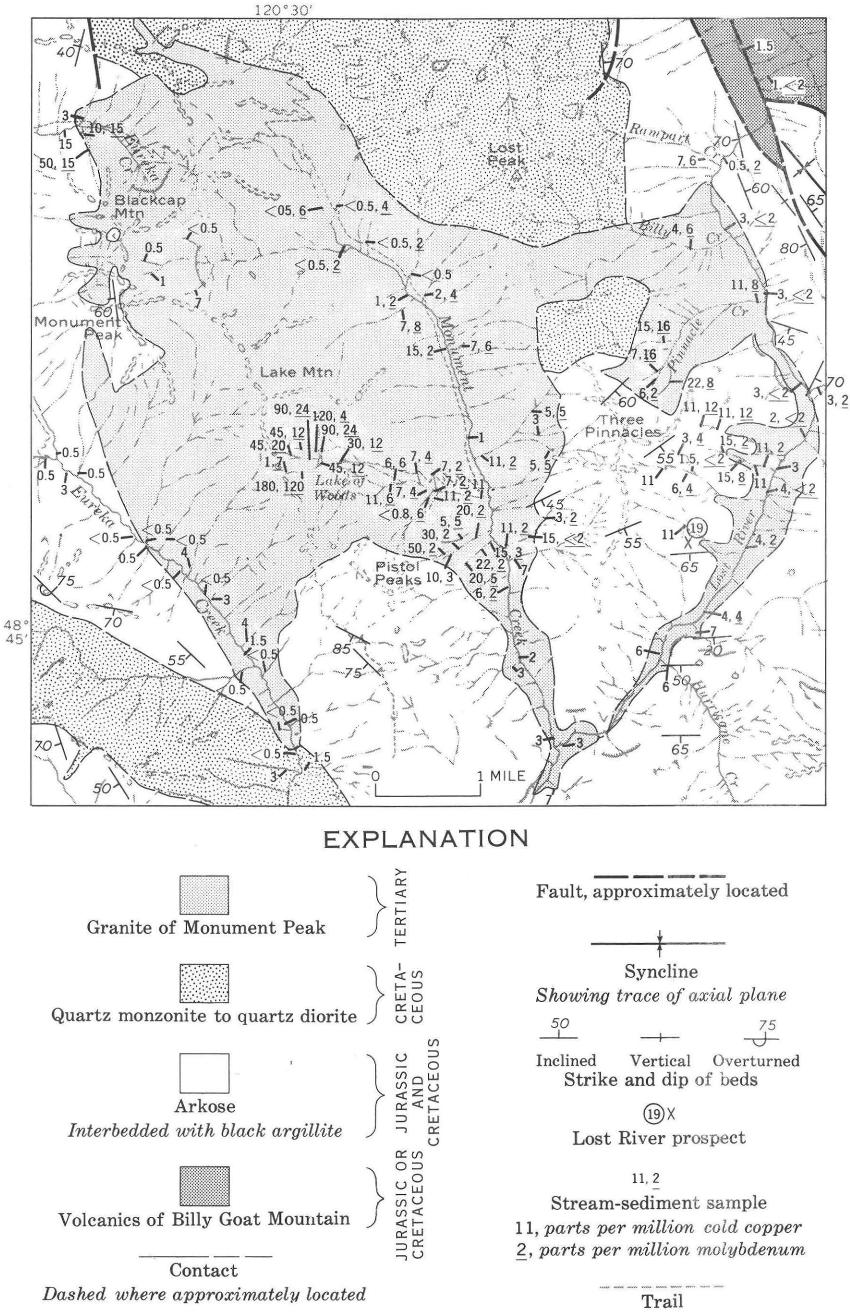

FIGURE 19.—Monument Peak stock showing geochemical analyses for cold copper and molybdenum. Base from U.S. Forest Service planimetric maps, 1955.

deposit of higher grade than those seen in other parts of the Monument Peak stock. This area, which is near Lake of Woods, has not been extensively prospected because of the lack of access and extremely rugged terrain, but it warrants further investigation. If exploitable mineral deposits are found, road building into the area would be a formidable and costly task.

Only two claims are known in the vicinity of the stock. These were staked on narrow fluorite veins above Lost River near the east edge of the pluton. They contain at the most only a few hundred tons of fluorite.

Geochemical anomalies in the vicinity of the Monument Peak stock are in six areas: (1) Pinnacle Creek, (2) west side of Lost River, (3) east side of Monument Creek, (4) Lake of Woods area, (5) west side of Monument Creek, and (6) upper Eureka Creek.

Pinnacle Creek

Pinnacle Creek is a small eastward-flowing tributary of Lost River. A stream-sediment sample (210, pl. 2) collected at the mouth of Pinnacle Creek contained 22 ppm heavy metals, 11 ppm cold copper, and 8 ppm molybdenum. Four sediment samples (205, 206, 208, 209) from small tributaries in the high basin at the headwaters contained anomalous amounts of cold copper, heavy metals, or molybdenum. Sample 205 from a small rill that emerges from talus on the south side of the basin gave the highest heavy-metal (35 ppm) and cold copper content (22 ppm). Some of the talus blocks show light iron oxide staining along fractures, but not the deeper red-brown staining that marks most disseminated zones. Pyrite and chalcopyrite are common in some of the blocks, and molybdenite is found in places. A chip sample (207) of material from the talus south of sediment sample 205 yielded 1,000 ppm total copper and 200 ppm molybdenum. Although this chip sample did not contain anomalous amounts of lead or zinc, the high heavy-metal content (35 ppm) of the neighboring sediment sample suggests that these metals are present in other nearby rocks.

The anomalies in the other branches of Pinnacle Creek probably represent several other low-grade disseminated deposits. The molybdenum content of the two northernmost branches sampled was higher than that of the southern branch; the reverse was true of copper. Qualitative analysis of the sediment samples and the chip sample also indicates a little gold.

West Side of Lost River

Down the steep east side of the Three Pinnacles, four short tributaries flow eastward into Lost River (fig. 19). All four are narrow V-shaped gullies that in some places are filled with talus and in other places are cut into bedrock. These gullies have several water-falls, and their upper ends and sides are bounded by cliffs. Many samples from these four tributaries have anomalous amounts of cold copper; some also yield anomalous amounts of heavy metals or molybdenum. These high values are not reflected in four samples taken in Lost River near where the tributaries enter. Here, as in the other larger streams, large waterflow quickly dilutes unusual amounts of metals brought in by adjacent tributaries.

The lower parts of the tributaries are in the granite of Monument Peak, and the upper parts are in the plagioclase arkose and argillite sequence that has been metamorphosed by the intruding granite.

Near this contact on the southernmost stream is the Lost River fluorite prospect (loc. 19, fig. 19). Above this prospect, float of a narrow quartz vein containing molybdenite was found. A stream-sediment sample (242) in this same area had 11 ppm cold copper.

About halfway up the second tributary to the north, malachite is exposed on the north wall along seams in metamorphosed arkose containing disseminated sulfides. A chip sample (239) across a narrow seam and its bounding zone of disseminated sulfides had 300 ppm zinc, 2,300 ppm total copper, and 5,000 ppm arsenic (table 1). Several other small seams that contain copper minerals and small irregular disseminated sulfide zones were noted in this area. Stream-sediment samples on two branches of this tributary give slightly anomalous cold copper values along the southernmost branch.

Four stream-sediment samples (234–237) along the third tributary to the north show anomalous cold copper (fig. 19); the downstream two also have anomalous heavy-metal content. A chip sample (231) of highly iron-oxide-stained metamorphosed arkose taken just above the granite contact did not contain anomalous amounts of lead, zinc, or silver. The source of the heavy-metals anomalies evidently lies close to but below the granite–sedimentary rock contact, as the stream-sediment samples above it were negative. The source of most of the cold copper anomaly, however, is in the sedimentary rocks in the cliffs above the sample collected nearest the headwaters, as all the stream-sediment samples yield anomalous amounts of cold copper.

The two sediment samples taken in the headwaters of the fourth tributary to the north have anomalous amounts of cold copper. The copper, like that of the third tributary to the north, must come from cliffs that bound the upper part of this tributary.

In summary, the geochemical anomalies of the four tributaries on the west side of Lost River are moderate in value and are formed in fairly short streams with small flow. This suggests that the copper content of their sources is not high. In the southern part of the area small seams and disseminated zones containing copper minerals and molybdenite have been found, and similar seams and disseminated zones are the probable sources for the other anomalies found in this area.

East Side of Monument Creek

Monument Creek is a major southerly flowing tributary of Lost River. Samples 257 and 304 collected near the mouths of two tributaries west of the Three Pinnacles yielded 11 ppm cold copper (fig. 19). The contact between the granite and the overlying sedimentary rocks crosses the middle and upper parts of these two tributaries.

Two other sediment samples were collected in the southernmost of these two tributaries; one came from a few hundred feet below the contact, and the other, a little above the contact. The lower one (305) had 15 ppm cold copper and the upper one 3 ppm. Along the contact, disseminated pyrite was noted both in the granite and in an adjacent bed of conglomerate. Chip samples of the granite (306) contain 100 ppm total copper, and of the conglomerate (307), 500 ppm. The molybdenum content of the two rocks was 20 ppm and 30 ppm, respectively. These low-grade disseminated zones are the source of the metals found in this stream.

In the northernmost of the two tributaries, three samples were collected from a different branch of this tributary, 1,000–1,500 feet west of the granite–sedimentary rock contact (fig. 19). All three were low in cold copper. Hence, the source of the cold copper anomaly found at the mouth of this tributary is assumed to be in the granite a short distance east of the mouth of the stream. The nearness of the source to the anomalous sample and the relatively low metal content (11 ppm) suggest that the source is small or low grade, or both.

Lake of Woods Area

Along the west side of Monument Creek a tributary drains a high broad basin that contains Lake of Woods, where the source of one of the strongest geochemical anomalies seems to lie buried under glacial deposits. A sample (256) taken near the mouth of this creek yielded 14 ppm heavy metals and 11 ppm cold copper (table 1). Traced upstream, the values point toward several separate sources or to a single fairly large source in the upper basin. A small rill coming out of the upper basin (sample 265) and the outlet of the Lake of Woods (sample 266) contain, respectively, 30 and 90 ppm cold copper, 7 and 35 ppm heavy metals, and 24 and 12 ppm molybdenum. Two samples (267, 268) of the sediment taken along the west shore of Lake of Woods had 45 and 120 ppm cold copper.

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Lake of Woods lies in a basin filled with glacial debris, which covers the slope for about 1,000 feet above the lake. Four samples (269, 271, 272, 273, table 1) were taken from three small rills that cross the glacial debris. They ranged from 45 to 180 ppm cold copper, 40 to >45 ppm heavy metals, and 12 to 120 ppm molybdenum (table 1). Cold copper and molybdenum values were highest on the southernmost rill (fig. 19). Qualitative analysis indicates small amounts of gold in some of these samples. Above the covered slope the main ridge rises abruptly and exposes prominent granite outcrops. Some of the granite is slightly iron oxide stained, but no sulfides were noted. A small rill draining the iron-oxide-stained granite to the west of the area covered by glacial debris had only 1 ppm each of cold copper and heavy metals. Lack of exposures prevents sampling the area due west of the lake, but four other iron-oxide-stained zones were sampled. One sample (270) was from a small outcrop of granite east of the lake; the other three samples (274, 275, 276) represented iron-oxide-stained zones in granite 2,000–3,000 feet south of the lake (pl. 2). None contained anomalous amounts of copper, lead, zinc, or molybdenum (table 1).

These data indicate that the source of the anomalously high metal values is hidden by glacial debris west of the lake. This is one of the highest grade anomalies in a favorable area. Physical exploration or soil sampling might be the best technique to further localize this source.

The anomalies around Lake of Woods all have a considerably higher cold copper content than heavy-metal content; those found in the lower part of the basin generally have a slightly higher heavy-metal content. This change in the metal content probably does not reflect different sources, but probably is due to zinc's traveling farther in solution than copper; thus zinc makes up a greater proportion of metal in those samples collected at greater distances from the source.

West Side of Monument Creek

South of Lake of Woods, two small tributaries that lie east of Pistol Peaks (fig. 19) give geochemical anomalies caused by low-grade disseminated sulfide zones. The north tributary gave a cold copper anomaly that increased gradually upstream from about 20 to 50 ppm (samples 296, 297, 299, table 1). The heavy-metal content is only 7 to 10 ppm and the molybdenum content, 2 to 3 ppm. Most of the country rock is granite, but between the granite and the plagioclase arkose and argillite is a thick dike of quartz diorite (the quartz diorite is mapped together with the granite in fig. 19). For several hundred feet below the granite–quartz diorite contact the granite is sheared and iron oxide stained. Sulfides were not noted, but a sample (298) of this rock had 70 ppm copper and 70 ppm lead. The copper content of these disseminated zones is not large enough to produce the cold copper anomalies found. Hence, the source of much of the copper must be on the steep mountain face above the contact with the sedimentary rock, most likely in one or more disseminated zones.

The south tributary gave 15–20 ppm cold copper and 10–15 ppm heavy metals. The source is probably an iron-oxide-stained zone several hundred feet thick that contains disseminated pyrrhotite and a little chalcopyrite. The zone is in the granite 500 feet below the quartz diorite dike. A sample (301) of this granite with visible disseminated sulfides showed 300 ppm copper and 50 ppm lead, but chalcopyrite in this zone appears to be erratically distributed.

Upper Eureka Creek

A prominent anomaly was found in a small north-flowing tributary of upper Eureka Creek (pl. 3; northwest corner of fig. 19) that drains the north side of Blackcap Mountain. Samples taken at the mouth of this tributary and in Eureka Creek 100 feet below its junction with the tributary contained 11 ppm (sample 324) and 15 ppm (sample 323) cold copper, respectively (table 1). However, a sample from Eureka Creek above this tributary yielded only 4 ppm. Upstream, about 1,400 feet from the mouth of the tributary draining the north side of Blackcap Mountain, a stream-sediment sample (325) contained 50 ppm cold copper, 10 ppm heavy metals, and 15 ppm molybdenum. For 2,000 feet farther upstream, several iron-oxide-stained zones (pl. 2; table 1) are in plagioclase arkose and argillite that have been metamorphosed by the adjacent granite stock and cut by numerous quartz porphyry dikes. Chip samples taken across five altered zones in this area contain widely differing amounts of copper, molybdenum, or silver but no unusual amounts of lead or zinc.

About 500 feet south of stream-sediment sample 325 a 3-foot-wide fault zone that strikes N. 60° W. and dips 50° SW. is exposed in the creek bottom. This fault zone is mainly in arkose but also cuts several quartz porphyry dikes. A sample (326) taken across this fault zone in the arkose had 100 ppm total copper and 50 ppm molybdenum (table 1); a second sample (327), taken across 15 feet of iron-oxide-stained quartz porphyry dike adjacent to the fault had only 50 ppm copper and 5 ppm molybdenum. At the head of the stream, near where the stream emerges from beneath the talus, a 6-foot-wide zone of iron-oxide-stained argillite contains disseminated pyrite and sparse chalcopyrite. A sample (328) taken across it yielded 500 ppm copper and <5 ppm molybdenum. Farther uphill is a 15-foot-wide iron-oxide-stained zone in a quartz porphyry dike. A sample (329) from across this dike contained only 50 ppm copper and 10 ppm molybdenum. Above this dike on Blackcap Mountain is an iron-oxide-stained quartz porphyry dike containing irregular inclusions of metamorphosed arkose 2–4 feet in diameter. These altered inclusions are speckled with disseminated chalcopyrite and a little molybdenite. Fractures are commonly coated with chrysocolla. A sample (330) from across a 4-foot inclusion had >5,000 ppm copper, 50 ppm molybdenum, 30 ppm silver, and 300 ppm tin.

Several small disseminated zones occur in the metamorphosed sedimentary rocks adjacent to the west side of the Monument Peak stock on the north side of Blackcap Mountain. None of those seen appear large enough to warrant economic interest, but larger disseminated zones may occur in the vicinity.

UPPER LEASE CREEK

Plate 3

The headwaters of Lease Creek consist of a fan-shaped group of converging tributaries that drain the north side of Osceola Peak, Mt. Carru, and Mt. Lago. Cold copper anomalies of 7 to 15 ppm were found in the stream-sediment samples from some of these tributaries, and the sources of several of these anomalies were traced. None of the zones tested in this area are of high enough grade to be of economic interest.

This area is underlain by rocks of the plagioclase arkose and argillite sequence that has been intruded by small granodiorite bodies satellite to the Lost Peak stock to the east. Zones of disseminated sulfides, many only 10 to 15 feet across, contain pyrite and minor chalcopyrite. The copper of the stream sediments comes from several disseminated sulfide zones bounding the tributaries. Hence, the copper content (table 1) of most tributaries remains fairly constant (10–20 ppm cold copper) throughout their length. Chip samples of the iron-oxide-stained disseminated zones bounding these tributaries commonly contain 70–150 ppm total copper. At the headwaters of a small tributary draining the northeast side of Osceola Peak, a stream-sediment sample (396) had 150 ppm cold copper, and chip samples (397 and 398) from disseminated zones nearby yielded 500 and 300 ppm total copper, respectively.

ROCK CREEK AREA

Plate 3

Rock Creek, an eastward-flowing tributary of Pasayten River, bisects the Rock Creek stock. Stream-sediment samples from several tributaries of Rock Creek that drain the edge of this granodiorite body contain anomalous amounts of cold copper; some also yielded anomalous amounts of heavy metals and molybdenum. No gold was found in the several samples that were analyzed qualitatively for this element. Samples from two small northwestward-flowing tributaries that drain the west side of the stock also have anomalous amounts of copper. The largest of these was sampled southward for about a mile; the two samples (485, 486) farthest upstream contained 50 and 20 ppm cold copper. Disseminated zones adjacent to these sample sites contain abundant pyrite and a little chalcopyrite. These zones occurred both in the stock and in the adjacent arkose and argillite. About 100 yards west of sample locality 486 at the head of the creek, talus boulders of quartz diorite contain pyrite, chalcopyrite, malachite, and chrysocolla.

Two small southward-flowing tributaries that also drain the west side of the stock contain anomalous highs of 20 and 22 ppm cold copper. Iron-oxide-stained quartz diorite adjacent to these samples appears to be the source of the copper. Along the east side of the stock a sample (491) from a small northward-flowing tributary yielded anomalous amounts of cold copper. Several zones containing disseminated pyrite were found in the quartz diorite in this area.

The deposits in the Rock Creek area do not appear to be of economic significance, because (1) sediment samples do not exceed 50 ppm cold copper and generally are less than 20 ppm and (2) the sulfides, especially chalcopyrite, are sparse in the disseminated zones.

ROBINSON CREEK AREA

Plate 3; figure 32

The Robinson Creek area lies along the northwest side of the Slate Creek mining district. Many veins and mineralized shear zones have been prospected for gold or copper in this area, and although numerous anomalies might be expected, few were found. All 48 stream-sediment samples collected in the area were analyzed for heavy metals, 47 of them for cold copper, and 27 qualitatively for gold.

The only stream sediments with anomalous amounts of heavy metals were found in the headwaters of a tributary south of Midnite Creek, where two (437, 438) of six closely spaced samples contained 11 and 7 ppm, respectively. As these anomalous values are small and the samples were collected near the headwaters of the tributary, the source or sources of this anomalous heavy metal content is likely to be a small vein or sparsely disseminated zinc or lead minerals.

Samples from four parts of the area have anomalous cold copper values (fig. 32). One is on the south side of Devils Peak, where samples (444, 445) from two small tributaries yielded 11 ppm copper. Samples from the second contained 6 and 7.5 ppm copper derived from drainage coming off the ridge on which are several small copper prospects (locs. 30, 31, 32, 33). The third part of the area is on Robinson Creek just southeast of Beauty Creek, where several short tributaries that drain both sides of the valley show small anomalous values (6–7 ppm). The sources of the samples from these three areas do not appear promising, as the anomalous values are low, the maximum distance the copper traveled was less than a mile, the flow of all tributaries was small, and the known copper-bearing prospects are small. The fourth part of the area, near a little tarn to the northeast, is in the headwaters of a small tributary draining a fractured quartz diorite ridge. Short high-grade chalcopyrite veinlets are erratically scattered in the quartz diorite. These veinlets (loc. 25) are described on page 122.

Gold was detected in four of the samples analyzed for this element. One (sample 430) was collected in the headwaters of Beauty Creek; the other three samples (459, 463, 464) came from the central part of Robinson Creek. Although the sample from Beauty Creek, which came from just south of the quartz diorite intrusive, contained detectable gold, four other samples collected downstream from it did not.

With the exception of those samples from below the chalcopyrite veinlets in the quartz diorite near the tarn, the anomalous values in the samples are generally low, even in the headwaters of the streams. These results are substantiated by analyses of adjacent veins and shear zones, which are small in size or show only small amounts of gold, silver, copper, lead, zinc, or molybdenum.

BUCKSKIN RIDGE

Plate 3; figure 37

Buckskin Ridge is a steep-sided mountain between the West and Middle Forks of the Pasayten River. Many of the drainage lines shown in figure 39 are steep scree-filled gullies, and, therefore only a few samples were collected from tributaries draining Buckskin Ridge. Much sediment, however, is carried directly down the steep mountainsides into the West and Middle Forks of the Pasayten River. Interpretation of samples taken from these two rivers is complicated by the fact that more than half the sediment in these two rivers comes from the somewhat larger drainage areas on the west side of the West Fork and the east side of the Middle Fork. Seventeen sediment samples from the two rivers and the tributaries that drain the Buckskin Ridge area (fig. 39) were analyzed either chemically for heavy metals and cold copper or spectrographically for 26 elements, or both. Five of these samples were also qualitatively analyzed for gold. None of these analyses showed anomalous amounts of zinc, lead, copper, silver, or molybdenum. Three of the samples (501, 502, 510), all from the West Fork of the Pasayten River, contained a little gold. The gold in these samples may have come from either side of the river. One of the samples (502), however, came from just below the adits at locality 45.

On Buckskin Ridge eight localities containing veins and shear zones are known. Some veins, like those at locality 45, have few sulfides other than sparse pyrite; others, like the New Hope (loc. 41), contain massive sulfides, mainly pyrrhotite and pyrite. Analyses of the veins and shear zones indicate that they contain little copper, lead, zinc, molybdenum, or silver. Assays from only one small area showed substantial amounts of gold. The lack of geochemical anomalies of heavy metals and cold copper, though due partly to the sparseness of tributaries draining this ridge and partly to the large flow of the two rivers on either side of the ridge, is also the result of the low content of these metals in the veins and shear zones. The qualitative nature of the analysis makes the gold difficult to trace.

JIM PEAK-WINDY PASS AREA

Plate 3; figure 45

The ridge connecting Jim Peak and Windy Pass separates the drainage of the West Fork of the Pasayten River to the east from that of Canyon Creek, Barron Creek, and a tributary of Slate Creek to the west. Barron and Slate Creeks lie wholly outside the wilderness area. Likewise, numerous gold mines and prospects of the Slate Creek mining district lie outside the area. No known production has come from within the wilderness area, but 10 prospects dug on veins or shear zones (figs. 45, 46) were examined. Nineteen sediment samples were taken within the wilderness area from the West Fork of the Pasayten River, Canyon Creek, and the tributaries draining into them from the Jim Peak–Windy Pass ridge. Iron-oxide-stained disseminated sulfide zones are common in this area, and 13 chip samples were collected from them.

Though no anomalous stream-sediment samples were found on either of the major streams, one sample from a tributary on the east side of the ridge, from an area below the Ptomigan prospect (loc. 56, fig. 45), contained 9 ppm heavy metals. A qualitative analysis of one sample (511) from a tributary that drains the east side of Tamarack Peak contained gold. Of the seven stream-sediment samples collected from tributaries draining the west side of the Jim Peak–Windy Pass ridge, only two (581, 584) had anomalous amounts of heavy metals and cold copper. Sample 581 yielded 9 ppm heavy metals and 11 ppm cold copper. It came from a tributary that drains the west side of the ridge directly downslope from a mineralized shear zone at locality 48. Sample 584 yielded 20 ppm heavy metals and 45 ppm cold copper. It was collected at the mouth of a small tributary that drains the ridge a little south of Jim Peak. At its headwaters this tributary splits into three branches. From this junction a zone of iron-oxide-stained arkose and argillite that trends N. 60° E. and lies parallel to a well-developed joint set can be traced down the creek for 600 to 800 feet. It is generally 6 to 8 feet wide but in the westernmost part thickens to 20 feet. In part, the zone is heavily stained with iron oxide, but in the upper part, where erosion has been rapid, only a little staining was noted. The zone contains finely disseminated pyrite and locally thin pyrite veinlets. Four chip samples (585, 586, 587, 588, table 1) of this zone were taken: one (588) from across the entire 6-foot zone at the tributary junction; the second (587) from across an arkose bed 200 feet lower and to the west; the third (586) from the same locality but in black argillite; and the fourth (585) from near the west end of the zone, where it widens to 20 feet. These four samples had small amounts of copper, ranging from 20 to 100 ppm, but no measurable gold. Other small disseminated zones and veins (loc. 50) occur in the northernmost of the tributary's three small branches. The anomalous copper values obtained in this area appear to have come both from the low-grade disseminated sulfide zone and from the many smaller low-grade zones and veins at locality 50.

A group of disseminated sulfide zones from less than a foot to several hundred feet wide is clustered on the north and east sides of Tamarack Peak (pl. 3). Two of the zones near the top of Tamarack Peak contain anomalous amounts of copper. One consists of widely scattered spots of heavily iron-oxide-stained rock in apparently unaltered arkose. A sample (528) cut across one of these small iron-oxide-stained areas had 3,000 ppm copper, 70 ppm molybdenum, and 15 ppm silver (table 1). At the other, a small 2-inch-wide sheared zone contains disseminated sulfides and has a thin coating of malachite or azurite on some of the fractures. A sample (529) cut across this thin sheared zone yielded 2,000 ppm copper, <2 ppm molybdenum, and 1 ppm silver. The other four samples from wider disseminated zones have from 20 to 70 ppm copper, <2 ppm molybdenum, and <1 ppm silver.

Three disseminated zones along the east side of Canyon Creek (pl. 3) contain from 100 to 700 ppm copper (582, 583, 589).

HEADWATERS OF CANYON CREEK

Plate 3

Sixteen sediment samples were collected on Canyon Creek and its tributaries from just west of Holman Pass downstream into the Jim Peak–Windy Pass area. Here Canyon Creek is bounded by steep valley walls that rise to ridges 2,000–3,000 feet above the creek. Six of these samples had slightly anomalous amounts (7–11 ppm) of heavy metals or cold copper, or both. As the anomalous values are small and all came from small tributaries not more than a mile long, the sources of the anomalous metal content are probably low grade or small in size, or both.

CANYON CREEK AREA

Plate 3; figure 53

The Canyon Creek area lies southwest of the Jim Peak–Windy Pass area. The samples discussed in this section came from ridges and tributaries on the northwest side of Canyon Creek. The two principal tributaries in this region are Cascade Creek and the North Fork of Canyon Creek. In the upper part of Cascade Creek is the old Anacortes gold mine (loc. 59, fig. 53). Several old gold placers lie along Canyon Creek below Chancellor. Zones of disseminated sulfides are common, especially along Canyon Creek below its junction with the North Fork of Canyon Creek. Within this area 14 stream-sediment samples and 13 chip samples from disseminated zones were collected.

Anomalous amounts of cold copper were found in samples taken at the mouths of Cascade Creek (6 ppm) and the North Fork of Canyon Creek (11 ppm). Stream-sediment samples collected above Cascade Creek on the North Fork of Canyon Creek and on Cascade Creek, three-fourths mile west of its mouth showed no anomalies. Several iron-oxide-stained disseminated zones are exposed on the west side of the North Fork of Canyon Creek below the mouth of Cascade Creek. Samples (565, 566) of two of these zones yielded 150 and 50 ppm total copper. Three samples that had cold copper anomalies were collected from small tributaries draining the northwest side of Canyon Creek. Two of them (597, 598), containing 20 ppm cold copper, drain areas in which are large disseminated zones. Two samples (599, 600) from adjacent iron-oxide-stained zones contain 150 and 200 ppm total copper. The third anomalous (15 ppm) cold copper sample (601) was taken on a small tributary of Canyon Creek just below the adit of the Minnesota mine (loc. 68, fig. 53). Similar disseminated zones are also common along Canyon Creek above Chancellor. Six samples from these zones contain from 70 to 300 ppm total copper. Most of the copper in this area occurs in low-grade zones of disseminated sulfides; very little copper occurs in the veins. Most of the samples from the disseminated zones had no detectable gold; one sample (593) had 0.02 ounce per ton.

Heavy-metal anomalies were found just below the adit of the Minnesota mine (15 ppm) and in the headwaters of a small tributary on the south side of Cascade Creek (10 ppm). The source of the latter anomaly is not known.

The veins in this area are principally gold-quartz veins. Pyrite is generally the only sulfide mineral present. Veins of this type are not likely to be found by geochemical sampling for associated metals such as copper, zinc, lead, molybdenum, and arsenic.

LOWER CANYON CREEK AREA

Plate 3

The Lower Canyon Creek area lies downstream from the Canyon Creek area, between the mouths of Boulder and Granite Creeks. In the east half, Canyon Creek has cut cliffs in black argillite and a few beds of arkose. Iron-oxide-stained disseminated zones 10 to more than 300 feet wide are numerous. Pyrite is the principal sulfide. Three adits and a trench have been dug into three of these zones at localities 72, 73, and 74 (pl. 3). Ten chip samples were taken of the disseminated zones and 13 sediment samples from tributaries draining into Canyon Creek. Samples of the disseminated zones had from <5 to 200 ppm total copper (table 1). Anomalous amounts of lead, zinc, molybdenum, or silver were not found. Two samples (606, 613) yielded 0.003 ounce of gold per ton; the others did not contain any detectable gold.

Seven of the sediment samples were collected from the lower parts of the tributaries, six from the upper parts. Five of those collected from the lower parts had anomalous amounts of cold copper, ranging from 7 to 20 ppm. None of those from the upper parts contained anomalous amounts of cold copper.

Anomalous stream-sediment samples in the Lower Canyon Creek area probably are due to nearby zones of disseminated sulfides. Copper is the only metal of potential interest in the numerous disseminated zones, but its content seems too low to have commercial possibilities.

MIDDLE CREEK

Plate 3

Middle Creek is a northerly flowing tributary of Cinnamon Creek about 6 miles east of Ross Lake. It cuts rock of the plagioclase arkose and argillite sequence. A stream-sediment sample (673) at its mouth had 9 ppm heavy metals, 3 ppm cold copper, and 2 ppm molybdenum. An additional 20 sediment samples and four chip samples of disseminated zones were taken along this creek. Twelve of these samples had anomalous amounts of heavy metals, and seven also had anomalous amounts of cold copper. Tributaries that flow into both the east and west sides of Middle Creek contain anomalous amounts of heavy metals. Samples (675, 684) from two tributaries that flow into the east side of Middle Creek yielded the largest amounts of heavy metals (>50 and 50 ppm) and cold copper (20 and 20 ppm). The two heavy-metal anomalies were traced upstream; these anomalies were due mainly to zinc in disseminated sulfide zones.

The northernmost of these two tributaries leads to a steep basin about a mile to the southeast. The basin is densely vegetated, and much of it is covered with talus. Iron-oxide-stained disseminated zones form much of the north half of the basin. These zones have a general northwest strike and a steep northeast dip. A sample (678) from a small tributary that drains the northern part of the basin had 20 ppm heavy metals, 3 ppm cold copper, and 3 ppm molybdenum; one (676) from a tributary that drains the eastern part of the basin had >50 ppm heavy metals, 10 ppm cold copper, and 2 ppm molybdenum (table 1). Samples (679, 680) from two small altered zones exposed along the tributary that drains the northern part of the basin yielded 50 ppm total copper, <10 ppm lead, and <200 ppm zinc. Float of iron-oxide-stained breccia consisting of argillite and arkose fragments cemented by quartz from the head of the tributary that drains the eastern part of the basin (sample 677) yielded 700 ppm zinc, 50 ppm lead, and 30 ppm copper. Some iron-oxide-stained zones extend to the ridge bounding the east side of the basin, but in most the staining is light. A sample (681) from one of these zones did not yield anomalous amounts of zinc, lead, copper, molybdenum, or silver. All samples of altered rock were analyzed for gold; none was found.

The southernmost of the two tributaries that enter Middle Creek from the east also heads in a steep basin about a mile to the southeast, where it divides into three branches. A stream-sediment sample (685) collected just above the junction of the middle one contains 100 ppm cold copper, 20 ppm heavy metals, and 2 ppm molybdenum. In the streambed above this sample is a small exposure of iron-oxide-stained breccia of argillite and arkose cemented by quartz that contains abundant pyrrhotite, some pyrite, and a little chalcopyrite. A sample of this breccia (685a) yielded 1,500 ppm total copper, >200 ppm zinc, 30 ppm lead, and 5 ppm silver. A second source of heavy metals between the mouth of this tributary and the upper basin is suggested by the higher heavy-metals anomaly that occurs in the sample (684) collected at the mouth of the tributary.

The rocks of the Middle Creek drainage basin contain many iron-sulfide-bearing disseminated zones, some of which are brecciated. These zones are believed to be the source of the anomalous metal content found in the stream sediments on Middle Creek.

BOUNDARY CREEK AREA

Plate 3; figure 62

A hornblende diorite stock underlies an area of a little more than a square mile between Boundary Creek and Lightning Creek; a satellite body is exposed about half a mile to the west along Lightning Creek. Parts of the stock and the surrounding plagioclase arkose and argillite are silicified and iron oxide stained from weathering of disseminated sulfides. Sediment samples collected from streams draining this area showed a number of anomalies.

Ten of the stream-sediment samples (706, 707, 709, 710, 726, 727, 728, 731, 732, 733) contained anomalous amounts of heavy metals; four (709, 710, 726, 727) also contained anomalous amounts of cold copper; and one (732) contained an anomalous amount of molybdenum (table 1).

Four chip samples (711, 712, 713, 714) were taken from the ridge at the northwest end of the stock, and five chip samples (715, 716, 717, 718, 719) were taken from a large iron-oxide-stained zone on the west-facing slope of a north-flowing tributary of Boundary Creek. These samples had 70–500 ppm total copper. Three of them (712, 713, 714) yielded 70 to 150 ppm cobalt; four (713, 714, 715, 719), 15 to 70 ppm molybdenum; and one (717), 1,000 ppm zinc. All samples were also analyzed for gold; the only gold detected was in five samples (715–719) from the area that bounds the tributary to Boundary Creek. Nine of the 10 stream-sediment samples were several times higher in heavy metals than in cold copper. This preponderance of heavy metals over cold copper is probably due primarily to zinc and, to a somewhat lesser extent, to cobalt. Although zinc was reported in only one of the spectrographic analyses of the iron-oxide-stained rock, the sensitivity of this analysis is 200 ppm and only a large anomaly of zinc would be detected.

The stream sample that had the highest metal content came from a small seep at the base of a talus slope about 500 feet below a small adit (loc. 85, fig. 62). This sample (709, pl. 3; table 1) had 200 ppm heavy metals and 300 ppm cold copper. A sample (710) from another small tributary several hundred feet southwest yielded 30 ppm heavy metals and 7 ppm cold copper. These small tributaries drain a large iron-oxide-stained zone extending to the ridge above. Pyrite is common throughout this zone, and in one place sphalerite was recognized. Five chip samples (715, 716, 717, 718, 719) taken across this zone contained 100–500 ppm total copper, $<$200–1,000 ppm zinc, $<$5–70 ppm molybdenum, and 0.03–0.3 ppm gold. Metal values appear to be quite erratic. The high cold copper value obtained from the stream-sediment sample (709) probably was derived at least in part from a more copper-rich part of this zone than the part sampled by us. Further exploration of this area may disclose its location.

Four samples (726, 728, 731, 732) from westward-flowing streams that drain the ridge east of Lightning Creek contain 10–30 ppm heavy metals. One (726) also had anomalous cold copper (10 ppm), and one (732), anomalous molybdenum (7 ppm). Two other samples (706, 707) from southeastward-flowing streams that drain the southeastern part of the stock are somewhat lower in metal content, having 10 and 7 ppm heavy metals.

The results of the mapping and sampling indicate that zones of disseminated sulfides occur in and adjacent to the hornblende diorite stock. These zones in places contain anomalous zinc, copper, molybdenum, gold, and cobalt. The metal content of the disseminated zones tested was low and somewhat erratic, but the concentration of the disseminated zones in this area and the high metal content of one sediment sample suggest that other disseminated zones may have a higher metal content.

HOZOMEEN MOUNTAIN

Plate 3

Hozomeen Mountain lies just west of the Boundary Creek area and consists of two prominent peaks connected by a high saddle. This mountain is carved principally in rocks of the Hozomeen Group of Cairnes (1944) that here are mainly greenstone with some interbedded chert, argillite, marble, and quartzite. A small quartz diorite stock has been intruded along the southeast side of Hozomeen Mountain (fig. 7), metamorphosing the country rock. An eastward-trending ridge that crosses the south end of this intrusive exposes a heavily iron-oxide-stained zone for at least 3,500 feet. Although this altered zone is exposed on both sides of the intrusive, most of it lies to the east. This zone contains disseminated sulfides. Pyrrhotite is the most common sulfide; pyrite is found in some places; and chalcopyrite was seen in a few places. Four samples were taken along this ridge. Two samples (734, 735) taken adjacent to and on either side of the intrusive yielded 100 and 150 ppm total copper (table 1). Two samples (736, 737) taken farther east on the ridge had 100 ppm copper. All these samples were low in zinc, lead, molybdenum, and silver.

Four sediment samples (725, 729, 738, 739) were collected at the mouth of tributaries that drain this area. They yielded 2–10 ppm cold copper and 7–30 ppm heavy metals. The cold copper and perhaps the heavy-metal anomalies found in the stream sediments could have been derived from the big disseminated zone just described.

LOWER LIGHTNING CREEK

Plate 3

Eight stream-sediment samples were taken from Lightning Creek and its tributaries below its junction with Three Fools Creek.

The major tributary is on the north side of Lightning Creek about 1 mile southwest of the mouth of Three Fools Creek. This area is in the Hozomeen Group. A sample (753) collected here from a small tributary less than an inch deep contained 300 ppm cold copper, 30 ppm heavy metals, and 2 ppm molybdenum. One hundred feet vertically above this sample site this tributary emerges from beneath talus that covers the steep slopes. A field test made on a second small tribuary a few yards to the west showed 60 ppm cold copper. A small outcrop of argillite exposed through the talus near this sample site contains disseminated pyrite. A soil sample (751) of limonitic greenstone yielded 100 ppm total copper. A small rill that drains outcrops above the talus yielded <1 ppm cold copper and 10 ppm heavy metals. A small zone of disseminated sulfides in this area had 100 ppm total copper. The source of the high copper in the sample taken at the mouth of the tributary apparently lies hidden under the talus in the lower part of the slope.

A second, lesser anomaly of 20 ppm (sample 755) cold copper was obtained from a tributary on the north side of Lightning Creek about 2,300 feet above its mouth. This tributary was but a trickle that drained the central part of the greenstone mass. Its source (or sources) is most likely one or more small disseminated zones.

JACK MOUNTAIN AREA

Plate 3

This area extends along the east side of Ross Lake. It consists mainly of a thick sequence of greenstone that is faulted against phyllite along its southwest side. Shearing occurs on both sides of the fault. Scattered in this zone of shearing are many small zones of disseminated sulfides a few feet to several hundred feet long and less than a foot to about 100 feet wide. In the greenstone these zones are generally irregularly shaped, but in the phyllite they are generally tabular. Pyrrhotite is the most common mineral in most places; pyrite, in some. Chalcopyrite has been noted in a few places. Small irregular quartz veins are also found in the greenstone. Some of these veins do not contain visible sulfides, but in some, scattered sulfides, chiefly pyrite, can be noted.

Most of the anomalous samples were collected in the May Creek–Roland Creek and Crater Creek areas.

May Creek-Roland Creek Area

This area drains the west side of Jack Mountain. Disseminated zones are irregularly distributed in the area. Just below the glacier at the head of May Creek and on the cirque wall (fig. 17) to the east, small disseminated zones are common. Four of the zones that were sampled (642, 643, 645, 647) contain 500, 200, 10, and 300 ppm total copper, respectively. Three stream-sediment samples were taken from tributaries draining various parts of the cirque. Two (644, 646), from tributaries draining the eastern and southeastern parts of the cirque, had 20 and 50 ppm cold copper and 15 and 10 ppm heavy metals. The third, from a tributary draining the southwest side of the cirque, yielded only 5 ppm cold copper and 3 ppm heavy metals; disseminated zones were not observed along this tributary. Two other stream-sediment samples (648, 649) were taken from the lower part of May Creek. Each contained 50 ppm cold copper and 10 ppm heavy metals. The consistency of the metal content of these samples down the length of the stream, despite an increase in flow, points toward continued additions of metals to the stream system; that is, copper and other heavy metals are probably derived from many small disseminated zones scattered along the drainage basin of this stream.

Four small streams between May and Roland Creeks were sampled. Three samples had a low cold copper content, but the fourth (766) contained 10 ppm cold copper. Samples also were taken at least a mile above the mouths of the two longest streams. These two samples (767, 768) had 10 and 15 ppm cold copper; this represents at least a fivefold increase over the content in samples taken at their mouths and indicates that the metal content of the sediments has been diluted downstream by addition of material with low metal content. As the streams are small here and the distance to their headwaters is short, the source of the copper is probably small or low grade, or both.

Along most of its course Roland Creek crosses phyllite. Seven sediment samples from along 1.7 miles of its length contained 15–20 ppm cold copper and 10–30 ppm heavy metals. The uniformity of the metal content of these samples along a stream of constantly increasing flow suggests multiple sources. Four disseminated zones 100–400 feet long and as much as 50 feet wide were sampled along the main stream. The samples (631, 633, 635, 638) yielded 10–200 ppm total copper. Sample 631 also contains 3,000 ppm nickel.

Crater Creek Area

A suite of 16 samples was collected over a distance of 4.5 miles along Crater Creek and its tributaries. The metal content of these samples ranged from 1 to 20 ppm cold copper and from 1.5 to 20 ppm heavy metals. On most samples the cold copper content exceeded the heavy-metal content by at least 2 to 1. No particular distribution pattern of the metal content was noted in samples from various parts of this drainage basin. Samples collected along the main stream contained 3–20 ppm cold copper; those from tributaries that drain the west side of the basin, 1–20 ppm cold copper; and those from tributaries that drain the east side of the basin, 3–20 ppm cold copper. The erratic distribution of high and low metal content found in Crater Creek and its tributaries points to numerous small scattered sources.

AEROMAGNETIC INTERPRETATION

By GORDON P. EATON and MORTIMER H. STAATZ

In September 1968 the U.S. Geological Survey flew an aerial magnetic survey of the entire study area. The aeromagnetic data compiled from these results are shown on the geologic map (pl. 1). Direct correlations occur between the magnetic data and several of the rock types; these are briefly described below. Inasmuch as no laboratory study of rock properties was made, the following description is based entirely on magnetic relations apparent from the map.

The magnetic patterns shown on plate 1 vary, like the geology, on either side of the Eightmile Creek fault. The more heterogeneous metamorphic and plutonic rock units east of the fault are characterized by many positive and negative anomalies at least 1 mile across with appreciable magnetic relief. The more homogeneous rocks west of the Eightmile Creek fault are characterized by the regional gradient of the earth's main magnetic field interrupted by several positive anomalies associated with quartz diorite intrusives and some of the more mafic volcanic rocks.

The irregular magnetic pattern east of the Eightmile Creek fault is attributed partly to the absence of large areas of nonmagnetic rocks which provide stark magnetic contrasts with more magnetic rocks, and partly to the compositional variations in the two largest units: (1) the quartz monzonite, granodiorite, and quartz diorite, and (2) the granodiorite gneiss complex of the Quartz Mountain area. The largest positive anomalies are in the northwest and northeast corners. The highest anomaly to the northwest is centered on the Canadian border, 2 miles northwest of Sheep Mountain. This anomaly—650 gammas—is underlain by the hornblende gneisses of the Sheep Mountain area, the most mafic rocks in the area. This unit, however, cuts across the magnetic high, and the east end lies along the northwest side of a well-defined magnetic low. The lack of correspondence between the eastern part of the hornblende gneisses and the magnetic pattern could be due to the presence of less magnetic minerals in the eastern part or to an abrupt eastward thinning of the hornblende gneisses. The presence of numerous dikes derived from the adjacent quartz monzonite, granodiorite, and quartz diorite unit in the hornblende gneisses of the Sheep Mountain area to the east makes this rock less magnetic and suggests that this area is near the lower edge of the hornblende gneisses.

The highest anomaly in the northwestern part of this area is surrounded by several other anomalies of high amplitude and short wavelength. These anomalies are underlain by the granodiorite gneiss complex of the Quartz Mountain area. The granodiorite gneiss complex, though predominantly a hornblende-biotite granodiorite gneiss, includes some hornblende gneiss, and lesser amounts of hornblende biotite quartz gneiss, biotite quartz schist, and pyroxene-quartz gneiss. The diverse character of this unit is reflected in the magnetic pattern. A small intrusive of Ashnola Gabbro intruded the granodiorite gneiss complex in the eastern part of the area. This gabbro lies on the steep flank of a positive magnetic anomaly. Depth estimates on the anomaly indicate that the source could be as much as 1,000 feet below the surface. Thus, the exposures of gabbro could represent only the higher part of a larger body, and this rock type could be in part responsible for the high magnetic anomalies in this area.

In the northeast corner of the study area two positive magnetic anomalies connected by a ridge form a rough hourglasslike pattern. The extent of this anomaly corresponds roughly with the gneissic quartz diorite of the Middle Fork of Toats Coulee Creek. The center of the southern positive anomaly, however, lies about 1 mile to the east of the east border of the gneissic quartz diorite. This offsetting of the center of the anomaly to the east of the exposed gneissic quartz diorite suggests that this rock thickens to the east beneath a cover of the less magnetic quartz monzonite, granodiorite, and quartz diorite unit.

The greater part of the rest of the mapped area east of the Eightmile Creek fault is underlain by the quartz monzonite, granodiorite, and quartz diorite unit (pl. 1). The rocks in this unit vary in composition from place to place, and these changes in composition may well be responsible for much of the variable character of the magnetic pattern.

Several distinct positive anomalies occur west of the Eightmile Creek fault. A prominent northwest-trending magnetic ridge underlain by the volcanics of Billy Goat Mountain lies adjacent to the west side of this fault. This magnetic field is typical of that of a steeply dipping tabular body having relatively high susceptibility. The gross form of this anomaly is essentially the same from the south end of the area to where these volcanics are overlain by the

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less magnetic volcanics of Island Mountain to the north. North of the volcanics of Island Mountain the magnetic ridge is virtually absent. This diminution and loss of signature result partly from the northward thinning of the volcanics of Billy Goat Mountain, partly from the overriding effect of the steep magnetic gradient associated with a strong positive anomaly overlying the western part of the granodiorite gneiss complex of the Quartz Mountain area, and perhaps partly from decreased magnetic susceptibility of the volcanics. The steep-flanked magnetic low at the south edge of the map area probably is due to reversed polarization, a common feature of volcanic rocks of mafic and intermediate composition. The only apparent anomalous feature on this magnetic ridge is the northeast-trending high over Billy Goat Mountain itself. The trend of this subsidiary high is nearly perpendicular to the outcrop belt of the volcanics, as well as to the axis of the principal magnetic anomaly. A crude depth estimate suggests that the top of the anomaly source is close to the top of Billy Goat Mountain; if so, the rock mass causing it must be part of the volcanic unit itself, rather than a different rock unit.

The two most conspicuous anomalies west of the Eightmile Creek fault overlie the quartz diorite Rock Creek stock and the Pasayten dike. The anomaly over the Pasayten dike is principally over its northwest half, where it is as much as 300 gammas. This anomaly is only about 40 gammas over the southeast end of the Pasayten dike. This change in the magnetic pattern over the intrusive may be due either to a change of magnetic susceptibility of the rock or to a thinning of the intrusive to the southeast. Three subtle magnetic features associated with this large dike suggest possible extensions of the surface of this body at depth: (1) a plunging magnetic nose that trends westward from the Pasayten Peak to a point 1½ miles west of Center Mountain, (2) a somewhat more subtle nose that trends southwestward from Pasayten Peak through Tamarack Peak, and (3) a closed magnetic high of low amplitude, trending northwestward, in the Devils Peak–Robinson Mountain area. The last feature is associated with small exposures of quartz diorite that probably represent a cupola of a larger body at depth. Alternatively, this latter anomaly might in part be due to the red-bed and volcanic sequences of the Midnight Peak Formation, which are exposed here, although there is no anomaly over similar rocks exposed to the south.

We had previously thought (Tabor and others, 1968, p. C46) that the Rock Creek stock and Pasayten dike were connected at depth. The sharp valley between the positive magnetic anomalies overlying the Rock Creek stock and the Pasayten dike suggests that the two are not connected, unless the connection is quite deep.

Somewhat less conspicuous is an east-northeast-trending anomaly in the northwest corner of the study area, which crosses four separate exposures of intrusive rock. To the west, along the east side of Ross Lake, exposures of quartz diorite were the easternmost known outcrops of the Chilliwack batholith. Another small stock of quartz diorite is also exposed on Hozomeen Mountain near the center of the anomaly, and two hornblende diorite intrusives occur near the east end of the anomaly. This latter rock type is rather rare east of Ross Lake but is quite common west of it, where similar rock is a mafic facies of the Chilliwack composite batholith. The anomaly probably reflects the presence of a large pluton at very shallow depth consisting of rocks with a composition like that of a quartz diorite or diorite. This pluton is thought to be an eastward extension of the Chilliwack batholith. The magnetic data seem to support this interpretation, for the elongate east-northeast-trending positive anomaly appears to be an eastward extension of a large positive feature centered west of Ross Lake.

Three other plutonic bodies west of the Eightmile Creek fault that have a more siliceous composition have only a weak magnetic expression. These bodies, which range in composition from hornblende-biotite granodiorite to biotite granite, are the Castle Peak, Lost Peak, and Monument Peak stocks. Their magnetic expression consists of broad magnetic noses that project in a southerly or westerly direction down the regional gradient. If this regional gradient were removed, the anomalies would appear as broad magnetic highs with closures of only 20 gammas or so. The magnetic data over the various plutons seem to reflect compositional contrasts between them. All three have positive magnetic expression, but their amplitudes, which reflect major differences in magnetic susceptibility, are strikingly different.

A small broad anomaly occurs just east of the south end of Ross Lake beneath Jack Mountain and Crater Mountain. Small intrusives of serpentine are exposed in various parts of this area (mostly too small to be shown on pl. 1). As these rocks commonly contain magnetite, a larger buried intrusion of this rock could be the cause of this anomaly.

The rest of the western area is, apart from the southwest-sloping regional gradient, nearly featureless, magnetically speaking, which reflects the nonmagnetic character of both the areally extensive plagioclase arkose and argillite sequence and the Hozomeen Group of Cairnes (1944).

The aeromagnetic survey, though of considerable aid in making geologic correlations, was of little direct use in locating unknown mineral deposits in this area. Veins are too small to be located by this type of survey. Large disseminated deposits in many districts in the Western United States are associated with plutons having magnetic anomalies like those of the Rock Creek stock and the Pasayten dike. The magnetic anomalies in the Pasayten Wilderness, however, lack adjacent magnetic lows that characterize extensive rock alteration associated with mineralization.

MINES AND PROSPECTS

Claims have been recorded in the Pasayten Wilderness area since about the 1880's. Most of the prospecting was done prior to 1920, and since that time exploration pits have sloughed in, tunnels caved, trees grown up, and claim posts rotted away. Hence, in many areas in which claims were located we were unable to find any sign of their existence. Not all the claims were found or recognized because of vaguely recorded location descriptions or lack of recognizable discovery work. In some areas where we found prospect pits we are uncertain as to what claim they are on. It was particularly difficult to find claims in the western part of the study area because of dense vegetation.

To simplify the following descriptions, each prospect or locality is given a locality number, which is followed by the name of the claim, if known. All mineralized veins and shear zones were sampled, and all that were found are described in following parts of the report.

HORSESHOE BASIN AREA

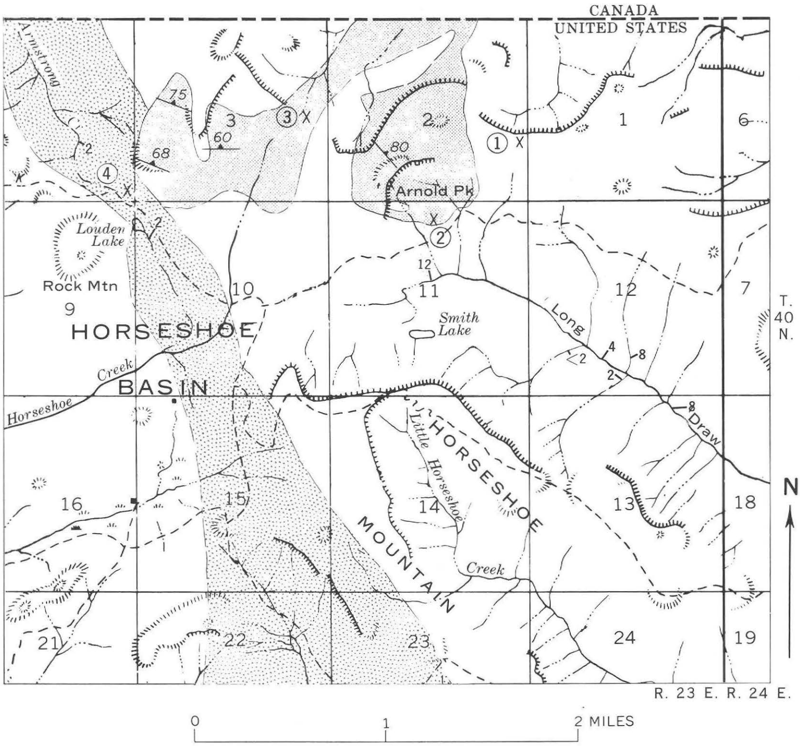
Four properties (fig. 20) were located for gold and molybdenum on the north side of Horseshoe Basin in and adjacent to roof pendants of metamorphic rocks surrounded by younger granitic rocks. All lie along the north side of the basin, and the only workings are trenches and small cuts.

LOCALITY 1 (CALEDONIAN CLAIM)

Locality 1 (fig. 20) is on a black andesite porphyry dike cutting light-tan quartz diorite. No workings were noted, but, according to the discovery notice on the dike, the property is the Caledonian mining claim located on July 1, 1939, by E. J. Doherty. According to records, the Caledonian claim is a relocation of the Windy Pass claim. The dike is 12 feet wide, and can be traced for about 200 feet north of the discovery notice. It strikes N. 4° W. and dips 86° SW. The dike consists of small phenocrysts of hornblende and plagioclase set in a glassy matrix. No sulfides or signs of alteration were noted.

LOCALITY 2 (HORSESHOE BASIN CLAIMS)

Locality 2 comprises Horseshoe Basin No. 1 and No. 2 claims on the southeast side of Arnold Peak (fig. 20). These claims were located



EXPLANATION

CRETACEOUS

Quartz monzonite, granodiorite, and quartz diorite

PRE-CRETACEOUS

Gneissic quartz diorite

Plagioclase-hornblende-biotite, hornblende-quartz-augite, and quartz-biotite feldspar gneisses

Contact
Dashed where approximately located

68
Strike and dip of foliation

④ X
Prospect locality and number

4
Stream-sediment sample
Showing parts per million molybdenum

Trail

Cliff

Figure 20.—Location of prospects and general geology in the Horseshoe Basin area. Base from U.S. Forest Service planimetric map, 1955.

by Paul Loudon, Robert Curtis, and Loy McDaniels, all of Loomis, Wash., in July 1951 (Purdy, 1954, p. 46–47). The principal workings (fig. 21) consist of three opencuts, the largest of which is 16 feet long and 10 feet wide, and has a depth of about 12 feet at the back. These workings are on an irregular pegmatite that contains molybdenite. The pegmatite is exposed for 110 feet and ranges in width from about 1 to 7.5 feet. This rock is made up mainly of perthite and quartz and a little fine-grained biotite. Molybdenite and pyrite are erratically scattered through it. Molybdenite was seen only in the central and northern cuts (fig. 21), where it occurred in the wider

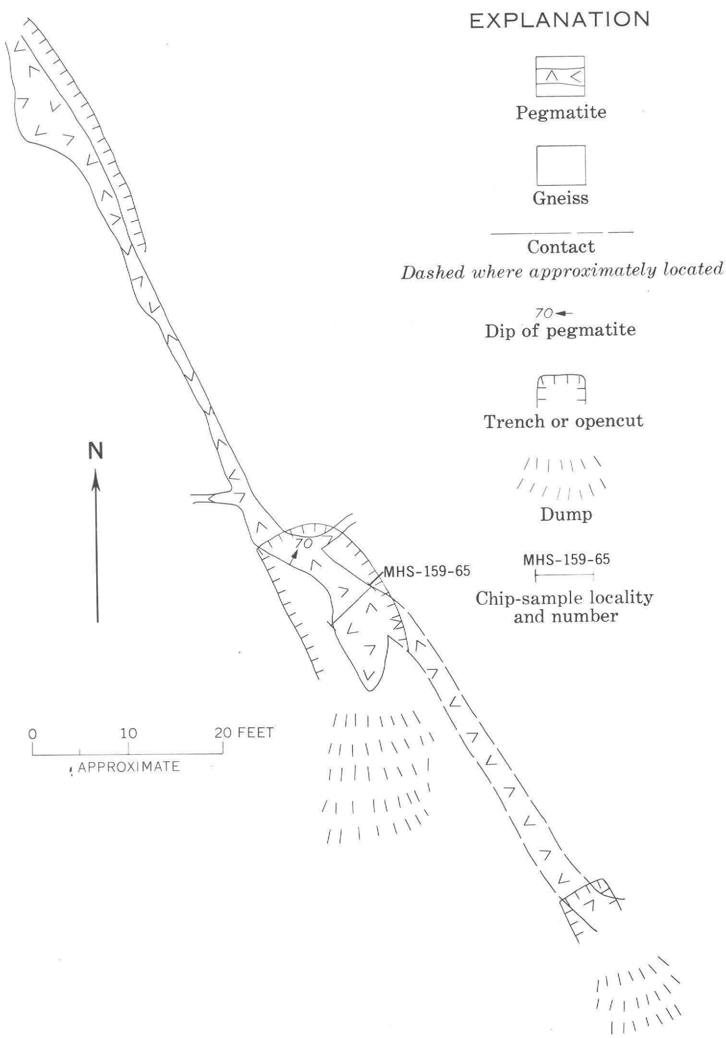


FIGURE 21.—Horseshoe Basin property (loc. 2).

parts of the pegmatite in narrow lens-shaped areas a few feet long. One 6-foot chip sample was taken in the central pit (fig. 21). This sample (MHS–159–65, table 2) contained only 0.039 percent molybdenum. The molybdenum is concentrated principally in the central part of the pegmatite. Copper content of 0.039 percent in this sample may be due to chalcopyrite.

A few specimens on the dump contained at least several percent molybdenum. An assay from this property containing 1.12 percent MoS_2, or 0.67 percent molybdenum, was reported by Huntting (1956, p. 270).

The molybdenum-bearing pegmatite is intruded near the edge of a roof pendant of gneiss (fig. 20), which, near the pits, consists principally of plagioclase, hornblende, and biotite, but farther west is made up of quartz, hornblende, and augite. The roof pendant is surrounded by a large quartz monzonite body. In places dikes of quartz monzonite also cut the gneiss. Several other similar-appearing perthite-quartz pegmatites occur in the vicinity of the pegmatite described above. Purdy (1954, p. 48) reported that some molybdenite had been found in a pegmatite about 300 feet northwest of the central pit shown on figure 21. Emmett Smith (oral commun., 1965), a local sheepherder, found a piece of pegmatite float containing molybdenite on a ridge about 1,000 feet west of the central pit. Other molybdenite-bearing pegmatites could probably be found in this same area. A few pounds of molybdenite can probably be produced from some of the higher grade lenses within the pegmatites.

Because of their small size, generally low molybdenum content, and erratic distribution of the molybdenum minerals, the deposits have no economic potential under present conditions or in the foreseeable future.

LOCALITY 3 (MELA NO. 7 AND MELA NO. 8 CLAIMS)

Two partly caved trenches at locality 3 cross a quartz vein (fig. 22). New claim posts indicate that the trenches are on the Mela No. 7 and Mela No. 8 claims located by J. Healan on July 21, 1965. As the trenches were dug many years ago, these claims are evidently a relocation of an earlier claim or claims. The two trenches are approximately 450 feet northeast of the saddle on the west side of Arnold Peak. The country rock is a dark-green finely banded gneiss that consists principally of hornblende, quartz, and augite. Although the quartz vein was not observed in the trench, float indicates that the vein trends about N. 50° E. and is at least 30 feet long. Pieces of vein material on the dump indicate that at least part of the vein was 1 foot wide. The vein is more than 99 percent white opaque quartz; it is in part vuggy. The quartz has many irregular fractures stained

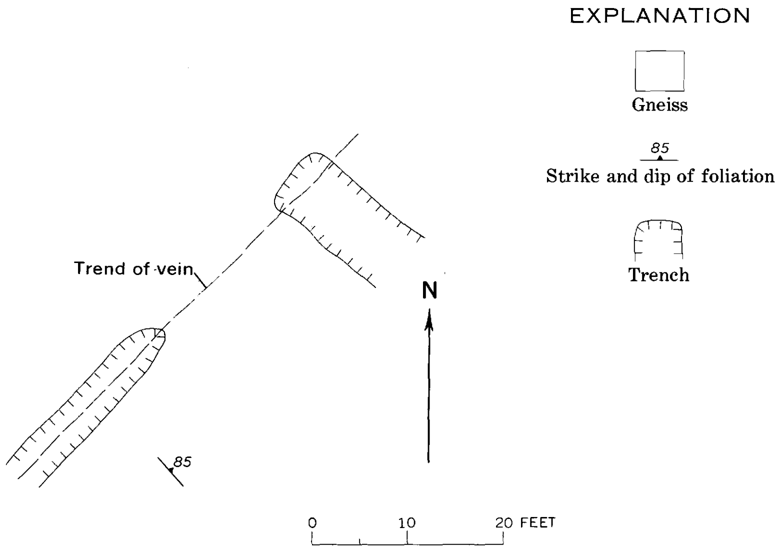


FIGURE 22.—Workings on the Mela No. 7 and Mela No. 8 claims (loc. 3).

with limonite. The only other mineral noted was pyrite, occurring as a few scattered crystals. A sample was taken by breaking small chips off many pieces of quartz vein found on the dumps (MHS–156–65; table 2). The analysis showed only 0.03 ounce of silver per ton and no gold.

LOCALITY 4

A trench at locality 4 (fig. 20) is approximately 800 feet north of Louden Lake and 210 feet northwest from the common corner of secs. 3, 4, 9, and 10, T. 40 N., R. 23 E. A discovery post is beside the trench, but no location notice was found. Records in the Okanogan County Courthouse indicate that the Windy and Valley View claims were located in this area by R. R. McPherson in 1937.

A vertical vein trending N. 32° W. is exposed in this trench and on the hillside above; total exposed length of the vein is 18 feet. The vein cuts gneissic quartz diorite and ranges in thickness from 0.6 to 3.3 feet. It consists principally of very fine grained greenish-gray chalcedony with small scattered cubes of pyrite. Two chip samples were taken across the vein and analyzed for gold and silver (MHS–153–65, P–NC–7; table 2). They contained 0.06 and 0.1 ounce of silver per ton and one showed a trace of gold.

A second trench, 174 feet S. 27° E. from the section corner, exposed a siliceous lens-shaped vein containing pyrite. The vein trends N. 65° W. and dips vertically. It is 8 feet long and has a maximum thickness of 1.3 feet. Cubes of pyrite as much as one-sixteenth of an inch across were observed. A sample (P–NC–9; table 2) of the vein contained only a trace of gold and silver.

In addition to the two veins, siliceous rock containing small cubes of pyrite is exposed on a rounded knoll 56 feet south from the discovery trench. This is probably a different mineralized body, as it is not on the projected strike of either vein. The known length is 29 feet, the exposed width 11 feet, and the exposed depth 9 feet. A random chip sample (P–NC–8, table 2) taken from the exposure contained 0.1 ounce of silver per ton and a trace of gold.

TUNGSTEN CREEK AREA

The Tungsten Creek, or Wolframite Mountain, area is 1½ to 3 miles south of the Canadian border. The Boundary group, Last Chance, Whistler Lode, and Thunder claims are the principal prospects in the area. Wolframite-bearing quartz veins cut coarse-grained porphyritic biotite quartz monzonite on the south side of Wolframite Mountain and on the north and east sides of Apex Mountain, at elevations of 6,500–8,000 feet (fig. 23).

The early history and production of the area was described by Culver and Broughton (1945, p. 41). Tungsten minerals were discovered in 1898 by the staff of the International Boundary Commission. The first mining claims were not located until about 1906, when the Tungsten Consolidated Co. drove a 60-foot tunnel (Mining and Scientific Press, 1907, p. 11). Since that time, more than 40 claims have been located in this area. Several have been restaked as many as four times, commonly under different names; the actual number of properties represented is not known. Most development on the claims was done in 1915 and 1916. A total of six cars of handpicked ore was produced from the area before 1920, and about 30 tons was shipped at a later date.

The deposits are in a rugged mountainous area at altitudes where winter weather is severe—with snow on the ground from October to May or June. Most of the prospects are on the slopes of the glaciated valley of Tungsten Creek. Adequate water for mining and milling is available in the valley; however, supplying water to the Last Chance, Whistler Lode, and Thunder claims on the slopes would require pumping. Soil, talus, and underbrush make prospecting relatively difficult on the lower slopes and in the valley bottom.

The properties are about 50 miles from the nearest rail shipping point at Tonasket, Wash., by way of the Loomis and Toats Coulee Creek road and an 18-mile jeep trail. This trail would require widening, grading, replacement of culverts, and graveling of most sections in order that concentrates and supplies could be hauled during rainy periods.

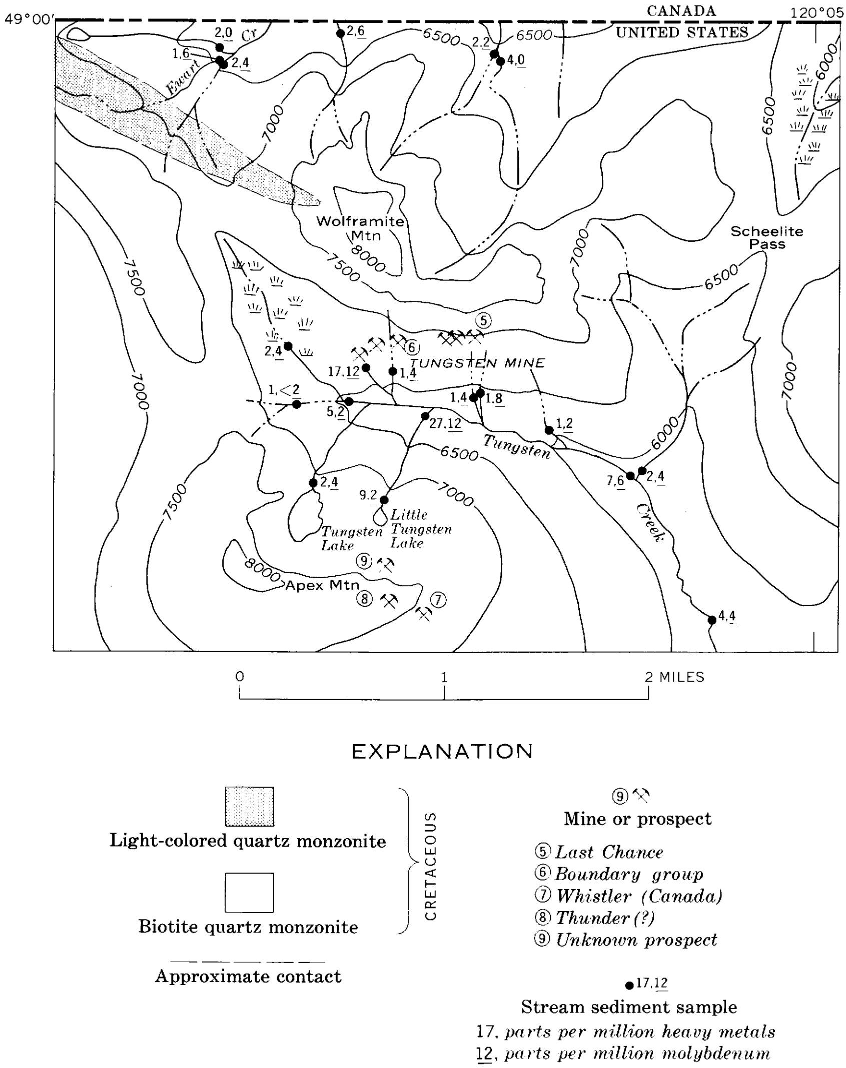


FIGURE 23.—Location of mines, prospects, and samples in the Tungsten Creek area. After Daly (1912) and S. W. Hobbs (unpub. data, 1942).

Exposures, sample data, and other information are not adequate to completely define the grade and tonnages of vein material in the area. If the veins persist and their grade is as consistent as indicated by available data, the vein material at the prospects would amount to 300,000 to 400,000 tons containing 0.4 to 0.6 percent tungsten (0.5 to 0.8 percent WO_3). The gross value at 1968 prices would be between $6,450,000 and $13,760,000. Small sections of the veins may contain 1 to 3 percent WO_3. Total resources of the area may approach a million tons or more if the veins extend between prospects. The deposits are submarginal at present because the costs of mining, milling, and marketing are estimated to be three to six times the contained values.

LOCALITY 5 (LAST CHANCE CLAIM)

The Last Chance claim (figs. 23, 24) is developed by three adits and six small pits. Two of the adits, totaling 274 feet in length, are accessible. The prospect was described as part of the Wolframite Mountain area by Culver and Broughton (1945, p. 40). Hence, a small part of the production reported from the Wolframite Mountain area in the early days might have come from these workings. This claim was relocated by Loy McDaniels and others in 1955.

The deposit consists of flat-lying quartz veins containing wolframite and minor values of silver. Samples contained a trace to 2.77 percent tungsten (3.50 percent WO_3); the veins probably average 0.8 ounce of silver per ton and 0.6 percent tungsten (0.8 percent WO_3). The veins are 4–17 inches wide and can be traced intermittently for 950 feet. Float indicates that the veins may extend eastward for another 920 feet. The veins may also extend 1,800 feet westward beneath the overburden to the workings of the Boundary Group.

The main adit (fig. 24) exposes a white quartz vein that strikes

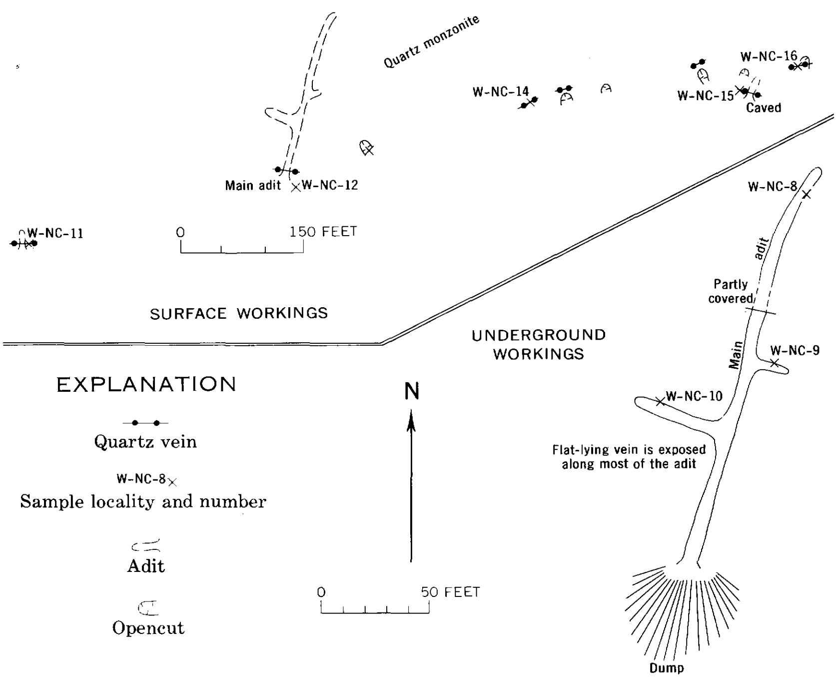


FIGURE 24.—Workings on Last Chance claim (loc. 5).

northeast and dips 15°–20° NW. Faulting has displaced the vein in places and changed the strike. The vein is exposed for 200 feet along the strike in the walls of the adit. A 21-foot-long lateral to the east and a 45-foot-long lateral to the west provide exposures for 71 feet along the dip. Width of the vein ranges from 4.5 to 12 inches and averages 10 inches. The vein splits into three branches at the face; the largest is 6 inches thick. Wolframite is scattered through the vein, and a small amount of scheelite was observed at one point in the adit and at another point in the east lateral. Chip sample W–NC–8 (fig. 24; table 2), taken across the veins at a point 16 feet from the face, contains a trace of gold, 0.65 ounce of silver per ton, and no tungsten. Sample W–NC–9 (table 2) taken near the face of the east lateral has a trace of gold, 1.1 ounces of silver per ton, and 0.87 percent tungsten. Sample W–NC–10 (table 2), taken from the north side of the west lateral and near the face, yielded a trace of gold, 0.5 ounce of silver per ton, and 2.76 percent tungsten.

At the portal the vein is split into two parallel veins by 10 inches of silicified quartz monzonite. The upper vein is 2–3 inches thick and the lower vein, 6–8 inches. On the surface these veins are exposed for 25 feet downdip. They contain scattered particles of wolframite and a small amount of limonite, hematite, and manganese oxide stain along fractures. A chip sample (W–NC–12, table 2) from the surface exposures assayed a trace of gold, 0.3 ounce of silver per ton, and 0.33 percent tungsten (0.42 percent WO_3).

Three hundred and twenty feet west-southwest of the main adit is a small 15-foot adit (fig. 24). A quartz vein is exposed in the back of the adit and for 25 feet on the surface. It strikes northeast, dips 21° NW., and may be located on the same structure as the vein exposed in the main adit. The vein in the small adit is 12 inches wide and contains minor wolframite. A chip sample (W–NC–11, table 2) taken along the exposure assayed 1.6 ounces of silver per ton and a trace of gold and tungsten.

A vein exposed 300 feet northeast of the portal of the main adit contains wolframite. The exposure is 9 feet long, and the vein is as much as 17 inches thick. A chip sample (W–NC–14, table 2) of the exposure assayed a trace of gold, 0.3 ounce of silver per ton, and 0.31 percent tungsten (0.39 percent WO_3).

The quartz vein or veins can be traced by minor shows and float to the portal of a caved adit 240 feet farther east. On the surface above the portal, a vein 8–14 inches thick is exposed for 15 feet down its 10°-NW. dip. The vein is predominantly white quartz with small amounts of wolframite. Limonite, hematite, and manganese oxide stain occurs along fractures. A chip sample (W–NC–15, table 2) of the vein assayed a trace of gold, 1.0 ounce of silver per ton, and 0.07 percent tungsten (0.09 percent WO_3).

Sixty feet northeast of the caved portal, a quartz vein dipping 12° NW. is exposed in a trench. The vein is exposed for 14 feet; it has a maximum thickness of 12 inches, but pinches to 4 inches at its east end. A chip sample (W–NC–16, table 2) taken from the exposure assayed 1.17 percent tungsten (1.48 percent WO_3) and a trace of gold and silver.

The flat-lying veins would be expensive to mine. The ratio of vein material to waste would be about 1:5.

The workings are at the top of a steep talus slope that lies below an escarpment. There is no flat area on the property that is suitable for construction of a mill or tailings pond. For servicing the workings to a suitable road site below, an inclined tramway 300–400 feet long would be required. The ore could then be trucked to a millsite near the Boundary group.

The costs of mining, marketing, and milling at present are estimated to be about three to four times the average value in the quartz veins. Exploration might disclose higher grade ore bodies.

The resources of the deposit are estimated to total 170,000 to 220,000 tons of vein material containing about 0.8 ounce of silver per ton and 0.6 percent tungsten (0.8 percent WO_3).

LOCALITY 6 (BOUNDARY GROUP)

At locality 6 (fig. 23) there is a group of three claims, generally known as the Boundary mine but at various times also known as the Border Lord, Wolframite Mountain, and Hatfield tungsten deposits (Huntting, 1956, p. 346). At this property, on the north side of Tungsten Creek, are an old 10-ton mill and several buildings. The property is developed by about 1,600 feet of workings and many small opencuts (fig. 25). Most of the workings are in two principal adits, several hundred feet above the stream. In 1962 the property containing the buildings along the stream was relocated by Loy and Jim McDaniels, and in 1963 the property containing the principal workings was relocated by W. B. McPherson, F. L. Monohan, E. L. Bracket, and Henry Dammann as the Wolframite Mountain claim.

Most development, including construction of a steam-driven gravity concentrator and sawmill, was done in 1915–18. A total of six cars of handpicked tungsten ore had been packed out and shipped before closure of the mine in 1920. A forest fire destroyed the sawmill and concentrating plant in 1930. In 1936, 30 tons of material was shipped, reportedly at a financial loss (Culver and Broughton, 1945, p. 41). A 10-ton-per-day mill was constructed at the property in the late 1930's or early 1940's, and 300 pounds or more of concentrates were produced

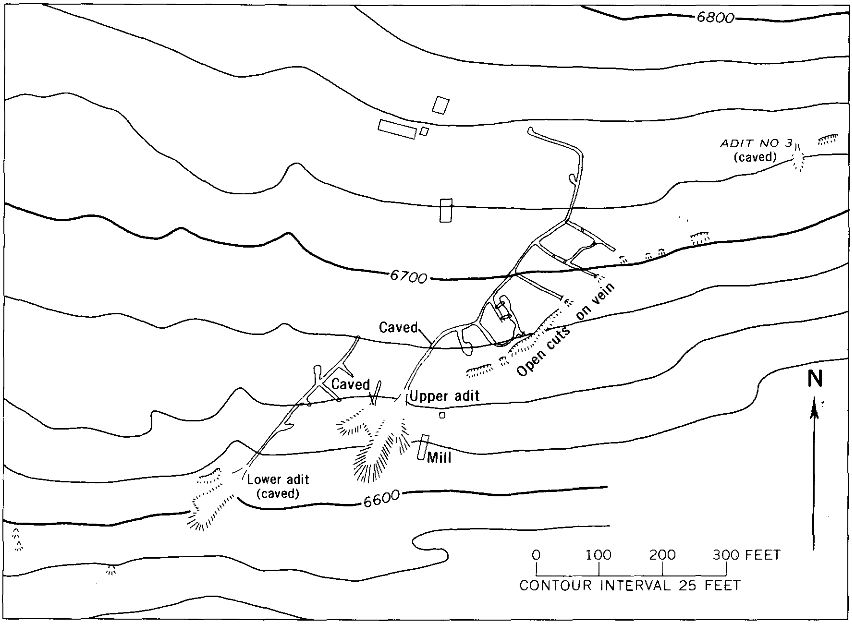


FIGURE 25.—Location of underground workings of the Boundary group (after S. W. Hobbs, unpub. data, 1942).

(S. W. Hobbs, written commun., 1942). There has been no production since that time.

The deposits were mapped and studied by S. W. Hobbs, U. S. Geological Survey (written commun., 1942), by Culver and Broughton (1945, p. 36–41), and by W. P. Puffett and E. A. Magill (written commun., 1952). At the time of our visit, the underground workings were inaccessible, and most of the trenches and pits were badly slumped. Detailed description of the deposits therefore draws extensively on previous work, supplemented where appropriate by information and analyses obtained during the present study.

The deposit at the Boundary group of claims consists of one or more white to clear, massive and vuggy quartz veins that strike northeasterly and dip generally 10°–20° NW. The attitude of the veins is, in general, parallel to a prominent joint set in the country rock. The veins pinch, swell, split and rejoin, and are offset a few feet by many high-angle and low-angle normal faults. As many as five parallel quartz veins have been noted at one place in the underground workings. No vein has been traced continuously for more than 300 feet, small faults are numerous and most of the surface exposures may be part of one interconnected vein system. Maximum vein thickness is about 2 feet, the average thickness is about 5 inches, and many of the veins are only 2 to 3 inches thick.

The quartz veins contain wolframite, scheelite, sphalerite, pyrite, and possibly galenobismuthinite. The principal ore mineral is wolframite, which occurs as blades, grains, and small patches scattered erratically in the quartz. In a few small areas it makes up as much as 12 percent of the vein, but in many places the veins are barren or contain only a fraction of a percent of wolframite. Sphalerite is not common and is difficult to distinguish from the wolframite in hand specimen. Pyrite is locally scattered through the veins. Scheelite and galenobismuthinite(?) were reported by Culver and Broughton (1945, p. 37), but none was found during our 1965 examination. A composite grab sample (W–147, table 2), composed of the richest fragments found on the dumps and at the mill, contained 0.34 percent tungsten, 0.10 percent zinc, 0.85 ounce of silver per ton, 0.03 percent copper, and traces of lead. No gold was found. The operator of the property in 1952 reported to S. W. Hobbs (written commun., 1942) that ore picked from the dumps and surface pits and run through his mill had an average grade of 0.34 percent and 0.49 percent tungsten on two separate runs. Certain shoots and patches of high-grade ore have been found in this mine. Zellweger (1939) packed out two small lots of handpicked high-grade ore to do millwork on. These two lots contained 3.72 and 6.90 percent tungsten.

The upper adit (fig. 25), now mostly inaccessible, was described as follows by Culver and Broughton (1945, p. 38–39):

This is the principal adit of the Wolframite Mountain area, as it produced most of the ore shipped.

An 8-inch vein with three narrow splits below is exposed in the main adit at 130 feet; it carries some wolframite here but the mineral is particularly conspicuous 10 to 15 feet farther along in the adit where blades 1 to 3 inches long are inclined to the plane of the vein. At 200 feet the vein retains a 6- to 7-inch width * * *. Between 240 and 280 feet the vein widens to 1 foot in one place then starts to narrow, finally splitting in two parts that terminate beyond the fifth side drift; at one place there is a relatively high tenor in wolframite with 22 clusters of crystals along 10 feet of surface. * * * At some 330 feet from the portal four veins each 1 to 2½ inches wide and 6 to 8 inches apart are visible, and the remainder of the adit shows no vein of greater width. Another vein, or a faulted segment * * * appears at the head af the 35° incline * * * which leaves the main adit at 340 feet from the portal; its width is only 5 to 6 inches, but the wolframite reaches a maximum estimated at 4 to 5 percent of the volume of the vein. * * * The stope on the northeast side of the third side drift shows * * * three veins that are 6, 1½, and 1 inches wide * * *. The southeast side of the stope shows the vein widening to 10 inches close to the surface. The vein in this stope shows considerable wolframite, particularly next to the adit, together with scheelite.

This main adit is now caved 80 feet from the portal. A vein in the adit, however, is visible at two places 15 and 30 feet from the portal. The vein strikes N. 3°–20° E. and dips 10°–20° NW. It is composed of white quartz with dendritic manganese oxides along fractures. No wolframite or scheelite was observed in the vein. Chip samples taken across the vein at 15 feet and 30 feet from the portal assayed a trace of gold, silver, and tungsten.

The lower adit (fig. 25) is caved, but a vein is exposed at the east side of the portal. Pits, now sloughed, have been dug on the general trend of the vein 370 feet southwest from the portal. Very little vein material is on the dumps. The vein at the portal strikes N. 60° E. and dips 70° NW. It is composed predominantly of white quartz with some wolframite. One mass of wolframite was 3.5 inches long and 1.7 inch in diameter. A representative chip sample (W–NC–6, table 2) of the vein assayed 1.90 percent tungsten (2.40 percent WO_3) and 0.1 ounce of silver and 0.01 ounce of gold per ton.

Culver and Broughton (1945, p. 38) described the vein in the lower adit as follows:

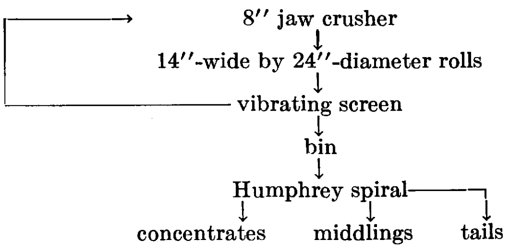
> The vein is first seen at about 70 feet from the portal where it is cut by one or more dikes * * *. Much wolframite occurs in the vein where it lies close to the floor of the first drift southeast. At 115 feet from the portal in the main adit the vein is faulted up 3 feet above the floor and shows a width of 6 to 7 inches with considerable wolframite; it strikes north and dips 15° west. In the second side drift southeast there is sparse mineralization of wolframite and pyrite. * * * The width remains at 6 to 8 inches along the adit up to the northwestward drift along which the vein decreases to 2 or 3 inches * * * until faulted out close to the face of the adit. In general wolframite occurs as occasional blades from 1 to 2 inches long in both the main vein and splits therefrom.

A caved adit between the upper and lower adits was reported by Culver and Broughton (1945, p. 38) to be 40 feet long and to follow a 6- to 8-inch-wide vein. The vein is said to strike N. 40° E. and dip 10°–15° NW. Sparse pyrite and wolframite was present in the face of the adit.

Pits and trenches, now sloughed, have been dug at intervals along the trend of the veins to a caved adit (adit no. 3, fig. 25) 700 feet northeast from the portal of the upper (principal) adit. Veins were not exposed in these workings, but material on the dumps indicates that widths vary from 2 to 12 inches. Crystals of wolframite a maximum of 1½ inch long, ½ inch wide, and ⅛ inch thick were observed in the quartz vein. Some pieces contain as much as 20 percent combined wolframite and pyrite. The average content is probably near 0.5 percent wolframite. The last 10 feet of the adit exposed a vein that, according to Culver and Broughton (1945, p. 39), was 4 inches wide, split into two parts, and contained no wolframite.

Information necessary to permit accurate calculation of reserves is not available. The grade of the vein varies widely from place to place. Miners reported to S. W. Hobbs (written commun., 1942) that much high-grade ore was removed from the mine in 1915 and 1916, and that in 1936 hand-sorted ore was packed out without concentration. No such ore is exposed. Systematic sampling of the underground workings has not been done, and the above vague information is the only clue to the tenor of the ore removed in previous operations. Most of the better ore, developed by past ventures, has probably been removed, and the vein material left is either too low grade or too narrow to be mined (S. W. Hobbs, written commun., 1942). The possibility always exists that other richer ore shoots, similar to the one now stoped out in the old workings, will be found.

Most of the existing milling equipment was still usable in 1965, but considerable repairs and a new powerplant would be needed to put the mill in operating condition. The flowsheet is as follows:



The Boundary group has no minable ore reserves in sight because the vein material left is too low in grade and too narrow to be mined. From previous reports and present samples, 0.5 percent WO_3 appears to be a good estimate of the grade of ore material left. Higher grade shoots, similar to those mined in earlier days, probably occur in the veins. Total resources of overall mineralized material are estimated to total 100,000 tons.

The cost of mining, milling, and marketing the average vein material at present is estimated at more than five times the contained value. Exploitation of higher grade shoots, if present, would probably be on a relatively small scale, as in the past.

LOCALITY 7 (WHISTLER LODE, CANADA LODE)

The Whistler lode (fig. 23) on the east side of Apex Mountain was staked by Paul Loudon, Loy McDaniels, and Robert Curtis on June 27, 1951.

424–547 O—71——8

The Whistler lode is a quartz vein that strikes N. 10° E. and dips 10°–22° NW. It contains wolframite and minor quantities of silver-bearing minerals. The vein outcrop is nearly parallel to the contour and is intermittently exposed in small pits for approximately 350 feet along the slope. The vein is a fraction of an inch to 40 inches thick. Near the south end it splits into three parts, 8, 24, and 8 inches thick. Float was found 400 feet southwest and 100 feet northeast along the projected strike of the vein (fig. 26).

Vein material is almost entirely white massive to vuggy quartz. Gray to dark-gray zones, which may contain finely disseminated metallic minerals, are present in a few exposures. The only recognizable metallic minerals noted were a few widely scattered grains of pyrite, generally less than one-eighth of an inch in diameter. The wallrocks are slightly weathered and stained with iron oxides; locally they are kaolinized.

A composite grab sample of gray quartz was collected for analysis (W–152, table 2). It contained 0.15 percent tungsten, <0.09 ounce of silver per ton, a trace of copper and tin, and no gold. A 24-inch channel sample from the 15-foot cut near the north end of the vein (W–150, table 2) contains 0.19 percent tungsten, 0.013 percent zinc, traces of tin and copper, and no gold. Two samples taken during a Defense Minerals Exploration Administration study in 1951 contained 0.12 and 0.18 percent tungsten (0.15 to 0.23 percent WO_3) and 0.3 and 0.5 ounce silver per ton.

The flat-lying veins would be expensive to mine. Long-wall retreating or room-and-pillar methods could be used in mining. The ratio of vein material to waste would be about 1:4. The cost of mining, milling, and marketing at present would be more than five times the values in the quartz veins.

The resources of the deposit are estimated to total 30,000 to 80,000 tons of vein material containing about 0.16 percent tungsten (0.2 percent WO_3).

LOCALITY 8 (THUNDER? CLAIM)

Locality 8 (fig. 23) is about one-fourth mile west of locality 7 along the crest of the ridge trending east from the highest point on Apex Mountain. It was not specifically identified, but may be the Thunder claim.

Three pits at this locality are about 8 feet wide and extend 12 feet into the slope of the hill. No vein material was found in place, but fragments of white vuggy vein quartz are among the rock fragments in all three pits. Maximum thickness of the vein material was 6 inches. No other minerals were noted in the quartz veins, but

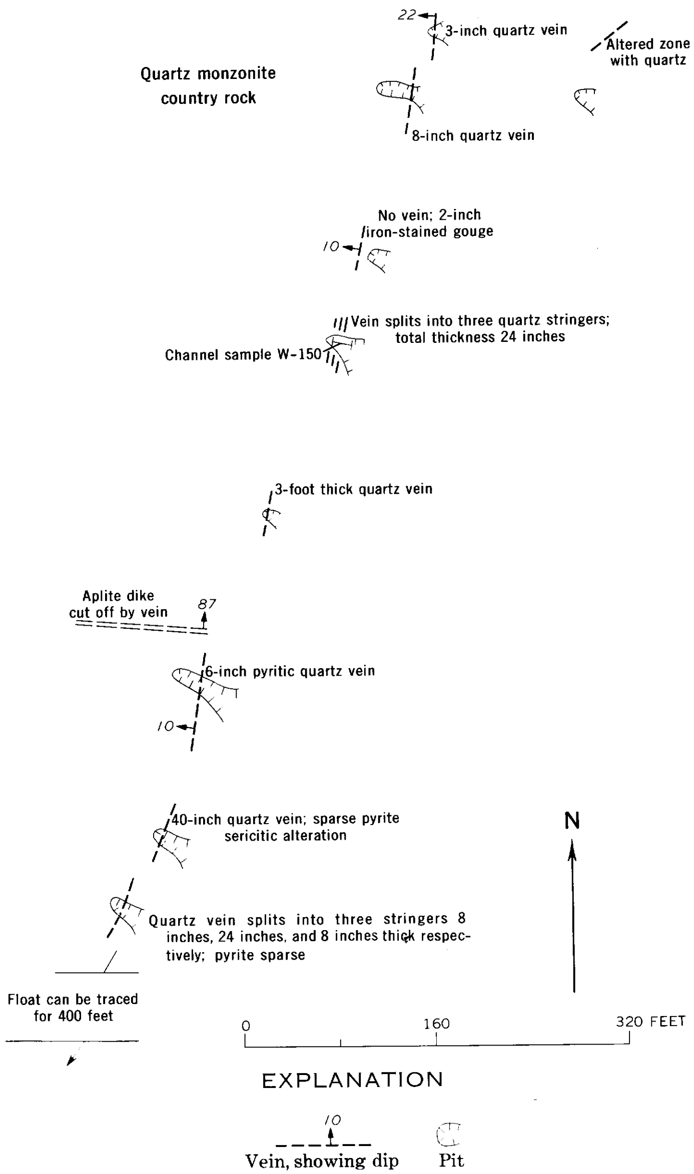


FIGURE 26.—Whistler (Canada) claim, Tungsten Creek area (loc. 7).

some of the quartz and adjacent parts of the country rock are stained with iron oxide.

LOCALITY 9

Locality 9 is north of locality 8 and south of Little Tungsten Lake (fig. 23). Here quartz veins crop out in a few places. No prospect pits or claim notices were found, but scattered rock and vein fragments indicate that some blasting has been done, most probably on float boulders that lie close to their original positions. Fragments of vuggy white quartz, apparently from veins as much as 6 inches thick, were noted on the slope, and some are associated with sericitized quartz monzonite. A sample of the vein material (W–148, table 2) contained 0.010 percent tungsten, 1.38 ounces of silver per ton, and a trace of lead.

LOCALITY 10 (SHEEP MOUNTAIN AREA)

Trace amounts of molybdenite occur in the Sheep Mountain area. which is 1 to 2 miles southeast of International Boundary Monument No. 90 (pl. 2; fig. 27). This area is accessible via a steep 5-mile trail from the end of a road in Canada, or by way of a 15-mile trail from the end of the Eightmile Creek road to the south.

The area is underlain by quartz-hornblende-biotite gneiss and granodiorite, which are cut by quartz veins and quartz-rich pegmatites that contain minor molybdenite and pyrite. Prospect pits, trenches, and short adits are scattered along a N. 40° W. trend from the ruins of the Barker Brown cabin to a point about 1½ miles north of the summit of Sheep Mountain (fig. 27). The elevation of the workings ranges slightly less than 7,000 to 8,150 feet above sea level.

The workings were staked as two separate groups. One group consists of the Barker Brown claims. The other is considered to be the Sheep Mountain (Dodd) group. According to courthouse records, nine of the Sheep Mountain claims were recorded in 1906 by S. Walters, J. M. Dodd, and C. E. Perry. Huntting (1956, p. 271) listed the owners as of 1942 as J. J. Sullivan of Pateros, and Orin and Lester Dodd of Wenatchee.

The workings on the Barker Brown claims consist of a trench and several small pits scattered along the southeast slope of Sheep Mountain near the main trail just north of the Barker Brown cabin ruins. They expose short, nearly parallel quartz veins in a quartz-hornblende-biotite gneiss.

A 50-foot trench near the trail just above the cabin (fig. 27) exposes a quartz vein 2 to 3 feet thick. The vein strikes N. 35° W. and dips vertically. The vein pinches out a few feet beyond the ends of the trench. Quartz fragments along the trench contain minor pyrite and

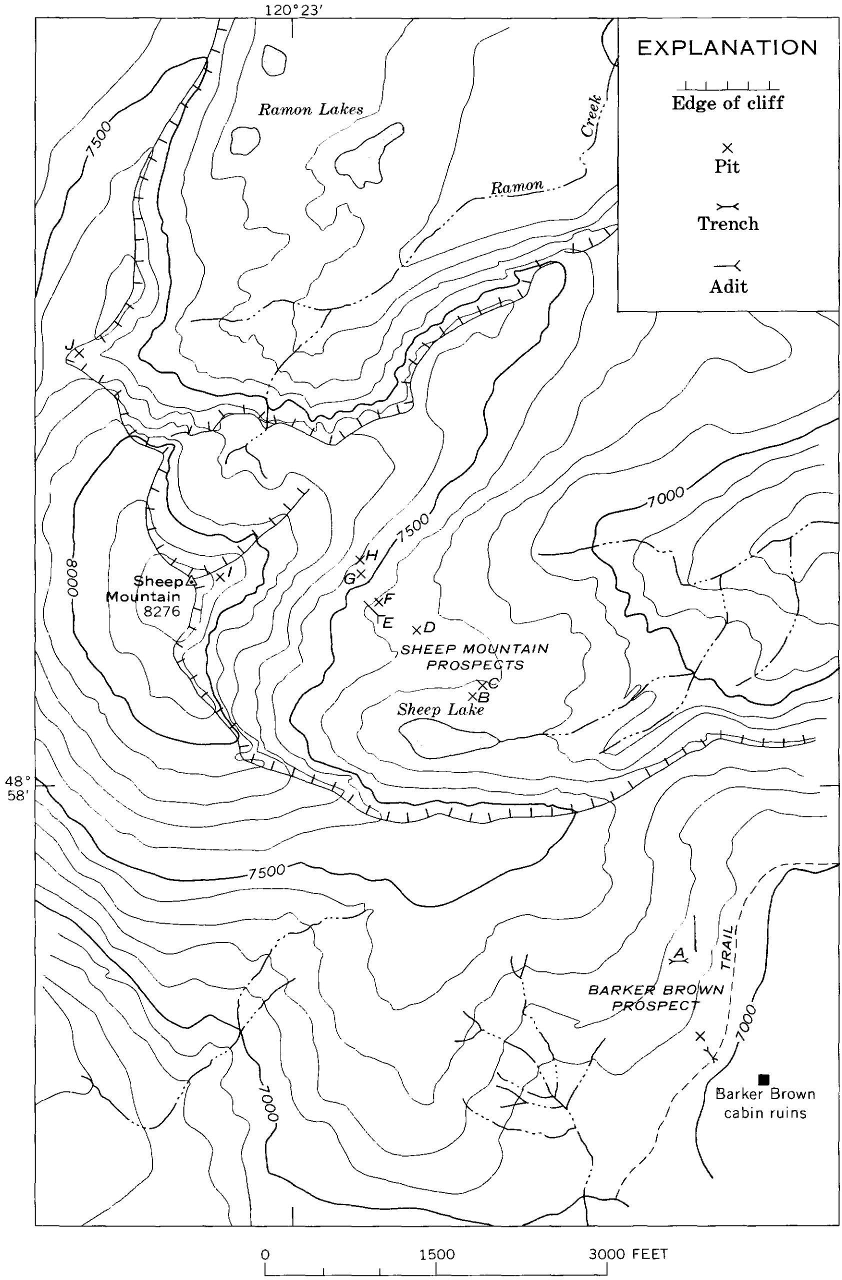


FIGURE 27.—Sheep Mountain area (loc. 10). Topographic base by R. M. Van Noy from aerial photographs, 1966.

molybdenite. No metallic minerals were found in place. A grab sample (RV–66–26A, table 2), contained only a trace of gold and silver. Several very narrow quartz lenses containing traces of molybdenite are exposed in small pits along the slope above the trench. These veins strike N. 30°–50° W., are 6 to 30 inches thick, and pinch out within a few feet.

The southernmost working of the Sheep Mountain group is a 65-foot trench with a 5-foot adit at its west end (point A, fig. 27). A 6-inch- to 5-foot-thick quartz lens is exposed at the west end of the trench and in the adit. The lens strikes N. 65° W. and dips vertically. Minor molybdenite and pyrite are scattered along limonite-stained fractures and in vugs within the quartz. The metallic minerals are found near the edge of the quartz body. A 30-inch chip sample (86R–65, table 2) taken across the quartz, in which a few specks of molybdenite and pyrite were visible along one edge, assayed less than 0.02 ounce of gold per ton and 0.014 percent molybdenum. A 4-foot chip sample (WR–66–6A, table 2) across the quartz vein in the adit contained only a trace of gold, silver, and molybdenum.

Most of the other workings of the Sheep Mountain group are in the large cirque just to the north.

Two pits at B and C (fig. 27) near the north shore of Sheep Lake expose two roughly parallel northwest-trending white quartz veins. At locality B the vein is 3 feet thick, and appears to pinch out within 10 feet. At pit C a quartz vein is exposed for 2 feet along sloughed walls of the pit. The veins are slightly stained by limonite, but no sulfide minerals were found. A sample (WR–66–5A, table 2) cut across the vein at pit C showed a trace of gold and silver, but no molybdenum.

About 770 feet to the northwest is another small pit which exposes a quartz vein 12 to 14 inches thick (point D, fig. 27). The vein is stained with iron oxides. Minor pyrite and molybdenite were observed on joint planes. A grab sample (WR–66–1A, table 2) from a small stockpile of the quartz vein yielded a trace of gold and silver and 0.01 percent molybdenum.

At the base of the cirque wall about 420 feet to the northwest, there is a 20-foot adit at the end of a 50-foot trench (point E, fig. 27) dug in medium-grained granodiorite. A quartz lens, 4 feet thick at its widest part, feathers into thin stringers in the adit. The lens trends N. 50°–70° W. and dips 30° SW. It contains some feldspar and sparsely disseminated blebs of pyrite and molybdenite along fractures and in minor vugs. Although free gold has been reported (Huntting, 1956, p. 271), none was observed during our examination. A chip sample (WR–66–3A, table 2) across the thickest part of the lens shows only a trace of gold and silver and 0.02 percent molybdenum. A grab sample (WR–66–2A, table 2) of stockpiled quartz vein at the portal assayed only a trace of gold, silver, and molybdenum.

Another trench located just northeast of the adit (point F, fig. 27) exposes a 2½- to 3-foot-thick body of quartz that might be the same body as in the adit. The quartz body contains minor feldspar, is stained with iron oxides, and contains a little pyrite. A grab sample (WR–66–4A, table 2) from a 5-ton stockpile of quartz showed only a trace of gold and silver and 0.02 percent molybdenum.

About 130 feet higher, along the cirque wall, is a slumped pit (point G, fig. 27). A grab sample (RV–66–25A, table 2) of stockpiled vein quartz at the end of the trench had only a trace of gold, silver, and copper, and 0.02 percent molybdenum.

A quartz lens exposed in a pit (point H, fig. 27) 126 feet northeast of point G is composed of quartz and some feldspar; it trends N. 10° W. and dips 30° SW. The lens can be traced only a few feet beyond the trench to the north. Some pyrite and molybdenite were observed in the quartz, but assays of a grab sample (RV–66–24A, table 2) from a small stockpile yielded only a trace of gold, silver, and molybdenum, and 0.02 percent copper. A 5-foot chip sample (RV–66–23A, table 2) cut across the lens at its widest part showed only a trace of gold and silver, and 0.01 percent molybdenum.

A small pit 100 feet N. 80° E. of the summit of Sheep Mountain (point I, fig. 27) exposes a small limonite-stained quartz vein. A grab sample of the vein material (RV–66–21A, table 2) contained only a trace of gold and silver.

The northernmost working in the Sheep Mountain area is a small slumped pit about 2,300 feet N. 25° W. of the summit of Sheep Mountain (point J, fig. 27). The pit is just below the crest of the ridge southwest of the Ramon Lakes. A small stockpile of limonitic vein quartz beside the pit was sampled. The grab sample (RV–66–22A, table 2) contained a trace of gold, silver, and molybdenum. Some small quartz veins are exposed west of the pit but no other workings were found.

In summary, all the prospecting activity in this area has exposed generally narrow and discontinuous quartz-rich pegmatites, quartz veins, and quartz lenses. Assays of material from exposures of these bodies in place and from selected material in numerous small stockpiles show the mineral values to be well below levels required for economic exploitation.

LOCALITY 11 (LOST MINE)

The Lost "mine" is located northeast of Billy Goat Mountain on Drake Creek about 2 miles upstream from its confluence with Jinks

Creek (pl. 2). This prospect is accessible by way of the trail to Hidden Lakes as far as Drake Creek, then upstream on an unmaintained trail.

The prospect is situated on the south edge of the creek at the west side of a grass-covered avalanche scar on the north slope of the valley. The workings cannot be seen from the trail. The prospect was staked in 1919 by C. R. Nelson and was worked several times by others. No production is known. The prospect consists of a caved adit which is about 40 feet long and two cuts. The cuts are 25 to 50 feet west of the adit.

Country rock is mostly rhyolite and dacite tuffs and breccias that are part of the volcanics of Billy Goat Mountain. A narrow shear zone cutting a gray andesitic mudflow is exposed at the portal. It strikes east and dips 25° N. The adit does not follow this structure, and what, if any, structure was followed is not known. The rock along the shear is highly kaolinized and contains finely disseminated pyrite. The adjacent unaltered dacite porphyry also contains sulfides. Rock exposed in the pits is not kaolinized but does contain minor pyrite. The sulfide-enriched rock could not be traced beyond the workings because of the thick overburden.

Chip samples (table 2) were taken of the shear zone on the west side of the portal (EVK–67–13B) of unaltered pyrite-bearing rock adjacent to the shear zone (EVK–67–14B) and of the rock exposed in the pit 25 feet to the west (EVK–67–15B). All contained a trace or less of gold, silver, copper, and molybdenum except for sample EVK–67–14B, which contained 0.05 ounce of silver per ton.

Judged from what is exposed, this prospect has no economic potential.

BILLY GOAT MOUNTAIN AREA

The Billy Goat Mountain area is about 68 miles north-northwest of Pateros, Wash., the nearest rail shipping point. Access from Pateros is by State Highway 16 and county and Forest Service roads. The area (fig. 28) lies along the south flank of Billy Goat Mountain and on the north end of Isabella Ridge. It is drained by the headwaters of Eightmile, Jinks, and Drake Creeks.

Numerous prospects are situated along the ridge between Billy Goat Pass and Eightmile Pass (fig. 28). Most of the prospects are at the end of the Eightmile Creek road just outside the wilderness area boundary, but some are within the wilderness area. The terrain is very rugged, total relief being 3,000 feet between the end of the road and Billy Goat Mountain, the highest point on the ridge.

Weather is severe, with the road usually closed until late June. Snow stays in the shadowed cirques and upper ridges into July.

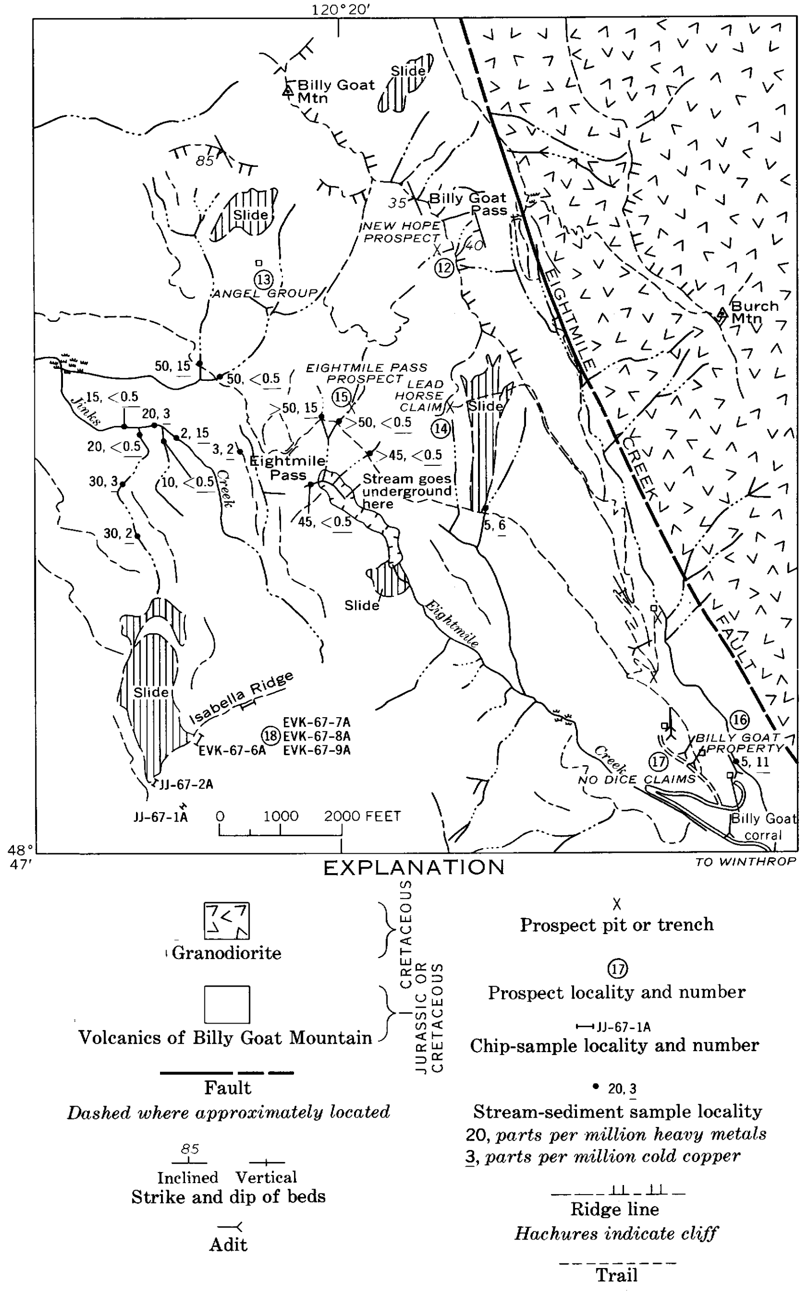


FIGURE 28.—Location and general geology of prospects in the Billy Goat Mountain area. Planimetric base by R. M. Van Noy from aerial photographs, 1966.

The Billy Goat Mountain area is underlain by a thick sequence of volcanic rocks. Most of these are andesite tuff, breccia, and flows, although some rhyolite tuffs and flows are present. All the volcanic rocks strike northwest, and most of them dip steeply to the southwest. These rocks are overlain by a thick sequence of interbedded plagioclase arkose and black argillite. To the east the volcanic rocks are separated from plutonic rocks (quartz monzonite, granodiorite, and quartz diorite) by the northwestward-trending Eightmile Creek fault.

Copper, lead, and silver are the important metals present. They occur as sulfide minerals along shears and fractures in the volcanic rocks. All known occurrences are within three-quarters of a mile of Eightmile Creek fault. Copper deposits are generally in the southern part of the district, and the lead deposits, in the northern part. A copper-silver property (loc. 12, fig. 28) however, occurs in broad shears in the northern part of the district near Billy Goat Pass. The copper deposits in the southern part of the area near the end of the Eightmile Creek road (locs. 16, 17, fig. 28) contain pyrite and chalcopyrite along many small shears in shattered andesitic pyroclastic rocks that are cut by several plagioclase porphyry dikes. A few tons of ore have been shipped from the southern part of this area. Copper also has been produced 2½ miles south of here, outside the study area, at the small Copper Glance mine.

The lead deposits at the north end of this district (locs. 12, 13, 14, 15, fig. 28) are in the headwaters of Eightmile Creek and on the northeast side of Jinks Creek, but high anomalies in the stream-sediment samples (fig. 28) indicate that some may occur on the south side of Jinks Creek as well.

LOCALITY 12 (NEW HOPE PROSPECT)

The New Hope prospect consists of one caved adit located about 3,100 feet N. 40° E. of Eightmile Pass. The portal is at an elevation of 6,460 feet, 300 feet below the crest of the knife-edged Billy Goat ridge on a large active talus slope. The claim may be reached from the end of the Eightmile Creek road, by way of the Hidden Lake trail to Eightmile Pass, a distance of about 2½ miles. From the pass an indistinct trail to the southwest crosses a major slide to the caved portal of the adit.

Development of the property would require extending the Eightmile Creek road to a point near the pass, and probably construction of a 1,000-foot tram system up the talus slope.

The nearest water supply is from intermittent streams which feed Eightmile and Jinks Creeks. Water could be impounded during the spring runoff. Potential impounding sites would be at about the same elevation as Eightmile Pass.

The working season in this district would normally be from late June through November. The prospect is in a location which holds snow well into the summer.

This prospect was probably located originally as the Peacock claim, which, according to Huntting (1956, p. 69), was staked in 1946 by Charles Kenny of Winthrop, Wash. Huntting reported that the Peacock was developed by a 60-foot drift along a 2- to 5-foot-thick mineralized zone. A claim notice shows that the property was restaked as the New Hope by Glen(?) Parker, Thomas W. Martin, and C. A. Hotchkiss in 1960. No production is known.

The area in the vicinity of the adit is underlain by andesitic mudflows, flow breccias, and tuffs, and rhyolitic and dacitic tuffs. The mudflow consists of angular to subangular fragments of andesite, less than 1 inch to 5 feet in diameter, in a fine-grained matrix. Where best exposed on the ridge above, these rocks strike approximately N. 75° E. and dip 40°–45° NW.

The portal has been closed by talus blocks, but the trend of the mineralized zone is apparent from the topography. The zone consists of several calcite- and barite-filled, essentially parallel, shear zones that trend eastward and dip 40°–60° northward (fig. 29). One hundred feet above the portal the zone is 15 feet wide and is made up of three main shears, 4 to 24 inches thick, separated by somewhat less brecciated slightly altered andesite. At the crest only one of the shear planes is exposed. It contains orange to brown limonite-rich gouge with no apparent metallic minerals. The main trend of the shear zone can be traced down the east slope of the ridge toward Billy Goat Pass. Calcite, comprising a 6-inch vein, is the only visible secondary mineral in a wide zone of barren brecciated andesite. No metallic minerals were seen.

Six samples were cut across the mineralized zones, and one was taken of a small stockpile on the dump near the portal of the adit.

Just above the portal a sample (RV–67–1A, table 2) was chipped across 5 feet of the main shear and 3 feet of country rock. No copper was detected and no gold or silver was found. Four other samples were chipped across three branches of the zone as shown on figure 29. Sample JM–67–2A (table 2) represents 4 inches of sulfide-enriched sheared material. It contained a trace of gold, 4.6 ounces of silver per ton, and 2.89 percent copper. Sample JM–67–3A (table 2) represents 12 inches of sheared material that assayed 2.1 ounces of silver per ton, 1.11 percent copper, 0.2 percent zinc, and no gold. Sample JM–67–4A (table 2) was cut across 2 feet of sheared material.

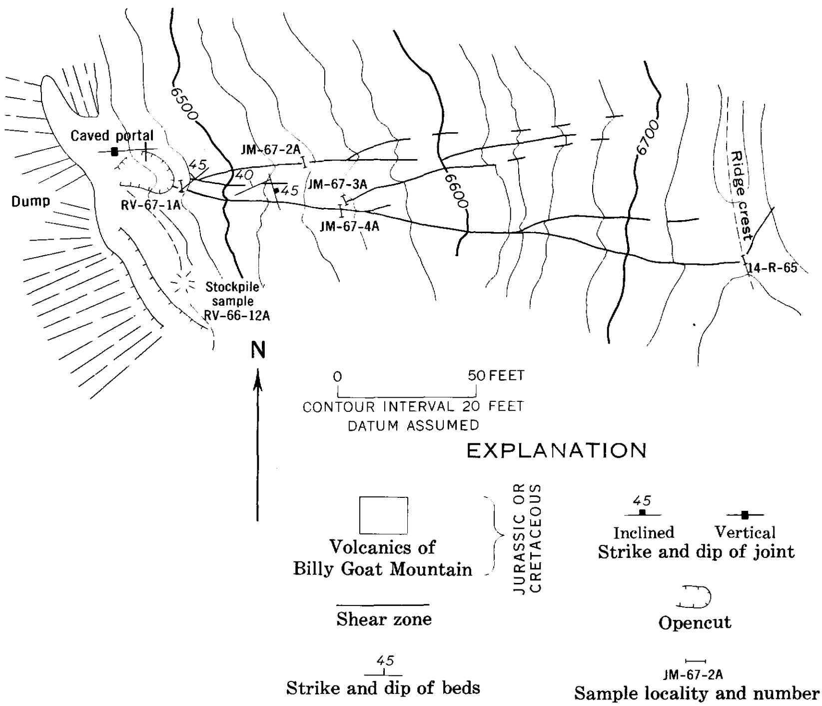


FIGURE 29.—New Hope prospect (loc. 12).

It contained no gold, 9.9 ounces of silver per ton, 4.20 percent copper, and no zinc. A 4-inch chip sample (14–R–65, table 2) of the shear at the crest contained 0.05 ounce of gold and 5.83 ounces of silver per ton, 2.2 percent lead, 0.30 percent zinc, and 0.33 percent copper.

The main zone on the other side of the ridge at an elevation of 6,140 feet was also sampled. A chip sample (RV–67–2A, table 2) from a 0.5- to 1.0-foot-wide calcite-rich vein contained no gold or silver, and only a trace of copper. A sample (RV–66–12A, table 2) was chipped from pieces of rock on the small stockpile that presumably came from the adit. These rocks are highly bleached and contain covellite, bornite, chalcopyrite, azurite, malachite, and a trace of molybdenite set in a gangue of calcite and barite. This sample yielded a trace of gold, 20.6 ounces of silver per ton, 10.2 percent copper, and no lead or zinc.

The average tenor of sulfide zones sampled on the surface is 2.9 percent copper and 6.9 ounces of silver per ton. Indicated marginal reserves with a dilution factor of 4 is about 100,000 tons. Inferred reserves would be in the order of 400,000 tons.

Much of the zone above the portal could be mined by surface methods. It is not known to what depth the zone extends below the portal, but if large tonnages were found by exploration, they could be mined by combined shrinkage stoping and selective mining from a haulageway below.

A small mill could be constructed near the pass, but concentrates would have to be hauled about 70 miles to the railhead at Pateros.

LOCALITY 13 (ANGEL GROUP)

Locality 13 is half a mile due north of the crest of the trail at Eightmile Pass, at an elevation of about 6,500 feet (fig. 28). This locality is probably the north end of the Angel group of six claims that were located in 1956 by Lyle Hosier, R. W. Reneau, and Lloyd Farmer. Rocks in the area are gray, greenish-gray, and dark-greenish-brown andesitic volcanics.

At locality 13 a prominent outcrop of iron-oxide-stained, altered, and locally brecciated andesite is about 500 feet long and 30–50 feet wide. The outcrop forms a cliff 10–30 feet high that trends about N. 35° W. At the northwest end, an adit 10 feet long has been driven into the rock. No veins, shears, or sulfides were noted. Two samples collected from the adit (1602, 1603, table 2) contained 0.007 percent and 0.02 percent copper, 0.03 and 0.03 percent lead, 0.01 and less than 0.005 percent zinc, and no gold.

About 500 feet northeast of the adit are three smaller irregular iron-oxide-stained zones along a narrow trail to a small cabin. These altered zones, in locally silicified andesite, have a general en echelon trend of N. 65° W. and dip 65° NE. Tiny grains of disseminated pyrite and hematite were the only metallic minerals noted.

A composite sample (RV–66–10A, table 2) composed of 5-foot chip samples from each of the three altered zones contained only traces of gold, silver, and copper.

LOCALITY 14 (LEAD HORSE CLAIM)

The Lead Horse prospect consists of one unpatented claim on the steep southwest flank of Billy Goat Mountain near the top of a great talus slide at an altitude of 6,500 feet (fig. 28). It is reached by 2 miles of generally narrow and precipitous trail from the end of the Eightmile Creek road. The Lead Horse was held in 1965 by Fred Floyd, Mr. Eddy of Twisp, and a man named Star. The prospect has been developed by two short adits and several cuts (fig. 30).

The country rock is a multicolored steeply dipping andesite breccia which is jointed and faulted. Most of the joints show at least slight movement and some bleaching. Two nearly parallel steep faults are exposed in the main adit, and their surface trace is appar-

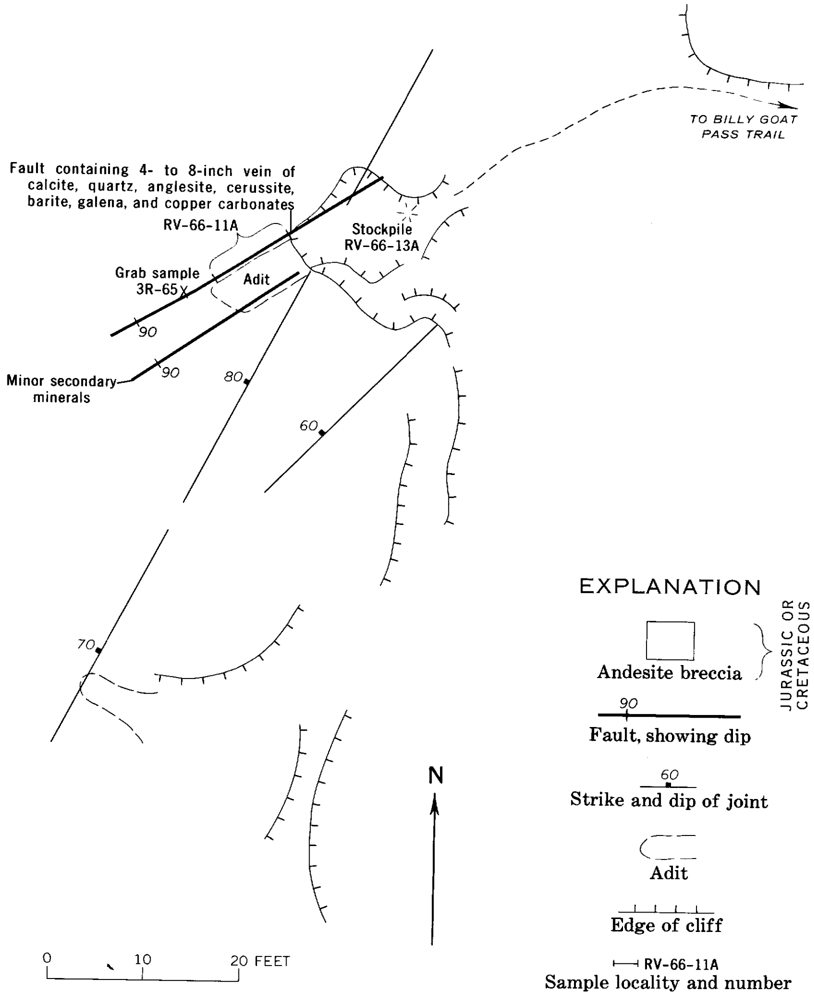


FIGURE 30.—Lead Horse prospect (loc. 14).

ent to the southwest for at least 100 feet. The north fault contains 4 to 8 inches of vein material and the adjacent country rock is brecciated and bleached. The south fault is less mineralized and contains only minor secondary ore minerals. In the adit and near the surface the vein along the north fault is made up of malachite, azurite, cerussite, galena, and anglesite, set in a gangue of quartz, calcite, barite, and limonite. In a small channel cut along this fault southwest of the adit, pods of galena are surrounded by anglesite and quartz. The ore minerals are irregularly scattered along the fault. A sample (3R-65, table 2) of the highest grade rock exposed, a pod of galena 6 inches wide, contains 31 percent lead and 6.71 ounces of silver per ton. The main fault was also sampled (RV–66–11A, table 2) along the north side of the adit. This sample had 0.01 ounce of gold and 4.3 ounces of silver per ton, and 0.37 percent copper. A grab sample (RV–67–13A, table 2) of a small stockpile near the portal of the adit contained a trace of gold, 12.4 ounces of silver per ton, 0.90 percent copper, 7.85 percent lead, and 0.90 percent zinc.

LOCALITY 15 (EIGHTMILE PASS PROSPECT)

A prospect pit about 1,100 feet east of Eightmile Pass, in an intermittent stream (fig. 28), is reached from the end of the Eightmile Creek road by the Hidden Lake trail. Although no claim notice was found, this prospect might be the southern part of the Angel group (six claims) staked in 1956 by Lyle Hosier, R. W. Reneau, and Lloyd Farmer. The pit is 7 feet in diameter and partly caved. In it is exposed a 3.5-foot-thick slightly limonitic shear zone which trends from due north to N. 15° E. and dips 30°–50° W. This same shear zone is also exposed to the south where it crosses the trail. The shear zone cuts porphyritic andesite. The only metallic mineral observed in it is a little specular hematite.

A chip sample (RV–66–14A, table 2) of the shear zone in the pit contained only a trace of gold and copper and 0.2 ounce of silver per ton.

LOCALITY 16 (BILLY GOAT PROPERTY)

A group of eight unpatented mineral claims that constitute the Billy Goat property are clustered near the southeast end of the ridge from Billy Goat Mountain and near the north end of the Eightmile Creek road (fig. 28). The original Billy Goat property consisted of four claims (Huntting, 1956, p. 62)—the Billy Goat and Billy Goat Nos. 2 to 4. The owners in 1965, J. J. Adams, M. M. Moore, and Frank O'Shea, had consolidated these with a Billy Goat No. 5 claim, two claims that were formerly part of the Carr claims, and one that was formerly a part of the Mountain Beaver claims. The status of the four other former claims that belonged to the Carr and Mountain Beaver groups is uncertain. The No Dice or Hanks claim, owned by a Mr. Parker of Winthrop, lies adjacent to, and is almost surrounded by, the Billy Goat claims (fig. 28). These claims are at altitudes that range from 4,500 to 5,300 feet above sea level. All the claims have been prospected for copper, gold, and silver.

The Billy Goat property is underlain by andesite tuff and flow breccia with minor interbedded red to black shale and siltstone. The bedding strikes generally N. 30° W. and dips westerly 70° to vertical. A plagioclase porphyry dike or sill is discontinuously exposed along the west edge of the area. Pyrite and copper minerals occur locally in ¼- to 2-inch-wide quartz veinlets, which are closely associated with steeply dipping northwest-trending faults and fractures. The veinlets are disseminated through fractured and layered andesite and plagioclase porphyry.

Workings consist of at least four shallow shafts, a partly open 700-foot adit, and a dozen smaller adits, all but two of which were caved in 1965. The Mountain Beaver claim is reported to have two adits with 275 feet and 200 feet of workings. No maps of those workings, caved at the time of the visit, were available.

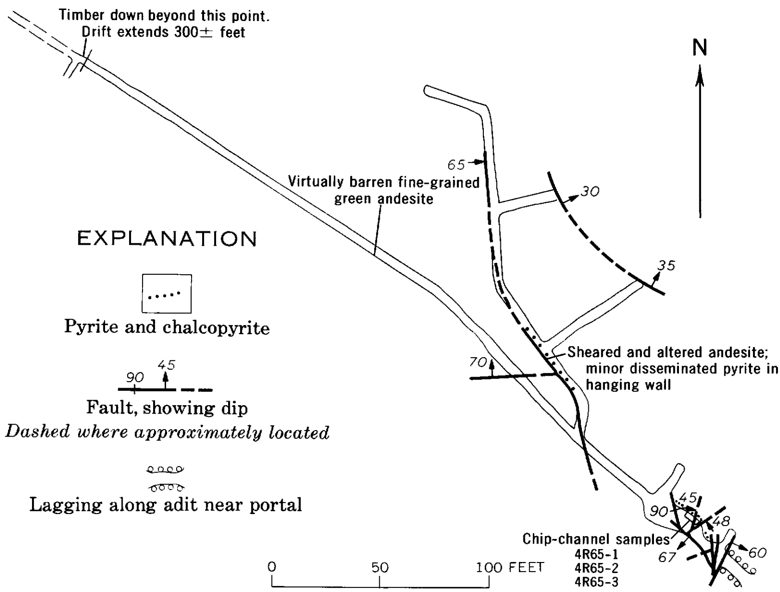


FIGURE 31.—Billy Goat Tunnel No. 1, Billy Goat claim (loc. 16). (From notes by J. F. Robertson in 1965, and by M. T. Huntting in 1946.)

The 700-foot adit on the Billy Goat claim (fig. 31) penetrates altered, sheared, and fractured andesite tuff and breccia. The main drift was examined for 400 feet; beyond that point timbers block passage. One hundred feet from the portal a drift branches off to the right and follows a fault for nearly 200 feet.

Along the main adit from the portal to the right-hand drift, (fig. 31) and then along the right-hand drift, pyrite, chalcopyrite, and minor bornite and tetrahedrite are found locally along faults and fractures. Minor amounts of chalcocite, malachite, azurite, quartz, calcite, and ankerite occur with the primary ore minerals. Along the northeast wall of the adit, 20 to 50 feet from the portal, the sulfides occur in coarse-grained clots. Beyond the right-hand drift in the main adit the rock is unfractured and largely barren of ore minerals.

The andesite wallrock has been altered. Most of the original minerals and glass shards have been replaced by chlorite, sericite, albite, magnetite, epidote, calcite, and quartz. Only remnants of the original plagioclase and olivine remain, and only crystal outlines indicate that the original rock contained some pyroxene.

Three chip samples were taken along the northeast wall of the drift, 37 to 41.5 feet from the portal, in the most highly mineralized area exposed (table 2). The first sample (4R65–1), 9 inches long, is from the footwall side of a small fault. It contained 3.4 percent copper. The other two samples (4R65–2, 4R65–3) are 2.5 feet and 1.5 feet long and are progressively farther from the fault. They have 1.9 and 1.5 percent copper, respectively. The weighted average of the mineralized rock over the combined length of 4.7 feet is 2.0 percent copper, 0.21 ounce of gold per ton, and 0.26 ounce of silver per ton. These values might be inferred for a total length of 15 feet along the adit.

Various opencuts and pits northwest of the long adit on the Billy Goat claim expose fractures and shear zones in weathered andesite. M. T. Huntting (written commun., 1965), during his 1946 visit, investigated an opencut and a 10-foot-deep shaft about 1,000 feet northwest of the 700-foot adit. The cut and shaft exposed a vertical 15-foot-wide mineralized shear zone that strikes N. 50° W. He found that chalcopyrite and pyrite are abundantly but irregularly disseminated in the sheared rock and occur in stringers less than half an inch thick. Huntting estimated that the copper content from these workings would run 3 percent.

The lower or "base level" adit of the Billy Goat property is at the level of the Forest Service road 0.2 mile south of the 700-foot adit on the Billy Goat claim. The lower adit was caved in 1965, but from the outcropping of bedrock on the ridge above the adit, it appears to be in altered plagioclase porphyry. This adit was open in 1946 when Huntting visited the property, and he reported (written commun., 1965) that it trends N. 16° W. and extends 85 feet to the face; very little evidence of any mineralization was seen, but he noted some ¼-inch stringers of quartz and pyrite in country rock on the dump. One specimen also had a little molybdenite along the stringer walls. In 1965, pieces of a bleached medium-grained plagioclase porphyry that contained disseminated pyrite and sparse grains of chalcopyrite and bornite were found on the dump.

The old Carr prospects now make up the northwestern part of the Billy Goat property and are half a mile from the main 700-

foot adit. Workings scattered across a southeast-trending spur ridge include two shallow shafts and three short adits, only one of which was open in 1965.

The open adit is adjacent to the trail to Billy Goat Pass on the southeast side of the ridge. It trends northeast for 26 feet, exposes fractured and iron-oxide-stained andesite breccia, and contains minor disseminated pyrite and chalcopyrite. The two caved adits are about 850 feet northwest of the open adit; one is 30 feet above the other. They trend northeast and appear to be at or near the contact between andesite breccia and a pyritic plagioclase porphyry dike. Huntting (1956, p. 63) reported chalcopyrite, sphalerite, galena, and molybdenite from these workings, and stated that the assays are similar to those of the Billy Goat. A caved shaft occurs approximately 600 feet west and downslope from the open adit. This shaft is about 30 to 40 feet deep and appears to have been started in glacial drift. Bedrock waste on the dump is andesite breccia; sulfides were not noted. The other shaft is near a cabin on the northeast side of the ridge; it was sunk in dark-gray, steeply dipping siltstone interbedded with andesite tuff and breccia that strikes generally north. No ore minerals were found on the dump around the shaft, but interest may have been aroused by the discovery of scattered sulfides at the surface nearby and by the proximity to the Eightmile Creek fault several hundred feet to the northeast.

The Mountain Beaver workings are at the end of an access road that branches northwest 0.35 mile from the end of the Eightmile Creek road (fig. 28). Now part of the Billy Goat property, the workings consist of four adits (Huntting, 1956, p. 155)—one 275 feet long, another with 200 feet of workings, and two shorter ones. The main adits were caved when Huntting visited the area in 1946, and were still inaccessible in 1965. Country rock is andesite tuff and breccia, highly weathered around the portals of the workings, and in the material found in the dumps. Ore minerals include pyrite, chalcopyrite, bornite, and chalcocite. Small shipments of ore were made to a smelter from these workings in 1922, 1931, 1934, and 1935 and represent the only production known from any of the present Billy Goat properties. One shipment of 3,639 pounds made in 1934 assayed 4.1 percent copper, and 2.08 ounces of gold and 1.9 ounces of silver per ton, and returned $57.50 per ton to the owners (M. T. Huntting, written commun., 1965). Another shipment of crude ore gave 1.81 percent copper, and 1.53 ounces of gold and 1.13 ounces of silver per ton; a minor amount of bismuth was also reported (Huntting, 1956, p. 144).

LOCALITY 17 (NO DICE CLAIMS)

The No Dice claims, which were formerly called the Hanks claims, adjoin the Billy Goat property on the west and consist of three unpatented claims owned by Mr. Parker of Winthrop (fig. 28). Principal workings are two adits 20–30 feet long, near the beginning of the Hidden Lakes trail and south of the old Mountain Beaver workings. The first adit is about 250 feet northwest of the trail head, and the second is about 300 feet farther to the northwest. Both adits trend slightly east of north, but were barricaded at their portals at the time of our visit in 1965. Rock material on their dumps show that the country rock is medium-dark-greenish-gray fine-grained andesite. Sparsely disseminated pyrite and some chalcopyrite are found along small fractures and in quartz veinlets. Sphalerite, galena, and molybdenite have also been reported (Huntting, 1956, p. 65), although they probably occur in small amounts. Several small prospect pits in the immediate vicinity were sunk in weathered andesite. No mineralized rock of ore grade has been reported from the No Dice claims, despite the proximity of the former productive Mountain Beaver claims and the fact that they are in the same country rock.

LOCALITY 18

Locality 18 consists of three limonite-stained zones located on the north end of Isabella Ridge about 4,200 feet S. 18° W. of Eightmile Pass (fig. 28).

No claims are known in this locality, nor is there any evidence of any prospecting.

The limonitic zones are in rhyolitic volcanic breccia that is interlayered with andesitic volcanic rocks. The zones are 100 to 300 feet thick, trend northwest, and dip to the east.

Of six samples (JJ–67–1A, –2A, EVK–67–6A, –7A, –8A, –9A, table 2) collected from these zones, none contained detectable quantities of copper, lead, zinc, or molybdenum; only three contained a trace of silver, and one contained a trace of gold.

LOCALITY 19 (LOST RIVER CLAIM)

Locality 19 is at an elevation of 4,500 feet on the southwest side of the fourth canyon south of Drake Creek on the northwest side of Lost River, and 1.8 miles below the mouth of Drake Creek (fig. 19). The Lost River claim was located here by Howard E. Culp and C. B. Wilhem in 1951. A shallow discovery pit in a solution cave exposes a 2- to 4-inch vein of calcite, quartz, and fluorite cutting altered hornfels not more than 10 feet above the gently southeast-dipping roof of the Monument Peak stock. The vein is along a shear zone that strikes N. 30° E. and dips 55° NW. On the northeast side of the canyon the shear zone is 8 feet wide and contains large vugs bearing drusy quartz and 1-inch fluorite cubes. A second 10- to 15-inch-wide fluorite vein crops out about 30 feet to the northwest of the discovery pit, and the entire area is cut by tiny veins of calcite and fluorite. No sulfides were noted in place in any of the veins, but vein quartz bearing coarse flakes of molybdenite was found as float in the canyon. A chip sample (RWT–49–65, table 2) across the vein and 8 feet of altered rock exposed in the cave yielded 0.002 ounce of gold and 0.09 ounce of silver per ton. Eight other large chip samples (EVK–67–1A, –2A, –4A; RV–67–3A, JJ–67–3A, –4A, –5A, –6A, table 2) of this vein contained a trace or less of gold and silver.

This fluorite is not in sufficient quantity to be of commercial interest.

LOCALITY 20

Locality 20 is at 7,500 feet elevation on the ridge southwest of the summit of Wildcat Mountain (pl. 3). No name was given to the prospect, located by R. C. Martinez, Gordon Johnson, and Fred Blake in 1958. The country rock is thick-bedded arkose with minor thin beds of black argillite and has been thermally metamorphosed by the thick Pasayten dike that crops out 2,000 feet to the southwest (pl. 1). The arkose strikes N. 42° W. and dips 80° SW. Three shallow pits are dug in a 4-inch bed of graphitic argillite which contains small quartz veins. The bed is bordered on the south side by a 10-foot-thick hornblende dacite dike. A second, very thin graphite-rich bed lies 8 feet to the north, and thin lenses of graphitic argillite border the dike on the south. The graphitic rock extends at least 100 feet down the southeast side of the ridge. This deposit is too small and too low grade to merit consideration as a source of graphite.

NORTHERN PART OF THE SLATE CREEK MINING DISTRICT

The northern part of the Slate Creek district, for purposes of this report, is that part of the Pasayten Wilderness between the Anacortes mine—about 8½ miles northwest of Harts Pass—and Beauty Creek—about 6 miles to the southeast of the pass.

The easternmost edge of this district is accessible from Winthrop: to the east by about 25 miles of well-maintained county road. Harts Pass, located in the center of the district, may be reached by an additional 12 miles of mountain road which is only open for travel from July through most of October. The west end of the district is reached by an additional 12 miles of narrow road extending beyond Harts

Pass to Chancellor, a former mining camp. Chancellor is about 7 miles up Canyon Creek from the new north cross-State highway route. Nearly all the prospects mentioned in the following section are accessible only by trail. Future development of the prospects would require construction of access roads.

Quartz veins and narrow mineralized shears related to intrusive bodies are common in this district. The most valuable metal in the district is gold; silver, copper, lead, and zinc are of secondary importance.

No mineral production is known from lode prospects within the Pasayten Wilderness area in this district. Several mines located just outside the wilderness area west of Harts Pass have produced gold and silver. These are in Allen Basin in which the old mining settlement of Barron is located. The principal mines here are the Mammoth and the New Light. Production figures are vague, but according to Huntting (1956), at least $1,500,000 in gold and silver is estimated to have been produced from this basin during 1900–42. The New Light property has an operable 500-ton-per day flotation mill which could be activated should the price of gold become favorable to the miner.

Some production is claimed for placers along Ruby and Canyon Creeks. In this study, no significant placer gold values were found, but placered areas are near Chancellor. The prospects within the wilderness that have apparent mineral potential will be discussed in four subareas. From east to west they are the Robinson Creek area (fig. 32); Buckskin Ridge area (fig. 39); the Jim Peak–Windy Pass area (figs. 45, 46); and the Canyon Creek area (fig. 53).

ROBINSON CREEK AREA

The Robinson Creek area stretches along the northeast side of the Slate Creek district. Within this area deposits are found mainly from Beauty Creek northwest to the headwaters of Robinson Creek (fig. 32). Part of a thick plagioclase arkose and argillite sequence is exposed along Robinson Creek. This rock sequence is overlain by red beds and volcanic rocks of the Midnight Peak Formation, which are best exposed along the ridges. The Pasayten dike, a long northwestward-trending quartz diorite intrusive a little more than a mile wide, is at the head of Beauty Creek. Many plagioclase and quartz porphyry dikes, most of which have a northeasterly trend, crop out in the area. A total of 17 claims have been filed in this area according to the records in the Okanogan County Courthouse. Some claims are not sufficiently described in the courthouse records to be recovered in the field. The first claims were located in 1906, and the

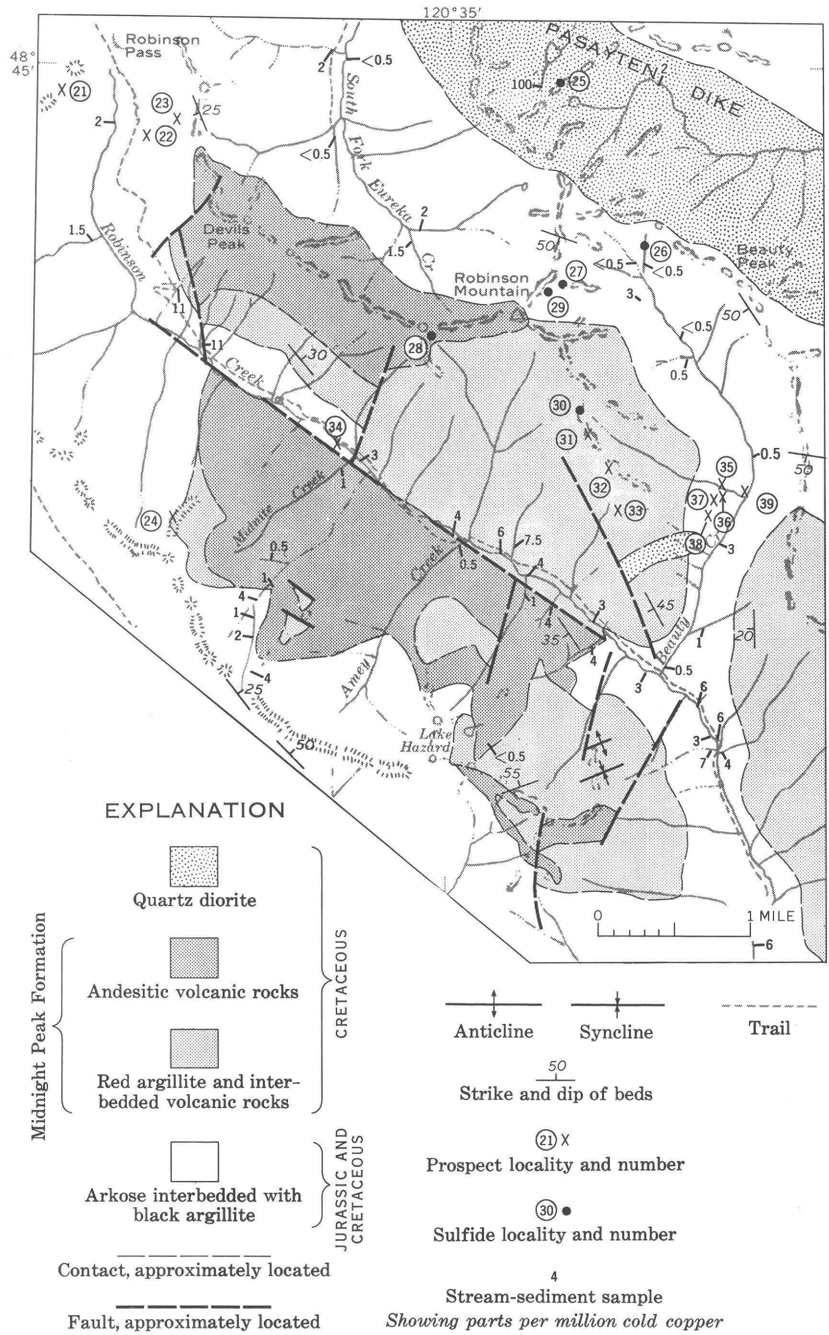


Figure 32.—Location and general geology of prospects in the Robinson Creek area. Base from U.S. Forest Service planimetric map, 1955.

most recent in 1956. Most of the claims are in a belt parallel to and within 2 miles of the southwest contact of the Pasayten dike. No production is known from the area.

Many veins and mineralized shear zones occur in the area, some of which are explored by small workings. Pyrite, chalcopyrite, malachite, azurite, and covellite are the common ore minerals in quartz veins. Traceable length of individual veins is between 37 and 220 feet; width is between 2 inches and 3.5 feet. Assays of samples from the best properties contain a trace to 0.93 ounce of gold per ton, a trace to 3.06 ounces of silver per ton, and 0.04 to 4.0 percent copper. Only the better prospects are described below.

The known deposits are submarginal, but some would be nearly economic for small-scale mining. Submarginal vein material of the better prospects in the district is estimated to be 4,000 to 5,000 tons containing 0.11 to 0.93 ounce of gold per ton and 0.18 to 1.37 ounces of silver per ton. The copper would only be a byproduct. The Beauty Creek area has a good potential for discovery of deposits of similar grade and possibly some of higher grade.

The nearest rail shipping point is at Pateros, which, from the point where the Methow Valley–Harts Pass road crosses Robinson Creek, is about 70 miles to the southeast. Access to prospects in the vicinity of Beauty Creek would require construction of about 5 miles of road.

LOCALITY 21 (RED MOUNTAIN? CLAIM)

Locality 21, 0.4 mile southwest of Robinson Pass (fig. 32), has two circular pits about 10 feet in diameter and as much as 7 feet deep. They may be on the Red Mountain claim, which was located in this general area in 1955 by Dallas Hanes.

Two parallel veins exposed in the deepest pit are 3 feet apart, strike N. 85° W., and dip from 80° N. to vertical. The northernmost vein is 0.3 to 0.6 foot thick and the southernmost is 1.3 to 3.8 feet thick. The smaller vein is exposed only on the east side of the pit; the larger vein can be traced for 45 feet west of the pit. The veins, which are in or along the south contact of a 200-foot-thick plagioclase porphyry dike, consist principally of white opaque quartz with many irregular limonite-stained fractures. In places a little pyrite, sphalerite, and galena were found. Two 3-foot chip samples were cut across the larger vein (MHS–55–65, NC–P–71, table 2). These samples yielded none and a trace of gold, and only 0.06 ounce per ton and a trace of silver.

One hundred twenty-three feet west of the deep pit a shallow pit exposes a vein of similar composition. This exposure is on the projected strike of the larger vein and may be on the same structure.

The vein in the shallower pit strikes N. 80° E. and dips 65° N. It is exposed for 4 feet and has an average thickness of 2.5 feet. A chip sample (NC–P–72, table 2) taken across the vein assayed only a trace of gold and silver.

Locality 22 (Greyling Claim)

A cut 28 feet long and 7 to 16 feet wide (figs. 32, 33) and a small pit are found at locality 22. These workings are on the east side of Robinson Creek, 160 feet above the trail to Robinson Pass. This is probably the Greyling claim, located south and east of Robinson Pass by Frank Jenks and Charles Kenny in 1924. As stated in the courthouse records, this is a relocation of a very old claim, probably staked 30 years before.

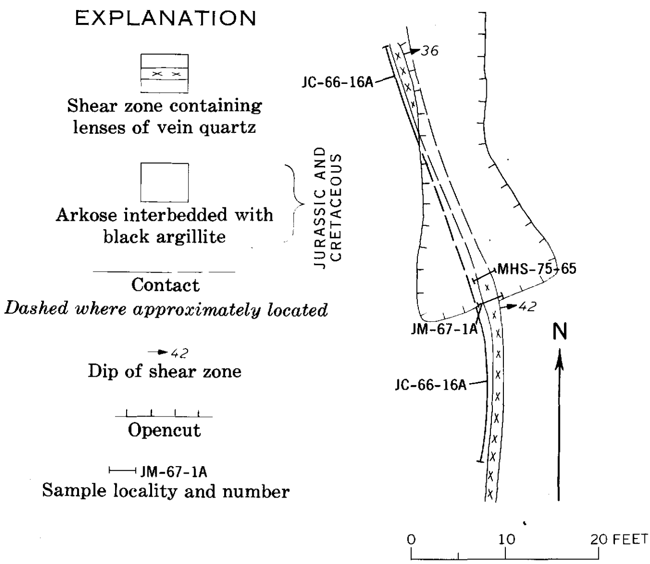


Figure 33.—Workings at the Greyling claim (loc. 22).

The cut exposes a shear zone in interbedded plagioclase arkose and argillite that is 1.4 to 2.5 feet wide and can be traced for 18 feet beyond the cut to the south (fig. 33). The shear zone strikes N. 18° W. and dips 36°–42° E. Along the shear zone lenses of quartz ranging from 0.3 to 1.0 foot thick lie in country rock. The quartz contains disseminated pyrite, chlorite, pyrrhotite, chalcopyrite, sphalerite, and covellite.

Two chip samples 1.5 feet long and 3 feet apart were cut across the shear zone near the south end of the cuts (fig. 33). Roughly half the zone here is sulfide-bearing quartz. The north sample (MHS–75–65, table 2), contains 0.13 percent copper and no gold. The south sample (JM–67–1A, table 2) yielded 0.01 ounce of gold and 0.25 ounce of silver per ton, 0.06 percent copper, and 0.1 percent zinc. A 20-foot sample (JC–66–16A, table 2) was also taken along the strike of this zone. It assayed 0.01 ounce of gold per ton and 0.03 ounce of silver per ton.

The small pit is 125 feet south of and upslope from the main cut. No bedrock is exposed in this partly sloughed pit. Adjacent to it is a small stockpile of sulfide-bearing rock. A sample (JC–66–17A, table 2) from this stockpile assayed only a trace of gold and 0.3 ounce of silver per ton.

Locality 23

There is a short adit at locality 23, about 1,200 feet N. 50° E. of the Greyling claim (loc. 22). This working is about 480 feet vertically above the Greyling pit, at an elevation of 6,720 feet. The prospect may be reached from Robinson Pass either by following the main trail to a point below the adit and then ascending a vertical distance of 700 feet, or by climbing to the pass and traversing the open slope directly to the adit.

The name of this claim is not known. Presumably the claim was staked before the turn of the century, probably by the same people that staked the original Greyling claim.

The adit has no prominent dump and is only 5 feet long, with an 8-foot cut leading to the portal (fig. 34). The country rock is black

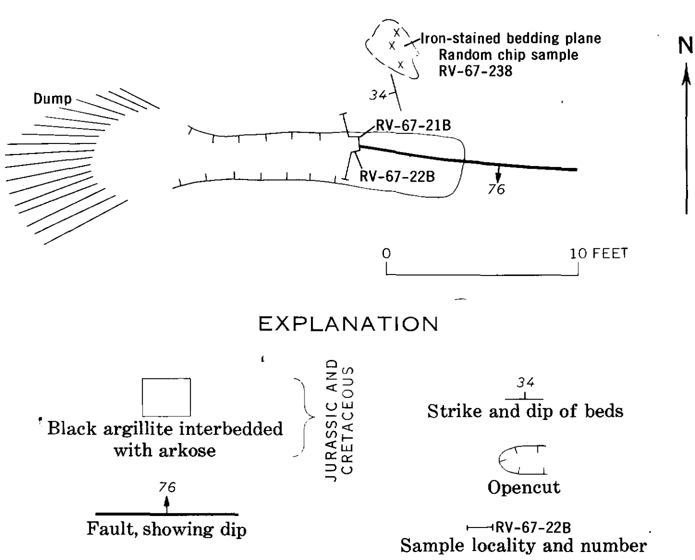


FIGURE 34.—Workings at locality 23.

argillite and intercalated buff-colored arkose, which strike N. 15° W. and dip 34° W. The adit exposes a fault zone as much as 15 inches thick that strikes N. 85° W. and dips 76° S. It is composed of breccia cemented with quartz and calcite with a high limonite content and minor pyrite. The adjacent country rock also contains scattered crystals of pyrite. At the north edge of the portal along a bedding plane is a layer 2–3 inches thick, of iron-oxide-stained rock with minor pyrite.

A 15-inch chip sample (RV–67–21B, table 2) was cut across the fault zone at its widest part near the mouth of the adit (fig. 34). It contained a trace of gold and 0.045 ounce of silver per ton, but no copper. A second sample (RV–67–22B, table 2) representing 4 feet of the adjacent country rock was taken on either side of the fault. No gold or copper was detected, but the sample assayed 0.05 ounce of silver per ton. A random chip sample of the iron-oxide-rich rock along the bedding plane (RV–67–23B, table 2) had no copper or gold, and only a trace of silver.

Locality 24

Locality 24 (fig. 32) is at 6,750 feet elevation on the ridge between Robinson Creek and Rattlesnake Creek, 2.3 miles southeast of Harts Pass, and adjacent to an old sheep trail skirting the northeast side of the ridge. No notice of a claim was found, but a shallow discovery pit has been dug in an altered zone which crosses the contact of the plagioclase arkose with red argillite and sandstone. This zone is cut by small calcite veins. Southeast of this zone is a large southwest-trending quartz prophyry dike. A 25-foot chip sample (RWT–24–65, table 2) cut across the strike of the most altered rock exposed in the prospect yielded <0.002 ounce of gold and 0.06 ounce of silver per ton.

Locality 25

Locality 25 is on the northwest side of the ridge south of the tarn that lies at the headwaters of a tributary of the South Fork of Eureka Creek (fig. 32). No workings were noted in this area. The country rock along the ridge is quartz diorite which is cut by shear zones every hundred feet or so. The shear zones consist of closely spaced joints that strike N. 25° W. and dip 45° SW. Many of them have thin chlorite-rich seams along them. About 300 feet below the ridgetop in a small northwest-trending gully, some of the joints are coated with crusts of chrysocolla generally less than one-thirty-second of an inch thick. There is also a vein one-thirty-second to three-quarters of an inch thick made up principally of chalcopyrite and pyrite. The vein is only 10 feet long. Other minerals noted in this vein are chrysocolla, malachite, and a little azurite and molybdenite. Several cross fractures have thin coatings of chalcopyrite or, more commonly, of malachite, chrysocolla, and pyrite. A sample (RWT–225–65, table 2) of the vein where it was three-quarters of an inch thick, contained 10.6 percent copper, and 2.36 ounces of silver and 0.002 ounce of gold per ton.

A second group of copper veinlets on cross fractures is 100 feet farther down the gully. The longest of these veinlets is 10 feet long and as much as 1 inch thick and consists of crushed quartz diorite that was impregnated with pyrite and chalcopyrite and stained with chrysocolla. Several irregular lenses, as much as 6 inches thick but only 6 inches to 2 feet long, are in this same area. A little molybdenite was also found on some pieces. Along this north-facing ridge slope several other small areas of copper minerals were seen.

A stream-sediment sample from a small gully draining the ridge several hundred feet west of where these copper-bearing veinlets were found contained 100 ppm copper. As no copper minerals were noted in this area, the copper probably comes from veinlets hidden by glacial debris.

Although parts of the veins seen are rich in copper, they are of little economic value because of their small size. Hidden veinlets may be larger, but it is unlikely that they represent either a large vein or a large disseminated deposit, as the fractures in the quartz monzonite are fairly tight and no altered rock is found in the vicinity of the geochemical anomaly.

Locality 26

Locality 26 (fig. 32) is at the headwaters of Beauty Creek, 1,000 feet east of a saddle separating Beauty Creek from a tributary of Eureka Creek. It is at an elevation of approximately 6,900 feet. Workings were not noted in this area. The country rock is a light-gray arkose. At this locality an irregular northeast-trending shear zone 0.7 to 2.0 feet wide is exposed for a distance of 6 feet. The arkose in this zone is darker than that in the surrounding rock, and contains sparse pyrite. A 1-foot chip sample (MHS–65–65, table 2) was taken across this zone. The sample did not contain appreciable gold.

Locality 27

Locality 27 (fig. 32) is on the south side of the ridge about 1,800 feet northeast from the top of Robinson Mountain. Here a small quartz vein cuts a plagioclase porphyry dike. The vein, ½–2 inches thick, has a general north strike and a 80° E. dip, and can be traced for 40 feet. Toward its south end it splits into several small veins. No minerals other than quartz were noted. A chip sample

(MHS–79–65, table 2) taken across the vein did not contain any gold.

Locality 28

Locality 28 (fig. 32) is on the south side of the ridge 3,500 feet west of the top of Robinson Mountain. No workings were noted in this area. Country rock is an andesite flow. In this rock a lens-shaped area 2 feet by 1.5 feet is impregnated with pyrite and iron oxides. A chip sample (MHS–83–65, table 2) was taken of this small area. It contained 0.12 ounce of silver per ton and traces of copper and zinc.

Locality 29

Locality 29 is a quartz-cemented breccia zone on a fault 2,400 feet northeast of Robinson Mountain. A 15-foot chip sample (RV–66–16A, table 2) taken across the lower part of the breccia body contained a trace of gold and 0.1 ounce of silver per ton.

Locality 30

Locality 30 (fig. 32) is on the crest of the main southeast ridge of Robinson Mountain, 0.85 mile from the summit, at an elevation of 7,800 feet. There are no workings. Azurite and malachite stain a dark-green argillite along the contact of an underlying feldspar porphyry flow. A grab sample of stained material from the talus (RWT–142–65, table 2) contained 1.2 percent copper and 0.15 ounce of silver per ton.

Locality 31

Locality 31 (fig. 32) is 800 feet southeast of locality 30, at an elevation of 7,500 feet. A small caved pit about 3 feet deep might possibly mark either the Blue Queen, a claim located by Dallas Hanes in 1955, or the Storm King claim. The pit was dug in thin-bedded gray arkose and purple argillite and is cut by a granite porphyry dike just up the ridge. Rock on the dump contains small seams of covellite and malachite, but only a minor amount of the copper-bearing rock was seen in place. A grab sample of the rock with the copper-bearing seams from the dump (RWT–144–65, table 2) contained 4.0 percent copper and 3.06 ounces of silver per ton.

Locality 32 (Blue Queen or Storm King Claim)

Locality 32 is on the crest of the ridge west of Beauty Creek, at an elevation of 7,150 feet, 1,200 feet southeast of locality 31 (fig. 32). A claim, marked by an old post, may be either the Blue Queen, located by Dallas Hanes in 1955, or the Storm King. Fifty feet southwest and directly downslope from the post are two caved adits along a vertical fault that strikes N. 40° E. The fault is covered by talus below the workings, but can be traced to the east side of the ridge, a distance of about 100 feet. The zone is no more than 6 inches wide. The country rock is argillite, which is bleached along the structure. Pyrite and minor amounts of other metallic minerals are present along the fault in a limonitic quartz boxwork with some manganese oxide staining. A grab sample (RWT–145–65, table 2) from a small stockpile of altered pyrite-bearing material near the claim post contained 0.72 ounce of gold and 1.37 ounces of silver per ton. A chip sample (RV–66–20A, table 2) taken between the upper adit and the ridge crest yielded 0.93 ounce of gold and 0.5 ounce of silver per ton, 0.5 percent lead, 0.05 percent zinc, and a trace of copper.

Vein material of this deposit is submarginal in grade, and is estimated to aggregate only a few hundred tons.

Locality 33

Locality 33 (fig. 32) is at an elevation of 6,200 feet on the ridge 1.1 miles N. 15° W. from the mouth of Beauty Creek.

A mineralized shear zone 2.5 feet wide extends obliquely across the ridge, cutting red argillite and interbedded volcanic rocks. The zone strikes north and dips 60° W. It can be traced for 80 feet and is exposed over a slope relief of 20 feet; overburden covers each end.

The zone is highly silicified and contains about 15 percent combined hematite and limonite. A grab sample (NC–P–65, table 2) taken along the exposure assayed 0.8 ounce of gold and 0.4 ounce of silver per ton.

On the basis of one assay, this deposit appears to approach minable grade, although its small size and difficult access preclude development at this time. The submarginal reserves are estimated to be between 1,000 and 2,000 tons, but additional work would be required to delineate the deposit.

Locality 34 (Reliance Claim)

The Reliance claim was located by W. B. Robinson in 1906, along Robinson Creek 6 miles by trail from the Harts Pass road and less than 100 feet northeast from the ruins of Robinson's cabin (fig. 32).

Dacite porphyry at its contact with argillite is silicified and pyritized. The mineralized rock is exposed in a small trench and in the creek bank (fig. 35). Thickness of the zone ranges from 2.5 to 7 feet, and the exposed depth is less than 10 feet.

The silicified rock contains less than 1 percent pyrite in 0.1-inch cubes where it is exposed in a trench 32 feet long and 1.5 feet deep. A 20-foot chip sample (NC–P–69) taken along the exposure contained only a trace of gold and silver.

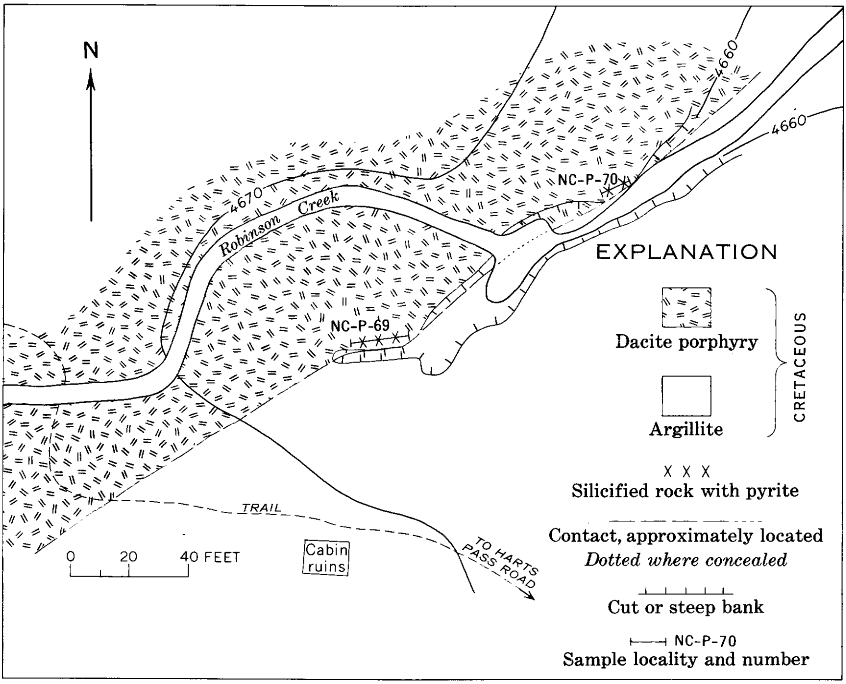


FIGURE 35.—Reliance claim (loc. 34).

Similar mineralized rock is exposed in the creek bank at a point 58 feet northeasterly from the trench. The exposure is 14 feet long, 2.5 feet thick, and 4.5 feet deep. A random sample (NC–P–70) of the exposure contained only a trace of gold and silver.

LOCALITY 35 (BEAUTY CREEK QUARTZ LODE)

Locality 35 is on the west side of Beauty Creek at an elevation of about 5,750 feet. At this locality two trenches 8 feet wide and 12 feet long are a few hundred feet north of a small tributary to Beauty Creek (fig. 32). This locality may be covered by one of the following claims: Wampus Cat 1 to 6, located by Allen Ives, W. A. Darlington, and Arch Fuller in 1938; Miracle 1 and 2, located by Gene Yost, Dale G. Hill, and Jack H. Hill in 1940; or Nonpariel, located by W. B. Robinson in 1906; all were located in this general region. The two trenches are cut in a light-gray fine-grained arkose, which has a northerly strike and a gentle westerly dip (fig. 36). A shear zone cutting the arkose strikes N. 50° E. and dips 80° SE. It is exposed only in and between the two pits, a distance of 34 feet, and varies from 0.5 to 2.0 feet in width. Small grains of pyrite are scattered along the zone, most commonly in the north trench where the zone is 2 feet wide. Two 2-foot chip

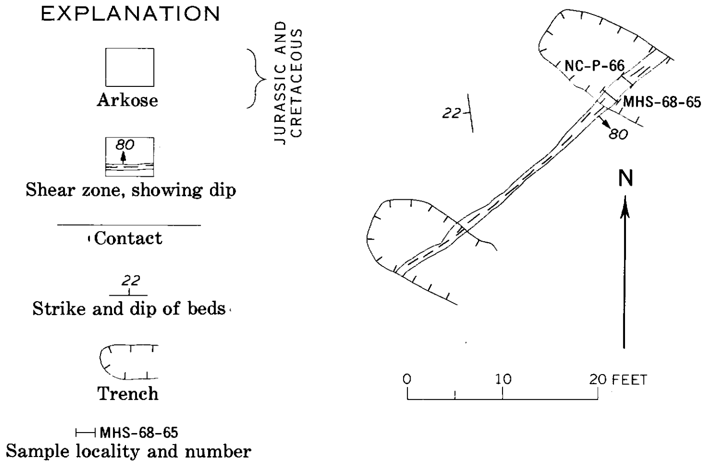


FIGURE 36.—Workings at locality 35.

samples (MHS–68–65, NC–P–66, table 2) were taken across the shear zone in the north trench. One contained only a trace of copper; the other, a trace of gold and silver.

LOCALITY 36

Locality 36 is approximately 1,000 feet south of locality 35 at an elevation of 5,650 feet (fig. 32). A trench here is 15 feet long, 6 feet wide, and as much as 6 feet deep. This working, like those at locality 35, might be on one of the following claims: Wampus Cat 1 to 6, Miracle 1 or 2, or the Nonpariel. The country rock is light-gray fine-grained arkose. It is cut by a shear zone that strikes N. 70° E. and dips 80° SE. This zone is exposed for only 8 feet and is not more than 0.3 foot wide. Small grains of pyrite are scattered along the zone. Two chip samples (MHS–71–65, NC–P–63, table 2) were taken across the shear zone. One sample did not assay any precious metals, but the other assayed 0.26 ounce of gold and 0.3 ounce of silver per ton.

LOCALITY 37

Locality 37 is about 1,000 feet southeast of the Beauty Creek Lode at an elevation of approximately 5,750 feet (fig. 32). At this locality there is an irregular opencut whose maximum dimensions are 12 feet by 12 feet (fig. 37). At the north end of this cut an inclined shaft 28 feet deep was sunk on a shear zone 1.5 to 3.5 feet wide. Eight feet below the top of the shaft on its south side is a level that is probably only a short crosscut. Water fills the shaft to within 20 feet of its top. As at localities 35 and 36, these workings

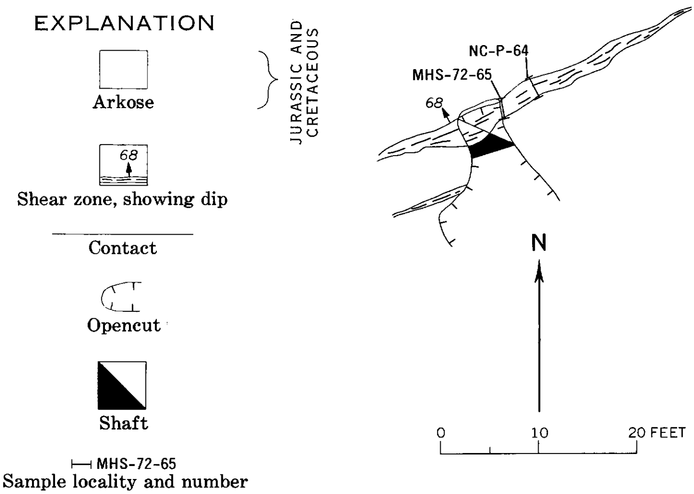


FIGURE 37.—Geology of the workings at locality 37.

may be on one of the following claims: Wampus Cat 1 to 6, Miracle 1 and 2, or Nonpariel.

The opencut is in light-gray fine-grained arkose. This rock is cut by two parallel shear zones that strike N. 65° E. and dip 68° NW. The larger one, on which the shaft was sunk, can be traced for 37 feet on the surface and is visible to the water level in the shaft. Along the sides of the shaft it is 1.5 to 3.5 feet wide, and it thins laterally. The smaller shear zone can only be traced for 8 feet and is 0.2 to 1.0 foot wide. In the shear zones are quartz veinlets and scattered pyrite, pyrrhotite, possibly arsenopyrite, and a little chalcopyrite; sulfides are much commoner in the large shear zone. A 1-foot chip sample (MHS–72–65, table 2), taken across the large shear zone on the east side of the shaft (fig. 37), yielded 0.05 ounce of gold and 0.23 ounce of silver per ton, and 0.04 percent copper. A similar sample (NC–P–64, table 2) taken a few feet to the northeast contained 0.17 ounce of gold and 0.4 ounce of silver per ton.

The deposit cannot be mined economically at present because of its small size and low grade.

LOCALITY 38

Locality 38 is on the west side of Beauty Creek approximately 600 feet southwest of locality 37 at an elevation of about 5,600 feet (fig. 32). At this locality are two trenches, 32 feet apart. The north one is 12 feet long and 6 feet wide; the south one is not quite as long and is filled with slope wash. Like the workings at localities 35, 36, and 37, these trenches may be on one of the following claims: Wampus Cat 1 to 6, Miracle 1 and 2, or the Nonpariel. Country rock is light-gray fine-grained arkose. A 2-foot-wide shear zone is exposed in the north trench and can be traced to the filled south trench; it is exposed for a total distance of 38 feet. This zone strikes N. 15° E. and dips 16° NW., parallel to the bedding of the arkose. Sparse pyrite and pyrrhotite are scattered along this zone. A 2-foot chip sample (MHS–74–65, table 2) was taken across the shear zone in the north trench. The sample contained no gold and only a trace of silver.

Locality 39 (Beauty Creek Lode)

Locality 39 is along Beauty Creek about 750 feet southeast of locality 35 (fig. 32). The Beauty Creek claim was relocated in 1956 by William Parson, but the vein probably was discovered in the early 1900's. The discovery pit is at an elevation of 5,200 feet on the west edge of Beauty Creek, 1.3 miles from its mouth.

A vein that cuts light-gray fine-grained arkose, in the bottom of a cleft occupied by the creek, is exposed intermittently for a distance of 220 feet from the discovery pit northeastward (fig. 38). The vein

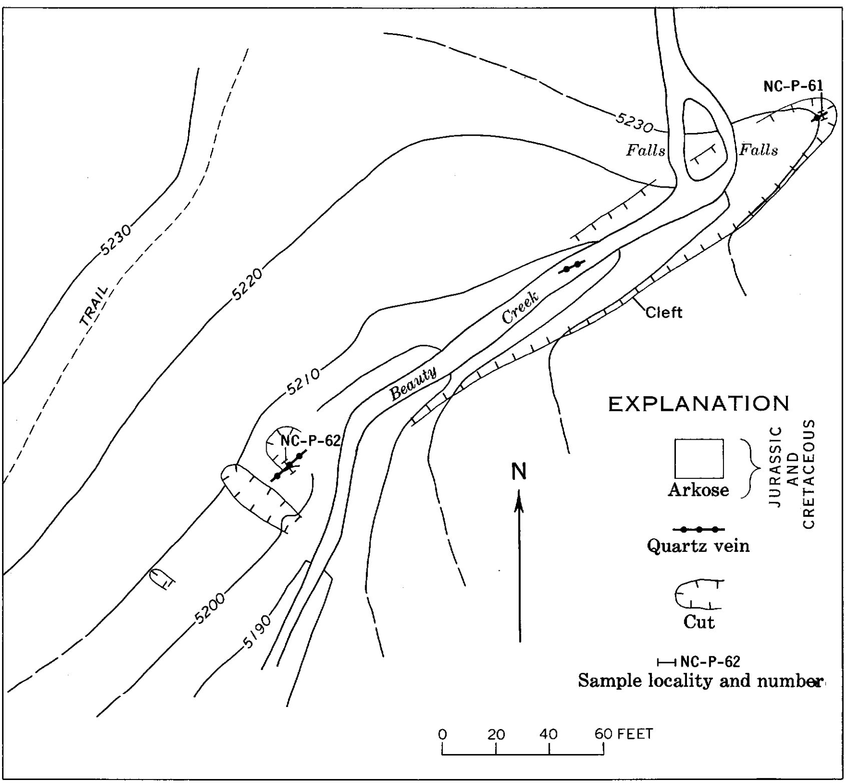


FIGURE 38.—Beauty Creek lode (loc. 39).

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strikes N. 46° E., dips vertically, and ranges in thickness from 2 to 18 inches. It pinches to 2 inches at the northeast end of the cleft, where any extension is obscured by overburden. The south end of the vein probably extends 20 feet beyond the discovery pit to a sloughed trench. The vein is not exposed in the sloughed discovery pit, but mineralized material on the dump is predominantly quartz and silicified gangue with pyrite, pyrrhotite, hematite, and limonite. One piece of massive sulfides found on the dump was 4 inches long, 3 inches wide, and 1.5 inches thick. A grab sample (NC–P–62, table 2) of the mineralized material on the dump assayed 0.68 ounce of gold and 0.7 ounce of silver per ton.

A 10-foot exposure of the vein 110 feet northeast of the discovery pit is under water and was not sampled, but the vein appears to be 4 to 18 inches wide, and the country rock is altered for a few inches along it.

The vein as exposed at the northeast end of the cleft is 2 inches wide, 2 feet long, and 3.2 feet deep. At this point it is composed predominantly of quartz and limonite but contains about 1 percent pyrite. A chip sample (NC–P–61, table 2) of the vein assayed 0.06 ounce of gold and 0.3 ounce of silver per ton.

The deposit may contain a few thousand tons of ore, but the grade is too low and the vein too narrow to permit mining economically at present.

BUCKSKIN RIDGE AREA

Buckskin Ridge trends north from Slate Peak and lies between the West and Middle Forks of the Pasayten River (fig. 39). The western faulted segment of the Pasayten dike forms the central part of the area. This quartz diorite dike intruded mainly arkose on the north and black argillite on the south. The sedimentary rocks, especially those south of the intrusive, are cut by numerous plagioclase porphyry and quartz porphyry dikes. Contact metamorphism adjacent to the intrusive caused recrystallization of feldspar and quartz and formation of biotite. Sulfide-bearing quartz veins are found in the sedimentary rocks; most are to the south and within 2 miles of the quartz diorite.

Two groups of workings are found in this area: one, a group of seven adjacent adits (loc. 45), is on the west side of the ridge; the other consists of several small pits (locs. 41, 42, 43, 44, fig. 39) that extend along the ridge crest and down its east flank toward Silver Creek.

The main workings of both groups are accessible by good trails from the Slate Peak road. If these prospects are further developed, a road to each group would have to be constructed. A road to the western group from Slate Peak would be about 3 miles long; an access road to the general area of the other prospects would be along the opposite side of the ridge and would be about 4 miles long.

No production has been recorded from any prospect in the Buckskin Ridge area.

Locality 40

Locality 40 (fig. 39) lies on the ridge between Threemile Creek and the Middle Fork of the Pasayten River, approximately 3,000 feet north of the quartz diorite intrusive. No workings were noted at this locality. Gray fine-grained arkose, which strikes about N. 30° W. and dips 50° SW., is cut by a fracture that trends N. 20° E. and dips 70° SE. Along this fracture, which can be traced for 30 feet, is a vein ¼–3 inches thick that consists of iron oxides, chrysocolla, quartz, malachite, and pyrite. This vein is not well exposed, so a grab sample (MHS–100–65, table 2) was taken of pieces of it from the talus. The sample contained 11.7 percent copper, 0.67 ounce of silver per ton, and small amounts of lead, zinc, and gold.

Locality 41 (New Hope Claims)

Locality 41 is on the southeast side of a small ridge on the east side of the south branch of Silver Creek (fig. 39). It is 2,000–3,000 feet south of the Pasayten dike. Workings consist of six cuts and trenches on three or four principal veins. These workings are on the New Hope property, which, according to Huntting (1956, p. 68), consists of seven claims located in 1951 by R. C. Matney and R. A. Morgan. Courthouse records show that other claims in the area were recorded in 1950 and 1951. Country rock is arkose with some interbedded argillite that strikes N. 38° E. and dips 25° SE. In places these older rocks are cut by plagioclase porphyry dikes.

The northernmost vein, which is exposed in two opencuts 15 and 23 feet long, is enclosed in a quartz porphyry dike and can be traced for about 100 feet (fig. 40). In the two cuts, the vein is from 1 to 1.4 feet thick; west of the cuts, it thins to about 0.5 foot. The dip is 75° N. The vein consists principally of quartz, but in places pyrrhotite and chalcopyrite make up most of the vein. A chip sample (MHS 107–65, table 2) taken across 1 foot of vein rich in sulfides in the northernmost cut (fig. 40) contained 1.1 percent copper and 0.05 ounce of gold per ton. Another sample (JC–66–18A, table 2), cut along the strike of the zone in the southernmost cut (fig. 40), had 0.60 percent copper, and 0.04 ounce of gold and 0.3 ounce of silver per ton. A sample (JC–66–19A), from a narrow gouge zone 0.5–1 inch thick in the northernmost cut, yielded 0.48 ounce of gold and 0.3 ounce of silver per ton.

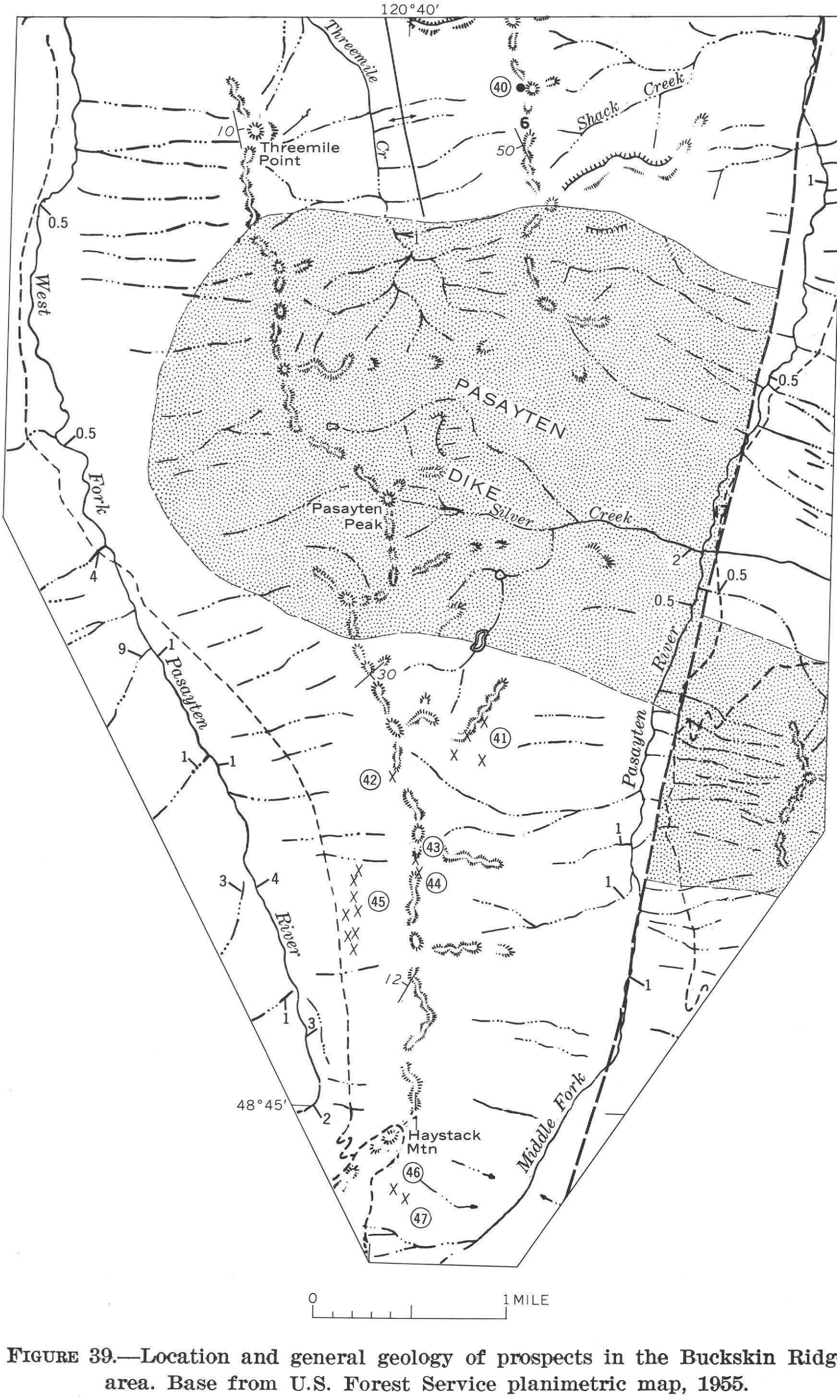


FIGURE 39.—Location and general geology of prospects in the Buckskin Ridge area. Base from U.S. Forest Service planimetric map, 1955.

EXPLANATION

Quartz diorite — CRETACEOUS

Arkose interbedded with black argillite — JURASSIC AND CRETACEOUS

Contact
Dashed where approximately located

Fault, approximately located

Anticline
Showing trace of axial plane

50
Strike and dip of beds

(41) X
Prospect locality and number

(40) •
Sulfide locality and number

2
Stream-sediment sample
Showing parts per million heavy metals

Trail

About 200 feet south of the northernmost vein and at about the same elevation, a second shear zone is exposed in an opencut 6 feet wide, 13 feet long, and 5 feet deep at the back. The cut is in brown arkose. The shear zone strikes N. 68° E., dips 70° NE., and is as much as 5 feet wide. Along the shear zone are found lens-shaped veins 1 to 4 inches thick and 2 to 3 feet long. The veins are principally of quartz but also contain pyrite, pyrrhotite, chalcopyrite, and chalcocite. A 5-foot chip sample (MHS–105–65, table 2) was taken across the shear zone, and included three 1- to 4-inch-thick veins. This sample contained 0.14 percent copper and 0.08 ounce of gold per ton.

About 700 feet southeast of the northernmost vein and about 200 feet below it a third vein is exposed principally in a trench 25 feet long and 10 feet wide in brown arkose. The vein can be traced for an additional 18 feet above the trench. It varies in thickness from 1.5 to 8 feet, strikes N. 65° W., and dips 48° NE. The vein consists principally of quartz, pyrrhotite, and some chalcopyrite. An 8-foot

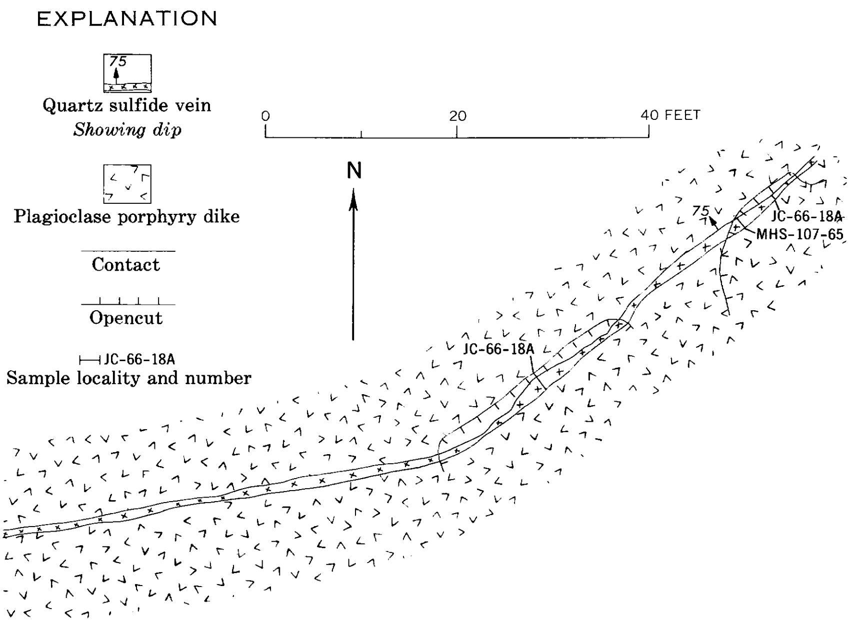


FIGURE 40. —Northernmost vein on the New Hope property (loc. 41).

chip sample (MHS–108–65, table 2), taken across this vein in the trench, had 0.27 percent copper and less than 0.02 ounce of gold per ton.

About 400 feet northwest and 170 feet above the last described vein is another vein exposure in a trench. These two may or may not be the same vein. This trench is in arkose and is 26 feet long and 8 feet wide. In the trench a 1- to 4-foot-thick vein is exposed for 22 feet. It strikes N. 80° E. and dips 65° NW. This vein consists principally of quartz, pyrrhotite, and a little chalcopyrite. Two 4-foot chip samples (MHS–110–65, RW–66–1B, table 2) taken across the vein contained 0.16 percent copper and less than 0.02 ounce of gold per ton, and 0.13 percent copper and a trace of gold and silver, respectively. A spectrographic analysis of the second sample showed nickel in the range of 0.03 to 0.3 percent.

The uppermost cut is located about 450 feet upslope, northwest of the last working. It exposes a small limonitic breccia zone in a dark arkose. The breccia zone contains sparse sulfides.

LOCALITY 42 (SILVER BELLE NO. 2 CLAIM)

Locality 42 (fig. 39) lies on the ridge between the West and Middle Forks of the Pasayten River, approximately 2,000 feet southwest of locality 41. A small caved pit 4 feet long, 3 feet wide, and 1 foot deep is on the ridgetop, and a second pit, which is 6 feet long, 3 feet wide, and 1 foot deep, lies 50 feet to the east. These pits are on the Silver Belle No. 2 claim, which was located by Robert W. Mullen, July 9, 1951.

Both pits are in arkose. A bleached quartz-plagioclase porphyry dike cuts the arkose just north of the two pits. On the dump of the first pit are a few fragments of vein quartz with scattered pyrite grains, and much iron-oxide-stained arkose; on the dump of the second pit only iron-oxide-stained arkose was found. A grab sample (MHS–91–65, table 2) was taken of iron-oxide-stained quartz vein from the dump of the first pit; it contained only 0.12 ounce of silver per ton and no gold.

Locality 43

Locality 43 (fig. 39) lies on the main ridge between the West and Middle Forks of the Pasayten River, about 500 feet north of locality 44. This locality is marked by two slumped pits 6 feet long by 3 feet wide that are now only 1 to 2 feet deep. These pits are about 6 feet apart in platy iron-oxide-stained arkose. Plagioclase porphyry dikes lie about 10 feet north of and about 75 feet south of the pits. The pits are on a 4- to 8-foot-wide iron-oxide-stained zone that contains finely disseminated pyrite. This zone dips steeply and trends approximately N. 70° W. In places the altered zone contains a 1- to 4-inch quartz vein. Exposures are poor, and the altered zone and quartz vein crop out only on the ridge about 50 feet east of the easternmost pit. A chip sample (1739, table 2) across the altered zone and a channel sample of the vein (1740, table 2) were taken on the outcrop 50 feet east of the pits. The quartz vein was barren, but the altered rock contained 0.09 ounce of gold per ton and small amounts of copper and zinc. Four grab samples of the rubble in the pit were taken: one of the iron-oxide-stained quartz vein (1741, table 2) and three of iron-oxide-stained arkose (1742, MHS–90–65, RV–66–7B, table 2). The quartz vein yielded 0.79 ounce of gold and 0.17 ounce of silver per ton; the three samples of altered arkose had 0.12, 0.77, and 0.25 ounce of gold per ton, and a trace, 1.63 ounces per ton, and a trace of silver.

Locality 44 (Alfrine Claim)

Locality 44 (fig. 39) is on the top of the main ridge between the West and Middle Forks of the Pasayten River, about 1.2 miles north of Haystack Mountain. The claim is marked by a small caved pit roughly 3 feet long and 1 foot wide. This claim is the Alfrine, located by William Brant on June 16, 1936. Rock around the pit is iron-oxide-stained argillite. About 40 feet north of the pit is a bleached quartz-feldspar porphyry dike. Vein quartz can be traced for 100 feet downslope to the east and 10 feet downslope to the west. Width of vein, as indicated by size of float pieces, is ½–1 inch. Quartz was the only mineral other than a little limonite noted in the vein material. A sample of the quartz float (MHS–88–65, table 2) contained small amounts of silver, copper, zinc, and lead, but no gold.

None of the veins observed at localities 41, 42, 43, and 44 contain economic quantities of ore minerals. Further prospecting in the area may disclose higher value extensions of the veins or other zones of value.

Locality 45

A group of adits about 1.7 miles north of Slate Peak is commonly referred to as the Gold Ridge claims. They were recorded prior to 1900 (fig. 39). According to the location given by Landes, Thyng, Lyon, and Roberts (1902, p. 48–49), there is some doubt as to whether these are the original Gold Ridge workings.

Seven adits have been driven in north-striking moderately eastward dipping interbedded arkose and argillite that forms several small bluffs (fig. 41). The workings expose several narrow sulfide-bearing joints and shear zones that strike nearly normal to the ridge and to the strike of the country rock and strike parallel to the contact of the Pasayten dike about 1½ miles to the north. The structures contain quartz and calcite with sulfide minerals and iron oxides; gouge is common. The chief sulfides are pyrite and pyrrhotite, and there are minor amounts of chalcopyrite, galena, and sphalerite. The mineralized veins are as much as 1.5 feet wide, but the maximum width of shear zones exposed is 5 feet.

Seven adits are near the trail, and a pit, probably a more recent effort, is about one-fourth mile north of the group and about 500 feet above the trail. The main group is shown in figures 41 to 44.

Adit A is 14 feet long and follows a fracture zone in iron-oxide-stained arkose (fig. 42). The zone is 2 feet or less in width and contains an iron-oxide-stained quartz vein as much as 0.7 foot wide that strikes N. 67° E. and dips 84° S. A chip sample (MHS–57–65, table 2) showed no gold and only traces of silver, copper, and zinc.

Adit B is 148 feet long and was driven to intersect a mineralized shear zone exposed in adit C (fig. 42). Adit B was driven through light-gray arkose for 60 feet, then into black silicified argillite to the face. Two narrow calcite veins that trend normal to the line of the adit contain minor sulfides. An inclined raise from adit B probably gives access to an intermediate level that is caved.

The biggest shear zone of the group is exposed in adit C (fig. 42). Adit C is 45 feet long and follows a shear zone that varies in

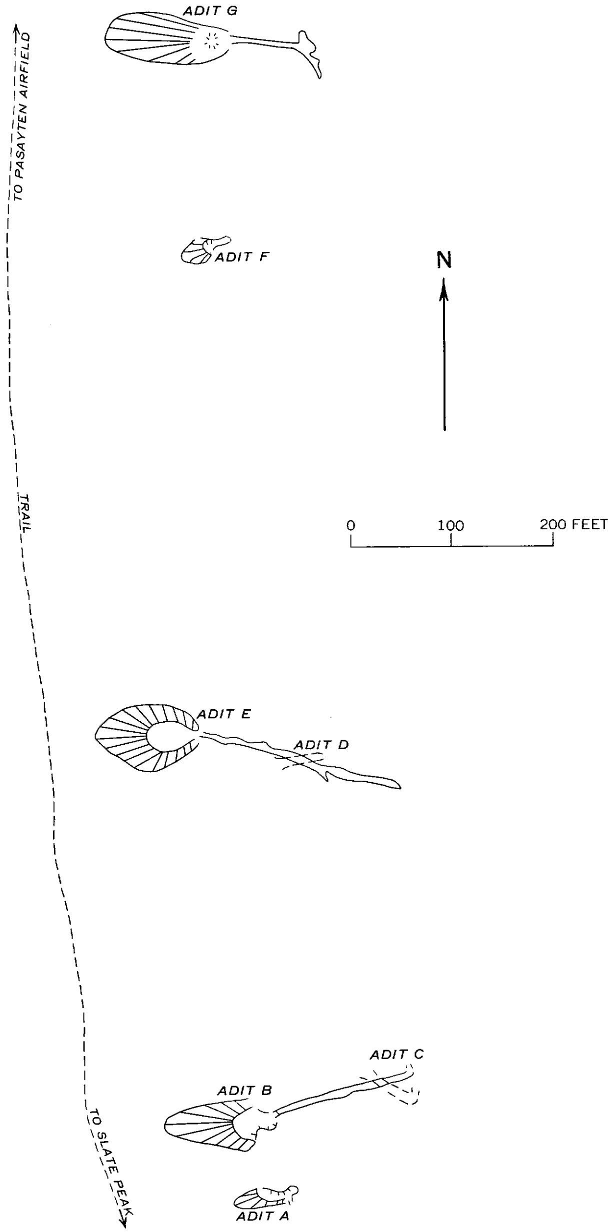


FIGURE 41.—The property in the upper part of the basin of the West Fork of the Pasayten River (loc. 45).

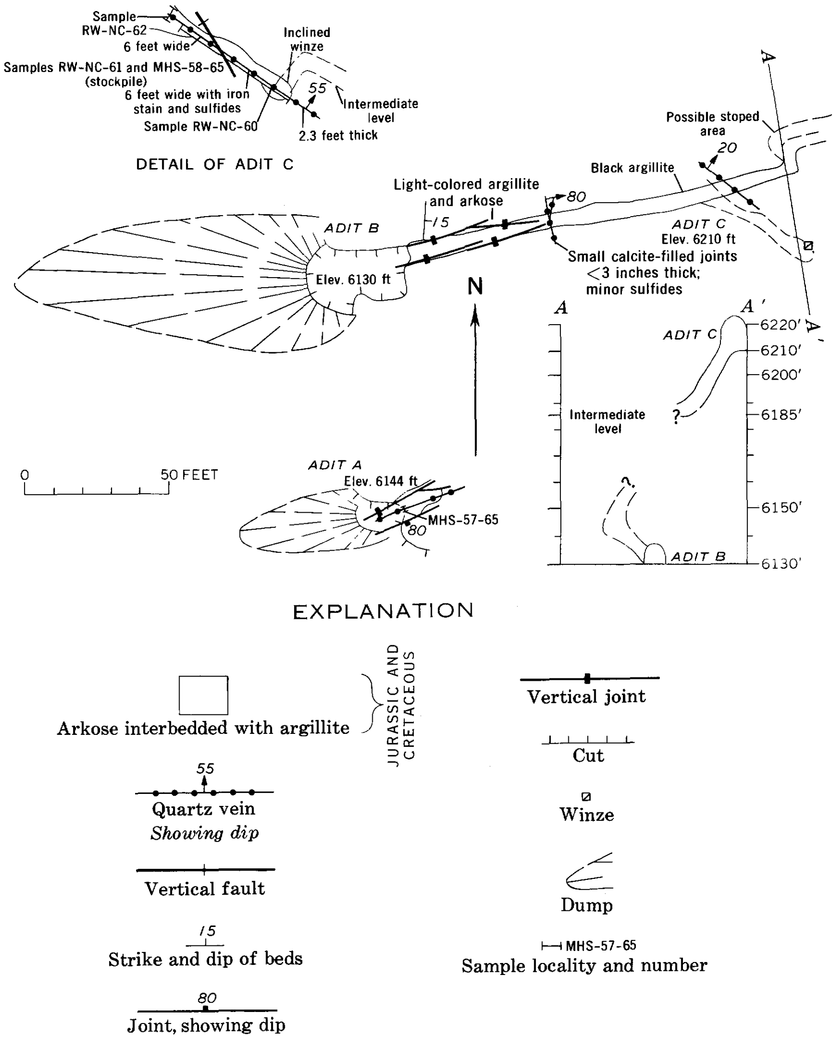


FIGURE 42.—Adits A, B, and C of property in the upper part of the basin of the West Fork of the Pasayten River (loc. 45).

width from 5 feet at the portal to 2½ feet at the face. Within the zone is a 6-inch-wide vein that contains iron-oxide-stained quartz, pyrite, and minor galena and sphalerite. Overall, the zone strikes N. 62° W. and dips 55° NE. An inclined winze at the heading follows the zone downdip for 25 feet to the supposed intermediate level.

A 40-foot chip sample (RW–NC–60, table 2) was taken along the back of adit C. It showed 0.08 ounce of gold and 2.0 ounces of

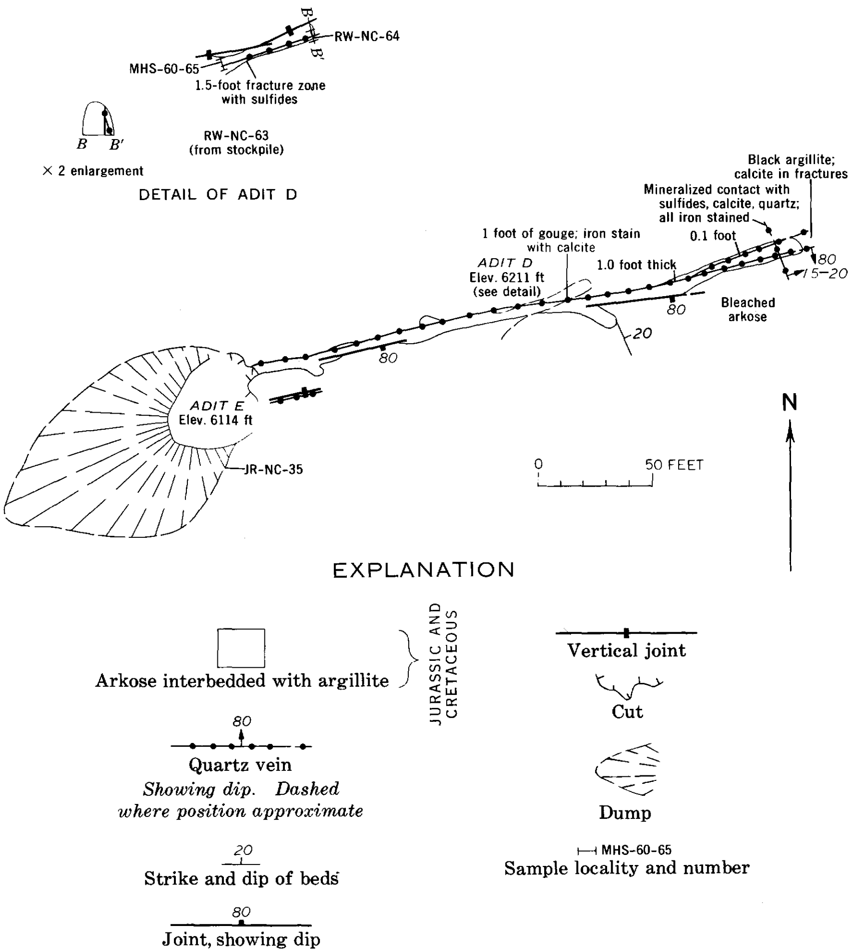


FIGURE 43.—Adits D and E of property in the upper part of the basin of the West Fork of the Pasayten River (loc. 45).

silver per ton, 2.5 percent lead, 1.55 percent zinc, and a trace of copper. An 18-inch chip sample (RW–NC–62, table 2) was cut across the sulfide-rich portion of the shear zone at the portal. It yielded only a trace of gold, 1.4 ounces of silver per ton, 1.1 percent lead, and a trace of zinc and copper. Two samples were taken of a small stockpile that contained sulfide-rich quartz and calcite. Sample RW–NC–61 (table 2) shows 0.14 ounce of gold and 1.9 ounces of silver per ton, 2.1 percent lead, 2.0 percent zinc, and a trace of copper. Sample MHS–58–65 showed 0.10 ounce of gold and 1.08 ounces of silver per ton, 1.1 percent lead, 1.0 percent zinc, and 0.064 percent copper.

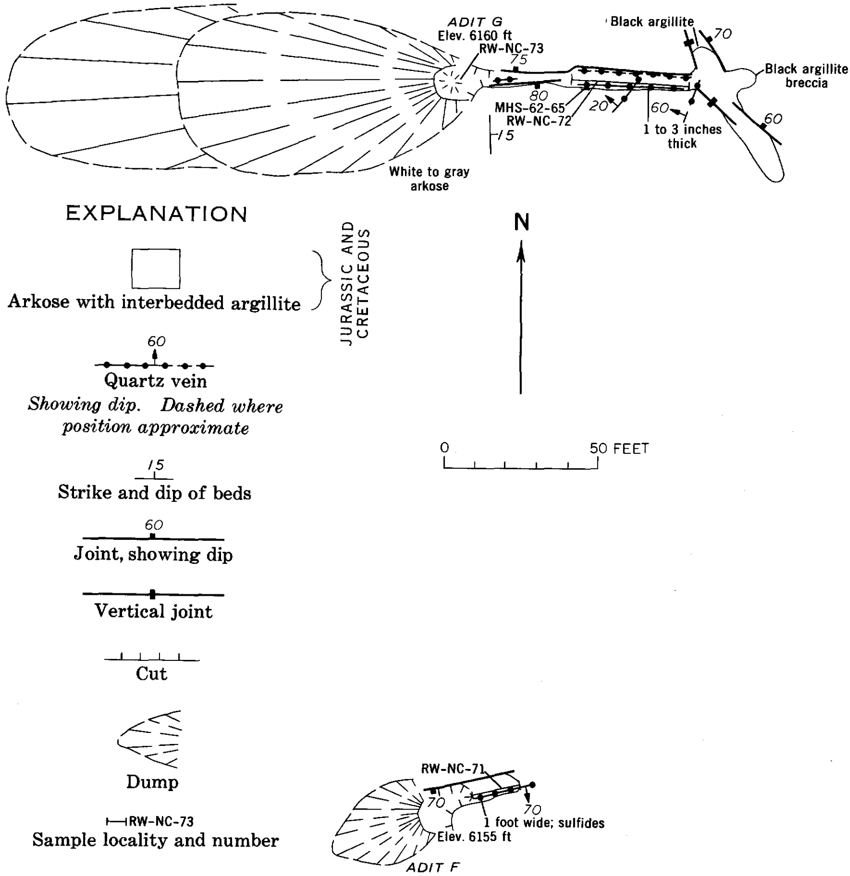


FIGURE 44.—Adits F and G in the upper part of the basin of the West Fork of the Pasayten River (loc. 45).

The chip samples represent a zone of sulfide-rich quartz-calcite vein that is 1.5 feet wide at the portal but averages 0.5 feet toward the face. The mineralized zone was not intersected by the lower adit; therefore its downward extension is not known. It appears, however, that there is limited tonnage of the grade of rock represented by the samples.

Adits D and E (figs. 41, 43) are located 450 feet north of C and B. Adit E, the lower working, is 245 feet long, and follows a shear zone that averages 1 foot in width. It is composed of iron-oxide-stained gangue, iron sulfides, some quartz and calcite, and fragments of bleached shale. The zone of sulfide minerals within the shear zone averages 0.5 foot in width along the total length of the adit. The mineralized shear zone parallels the trend of the major jointing (N. 80° E., 80°–90° S.) exposed in the working and at the surface. Two samples were taken. A chip sample (JR–NC–34, table 2) taken along the mineralized structure from the face to portal showed 0.60 ounce of gold and 0.25 ounce of silver per ton, no lead, 0.15 percent zinc, and a trace of copper. A representative sample (JR–NC–35, table 2) of the dump shows 0.03 ounce of gold and 0.1 ounce of silver per ton, no lead, 0.05 percent zinc, and a trace of copper.

Adit D, 97 feet above adit E, exposes the same mineralized zone (fig. 43). It is 40 feet long, including an 8-foot opencut to the portal. The adit follows the trend of the mineralized fracture zone, which strikes N. 85° W. and dips 80° SE. The zone is 1.5 feet wide at the portal and branches at the face. The upper part of the zone at the face is 0.4 foot wide, and each branch near the floor is 0.4 foot wide. Intervening gangue is 0.2 foot wide. Sample MHS–60–65 (table 2) cut across the zone near the portal contains 0.03 ounce of gold and 0.15 ounce of silver per ton, 0.01 percent lead, and 0.054 percent zinc. A chip sample (RW–NC–64, table 2) of the mineralized material taken at the face showed only a trace of gold and 0.1 ounce of silver per ton, no lead, and a trace of zinc and copper. A sample (RW–NC–63, table 2) of a small stockpile contained only a trace of gold, 0.2 ounce of silver per ton, a trace of lead, 0.85 percent zinc, and 0.06 percent copper.

Five hundred and fifty feet farther north is a short adit (adit F) in a well-jointed iron-oxide-stained arkose (figs. 41, 44). The working is 25 feet long and has a 10-foot opencut to the portal. The adit follows a 1- to 2-foot fracture zone, which includes a 0.4-foot vein of sulfide-rich quartz and calcite. It strikes about N. 80° E. and dips 70° SE. A chip sample (RW–NC–71, table 2) taken along the vein from the portal to the face contained 0.28 ounce of gold and 0.3 ounce of silver per ton and 0.08 percent copper, but no lead or zinc.

Adit G is 230 feet north of adit F. This working consists of a 20-foot cut followed by a 76-foot adit, and a 50-foot drift that intersects the adit 47 feet from the portal (fig. 44). The adit follows an east-striking south-dipping group of quartz and calcite veinlets within an ill-defined shear zone. The veinlets are 0.1–0.3 foot wide and contain some sulfides. A small stockpile on the dump contains iron-oxide-stained quartz with pyrite and a small amount of pyrrhotite and chalcopyrite. A sample (RW–NC–73, table 2) of this material yielded 0.05 ounce of gold per ton and a trace of silver. A 40-foot chip sample (RW–NC–72, table 2) cut westward along the south wall of the shear zone from the intersection of the drift contains only a trace of gold, silver, and zinc, and no lead or copper. A 0.4-foot chip sample from the zone at the portal (MHS–62–65, table 2) contained less than 0.02 ounce of gold and 0.06 ounce of silver per ton, and 0.04 percent copper.

The drift was apparently driven on a bleached zone along the contact between black argillite and light-gray arkose. The bleached zone trends parallel to the north strike of the country rock. No sulfides were seen.

A pit about 1,700 feet northeast of adit G is about 10 feet wide and exposes serpentinized iron-oxide-stained argillite. A grab sample (RW–NC–74, table 2) of the iron-oxide-stained rock contained only a trace of gold and silver. This pit is probably more recent than the others, and it may not be on the same group of claims.

Submarginal material in veins explored by the adits is estimated at 5,000 to 8,000 tons averaging 0.06 ounce of gold and 1.4 ounces of silver per ton, and 0.24 percent copper.

Geochemical sampling and drilling would be necessary to determine the extension of the known zones.

No mineral production from the area is known.

Locality 46

Locality 46 is on the north side of a small basin northeast of Slate Peak and 1,400 feet south of Haystack Mountain (fig. 39). At this locality a shallow caved pit 12 feet long by 7 feet wide has been dug in light-gray arkose. Along the back of the pit the rock is irregularly fractured, and the fractures are filled with limonitic material in which are casts of pyrite. A grab sample (MHS–147–65, table 2) of arkose with limonitic seams was taken from the dump of the pit. The sample was barren of gold.

Locality 47 (H. and S. Claim)

Locality 47 is on the north side of a small basin northeast of Slate Peak and about 350 feet southeast of locality 46 (fig. 39). At this locality a trench 6 feet wide, 12 feet long, and 2 feet deep exposes a 2-foot band of limonitic arkose that contains numerous scattered cubes of pyrite. A prominent outcrop of arkosic conglomerate 100 feet S. 70° E. of the trench is in part silicified and stained with iron oxides. A discovery post at the conglomerate outcrop indicates that this is the H. and S. claim located by Dallas Hanes and Gerald Snell on August 4, 1955. One 20-foot and two 50-foot chip samples (MHS–149–65, RW–NC–91, JR–NC–45, table 2) were taken across iron-oxide-stained conglomerate outcrops, and a 2-foot chip sample (MHS–148–65, table 2) was taken across the arkose exposed in the trench. The samples contained only traces of silver and gold.

JIM PEAK–WINDY PASS AREA

The Jim Peak–Windy Pass area (fig. 45) lies along a high ridge that separates the West Fork of the Pasayten River from Canyon Creek. This ridge forms part of the Cascade Divide and also serves as the boundary between Whatcom and Okanogan Counties. South of Foggy Pass the ridge is also the boundary of the Pasayten Wilderness (figs. 45, 46). Only the part within the wilderness area will be considered here. The area is 4 to 6 miles northwest of Harts Pass. Access to Windy Pass from Harts Pass is by way of the Chancellor road for 2.8 miles, then north through Barron on the Windy Pass road for 3.2 miles. The snow-free season is from July to October. Most of the prospects examined are above timberline, usually along talus slopes. Water is available from intermittent creeks and springs.

Barron is situated in Allen Basin, the site of considerable past mining activity. Several mines in the basin have had an aggregate production of gold and silver in excess of $1,500,000.

The ridge is made up of a thick sequence of plagioclase arkose interbedded with black argillite, which has a general northerly strike and a moderate eastward dip. These rocks form the east limb of a northerly trending anticline (fig. 45). The sedimentary rocks are cut here and there by various dikes, mostly of plagioclase porphyry. The west edge of the quartz diorite Pasayten dike is about 2 miles east of the ridge (pl. 1). The small mining district around Barron, south of the wilderness area (pl. 3), is also in arkose interbedded with black argillite.

The prospects in the wilderness area expose iron-oxide-stained shear zones with quartz veins that contain pyrite and arsenopyrite and minor sphalerite, galena, and chalcopyrite. The mineralized structures in the wilderness area may be northern extensions of some of the productive structures in the Allen Basin.

Only the Clearview, Windy Basin, and Homestake prospects are thought to have future economic potential. The values found in samples are marginal at best; these prospects probably will not be exploited unless the price of gold increases enough to allow activation of the mines in Allen Basin.

Ore from the prospects could be custom milled at the New Light mill in Allen Basin. Concentrates could then be shipped to the rail siding at Pateros, a total distance of 85 miles. To develop the better prospects, a 1½-mile road probably would have to be constructed from Windy Pass to Oregon Basin.

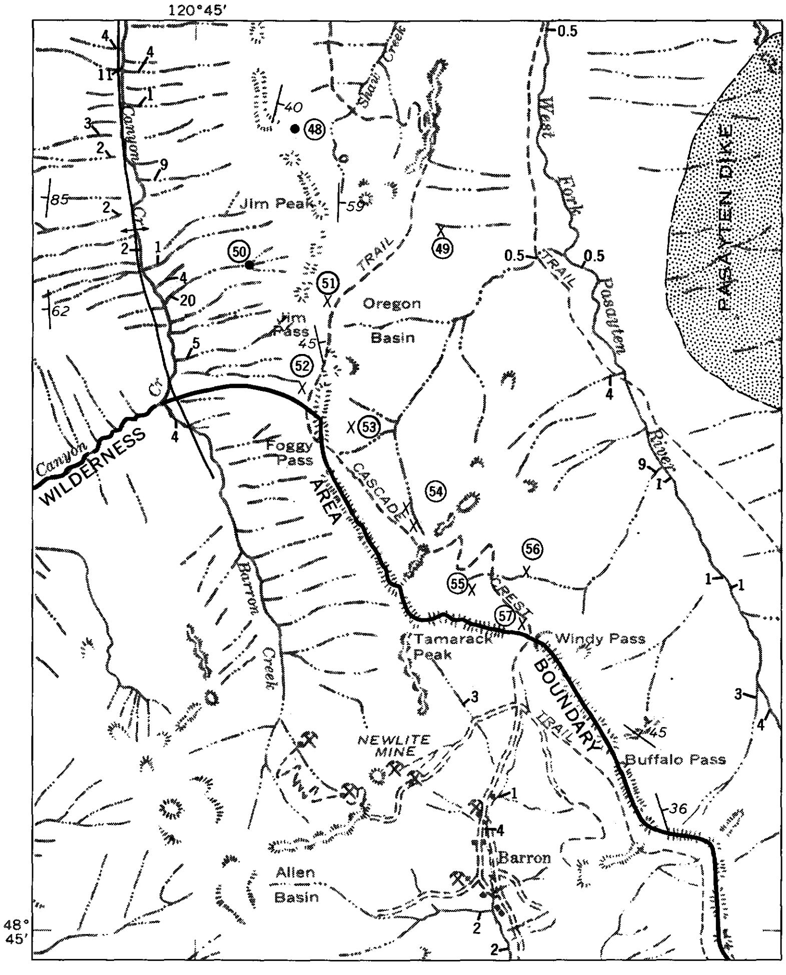
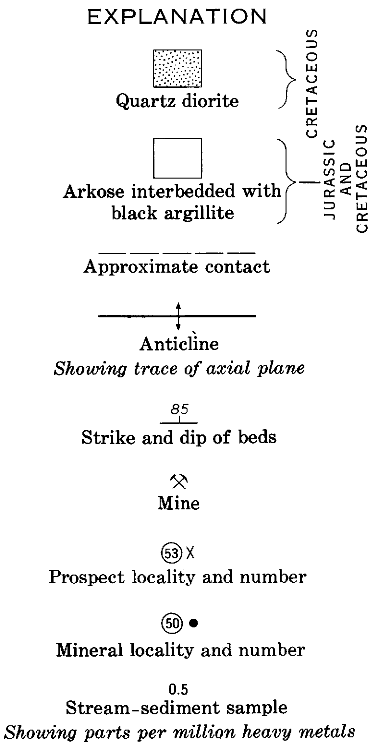


FIGURE 45.—Location and general geology of prospects in the Jim Peak-Windy Pass area. Geology not shown south of the wilderness area boundary. Base from U.S. Forest Service planimetric map, 1955.

LOCALITY 48

Locality 48 is 2,300 feet north of Jim Peak on the ridge that forms the Okanogan-Whatcom County boundary (fig. 45). No workings were noted in this area. Country rock is arkose that strikes N. 50° E. and dips 40° SE. On the ridge a shear zone, 0.5 to 1 foot wide, is exposed that strikes N. 86° W. and dips 65° NE. This zone can be traced for 40 feet. Rock in the zone is altered and impregnated with iron oxides. A grab sample (MHS–150–65, table 2) of pieces of the



shear zone was taken; it contained 0.056 percent copper and 0.02 ounce of gold per ton.

Locality 49

Locality 49 is 3,500 feet east of Jim Peak and several hundred feet below the Cascade Crest trail (fig. 45). It is on a partly reforested avalanche scar, about 120 feet from its south edge. At this locality is a partly caved trench, 30 feet long, 7 feet wide, and as much as 6 feet deep. An 8-inch-diameter alpine fir growing on the dump indicates that no work has been done in this trench for many years. The trench is in arkose and follows a shear zone that strikes N. 85° E. and dips 80° SE. to 80° NW. Only about 10 feet of shear zone is exposed. Float on the dump indicates that in places a quartz vein occupies part of the shear zone although it is not exposed. The vein is principally opaque quartz and a little pyrite heavily stained with limonite. A grab sample (MHS–111–65, table 2) was taken of the vein material on the dump; it contained 0.02 percent copper and less than 0.02 ounce of gold per ton.

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Locality 50

Locality 50 is on the west side of the ridge between Jim Peak and Jim Pass, at the headwaters of a small tributary of Canyon Creek (fig. 45). A stream-sediment sample taken at the mouth of this tributary contained 45 ppm cold copper. The stream was followed headward to a point where it flowed through a 600- to 800-foot-long iron-oxide-stained zone. Farther upstream the tributary is derived from three smaller tributaries. Along the northernmost are five joint sets, which locally contain iron-oxide-stained zones and brecciated quartz veins, with calcite and considerable limonite. None of the veins or surrounding zones of alteration could be traced for more than 50 feet, and most are less than an inch thick, although, at the junction of three joints, an altered zone widens to 2 feet for a distance of 5 feet. In the next 6 feet, however, it pinches down to an inch in thickness. These altered and mineralized joints are generally about 50 to 100 feet apart. A sample (1738, table 2) was taken from the float of the brecciated quartz vein; it had no measurable gold and only 0.004 percent copper. The large iron-oxide-stained zone in the main tributary that does not contain veins is described on page 72.

Locality 51

Locality 51 is on the ridge about 200 feet west of the trail along the Cascade crest, about 400 feet north of Jim Pass (fig. 45). The name of the claim and the names of the owners are unknown.

The prospect has been developed by a trench 26 feet long, 4 to 8 feet wide, and about 5 feet deep. The trench trends N. 65° W. and exposes a mineralized shear zone as much as 3 feet wide which in places is bounded along both edges by limonite-stained quartz veins 4 to 6 inches wide. Arsenopyrite is scattered through the quartz veins. The wallrock is light-gray silty arkose, which is well fractured and stained with iron oxides along the fracture surfaces.

Two chip samples (MHS–140–65 and JR–NC–42, table 2) cut across the veins contained less than 0.02 and 0.08 ounce of gold per ton. A third sample (JR–NC–41, table 2), cut across the two veins and the sheared material between, contained 0.16 ounce of gold per ton.

Locality 52

Locality 52 is about 1,200 feet north of Foggy Pass on the west side of the ridge below the Cascade Crest trail (figs. 45, 46). At this locality two adits about 85 feet apart vertically follow a shear zone in arkose and black argillite that is cut by a westward-trending plagioclase porphyry dike. A 0.2- to 0.5-foot-wide shear zone cuts the dike. It is exposed above the upper adit, which is caved. This

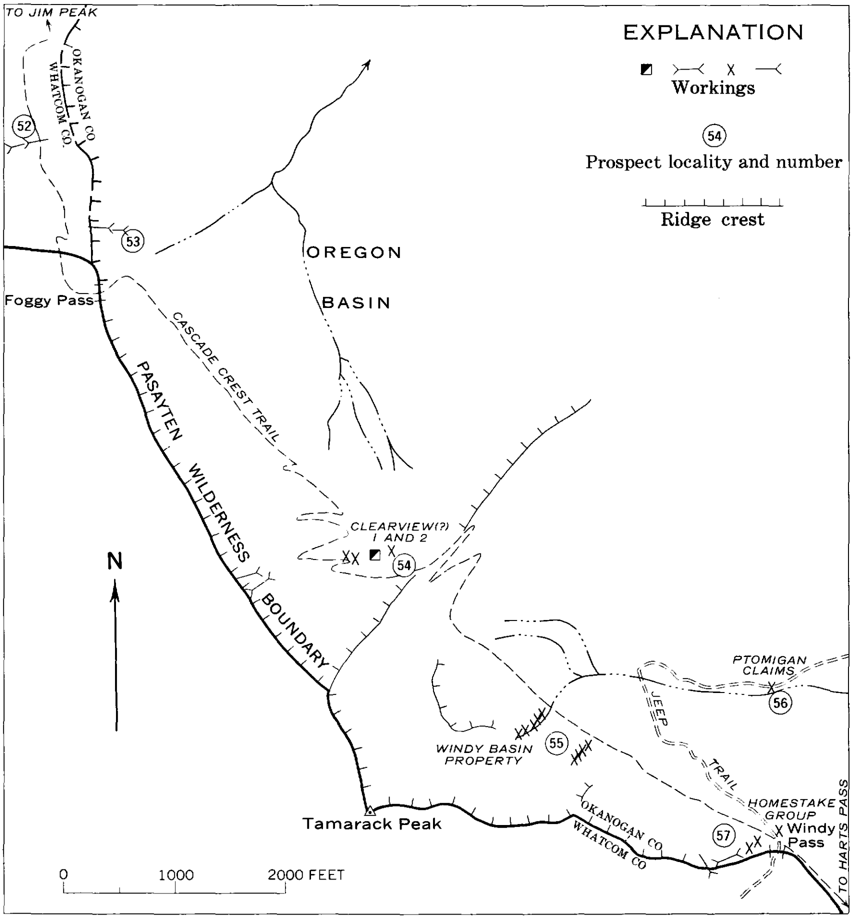

FIGURE 46.—Foggy Pass and Windy Pass area.

zone strikes N. 70° W., dips 84° SW., and consists of iron-oxide-stained and sheared dike rock that contains lenses and veins of quartz. In places the veins contain a little arsenopyrite. A 0.5-foot channel sample (MHS–136–65, table 2) was taken across the shear zone. A chip sample 2.5 feet long (JC–66–1A) was cut across the zone and adjacent altered and brecciated material. The 0.5-foot sample contained 0.074 percent zinc, 0.025 percent copper, and 0.48 ounce of gold per ton. The 2.5-foot sample contained a trace of gold and 0.1 ounce of silver per ton.

The lower adit is 145 feet long and is connected to a 45-foot crosscut (fig. 47). The country rock is arkose; the plagioclase porphyry dike is about 10 feet north of the portal and strikes N. 85° W. and dips 86° N. The adit follows a steeply dipping shear zone that in

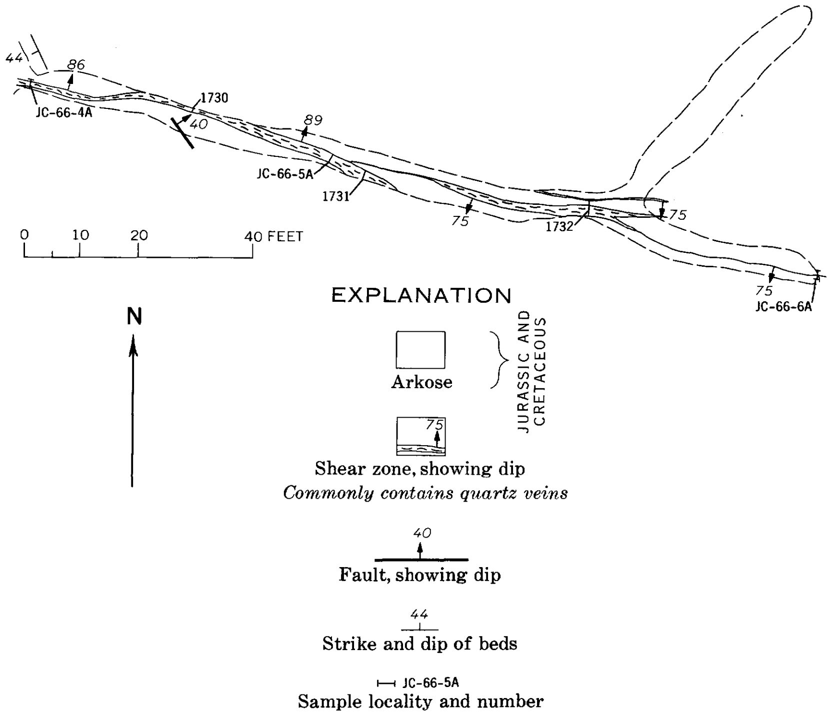

FIGURE 47.—Lower adit at locality 52.

places divides into several anastomosing shears (fig. 47). Width of the shear zone is highly variable and ranges from half an inch to 2 feet. The zone generally consists of iron-oxide-stained sheared arkose and some quartz. In places the quartz is brecciated, indicating late shearing. In addition to quartz the zone also contains arsenopyrite and a little pyrite, sphalerite, galena, and chalcopyrite. Six chip samples (JC–66–4A, 1730, JC–66–5A, 1731, JC–66–6A, 1732, table 2) were cut across the shear zone along the drift, and two grab samples (MHS–138–65, JC–66–3A, table 2) of quartz were collected on the dump and from a small stockpile near the portal. The eight samples yielded 0.06, trace, trace, 0.21, trace, 0.009, 0.16, and 0.12 ounce of gold per ton, respectively. The maximum silver content is 0.1 ounce per ton in two samples.

LOCALITY 53 (MIDAS? CLAIM)

Locality 53 is about 300 feet northeast of Foggy Pass (figs. 45, 46) where two adits were driven on a shear zone. The upper working is at about the same elevation as Foggy Pass and consists of a 38-foot drift at the end of a 14-foot opencut (fig. 48). The second adit is S. 80° E. of the first adit and about 200 feet below it. The lower adit

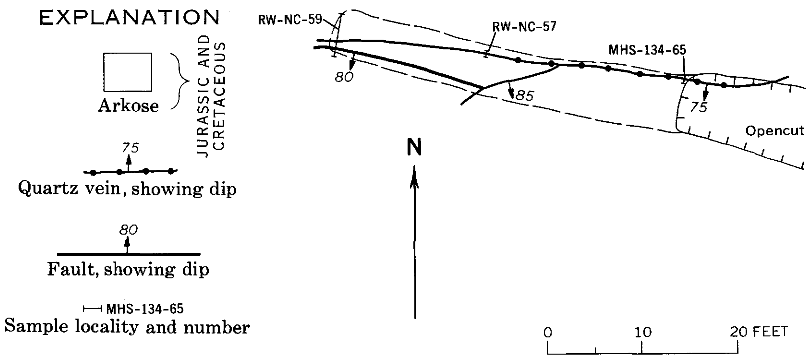

FIGURE 48.—Upper level at locality 53.

is now caved, but as its dump is a little larger than that of the first, the working probably is longer. Both adits were driven in arkose that strikes about N. 45° W. and dips 50° NE. These adits may be on the old Midas claim, which was located in this general region prior to 1899.

Several branching shears or faults are exposed in the upper adit (fig. 48). The principal shear, which parallels the drift, strikes N. 87° W. and dips 75° S. An undulating vein follows this shear in the eastern part of the adit. This vein is as much as 8 inches thick but averages 3 inches. It consists mainly of quartz, with some calcite and scattered pyrite. Fragments of arkose are present in some parts of the vein. An 8-inch channel sample (MHS–134–65, table 2) was taken across the vein near the portal (fig. 48); it contained traces of zinc and lead, but no gold. A chip sample (RW–NC–57, table 2) taken for 38 feet along the strike of the vein contained only a trace of gold and silver and no lead or zinc. A 6-foot chip sample (RW–NC–59, table 2) cut across the face of the adit showed 0.1 ounce of silver per ton, a trace of gold and copper, and no lead or zinc.

A grab sample (RW–NC–58, table 2) of quartz and minor calcite taken from the lower dump contained only a trace of gold, silver, and copper, and no lead or zinc.

LOCALITY 54 (CLEARVIEW? 1 AND 2 CLAIMS)

A shaft, four trenches, and two pits are located in Oregon Basin, about 1 mile northwest of Windy Pass via the Cascade Crest trail and about 2,400 feet north of Tamarack Peak (figs. 45, 46). These workings may be on the Clearview 1 and 2 claims, which were located in this general area in 1940 by L. A. Gourlie and M. F. Behnke. The eastermost pit is at A (fig. 49), about 60 feet below the trail and about 250 feet west of the trail summit on the divide between Oregon

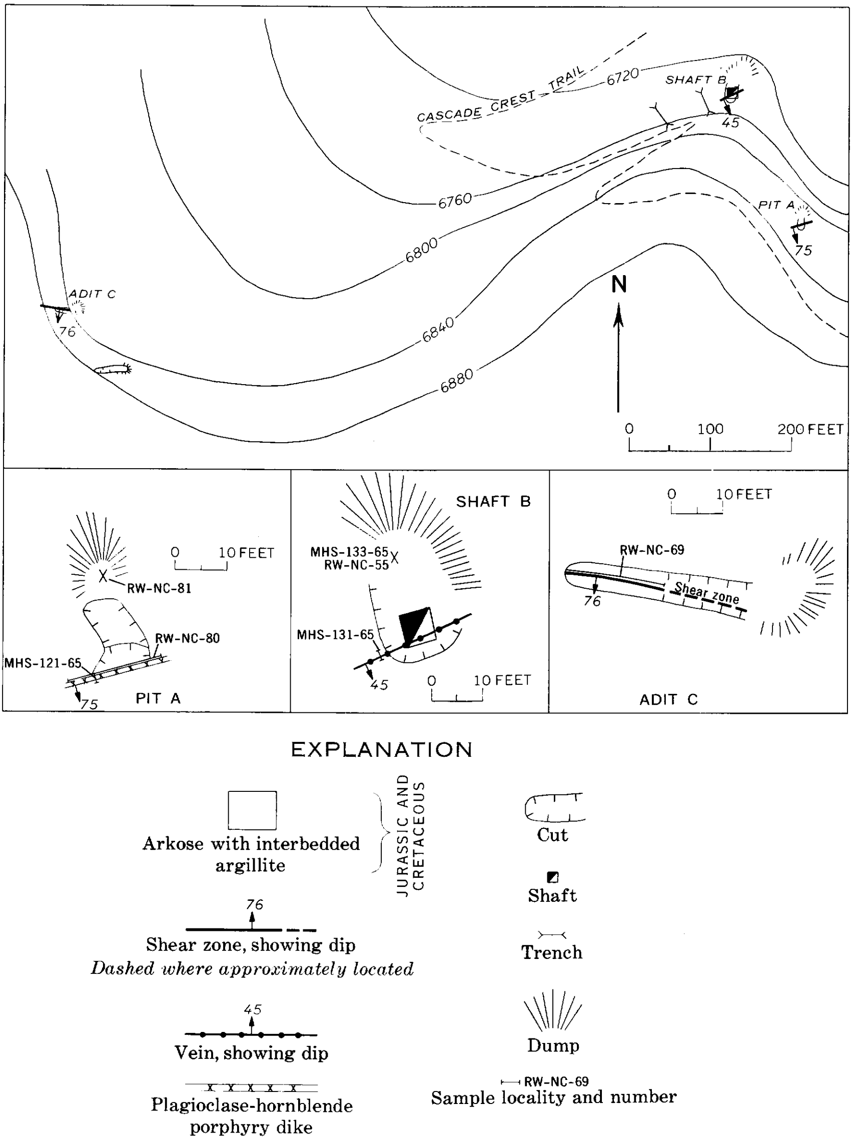

FIGURE 49.—Workings at locality 54 (Clearview? 1 and 2 claims).

Basin and Windy Basin to the east. The pit is 10 feet wide, 15 feet long, and about 15 feet deep. It exposes a shear zone in an altered plagioclase-hornblende porphyry dike. The dike is silicified along the shear zone, whose apparent width is 6 to 12 inches. The zone strikes N. 65° E. and dips 75° SE. A 3- to 5-inch quartz vein with pyrite and minor galena and sphalerite occurs in the shear zone. A 4-inch chip sample (MHS–121–65, table 2) was taken across the vein. It yielded 2.1 percent lead, 0.67 percent zinc, and 5.34 ounces of silver and 0.13 ounce of gold per ton. A chip sample (RW–NC–80, table 2) representing the zone exposed in the pit contained a trace of zinc, 0.5 percent lead, and 1.1 ounces of silver and 0.13 ounce of gold per ton. A grab sample (RW–NC–81, table 2) of quartz sulfide debris on the dump had 0.24 ounce of gold and 3.4 ounces of silver per ton, 1.75 percent lead, and 0.15 percent zinc.

Working B is an opencut that has a shaft filled with water to within 32 feet of its collar. This working is located 165 feet N. 15° W. of pit A, on a small rocky ridge 60 feet east of a trail switchback (fig. 49).

The cut is 17 feet long and about 14 feet wide, and exposes a plagioclase porphyry dike and a shear zone that strikes N. 65° E. and dips 45° SE. The zone is exposed on both sides of the shaft and in the back of the cut; it can be traced for a distance of 22 feet along strike. The shear structure apparently has controlled the emplacement of a quartz vein, which has been essentially mined out, but judged by material in the dump it was at least 1.2 feet thick. The vein material consists principally of white opaque quartz, some calcite, and minor pyrite, chalcopyrite, arsenopyrite, galena, and sphalerite. The vein is banded in places and commonly contains angular pieces of partly replaced wallrock.

A chip sample (MHS–131–65, table 2) was taken across the shear zone where it is exposed above the shaft (fig. 49). It contained only a trace of gold, silver, lead, and zinc. A grab sample (MHS–133–65, table 2) was taken of the vein material found on the dump, and another (RW–NC–55, table 2) was taken of a small sulfide-rich stockpile. The dump sample yielded 0.37 percent lead, 0.36 percent zinc, and 1.08 ounces of silver and 0.08 ounce of gold per ton. The stockpile sample contained only a trace of lead and copper, 2.2 percent zinc, and 0.01 ounce of gold, and 0.4 ounce of silver per ton.

Two smaller cuts, a short distance west of the shaft, are slumped, and no mineralized material was noted.

The uppermost workings at C are 850 feet S. 85° W. of shaft B, and about 100 feet higher (fig. 49). They consist of an adit, an opencut, and a small pit. The adit is 17 feet long and follows a mineralized shear zone that strikes N. 80° W. and dips 76° S. The country rock exposed in the adit is arkose, but granitic rock is common in talus in the cirque below. The shear zone has an average thickness of 18 inches in the adit but is only 6 inches thick at the surface above the portal; it reaches a maximum thickness of 23 inches at the lower part of the adit face. Sulfide minerals are concentrated in layers about 3 inches wide along each side of the zone. A chip sample (RW–NC–69, table 2) representative of the total length of the zone (17 feet) exposed in the adit (fig. 49) contained 0.05 ounce of gold and 0.9 ounce of silver per ton, 0.6 percent lead, and only a trace of zinc and copper.

Two other opencuts, about 85 feet south of the adit, are sloughed; mineralized material or significant geologic structures were not seen.

All the zones described at this locality probably continue beyond their exposures, but because of talus and other overburden in the cirque area, their extent is not known.

The country rock that encloses the veins stands well, and no unusual mining problems would be expected. The ore-to-waste ratio for normal mining methods would be about 1:5. If the two mineralized structures are continuous between the workings, which are 850 feet apart, then there is from 20,000 to 40,000 tons of marginal material present, averaging about 0.1 ounce of gold and 2.0 ounces of silver per ton, 0.6 percent lead, and 0.6 percent zinc.

LOCALITY 55 (WINDY BASIN PROPERTY)

Two groups of workings are located on a cirque headwall northwest of Windy Pass (figs. 45, 46). The first group is about 2,000 feet northwest of the pass via the Cascade Crest trail; the other group is about 450 feet farther northwest. The mineralized zones in both groups are poorly exposed.

The first group consists of five sloughed pits on a line trending N. 55° E.; the lowest pit, E, is about 90 feet (slope distance) above the trail (fig. 50). The difference in elevation between the upper and lower pits is 120 feet. The upper two pits, A and B (fig. 50), expose a series of narrow quartz veins in arkose. The veins average less than half an inch in thickness and follow the two predominant fractures in the country rock which trend N. 62° E., 80° NW., and N. 25°–35° E., 85° W. Some of the vein material on the dump of pit A, however, is as much as 4 inches thick. Pyrite was the only metallic mineral observed and constitutes as much as 2 percent of the vein material. A grab sample (RW–NC–65, table 2) of quartz vein from the dump of pit A contained 0.12 ounce of gold and 0.4 ounce of silver per ton, 0.1 percent lead, 0.35 percent zinc, and a trace of copper. A sample (RW–NC–66, table 2) of the vein between pits A and B yielded a trace of gold, 0.2 ounce of silver per ton, a trace of lead, 0.2 percent zinc, and a trace of copper.

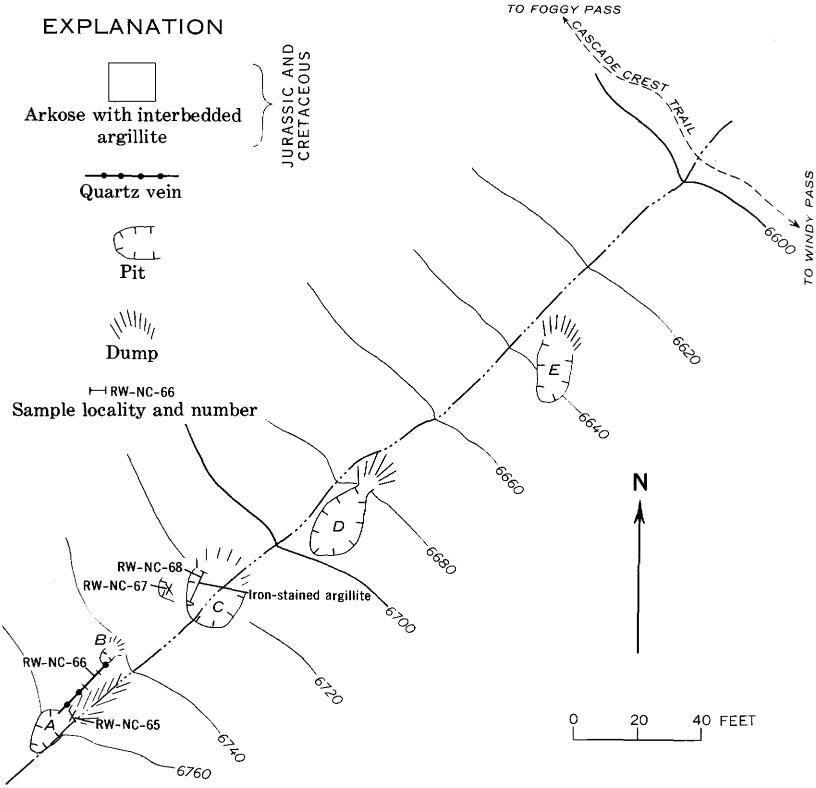

FIGURE 50.—Workings on the eastern group of the Windy Basin property (loc. 55).

Pit C (fig. 50) is partly sloughed; limonitic-stained argillite is exposed in the west wall of the working. A chip sample (RW–NC–68, table 2) taken across the iron-oxide-stained rock contained only a trace of gold and silver.

Above and slightly to the west (fig. 50) is a small sloughed cut which is on the trend of the mineralized zone exposed in the upper workings. No bedrock is exposed here, but pieces of quartz vein in a small stockpile are as much as 3 inches thick. A grab sample (RW–NC–67, table 2) of the stockpiled rock had 0.08 ounce of gold and 2.5 ounces of silver per ton, 0.85 percent lead, 2.8 percent zinc, and a trace of copper.

Pits D and E (fig. 50) are caved, and no bedrock is exposed.

The second group of workings, to the northwest, consists of three trenches and three small pits (fig. 51). The cuts are along a line that trends N. 40° E. across a steep debris-covered slope about 250 feet above the Cascade Crest trail. The workings are quite old.

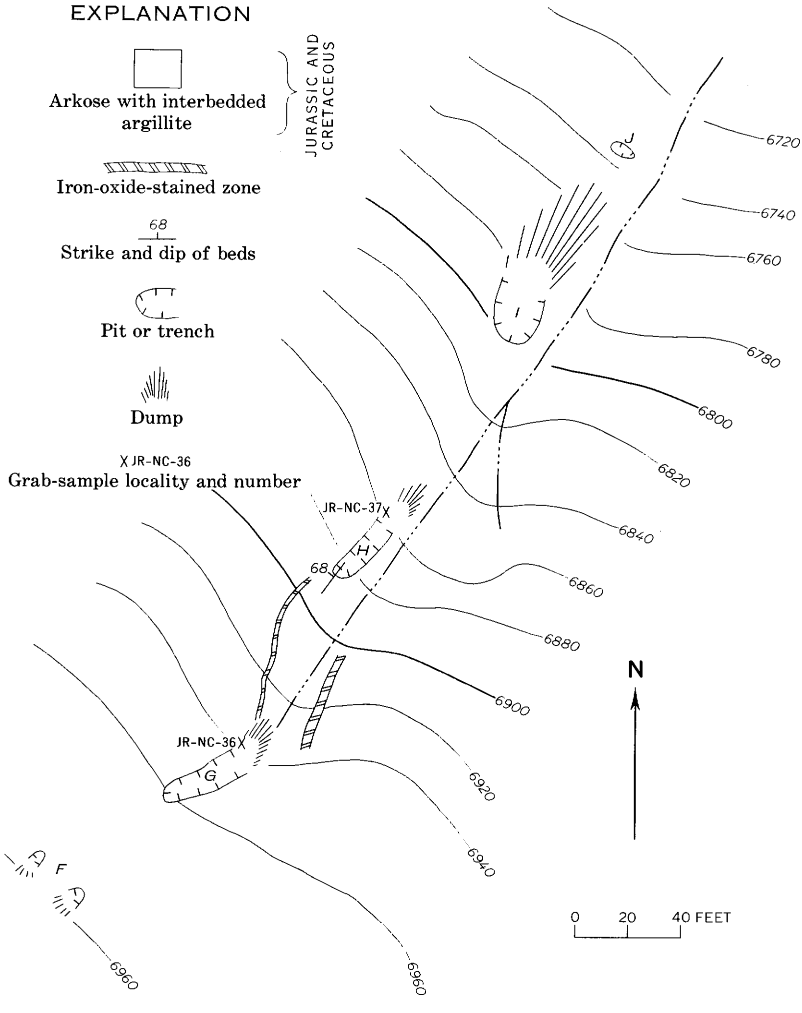

FIGURE 51.—Workings on the western group of the Windy Basin property (loc. 55).

The largest cut is at G (fig. 51). It is 30 feet long and as much as 12 feet wide; before sloughing it was probably about 12 feet deep. Other workings are caved, although bedrock is exposed in trench H.

A 6- to 12-inch shear zone, containing quartz veins with pyrite and galena, is exposed between trenches G and H. Some pieces of quartz float were found in trench I, but they probably came from above. The shear zone is conformable to the bedding of the arkose, which strikes N. 42° E. and dips 68° NW.

A grab sample (JR–NC–36, table 2) of sulfide-bearing quartz from the dump of trench G (fig. 51) yielded 0.32 ounce of gold and 12.8 ounces of silver per ton, 6.35 percent lead, 0.2 percent zinc, and a trace of copper. A second sample (JR–NC–37, table 2) from a small stockpile at the end of trench H (fig. 51) yielded 0.2 ounce of gold and 8.7 ounces of silver per ton, 4.95 percent lead, 0.3 percent zinc, and a trace of copper.

LOCALITY 56 (PTOMIGAN CLAIMS)

Locality 56 is about 1,500 feet north of Windy Pass (figs. 45, 46). It can be reached from Windy Pass by an old bulldozer track down the West Fork of the Pasayten River that passes the discovery pit. The property consists of four claims: Ptomigan 1, 2, 3, and 4. They were located by Mrs. Florence A. Gourlie in June 1948. The area around the discovery pit is a relocation of the Quartz Lode No. 1 claim. The property has been explored by an opencut about 30 feet long and 10 feet wide in fine-grained gray arkose. At the back of the cut two steeply dipping veins are exposed several feet apart that strike N. 76° E. The northernmost is 0.4 to 0.6 foot thick and dips 75° NW.; the southernmost is 0.5 to 0.6 foot thick and dips 65° NW. This property was visited in June 1952 by J. S. Vhay of the U.S. Geological Survey. At the time of Mr. Vhay's visit the cut was about 20 feet long. Mr. Vhay (written commun., 1952) stated that there was only one vein, 0.5–2.0 feet thick, then exposed.

The two veins consist mainly of quartz and pyrite, some pyrrhotite, sphalerite, arsenopyrite, and chalcocite, and a little chalcopyrite and galena. One 0.5-foot chip sample was taken across each vein. The sample from the northernmost vein (MHS–43–65, table 2) contained 0.082 percent copper and only small amounts of zinc, gold, and silver. The sample from the southernmost vein (MHS–44–65, table 2) yielded 0.39 percent copper, 2.2 percent zinc, 0.033 percent lead, 0.26 ounce of silver per ton, and a trace of gold.

LOCALITY 57 (HOMESTAKE GROUP)

Locality 57 is on a broad ridge about 100 yards west of Windy Pass (figs. 45, 46, 52). Here a shear zone crosses the ridge, along which are several trenches, three pits, two adits, and an inclined shaft. The boundary of the Pasayten Wilderness follows the crest of this ridge. Although the greater part of the workings are along the south side of the ridge and are not in the wilderness area, some of them extend across the boundary. According to W. C. Moen (oral commun., 1965), these workings are on the Homestake group of claims—11 claims staked on July 1, 1956, by E. H. Spafford. The

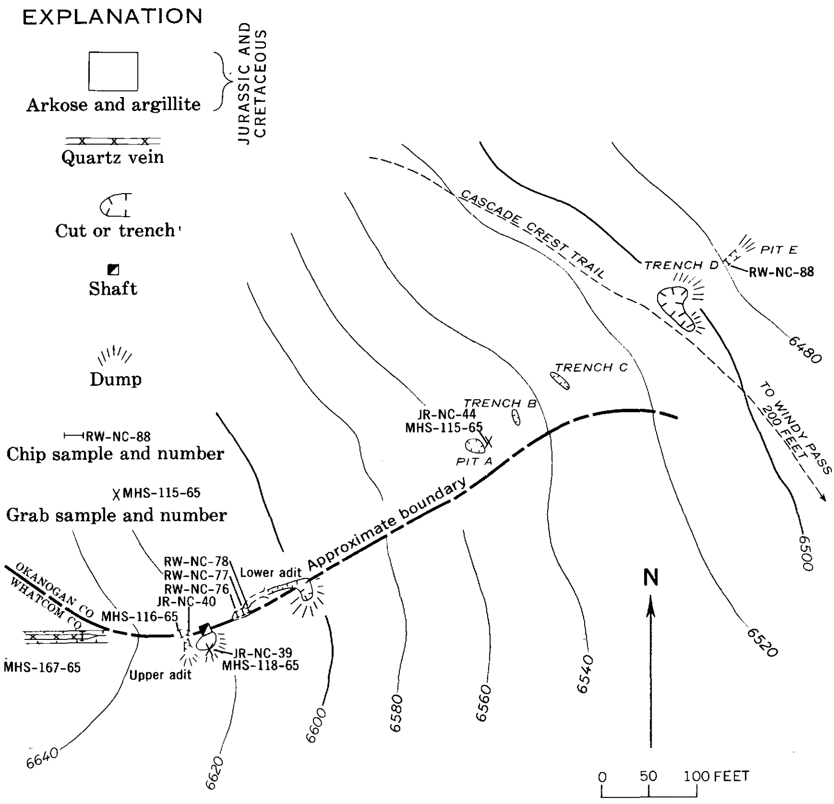

FIGURE 52.—Homestake property (loc. 57).

principal workings are on the Homestake claim. The westernmost working is a 78-foot bulldozer cut made during the summer of 1965 (fig. 52). Here the shear zone trends east and is exposed along the full length of the trench. At the west end of the cut the vein is 0.7 foot thick. The vein undulates along the trench and is as much as 3.9 feet thick. The shear zone consists of bleached argillite containing galena, pyrite, and sphalerite. A 3.9-foot chip sample (MHS–167–65, table 2) was taken across the shear zone 60 feet east of its west end. This sample contained 0.31 percent lead, 0.10 percent zinc, and 0.29 ounce of silver and 0.06 ounce of gold per ton.

Seventy-five feet east of the east end of the bulldozer trench is a 6-foot adit (fig. 52) that cuts the shear zone, which is in arkose. Along the shear zone is a 0.4-foot vein of quartz with pyrite that strikes N. 63° E. and dips 55° NW. Two chip samples were taken across this vein. Sample MHS–116–65 (table 2) contained 0.02 ounce of gold and 0.06 ounce of silver per ton; sample JR–NC–40 (table 2) yielded 0.03 ounce of gold and 0.10 ounce of silver per ton.

Twenty feet northeast of this small adit is an inclined shaft sunk on the same vein. The vein in the shaft is about 0.3 foot thick and consists principally of banded vuggy quartz and pyrite with some galena and sphalerite, and a little calcite and covellite. Two grab samples of vein material were taken from the dump. One sample (MHS–118–65, table 2) contained 8.0 percent zinc, 3.8 percent lead, and 1.92 ounces of silver and 0.25 ounce of gold per ton; the other sample (JR–NC–39, table 2) yielded 6.1 percent zinc, 1.8 percent lead, 0.95 ounce of silver and 0.17 ounce of gold per ton.

The samples probably represent a small tonnage; however, the structure is prominent, and more prospecting might disclose additional material of similar or higher grade.

A short distance northeast of and below the shaft is a caved adit that connects to the shaft. We reopened the adit and sampled it. Two samples were taken at the face. The first (RW–NC–76, table 2) was a chip sample taken across a 44-inch shear zone consisting of silicified and sheared arkose with some calcite and pyrite. The pyrite occurs in a band only 2 to 4 inches thick. The sample contained 0.02 ounce of gold and 0.1 ounce of silver per ton, and a trace of zinc. The second sample (RW–NC–77, table 2) was from the pyrite-bearing band included in sample RW–NC–76. It yielded a trace of gold and silver, but no copper, lead, or zinc. A third chip sample (RW–NC–78, table 2) taken from the shear zone 12 feet from the adit face contained a trace of gold and silver.

Several hundred feet northeast of the caved adit, on the center of the ridge, are three pits. The largest (pit A, fig. 52) is 15 feet in diameter, at least 8 feet deep, and partly slumped. Although no vein material is exposed in the pit, the dump contains pieces of opaque white quartz as much as 1.5 feet thick, with scattered pyrite. A grab sample (MHS–115–65, table 2) was taken of pieces of vein on the dump. It contained 0.003 percent lead, 0.015 percent zinc, 0.010 percent copper, and 0.02 ounce of gold per ton. A second grab sample of vein material (JR–NC–44, table 2) yielded only a trace of gold and silver. The other two pits were not dug through the overburden.

A bulldozer trench is on the same trend several hundred feet to the northeast (trench D, fig. 52) and a few feet below the Cascade Crest trail. The trench exposes iron-oxide-stained hornfels but no vein material.

Sixty feet northeast of trench D and about 25 feet below it is pit E. An area 2 feet by 2 feet of iron-oxide- and manganese-oxide-stained rock is at the southwest end of this pit. A sample (RW–NC–88, table 2) of this rock had only a trace of gold and silver.

The shear zone at locality 57 is at least 300 feet long and ranges in thickness from a few tenths of a foot to at least 3.9 feet. The metal content of the zone is variable, but generally low.

CANYON CREEK AREA

The Canyon Creek area lies along the northwest side of Canyon Creek, from about 2 miles north of Chancellor to a little more than a mile southwest of the mouth of Mill Creek (fig. 53). It is accessible only by the Chancellor road.

The region is underlain by an arkose and argillite sequence that contains local conglomerate beds. In the upper part of Cascade Creek and west of Chancellor these rocks are cut by several northwest-trending dikes of hornblende-quartz diorite. The sedimentary rocks are folded into northwest-trending anticlines and synclines.

Numerous iron-oxide-stained sulfide-bearing zones are found along both sides of Canyon Creek. The most extensive workings in the study area are at the Anacortes mine on Cascade Creek and the Minnesota mine on Canyon Creek. These mines and other prospects in the area are on steeply dipping quartz veins that contain a little pyrite. The veins differ from most veins farther east in the Slate Creek district in that they are almost entirely quartz and lack sulfides other than pyrite.

Locality 58

Locality 58 is on a northwest-trending spur ridge 3,000 feet southwest of Anacortes Crossing and about 3,000 feet west of the old mill on the Anacortes property (fig. 53). This locality may be on the old Whatcom claim that was located in the 1890's. Here a 20-foot trench that trends S. 77° W. was dug into the ridge. A short adit, now caved, continues from the west end of the trench. The east end of the trench is in chert pebble conglomerate, part of a layer at least 500 feet thick, and the west end is in plagioclase arkose; the beds strike N. 20° W. and dip 55° NE. The trench is in the center of a strongly limonite stained oval area about twice the size of the trench. Although no veins were noted in place, fragments of quartz veins, as much as 6 inches thick, were found on the dump. The vein material contains, in addition to quartz, sparse ankerite and pyrite. Neither a grab sample (MHS–49–66, table 2) of the quartz found on the dump, nor a chip sample (1263, table 2) of limonite-stained conglomerate from the south side of the trench contained any measurable gold or silver, nor more than traces of copper.

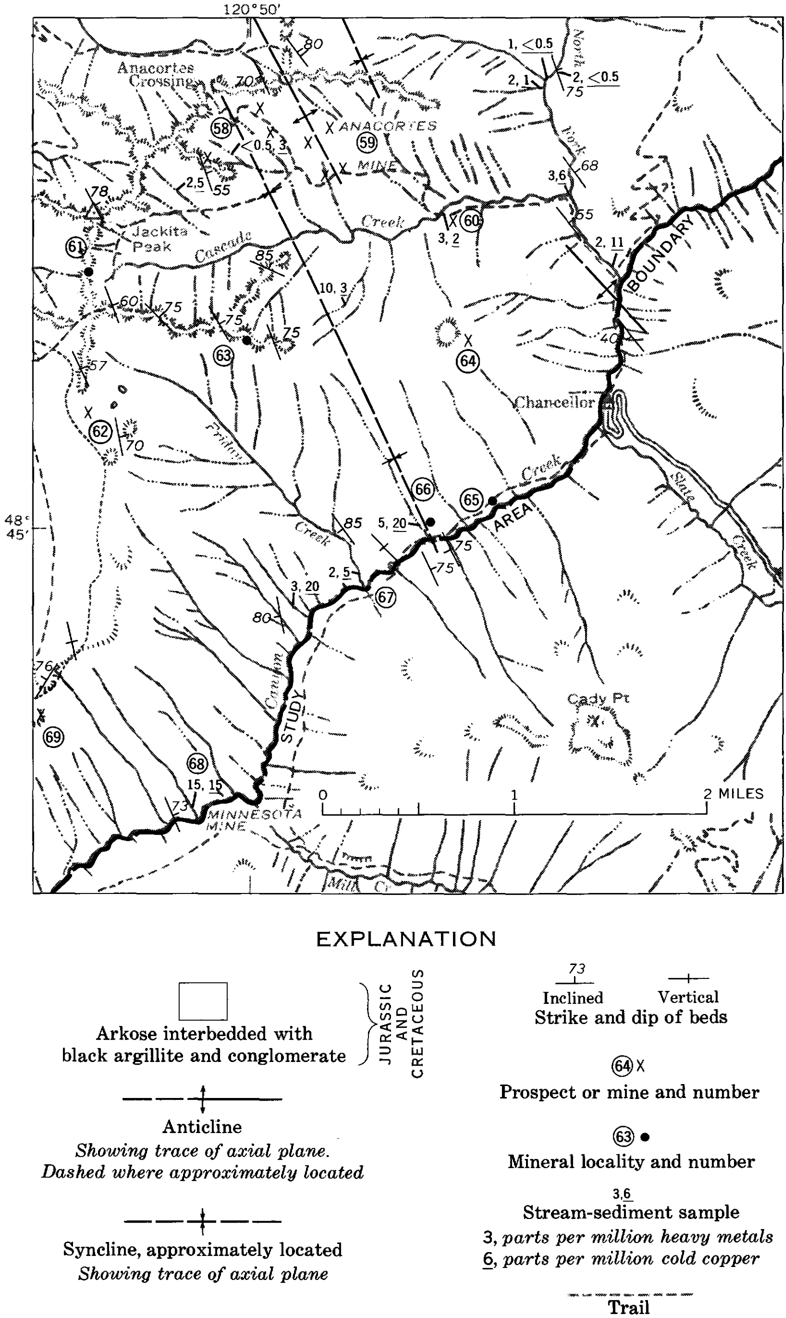

FIGURE 53.—Location and general geology of prospects in the Canyon Creek area. Geology not shown southeast of the wilderness area boundary. Base from U.S. Forest Service planimetric map, 1955.

LOCALITY 59 (ANACORTES GROUP)

The Anacortes group is on the slope north of Cascade Creek, a west tributary of the North Fork of Canyon Creek (fig. 53).

The area is about 4¾ miles by a steep trail from the end of the road at Chancellor. The trail follows the creek for about 1½ miles and then ascends steeply to the workings.

The oldest claim in this locality, according to Whatcom County Courthouse records, was recorded in 1892 by Henry Benke and Henry Jaeger. It was restaked 2 years later and an adjacent claim recorded. By 1897, at least 10 claims were filed by Douglass Almond, J. H. Young, T. B. Childs, P. E. Nelson, D. M. Woodbury, M. S. Smith, and John Russner. Several other claims have been staked, but location descriptions are vague. The most recent claims were located in 1955 by John W. Cannon, Jack White, and Walter Bortz. They staked three claims which essentially cover formerly claimed ground.

In the early days, according to Douglass Almond (Hodges, 1897, p. 57), a 10-pound sample taken across a 20-inch vein on the Anacortes claims yielded $76.40 in gold. Lyon (in Landes and others, 1902, p. 49) reported that by 1901 development on these claims included drifts on three levels. At that time the lower drift was 310 feet long; the second one, 100 feet higher, was 100 feet long; and the third, about 1,200 feet above the second, was about 90 feet long. Later, several other drifts were driven, and additional work was done in the lower drift. In 1935 the property was obtained by the Anacortes Gold Mining Co. from Mrs. Douglass Almond (Mining Journal, 1935), and in 1936 a 50-ton Harding mill was packed in and erected near the dump of the main working. The company stated that the property then had 3,000 feet of underground workings (Mining Journal, 1936). The mill has since collapsed, and the remains are scattered down the hill. Huntting (1956, p. 175) reported that the property was owned by the Anacortes Gold Mining Co. until 1939.

Prospecting activity centered on cleavage-controlled quartz veins or quartz-cemented breccia zones as much as 5 feet thick. The quartz is probably related to a quartz diorite intrusive which is irregularly exposed in the lower workings. The veins, according to Huntting (1956, p. 175), contained free gold, tellurides, and sulfides. We did not observe any metallic minerals in the quartz veins except a little pyrite.

Most of the workings are near the Anacortes Crossing trail, which switchbacks up the steep ridge (fig. 54). The workings include 10 adits, six of which are caved and cannot be entered, and numerous pits and trenches.

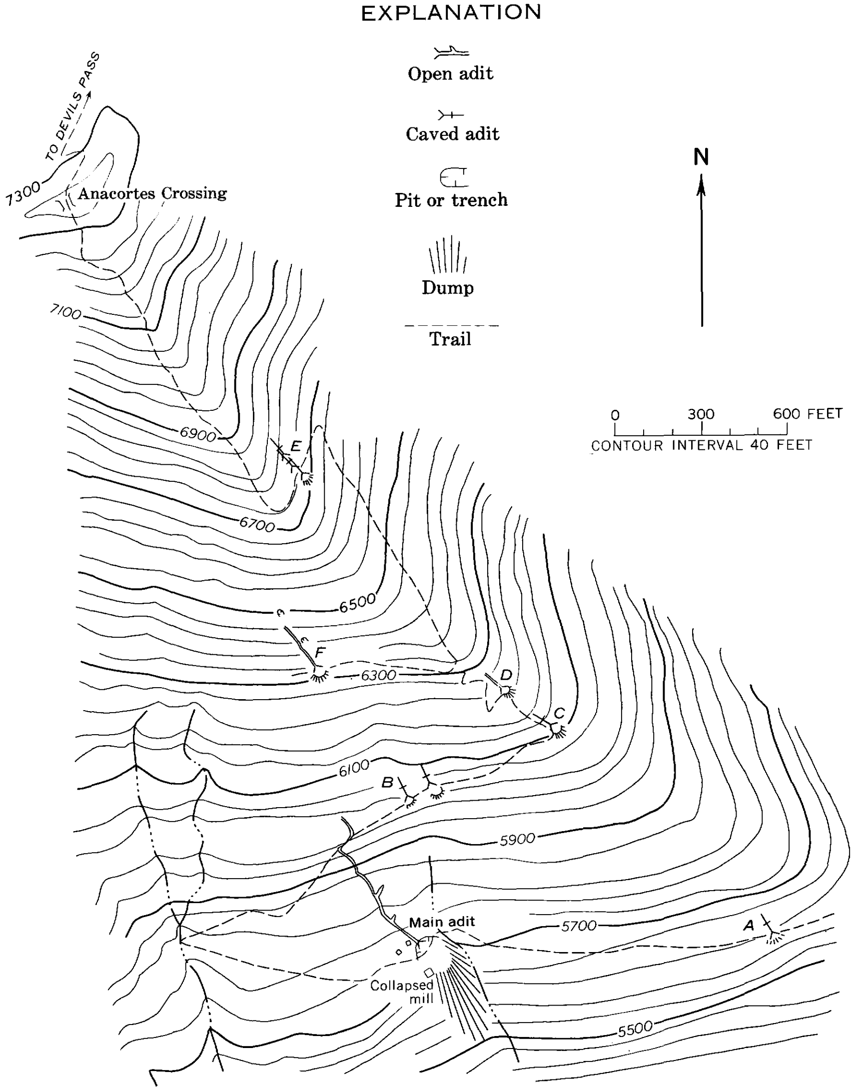

FIGURE 54.—Workings on the Anacortes group (loc. 59).

Adit A, the lowest working, is on the trail. The overburden is thick around the portal, and the only rock exposed is quartz diorite in the walls of a partly caved adit. This adit is about 30 feet long, as estimated from the size of the dump. A grab sample (MHS–146–65, table 2) of limonite-stained quartz taken from a small stockpile contained less than 0.02 ounce of gold and 0.06 ounce of silver per ton.

The main adit, mill ruins, and several collapsed buildings are on the trail about 400 yards west of adit A (fig. 54). The first 100 feet

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of the main adit was timbered, but it is now dangerous because of a general collapse of the back. The adit is 565 feet long and has several minor laterals and three small stopes (fig. 55). In general, it follows the cleavage of the argillite country rock, which strikes N. 40°–55° W. and dips steeply southwest. Cleavage and some faulting have controlled the localization of small quartz veins and lenses. The veins are generally narrow, but wider parts have been stoped. The main stope, 225 feet from the portal, is 30 feet high and exposes a lens-shaped breccia zone with stringers and lenses of quartz. A 5-foot chip sample (RV–66–3A, table 2) cut across the breccia zone yielded only a trace of gold and silver. The second stope is 365 feet from the portal (fig. 55), and a 6-foot chip sample (RV–66–2A, table 2) cut across the width of a quartz-cemented breccia lens also contained only a trace of gold and silver.

Several narrow quartz veins and lenses associated with an irregular quartz diorite body are exposed about 60 feet from the face. A 6-foot chip sample (RV–66–1A, table 2) taken along the wall was cut in argillite and small quartz veins and lenses as much as 1.5 inches thick. This sample showed only a trace of gold and silver.

The dump of the main working is composed mostly of argillite with minor conglomerate and vein quartz. The quartz is slightly iron oxide stained and contains minor pyrite. A grab sample of the quartz (MHS–145–65, table 2) had 0.12 ounce of gold and 0.09 ounce of silver per ton. A sample (P–NC–50, table 2) was also taken of limonite-stained quartz from the remains of the ore bin; it contained 0.40 ounce of gold and 0.30 ounce of silver per ton.

Above the main working and on the trail at B (fig. 54) is a trench that might be part of a caved adit. The trench is 15 feet long and exposes a minor amount of quartz diorite. A sample (P–NC–51, table 2) of vein quartz that contained about 10 percent limonite and minor pyrite was taken from the dump; it yielded only a trace of gold and silver.

A caved adit is 80 feet east of B on the trail (fig. 54). This working, which was originally part of the Anacortes claims, was relocated in 1955 by Walter Bortz and John Cannon as the Telluride No. 2 claim. A 15-foot trench leading to the collapsed portal trends N. 15° W. Quartz diorite is exposed along the east side of the trench; however, the dump consists mainly of black argillite and some quartz. A sample (P–NC–52, table 2) of limonite-stained quartz from a small stockpile yielded only a trace of gold, and 0.1 ounce of silver per ton. A grab sample (MHS–142–65, table 2) of quartz vein material on the dump contained no gold.

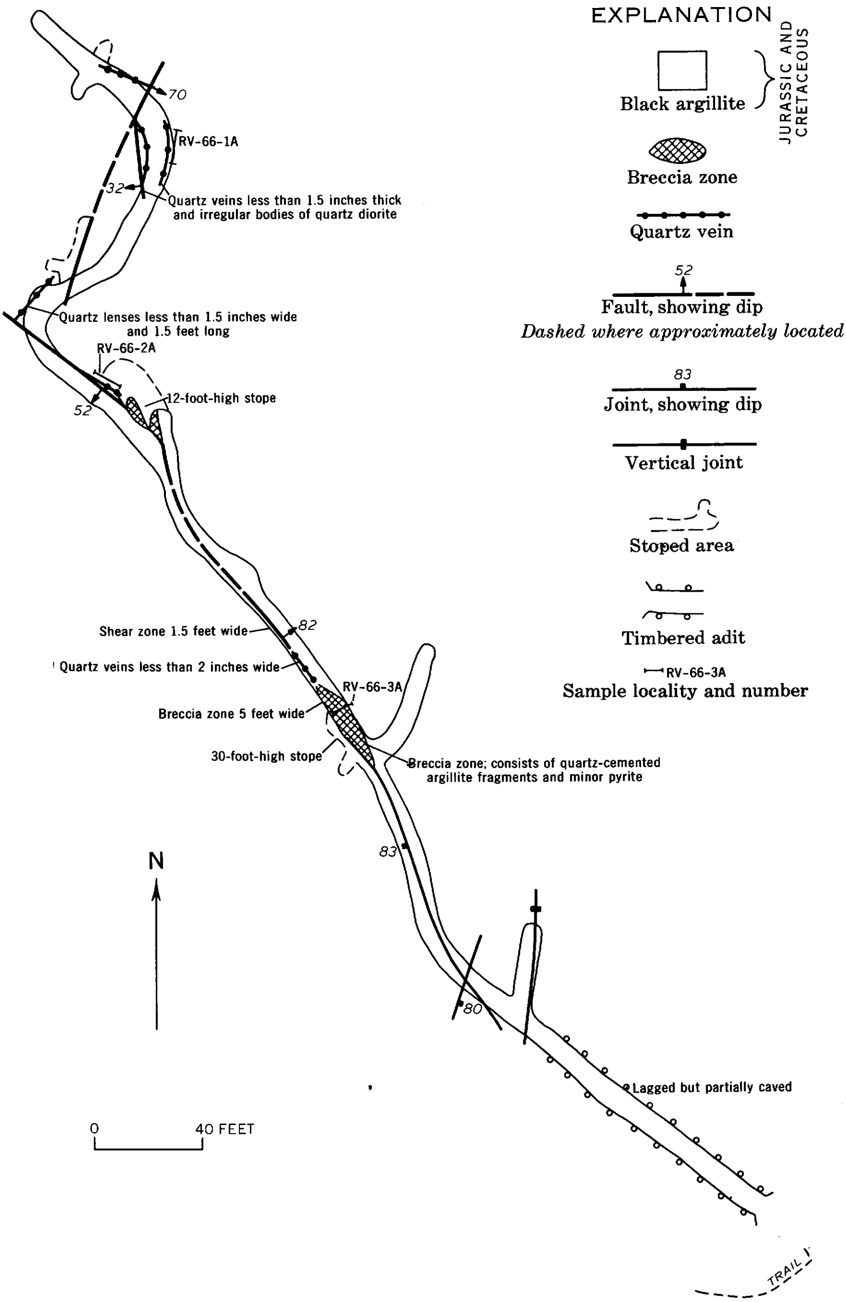

FIGURE 55.—Main workings on the Anacortes group (loc. 59).

Another caved adit is located at C about 500 feet up the trail from B (fig. 54). The dump consists mostly of black argillite; a little of the argillite is bleached, and in it are scattered cubes of pyrite. Only a few pieces of vein quartz were observed on the dump.

A 90-foot adit at D lies about 90 feet above and 230 feet northwest of the adit at C (figs. 54, 56). This working may be the upper adit referred to by Lyon (in Landes and others, 1902, p. 49). Along its entire length, a wide white quartz vein cuts black argillite. The quartz body is somewhat irregular but trends N. 40°–45° W. and has an approximate dip of 70° SW. The vein, 4 to 10 feet thick, is stained with iron oxides and has a little pyrite. Four chip samples (JC–66–12A, MHS–144–65, MHS–143–65, JC–66–13A, fig. 56) cut across this vein and a grab sample (JC–66–4A) from a stockpile yielded only trace amounts of gold and silver. A sample (JC–66–12A) was taken at the face; it contained 0.02 ounce of gold and 0.1 ounce of silver per ton.

The uppermost workings are at E at an elevation of 6,730 feet, about 1,200 feet horizontally southeast of Anacortes Crossing and

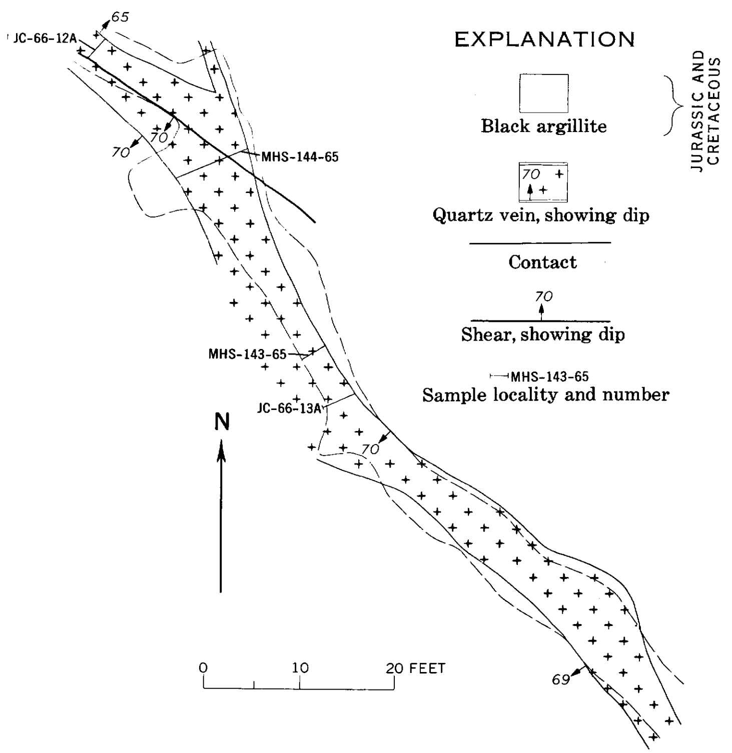

FIGURE 56.—Adit D of the Anacortes group (loc. 59).

about 1,700 feet northwest of the main adit (fig. 54). These were formerly part of the Anacortes group but were restaked by Walter Bortz and John Cannon of Winthrop, Wash., in 1955 as the Telluride No. 1 claim. According to Walter Bortz (oral commun., 1966), they found several specimens that contained visible free gold but no tonnage of ore. Workings comprise three adits, two of which are caved, and two small pits. The three adits have been driven on a N. 40° W. trend and follow a shear zone with a near-vertical dip. The two adits located above the trail are caved, and their collapse has formed two trenchlike exposures. The upper trench is about 70 feet long and exposes a minor amount of black argillite and a fault gouge seam as much as 6 inches thick. A sample (JC–66–15A, table 2) of the gouge assayed 0.50 ounce of gold and 0.30 ounce of silver per ton. A grab sample (MHS–170–65, table 2) of quartz vein material with minor pyrite and galena from a small stockpile at the lower end of the trench contained 0.10 ounce of gold and 0.09 ounce of silver per ton. The maximum width of quartz vein material in the stockpile was 6 inches.

Collapse of the middle adit has formed a 40-foot-long trench. Exposed above the caved portal is black argillite and conglomerate, at the contact of which is a 0.3-foot-thick quartz vein. The vein trends N. 35° W. and dips 85° SW. A grab sample (JC–66–9A, table 2) of the quartz from a small stockpile yielded 0.78 ounce of gold and 1.4 ounces of silver per ton.

The portal of the third adit lies about 15 feet below the trail. It is 30 feet long and is lagged along most of its length. A quartz vein on the wall of a shear zone is exposed at the face. The vein is ½ to 4 inches thick and contains some limonite staining and thin pyrite veinlets. Two chip samples (MHS–171–65, JC–66–11A, table 2) taken across the vein at its widest part contained an insignificant quantity of gold and silver. A grab sample (JC–66–10A, table 2) of quartz material from a small stockpile on the dump contained 0.06 ounce of gold and 0.15 ounce of silver per ton.

Adit F and two small caved pits above it are located between E and B, about 650 feet south of the workings at E (figs. 54, 57). The portal is at an elevation of 6,340 feet. The adit is 170 feet long and follows a gouge zone that trends N. 30° W. and dips 50°–55° SW. The gouge zone pinches and swells erratically and has a quartz vein along it. The country rock is black argillite, and near the gouge zone it is iron oxide stained. Total width of the shear zone plus the iron-oxide-stained argillite is 4 to 6 feet; total width of the quartz vein and gouge is 5 inches to 2 feet. Two 20-foot random chip samples were taken along the structure (fig. 57), one near the end of the

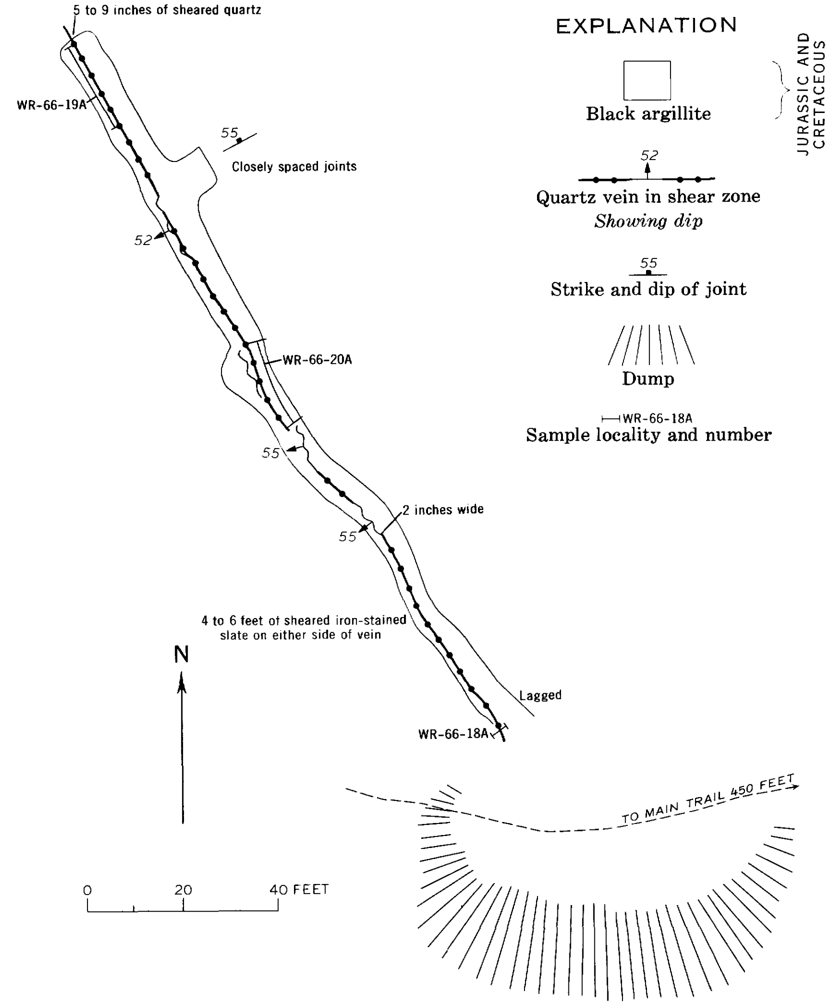

FIGURE 57.—Adit F of the Anacortes group (loc. 59).

adit (WR–66–19A, table 2) and the other (WR–66–20A, table 2) about midway in the adit. Neither sample had more than a trace of gold or silver. A chip sample (WR–66–18A, table 2) taken across a 1-foot-thick quartz vein at the portal assayed 0.01 ounce of gold and 0.2 ounce of silver per ton.

Numerous shallow pits and trenches along this slope provided several samples of pyrite-bearing rock that showed only a trace or less of gold and silver.

In summary, apparently gold and silver values are erratically distributed and are generally low. Upper workings, where the better values were found, represent relatively small tonnages, and there is no reason to believe that the tenor of the material will increase at depth. The mineralized structures continue southeastward down the slope for an unknown distance beneath heavy soil cover.

Locality 60

Locality 60 is on a small north-flowing tributary of Cascade Creek (figs. 53, 58), about 2¼ miles by trail from Chancellor. A short distance east of the point the Anacortes Crossing trail crosses Cascade Creek is an old cabin site, and the workings are about 250 feet to the south.

The country rock in the vicinity of the prospect is largely argillite. The beds trend N. 20°–30° W. and dip steeply northeast. Quartz diorite crops out in a ravine 40 to 50 feet west of the workings.

The workings consist of an adit and two shallow pits at higher elevations (fig. 58). The adit is 105 feet long and follows a discontinuous 8-inch quartz vein that trends N. 20°–30° W. and dips 75° NE. The pits, which are 40 and 130 feet south of the adit portal, do not expose vein material in place, although small stockpiles contain chunks of vein quartz as much as 12 inches thick.

The quartz vein in the adit is iron oxide stained along fractures; the only sulfide mineral observed was pyrite, in minor amount. A chip sample (RV–66–6A, table 2) taken across the face of the adit assayed 0.03 ounce of gold and 0.1 ounce of silver per ton and a trace of copper. A chip sample (RV–66–9A, table 2) taken across the vein 66 feet from the portal yielded only a trace of gold and silver; a grab sample (RV–66–8A, table 2) of vein quartz from the upper pit stockpile also contained only a trace of gold and silver.

Locality 61

Locality 61 is on the ridgetop at the head of Cascade Creek and 1,500 feet due south of the top of Jackita Peak (fig. 53). No workings were found at this locality. One-half- to two-inch veinlets of quartz in a zone of brecciated limonitic arkose parallel the bedding in gray medium-grained arkose that strikes N. 20° W. and dips 84° E. Two chip samples (1687, 1688, table 2) were taken across this zone. Neither contained more than a trace of gold or silver.

Locality 62 (Bird Group–Gardula Group)

The prospects collectively known as the Bird group and Gardula group of claims are for the most part on the west and south walls of the cirque at the head of Friday Creek (fig. 53), although the western extension of the Bird group occupies the crest of the ridge between Friday Creek and Devils Creek. The prospects may be

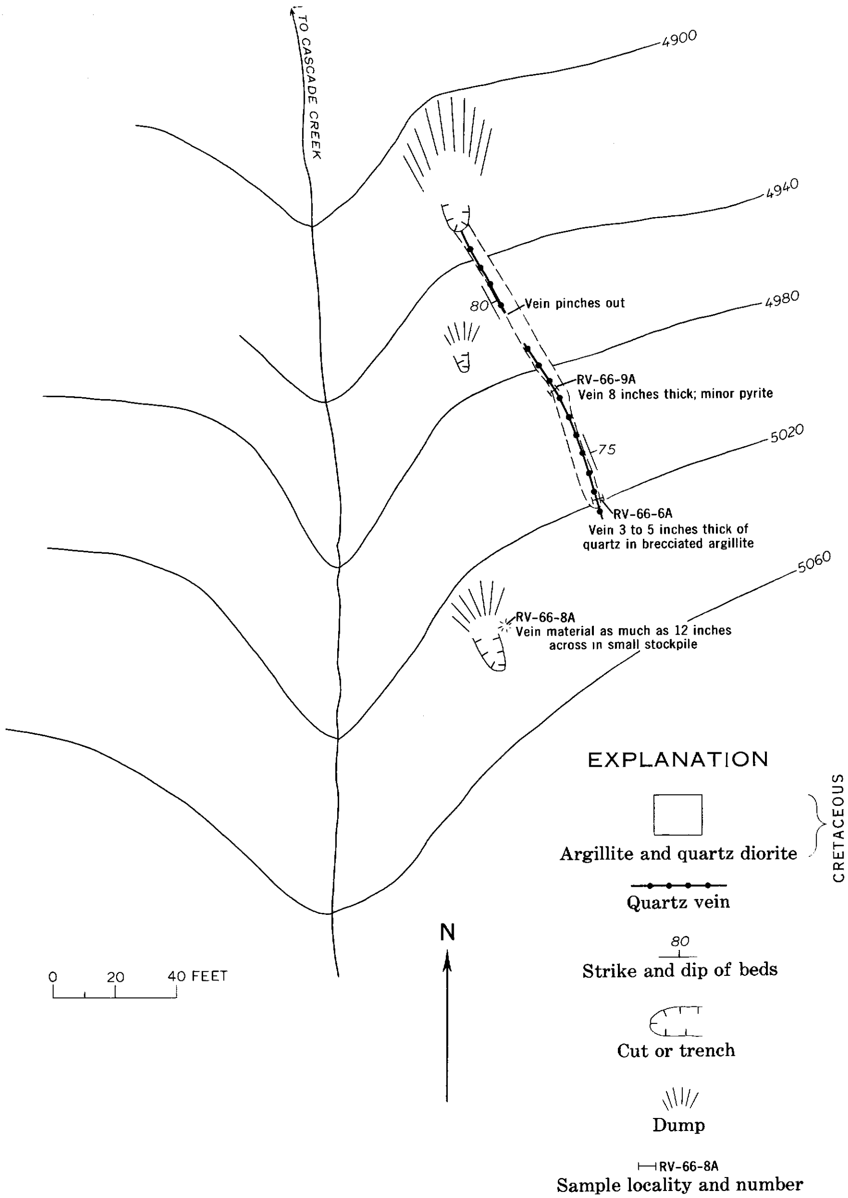

FIGURE 58.—Locality 60 (Cascade Creek prospect). Overburden is thick and outcrops are sparse. The only rocks exposed are in the workings and along the creekbed.

reached by following the Devils Pass trail for about 1 mile northeastward from the Devils Park shelter.

The Bird group consists of the Red Bird, Blackbird, and Snowbird claims located in 1900 by John Siegfried, William Baer, and C. H. Clendenin, respectively. The Red Bird and Blackbird were relocations of the Red Cross No. 1 and No. 2, filed in 1885. The Bird claims were in turn relocated in 1903 as the Devil, Summit, Crater, and Apex claims by P. H. Miller, F. F. Peck, and H. J. Numan.

The Gardula No. 1 and No. 2 were located by John Siegfried; the Gardula No. 2 was a relocation of the Olympia claim.

The country rock in the Friday Creek area is interbedded gray to black slaty argillite, medium- to dark-gray conglomerate, and tan to gray arkose. The bedded rocks strike N. 45°–50° W. and dip steeply northeast. In the vicinity of the Bird group workings, the sedimentary rocks are intruded by a small complex of dikes or dikelike andesitic and later rhyolitic bodies. The Gardula claims, located east of two small lakes in the Friday Creek cirque, are on a small stock of diorite.

There are three small pits on the Bird group. One is 30 feet west of the Devils Creek–Friday Creek ridge crest; the other two are a few tens of feet east of the ridge crest on the Friday Creek side. The westernmost pit is about 12 feet long, 4 feet wide, and 3 feet deep; the central pit is 10 feet long, 8 feet wide, and 3 feet deep; and the easternmost working is a shallow, sloughed-in depression. The workings appear to be on a rhyolite dike that can be traced from a short distance west of the ridge crest to just above the floor of the Friday Creek cirque. The two western pits expose a discontinuous 6- to 8-inch vertical quartz vein that strikes nearly east. The quartz and immediately surrounding country rock, which contain small scattered grains of pyrite, are slightly to moderately iron oxide stained. A sample (WR–66–10A, table 2) of gray quartz taken from a stockpile near the pits contained a trace of gold and silver.

No workings were found in the area described in courthouse records as being the Gardula claims. The southernmost claim (Gardula No. 2) apparently covered a mineralized area made up of several parallel shear zones. The shear zones trend nearly north, are vertical, and vary in width from a few inches to 2 feet. They are made up of fractured, iron-oxide-stained quartz diorite and quartz. No sulfide minerals were observed. A grab sample (WR–66–11A, table 2) of quartz float taken from talus below the outcrop assayed only a trace of silver and gold.

The Gardula No. 1 claim adjoins the No. 2 to the north. The No. 1 claim covers a small iron-oxide-stained zone that occurs where a body of quartz diorite intrudes slaty argillite. Both the intrusive and sedimentary rocks are moderately iron oxide stained; the intrusive rock is slightly bleached, moderately silicified, and contains several thin quartz stringers. No metallic minerals were observed. A chip sample (WR-66-12A, table 2) taken across the iron-oxide-stained zone assayed only a trace of gold and silver.

Locality 63

Locality 63 lies on an east-trending ridge between Cascade and Friday Creeks and 10,000 feet west-northwest of Chancellor (fig. 53). No workings were noted. Country rock is a plagioclase arkose containing a 25-foot-thick layer of chert-pebble conglomerate that strikes N. 30°–50° W. and dips 75°–85° NE. A 1.5-foot limonitic zone that contains thin quartz veins parallels the bedding. A chip sample (1719, table 2) cut across the limonite zone yielded a trace of gold.

Locality 64

Locality 64 is 4,000 feet northwest of Chancellor (fig. 53), on the southwest slope of a steep mountain just below its crest. A northwest-trending adit about 145 feet long (fig. 59) and a small trench were driven in hornblende quartz diorite. The adit follows a shear zone that contains one or two white quartz veins (fig. 59). The quartz vein is locally vuggy and limonitic and ranges in thickness from half an inch to 3 feet. A chip sample (1720, table 2) was taken in the adit 45 feet from the portal, across two 4-inch quartz veins; it contained only traces of gold, silver, and copper. The trench lies 80 feet uphill, northwest of the adit; it is partly slumped, but originally was 8 feet long, 6 feet wide, and 4 feet deep at the back. The quartz vein exposed in the trench is 1½ feet thick.

Locality 65

Locality 65 is on the northwest side of Canyon Creek, about 3,500 feet southwest of Chancellor (fig. 53). At this locality a 3-foot bleached, iron-oxide-stained zone cuts fine-grained dark-gray arkosic quartzite. The zone cuts across the strike of the country rock and has a N. 40° E. strike and a vertical dip. Within this zone thin veins—principally of quartz and a carbonate mineral (calcite?)—contain sparse pyrite and a few grains of a black opaque mineral. A chip sample (1610, table 2) taken across this zone contained only traces of copper and no measurable amounts of gold or silver.

Locality 66

Locality 66 is on the hillside on the northwest side of Canyon Creek, about 1 mile southwest of Chancellor (fig. 53). The hillside

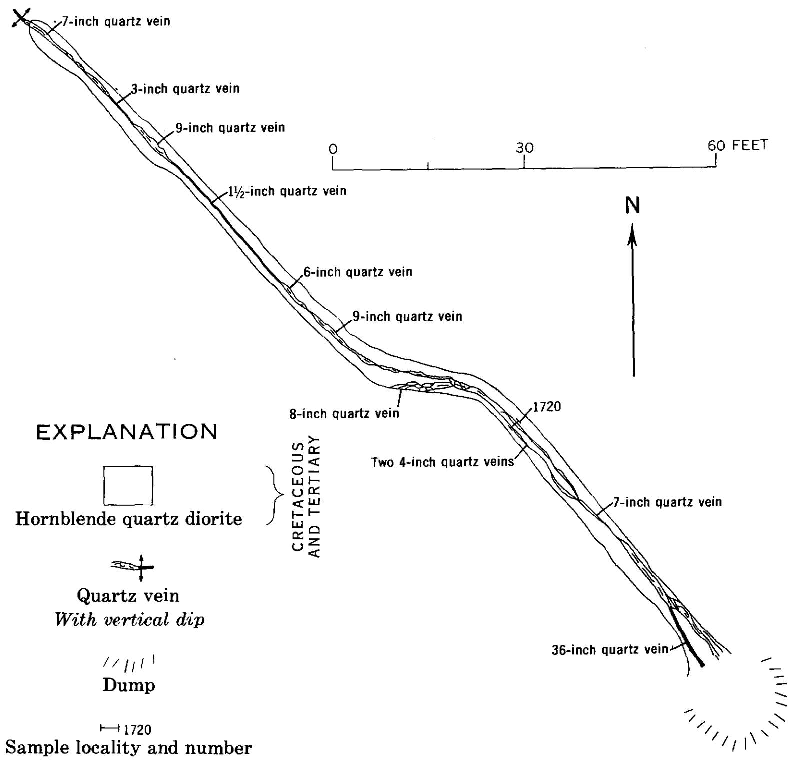

FIGURE 59.—Adit at locality 64.

is mainly talus, but there are some exposures of iron-oxide-stained massive arkosic quartzite with thin white quartz veins that contain scattered pyrite crystals. Similar altered quartzite is found on the southeast side of Canyon Creek in two parallel steeply dipping iron-oxide-stained zones about 6 to 10 feet wide. A representative grab sample (1611, table 2) of the altered rock with the quartz veins was collected from the talus on the northwest side of Canyon Creek. It yielded only traces of copper and no measurable gold or silver.

LOCALITY 67 (NEVADA CITY CLAIM)

The Nevada City prospect is 350 feet west of Cedar Crossing, where the main trail crosses Canyon Creek (fig. 53). The prospect consists of a 110-foot adit whose portal is about 15 feet above Canyon Creek (fig. 60). According to Wayne Moen, Washington State Bureau of Mines and Geology, this claim was located by J. H. Young in 1920. No production has been recorded.

There are two intersecting shear zones at the portal of the adit; one strikes N. 40° W. and dips 20° SW., and the other strikes N. 5°

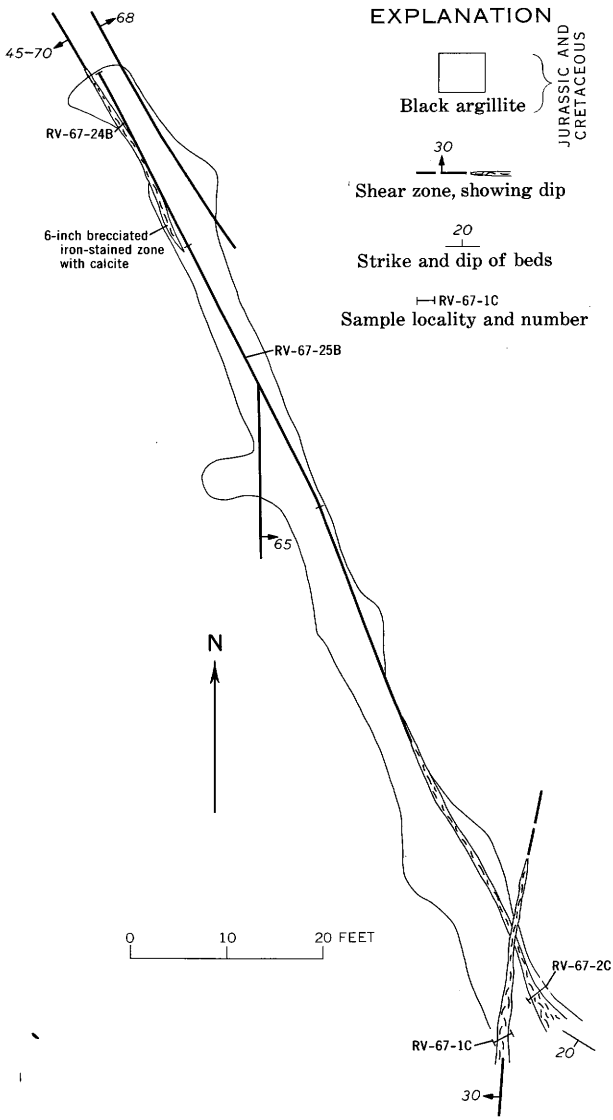

FIGURE 60.—Adit on the Nevada City claim (loc. 67).

E. and dips 30° W. The first is exposed for the length of the adit, and at the face its dip steepens; it ranges in thickness from 4.5 feet at the portal to 2 inches at the face. The composition of the zone also changes from a sheared black argillite with iron-oxide-stained gouge at the portal to a gouge containing brecciated argillite, calcite, quartz, and minor iron oxides near the face. The second zone is 2 feet thick on the west side of the portal; it crosses the first shear zone and disappears into the wall.

Four samples were taken along the adit. A 20-foot chip sample (RV–67–24B, table 2) cut along the fault from the face to a point 90 feet from the portal yielded a trace of silver, but no gold or copper. A second sample (RV–67–25B, table 2) taken along the same structure from the end of RV–67–24B to a point 66 feet from the portal had no gold, silver, or copper. A 4.5-foot chip sample (RV–67–2C, table 2) from this same shear zone at the portal contained no gold, silver, or copper. A 2-foot chip sample (RV–67–1C, table 2) from the other shear zone yielded only a trace of copper, but no gold or silver.

Locality 68 (Minnesota Mine)

A tramline extends several hundred feet to the east from an old collapsed mill on the north side of Canyon Creek, 2,000 feet west of the mouth of Mill Creek, to a small gully where the entrance to a 485-foot adit is partly hidden by rock debris (figs. 53, 61). This property is the Minnesota mine. The mill was erected in 1908 by the Seattle–St. Louis Mining Co. (Yale, 1909, p. 582). It was a four-stamp amalgamation mill, and tests made in it were reported in 1912 and 1913 (Gerry, 1913, p. 923; Gerry, 1914, p. 801). Whether any ore was actually shipped is uncertain, but in 1918 J. T. Voight, president of the Seattle–St. Louis Mining Co., reported that there had been no shipments (Norman, 1918, p. 201).

The adit was driven due north for 40 feet to a northwest-trending shear zone, which it follows for 445 feet. The tunnel is all in black argillite. The shear zone thickens and thins from 0.3 to 4.0 feet (fig. 61). There are from one to five quartz veins along it, although in a few places the shear zone has no quartz veins.

The quartz veins also thicken and thin and attain a maximum thickness of 2 feet at the end of the adit, where the vein fills the entire shear zone. The vein is almost entirely white quartz, although a little pyrite and calcite were noted. Three chip samples (MHS–53–66, MHS–54–66, MHS–55–66, table 2) were taken across the shear zone (fig. 61). Only one of the three showed any measurable gold, and it contained only 0.006 ounce of gold per ton.

As no stopes are found along this adit, apparently the operators did not find any ore.

Locality 69 (South Devils Park Prospect)

A small prospect is located south of the ridge crest at the extreme southeast end of Devils Park. This prospect is about three-fourths

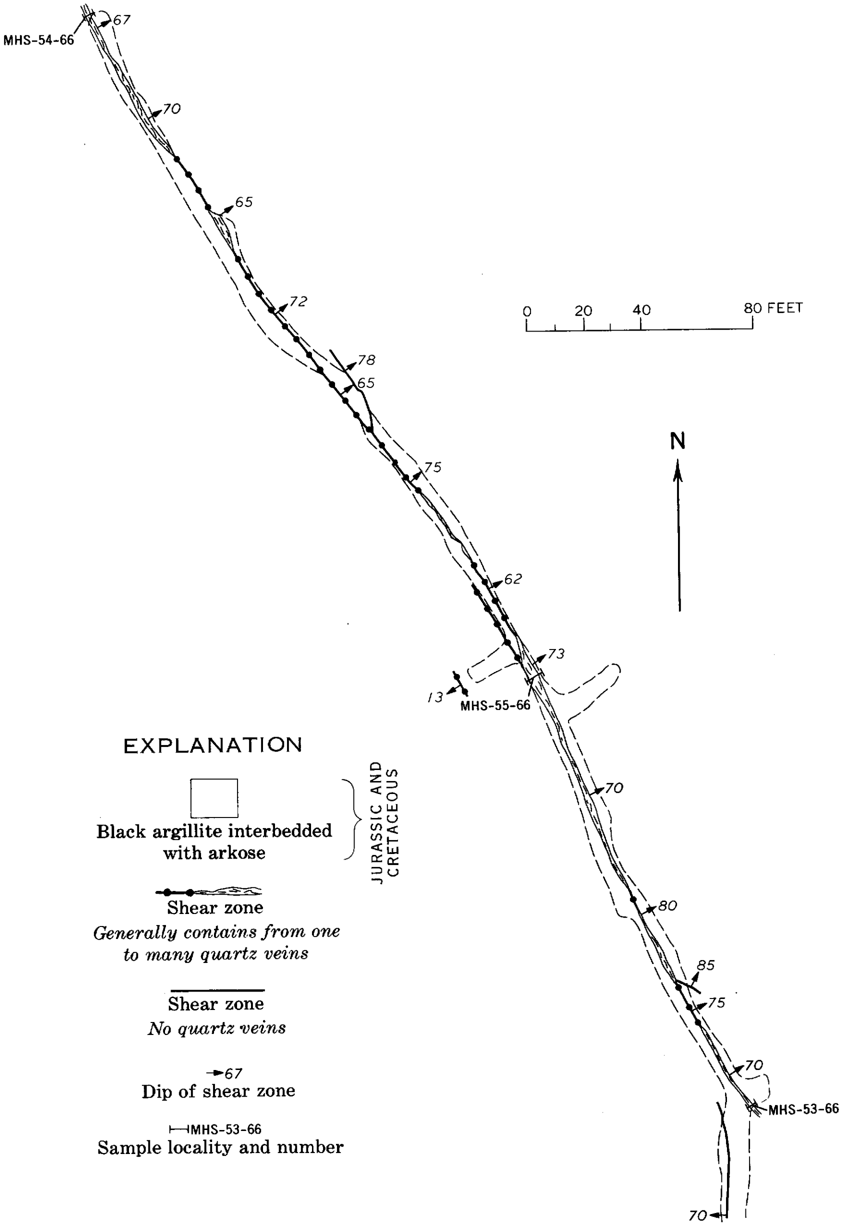

FIGURE 61.—Adit at the Minnesota mine (loc. 68).

of a mile southeast of the Devils Park shelter and approximately a quarter of a mile south of the Devils Pass trail (fig. 53).

The area is underlain by fresh, unfractured medium- to dark-gray slaty argillite. The prospect working consists of a shallow opencut measuring 2 feet wide by 6 feet long that trends N. 55° W. Beside the small cut is a stockpile of 75 to 100 pounds of vuggy iron-oxide-stained quartz containing sparse pyrite. As none of this material was found in place within the prospect cut, the stockpile probably represents the entire occurrence. A grab sample (WR–66–14A, table 2) of the stockpiled material assayed a trace of gold and 0.2 ounce of silver per ton.

LOCALITY 70 (NICKEL CREEK PROSPECT)

The Nickol Creek prospect is along the Devils Pass trail about 700 feet north of where the trail crosses Nickol Creek (pl. 3), which is about 2 miles upstream from the mouth of this creek. The country rock in the vicinity of the prospect is iron-oxide-stained serpentine having closely spaced joints.

The prospect workings consist of a shallow opencut 3 feet wide and 10 feet long that trends S. 55° W. and terminates in a 4-foot by 5-foot inclined shaft that is 18 feet deep. The workings explore a 4-foot-wide shear zone that trends N. 35° W. and dips 60° SW. The rock within the shear zone is silicified, and contains numerous thin quartz stringers and some iron-oxide-stained siliceous boxwork. The quartz stringers and boxwork near the footwall and hanging wall of the shear zone contain intermittent stains, streaks, and small masses of a light-olive-green mineral, tentatively identified as the nickel silicate garnierite. The greater part of the quartz stringers and boxwork appears to be devoid of metallic minerals.

A chip sample (WR–66–13A, table 2) taken across the shear zone on the floor of the inclined shaft had 0.12 percent nickel and a trace of gold and silver.

Nickel silicate deposits have economic significance only when of far greater size than the prospect on Nickol Creek.

LOCALITY 71 (RAINBOW GROUP)

A group of four claims staked along Nickol Creek(?) in 1938 about 1½ miles downstream from locality 70 (pl. 3) belongs to the Rainbow group. No workings were found except pits and trenches associated with placer mining on nearby Canyon Creek.

Nickol Creek has a steep gradient and cuts through a brown carbonate body surrounded by phyllite. This body, which is exposed in the streambed between elevations of 3,200 and 4,200 feet, is highly contorted, but trends N. 40° W.–N. 20° E. and dips 30°–50° W. It was traced from 400 feet east of the creek to 100–200 feet west of it. The bulk of this rock is impure magnesite, but it also has the earthy green chromium-bearing mica, fuchsite.

Three chip samples (not listed in table 2) were cut in this rock near the creek. A 26-foot chip sample cut across the lower contact had 0.10 percent nickel, but no gold or silver. A spectrographic analysis of the rock showed chromium in the range of 0.01 to 0.1 percent. An 18-foot chip sample at an elevation of about 3,800 feet had 0.06 percent nickel, but no gold or silver. A spectrographic analysis showed chromium also in the range of 0.01 to 0.1 percent. A 100-foot chip sample taken along the creek near the top of the carbonate body had 0.06 percent nickel, a trace of gold, and 0.05 ounce of silver per ton.

Locality 72

Locality 72 is on the north side of Canyon Creek 1,600 feet southwest of the mouth of Nickol Creek (pl. 3). The country rock is black argillite interbedded with plagioclase arkose. Here, a caved adit is about 20 feet above the stream. It was driven in a steep slide, which now almost completely covers it. The dump is small, and the adit was probably no more than 50 feet long. The adit was driven into an 80-foot-wide limonite-stained zone containing pyrite. The altered zone strikes N. 40° W., parallel to the strike of the bedding, and can be traced for at least 100 feet on both sides of Canyon Creek. No quartz veins were found in the slide or on the dump. A grab sample (1272, table 2) of the altered rock was taken from the dump. It contained only 0.003 ounce of gold per ton and 0.01 percent copper.

Locality 73

Locality 73 is on the north side of Canyon Creek 2,000 feet southwest of the mouth of Nickol Creek (pl. 3). Here, on a small terrace about 25 feet above Canyon Creek, are two caved adits about 200 feet apart. Both adits are driven into what appears to be the same iron-oxide-stained zone in black argillite and plagioclase arkose. A little pyrite is scattered through the zone. The hillside into which the adits are driven is very steep and is covered by a large slide that fills the entrances to the tunnels. From the size of the dumps we estimate that the east tunnel had about 200 feet of workings and the west about 100 feet. Two samples of iron-oxide-stained material were taken from the dumps: 1273 (table 2) from that of the east adit and 1274 (table 2) from that of the west adit. Neither contained any measurable gold; sample 1274, however, contained 0.02 percent copper.

Locality 74

Locality 74 is on the north side of Canyon Creek at a sharp bend in the creek about 1 mile southwest of the mouth of Nickol Creek and 1.5 miles northeast of the mouth of Granite Creek (pl. 3). Here, a 40-foot northerly trending trench was found on a small rock terrace between two cliffs. Country rock is black argillite cut by a westerly trending plagioclase porphyry dike. This locality lies on the north flank of a small anticline. The trench cuts both dike and argillite, and one end abuts a steep hillside covered with limonitic argillite talus. The trench is in unaltered rock, and appears to have been used as a channel along which limonitic argillite was dragged by a slusher to some sort of separator at the other end. The old slusher and a donkey engine are still on the dump. A sample (1279, table 2) was taken of the limonitic argillite from the talus; it contained only 0.003 ounce of gold per ton and 0.015 percent copper.

Locality 75 (Lucky Strike Claim)

The location post and shallow pit of the Lucky Strike claim were noted at an elevation of about 2,900 feet on a densely forested south-facing slope of Canyon Creek (pl. 3). The post is approximately 200 feet south of the Crater Mountain trail at a point 1.2 miles northeast of the Granite Creek guard station.

The claim was recorded in 1933, as a lode claim, by Tom Reed and Harry H. Nixon. Bedrock is not exposed in or near the pit, so the claim probably was for high bench-placer material that underlies an area averaging 150 feet in width and extending for 500 feet parallel to the contour of the hill. The slope of the placer area is 15°–20° to the south, much less than the surrounding hillside. The placerable material is as much as 8 feet deep, but would average less than 5 feet. A stream a few hundred feet to the west could furnish adequate water for a placer operation.

A 30-pound sample of dump material from the shallow pit was panned. No gold or other valuable minerals were detected.

Locality 76 (Stray Horse No. 2 Claim)

A claim identified as the Stray Horse No. 2 is located on a spur ridge that extends southward from Jack Mountain (pl. 3). The Jack Mountain area is reached by following a secondary pack trail northeasterly for about 3 miles from its junction with the Ruby Creek trail near the Ruby Creek barn.

The country rock consists of laminated iron-oxide-stained dark-gray phyllite interbedded with lesser amounts of banded light- to medium-gray calcareous phyllite. The metasedimentary rocks trend

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N. 45°–55° W. and dip steeply southwest. They are intruded by numerous small diverse-trending dikes that are medium grained, gray, and of intermediate composition.

A trench on this prospect is 25 feet long, 5 feet wide, and 5 to 6 feet deep. It was dug along a 3½- to 4-foot wide, steeply dipping shear zone that trends about N. 40° W. Within the shear zone is a brecciated and intensely iron oxide stained dike. Adjacent to the shear zone the wallrock is also brecciated, and iron oxide staining extends 3 to 4 feet out from this zone.

The rock exposed in the opencut varies in color from mottled dark reddish brown to black to yellowish brown. It is in part argillized and soft and in part hard and silicified. Boxwork structure is common; veins of quartz, however, were not noted. Partly oxidized pyrite and pyrrhotite are present. The rocks are coated with manganese oxides and a white sulfate. A 3-foot chip sample (RV–66–4A, table 2) was taken across the shear zone at the face of the opencut. The assay showed a trace of gold and copper, and 0.1 ounce of silver per ton.

Locality 77

Locality 77 is at the base of a series of vertical cliffs above a long talus slope on the steep southwest flank of Jack Mountain, at an elevation of about 7,000 feet (pl. 3). The country rock is highly fractured and sheared greenstone of the Hozomeen Group of Cairnes (1944), which is intruded by a swarm of northwest-trending hornblende diorite dikes and partly sheared and serpentinized dunite dikes. Thin lenses of sedimentary chert are scattered through the greenstone and their general orientation indicates that the formation has a northeast strike and a moderate northwest dip. Most of the greenstone contains widely dispersed fine-grained pyrite, and most of the fractures are limonite stained. The greenstone is cut by a 2-foot-thick limonitic shear zone that strikes roughly northeast and has a very gentle dip to the northwest. The shear zone is exposed for about 20 feet. Within it are sparsely disseminated pyrite, calcite, quartz veinlets, and minor malachite staining. Chip samples 2244 and 2291 (table 2) were taken across the shear zone at points several feet apart. They contained 0.025 percent and 0.21 percent zinc, respectively. Sample 2291 also contains 0.014 percent copper and 0.009 ounce of silver and 0.008 ounce of gold per ton. By semiquantitative spectrographic analysis, sample 2291 contained, in addition to the elements shown in table 2, 0.07 percent arsenic, 0.01 percent beryllium, and 0.02 percent yttrium. Although the values of all elements are well below economic grade, this sample has some of the highest amounts of beryllium, yttrium, and arsenic of any samples obtained in the area.

LOCALITY 78

Locality 78 is high on the narrow and serrated southwest-trending ridge of Jack Mountain (pl. 3). The ridge is underlain by greenstone that contains a few thin chert lenses and is crisscrossed by random fractures. A gray fine-grained hornblende-plagioclase dike about 3 feet thick intrudes the greenstone. The dike strikes N. 15° W. and dips 75° SW. Closely spaced parallel joints are developed in a zone at least 20 feet wide on each side of the dike. The greenstone next to the dike is metamorphosed and contains microscopic crystals of hornblende, actinolite, and magnetite.

The joints and fractures adjacent to the dike are coated with limonite and, in places, chalcopyrite and pyrite. Two chip samples (2253 and 2254, table 2) taken of this limonite-stained rock contained 0.12 and 0.006 percent zinc and 0.03 and 0.028 percent copper. Little or no lead, molybdenum, cobalt, nickel, or gold was detected.

LOCALITY 79

A wide zone of shearing is exposed along a trail that traverses the cliffs along the east shore of Ross Lake ¼ to ½ mile south of the mouth of Devils Creek (pl. 3). Shears in the zone have a general strike of N. 35° W. and dips of 40°–50° NE. The shears mark a fault zone that separates greenstones of the Hozomeen Group of Cairnes (1944) from dark-gray phyllites. Both of these rocks are highly sheared and contorted within the fault zone and are folded into minor synclines and anticlines whose axes commonly plunge 15°–18° S., 75° E.

Blasting during trail construction exposed many small irregular fresh white quartz veins. Some of the veins are vuggy, containing fine- to medium-sized quartz crystals, and many are stained by iron and manganese oxide. Sparsely scattered through the quartz veins are pyrite, pyrrhotite, and traces of chalcopyrite and bornite. One such quartz vein contained minute particles of free gold in a vug. The vug was lenticular and approximately 6 inches long by 2 to 3 inches across. Its walls were lined with well-formed, clear, colorless quartz crystals with wires of gold sparsely scattered among them. No sample of this gold-bearing vuggy quartz was available for assay, but two samples (2272 and 2272A, table 2) of limonite-stained fractured quartz from nearby contained no gold or silver. Although a diligent search was made among the quartz veins for other signs of gold, none was found. Apparently, then, gold occurs very sparsely in isolated pockets in the quartz veins but is not particularly associated with the sulfide minerals.

Locality 80

Locality 80 is at approximately 6,600 feet elevation on the west shoulder of Devils Dome and 1,500 feet west-northwest of an old lookout (pl. 3). Here a limonitic zone as much as 200 feet wide parallels beds of gray plagioclase arkose. This zone, which is best exposed on the north side of the ridge, consists of a quartz-cemented arkose breccia with rare 4- to 6-inch quartz veins. No workings were found in the area. A chip sample (RWT–268–65, table 2) taken across 7 feet of the most highly altered rock contained no gold, and only 0.06 ounce of silver per ton.

Locality 81

Locality 81 is on the east side of Middle Creek, about 1,200 feet south of its junction with Cinnamon Creek (pl. 3). The rocks here are plagioclase arkose and interbedded black argillite that have been tightly folded, sheared, and cut by several quartz porphyry dikes. At this locality a 2- to 3-inch quartz vein that strikes N. 25° E. and dips 65° NW. cuts across the arkose. The vein is exposed for a distance of about 10 feet. In addition to quartz it contains some pyrrhotite and a little chalcopyrite. A chip sample (1337, table 2) taken across the vein contained no gold.

Locality 82

Locality 82 is on the south side of Cinnamon Creek, about 2,350 feet northwest of its junction with Middle Creek (pl. 3). This locality may be on an old claim, as some of the trees have been cut and blazed. At this spot several discontinuous 1-foot quartz-calcite veins are exposed for about 10 feet on the steep south wall of the canyon. They intruded tightly folded and sheared plagioclase arkose interbedded with black argillite. The veins strike N. 20° E. and dip 75° SE., and cut obliquely across the sedimentary rocks. Sulfides were not noted in the veins. A chip sample (1334, table 2) taken across two of these veins contained no gold.

BOUNDARY CREEK-LIGHTNING CREEK AREA

The Boundary Creek–Lightning Creek area comprises that part of the Boundary Creek drainage south of the Canadian border, the upper part of Lightning Creek, and a small part of Freezeout Creek drainage (fig. 62). Most of the area is underlain by the north-trending plagioclase arkose and argillite sequence, and greenstone of the Hozomeen Group of Cairnes (1944) that forms the western part of the area. In the north-central part, a hornblende diorite stock occupies about 1 square mile, and several satellite bodies are nearby.

Intrusion of the diorite stock was apparently accompanied by sulfide mineralization. Disseminated pyrite is found in many places, and its weathering has formed numerous large brown iron-oxide-stained areas, partly in the diorite but mostly in the plagioclase arkose and argillite sequence, which locally has been silicified. These evidences of mineralization attracted the attention of early prospectors, and many claims were staked here in 1910 and 1911. Workings were found on only one property (fig. 62), and apparently all the claims were abandoned many years ago.

LOCALITY 83 (UPPER LIGHTNING CREEK)

Iron-oxide-stained canyon walls are found along Lightning Creek ⅛–1¾ miles south of the International Boundary (fig. 62). At least 25 claims were filed here around 1910, presumably to cover the intensely iron oxide stained canyon walls. No workings were found, and probably the claims were abandoned shortly after filing. The country rock is arkose, which near its contact with the hornblende diorite is silicified and contains disseminated sulfides, mainly pyrite. Quartz veins and veinlets are common at or near the intrusive contact. Fifteen samples of iron-oxide-stained rock, quartz veins, and pyrite-rich veinlets were taken west of the stock (fig. 62; table 2). A grab sample (JJ–67–15A) which had about 10 percent pyrite yielded 0.14 percent copper, a trace of gold, a trace of silver, and no molybdenum. Most of the other samples were taken from large zones of disseminated sulfides; none contained more than a trace of gold, silver, copper, molybdenum, or lead (table 2).

LOCALITY 84 (RIDGE EAST OF UPPER LIGHTNING CREEK)

According to courthouse records, at least eight claims were staked between 1910 and 1911 on the ridge that parallels upper Lightning Creek on the east. No workings were found during the present study. This area is underlain by hornblende diorite, argillite, and arkose. A sample (EVK–67–19A, table 2) taken of hornblende-rich diorite that crops out on the northern part of the ridge contains a trace of gold, but no silver, copper, or molybdenum. Traces of gold and silver were found in two of three random chip samples (JJ–67–16A, JM–67–11A, JM–67–12A, table 2) of iron-oxide-stained diorite taken from the southern part of the ridge (fig. 62). A trace of copper was found in one; no molybdenum or lead was detected. Three other samples (712, 713, 714, table 1) of similar rock in the same area yielded 0.02–0.05 percent copper and a little molybdenum.

LOCALITY 85 (BOUNDARY CREEK PROSPECT)

The Boundary Creek prospect is on a short spur ridge north of the east end of the hornblende diorite stock. The ridge is made up of bleached, silicified, and iron-oxide-stained plagioclase arkose

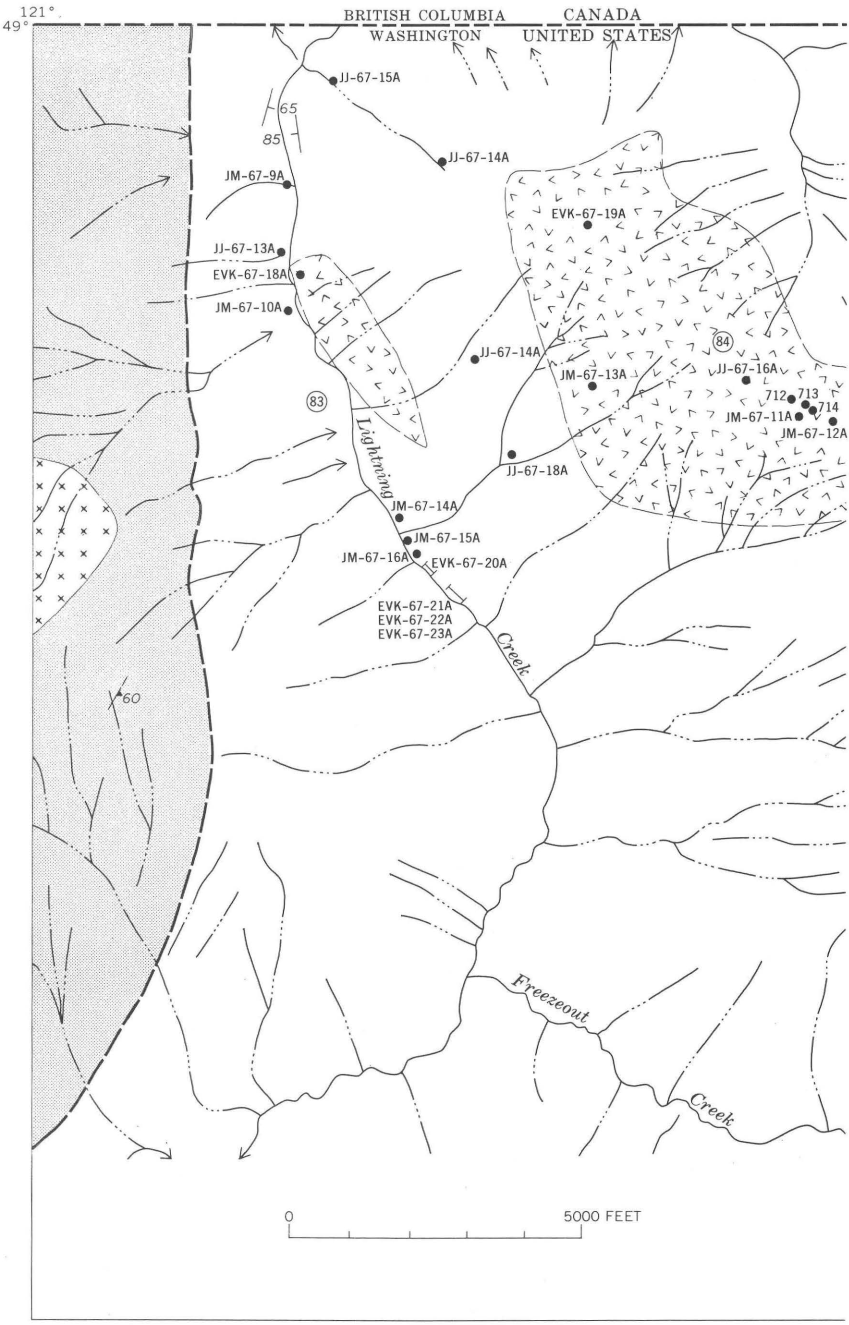
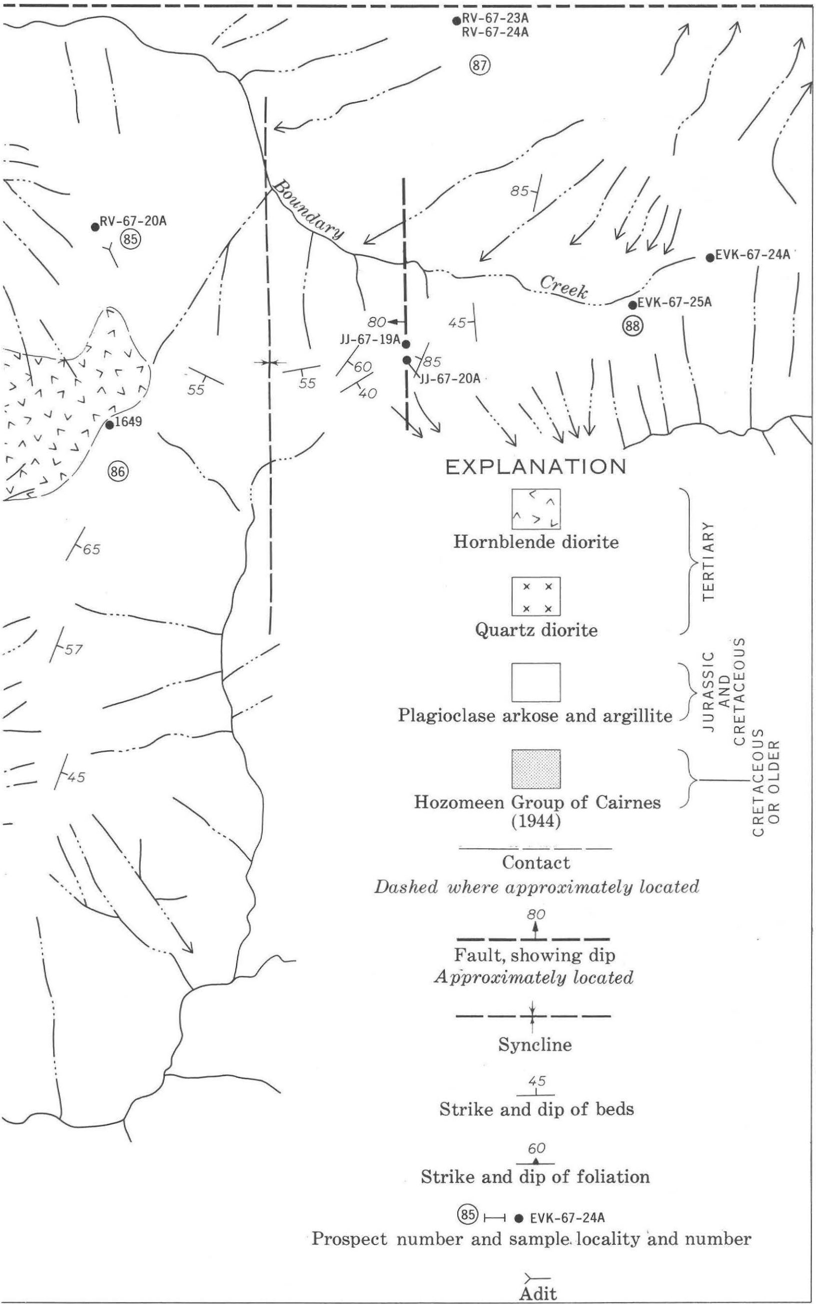


Figure 62.—Sample localities in the vicinity of



claims and prospects, Boundary Creek area.

(fig. 62). Three workings (fig. 63) have been driven near the ridge crest. The largest, about 100 feet west of the ridge crest, consists of a 52-foot adit that trends S. 34° E. The adit follows an irregular brecciated silicified zone in the arkose. The zone is apparently formed along the intersection of two sets of shear planes, one striking about north and dipping about 60° W. and the other striking about N. 60° W. and dipping 30°–70° NE. The silicified rock is cut by numerous short randomly oriented vuggy quartz veinlets, generally less than a quarter of an inch thick. Pyrite is scattered through the

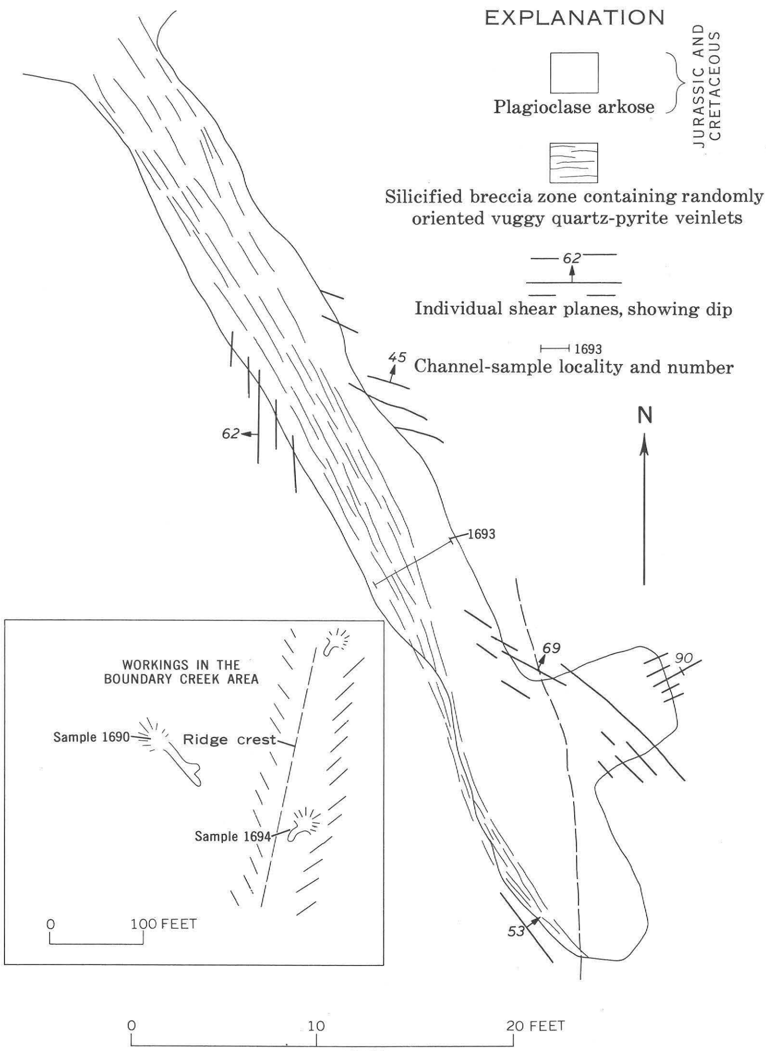


FIGURE 63.—Workings, Boundary Creek area (loc. 85).

veinlets and more sparsely in the silicified arkose. Sphalerite was found in one sample from the dump. A 5-foot channel sample (1693, table 2) taken across the mineralized zone 30 feet from the portal contained 0.0025 percent lead, 0.02 ounce of silver per ton, but no gold. A grab sample (1690, table 2) of the most intensely mineralized rock from the dump yielded only 0.03 percent lead, and 0.0075 percent zinc.

One hundred fifty feet southeast of the adit is a second, smaller adit, 15 feet long and 4 to 7 feet wide (fig. 63). It is driven on a sheared and gouged zone that strikes N. 50° E., dips 55° NW., and is 10 to 18 inches thick. A 16-inch channel sample (1694, table 2) taken at the portal contained 0.025 percent lead but no detectable zinc, silver, or gold.

Two hundred feet N. 60° E. of the large adit (fig. 63) is a prospect pit 5 feet wide, 6 feet long, and 7 feet high at the face, in sheared and iron-oxide-stained rock. No sulfides or vein minerals are exposed at this pit.

Two thousand feet downslope and northwest from the workings, an overhanging cliff, about 80 feet high, exposes disseminated pyrite in silicified arkose. A random sample (RV–67–20A, table 2) taken across the cliff face (fig. 62) showed only a trace of gold, a trace of silver, and no copper, molybdenum, or lead.

Locality 86

At locality 86, a 500-foot cliff that consists entirely of hornblende diorite forms the head of a southeast-facing cirque on the southeast side of the stock (fig. 62). At the foot of the cliff a few blocks of talus are cut by quartz veins bounded by iron-oxide-stained zones generally less than 1 foot thick. A little pyrite occurs in some of the veins. A sample (1649, table 2) from one of the veins had no detectable gold or silver.

Locality 87 (Wild Rose Claim)

Courthouse records show a claim called the Wild Rose, staked in 1911 at International Boundary Monument 76. The claim includes a grass-covered ridge underlain by argillite and plagioclase arkose. About 250 feet south of the monument a fault zone crops out that trends N. 10° E. and dips 65°–70° W., parallel to the strike of the country rock (fig. 62). The fault zone, 100–200 feet wide, is composed of iron-oxide-stained gouge and brecciated country rock. Sample RV–67–23A (table 2) cut across this fault zone had a trace of silver but no gold or molybdenum. A second sample (RV–67–24A, table 2) of the adjacent moderately iron oxide stained country rock also contained a trace of silver but no gold or molybdenum.

Locality 88

According to courthouse records, several claims were recorded in 1910 in an area 1–1¼ miles south and southeast of International Boundary Monument 76. The locations coincide with an iron-oxide-stained fault zone that crops out on the east-trending ridge at the headwaters of Boundary Creek (fig. 62). No evidence of workings was found.

The fault zone is about 150 feet wide, strikes north, and has a steep dip. It cuts rocks of the plagioclase arkose and argillite sequence, some of which are moderately stained by iron oxides. Two chip samples (JJ–67–19A, JJ–67–20A, table 2) taken of rock in the fault zone had no gold, silver, copper, or lead. Two chip samples (EVK–67–24A, EVK–67–25A, table 2) taken across adjacent iron-oxide-stained country rock also had no gold, silver, copper, or molybdenum.

PLACER DEPOSITS

Placer claim locations have been recorded in the Whatcom County Courthouse at Bellingham, Wash., from 1891 through 1960 in the Canyon Creek and Lightning Creek–Three Fools Creek drainages.

Available published records of placer gold production are incomplete. An estimated $100,000 in gold at $20.67 per ounce had been produced from the Slate Creek district placers prior to 1877 (Hodges, 1897, p. 56). Placer mines in the Slate Creek mining district produced $14,617 in gold at $20 per ounce in 1906 (Yale, 1907, p. 368). The Ruby Creek mine, at the mouth of Ruby Creek, was the largest producing placer mine. In 1907 gold production was about the same as that in 1906 (Yale, 1908, p. 477).

Present-day streams with their V-shaped valleys and steep gradients preclude the formation of anything except "flood" gold deposits in most of the areas investigated. Placer deposits would be restricted to remnants of older stream gravels left as bench placers and to those recent stream areas near productive lode mines or at the junctions of the larger streams.

Stream deposits were pan sampled at the most favorable locations for heavy minerals. Test pits were dug and a seismic timer device used to determine soil depths of both of the major stream drainages. An attempt to use a small churn drill at Chancellor failed because of numerous large boulders. Cobbles and boulders larger than 6 inches in diameter represent 20–90 percent of the alluvial material in all the deposits sampled. Concentrates from 77 samples, representing sample material weighing from 4 to 560 pounds, showed gold values ranging from nil to 4.16 cents per cubic yard. Black sand concentrates average less than 2 pounds per cubic yard over the entire area studied.

The sampling in the Canyon Creek area is described under five separate geographic localities. The Lightning Creek–Three Fools Creek area is described under one general heading; all sample results are shown in tabular form in the appropriate sections.

CANYON CREEK DRAINAGE

Discovery of placer gold in the Slate Creek mining district, which includes all of Canyon Creek and its tributary streams, is credited by Hodges (1897, p. 56) to "a man named Rowley." The Whatcom County Courthouse records show 1891 as the first year that placer claims were recorded in the district. A historical note by Hodges (1897, p. 6) indicates that the placers were the first operated around 1870 following "the returning tide of miners from the Cariboo District of British Columbia in the early 60's."

The early prospectors on Canyon Creek were looking for placer gold. Hodges (1897, p. 56) further stated: " * * * the placer ground was limited, the creeks were difficult to handle, the cost of getting to the camp was enormous, and the trip extremely hazardous, the camp was short lived, although upwards of 2,500 men went in the first season and fully $100,000 worth of dust was taken out. In those days the only route to the diggings was through British Columbia." These statements were further documented by Trimble (1914) in his historical account of "The Mining Advance into the Inland Empire" prior to 1870.

About 54 individual claims and groups of claims were filed for placers on the Canyon Creek drainage within the study area. Many of these were found to be relocations. The first five groups of claims were recorded in 1891 and 1892.

The gradients of the placers examined average 2.6 percent, or 133 feet per mile. The optimum gradient for placers is considered 1 percent, or about 50 feet per mile. Digging test pits and reconnaissance pan sampling indicated only very fine "flood" gold as being deposited by the present fast-rushing stream. Our study of placer deposits in this area shows a maximum value of $0.04 per cubic yard of gravel (fig. 64; table 3). We estimate that processing the placer material would cost $0.50–$2 per yard.

Elk Creek Placer

Elk Creek, a small eastward-flowing tributary of the North Fork Canyon Creek (fig. 64), was examined because it had been located for placers in the 1930's. Less than 100 cubic yards of placerable

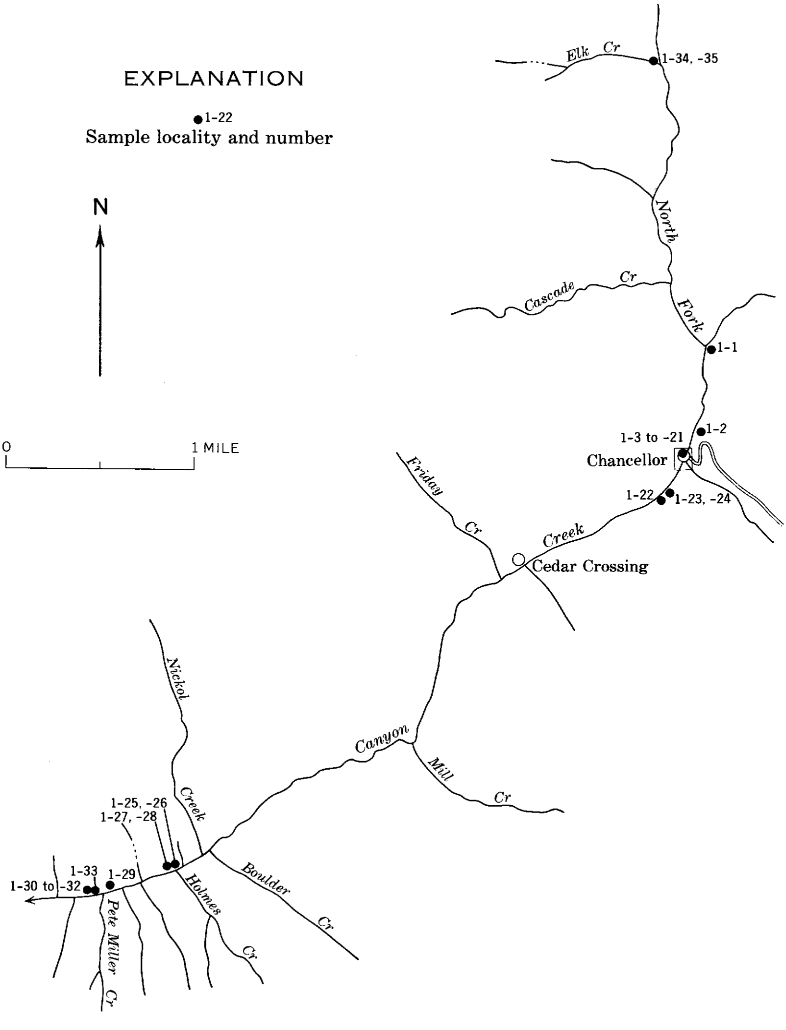


FIGURE 64.—Placer sample localities in the Canyon Creek drainage. Area outlined at Chancellor shown in figure 65.

alluvial gravel is available in the area examined. Pan concentrates from two 1-cubic-foot reconnaissance samples contained no gold or silver and less than 1 pound of heavy minerals per cubic yard.

CHANCELLOR PLACER

The Chancellor placer deposit (fig. 65) is located approximately 10 miles from Harts Pass at the end of the road near the mouth of Slate Creek. Mr. Frank M. Carroll, Winthrop, Wash., currently holds the Lucky claim at the junction of Slate Creek and Canyon

Creek. The property examined is thought to be part of the Farrar placer (Huntting, 1955, p. 132).

The placer ground was explored by test pits and one churn drill hole. The use of a seismic timer device indicated an average soil depth of 11 feet at the drill-hole site. The churn drill hole was abandoned at a depth of 5 feet because of numerous large boulders. The churn drill samples consisted mainly of ground-up quartz diorite, arkose, and argillite rock. In spite of this, a trace amount of gold was detected in all samples, and silver in one. Large boulders were broken by use of explosives in the test pits. Water prevented putting down test pits to bedrock.

Placer material in the deposit is a mixture of sand, pebbles, and rock fragments; about 50 percent of the material ranged from 6 inches to more than 3 feet in diameter.

The deposit (fig. 65) represents one of the largest placers on Canyon Creek. Approximately 75,000 cubic yards of material is available, but it would be difficult to mine without great expense. The panned concentrates consisted mainly of ferromagnesian minerals, with some quartz, mica, and a trace of magnetite, pyrite, and fine gold. Samples 1–1 through 1–21 (table 3) showed a trace to 4.2 cents of gold per cubic yard. Concentrates were fire assayed.

The stream gradient from Chancellor to North Fork Canyon Creek averages about 2 percent, or an approximate 100-foot drop per mile—about double the optimum for placer formation.

Chancellor to Cedar Crossing

Placer claims have been recorded that cover all the canyon between Chancellor and Cedar Crossing.

The present-day creek channel is relatively steep and rugged, and is strewn with boulders more than 3 feet in diameter. Reconnaissance pan sampling throughout the entire northwest side of the stream indicated trace amounts of gold and less than 2 pounds of concentrate per cubic yard. Remnants of a mined-out bench placer half a mile below Chancellor indicate that about 10,000 cubic yards of placer material was washed many years ago from a pit measuring 300 feet long by 75 feet wide and estimated to average 12 feet in depth. Numerous boulders larger than 3 feet in diameter stacked alongside the trail indicate the great amount of work performed by past operators.

The stream gradient in this area averages about 3 percent. A trace to 0.05 cent worth of gold per cubic yard was found by fire assay of concentrates from samples 1–22, 1–23, and 1–24 (table 3; fig. 64).

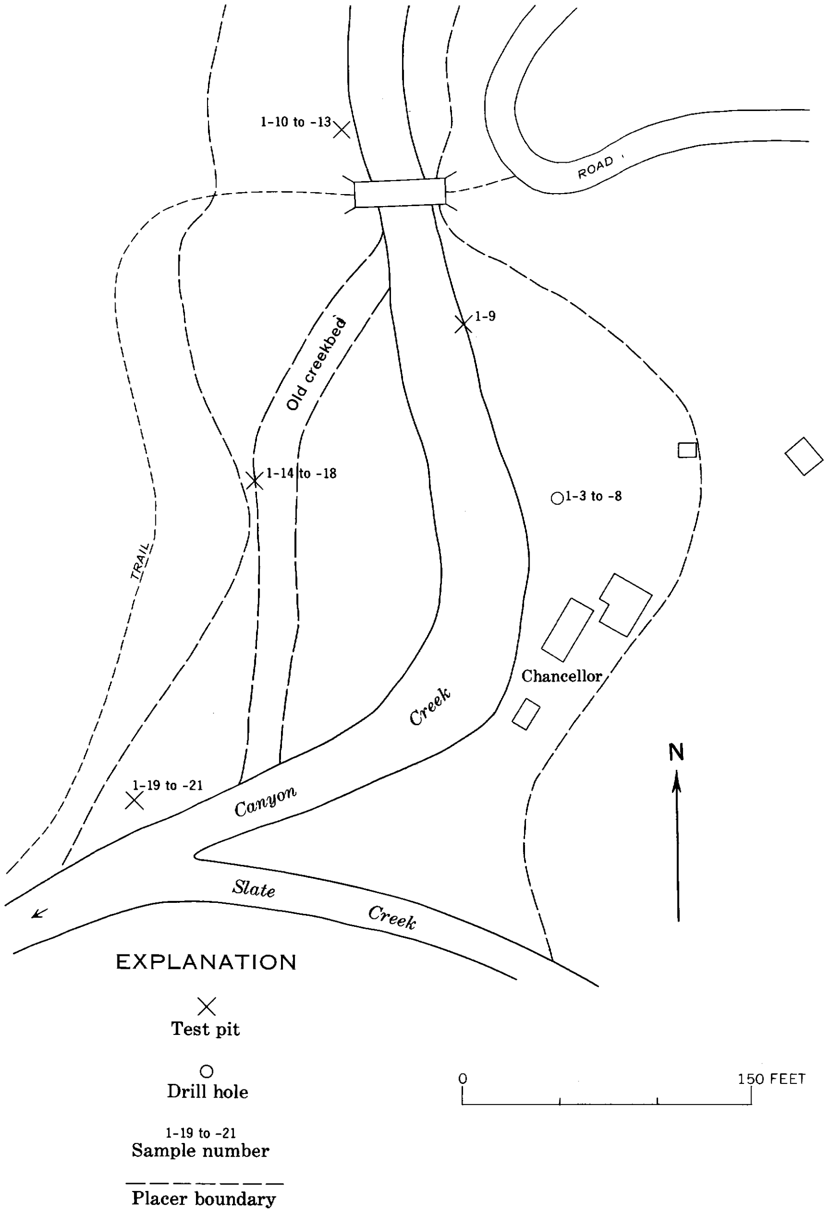


FIGURE 65.—Placer sample localities in the vicinity of Chancellor.

Cedar Crossing to Boulder Creek

About 12 placer claims were located during 1892–1940 between Cedar Crossing and Boulder Creek. Samples were not taken in this area because of the steepness of the canyon, limited alluvial material, and the lack of significant gold values in the canyon above and below the area. The gradient in this reach is about 130 feet per mile.

Boulder Creek to Pete Miller Creek

The first claims in the Slate Creek mining district were recorded in 1891 as Boulder Placer Nos. 3 and 4. They were located directly opposite the mouth of Boulder Creek, which is a quarter of a mile northeast of Holmes Creek. Twelve claims or groups of claims have been located from 1891 to the present time in the mile of canyon below the mouth of Boulder Creek. This area extends to the site where the canyon narrows to a tight V below Pete Miller Creek. Mr. Paul Allen (oral commun., 1966) said that his uncle, Herbert J. Nunan, first worked on the claims in 1895 for a company that planned to flume water from Boulder Creek to hydraulic the bench placers in the area. Hodges (1897, p. 58) stated: "Frank Ledger and others built a flume a mile long and worked the Old Discovery claims near the mouth of Canyon Creek for about a month, employing seventeen men."

Remnants of the flume can be seen on the south canyon wall above Holmes Creek. The planned hydraulic mining was terminated after considerable time and expense.

The New Discovery and Ruby Bar unpatented placer claims are between Holmes and Pete Miller Creeks, small tributary streams that enter Canyon Creek from the south. These claims are now (1967) held by Paul Allen of Oak Harbor, Wash.

Much of the stream in this area was worked for placers many years ago. Numerous caved adits, with several waste dumps at the edge of an alluvial bench 40 feet above the present stream, indicate that a drift-mining operation was in progress at one time. Coarse gold was reported to have been recovered in pockets near bedrock when drift mining was in progress. The bench, opposite and 400 feet downstream from Holmes Creek, is estimated to contain about 10,000 cubic yards of gravel buried under about 90,000 cubic yards of talus and slide rock. No other potential unmined bench placer was observed in the area, although other bench placers appear to have been mined on the south side of the stream at one time.

Other evidence of extensive bench-placer mining was investigated across from Pete Miller Creek. This mine was reported to have been last operated by Walt Woodrich of Sedro Woolley, Wash. (Huntting, 1955, p. 133). Very little unworked gravel was found on this bench. Samples 1–30 through 1–33 (table 3; fig. 64) taken from this property showed a trace to 3.0 cents of gold per cubic yard.

Samples 1–25, 1–26, 1–27, and 1–28 from the largest potential stream placer in the area are listed in table 3. Black sand and concentrate averaged less than 1 pound per cubic yard. Gold valued at 1.6 cents per cubic yard was reported in sample 1–27. Sample 1–29, taken midway between the mined areas, showed 2.2 cents per cubic yard.

Streamfall of 190 feet from Boulder Creek to below Pete Miller Creek gives an average gradient of 3.6 percent which permits formation of only transitory placer deposits.

LIGHTNING CREEK–THREE FOOLS CREEK AREA

Courthouse records show that 99 placer claims were located in the Lightning Creek–Three Fools Creek area (fig. 66). Eight of these claims were recorded from 1895 through 1902. Ninety-one claims were recorded in 1932 and 1933, during the difficult years of the "great depression." No claim notice or any other evidence of placer mining was seen in the area. Ruins of a cabin at the mouth of Shull Creek, in addition to the shelters shown in figure 66, were the only signs of human habitation seen in the area.

An attempt was made to sample all the located placer claims, though many of the locations are vaguely described.

The depth of gravel was determined by seismic refraction soundings near the mouth of Cinnamon Creek and Deer Lick Cabin on Lightning Creek. Indicated gravel depth at both averaged 7½ feet. Bedrock was exposed nearby in the streams. Test pits were not completed to bedrock, owing to large boulders and excessive water, but samples panned from bedrock exposures near the test pits showed low values. Sample size represented by the pan concentrates ranged from 50 to 560 pounds. The larger samples were from gravel containing 95 percent cobbles and boulders more than 3 inches in diameter.

One placer claim located on Elbow Creek had less than 50 cubic yards of alluvial material. Many of the gravel bars were formed behind logjams in the creeks.

Stream gradient in the Lightning Creek–Three Fools Creek area averages more than 3 percent, ranging from 2 percent at Deer Lick Cabin to 20 percent on Elbow Creek. Table 4 shows that the best gold values (0.2 cent per cubic yard) were found in sample 2–35 from the large bar above Deer Lick Cabin, and in sample 2–10 from a bar at the junction of Cinnamon and Three Fools Creeks. Sample

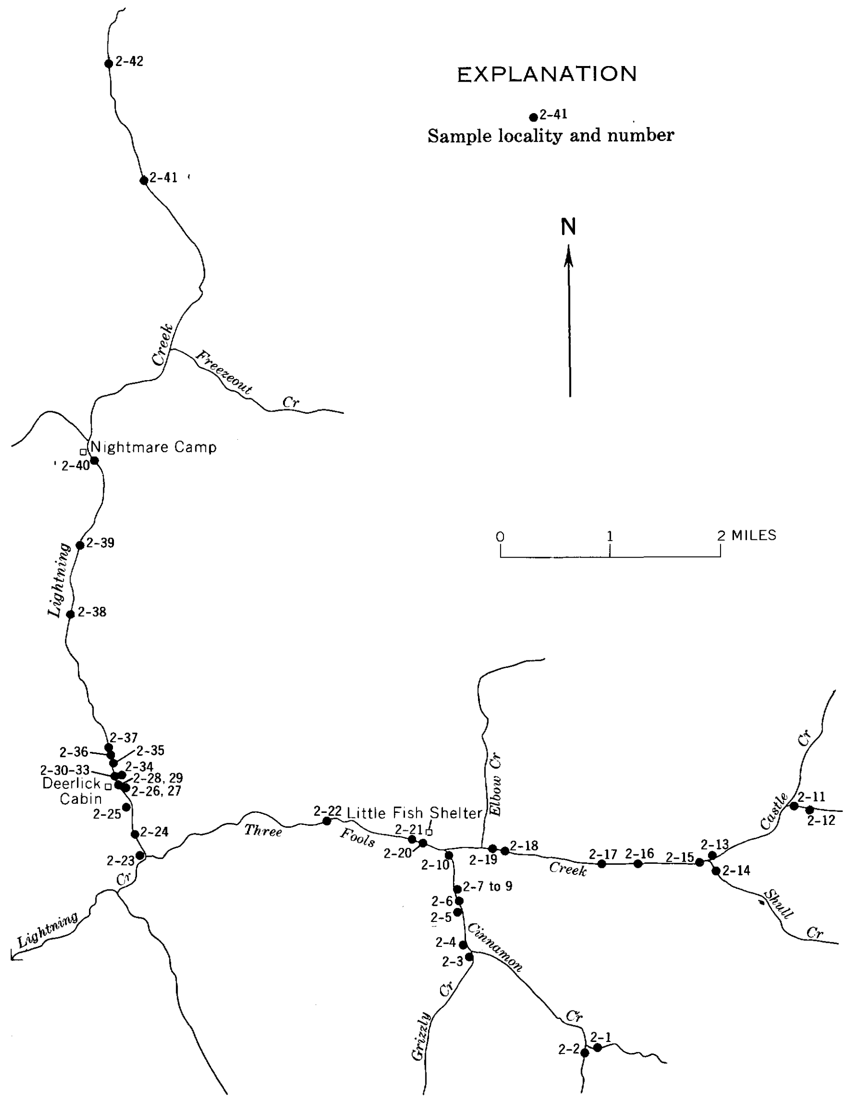


FIGURE 66.—Placer sample localities in the Lightning Creek–Three Fools Creek drainages.

2–35 contained a trace of pyrite, which had the appearance of gold when casually inspected in the pan concentrates. In summary, test pits and other sampling indicated trace amounts of fine gold and less than 2 pounds per cubic yard of other heavy-mineral concentrates. Gold content of samples 2–1 through 2–42 from the Lightning Creek–Three Fools Creek drainage area is shown in table 4.

424-547 O—71——14

A block of arkose, 6 by 6 by 12 inches, with a 1-inch quartz vein containing about 5 percent molybdenite crystals, was found one-third of a mile above the mouth of Cinnamon Creek. Its source was not located.

CONCLUSIONS

The Tungsten Creek, Slate Creek, and Billy Goat Mountain areas contain submarginal mineral deposits or appear to have a potential for the discovery of economic deposits. The commodities present are tungsten, copper, gold, and silver.

Submarginal tungsten resources at prospects in the Tungsten Creek area are estimated to be 300,000 to 400,000 tons, but the costs of mining at present are estimated to be three to six times the contained values. Small high-grade sections of the veins may be marginal. The total tungsten resources of the area, including sections between the prospects, may approach a million tons of rock.

The value of ore produced from those parts of the Slate Creek district that are outside the wilderness area but within 2 miles of the wilderness boundary totals more than $1,500,000. No recorded production from prospects within this part of the wilderness is known. Known deposits within this part of the wilderness are estimated to contain 75,000 to 140,000 tons of submarginal vein material. The principal metal of value is gold, but values in silver and copper also are present. Most of the deposits are small and could be developed only on a small scale, but further prospecting might reveal larger or higher grade deposits in the 1- to 2½-mile-wide belt adjacent to the Slate Creek district.

In the Billy Goat Mountain area only one prospect with economic potential is known within the wilderness area. It is less than a mile from the boundary and is estimated to contain 100,000 to 400,000 tons of marginal copper, silver, and lead resources.

Several geochemical anomalies around the Monument Peak stock indicate the possible existence of low-grade disseminated deposits of copper and molybdenum. Extensive physical exploration, far beyond the scope of this study, would be needed to determine the extent of the deposits.

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ANALYSES OF SAMPLES

TABLE 1.—*Analyses of samples from stream sediments, panned concentrates,*

[Leaders (--) indicate element not looked for; <, less than the amount shown; >, more than the amount
D. J. Grimes, A. P. Marranzino, W. B. Crandell, Joseph Harris, H. G. Neiman, Arnold Farley, Jr.,
Post, W. L. Lehmbeck, W. P. McKay, C. L. Whittington, and W. H. Raymond, Jr.; and atomic-absorp-
J. A. Thomas. Footnote is given at end of table.]

	Semiquantitative spectrographic analyses (ppm)																		
Sample	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co	Ag	Be	Ga	As	Sb
Long Draw drainage																			
1	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
2	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
3	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
Middle Fork of Toats Coulee Creek drainage																			
4	10,000	<100	1,000	500	1,500	300	<30	5	<1	<30	70	<3	<3	15	<.1	<1		20	<100	<100
5	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
6	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
Horseshoe Creek drainage																			
7	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
8	5,000	<200	1,000	150	50	<20	15	30	10	5	20	<2	<10	20	<1	1	20	<500	<50
9	5,000	<200	1,000	150	20	<20	7	10	10	7	5	<2	<10	10	<1	<1	15	<500	<50
10	1,000	<100	500	10	150	50	<30	70	7	<30	15	<3	<3	<1	<.1	1	10	<100	<100
11	700	<200	1,500	20	30	<20	5	3	15	5	5	3	<10	<5	<1	1	10	<500	<50
12	1,500	<200	700	70	100	50	3	5	10	5	15	<2	<10	5	<1	1	15	<500	<50
13	2,000	<200	700	30	50	<20	5	7	10	<5	7	<2	<10	5	<1	1	10	<500	<50
14	>10,000	<200	1,500	300	500	500	20	10	<10	10	150	<2	<10	10	<1	<1	30	<500	<50
Small creeks flowing into Canada east of Cathedral Peak																			
15	2,000	<100	700	150	150	<30	<30	3	<1	<30	15	<3	<3	15	<.1	<1	10	<100	<100
16	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
17	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
18	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
Tungsten Creek drainage																			
19	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
20	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
21	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
22	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
23	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
24	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
25	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
26	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
27	>10,000	<200	1,500	200	1,000	500	10	10	<10	15	100	<2	<10	15	<1	<1	50	<500	<50
28	>10,000	<200	3,000	300	500	500	50	3	<10	20	100	<2	<10	15	<1	<1	30	<500	<50
Cathedral Creek drainage																			
29	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
30	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
31	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
32	1,500	<200	1,000	50	70	30	7	5	15	7	15	3	<10	10	<1	1	15	<500	<50
33	>10,000	<200	>5,000	300	200	500	5	5	<10	15	70	<2	<10	15	<1	<1	50	<500	<50
Chewack River drainage																			
34	1,500	<200	700	30	50	20	3	5	20	10	7	<2	<10	5	<1	1	15	<500	<50
35	1,000	<200	500	50	30	50	2	3	10	5	10	<2	<10	<5	<1	1	15	<500	<50
Fire Creek drainage																			
36	1,000	<200	300	30	150	<20	5	20	15	5	7	<2	<10	5	<1	1	15	<500	<50
37	1,000	<200	300	50	20	300	5	3	15	5	30	<2	<10	5	<1	1	15	<500	<50
38	2,000	<200	500	50	200	<20	2	5	20	5	10	<2	<10	5	<1	1	15	<500	<50
Little Andrews Creek drainage																			
39	1,500	<200	700	70	70	100	5	3	15	<5	10	<2	<10	7	<1	<1	20	<500	<50
Ram Creek																			
40	1,500	<200	700	50	50	<20	5	2	15	<5	7	<2	<10	7	<1	<1	15	<500	<50
41	>10,000	<200	700	200	150	150	5	5	<10	10	10	<2	<10	15	<1	<1	20	<500	<50

and fresh and altered rocks in the Pasayten Wilderness Area, Washington

shown; M, greater than 10 percent. Six-step semiquantitative spectrographic analyses were made by and K. C. Watts, Jr.; colorimetric analyses for heavy metals, cold copper, and molybdenum, by E. V. tion analyses for gold, by E. E. Martinez, R. L. Miller, T. A. Roemer, J. G. Frisken, J. E. Troxel, and

	Semiquantitative spectrographic analyses--Continued							Chemical analyses				
	(ppm)				(percent)			(ppm)				
Sample	Sc	Cr	Ba	Sr	Fe	Mg	Ca	cxHM	cxCu	Au	Mo	Sample description 1/
							Long Draw drainage					
1	--	---	-----	-----	-----	-----	-----	3	<.5	1	12	Active stream sediment.
2	--	---	-----	-----	-----	-----	-----	2	<.5	-----	8	Do.
3	--	---	-----	-----	-----	-----	-----	1	1.5	-----	8	Do.
							Middle Fork of Toats Coulee Creek drainage					
4	15	200	200	50	M	.05	1.5	-----	-----	-----	---	Panned concentrate.
5	--	---	-----	-----	-----	-----	-----	7	<.5	-----	---	Active stream sediment.
6	--	---	-----	-----	-----	-----	-----	11	<.5	-----	---	Do.
							Horseshoe Creek drainage					
7	--	---	-----	-----	-----	-----	-----	1	.5	-----	2	Active stream sediment.
8	15	50	700	500	7	1.5	2	3	1	-----	---	Do.
9	7	20	500	300	5	1	2	-----	-----	-----	8	Do.
10	3	10	1,500	70	1	.2	.5	-----	-----	-----	---	Quartz monzonite.
11	<5	<5	300	150	1.5	.2	.5	3	<.5	-----	6	Active stream sediment.
12	5	5	300	200	2	.3	1	1	-----	-----	---	Do.
13	<5	10	300	200	1.5	.5	.7	.5	<.5	-----	---	Do.
14	20	100	200	70	20	.2	.5	-----	-----	-----	---	Panned concentrate.
							Small creeks flowing into Canada east of Cathedral Peak					
15	20	20	2,000	200	5	1.5	3	-----	-----	-----	---	Gneissic quartz diorite.
16	--	---	-----	-----	-----	-----	-----	2	<.5	-----	6	Active stream sediment.
17	--	---	-----	-----	-----	-----	-----	1	<.5	-----	6	Do.
18	--	---	-----	-----	-----	-----	-----	2	<.5	-----	6	Do.
							Tungsten Creek drainage					
19	--	---	-----	-----	-----	-----	-----	17	6	-----	12	Active stream sediment.
20	--	---	-----	-----	-----	-----	-----	2	<.5	-----	4	Do.
21	--	---	-----	-----	------	-----	-----	1	<.5	-----	4	Do.
22	--	---	-----	-----	-----	-----	-----	9	<.5	-----	2	Do.
23	--	---	-----	-----	-----	-----	-----	27	.5	-----	12	Do.
24	--	---	-----	-----	-----	-----	-----	1	<.5	-----	8	Do.
25	--	---	-----	-----	-----	-----	-----	1	-----	-----	2	Do.
26	--	---	-----	-----	-----	-----	-----	7	<.5	-----	6	Do.
27	50	50	70	100	15	1	.7	-----	-----	-----	---	Panned concentrate.
28	50	50	200	100	15	1	.5	-----	-----	-----	---	Do.
							Cathedral Creek drainage					
29	--	---	-----	-----	-----	-----	-----	4	<.5	-----	6	Active stream sediment.
30	--	---	-----	-----	-----	-----	-----	1	<.5	-----	4	Do.
31	--	---	-----	-----	-----	-----	-----	.5	<.5	-----	16	Do.
32	5	20	300	200	2	.5	1	2	<.5	-----	---	Do.
33	30	200	150	100	15	1	.5	-----	-----	-----	---	Panned concentrate.
							Chewack River drainage					
34	<5	5	300	200	1.5	1	-----	-----	-----	-----	---	Active stream sediment.
35	<5	10	300	200	2	.2	1	-----	-----	-----	---	Do.
							Fire Creek drainage					
36	<5	<5	300	200	1	.3	1.5	2	-----	-----	---	Active stream sediment.
37	5	7	500	300	1.5	2	1.5	-----	-----	-----	---	Do.
38	5	10	300	200	2	.5	1	-----	-----	-----	---	Do.
							Little Andrews Creek drainage					
39	<5	10	500	300	3	.5	1.5	-----	-----	-----	---	Active stream sediment.
							Ram Creek					
40	<5	7	500	500	2	.5	1.5	2	-----	-----	---	Active stream sediment.
41	10	150	300	300	15	1	1	-----	-----	-----	---	Panned concentrate.

TABLE 1.—*Analyses of samples from stream sediments, panned concentrates, and*

Semiquantitative spectrographic analyses (ppm)

Sample	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co	Ag	Be	Ga	As	Sb
								Peepsight Creek drainage											
42	1,000	<200	1,000	30	70	<20	5	3	10	7	<5	<2	<10	5	<1	<1	15	<500	<50
43	1,500	<200	700	50	50	<20	7	5	10	7	7	<2	<10	7	<1	<1	15	<500	<50
44	500	<200	500	30	30	<20	2	15	10	10	<5	<2	<10	<5	<1	<1	15	<500	<50
45	1,000	<200	700	50	30	<20	2	3	10	7	<5	<2	<10	5	<1	<1	15	<500	<50
46	700	<200	700	30	50	<20	5	5	10	5	<5	<2	<10	7	<1	<1	15	<500	<50
47	3,000	<200	1,500	70	70	<20	7	5	20	10	20	<2	<10	10	<1	<1	20	<500	<50
48	1,500	<200	700	50	50	30	10	15	20	7	10	<2	<10	7	<1	<1	15	<500	<50
								Andrews Creek drainage											
49	1,000	<200	1,000	50	30	<20	10	10	15	20	<5	<2	<10	7	<1	1	10	<500	<50
50	2,000	<200	1,000	100	50	50	30	30	15	10	5	<2	<10	15	<1	1	15	<500	<50
51	1,500	<200	1,500	70	50	<20	15	7	10	<5	10	<2	<10	15	<1	1	10	<500	<50
52	1,500	<200	1,500	70	100	<20	15	10	10	10	10	<2	<10	15	<1	<1	15	<500	<50
53	2,000	<200	1,500	100	200	<20	2	7	10	5	15	<2	<10	15	<1	<1	15	<500	<50
54	>10,000	<200	2,000	300	300	150	5	5	<10	15	30	<2	<10	20	<1	<1	50	<500	<50
55	2,000	<200	500	50	100	30	5	2	10	5	10	<2	<10	5	<1	<1	15	<500	<50
56	1,000	<200	300	30	30	<20	5	10	15	<5	5	<2	<10	5	<1	<1	15	<500	<50
								Lake Creek drainage											
57	1,000	<200	1,000	50	50	<20	2	10	10	<5	7	<2	<10	<5	<1	<1	10	<500	<50
58	>10,000	<200	100	200	300	70	5	<2	<10	30	30	<2	<10	10	<1	<1	30	<500	<50
59	1,500	<200	300	30	50	<20	5	3	15	5	<5	<2	<10	5	<1	<1	15	<500	<50
60	700	<200	200	30	15	<20	<2	5	15	5	5	<2	<10	<5	<1	<1	15	<500	<50
61	2,000	<200	300	50	70	100	<2	<2	10	<5	10	<2	<10	5	<1	<1	15	<500	<50
62	500	<200	300	15	20	<20	<2	3	15	5	<5	<2	<10	<5	<1	<1	15	<500	<50
63	>10,000	<200	2,000	100	100	200	3	3	<10	10	>200	<2	<10	15	<1	<1	20	<500	<50
64	1,000	<100	300	15	100	<30	<30	<3	5	<30	7	<3	<3	<1	<.1	<1	10	<100	<100
65	>10,000	<200	1,500	500	200	150	20	10	<10	20	50	<2	<10	15	<1	<1	50	<500	<50
66	>10,000	<200	1,500	300	150	200	10	20	<10	15	50	<2	<10	15	<1	<1	70	<500	<50
								Spanish Camp area											
67	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
68	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
								Cathedral Fork drainage											
69	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
70	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
								Beaver Creek drainage											
71	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
72	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
73	>10,000	<200	1,500	200	20	70	10	20	<10	5	<5	<2	<10	30	<1	<1	15	<500	<50
								Bob Creek drainage											
74	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
75	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
76	>10,000	<200	2,000	300	200	50	10	5	<10	20	100	<2	<10	20	<1	<1	70	<500	<50
								Spotted Creek drainage											
77	300	<100	200	<1	30	<30	<30	1	10	<30	10	<3	<3	<1	<.1	1	10	<100	<100
78	>10,000	<200	5,000	200	200	200	5	10	<10	15	200	<2	<10	10	<1	<1	20	<500	<50
								Raven Creek drainage											
79	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
80	>10,000	<200	1,500	500	150	200	<2	15	<10	10	70	<2	<10	10	<1	<1	50	<500	<50
81	2,000	<100	1,000	70	150	<30	<30	1	5	<30	20	<3	<3	7	<.1	<1	10	<100	<100
								Gabril Creek drainage											
82	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
83	5,000	<100	1,500	300	5,000	150	<30	10	<1	<30	70	10	10	10	<.1	<1	30	<100	<100
84	3,000	<200	700	70	150	<20	<2	3	10	<5	30	<2	<10	5	<1	<1	10	<500	<50

fresh and altered rocks in the Pasayten Wilderness Area, Washington—Continued

	Semiquantitative spectrographic analyses--Continued							Chemical analyses				
	(ppm)				(percent)			(ppm)				
Sample	Sc	Cr	Ba	Sr	Fe	Mg	Ca	cxHM	cxCu	Au	Mo	Sample description [1]
							Peepsight Creek drainage					
42	<5	<5	500	500	1.5	.3	1.5	1	<.5	-----	---	Active stream sediment.
43	5	7	500	500	2	.7	1.5	1	-----	-----	---	Do.
44	<5	<5	500	500	1.5	.2	1.5	-----	-----	-----	---	Do.
45	<5	<5	300	500	1.5	.5	1	2	-----	-----	---	Do.
46	<5	20	700	700	1.5	.5	1.5	1	-----	-----	---	Do.
47	7	20	500	500	3	.7	2	-----	-----	-----	---	Do.
48	5	50	500	700	1.5	.7	2	1	<.5	-----	---	Do.
							Andrews Creek drainage					
49	<5	20	300	300	1.5	1	2	1	-----	-----	---	Active stream sediment.
50	7	100	300	300	3	1.5	2	3	<.5	-----	---	Do.
51	7	50	30	300	3	1.5	1.5	1	.5	-----	---	Do.
52	5	70	500	500	5	.7	1.5	2	-----	-----	---	Do.
53	10	30	300	500	5	1.5	2	1	<.5	-----	---	Do.
54	10	200	300	300	15	1	1	-----	-----	-----	---	Panned concentrate.
55	<5	10	300	500	1.5	.5	2	-----	-----	-----	---	Active stream sediment.
56	<5	10	500	500	1.5	.3	.2	1	-----	-----	---	Do.
							Lake Creek drainage					
57	<5	5	500	300	3	.5	2	4	<.5	-----	---	Active stream sediment.
58	7	30	150	100	>20	.1	.1	-----	-----	-----	---	Panned concentrate.
59	<5	5	300	500	1	.3	1.5	-----	<.5	-----	---	Active stream sediment.
60	<5	<5	300	500	1	.2	1.5	-----	-----	-----	---	Do.
61	<5	20	700	700	2	.3	1.5	-----	-----	-----	---	Panned concentrate.
62	<5	<5	500	500	1	.2	1.5	-----	-----	-----	---	Active stream sediment.
63	10	150	300	300	15	1	1	-----	-----	-----	---	Panned concentrate.
64	<1	3	500	500	1.5	.2	1.5	-----	-----	-----	---	Biotite quartz diorite.
65	7	20	300	300	20	.3	1	-----	-----	-----	---	Panned concentrate.
66	10	20	500	1,000	20	.3	1.5	-----	-----	-----	---	Do.
							Spanish Camp area					
67	--	---	-----	-----	-----	-----	-----	2	<.5	-----	8	Active stream sediment.
68	--	---	-----	-----	-----	-----	-----	1	<.5	-----	8	Do.
							Cathedral Fork drainage					
69	--	---	-----	-----	-----	-----	-----	4	<.5	-----	8	Active stream sediment.
70	--	---	-----	-----	-----	-----	-----	2	<.5	-----	6	Do.
							Beaver Creek drainage					
71	--	---	-----	-----	-----	-----	-----	4	<.5	-----	8	Active stream sediment.
72	--	---	-----	-----	-----	-----	-----	1	<.5	-----	6	Do.
73	30	150	150	300	10	5	1.5	-----	-----	-----	---	Panned concentrate.
							Bob Creek drainage					
74	--	---	-----	-----	-----	-----	-----	2	<.5	-----	8	Active stream sediment.
75	--	---	-----	-----	-----	-----	-----	3	<.5	-----	12	Do.
76	5	100	50	100	20	.1	1	-----	-----	-----	---	Panned concentrate.
							Spotted Creek drainage					
77	<1	<3	700	200	.5	.07	1	-----	-----	-----	---	Granodiorite.
78	10	5	100	100	>20	.3	.2	-----	-----	-----	---	Panned concentrate.
							Raven Creek drainage					
79	--	---	-----	-----	-----	-----	-----	7	<.5	-----	---	Active stream sediment.
80	7	20	300	500	20	.7	1	-----	-----	-----	---	Panned concentrate
81	10	<3	500	700	5	1.5	3	-----	-----	-----	---	Granodiorite gneiss.
							Gabril Creek drainage					
82	--	---	-----	-----	-----	-----	-----	3	<.5	-----	6	Active stream sediment.
83	15	15	70	30	M	.07	1.5	-----	-----	-----	---	Panned concentrate.
84	7	5	300	500	3	.7	3	1	-----	-----	2	Active stream sediment.

TABLE 1.—*Analyses of samples from stream sediments, panned concentrates, and*

Semiquantitative spectrographic analyses (ppm)

Sample	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co	Ag	Be	Ga	As	Sb
Spanish Creek																			
85	>10,000	<200	5,000	500	100	200	2	15	<10	15	70	<2	<10	15	<1	<1	50	<500	<50
Timber Wolf Creek drainage																			
86	3,000	<100	1,500	500	500	200	<30	10	<1	<30	70	<3	15	10	<.1	<1	30	<100	<100
87	3,000	<200	1,000	150	100	<20	3	7	<10	5	15	<2	<10	15	<1	<1	20	<500	<50
88	7,000	<200	1,000	300	700	150	<2	10	<10	20	30	<2	<10	15	<1	<1	50	<500	<50
Martina Creek drainage																			
89	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
90	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
91	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
92	3,000	<100	1,000	200	<3	<30	<30	7	<1	<30	15	<3	<3	30	<.1	<1	10	<100	<100
93	7,000	<200	>5,000	200	50	20	10	20	<10	<5	50	<2	<10	20	<1	<1	15	<500	<50
Ashnola River drainage																			
94	1,500	<200	300	30	20	<20	2	7	10	5	<5	<2	<10	<5	<1	<1	15	<500	<50
95	1,000	<200	700	20	70	20	2	3	15	5	5	<2	<10	<5	<1	<1	15	<500	<50
96	1,000	<200	1,500	30	20	<20	3	3	10	<5	<5	<2	<10	5	<1	<1	10	<500	<50
97	1,000	<200	500	30	15	<20	5	5	<10	<5	<5	<2	<10	5	<1	<1	15	<500	<50
98	700	<200	700	30	30	<20	2	20	10	5	10	<2	<10	<5	<1	<1	15	<500	<50
99	>10,000	<200	>5,000	500	100	500	<2	15	<10	10	150	<2	<10	15	<1	<1	50	<500	<50
100	1,000	<200	300	30	15	<20	<2	7	10	5	<5	<2	<10	<5	<1	<1	15	<500	<50
101	1,500	<200	1,000	30	20	<20	5	7	10	<5	10	<2	<10	5	<1	<1	15	<500	<50
102	7,000	<200	1,500	200	150	200	<2	15	<10	7	50	<2	<10	10	<1	<1	30	<500	<50
103	10,000	<200	2,000	300	1,000	200	5	15	<10	15	50	<2	<10	15	<1	<1	50	<500	<50
104	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
105	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
106	3,000	<100	1,000	150	100	<30	<30	20	<1	<30	20	<3	<3	20	<.1	<1	10	100	<100
107	5,000	<200	1,500	200	50	<20	15	30	10	<5	30	<2	<10	20	<1	<1	15	<500	<50
108	10,000	<200	2,000	300	700	150	<2	15	<10	50	70	<2	<10	15	<1	<1	30	<500	<50
Ramon Creek drainage																			
109	5,000	<100	1,000	300	150	<30	30	7	<1	<30	50	<3	<3	30	<.1	<1	10	<100	<100
Peeve Creek drainage																			
110	10,000	<200	1,500	300	200	100	5	10	<10	10	20	<2	<10	15	<1	<1	20	<500	<50
111	7,000	<200	1,500	200	70	70	10	20	<10	5	15	<2	<10	20	<1	<1	20	<500	<50
112	5,000	<200	1,000	150	70	30	10	10	10	<5	20	<2	<10	15	<1	<1	20	<500	<50
Eightmile Creek drainage																			
112a	10,000	<200	200	30	150	<20	<2	50	100	<10	10	<2	<10	<5	1	<1	<10	<200	<10
112b	7,000	<200	15	150	150	<20	<2	50	150	<10	<5	<2	<10	<5	15	<1	<10	<200	<100
113	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
114	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
115	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
116	5,000	<200	300	150	70	20	15	30	15	10	5	<2	<10	15	<1	<1	20	<500	<50
117	1,500	200	500	70	50	<20	10	70	70	7	20	<2	<10	15	1	<1	15	<500	<50
118	2,000	<200	1,000	70	50	<20	10	70	20	15	7	<2	<10	15	<1	1	20	<500	<50
119	2,000	<100	1,500	70	200	<30	<30	100	7	<30	10	<3	<3	7	<.1	<1	15	<100	<100
120	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
121	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
Goat Creek drainage																			
122	<10,000	<200	700	200	100	30	10	20	<10	10	5	<2	<10	30	<1	<1	20	<500	<50
123	2,000	<200	700	20	20	<20	15	30	10	20	10	<2	<10	15	<1	1	15	<500	<50
124	>10,000	<200	1,000	200	700	30	30	30	70	20	30	<2	<10	30	1	<1	20	<500	<50
125	700	<200	200	10	100	<20	7	15	70	7	20	3	<10	<5	<1	<1	50	<500	<50
126	3,000	<200	300	70	100	30	10	20	30	50	7	<2	<10	15	<1	1	30	<500	<50

fresh and altered rocks in the Pasayten Wilderness Area, Washington—Continued

	Semiquantitative spectrographic analyses--Continued							Chemical analyses				
	(ppm)				(percent)			(ppm)				
Sample	Sc	Cr	Ba	Sr	Fe	Mg	Ca	cxHM	cxCu	Au	Mo	Sample description[1/]
							Spanish Creek					
85	15	50	70	150	20	1	1	-----	-----	-----	---	Panned concentrate.
							Timber Wolf Creek drainage					
86	10	15	150	100	M	.03	1.5	-----	-----	-----	---	Panned concentrate.
87	15	20	500	1,000	7	1.5	3	3	<.5	-----	2	Active stream sediment.
88	7	10	200	200	20	.3	1	-----	-----	-----	---	Panned concentrate.
							Martina Creek drainage					
89	--	---	-----	-----	-----	-----	-----	1	<.5	-----	12	Active stream sediment.
90	--	---	-----	-----	-----	-----	-----	1	<.5	-----	12	Do.
91	--	---	-----	-----	-----	-----	-----	5	<.5	-----	12	Do.
92	30	15	300	700	10	3	7	-----	-----	-----	---	Hornblende gneiss.
93	20	20	300	500	7	7	3	-----	-----	-----	---	Panned concentrate.
							Ashnola River drainage					
94	<5	<5	300	300	1.5	.3	1	-----	-----	-----	---	Active stream sediment.
95	<5	<5	500	500	1.5	.2	1	-----	-----	-----	---	Do.
96	<5	5	300	300	1.5	.3	1	4	-----	-----	---	Do.
97	<5	10	500	500	1.5	.7	2	1	<.5	-----	---	Do.
98	<5	5	500	500	1.5	.3	1.5	-----	-----	-----	---	Do.
99	20	30	300	300	>20	.5	1	-----	-----	-----	---	Panned concentrate.
100	<5	<5	300	700	1.5	.3	1.5	-----	-----	-----	---	Active stream sediment.
101	<5	5	300	700	1.5	.1	2	1	-----	-----	---	Do.
102	10	20	300	700	15	1	1.5	-----	-----	-----	---	Panned concentrate.
103	10	30	300	300	20	.7	1.5	-----	-----	-----	---	Do.
104	--	---	-----	-----	-----	-----	-----	4	<.5	-----	6	Active stream sediment.
105	--	---	-----	-----	-----	-----	-----	2	<.5	-----	6	Do.
106	20	15	700	700	5	2	5	-----	-----	-----	---	Biotite hornblende gneiss.
107	10	20	300	500	7	1.5	3	1	<.5	-----	2	Active stream sediment.
108	10	20	100	100	>20	.7	1.5	-----	-----	-----	---	Panned concentrate.
							Ramon Creek drainage					
109	50	100	300	500	M	.5	7	-----	-----	-----	---	Panned concentrate.
							Peeve Creek drainage					
110	20	20	200	500	10	1.5	3	-----	-----	-----	---	Panned concentrate.
111	20	20	300	1,000	10	3	3	-----	-----	-----	---	Do.
112	10	30	300	1,000	7	2	3	.5	3	-----	---	Active stream sediment.
							Eightmile Creek drainage					
112a	15	10	>5,000	300	3	.1	.07	-----	-----	<.003	---	Iron oxide stained vol rocks.
112b	10	7	2,000	150	3	.03	.05	-----	-----	<.003	---	
113	--	---	-----	-----	-----	-----	-----	>50	<.5	-----	2	Active stream sediment.
114	--	---	-----	-----	-----	-----	-----	>50	15	-----	2	Do.
115	--	---	-----	-----	-----	-----	-----	>45	<.5	-----	---	Do.
116	10	50	300	300	5	1	.7	5	6	-----	---	Do.
117	5	30	300	150	2	1	.7	3	11	-----	---	Do.
118	7	30	500	500	3	1	.7	5	11	-----	---	Do.
119	7	10	1,500	500	3	1.5	2	-----	-----	-----	---	Plagioclase porphyry dike.
120	--	---	-----	-----	-----	-----	-----	>45	<.5	-----	---	Active stream sediment.
121	--	---	-----	-----	-----	-----	-----	7	.5	-----	---	Do.
							Goat Creek drainage					
122	20	30	200	300	15	1.5	1.5	-----	-----	-----	---	Panned concentrate.
123	10	30	300	300	2	1	1.5	4	2	-----	---	Active stream sediment.
124	10	70	300	300	15	3	1	-----	-----	-----	---	Panned concentrate.
125	<5	15	100	50	5	.05	.05	-----	-----	-----	---	Iron-stained qtz porphyry dike.
126	5	20	500	500	3	1	1.5	-----	-----	-----	---	Altered (iron-stained) arkose.

TABLE 1.—*Analyses of samples from stream sediments, panned concentrates, and*

Semiquantitative spectrographic analyses (ppm)

Sample	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co	Ag	Be	Ga	As	Sb
									Goat Creek drainage--Continued										
127	>10,000	<200	1,000	700	1,000	100	70	50	30	20	50	<2	<10	30	<1	<1	20	<500	<50
128	5,000	<200	700	100	50	<20	15	20	10	20	10	<2	<10	15	<1	<1	15	<500	<50
									Whiteface Creek drainage										
129	2,000	<200	700	70	150	30	7	10	10	7	20	<2	<10	10	<1	<1	10	<500	<50
									Pat Creek drainage										
130	3,000	<200	500	100	70	<20	15	20	15	5	10	<2	<10	15	<1	<1	15	<500	<50
131	5,000	<200	500	100	50	<20	10	20	15	7	10	<2	<10	15	<1	<1	15	<500	<50
132	2,000	<200	500	50	50	<20	10	20	30	15	10	<2	<10	10	<1	<1	15	<500	<50
133	2,000	<200	300	70	50	20	5	15	15	20	7	<2	<10	15	<1	1	15	<500	<50
134	2,000	<200	500	50	50	<20	10	30	50	10	10	<2	<10	15	<1	<1	15	<500	<50
									Jinks Creek drainage										
135	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
136	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
137	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
138	300	<200	200	<10	100	<20	<2	5	50	10	50	<2	<10	<5	<.5	1	20	<200	<100
139	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
140	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
141	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
142	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
143	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
144	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
									Drake Creek drainage										
145	3,000	<200	1,000	200	30	<20	10	20	20	7	20	<2	<10	20	<1	<1	50	<500	<50
146	3,000	<100	700	200	70	<30	50	20	<1	<30	15	<3	<3	20	<.1	<1	10	<100	<100
147	1,500	<200	700	100	50	<20	30	30	30	5	7	2	<10	20	<1	<1	15	<500	<50
148	3,000	<100	300	100	100	<30	<30	50	<1	<30	15	<3	<3	10	<.1	<1	10	<100	<100
149	>10,000	<200	700	200	700	500	2	5	<10	15	70	<2	<10	10	<1	<1	50	<500	<50
150	1,500	<200	2,000	50	150	20	2	5	15	5	10	<2	<10	7	<1	1	15	<500	<50
151	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
152	2,000	<100	500	70	70	<30	<30	10	<1	<30	10	<3	<3	10	<.1	<1	10	<100	<100
153	7,000	<100	1,000	500	1,500	300	<30	10	30	<30	70	<3	10	20	<.1	<1	20	<100	<100
154	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
155	2,000	<200	700	100	50	<20	15	20	20	7	10	<2	<10	15	<1	1	15	<500	<50
									Diamond Creek drainage										
156	1,500	<200	700	30	70	<20	5	5	20	7	5	<2	<10	5	<1	<1	15	<500	<50
157	1,500	<200	500	50	70	<20	2	5	10	15	7	<2	<10	<5	<1	<1	20	<500	<50
158	2,000	<200	300	70	70	<20	<2	5	15	5	<5	<2	<10	<5	<1	<1	15	<500	<50
159	1,500	<200	300	50	50	20	7	10	10	10	7	<2	<10	<5	<1	<1	10	<500	<50
160	2,000	<200	300	70	50	20	10	7	10	7	5	<2	<10	7	<1	<1	10	<500	<50
161	700	<100	300	10	70	<30	<30	<.3	7	<30	5	<3	<3	<1	<.1	<1	10	<100	<100
162	1,500	<200	500	30	50	<20	2	7	10	10	10	<2	<10	<5	<1	<1	15	<500	<50
163	1,000	<200	200	50	70	<20	<2	2	10	<5	<5	<2	<10	<5	<1	<1	10	<500	<50
164	1,500	<200	500	50	30	<20	<2	3	10	7	<5	<2	<10	5	<1	<1	20	<500	<50
165	>10,000	<200	700	300	150	150	5	20	<10	10	30	<2	<10	20	<1	<1	50	<500	<50
									Deception Creek										
166	3,000	<200	500	150	50	<20	10	30	15	10	5	<2	<10	15	<1	<1	20	<500	<50
167	3,000	<200	500	150	50	<20	15	30	15	10	5	<2	<10	20	<1	<1	15	<500	<50
168	3,000	<200	300	150	50	<20	15	20	20	5	7	<2	<10	15	<1	<1	15	<500	<50
169	3,000	<200	300	150	70	20	15	20	20	10	7	<2	<10	15	<1	<1	20	<500	<50
									Stub Creek drainage										
170	1,500	<200	200	70	50	<20	5	2	10	5	5	<2	<10	7	<1	<1	20	<500	<50
171	2,000	<200	300	70	70	<20	20	15	15	7	5	<2	<10	15	<1	<1	10	<500	<50
172	>10,000	<200	700	300	150	150	5	20	<10	10	30	<2	<10	20	<1	<1	50	<500	<50
173	2,000	<200	300	70	50	<20	20	20	10	10	5	<2	<10	10	<1	<1	10	<500	<50

fresh and altered rocks in the Pasayten Wilderness Area, Washington—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Sc	Cr	Ba	Sr	(percent) Fe	Mg	Ca	Chemical analyses (ppm) cxHM	cxCu	Au	Mo	Sample description 1/
												Goat Creek drainage--Continued
127	15	700	300	300	20	1.5	1	-----	-----	-----	---	Panned concentrate.
128	7	30	300	500	3	1	1	11.0	2	-----	---	Active stream sediment.
												Whiteface Creek drainage
129	5	15	300	500	3	.7	1.5	3	1.5	-----	---	Active stream sediment.
												Pat Creek drainage
130	7	30	500	300	3	1.5	1.5	.5	3	-----	---	Active stream sediment.
131	7	30	300	700	5	1.5	2	2	4	-----	---	Do.
132	7	15	700	500	2	1	1	1	4	-----	---	Do.
133	7	15	300	200	1.5	.3	1.5	-----	-----	-----	---	Do.
134	5	15	500	500	2	.7	1.5	1	6	-----	---	Do.
												Jinks Creek drainage
135	--	---	-----	-----	-----	-----	-----	10	<.5	-----	5	Active stream sediment.
136	--	---	-----	-----	-----	-----	-----	30	2	-----	2	Do.
137	--	---	-----	-----	-----	-----	-----	30	3	-----	2	Do.
138	<5	<5	150	50	2	.3	.15	20	<.5	-----	3	Do.
139	--	---	-----	-----	-----	-----	-----	20	3	-----	2	Do.
140	--	---	-----	-----	-----	-----	-----	15	<.5	-----	2	Do.
141	--	---	-----	-----	-----	-----	-----	2	15	-----	---	Do.
142	--	---	-----	-----	-----	-----	-----	11	<.5	-----	---	Do.
143	--	---	-----	-----	-----	-----	-----	17	<.5	-----	---	Do.
144	--	---	-----	-----	-----	-----	-----	14	<.5	-----	---	Do.
												Drake Creek drainage
145	20	20	200	300	7	2	10	-----	-----	-----	---	Mylonite; small cal veins.
146	15	200	700	700	5	2	5	-----	-----	-----	---	Andesite tuff.
147	7	30	300	500	7	1.5	2	-----	-----	-----	---	Alt and breccia near rhy dike.
148	10	50	700	500	3	.7	2	-----	-----	-----	---	Andesite breccia.
149	5	20	200	300	20	.5	.5	-----	-----	-----	---	Panned concentrate.
150	5	5	500	500	2	.7	1.5	4	<.5	-----	---	Active stream sediment.
151	--	---	-----	-----	-----	-----	-----	7	<.5	-----	---	Do.
152	7	15	1,500	700	3	1.5	2	-----	-----	-----	---	Dacite tuff.
153	10	200	300	70	M	.03	.5	-----	-----	-----	---	Panned concentrate.
154	--	---	-----	-----	-----	-----	-----	4	<.5	-----	---	Active stream sediment.
155	5	30	500	700	5	.7	1.5	7	3	-----	2	Do.
												Diamond Creek drainage
156	<5	5	500	700	2	.3	3	1	-----	-----	---	Active stream sediment.
157	<5	5	700	1,500	2	.3	1	3	<.5	-----	---	Do.
158	<5	<5	500	700	2	.2	2	1	<.5	-----	---	Do.
159	5	20	300	500	1.5	.2	1.5	3	<.5	-----	---	Do.
160	<5	20	300	500	1.5	.3	2	1	<.5	-----	---	Do.
161	<1	<3	1,500	300	1	.15	1.5	-----	-----	-----	---	Biotite quartz diorite.
162	<5	7	700	1,000	2	.5	1	4	<.5	-----	---	Active stream sediment.
163	<5	15	300	700	3	.1	1	.5	<.5	-----	---	Do.
164	<5	10	500	700	2	3	1	2	.5	-----	---	Do.
165	7	100	300	700	20	.7	1	-----	-----	-----	---	Panned concentrate.
												Deception Creek
166	10	30	500	500	3	1	1	2	6	-----	---	Active stream sediment.
167	10	50	500	700	5	1	1.5	1	4	-----	---	Do.
168	7	30	500	500	3	.7	1	2	4	-----	---	Do.
169	10	50	500	500	3	1	2	1	3	-----	---	Do.
												Stub Creek drainage
170	5	20	500	500	2	3	1	1	-----	-----	---	Active stream sediment.
171	5	100	300	300	2	1	1.5	.5	3	-----	---	Do.
172	15	300	200	200	20	5	1.5	-----	-----	-----	---	Panned concentrate.
173	5	50	500	500	2	.7	1.5	1	3	-----	---	Active stream sediment.

TABLE 1.—*Analyses of samples from stream sediments, panned concentrates, and*

Sample	Semiquantitative spectrographic analyses (ppm)																		
	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co	Ag	Be	Ga	As	Sb
	Gunbarrel Creek drainage																		
174	2,000	<200	1,000	100	50	<20	10	30	<10	15	10	<2	<10	15	<1	1	15	<500	<50
175	3,000	<200	700	70	50	<20	10	15	10	15	15	<2	<10	10	<1	<1	15	<500	<50
176	2,000	<200	700	70	30	20	15	20	<10	15	10	<2	<10	15	<1	<1	15	<500	<50
	Little Willy Creek																		
177	3,000	<200	500	100	100	30	15	70	10	10	15	<2	<10	15	<1	<1	15	<500	<50
178	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
178a	3,000	<200	500	150	NR	<20	10	150	<10	NR	20	<2	<10	10	<1	<1	NR	<200	<100
	West Fork of Ptarmigan Creek drainage																		
179	300	<100	50	<1	50	<30	<30	<.3	10	<30	15	<3	<3	<1	<1	2	10	<100	<100
180	3,000	<200	300	150	50	<20	30	70	<10	20	15	2	<10	30	<1	<1	20	<500	<50
181	1,000	<200	1,000	70	30	20	5	15	20	10	7	<2	<10	7	<1	<1	15	<500	<50
182	2,000	<200	300	100	50	20	10	10	10	15	5	<2	<10	10	<1	<1	15	<500	<50
	Ptarmigan Creek drainage																		
183	2,000	<100	200	50	150	<30	<30	3	7	<30	10	<3	<3	7	<.1	1.5	15	<100	<100
184	1,500	<200	700	50	50	20	3	5	20	5	20	2	<10	5	<1	1	15	<500	<50
185	2,000	<200	200	30	50	<20	7	15	30	<5	7	3	30	5	<1	3	10	<500	<50
186	3,000	<200	700	50	20	20	7	15	15	<5	7	2	<10	10	<1	<1	15	<500	<50
187	2,000	<200	300	50	50	30	7	20	15	5	7	<2	<10	7	<1	<1	15	<500	<50
188	2,000	<200	500	100	50	<20	10	30	10	10	10	<2	<10	15	<1	<1	15	<500	<50
189	7,000	<200	500	70	200	200	5	15	10	5	20	<2	<10	20	<1	<1	20	<500	<50
190	1,500	<200	200	70	50	30	5	7	10	7	10	2	<10	5	<1	1	20	<500	<50
191	2,000	<200	700	70	70	30	5	30	20	<5	7	<2	<10	10	<1	1	20	<500	<50
192	1,500	<200	500	70	20	<20	7	10	15	20	5	2	<10	7	<1	<1	20	<500	<50
193	1,500	<100	200	30	100	<30	<30	15	10	<30	7	<3	<3	3	<.1	1	15	<100	<100
	Johnny Creek drainage																		
194	2,000	<100	200	30	100	<30	<30	7	5	<30	7	<3	7	5	<.1	1	15	<100	<100
195	2,000	<100	200	30	200	<30	<30	2	5	<30	10	<3	<3	5	<.1	1.5	10	<100	<100
196	3,000	<200	700	70	150	30	10	30	30	5	10	2	<10	10	<1	1	30	<500	<50
197	2,000	<200	700	100	50	<20	10	30	15	5	20	<2	<10	15	<1	<1	15	<500	<50
198	>10,000	<200	1,000	500	150	300	10	30	<10	10	30	<2	<10	30	<1	<1	30	<500	<50
199	2,000	<200	500	50	50	70	7	30	20	<5	7	2	<10	10	<1	1	15	<500	<50
	Rampart Creek																		
200	5,000	<200	1,000	200	50	<20	30	70	50	<5	10	3	<10	30	<1	1	15	<500	<50
	Billy Creek drainage																		
201	1,000	<200	1,500	20	50	30	5	7	200	<5	7	30	10	5	3	1	20	<500	<50
202	1,500	<200	100	30	70	50	2	5	15	<5	10	<2	50	<5	2	1	20	<500	<50
203	2,000	<200	300	50	50	<20	5	15	20	5	15	10	<10	7	<1	2	20	<500	<50
	Pinnacle Creek drainage																		
204	2,000	<100	500	150	70	<30	50	10	<1	<30	15	<3	<1	10	<.1	2	15	<100	<100
205	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
206	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
207	200	<100	70	<1	100	<30	<30	1,000	30	<30	50	200	20	<1	30	3	20	<100	<100
208	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
209	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
210	1,500	300	500	50	70	30	5	30	30	5	150	15	30	7	1	5	15	<500	<50
	Lost River drainage																		
211	2,000	<200	500	70	70	20	10	30	15	7	10	3	<10	10	<1	<1	10	<500	<50
212	3,000	<100	300	50	100	<30	70	30	5	<30	10	<3	<3	15	<.1	<1	10	<100	<100
213	2,000	<200	500	70	70	<20	10	15	20	10	10	<2	<10	15	<1	<1	15	<500	<50
214	1,500	<200	500	100	50	<20	7	20	<10	10	5	<2	<10	10	<1	<1	15	<500	<50
215	>10,000	<200	300	300	200	<20	50	30	<10	10	<10	<2	<10	15	<1	<1	30	<500	<50

fresh and altered rocks in the Pasayten Wilderness Area, Washington—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Sc	Cr	Ba	Sr	(percent) Fe	Mg	Ca	Chemical analyses (ppm) cxHM	cxCu	Au	Mo	Sample description 1/
							Gunbarrel Creek drainage					
174	5	20	300	700	3	1.5	1.5	2	3	-----	---	Active stream sediment.
175	10	20	300	300	7	1.5	2	1	6	-----	---	Do.
176	5	30	500	500	2	.7	1.5	2	-----	-----	---	Do.
							Little Willy Creek					
177	10	30	500	500	3	1	2	2	15	-----	---	Active stream sediment.
178	--	---	-----	-----	-----	-----	-----	2	20	-----	---	Do.
178a	NR	20	700	500	5	2	2	-----	-----	<.5	---	Lim arkose; sparse pyrite.
							West Fork of Ptarmigan Creek drainage					
179	<1	<3	500	30	.5	.02	.15	-----	-----	-----	---	Quartz porphyry dike.
180	15	70	500	700	10	2	3	-----	-----	-----	---	Lim argillite; sparse pyrite.
181	5	20	500	500	2	5	1	2	-----	-----	---	Active stream sediment.
182	5	30	500	700	3	.5	1	-----	-----	-----	---	Panned concentrate.
							Ptarmigan Creek drainage					
183	7	20	1,500	500	2	1	2	-----	-----	-----	---	Quartz diorite.
184	7	7	300	500	1.5	5	1.5	-----	-----	-----	---	Active stream sediment.
185	5	5	300	300	1.5	.2	.7	.5	6	-----	---	Do.
186	5	15	300	500	1.5	.7	.2	3	<.5	-----	---	Do.
187	5	20	300	300	1.5	.5	1.5	2	3	-----	---	Do.
188	7	30	500	500	3	1	1.5	3	6	-----	---	Do.
189	10	50	300	500	5	1	1.5	-----	-----	-----	---	Panned concentrate.
190	5	30	300	300	2	5	1	2	-----	-----	---	Active stream sediment.
191	7	20	700	500	5	1.5	1.5	-----	-----	-----	---	Sh lim gouge in qtz di stock.
192	5	300	500	700	3	7	1	-----	-----	-----	---	Active stream sediment.
193	3	200	1,000	300	1.5	.5	1	-----	-----	-----	---	Plagioclase porphyry dike.
							Johnny Creek drainage					
194	5	30	1,500	300	1.5	.5	1.5	-----	-----	-----	---	Quartz diorite.
195	5	15	1,000	500	2	.7	1.5	-----	-----	-----	---	Do.
196	7	20	700	500	3	1	3	-----	-----	-----	---	Shear zone in altered dike.
197	10	15	300	300	3	1	1	1	6	-----	---	Active stream sediment.
198	20	70	300	300	15	1.5	1.5	-----	-----	-----	---	Panned concentrate.
199	7	20	500	500	2	.7	1.5	1	3	-----	---	Active stream sediment.
							Rampart Creek					
200	5	100	300	300	5	1.5	1.5	3	7	-----	6	Active stream sediment.
							Billy Creek drainage					
201	<5	5	500	150	1.5	.1	.7	-----	-----	-----	---	Sh qtz di; with chalcedony.
202	<5	5	500	200	3	.2	1	-----	-----	-----	---	Bleached qtz di near 200.
203	5	7	500	300	2	5	1	1	4	-----	6	Active stream sediment.
							Pinnacle Creek drainage					
204	20	100	300	300	5	1.5	2	-----	-----	-----	---	Black argillite.
205	--	---	-----	-----	-----	-----	-----	35	22	-----	8	Active stream sediment.
206	--	---	-----	-----	-----	-----	-----	5	6	-----	2	Do.
207	<1	3	15	<3	1	.007	.2	-----	-----	-----	---	Granite; sparse sulfide specks.
208	--	---	-----	-----	-----	-----	-----	9	7	-----	16	Active stream sediment.
209	--	---	-----	-----	-----	-----	-----	5	15	-----	16	Do.
210	<5	5	200	300	3	.5	1	22	11	-----	8	Do.
							Lost River drainage					
211	7	20	500	300	2	.7	.7	1	7	-----	---	Active stream sediment.
212	10	150	1,000	500	2	2	3	-----	-----	-----	---	Dacite flow.
213	7	30	500	700	3	.5	1.5	1	3	-----	---	Active stream sediment.
214	7	20	700	500	2	2	1	-----	-----	-----	---	Do.
215	5	300	500	500	15	.3	.5	-----	-----	-----	---	Panned concentrate.

TABLE 1.—*Analyses of samples from stream sediments, panned concentrates, and*

	Semiquantitative spectrographic analyses (ppm)																	
Sample	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co	Ag	Be	Ga	As	Sb
								Lost River drainage--Continued											
216	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
217	2,000	<200	300	70	50	<20	15	20	10	7	5	<2	<10	10	<1	<1	10	<500	<50
218	3,000	<200	300	150	50	<20	15	20	10	10	5	<2	<10	15	<1	<1	20	<500	<50
219	2,000	<200	200	100	50	<20	10	10	10	5	7	2	<10	15	<1	<1	10	<500	<50
220	7,000	<200	500	300	50	<20	5	20	<10	70	20	10	<10	5	<1	1	20	<500	<50
221	>10,000	<200	700	150	150	50	7	15	10	10	15	<2	<10	10	<1	<1	20	<500	<50
222	5,000	<200	1,500	500	10	<20	10	100	<10	<5	15	2	<10	20	<1	<1	20	<500	<50
223	3,000	<200	200	100	70	<20	7	30	15	7	7	<2	<10	7	<1	<1	15	<500	<50
224	2,000	<200	200	70	50	<20	7	5	15	5	5	<2	<10	7	<1	<1	15	<500	<50
225	2,000	<200	700	150	50	<20	20	50	<10	<5	10	2	<10	20	1	<1	15	<500	<50
226	2,000	<200	500	70	50	20	10	20	10	5	10	<2	<10	10	<1	1	15	<500	<50
227	>10,000	<200	700	200	150	100	7	30	15	10	10	<2	20	15	<1	<1	20	<500	<50
228	2,000	<200	700	100	70	30	10	20	20	10	15	2	<10	15	<1	1	20	<500	<50
229	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
230	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
231	5,000	<200	1,000	150	150	<20	30	30	10	<5	10	10	<10	20	<1	1	15	<500	<50
232	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
233	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
234	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
235	1,000	200	500	50	150	70	7	30	200	<5	>200	10	20	<5	1	7	20	<500	<50
236	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
237	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
238	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
239	2,000	300	1,500	100	30	<20	20	2,300	20	15	5	<2	150	50	5	<1	50	5,000	<50
240	1,500	<200	500	70	50	20	5	15	10	5	15	<2	<10	7	<1	1	15	<500	<50
241	3,000	<200	700	100	70	<20	15	30	20	5	15	2	<10	10	<1	1	20	<500	<50
242	3,000	<200	1,000	100	50	<20	15	50	20	<5	10	<2	<10	15	<1	1	15	<500	<50
243	3,000	<200	700	100	70	<20	10	15	10	5	20	<2	<10	15	<1	1	20	<500	<50
244	3,000	<200	700	100	50	20	15	50	20	<5	10	<2	10	15	<1	2	15	<500	<50
245	3,000	<200	700	100	70	20	15	30	20	5	15	<2	<10	15	<1	1	20	<500	<50
246	3,000	<200	700	70	50	20	15	20	20	5	10	<2	<10	15	<1	1	15	<500	<50
247	3,000	<200	300	50	30	<20	5	15	15	<5	15	<2	10	7	<1	1	15	<500	<50
248	3,000	<200	150	70	100	20	2	20	20	5	15	<2	<10	7	1	1	10	<500	<50
249	3,000	<200	1,000	100	<50	30	10	50	20	5	15	<2	<10	15	<1	1	15	<500	<50
250	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
251	3,000	<200	700	100	70	<20	15	30	20	5	10	<2	<10	15	<1	<1	15	<500	<50
252	2,000	<200	300	30	70	<20	2	7	20	<5	15	2	<10	<5	<1	1	10	<500	<50
253	3,000	<200	1,000	70	70	30	15	30	15	10	20	<2	<10	15	<1	<1	20	<500	<50
254	2,000	<200	500	70	70	<20	10	15	20	5	20	<2	<10	15	<1	2	20	<500	<50
255	2,000	<200	500	70	70	30	10	20	15	<5	20	<2	10	7	<1	2	15	<500	<50
								Lake of Woods area											
256	1,000	<200	200	30	70	20	2	30	50	<5	30	2	10	<5	<1	5	15	<500	<50
257	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
258	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
259	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
260	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
261	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
262	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
263	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
264	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
265	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
266	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
267	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
268	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
269	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
270	200	<100	200	<1	300	<30	<30	20	20	<30	50	<3	<3	<1	<.1	5	15	<100	<100
271	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
272	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	--	---
273	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	--	---
274	1,000	<100	70	<1	300	<30	<30	7	20	<30	70	<3	<3	<1	<.1	5	15	<100	<100
275	300	<100	300	<1	300	<30	<30	5	50	<30	70	<3	20	<1	<.1	5	20	<100	<100

fresh and altered rocks in the Pasayten Wilderness Area, Washington—Continued

	Semiquantitative spectrographic analyses--Continued							Chemical analyses				
	(ppm)				(percent)			(ppm)				
Sample	Sc	Cr	Ba	Sr	Fe	Mg	Ca	cxHm	cxCu	Au	Mo	Sample description [1]
							Lost River drainage--Continued					
216	--	---	-----	-----	-----	-----	-----	1	6	-----	---	Active stream sediment.
217	7	30	300	700	2	.7	1.5	1	6	-----	---	Do.
218	10	50	500	700	5	1	2	.5	3	-----	---	Do.
219	7	30	300	500	2	.7	1	.5	4	-----	---	Do.
220	15	30	300	300	5	.7	1	-----	-----	-----	---	Lim argillite; sparse pyrite.
221	7	50	300	500	15	.5	2	-----	-----	-----	---	Panned concentrate.
222	30	20	300	500	15	7	3	-----	-----	-----	---	Sil pyrite lim zone.
223	5	20	300	500	2	.3	1.5	1	3	-----	2	Active stream sediment.
224	7	20	300	700	2	.3	1.5	1	3	-----	<2	Do.
225	10	30	300	300	5	1.5	2	-----	-----	-----	---	Sil lim fault zone in arkose.
226	5	20	500	700	2	.7	1	1	3	-----	<2	Active stream sediment.
227	7	100	300	1,000	15	.7	2	-----	-----	-----	---	Panned concentrate.
228	7	20	500	700	5	1	1.5	3	3	-----	---	Active stream sediment.
229	--	---	-----	-----	-----	-----	-----	5	11	-----	12	Do.
230	--	---	-----	-----	-----	-----	-----	4	11	-----	12	Do.
231	20	70	300	700	7	3	2	-----	-----	-----	---	Lim hornfels near granite.
232	--	---	-----	-----	-----	-----	-----	7	15	-----	2	Colluvial soil
233	--	---	-----	-----	-----	-----	-----	7	15	-----	8	Do.
234	--	---	-----	-----	-----	-----	-----	40	11	-----	---	Active stream sediment.
235	<5	5	70	200	3	.3	1.5	>45	11	-----	2	Do.
236	--	---	-----	-----	-----	-----	-----	2	11	-----	---	Do.
237	--	---	-----	-----	-----	-----	-----	3	6	-----	4	Do.
238	--	---	-----	-----	-----	-----	-----	>45	90	-----	<2	Fault gouge.
239	10	50	70	100	20	7	.3	-----	-----	-----	---	Py seam; lim bleached qtzte.
240	<5	7	500	500	3	.5	1.5	3	4	-----	2	Active stream sediment.
241	5	20	500	700	5	1	1.5	1	4	-----	2	Do.
242	7	20	300	500	5	1.5	1.5	2	11	-----	---	Do.
243	7	20	500	500	3	1	1.5	3	4	-----	4	Do.
244	7	30	500	700	5	1.5	2	1	7	-----	---	Do.
245	5	20	500	500	5	1	1.5	3	6	-----	---	Do.
246	5	20	500	500	5	1	2	1	6	-----	---	Do.
247	5	10	200	300	1.5	.3	1.5	1	3	-----	---	Do.
248	7	10	300	200	1.5	.2	1	4	4	-----	---	Do.
249	7	20	300	300	3	.5	2	3	7	-----	---	Do.
250	--	---	-----	-----	-----	-----	-----	2	2	-----	---	Do.
251	<5	30	300	300	3	.7	2	1	7	-----	---	Do.
252	10	10	300	200	1.5	.3	1	2	4	-----	---	Do.
253	7	30	300	300	5	1.5	1.5	1	11	-----	---	Do.
254	5	30	300	500	5	.7	1.5	1	3	-----	---	Do.
255	5	20	300	500	3	1	1.5	2	4	-----	---	Do.
							Lake of Woods area					
256	5	5	70	150	1.5	.2	.5	14	11	-----	---	Active stream sediment.
257	--	---	-----	-----	-----	-----	-----	3	11	-----	2	Do.
258	--	---	-----	-----	-----	-----	-----	5	7	-----	2	Do.
259	--	---	-----	-----	-----	-----	-----	22	7	-----	2	Do.
260	--	---	-----	-----	-----	-----	-----	9	<.5	-----	6	Do.
261	--	---	-----	-----	-----	-----	-----	9	7	-----	4	Do.
262	--	---	-----	-----	-----	-----	-----	9	7	-----	4	Do.
263	--	---	-----	-----	-----	-----	-----	5	6	-----	6	Do.
264	--	---	-----	-----	-----	-----	-----	9	11	-----	6	Do.
265	--	---	-----	-----	-----	-----	-----	7	30	-----	12	Do.
266	--	---	-----	-----	-----	-----	-----	35	90	-----	24	Do.
267	--	---	-----	-----	-----	-----	-----	22	45	-----	12	Lake sediment.
268	--	---	-----	-----	-----	-----	-----	>45	120	-----	4	Do.
269	--	---	-----	-----	-----	-----	-----	40	90	-----	24	Active stream sediment.
270	<1	<3	50	<3	1	.02	.15	-----	-----	-----	--	Iron oxide stained granite.
271	--	---	-----	-----	-----	-----	-----	>45	45	-----	12	Active stream sediment.
272	--	---	-----	-----	-----	-----	-----	45	45	-----	20	Do.
273	--	---	-----	-----	-----	-----	-----	>45	180	-----	120	Do.
274	10	<3	300	50	3	.02	.07	-----	-----	-----	---	Iron-stained granite.
275	<1	<3	30	<3	2	.02	.1	-----	-----	-----	---	Weathered limonitic granite.

TABLE 1.—*Analyses of samples from stream sediments, panned concentrates, and*

Semiquantitative spectrographic analyses (ppm)

Sample	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co	Ag	Be	Ga	As	Sb
								Lake of Woods area--Continued											
276	2,000	<100	200	30	150	<30	<30	20	50	<30	20	<3	<3	<1	1	1.5	15	<100	<100
277	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
								Monument Creek drainage											
278	200	<100	7	<1	100	<30	<30	3	10	<30	30	<3	<3	<1	<.1	3	15	<100	<100
279	200	<200	2,000	10	70	20	<2	30	10	<5	70	150	30	<5	<1	7	50	<500	<50
280	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
281	1,500	<200	1,000	50	50	50	7	5	15	10	150	10	<10	10	<1	7	20	<500	<50
282	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
283	1,500	<200	200	50	50	20	3	2	15	5	20	<2	<10	5	<1	15	20	<500	<50
284	1,000	<200	150	20	50	<20	<2	2	20	7	7	<2	<10	<5	<1	1	20	<500	<50
285	3,000	<200	300	50	150	70	7	15	30	5	70	2	<10	7	<1	2	15	<500	<50
286	2,000	<200	300	50	70	30	2	5	20	5	15	2	<10	5	<1	2	20	<500	<50
287	1,500	200	500	20	150	20	5	30	30	5	100	7	<10	<5	1	5	15	<500	<50
288	1,000	<200	500	30	30	20	2	7	20	<5	15	3	<10	<5	<1	5	20	<500	<50
289	1,500	<100	200	30	100	<30	<30	7	10	<30	10	<3	<3	3	<.1	1.5	15	<100	<100
290	300	<100	100	<1	150	<30	<30	<.3	30	<30	70	5	10	<1	<.1	5	20	<100	<100
291	1,500	<200	300	30	70	20	5	30	50	<5	20	5	15	<5	<1	2	15	<500	<50
292	2,000	<200	200	50	70	100	<2	7	20	5	15	<2	<10	5	<1	3	15	<500	<50
293	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
294	200	<200	50	<10	100	<20	<5	5	30	<10	30	<2	10	<10	<1	1	15	<500	<50
295	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
296	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
297	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
298	500	<200	200	<10	150	50	<2	70	70	<10	100	<2	15	<5	<.5	5	50	<200	<100
299	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
300	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
301	700	<200	200	<10	100	<20	<2	300	50	<10	70	<2	50	<5	2	5	30	<200	<100
302	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
303	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
304	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
305	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
306	700	<200	300	<10	200	<20	5	100	30	<10	150	20	10	<5	<.5	3	50	<200	<100
307	7,000	<200	3,000	500	50	<20	15	500	<10	<10	20	30	<10	15	1.5	<1	10	<200	<100
308	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
309	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
310	3,000	<200	300	70	100	20	2	20	20	<5	15	<2	<10	7	<1	1	15	<500	<50
311	3,000	<200	200	50	70	20	2	30	20	<5	10	<2	10	7	<1	1	15	<500	<50
								South Fork of Eureka Creek drainage											
312	2,000	<200	500	70	30		15	20	10	7	7	15	<10	15	<1	<1	15	<500	<50
313	2,000	<200	300	100	50	<20	2	50	<10	5	10	<2	<10	<5	<1	<1	20	<500	<50
314	3,000	<200	500	70	50	<20	15	20	10	5	7	<2	<10	15	<1	<1	10	<500	<50
315	3,000	<100	300	70	70	<30	50	7	<1	<30	10	<3	<3	15	<.1	<1	10	<100	<100
316	3,000	<100	500	70	70	<30	50	3	<1	<30	10	<3	<3	15	<.1	<1	10	<100	<100
317	2,000	<200	500	100	30	<20	15	7	<10	5	7	<2	<10	15	<1	<1	15	<500	<50
318	3,000	<200	300	150	50	<20	3	50	<10	<5	10	<2	<10	7	<1	<1	20	<500	<50
319	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
320	2,000	<200	1,500	150	50	20	15	150	20	10	10	30	<10	15	<1	1	20	<500	<50
321	3,000	<200	500	100	50	20	15	15	15	5	10	3	<10	10	<1	1	20	<500	<50
								Eureka Creek drainage											
322	1,500	<200	300	70	30	<20	10	20	10	<5	5	<2	<10	15	<1	1	15	<500	<50
323	2,000	<200	300	70	50	<20	15	70	20	<5	15	20	30	15	1	2	15	<500	<50
324	2,000	<200	300	70	50	20	15	100	20	10	15	15	20	15	1	3	15	<500	<50
325	-----	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
326	5,000	<200	1,000	50	150	<20	50	100	<10	<10	30	50	<10	20	<.5	7	20	<200	<100
327	2,000	<200	300	50	150	20	5	50	20	<10	15	5	10	<5	.5	1	30	<200	<100
328	7,000	<200	1,500	700	100	<20	50	500	<10	10	20	<5	<10	30	.5	<1	50	<200	<100
329	700	<200	100	<10	150	<20	5	50	20	<10	70	10	10	<5	<.5	5	50	<200	<100
330	2,000	<200	1,000	150	200	<20	10	>5,000	20	<10	70	50	300	50	30	1.5	70	<200	<100
331	2,000	<200	500	70	50	30	5	15	20	7	15	3	300	7	<1	2	20	<500	<50

fresh and altered rocks in the Pasayten Wilderness Area, Washington—Continued

	Semiquantitative spectrographic analyses--Continued							Chemical analyses				
	(ppm)				(percent)			(ppm)				
Sample	Sc	Cr	Ba	Sr	Fe	Mg	Ca	cxHM	cxCu	Au	Mo	Sample description[1/]
							Lake of Woods area--Continued					
276	5	7	300	150	2	.2	1	-----	-----	-----	---	Lim soil on top of granite.
277	--	---	-----	-----	-----	-----	-----	1	1	-----	7	Soil.
							Monument Creek drainage					
278	<1	<3	50	10	.07	.01	.2	-----	-----	-----	---	Quartz porphyry dike.
279	<5	<5	10	150	10	.02	.1	-----	-----	-----	---	Altered limonitic granodiorite.
280	--	---	-----	-----	-----	-----	-----	9	7	-----	---	Active stream sediment.
281	7	10	200	500	1.5	7	1.5	1	-----	-----	---	Do.
282	--	---	-----	-----	-----	-----	-----	1	<.5	-----	6	Do.
283	5	10	500	500	1.5	5	.7	1	<.5	-----	2	Do.
284	<5	5	70	200	1	2	.5	.5	-----	-----	---	Do.
285	7	15	300	300	1.5	.5	1.5	4	<.5	-----	2	Do.
286	5	10	300	300	2	5	.7	1	<.5	-----	---	Do.
287	5	10	100	150	2	.2	.5	3	7	-----	8	Do.
288	<5	5	300	200	1.5	2	.5	4	-----	-----	---	Do.
289	5	15	700	200	1.5	.5	1.5	-----	-----	-----	---	Hornblende biotite qtz diorite.
290	3	<3	15	3	.7	.015	.3	-----	-----	-----	---	Granite.
291	5	5	200	150	1.5	.1	.5	1	7	-----	6	Active stream sediment.
292	<5	7	200	200	1.5	5	.7	.5	1	-----	---	Do.
293	--	---	-----	-----	-----	-----	-----	7	5	-----	5	Do.
294	<5	5	20	<50	.7	.01	.2	-----	-----	-----	---	Limonite stained granite.
295	--	---	-----	-----	-----	-----	-----	7	22	-----	2	Active stream sediment.
296	--	---	-----	-----	-----	-----	-----	10	20	-----	3	Do.
297	--	---	-----	-----	-----	-----	-----	7	30	-----	3	Do.
298	<5	<5	10	<50	2	.05	2	-----	-----	<.1	---	Lim stained gr; sparse sul.
299	--	---	-----	-----	-----	-----	-----	7	50	-----	2	Active stream sediment.
300	--	---	-----	-----	-----	-----	-----	3	10	-----	3	Do.
301	<5	<5	70	<50	3	.05	2	-----	-----	.1	---	Lim stained gr; sparse sul.
302	--	---	-----	-----	-----	-----	-----	10	20	-----	5	Active stream sediment.
303	--	---	-----	-----	-----	-----	-----	15	15	-----	3	Do.
304	--	---	-----	-----	-----	-----	-----	11	11	-----	2	Do.
305	--	---	-----	-----	-----	-----	-----	10	15	-----	<2	Do.
306	<5	<10	<20	<100	2	.05	.5	-----	-----	-----	---	Lim. stained gr; sparse pyrite.
307	50	15	300	500	15	5	10	-----	------	-----	---	Lim hornfelsed cgl; sparse sul.
308	--	---	-----	-----	-----	-----	-----	1	7	-----	<2	Active stream sediment.
309	--	---	-----	-----	-----	-----	-----	5	6	-----	2	Do.
310	<5	7	300	200	1.5	.3	1	1	3	-----	---	Do.
311	5	7	200	200	1	.3	1	1	3	-----	---	Do.
							South Fork of Eureka Creek drainage					
312	7	30	300	300	3	7	.7	3	-----	-----	---	Active stream sediment.
313	5	20	500	200	5	1	.1	-----	-----	-----	---	Lim arkose; small qtz veins.
314	7	30	300	300	2	.7	1.5	3	2	-----	---	Do.
315	10	100	1,000	700	2	2	3	-----	-----	-----	---	Quartz diorite.
316	15	100	1,000	700	2	2	3	-----	-----	-----	---	Do.
317	7	50	500	700	2	7	1.5	2	3	-----	---	Active stream sediment.
318	7	20	1,500	1,000	3	1.5	2	-----	-----	-----	---	Lim qtzte near qtz di stock.
319	--	---	-----	-----	-----	-----	-----	15	100	-----	5	Quartz diorite stock.
320	7	50	300	500	5	2	1.5	5	45	-----	16	Active stream sediment.
321	7	70	300	500	3	7	1.5	2	4	-----	---	Do.
							Eureka Creek drainage					
322	7	20	300	500	2	.5	1	.5	3	-----	---	Active stream sediment.
323	7	30	300	200	2	.5	.7	3	15	-----	---	Do.
324	7	30	200	300	2	.7	1	2	11	-----	15	Do.
325	--	---	-----	-----	-----	-----	-----	10	50	-----	15	Do.
326	20	100	700	500	15	5	5	-----	-----	-----	---	Lim stained fault zone.
327	5	15	1,000	300	3	.7	1	-----	-----	-----	---	Lim stained qtz porphyry dike.
328	30	100	1,000	300	15	5	3	-----	-----	-----	---	Lim stained argillite.
329	<5	<10	100	<100	1.5	.1	.3	-----	-----	-----	---	Lim stained qtz porphyry dike.
330	20	20	500	100	15	1	3	-----	-----	-----	---	Hornfels inclusion w/Cu minerals.
331	5	20	200	200	5	.5	1	-----	-----	-----	---	Panned concentrate.

TABLE 1.—*Analyses of samples from stream sediments, panned concentrates, and*

	Semiquantitative spectrographic analyses (ppm)																		
Sample	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co	Ag	Be	Ga	As	Sb
								Eureka Creek drainage--Continued											
332	1,000	<200	500	50	20	<20	3	20	30	5	20	7	<10	<5	<1	5	20	<500	<50
333	5,000	<100	300	150	100	<30	70	100	<1	<30	20	<3	<3	20	<.1	<1	10	<100	<100
334	1,500	<200	300	50	70	<20	5	20	20	<5	15	10	20	7	<1	1	15	<500	<50
335	1,500	<200	700	70	30	<20	10	30	15	<5	10	<2	15	10	<1	1	10	<500	<50
336	1,500	<200	300	50	20	<20	5	30	<10	<5	7	<2	<10	5	<1	3	20	<500	<50
337	1,500	<200	200	50	70	<20	5	20	20	<5	10	<2	20	5	<1	1	15	<500	<50
338	2,000	<200	300	50	100	<20	5	50	20	<5	15	2	20	5	<1	3	15	<500	<50
339	7,000	<200	500	100	200	30	7	20	15	10	15	2	200	10	<1	2	20	<500	<50
340	1,000	<200	300	50	30	<20	7	10	10	<5	10	<2	<10	5	<1	2	20	<500	<50
341	1,500	<200	300	70	30	<20	10	5	10	5	10	<2	<10	7	<1	2	15	<500	<50
342	2,000	<200	300	100	30	<20	15	30	10	5	10	<2	<10	15	<1	2	15	<500	<50
343	>10,000	<200	1,000	700	700	150	50	30	10	10	50	<2	70	30	<1	<1	50	<500	<50
344	1,000	<200	300	50	20	<20	15	10	20	5	7	<2	<10	10	<1	1	20	<500	<50
345	2,000	<200	500	30	150	20	5	20	50	<5	50	2	20	<5	<1	5	20	<500	<50
346	1,000	<200	500	20	70	30	2	5	50	<5	30	3	20	<5	<1	2	20	<500	<50
347	1,500	<200	700	50	150	70	7	10	30	<5	100	2	15	5	<1	5	20	<500	<50
348	300	<100	70	<1	100	<30	<30	3	30	<30	50	<3	<3	<1	<.1	3	20	<100	<100
349	2,000	<200	500	70	70	20	15	30	15	5	15	<2	<10	15	<1	1	15	<500	<50
350	2,000	<200	700	100	15	<20	20	15	<10	<5	7	<2	<10	15	<1	1	20	<500	<50
351	>10,000	<200	700	500	1,000	150	70	20	20	15	70	<2	300	20	<1	1	50	<500	<50
352	2,000	<200	1,000	50	30	20	10	15	30	<5	15	<2	<10	10	<1	1	10	<500	<50
353	2,000	<200	700	100	50	<20	10	15	<10	10	10	<2	<10	10	<1	1	20	<500	<50
354	3,000	<200	700	100	100	20	10	50	10	10	10	<2	<10	10	<1	1	15	<500	<50
355	2,000	<200	1,000	70	50	20	15	30	20	7	15	<2	<10	10	<1	1	15	<500	<50
356	5,000	<200	700	150	500	100	20	30	10	5	50	<2	10	15	<1	1	20	<500	<50
								East Fork of the Pasayten River drainage											
357	500	<200	1,500	50	30	20	2	10	10	7	20	<2	<10	10	<1	1	15	<500	<50
358	700	<200	500	30	50	<20	<2	20	10	5	5	<2	<10	<5	<1	<1	15	<500	<50
359	700	<100	500	15	70	<30	<30	30	10	<30	30	<3	<3	<1	<.1	1	15	<100	<100
360	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
361	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
362	2,000	<100	1,000	500	1,500	100	<30	10	<1	<30	30	<3	15	<10	<.1	<1	30	<100	<100
363	2,000	<200	700	70	30	<20	10	15	10	5	10	<2	<10	15	<1	<1	15	<500	<50
364	3,000	<200	700	70	20	<20	7	20	10	<5	10	<2	<10	10	<1	<1	15	<500	<50
365	3,000	<200	700	100	50	<20	5	10	<10	20	10	<2	<10	15	<1	<1	20	<500	<50
366	1,500	<200	500	50	20	<20	5	30	<10	5	5	<2	<10	7	<1	<1	10	<500	<50
367	2,000	<200	150	50	30	<20	5	3	10	7	10	<2	<10	10	<1	<1	10	<500	<50
368	1,500	<200	700	30	30	<20	2	15	20	<5	70	<2	<10	<5	<1	<1	20	<500	<50
369	7,000	<200	500	500	1,000	<20	10	10	<10	20	50	<2	<10	15	<1	<1	15	<500	<50
370	2,000	<200	700	70	50	<20	10	7	10	<5	10	<2	<10	15	<1	<1	15	<500	<50
371	1,500	<100	7	30	150	<30	<30	15	10	<30	7	<3	<3	3	<.1	1	10	<100	<100
372	2,000	<200	700	150	50	<20	5	7	10	<5	15	<2	<10	10	<1	<1	20	<500	<50
373	1,500	<200	700	50	50	<20	10	7	<10	<5	7	<2	<10	10	<1	<1	15	<500	<50
374	1,500	<200	500	70	30	20	7	7	<10	15	20	<2	<10	7	<1	1	10	<500	<50
375	2,000	<200	500	70	50	<20	10	5	10	<5	10	<2	<10	7	<1	<1	15	<500	<50
376	>10,000	<200	700	300	500	30	10	15	<10	15	20	<2	<10	15	<1	<1	70	<500	<50
377	1,500	<200	700	100	20	<20	7	10	10	15	10	<2	<10	10	<1	<1	15	<500	<50
378	>10,000	<200	1,500	500	300	200	20	20	<10	15	30	<2	<10	20	<1	<1	30	<500	<50
379	1,500	<200	300	70	50	<20	7	7	15	7	5	<2	<10	10	<1	<1	15	<500	<50
								Central Creek											
380	1,500	<200	300	70	50	<20	7	7	<10	10	10	<2	<10	7	<1	<1	15	<500	<50
								Lodgepole Creek drainage											
381	2,000	<200	500	50	50	<20	7	5	15	10	10	<2	<10	10	<1	<1	10	<500	<50

fresh and altered rocks in the Pasayten Wilderness Area, Washington—Continued

	Semiquantitative spectrographic analyses--Continued							Chemical analyses				
	(ppm)				(percent)			(ppm)				
Sample	Sc	Cr	Ba	Sr	Fe	Mg	Ca	cxHM	cxCu	Au	Mo	Sample description 1/
							Eureka Creek drainage--Continued					
332	<5	10	150	200	1.5	3	.5	1	4	-----	---	Active stream sediment.
333	20	150	500	150	5	2	.7	-----	-----	-----	---	Black argillite.
334	7	10	300	200	2	.2	.7	.5	4	-----	---	Active stream sediment.
335	5	15	300	200	2	.2	1	1	3	-----	---	Do.
336	5	10	300	300	1.5	7	.5	-----	-----	-----	---	Do.
337	10	20	200	200	1.5	.3	1	1	3	-----	---	Do.
338	5	10	200	200	1.5	.3	1	1	4	-----	---	Do.
339	7	30	300	300	7	.7	1.5	-----	-----	-----	---	Panned concentrate.
340	5	10	300	300	2	5	1	2	-----	-----	---	Active stream sediment.
341	5	20	500	300	2	7	1	1	1.5	-----	---	Do.
342	5	30	300	300	2	.7	1.5	1	3	-----	---	Do.
343	20	700	300	500	20	2	1.5	-----	-----	-----	---	Panned concentrate.
344	5	30	300	300	1.5	.7	1.5	-----	-----	-----	---	Active stream sediment.
345	<5	5	200	100	3	.3	.5	2	4	-----	---	Do.
346	<5	<5	150	50	2	.1	.3	5	3	-----	---	Do.
347	5	5	300	200	3	.7	.7	3	4	-----	---	Do.
348	<1	10	70	5	.7	.01	.3	-----	-----	-----	---	Qtz por border phase of pluton.
349	7	30	300	300	2	1	2	-----	-----	-----	---	Active stream sediment.
350	10	70	500	700	3	15	2	.5	3	-----	---	Do.
351	10	700	150	200	15	1.5	1	-----	-----	-----	---	Panned concentrate.
352	5	15	500	500	2	.7	1.5	4	3	-----	---	Active stream sediment.
353	7	20	500	1,000	5	1.5	3	-----	-----	-----	---	Lim argillite; calcite py.
354	7	20	500	500	3	.7	3	-----	-----	-----	---	Limonitic argillite.
355	5	30	500	300	3	.7	1.5	3	6	-----	---	Active stream sediment.
356	15	100	300	300	7	1.5	1.5	-----	-----	-----	---	Panned concentrate.
							East Fork of the Pasayten River drainage.					
357	7	<5	500	300	5	.1	.5	-----	-----	-----	---	Limonitic biotite gneiss.
358	<5	<5	500	700	2	.5	5	-----	-----	-----	---	Lim quartz monzonite gneiss.
359	7	<3	1,500	300	1.5	.05	1.5	-----	-----	-----	---	Lim pegmatite near bi gneiss.
360	--	---	-----	-----	-----	-----	-----	1	<.5	-----	6	Active stream sediment.
361	--	---	-----	-----	-----	-----	-----	1	<.5	-----	6	Do.
362	7	15	100	100	M	.07	1	-----	-----	-----	---	Panned concentrate.
363	10	30	300	500	3	1	3	1	<.5	-----	---	Active stream sediment.
364	5	20	300	700	2	.5	3	2	<.5	-----	---	Do.
365	5	10	700	700	5	1.5	5	-----	-----	-----	---	Sil feldspar por dike; cal.
366	<5	10	300	500	1.5	.5	.7	.5	11	-----	---	Active stream sediment.
367	<5	10	500	500	1.5	.3	1	1	-----	-----	---	Do.
368	<5	<5	500	1,000	1.5	.3	3	-----	-----	-----	---	Do.
369	10	70	150	200	>20	1	2	-----	-----	-----	---	Panned concentrate.
370	5	20	300	500	2	.7	3	2	<.5	-----	---	Active stream sediment.
371	3	7	1,000	150	1	.3	.7	-----	-----	-----	---	Biotite dacite porphyry.
372	5	15	300	700	7	1	2	.5	-----	-----	---	Active stream sediment.
373	<5	20	300	500	2	.7	1.5	1	1	-----	---	Do.
374	7	20	300	200	2	.7	1.5	2	-----	-----	---	Do.
375	5	20	500	700	3	.7	2	3	<.5	-----	---	Do.
376	10	30	100	300	15	.5	1	-----	-----	-----	---	Panned concentrate.
377	7	7	300	500	3	.5	1.5	3	-----	-----	---	Active stream sediment.
378	20	70	200	300	20	1.5	2	-----	-----	-----	---	Panned concentrate.
379	5	20	500	500	1.5	.3	1.5	1	.5	-----	---	Active stream sediment.
							Central Creek					
380	5	20	500	700	2	1	1.5	.5	3	-----	---	Active stream sediment.
							Lodgepole Creek drainage					
381	5	10	500	300	1.5	.3	1.5	2	<.5	-----	---	Active stream sediment.

TABLE 1.—*Analyses of samples from stream sediments, panned concentrates, and*

	Semiquantitative spectrographic analyses (ppm)																		
Sample	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co	Ag	Be	Ga	As	Sb
								Lease Creek drainage											
382	1,500	<200	700	100	70	<20	10	70	<10	5	10	5	<10	10	<1	<1	15	<500	<50
383	1,500	200	1,000	70	50	<20	5	70	<10	10	10	<2	<10	10	1	<1	30	<500	<50
384	3,000	<200	700	100	70	<20	15	50	70	5	20	5	<10	20	<1	<1	20	<500	<50
385	5,000	<200	700	70	50	20	10	70	15	7	10	15	<10	15	1	<1	20	<500	<50
386	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
387	7,000	<200	1,000	300	150	<20	20	150	<10	<10	20	20	<10	15	<.5	<1	30	<200	<100
388	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
389	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
390	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
391	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
392	3,000	<200	300	150	150	<20	10	100	<10	<10	10	5	<10	5	<.5	<1	20	<200	<100
393	3,000	<200	500	150	150	<20	15	150	<10	<10	10	<5	<10	15	<.5	<1	20	<200	<100
394	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
395	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
396	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
397	5,000	<200	1,500	300	50	<20	20	500	<10	<10	10	70	<10	20	1.5	<1	30	<200	<100
398	1,000	<200	1,500	500	100	<20	15	300	<10	<10	20	5	<10	20	.5	<1	70	<200	<100
399	2,000	<200	700	70	50	<20	10	50	30	10	10	3	<10	15	<1	1	20	<500	<50
400	7,000	<200	500	200	700	150	10	30	<10	<5	15	30	<10	15	<1	<1	20	<500	<50
401	1,500	<200	300	50	50	<20	10	30	15	7	7	7	<10	7	<1	1	10	<500	<50
402	2,000	<100	300	70	100	<30	<30	20	<1	<30	15	<3	<3	7	<.1	<1	10	<100	<100
403	2,000	<200	300	70	30	<20	10	30	15	7	5	3	<10	10	<1	1	15	<500	<50
404	1,000	<200	300	50	30	<20	2	20	10	7	15	<2	<10	5	<1	1	<10	<500	<50
405	2,000	<200	200	50	20	<20	10	10	10	10	5	<2	<10	10	<1	<1	10	<500	<50
406	2,000	<200	500	100	70	20	7	30	15	10	10	10	<10	15	<1	1	20	<500	<50
407	3,000	<200	300	70	70	<20	7	20	15	7	10	2	<10	10	<1	1	15	<500	<50
408	10,000	<200	700	200	150	100	10	30	10	<5	15	<2	<10	15	<1	<1	20	<500	<50
409	2,000	<200	300	70	70	<20	10	15	15	7	10	<2	<10	10	<1	1	15	<500	<50
410	1,500	<200	300	100	50	<20	10	10	10	5	10	<2	<10	10	<1	<1	15	<500	<50
								Middle Fork of the Pasayten River drainage											
411	>10,000	<200	1,000	700	700	<20	100	20	<10	20	5	<2	<10	20	<1	<1	30	<500	<50
412	3,000	<200	700	70	50	<20	15	30	15	7	10	<2	<10	15	<1	<1	10	<500	<50
413	5,000	<200	500	70	70	<20	10	15	15	7	10	<2	<10	10	<1	<1	10	<500	<50
414	1,500	<200	300	50	70	<20	7	10	15	5	15	<2	<10	5	<1	<1	10	<500	<50
415	3,000	<200	500	70	30	20	15	10	10	7	10	<2	<10	20	<1	<1	20	<500	<50
416	2,000	<200	500	100	30	<20	15	7	<10	5	5	<2	<10	15	<1	1	15	<500	<50
417	3,000	<200	300	200	200	<20	15	15	10	10	5	<2	<10	15	<1	<1	20	<500	<50
418	2,000	<200	500	300	20	30	30	15	<10	7	20	<2	<10	30	<1	<1	30	<500	<50
419	10,000	<200	300	300	200	30	15	10	<10	20	10	<2	<10	15	<1	<1	10	<500	<50
420	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
421	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
422	1,500	<200	500	50	50	30	10	10	30	5	15	<2	<10	5	<1	<1	10	<500	<50
423	3,000	<200	700	100	70	30	15	20	10	5	30	<2	<10	15	<1	<1	15	<500	<50
424	>10,000	<200	100	500	200	50	30	20	<10	20	20	<2	<10	30	<1	<1	20	<500	<50
425	2,000	<200	700	100	50	20	10	15	<10	7	10	<2	<10	15	<1	<1	15	<500	<50
426	2,000	<200	500	100	70	<20	15	20	10	7	10	<2	<10	15	<1	<1	15	<500	<50
427	1,500	<200	200	50	50	<20	10	7	10	5	5	<2	<10	5	<1	<1	10	<500	<50
428	>10,000	<200	1,000	1,000	150	<20	20	20	<10	30	10	<2	<10	30	<1	<1	30	<500	<50
429	1,500	<200	200	50	20	<20	10	7	10	5	10	<2	<10	15	<1	<1	15	<500	<50
								Robinson Creek drainage											
430	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
431	1,500	1,000	2,000	100	70	50	20	1,500	10	5	20	7	<10	50	3	<1	15	<500	<50
432	2,000	<200	700	100	70	30	10	50	30	7	20	10	<10	15	<1	1	20	<500	<50
433	2,000	<100	500	100	70	<30	50	300	<1	<30	10	<3	<3	20	<.1	<1	10	<100	<100
434	2,000	<100	500	70	100	<30	<30	30	<1	<30	10	<3	<3	7	<.1	<1	10	<100	<100
435	1,500	<200	700	70	50	30	7	20	10	5	10	<2	<10	7	<1	1	10	<500	<50
436	10,000	<200	700	300	150	50	30	70	20	10	20	<2	<10	30	<1	<1	20	<500	<50
437	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
438	3,000	<200	700	70	50	20	15	15	15	7	10	<2	<10	10	<1	1	10	<500	<50
439	1,500	<100	500	70	70	<30	<30	5	10	<30	<3	<3	<3	7	<.1	<1	15	<100	<100

fresh and altered rocks in the Pasayten Wilderness Area, Washington—Continued

	Semiquantitative spectrographic analyses--Continued							Chemical analyses				
	(ppm)				(percent)			(ppm)				
Sample	Sc	Cr	Ba	Sr	Fe	Mg	Ca	cxHM	cxCu	Au	Mo	Sample description 1/
							Lease Creek drainage					
382	5	20	70	300	7	.5	5	-----	-----	-----	---	Limonitic shear zone in arkose.
383	7	20	50	50	20	1	.5	-----	-----	-----	---	Lim argillite near qtz por dike.
384	10	30	300	500	5	1.5	2	3	15	-----	---	Active stream sediment.
385	7	20	300	700	5	1.5	2	1	15	-----	---	Do.
386	--	-----	-----	-----	-----	-----	-----	1	10	-----	5	Do.
387	20	50	1,000	1,000	7	5	3	-----	-----	-----	---	Lim stained hornfelsed argillite.
388	--	-----	-----	-----	-----	-----	-----	1	10	-----	3	Active stream sediment.
389	--	-----	-----	-----	-----	-----	-----	1	10	-----	3	Do.
390	--	-----	-----	-----	-----	-----	-----	3	10	-----	3	Do.
391	--	-----	-----	-----	-----	-----	-----	15	20	-----	2	Do.
392	10	20	1,000	700	5	2	2	-----	-----	-----	---	Lim stained hornfelsed argillite.
393	10	20	500	700	7	2	3	-----	-----	-----	---	Do.
394	--	---	-----	-----	-----	-----	-----	20	15	-----	2	Active stream sediment.
395	--	---	-----	-----	-----	-----	-----	3	10	-----	5	Do.
396	--	---	-----	-----	-----	-----	-----	20	150	-----	5	Do.
397	15	50	1,000	700	15	5	5	-----	-----	-----	---	Lim stained qtz diorite; pyrite.
398	20	15	700	1,500	15	7	7	-----	-----	-----	---	Lim stained qtz diorite.
399	5	20	500	300	2	1	1.5	2	7	-----	---	Active stream sediment.
400	10	50	500	700	7	1	2	-----	-----	-----	---	Panned concentrate.
401	5	20	300	300	1.5	.7	.7	1	6	-----	---	Active stream sediment.
402	7	20	70	500	2	1.5	2	-----	-----	-----	---	Quartz diorite.
403	<5	30	300	300	2	.7	2	.5	6	-----	---	Active stream sediment.
404	5	20	300	150	1.5	3	1	3	11	-----	---	Do.
405	5	10	300	300	1.5	3	1.5	2	-----	-----	---	Do.
406	7	30	500	500	3	1	1.5	1	3	-----	---	Do.
407	5	20	300	300	3	1	1	1	4	-----	---	Do.
408	15	50	300	700	7	2	2	-----	-----	-----	---	Panned concentrate.
409	5	20	300	300	2	.7	1	1	4	-----	---	Active stream sediment.
410	5	15	300	700	2	.7	1.5	.5	3	-----	---	Do.
							Middle Fork of the Pasayten River drainage					
411	10	1,000	200	200	>20	1	.5	-----	-----	-----	<2	Panned concentrate.
412	10	30	300	500	3	.7	1.5	1	1.5	-----	---	Active stream sediment.
413	7	30	300	300	3	.7	2	1	<.5	-----	---	Do.
414	7	20	500	700	1.5	.7	1.5	-----	-----	-----	---	Do.
415	7	50	300	300	2	1.5	2	.5	<.5	-----	<2	Do.
416	7	50	300	700	3	1.5	2	.5	3	-----	2	Do.
417	5	150	300	300	10	.5	1	2	.5	-----	6	Do.
418	7	500	300	300	15	1	1	-----	-----	-----	---	Do.
419	<5	300	70	50	15	.5	.7	-----	-----	-----	---	Panned concentrate.
420	--	---	-----	-----	-----	-----	-----	.5	<.5	-----	---	Active stream sediment.
421	--	---	-----	-----	-----	-----	-----	1	.5	-----	---	Do.
422	5	30	300	500	1.5	.7	1	1	1.5	-----	---	Do.
423	7	30	300	500	3	1.5	2	1	3	-----	---	Do.
424	15	1,000	300	300	20	1.5	1	-----	-----	-----	---	Panned concentrate.
425	7	20	300	700	3	1.5	2	1	3	-----	---	Do.
426	5	30	500	700	5	1	1	1	4	-----	---	Do.
427	5	30	300	300	1.5	.7	1.5	.5	1	-----	---	Do.
428	5	2,000	300	150	>20	.3	.7	-----	-----	-----	---	Panned concentrate.
429	7	20	300	500	1.5	.7	1.5	2	-----	-----	---	Active stream sediment.
							Robinson Creek drainage					
430	--	---	-----	-----	-----	-----	-----	1	<.5	-----	---	Active stream sediment.
431	7	20	70	200	7	2	1	-----	-----	-----	---	Limonitic arkose.
432	7	20	300	300	3	1	2	1	3	-----	---	Active stream sediment.
433	15	100	700	500	3	1.5	3	-----	-----	-----	---	Hornblende biotite qtz diorite.
434	7	50	500	700	3	1	2	-----	-----	-----	---	Plagioclase porphyry dike.
435	<5	20	300	200	2	.7	2	2	3	-----	---	Active stream sediment.
436	10	200	500	200	15	1.5	1.5	-----	-----	-----	---	Panned concentrate.
437	--	---	-----	-----	-----	-----	-----	11	2	-----	---	Active stream sediment.
438	5	20	300	200	3	.5	1.5	7	1	-----	---	Do.
439	7	70	1,000	500	1.5	1	1.5	-----	-----	-----	---	Arkose.

TABLE 1.—*Analyses of samples from stream sediments, panned concentrates, and*

Sample	Semiquantitative spectrographic analyses (ppm)																	
	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co	Ag	Be	Ga	As	Sb
	Robinson Creek drainage--Continued																		
440	2,000	<200	700	100	70	20	15	20	20	10	10	<2	<10	15	<1	<1	15	<500	<50
441	2,000	<200	700	70	70	20	10	20	10	5	15	<2	<10	15	<1	1	15	<500	<50
442	1,000	<200	700	15	150	<20	3	7	10	5	20	2	<10	5	<1	2	20	<500	<50
443	2,000	<200	700	50	50	<20	10	10	10	10	10	<2	<10	10	<1	<1	10	<500	<50
444	2,000	<200	1,000	150	50	<20	15	30	10	10	10	<2	<10	20	<1	<1	15	<500	<50
445	2,000	<200	700	150	50	<20	10	30	15	10	5	<2	<10	20	<1	<1	20	<500	<50
446	2,000	<200	500	100	50	<20	30	30	10	10	5	<2	<10	15	<1	<1	15	<500	<50
447	>10,000	<200	700	500	150	20	30	70	10	10	10	<2	<10	10	<1	<1	20	<500	<50
448	2,000	<200	1,000	150	50	<20	15	20	10	10	15	<2	<10	20	<1	<1	20	<500	<50
449	>10,000	<200	700	700	150	<20	30	30	<10	10	10	<2	<10	50	<1	<1	20	<500	<50
450	1,000	<200	100	10	200	<20	<2	10	50	<5	30	2	<10	<5	<1	2	20	<500	<50
451	1,500	<100	200	15	300	70	<30	5	5	<30	30	<3	<3	3	<.1	1	15	<100	<100
452	2,000	<100	500	50	70	<30	<30	<.3	<1	<30	10	<3	<3	10	<.1	<1	10	<100	<100
453	5,000	<200	1,000	150	50	<20	20	30	<10	7	10	<2	<10	20	<1	<1	20	<500	<50
454	>10,000	<200	1,000	500	300	<20	70	30	<10	15	15	<2	<10	50	<1	<1	30	<500	<50
455	2,000	<200	1,000	70	50	20	15	20	30	5	20	<2	<10	10	<1	<1	15	<500	<50
456	2,000	<200	500	100	30	<20	15	20	15	10	10	<2	<10	15	<1	1	10	<500	<50
457	3,000	<200	1,000	150	70	100	20	50	10	5	10	<2	<10	20	<1	1	15	<500	<50
458	>10,000	<200	500	500	>1,000	<20	100	100	50	10	30	<2	<10	7	2	1	20	<500	<50
459	2,000	<200	700	100	70	20	15	30	<10	7	15	3	<10	20	<1	<1	20	<500	<50
460	2,000	<200	1,000	70	50	<20	10	15	10	5	15	2	<10	15	<1	1	15	<500	<50
461	3,000	<200	700	70	50	<20	15	30	10	7	10	2	<10	15	<1	1	15	<500	<50
462	2,000	<200	500	100	50	20	15	15	<10	10	10	<2	<10	15	<1	<1	15	<500	<50
463	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
464	3,000	<200	500	70	100	<20	15	30	10	10	10	2	<10	15	<1	<1	15	<500	<50
465	2,000	<200	500	50	50	20	10	30	15	10	10	<2	<10	10	<1	<1	10	<500	<50
466	3,000	<200	500	70	70	<20	15	20	<10	7	10	<2	<10	15	<1	<1	15	<500	<50
467	3,000	<200	700	100	70	<20	20	30	10	7	10	<2	<10	15	<1	<1	15	<500	<50
468	2,000	<200	500	100	70	<20	15	50	20	5	20	<2	<10	15	<1	<1	20	<500	<50
469	2,000	<200	500	70	50	30	15	15	10	7	10	<2	<10	15	<1	<1	15	<500	<50
470	3,000	<200	700	100	100	20	20	30	15	10	15	<2	<10	10	<1	<1	15	<500	<50
471	3,000	<200	1,000	150	70	<20	20	20	10	5	10	2	<10	20	<1	<1	20	<500	<50
472	>10,000	<200	1,000	1,000	1,000	20	70	70	50	20	50	<2	<10	30	<1	1	30	<500	<50
473	2,000	<100	700	200	50	<30	<30	30	7	<30	15	<3	<3	20	<.1	<1	15	<100	<100
	Rattlesnake Creek drainage																		
474	2,000	<200	1,500	150	100	<20	20	30	15	10	10	<2	<10	15	<1	<1	20	<500	<50
475	2,000	<200	700	100	30	<20	20	20	<10	10	7	<2	<10	15	<1	<1	10	<500	<50
476	2,000	<200	700	70	50	<20	15	15	10	5	7	<2	<10	15	<1	<1	10	<500	<50
	Soda Creek drainage																		
477	3,000	<200	200	100	50	<20	15	70	10	10	10	<2	<10	15	<1	<1	15	<500	<50
478	10,000	<200	700	300	700	20	70	30	<10	15	10	<2	<10	20	<1	<1	20	<500	<50
	Rock Creek drainage																		
479	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
480	5,000	<200	700	100	70	<20	15	30	<10	70	7	<2	<10	10	<.5	<1	20	<200	<100
481	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
482	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
483	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
484	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
485	7,000	<200	700	150	70	<20	30	150	<10	20	10	<2	<10	20	<.5	<1	20	<200	<100
486	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
487	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
488	3,000	<100	300	70	70	<30	<30	20	<1	<30	15	<3	<3	7	<.1	1	10	<100	<100
489	3,000	<100	700	70	150	<30	50	50	<1	30	15	<3	<3	10	<.1	1	15	<100	<100
490	20,000	<100	1,500	300	1,500	70	30	15	<1	<30	50	<3	<3	50	<.1	<1	20	<100	<100
491	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
492	500	<100	500	30	30	<30	<30	10	<1	50	10	<3	<3	<1	<.1	<1	7	<100	<100
493	2,000	<200	500	100	50	<20	10	30	<10	7	7	2	<10	15	<1	<1	15	<500	<50
494	>10,000	<200	1,000	1,000	500	20	70	30	<10	20	20	<2	<10	30	<1	<1	30	<500	<50

fresh and altered rocks in the Pasayten Wilderness Area, Washington—Continued

	Semiquantitative spectrographic analyses--Continued							Chemical analyses				
	(ppm)				(percent)			(ppm)				
Sample	Sc	Cr	Ba	Sr	Fe	Mg	Ca	cxHM	cxCu	Au	Mo	Sample description 1/
							Robinson Creek drainage--Continued					
440	10	50	300	300	3	1	1.5	4	1	-----	---	Active stream sediment.
441	5	20	300	300	3	1	1.5	4	2	-----	---	Do.
442	<5	5	300	150	2	.2	.02	-----	-----	-----	---	Limonitic plagioclase porphyry.
443	7	15	300	500	2	1	2	5	1.5	-----	---	Active stream sediment
444	7	70	300	500	5	1.5	1	1	11	-----	---	Do.
445	7	30	300	500	5	1.5	1	3	11	-----	---	Do.
446	7	30	300	500	2	1	1.5	3	-----	-----	---	Do.
447	20	200	200	500	20	1.5	1.5	-----	-----	-----	---	Panned concentrate.
448	7	70	300	700	5	1.5	1.5	2	3	-----	---	Active stream sediment.
449	20	300	200	300	>20	2	1.5	-----	-----	-----	---	Panned concentrate.
450	5	5	200	<50	2	.1	.1	-----	-----	-----	---	Limonitic qtz feldspar.
451	5	5	1,500	100	1.5	.15	1	-----	-----	-----	---	Quartz porphyry dike.
452	7	30	500	1,000	2	2	1.5	-----	-----	-----	---	Plagioclase porphyry flow.
453	10	70	300	700	7	1.5	1	2	4	-----	---	Active stream sediment.
454	15	150	200	300	>20	2	1.5	-----	-----	-----	---	Panned concentrate.
455	7	20	300	300	3	1	2	3	.5	-----	---	Active stream sediment.
456	10	30	300	300	3	1	1.5	3	6	-----	---	Do.
457	10	30	300	300	7	1.5	1	1	<.5	-----	---	Do.
458	10	700	700	200	>20	1	1	-----	-----	-----	---	Panned concentrate.
459	10	50	500	300	5	1.5	1	4	4	-----	---	Active stream sediment.
460	7	50	500	300	5	1	2	4	1	-----	---	Do.
461	7	50	300	300	5	1	1	2	3	-----	---	Do.
462	10	50	300	300	3	1.5	1	.5	4	-----	---	Do.
463	--	---	-----	-----	-----	-----	-----	1	<.5	-----	---	Do.
464	7	50	300	300	5	1	1	1	3	-----	---	Do.
465	5	20	300	300	2	.7	1.5	1	6	-----	---	Do.
466	7	30	300	300	5	1	1.5	1	3	-----	---	Do.
467	10	50	300	200	5	1	1.5	1	6	-----	---	Do.
468	10	30	300	700	5	1.5	2	1	7	-----	---	Do.
469	5	20	300	300	3	1	1	1	4	-----	---	Do.
470	10	5	500	700	7	1.5	1	-----	-----	-----	---	Panned concentrate.
471	10	70	300	300	5	1	1	1	6	-----	---	Active stream sediment.
472	10	1,000	200	200	>20	1	1	-----	-----	-----	---	Panned concentrate.
473	20	10	300	500	7	1.5	5	-----	-----	-----	---	Tuff.
							Rattlesnake Creek drainage					
474	10	50	300	200	5	1	.7	1	3	-----	---	Active stream sediment.
475	7	50	300	200	5	1	.5	1	4	-----	---	Do.
476	7	30	300	200	2	.7	1	.5	4	-----	---	Do.
							Soda Creek drainage					
477	10	30	300	300	2	1	.7	.5	1	-----	---	Active stream sediment.
478	10	200	300	500	10	1.5	.7	-----	-----	-----	---	Panned concentrate.
							Rock Creek drainage					
479	--	---	-----	-----	-----	-----	-----	2	22	-----	---	Active stream sediment.
480	10	30	1,000	1,000	5	.7	1.5	1	3	<.1	10	Do.
481	--	---	-----	-----	-----	-----	-----	5	11	-----	---	Do.
482	--	---	-----	-----	-----	-----	-----	5	20	-----	15	Do.
483	--	---	-----	-----	-----	-----	-----	3	15	-----	10	Do.
484	--	---	-----	-----	-----	-----	-----	-----	15	-----	---	Do.
485	10	150	2,000	1,000	7	1.5	2	20	50	<.1	7	Do.
486	--	---	-----	-----	-----	-----	-----	10	20	-----	7	Do.
487	--	---	-----	-----	-----	-----	-----	4	7	-----	---	Do.
488	10	70	1,000	300	3	.7	3	-----	-----	-----	---	Lim qtz di; qtz veinlets.
489	10	150	700	100	3	.15	.3	-----	-----	-----	---	Lim. qtz feldspar por dike.
490	20	500	150	100	M	.3	3	-----	-----	-----	---	Panned concentrate.
491	--	---	-----	-----	-----	-----	-----	22	30	-----	---	Active stream sediment.
492	5	10	200	300	2	1.5	7	-----	-----	-----	---	Lim breccia in ark and argillite.
493	5	30	300	300	2	1	1.5	.5	4	-----	---	Active stream sediment.
494	15	700	150	200	>20	1	1	-----	-----	-----	---	Panned concentrate.

TABLE 1.—*Analyses of samples from stream sediments, panned concentrates, and*

Semiquantitative spectrographic analyses (ppm)

Sample	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co	Ag	Be	Ga	As	Sb
								Kid Creek drainage											
495	3,000	<100	300	70	150	<30	<30	50	<1	<30	15	<3	<3	5	<.1	<1	10	<100	<100
496	700	<200	1,000	30	10	<20	7	15	10	20	10	<2	<10	10	<1	<1	15	<500	<50
								Shaw Creek drainage											
497	3,000	<200	700	70	50	<20	10	20	10	30	10	<2	<10	15	<1	1	10	<500	<50
498	5,000	200	700	150	50	<20	20	50	10	30	10	<2	<10	20	<1	<1	15	<500	<50
499	5,000	<200	700	100	70	<20	15	30	<10	50	10	<2	<10	15	<1	<1	20	<500	<50
500	>10,000	<200	1,000	200	500	30	10	20	<10	7	5	<2	<10	30	<1	<1	20	<500	<50
								West Fork of the Pasayten River drainage											
501	5,000	<200	700	150	70	<20	15	30	15	5	5	<2	<10	15	<1	<1	15	<500	<50
502	2,000	<200	1,000	100	50	20	20	20	15	5	10	<2	<10	15	<1	<1	10	<500	<50
503	2,000	<200	700	70	30	<20	15	15	10	5	5	<2	<10	15	<1	<1	10	<500	<50
504	>10,000	<200	1,000	300	200	<20	50	30	<10	15	15	<2	<10	50	<1	<1	30	<500	<50
505	300	<100	70	<1	100	<30	<30	2	7	<30	30	<3	7	<1	<.1	1	20	<100	<100
506	3,000	<100	1,000	100	100	<30	<30	20	10	<30	15	<3	<3	7	<.1	<1	15	<100	<100
507	2,000	<100	300	50	70	<30	<30	7	5	<30	<3	<3	<3	7	<.1	<1	10	<100	<100
508	3,000	<200	1,000	70	50	<20	15	20	<10	7	7	<2	<10	15	<1	<1	10	<500	<50
509	2,000	<200	300	50	50	<20	10	15	10	5	5	<2	<10	<10	<1	<1	10	<500	<50
510	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
511	3,000	<200	700	70	50	<20	15	15	<10	5	10	<2	<10	15	<1	<1	15	<500	<50
512	>10,000	<200	700	300	150	20	30	20	<10	15	15	<2	<10	20	<1	<1	30	<500	<50
513	3,000	<200	300	50	50	<20	15	15	10	10	7	<2	<10	10	<1	<1	10	<500	<50
514	10,000	<200	700	300	150	<20	15	30	10	10	10	<2	<10	15	<1	<1	20	<500	<50
515	1,500	<200	300	50	30	<20	15	20	<10	7	7	<2	<10	10	<1	<1	10	<500	<50
516	2,000	<200	500	100	50	<20	10	30	10	5	10	<2	<10	10	<1	<1	15	<500	<50
517	>10,000	<200	1,500	1,000	500	20	70	30	<10	20	20	<2	<10	30	<1	<1	30	<500	<50
518	1,500	<200	150	50	70	<20	10	20	<10	7	5	3	<10	10	<1	<1	10	<500	<50
519	3,000	<200	500	100	70	20	10	20	10	10	10	<2	<10	10	<1	<1	15	<500	<50
520	3,000	<200	300	100	50	<20	15	30	10	10	10	<2	<10	15	<1	<1	15	<500	<50
521	2,000	<200	500	70	50	<20	10	10	<10	5	5	<2	<10	15	<1	<1	10	<500	<50
522	10,000	<200	1,000	200	150	30	15	20	<10	10	15	<2	<10	15	<1	<1	10	<500	<50
								Pasayten River drainage											
523	3,000	<200	300	100	70	<20	10	10	10	5	10	<2	<10	10	<1	1	15	<500	<50
524	1,500	<200	200	50	20	<20	10	30	10	7	5	<2	<10	5	<1	<1	15	<500	<50
525	10,000	<200	1,000	200	200	150	5	20	<10	7	20	<2	<10	15	<1	<1	15	<500	<50
526	7,000	<200	700	150	150	70	5	20	10	10	15	<2	<10	10	<1	<1	20	<500	<50
527	>10,000	<200	1,000	300	500	100	20	20	<10	15	20	<2	<10	15	<1	<1	20	<500	<50
								Tamarack Peak area											
528	2,000	<200	700	100	30	<20	20	3,000	50	5	10	70	<10	20	15	<1	20	<500	<50
529	2,000	<200	150	70	50	<20	5	2,000	10	10	10	<2	<10	15	1	<1	15	<500	<50
530	1,500	<200	500	70	70	20	7	20	<10	10	10	<2	<10	5	<1	1	15	<500	<50
531	2,000	<200	300	70	100	20	5	70	15	50	10	<2	20	7	1	1	15	<500	<50
532	2,000	<200	700	50	50	20	10	30	10	10	10	<2	<10	10	<1	<1	10	<500	<50
533	2,000	<200	700	70	30	<20	10	30	15	70	7	<2	<10	7	<1	1	15	<500	<50
534	1,500	<100	1,500	70	70	<30	<30	30	<1	<30	<3	<3	<3	7	<.1	<1	15	<100	<100
535	2,000	<100	1,000	200	70	<30	100	100	<1	<30	10	<3	<3	15	<.1	<1	15	<100	<100
								Frosty Creek drainage											
536	3,000	<100	500	50	150	<30	30	20	<1	70	<3	<3	<3	7	<.1	1	15	<100	<100
537	3,000	<200	700	100	50	<20	15	20	70	30	5	<2	<10	15	1	<1	20	<500	<50
538	>10,000	<200	1,000	500	300	<20	30	70	10	15	10	<2	<10	50	<1	<1	30	<500	<50
								Chuchuwanteen Creek drainage											
539	5,000	<200	700	100	70	<20	30	30	15	70	<5	<2	<10	15	<1	<1	20	<500	<50
540	3,000	<200	1,500	150	50	<20	20	30	10	10	10	<2	<10	15	<1	<1	15	<500	<50
541	>10,000	<200	1,000	300	150	<20	20	30	<10	10	10	<2	<10	30	<1	<1	20	<500	<50
542	2,000	<200	1,000	100	50	<20	10	30	<10	7	5	<2	<10	10	<1	<1	10	<500	<50
543	2,000	<200	700	150	70	20	20	30	<10	10	10	<2	<10	15	<1	<1	15	<500	<50

fresh and altered rocks in the Pasayten Wilderness Area, Washington—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Sc	Cr	Ba	Sr	(percent) Fe	Mg	Ca	Chemical analyses (ppm) cxHM	cxCu	Au	Mo	Sample description 1/
Kid Creek drainage												
495	15	70	500	300	3	1	1.5	-----	-----	-----	---	Sheared limonitic arkose.
496	<5	10	1,000	200	1.5	.5	5	-----	-----	-----	---	Limonitic quartz diorite.
Shaw Creek drainage												
497	10	20	300	100	5	.1	.2	-----	-----	-----	---	Limonitic sheared arkose.
498	10	50	300	100	7	.1	.05	-----	-----	-----	---	Limonitic arkose.
499	10	70	700	200	7	.5	.2	-----	-----	-----	---	Do.
500	10	30	200	300	15	1.5	.7	-----	-----	-----	---	Panned concentrate.
West Fork of the Pasayten River drainage												
501	5	30	300	500	3	1	2	3	.5	-----	---	Active stream sediment.
502	7	30	300	300	3	1.5	2	4	.5	-----	---	Do.
503	5	20	300	300	2	1	2	3	<.5	-----	---	Do.
504	15	150	300	500	15	2	1	-----	-----	-----	---	Panned concentrate.
505	<1	3	150	50	.5	.01	.03	-----	-----	-----	---	Quartz feldspar porphyry dike.
506	10	20	500	700	3	1.5	3	-----	-----	-----	---	Plagioclase porphyry dike.
507	5	30	700	500	1.5	1	2	-----	-----	-----	---	Quartz diorite.
508	7	30	300	500	3	1.5	2	1	2	-----	---	Active stream sediment.
509	5	20	300	300	2	1	2	9	-----	-----	---	Do.
510	--	---	-----	-----	-----	-----	-----	1	.5	-----	---	Do.
511	5	15	300	500	2	1.5	3	4	<.5	-----	---	Do.
512	20	300	300	700	15	1.5	1.5	-----	-----	-----	---	Panned concentrate.
513	7	30	300	500	2	.7	1.5	.5	2	-----	---	Active stream sediment.
514	10	50	300	700	7	1.5	1.5	-----	-----	-----	---	Panned concentrate.
515	7	20	300	300	1.5	.7	1.5	.5	2	-----	---	Active stream sediment.
516	5	20	300	500	2	1	2	1	3	-----	---	Do.
517	20	1,500	200	300	>20	1.5	1.5	-----	-----	-----	---	Panned concentrate.
518	5	20	500	700	1.5	.5	1.5	1	4	-----	---	Active stream sediment.
519	7	30	500	500	2	.7	1.5	1	6	-----	---	Do.
520	5	30	300	500	3	1	2	.5	6	-----	---	Do.
521	5	20	300	500	2	1	1.5	.5	3	-----	---	Do.
522	15	150	300	500	7	1.5	1.5	-----	-----	-----	---	Panned concentrate.
Pasayten River drainage												
523	7	30	300	700	3	1	1.5	.5	4	-----	---	Active stream sediment.
524	5	15	300	500	1.5	.7	1	.5	3	-----	---	Do.
525	15	15	300	500	7	1.5	2	-----	-----	-----	---	Panned concentrate.
526	10	10	300	700	5	1	1.5	-----	-----	-----	---	Do.
527	15	20	300	500	10	.7	1.5	-----	-----	-----	---	Do.
Tamarack Peak area												
528	7	20	200	70	10	1	.1	-----	-----	-----	---	Limonitic arkose.
529	5	20	500	500	3	.7	.2	-----	-----	-----	---	Malachite azurite in lim seams.
530	5	10	200	300	2	.2	.7	-----	-----	-----	---	Limonitic arkose.
531	5	20	50	200	2	.2	.2	-----	-----	-----	---	Limonitic shear zone in arkose.
532	<5	20	300	300	2	.7	1	-----	-----	-----	---	Limonitic arkose.
533	5	20	500	200	2	.2	1	-----	-----	-----	---	Limonitic seams in arkose.
534	7	15	700	500	3	1	1.5	-----	-----	-----	---	Altered (sericitized) por dike.
535	15	200	1,000	700	5	2	2	-----	-----	-----	---	Plagioclase porphyry dike.
Frosty Creek drainage												
536	7	70	700	200	3	.2	.2	-----	-----	-----	---	Lim feldspar porphyry dike.
537	7	100	300	500	5	.7	1	-----	-----	-----	---	Limonitic arkose.
538	20	1,500	500	150	15	2	1	-----	-----	-----	---	Panned concentrate.
Chuchuwanteen Creek drainage												
539	7	150	300	200	7	.3	.05	-----	-----	-----	---	Limonitic arkose.
540	7	30	300	500	7	2	2	5	1	-----	---	Active stream sediment.
541	20	200	300	300	10	3	1.5	-----	-----	-----	---	Panned concentrate.
542	5	20	300	500	5	1.5	2	3	3	-----	---	Active stream sediment.
543	7	50	300	500	5	1.5	1.5	3	3	-----	---	Do.

TABLE 1.—*Analyses of samples from stream sediments, panned concentrates, and*

Semiquantitative spectrographic analyses (ppm)

Sample	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co	Ag	Be	Ga	As	Sb
Chuchuwanteen Creek drainage--Continued																			
544	3,000	<200	700	70	50	<20	10	20	<10	7	7	<2	<10	10	<1	1	15	<500	<50
545	3,000	<200	1,000	150	50	<20	20	70	15	15	15	<2	<10	20	<1	<1	15	<500	<50
546	3,000	<200	700	100	50	<20	15	30	10	10	10	<2	<10	15	<1	<1	10	<500	<50
547	2,000	<200	700	100	50	<20	15	30	10	10	10	<2	<10	10	<1	<1	10	<500	<50
548	3,000	<200	700	70	50	<20	15	20	<10	10	7	<2	<10	15	<1	<1	10	<500	<50
549	>10,000	<200	1,000	300	150	<20	20	30	<10	10	10	<2	<10	30	<1	<1	20	<500	<50
550	2,000	<200	500	100	50	<20	15	20	10	15	7	<2	<10	15	<1	<1	15	<500	<50
Castle Creek drainage																			
551	30,000	<100	2,000	200	2,000	500	30	7	<1	<30	70	<3	<3	20	<.1	<1	15	<100	<100
Slate Creek drainage																			
552	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
553	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
554	2,000	<200	700	100	30	<20	15	50	20	5	5	<2	<10	15	<1	<1	15	<500	<50
555	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
556	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
557	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
558	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
559	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
North Canyon Creek drainage																			
560	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
561	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	----	---
562	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
563	2,000	<100	700	50	70	<30	50	50	<1	<30	10	<3	<3	7	<.1	<1	7	<100	<100
564	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
565	2,000	<100	500	70	70	<30	150	150	<1	<30	10	<3	<3	15	<.1	1	10	<100	<100
566	2,000	<100	500	50	70	<30	<30	50	<1	30	10	7	<3	<1	<.1	1	7	<100	<100
567	3,000	<200	1,000	200	50	<20	50	50	10	15	15	<2	<10	20	<1	1	15	<500	<50
Cascade Creek drainage																			
568	>10,000	<200	3,000	200	100	<20	70	100	<10	20	10	<2	<10	5	<.5	<1	20	<200	<100
569	10,000	<200	1,000	150	50	<20	30	100	<10	10	10	<2	<10	5	<.5	<1	20	<200	<100
570	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
571	3,000	<200	1,500	150	50	<20	30	50	10	10	10	<2	<10	20	<1	<1	15	<500	<50
572	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
Canyon Creek drainage																			
573	3,000	<100	500	50	70	<30	30	100	<1	<30	10	<3	<3	7	<.1	<1	10	<100	<100
574	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
575	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
576	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
577	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
578	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
579	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
580	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
581	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
582	1,000	<100	700	50	30	<30	<30	100	<1	<30	10	<3	<3	7	<.1	<1	7	<100	<100
583	700	<100	70	50	50	<30	70	500	10	<30	15	50	<3	30	1.5	<1	7	<100	<100
584	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
585	5,000	<200	500	200	NR	<20	15	100	<10	NR	20	<2	<10	15	<.5	<1	NR	<200	<100
586	5,000	<200	500	200	100	<20	20	100	15	20	20	<2	<10	5	<.5	<1	20	<200	<100
587	3,000	<200	500	100	100	<20	20	20	15	30	10	<2	<10	5	<.5	<1	20	<200	<100
588	5,000	<200	300	100	150	<20	20	70	15	10	15	<2	<10	10	<.5	<1	20	<200	<100
589	1,500	<100	700	70	50	<30	<30	700	<1	<30	10	7	<3	150	1	<1	15	<100	<100
590	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
591	5,000	<200	500	300	70	<20	70	100	30	20	15	<2	<10	15	<.5	<1	20	<200	<100
592	7,000	<200	700	300	50	<20	50	200	<10	20	10	<2	<10	30	<.5	<1	20	<200	<100
593	5,000	<200	1,000	200	70	<20	70	100	50	20	10	<2	<10	30	<.5	<1	20	<200	<100

fresh and altered rocks in the Pasayten Wilderness Area, Washington—Continued

	Semiquantitative spectrographic analyses--Continued							Chemical analyses				
	(ppm)				(percent)			(ppm)				
Sample	Sc	Cr	Ba	Sr	Fe	Mg	Ca	cxHM	cxCu	Au	Mo	Sample description 1/
						Chuchuwanteen Creek drainage--Continued						
544	5	20	300	500	5	1	1.5	3	1.5	-----	---	Active stream sediment.
545	7	30	500	300	7	1	1	3	6	-----	---	Do.
546	5	30	300	30	5	1	1	2	4	-----	---	Do.
547	7	20	300	500	5	1	1.5	1	4	-----	---	Do.
548	7	30	300	500	3	.7	1.5	1	3	-----	---	Do.
549	15	100	200	200	10	2	1	-----	-----	-----	---	Panned concentrate.
550	7	30	300	500	5	1	1.5	2	3	-----	---	Active stream sediment.
						Castle Creek drainage						
551	30	700	200	150	M	.2	3	-----	-----	-----	---	Panned concentrate.
						Slate Creek drainage						
552	--	---	-----	-----	-----	-----	-----	3	60	-----	---	Active stream sediment.
553	--	---	-----	-----	-----	-----	-----	1	11	-----	---	Do.
554	5	20	300	300	3	1	1	4	11	-----	---	Do.
555	--	---	-----	-----	-----	-----	-----	7	7	-----	---	Do.
556	--	---	-----	-----	-----	-----	-----	9	22	-----	---	Soil sample below Tacoma vein.
557	--	---	-----	-----	-----	-----	-----	2	3	-----	---	Active stream sediment.
558	--	---	-----	-----	-----	-----	-----	7	6	-----	---	Do.
559	--	---	-----	-----	-----	-----	-----	2	<.5	-----	---	Do.
						North Canyon Creek drainage						
560	--	---	-----	-----	-----	-----	-----	1	<.5	-----	---	Active stream sediment.
561	--	---	-----	-----	-----	-----	-----	2	.5	-----	---	Do.
562	--	---	-----	-----	-----	-----	-----	1	<.5	-----	---	Do.
563	15	100	300	300	5	2	10	-----	-----	-----	---	Lim ark; calcite veinlets.
564	--	---	-----	-----	-----	-----	-----	2	1	-----	---	Active stream sediment.
565	30	700	200	500	5	2	7	-----	-----	-----	---	Limonitic arkose.
566	7	30	300	200	3	.3	1	-----	-----	-----	---	Do.
567	10	150	300	200	7	2	1.5	2	11	-----	---	Active stream sediment.
						Cascade Creek drainage						
568	20	700	700	100	10	.5	2	-----	-----	<.1	---	Limonitic conglomerate.
569	10	500	700	700	7	3	10	-----	-----	-----	---	Limonitic arkose.
570	--	---	-----	-----	-----	-----	-----	10	3	-----	5	Active stream sediment.
571	10	70	300	300	7	2	2	3	2	-----	---	Do.
572	--	---	-----	-----	-----	-----	-----	3	6	-----	---	Do.
						Canyon Creek drainage						
573	10	50	300	200	5	1.5	1	2	3	-----	---	Active stream sediment.
574	--	---	-----	-----	-----	-----	-----	7	1.5	-----	2	Do.
575	--	---	-----	-----	-----	-----	-----	2	6	-----	<2	Do.
576	--	---	-----	-----	-----	-----	-----	7	<.5	-----	2	Do.
577	--	---	-----	-----	-----	-----	-----	7	1	-----	2	Do.
578	--	---	-----	-----	-----	-----	-----	7	7	-----	4	Do.
579	--	---	-----	-----	-----	-----	-----	11	11	-----	<2	Do.
580	--	---	-----	-----	-----	-----	-----	3	<.5	-----	---	Do.
581	--	---	-----	-----	-----	-----	-----	9	11	-----	---	Do.
582	10	50	1,000	300	5	1	7	-----	-----	-----	---	Limonitic brecciated arkose.
583	10	50	150	50	7	.3	10	-----	-----	-----	---	Lim arkose; sparse pyrite.
584	--	---	-----	-----	-----	-----	-----	20	45	-----	---	Active stream sediment.
585	NR	50	700	500	5	2	2	-----	-----	<.5	---	Lim arkose; disseminated pyrite.
586	20	100	1,000	700	7	1.5	1	-----	-----	<.1	---	Lim argillite; disseminated py.
587	7	15	300	700	5	1.5	1.5	-----	-----	<.1	---	Lim arkose; disseminated pyrite.
588	10	30	1,000	1,000	7	1.5	2	-----	-----	<.1	---	Arkose with disseminated pyrite.
589	7	70	70	100	>10	.2	10	-----	-----	-----	---	Lim feldspar por dike; pyrite.
590	--	---	-----	-----	-----	-----	-----	5	<.5	-----	---	Active stream sediment.
591	15	150	700	1,000	7	1.5	1	-----	-----	<.1	---	Lim qtzte; sparse pyrite.
592	30	200	500	1,500	7	1	2	-----	-----	<.1	---	Do.
593	20	150	300	1,000	7	1	2	-----	-----	.7	---	Do.

TABLE 1.—*Analyses of samples from stream sediments, panned concentrates, and*

Semiquantitative spectrographic analyses (ppm)

Sample	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co	Ag	Be	Ga	As	Sb
								Canyon Creek drainage--Continued											
594	5,000	<200	500	200	50	50	20	70	<10	50	10	<2	<10	20	<.5	<1	30	<200	<100
595	5,000	<200	700	200	50	<20	15	100	10	70	10	<2	<10	20	<.5	1	50	<200	<100
596	3,000	<200	1,000	300	20	<20	20	300	<10	20	10	<2	<10	20	<.5	<1	30	<200	<100
597	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
598	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
599	3,000	<200	1,500	150	NR	<20	15	150	10	NR	20	<2	<10	15	<.5	<1	NR	<200	<100
600	5,000	<200	300	150	70	<20	20	200	<10	20	10	<2	<10	15	<.5	<1	30	<200	<100
601	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
602	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
603	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
604	10,000	<200	500	1,000	30	<20	20	<5	<10	70	10	<2	<10	<5	<.5	<1	30	<200	<100
605	10,000	<200	700	150	50	<20	20	5	<10	10	10	<2	<10	<5	<.5	<1	50	<200	<100
606	10,000	<200	700	100	30	<20	5	100	<10	10	15	<2	<10	<5	<.5	<1	30	<200	<100
607	10,000	<200	1,000	150	50	<20	20	5	<10	10	15	<2	<10	<5	<.5	<1	30	<200	<100
608	10,000	<200	1,000	500	70	<20	10	200	<10	20	15	<2	<10	<5	<.5	<1	20	<200	<100
609	5,000	<200	700	150	50	<20	10	100	<10	30	15	<2	<10	<5	<.5	<1	20	<200	<100
610	7,000	<200	500	200	70	<20	10	200	<10	30	15	<2	<10	<5	<.5	<1	20	<200	<100
611	5,000	<200	700	200	50	<20	10	150	<10	20	15	<2	<10	<5	<.5	<1	20	<200	<100
612	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
613	5,000	<200	700	150	50	<20	5	150	<10	20	15	<2	<10	<5	<.5	<1	20	<200	<100
614	5,000	<200	500	500	50	<20	10	100	<10	20	10	<2	<10	<5	<.5	<1	30	<200	<100
615	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
616	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
								Ruby Creek drainage											
617	3,000	<200	1,000	20	70	<20	30	150	10	70	15	20	<10	20	<.5	<1	20	<200	<100
618	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
								Crater Creek drainage											
619	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
620	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
621	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
622	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
623	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
624	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
625	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
626	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
627	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
628	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
629	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
630	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
								Roland Creek drainage											
631	100	<200	700	20	<10	100	3,000	10	<10	50	<5	<2	<10	50	<.5	<1	50	<200	<100
632	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
633	10,000	<200	1,000	150	70	<20	10	70	<10	30	15	<2	<10	5	<.5	<1	20	<200	<100
634	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
635	10,000	<200	700	300	70	<20	10	200	<10	<10	15	<2	<10	<5	<.5	<1	20	<200	<100
636	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
637	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
638	10,000	<200	300	200	50	<20	10	200	<10	100	15	<2	<10	<5	<.5	<1	30	<200	<100
639	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
640	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
641	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	----	---
								May Creek drainage											
642	5,000	<200	1,000	100	50	<20	150	500	10	20	10	3	<10	100	<.5	<1	15	<200	<100
643	5,000	<200	1,000	100	200	<20	20	200	<10	<10	70	3	<10	20	<.5	<1	20	<200	<100
644	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
645	10,000	<200	500	50	30	<20	2	10	<10	30	50	<2	<10	<5	1	<1	30	<200	<100

fresh and altered rocks in the Pasayten Wilderness Area, Washington—Continued

Sample	Semiquantitative spectrographic analyses--Continued							Chemical analyses				Sample description [1]
	(ppm)				(percent)			(ppm)				
	Sc	Cr	Ba	Sr	Fe	Mg	Ca	cxHM	cxCu	Au	Mo	
						Canyon Creek drainage--Continued						
594	20	100	700	1,000	7	1	1	-----	-----	.1	---	Limonitic bleached quartzite.
595	20	50	700	2,000	7	1.5	2	-----	-----	<.1	---	Lim qtzte; sparse pyrite.
596	30	100	300	1,500	10	3	5	-----	-----	<.1	---	Lim hornblende di; pyrite.
597	--	---	-----	-----	-----	-----	-----	5	20	-----	5	Active stream sediment.
598	--	---	-----	-----	-----	-----	-----	3	20	-----	2	Do.
599	NR	50	150	500	7	1.5	7	-----	-----	<.05	---	Lim qtzte and breccia; pyrite.
600	15	100	300	700	7	1.5	1.5	-----	-----	<.1	---	Do.
601	--	---	-----	-----	-----	-----	-----	15	15	-----	3	Active stream sediment.
602	--	---	-----	-----	-----	-----	-----	3	10	-----	3	Do.
603	--	---	-----	-----	-----	-----	-----	3	20	-----	<2	Do.
604	20	200	2,000	1,000	10	1	1.5	-----	-----	<.1	---	Limonitic argillite.
605	15	200	700	500	10	1	10	-----	-----	<.1	---	Lim argillite; sparse pyrite.
606	15	150	700	500	10	1	10	-----	-----	.1	---	Lim argillite and arkose; py.
607	10	200	1,000	500	10	1	10	-----	-----	<.1	---	Do.
608	20	100	1,000	300	10	1	10	-----	-----	<.1	---	Do.
609	20	100	1,000	500	10	1	5	-----	-----	<.1	---	Limonitic argillite; sul.
610	20	100	1,500	200	15	1	2	-----	-----	<.1	---	Do.
611	20	100	1,000	200	10	.5	2	-----	-----	<.1	---	Limonitic argillite.
612	--	---	-----	-----	-----	-----	-----	10	10	-----	3	Active stream sediment.
613	20	100	1,000	500	10	1	10	-----	-----	.1	---	Limonitic argillite.
614	30	200	1,000	500	7	.5	2	-----	-----	<.1	---	Do.
615	--	---	-----	-----	-----	-----	-----	3	7	-----	<2	Active stream sediment.
616	--	---	-----	-----	-----	-----	-----	7	10	-----	3	Do.
							Ruby Creek drainage					
617	30	50	300	500	10	1.5	5	-----	-----	<.1	---	Lim massive arkose; sc sul.
618	--	---	-----	-----	-----	-----	-----	7	2	-----	<2	Active stream sediment.
							Crater Creek drainage					
619	--	---	-----	-----	-----	-----	-----	3	20	-----	<2	Active stream sediment.
620	--	---	-----	-----	-----	-----	-----	3	20	-----	5	Do.
621	--	---	-----	-----	-----	-----	-----	3	10	-----	<2	Do.
622	--	---	-----	-----	-----	-----	-----	10	20	-----	<2	Do.
623	--	---	-----	-----	-----	-----	-----	2	7	-----	<2	Do.
624	--	---	-----	-----	-----	-----	-----	7	20	-----	<2	Do.
625	--	---	-----	-----	-----	-----	-----	3	10	-----	2	Do.
626	--	---	-----	-----	-----	-----	-----	7	5	-----	<2	Do.
627	--	---	-----	-----	-----	-----	-----	10	1	-----	2	Do.
628	--	---	-----	-----	-----	-----	-----	20	2	-----	3	Do.
629	--	---	-----	-----	-----	-----	-----	7	15	-----	2	Do.
630	--	---	-----	-----	-----	-----	-----	1.5	10	-----	2	Do.
							Roland Creek drainage					
631	<5	5,000	<5	<50	15	10	.05	-----	-----	<.1	---	Limonitic phyllite.
632	--	---	-----	-----	-----	-----	-----	30	15	-----	3	Active stream sediment.
633	30	100	2,000	500	15	.7	2	-----	-----	<.1	---	Limonitic phyllite.
634	--	---	-----	-----	-----	-----	-----	10	20	-----	2	Active stream sediment.
635	20	100	1,000	700	7	1	2	-----	-----	<.1	---	Limonitic phyllite.
636	--	---	-----	-----	-----	-----	-----	20	15	-----	5	Active stream sediment.
637	--	---	-----	-----	-----	-----	-----	10	15	-----	2	Do.
638	30	150	1,000	1,000	15	1	2	-----	-----	<.1	---	Limonitic phyllite.
639	--	---	-----	-----	-----	-----	-----	15	15	-----	5	Active stream sediment.
640	--	---	-----	-----	-----	-----	-----	15	20	-----	5	Do.
641	--	---	-----	-----	-----	-----	-----	10	15	-----	2	Do.
							May Creek drainage					
642	30	500	300	100	7	1.5	1.5	-----	-----	<.1	---	Lim sheared greenstone and chert.
643	50	30	150	100	7	1.5	1.5	-----	-----	<.1	---	Lim greenstone, sc sul.
644	--	---	-----	-----	-----	-----	-----	15	20	-----	5	Active stream sediment.
645	30	50	100	<50	15	.5	1.5	-----	-----	<.1	---	Lim greenstone; sc sul.

TABLE 1.—*Analyses of samples from stream sediments, panned concentrates, and*

	Semiquantitative spectrographic analyses (ppm)																		
Sample	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co	Ag	Be	Ga	As	Sb
May Creek drainage--Continued																			
646	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
647	10,000	<200	2,000	300	30	<20	150	300	<10	30	20	<2	<10	30	<.5	<1	20	<200	<100
648	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
649	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
649a	>10,000	<200	1,500	500	700	<20	500	300	10	100	30	<2	<10	100	1.5	<1	70	<200	<100
Devils Creek drainage																			
650	1,500	<200	1,000	300	15	<20	30	150	10	70	10	<2	<10	50	<.5	<1	15	<200	<100
651	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
652	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
653	10,000	<200	1,000	500	500	<20	100	70	<10	50	20	<2	<10	50	<.5	<1	50	<200	<100
654	>10,000	<200	1,000	500	1,000	<20	150	70	20	50	15	<2	<10	100	<.5	<1	>100	<200	<100
655	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
656	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
657	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
658	>10,000	<200	1,000	1,000	1,000	<20	300	70	<10	70	20	<2	<10	150	<.5	<1	100	<200	<100
659	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
660	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
661	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
662	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
663	3,000	<100	500	70	100	<30	<30	30	<1	<30	10	<3	<3	7	<.1	1	15	<100	<100
664	3,000	<100	500	30	200	<30	<30	50	<1	70	20	10	<3	10	<.1	1	15	<100	<100
665	3,000	<200	500	70	30	<20	30	10	<10	20	5	<2	<10	5	<.5	<1	20	<200	<100
666	30	<100	1,000	15	<3	<30	30	10	30	<30	10	<3	<3	<1	<.1	<1	<1	<100	<100
667	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
668	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
669	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
670	1,500	<100	700	100	15	<30	15	70	<1	200	15	<3	<3	30	<.1	<1	7	<100	<100
Big Face Creek drainage																			
671	3,000	<200	1,000	200	70	<20	30	100	15	100	20	<2	<10	10	<.5	<1	50	<200	<100
672	5,000	<200	1,000	200	70	<20	70	150	30	70	20	<2	<10	20	<.5	<1	15	<200	<100
Middle Creek drainage																			
673	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
674	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
675	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
676	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
677	1,500	700	1,000	100	100	<20	20	30	50	70	7	<2	<10	<5	<.5	<1	20	<200	<100
678	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
679	2,000	<200	1,000	150	70	<20	15	50	<10	20	7	<2	<10	5	<.5	<1	15	<200	<100
680	3,000	<200	1,000	200	70	<20	50	50	<10	10	10	<2	<10	7	<.5	<1	10	<200	<100
681	3,000	<200	1,000	150	70	<20	30	15	<10	10	7	<2	<10	5	<.5	<1	<10	<200	<100
682	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
683	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
684	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
685	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
685a	2,000	<200	500	100	NR	<20	30	1,500	30	NR	10	<2	<10	10	5	<1	NR	<200	<100
686	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
687	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
688	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
689	>10,000	<200	1,000	500	1,000	<20	100	200	20	50	30	<2	<10	150	<.5	<1	100	<200	<100
690	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
691	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
Grizzly Creek drainage																			
692	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
693	1,500	<100	1,000	70	70	<30	<30	15	<1	<30	15	<3	<3	10	<.1	<1	10	<100	<100
694	3,000	<100	1,000	70	70	<30	150	7	<1	<30	10	<3	<3	20	<.1	<1	10	<100	<100
695	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---

fresh and altered rocks in the Pasayten Wilderness Area, Washington—Continued

	Semiquantitative spectrographic analyses--Continued							Chemical analyses				
	(ppm)				(percent)			(ppm)				
Sample	Sc	Cr	Ba	Sr	Fe	Mg	Ca	cxHM	cxCu	Au	Mo	Sample description [1/]
							May Creek drainage--Continued					
646	--	---	-----	-----	-----	-----	-----	10	50	-----	5	Active stream sediment.
647	50	700	700	200	15	>10	15	-----	-----	<.1	---	Lim greenstone; sc pyrrhotite.
648	--	---	-----	-----	-----	-----	-----	10	50	-----	3	Active stream sediment.
649	--	---	-----	-----	-----	-----	-----	10	50	-----	2	Do.
649a	100	1,000	300	150	10	3	3	-----	-----	1.8	---	Panned concentrate.
							Devils Creek drainage					
650	50	70	15	<50	7	2	5	-----	-----	<.1	---	Limonitic greenstone.
651	--	---	-----	-----	-----	-----	-----	1.5	10	-----	<2	Active stream sediment.
652	--	---	-----	-----	-----	-----	-----	15	3	-----	2	Do.
653	70	1,000	70	100	10	2	2	-----	-----	<.1	---	Panned concentrate.
654	50	2,000	100	100	15	1.5	.5	-----	-----	<.1	---	Do.
655	--	---	-----	-----	-----	-----	-----	10	7	-----	2	Active stream sediment.
656	--	---	-----	-----	-----	-----	-----	2	7	-----	3	Do.
657	--	---	-----	-----	-----	-----	-----	2	7	-----	3	Do.
658	70	5,000	200	70	15	2	1.5	-----	-----	<.1	---	Panned concentrate.
659	--	---	-----	-----	-----	-----	-----	7	5	-----	---	Active stream sediment.
660	--	---	-----	-----	-----	-----	-----	5	15	-----	<2	Do.
661	--	---	-----	-----	-----	-----	-----	10	3	-----	2	Do.
662	--	---	-----	-----	-----	-----	-----	3	15	-----	5	Do.
663	15	30	500	300	5	.5	3	-----	-----	-----	---	Lim brecciated arkose.
664	20	30	1,000	100	5	.2	.15	-----	-----	-----	---	Do.
665	10	30	300	100	5	1	1	-----	-----	<.1	---	Lim hornblende plgc por dike.
666	<1	7	30	1,000	7	2	>10	-----	-----	-----	---	Limonitic argillite.
667	--	---	-----	-----	-----	-----	-----	7	3	-----	2	Active stream sediment.
668	--	---	-----	-----	-----	-----	-----	15	1	-----	5	Do.
669	--	---	-----	-----	-----	-----	-----	1.5	7	-----	---	Do.
670	50	70	1,000	100	5	2	5	-----	-----	-----	---	Lim greenstone and chert.
							Big Face Creek drainage					
671	30	200	1,000	300	7	2	1	-----	-----	<.1	---	Limonitic argillite.
672	20	150	100	300	7	1.5	1	-----	-----	<.1	---	Do.
							Middle Creek drainage					
673	--	---	-----	-----	-----	-----	-----	9	3	-----	2	Active stream sediment.
674	--	---	-----	-----	-----	-----	-----	11	3	-----	6	Do.
675	--	---	-----	-----	-----	-----	-----	>50	20	-----	2	Do.
676	--	---	-----	-----	-----	-----	-----	>50	10	-----	2	Do.
677	10	50	150	100	5	.5	.15	-----	-----	<.1	---	Limonitic breccia.
678	--	---	-----	-----	-----	-----	-----	20	3	-----	3	Active stream sediment.
679	15	50	150	300	5	1.5	.7	-----	-----	<.1	---	Lim argillite; sc sulfides.
680	20	150	150	150	5	2	.7	-----	-----	<.1	---	Do.
681	10	100	200	150	2	1.5	.7	-----	-----	<.1	---	Limonitic arkose.
682	--	---	-----	-----	-----	-----	-----	10	5	-----	2	Active stream sediment.
683	--	---	-----	-----	-----	-----	-----	10	5	-----	2	Do.
684	--	---	-----	-----	-----	-----	-----	50	20	-----	<2	Do.
685	--	---	-----	-----	-----	-----	-----	20	100	-----	2	Do.
685a	NR	70	300	100	5	.7	.15	-----	-----	-----	---	Ark and arg breccia with sul.
686	--	---	-----	-----	-----	-----	-----	10	3	-----	3	Active stream sediment.
687	--	---	-----	-----	-----	-----	-----	20	7	-----	<2	Do.
688	--	---	-----	-----	-----	-----	-----	10	10	-----	10	Do.
689	30	1,500	200	150	20	2	.7	-----	-----	<.1	---	Panned concentrate.
690	--	---	-----	-----	-----	-----	-----	7	3	-----	3	Active stream sediment.
691	--	---	-----	-----	-----	-----	-----	5	5	-----	7	Do.
							Grizzly Creek drainage					
692	--	---	-----	-----	-----	-----	-----	4	<.5	-----	2	Active stream sediment.
693	10	20	300	100	5	.3	.3	-----	-----	-----	---	Limonitic argillite.
694	15	300	100	200	3	.5	7	-----	-----	-----	---	Do.
695	--	---	-----	-----	-----	-----	-----	2	<.5	-----	---	Active stream sediment.

TABLE 1.—*Analyses of samples from stream sediments, panned concentrates, and*

	Semiquantitative spectrographic analyses (ppm)																		
Sample	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co	Ag	Be	Ga	As	Sb
									Three Fools Creek drainage										
696	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
697	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
698	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
699	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
700	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
701	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
702	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
703	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
704	5,000	<200	700	150	100	<20	70	100	20	70	15	<2	<10	30	<.5	<1	15	<200	<100
									Freezeout Creek drainage										
705	>10,000	<200	2,000	300	>1,000	<20	50	50	<10	50	30	<2	<10	50	<.5	<1	100	<200	<100
706	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
707	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
708	>10,000	<200	2,000	500	>1,000	150	100	50	10	70	20	<2	<10	50	<.5	<1	100	<200	<100
									Boundary Creek drainage										
709	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
710	-----	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
711	5,000	<200	700	150	70	<20	20	70	10	100	15	<2	<10	10	<.5	<1	30	<200	<100
712	3,000	<200	700	150	30	<20	15	500	<10	70	7	<2	<10	150	<.5	<1	50	<200	<100
713	5,000	<200	700	500	70	<20	50	200	10	70	30	30	<10	100	<.5	<1	50	<200	<100
714	5,000	<200	500	300	70	<20	30	300	30	30	30	15	<10	70	<.5	1	30	<200	<100
715	5,000	<200	700	150	200	<20	30	150	30	300	50	15	<10	30	<.5	<1	NR	<200	<100
716	5,000	<200	500	70	100	<20	20	200	30	30	20	<5	<10	30	.5	<1	NR	<200	<100
717	2,000	1,000	700	30	100	<20	15	200	10	1,000	30	5	<10	7	<.5	1	NR	<200	<100
718	2,000	<200	500	50	150	<20	15	100	20	50	30	7	<10	5	.5	<1	NR	<200	<100
719	3,000	<200	300	100	150	<20	15	500	70	15	15	70	<10	30	1	<1	NR	<200	<100
									Lightning Creek drainage										
720	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
721	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
722	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
723	5,000	<200	1,000	200	100	<20	15	70	20	100	20	3	<10	5	<.5	<1	20	<200	<100
724	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
725	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
726	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
727	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
728	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
729	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
730	>10,000	<200	1,000	1,000	>1,000	50	30	100	10	200	20	<2	<10	30	3	<1	>100	1,000	<100
731	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
732	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
733	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
734	3,000	<200	1,000	300	50	<20	20	100	<10	<10	15	<2	<10	15	<.5	<1	<10	<200	<100
735	10,000	<200	700	200	70	50	50	150	<10	30	15	2	<10	30	<.5	<1	15	<200	<100
736	5,000	<200	1,000	500	15	<20	50	100	<10	15	15	<2	<10	50	<.5	<1	15	<200	<100
737	5,000	<200	1,000	200	20	<20	100	100	<10	200	15	<2	<10	50	<.5	<1	20	<200	<100
738	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
739	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
740	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
741	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
742	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
743	>10,000	<200	1,000	700	>1,000	50	70	200	50	200	50	<2	<10	30	<.5	2	100	300	<100
744	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
745	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
746	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
747	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
748	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
749	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---

fresh and altered rocks in the Pasayten Wilderness Area, Washington—Continued

	Semiquantitative spectrographic analyses--Continued							Chemical analyses				
	(ppm)				(percent)			(ppm)				
Sample	Sc	Cr	Ba	Sr	Fe	Mg	Ca	cxHM	cxCu	Au	Mo	Sample description [1]
							Three Fools Creek drainage					
696	--	---	-----	-----	-----	-----	-----	1	0.5	-----	---	Active stream sediment.
697	--	---	-----	-----	-----	-----	-----	1	<.5	-----	---	Do.
698	---	---	-----	-----	-----	-----	-----	1	2	-----	---	Do.
699	--	---	-----	-----	-----	-----	-----	1	<.5	-----	---	Do.
700	--	---	-----	-----	-----	-----	-----	1	<.5	-----	---	Do.
701	--	---	-----	-----	-----	-----	-----	2	2	-----	---	Do.
702	--	---	-----	-----	-----	-----	-----	2	4	-----	---	Do.
703	--	---	-----	-----	-----	-----	-----	3	10	-----	<2	Do.
704	15	200	150	1,000	7	1.5	5	-----	-----	<.1	---	Limonitic arkose.
							Freezeout Creek drainage					
705	50	500	200	150	15	1.5	.7	-----	-----	<.1	---	Panned concentrate.
706	--	---	-----	-----	-----	-----	-----	10	3	-----	3	Active stream sediment.
707	--	---	-----	-----	-----	-----	-----	7	<1	-----	<2	Do.
708	50	500	150	150	15	1.5	1	-----	-----	<.1	---	Panned concentrate.
							Boundary Creek drainage					
709	--	---	-----	-----	-----	-----	-----	200	300	-----	5	Active stream sediment.
710	--	---	-----	-----	-----	-----	-----	30	7	-----	3	Do.
711	15	150	500	700	7	1.5	2	-----	-----	<.1	---	Lim xenoliths in diorite.
712	20	30	700	150	10	1	1	-----	-----	<.1	---	Lim hornfelsed ark; pyrite.
713	50	150	200	100	15	1.5	1	-----	-----	<.1	---	Argillite with pyrite.
714	30	150	200	300	10	1	1	-----	-----	<.1	---	Do.
715	30	50	700	500	7	1.5	1	-----	-----	.05	---	Lim arg, ark, cgl; brc w/py.
716	15	70	700	300	5	1.5	1.5	-----	-----	.03	---	Sil breccia and argillite.
717	20	7	300	500	3	.7	2	-----	-----	0.3	---	Lt gray sil ark w/sc py and sph.
718	10	20	150	300	3	.7	1.5	-----	-----	.13	---	Lt gray sil ark w/sc py.
719	15	70	700	200	5	1	1	-----	-----	.04	---	Do.
							Lightning Creek drainage					
720	--	---	-----	-----	-----	-----	-----	15	7	-----	5	Active stream sediment.
721	--	---	-----	-----	-----	-----	-----	20	5	-----	5	Do.
722	--	---	-----	-----	-----	-----	-----	10	1	-----	5	Do.
723	30	15	1,000	200	5	.7	1.5	-----	-----	<.1	---	Lim argillite; sc pyrite.
724	--	---	-----	-----	-----	-----	-----	10	7	-----	3	Active stream sediment.
725	--	---	-----	-----	-----	-----	-----	7	5	-----	2	Do.
726	--	---	-----	-----	-----	-----	-----	30	10	-----	3	Do.
727	--	---	-----	-----	-----	-----	-----	7	7	-----	3	Do.
728	--	---	-----	-----	-----	-----	-----	20	5	-----	5	Do.
729	--	---	-----	-----	-----	-----	-----	30	5	-----	5	Do.
730	100	2,000	300	<50	10	1	1	-----	-----	<.1	---	Panned concentrate.
731	--	---	-----	-----	-----	-----	-----	30	5	-----	5	Active stream sediment.
732	--	---	-----	-----	-----	-----	-----	10	2	-----	7	Do.
733	--	---	-----	-----	-----	-----	-----	10	2	-----	3	Do.
734	30	200	70	100	7	2	3	-----	-----	<.1	---	Lim qtz diorite; sc pyrrhotite.
735	30	20	150	150	7	2	5	-----	-----	<.1	---	Do.
736	50	100	20	100	7	2	3	-----	-----	<.1	---	Lim greenstone; sc py and pyrh.
737	50	300	200	100	7	2	1	-----	-----	<.1	---	Lim greenstone and chert.
738	--	---	-----	-----	-----	-----	-----	10	2	-----	3	Active stream sediment.
739	--	---	-----	-----	-----	-----	-----	15	10	-----	2	Do.
740	--	---	-----	-----	-----	-----	-----	7	5	-----	2	Do.
741	--	---	-----	-----	-----	-----	-----	2	10	-----	2	Do.
742	--	---	-----	-----	-----	-----	-----	10	5	-----	3	Do.
743	70	2,000	70	100	15	1	.5	-----	-----	<.1	---	Panned concentrate.
744	--	---	-----	-----	-----	-----	-----	7	7	-----	<2	Active stream sediment.
745	--	---	-----	-----	-----	-----	-----	20	2	-----	7	Do.
746	--	---	-----	-----	-----	-----	-----	15	2	-----	3	Do.
747	--	---	-----	-----	-----	-----	-----	7	7	-----	2	Do.
748	--	---	-----	-----	-----	-----	-----	20	3	-----	3	Do.
749	--	---	-----	-----	-----	-----	-----	10	3	-----	2	Do.

TABLE 1.—*Analyses of samples from stream sediments, panned concentrates, and*

	Semiquantitative spectrographic analyses (ppm)																		
Sample	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co	Ag	Be	Ga	As	Sb
								Lightning Creek drainage--Continued											
750	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
751	3,000	<200	1,000	300	20	<20	100	100	<10	100	10	<2	<10	50	<.5	<1	20	<200	<100
752	5,000	<200	1,000	300	70	<20	20	100	<10	100	10	<2	<10	10	<.5	<1	15	<200	<100
753	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
754	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
755	-----	----	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
								Hozomeen Creek drainage											
756	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
757	>10,000	<200	2,000	1,000	>1,000	50	150	50	<10	300	20	<2	<10	50	<.5	<1	>100	<200	<100
								Dry Creek drainage											
758	5,000	<200	1,000	500	20	<20	50	70	10	<10	10	<2	<10	30	<.5	<1	20	<200	<100
759	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
760	>10,000	<200	1,500	700	300	<20	500	200	20	200	30	<2	70	150	<.5	<1	70	<200	<100
								East side of Ross Lake											
761	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
762	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
763	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
764	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
765	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
766	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
767	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
768	-----	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---
769	10,000	<200	700	300	300	<20	20	70	10	<10	20	<2	<10	<5	<.5	<1	20	<200	<100
770	7,000	<200	1,000	150	300	<20	2	50	10	100	30	<2	<10	<5	<.5	<1	15	<200	<100

1/ Abbreviations used in Table:

alt	altered	cgl	conglomerate	lt	light	rhy	rhyolite
arg	argillite	cu	copper	plgc	plagioclase	sc	scattered
ark	arkose	di	diorite	por	porphyry	sh	sheared or shear
bi	biotite	gr	granite	py	pyrite	sil	silicified
brc	breccia	grnst	greenstone	pyrh	pyrrhotite	sph	sphalerite
cal	calcite	lim	limonitic	qtz	quartz	sul	sulfides
				qtzte	quartzite	vol	volcanic

fresh and altered rocks in the Pasayten Wilderness Area, Washington—Continued

	Semiquantitative spectrographic analyses--Continued							Chemical analyses				
	(ppm)				(percent)			(ppm)				
Sample	Sc	Cr	Ba	Sr	Fe	Mg	Ca	cxHM	cxCu	Au	Mo	Sample description 1/
Lightning Creek drainage--Continued												
750	--	---	-----	-----	-----	-----	-----	10	<1	-----	---	Active stream sediment.
751	30	150	20	100	7	2	5	-----	-----	<.1	---	Soil sample containing lim grnst.
752	20	30	1,000	150	7	2	.1	-----	-----	-----	---	Argillite; sc pyrite.
753	--	---	-----	-----	-----	-----	-----	30	300	<.1	2	Active stream sediment.
754	--	---	-----	-----	-----	-----	-----	5	10	<.1	2	Do.
755	--	---	-----	-----	-----	-----	-----	3	20	-----	2	Do.
Hozomeen Creek drainage												
756	--	---	-----	-----	-----	-----	-----	1.5	7	-----	2	Do.
757	50	3,000	50	<50	15	1.5	.7	-----	-----	<.1	---	Panned concentrate.
Dry Creek drainage												
758	20	300	100	150	7	2	2	-----	-----	<.1	---	Lim cal plagioclase ark; sc py.
759	--	---	-----	-----	-----	-----	-----	2	10	-----	3	Active stream sediment.
760	--	>5,000	200	150	20	2	2	-----	-----	-----	---	Panned concentrate.
East side of Ross Lake												
761	--	---	-----	-----	-----	-----	-----	3	10	-----	<2	Active stream sediment.
762	--	---	-----	-----	-----	-----	-----	2	15	-----	7	Do.
763	--	---	-----	-----	-----	-----	-----	7	15	-----	2	Do.
764	--	---	-----	-----	-----	-----	-----	5	2	-----	7	Do.
765	--	---	-----	-----	-----	-----	-----	15	10	-----	5	Do.
766	--	---	-----	-----	-----	-----	-----	2	10	-----	<2	Do.
767	--	---	-----	-----	-----	-----	-----	3	10	-----	<2	Do.
768	--	---	-----	-----	-----	-----	-----	2	15	-----	2	Do.
769	50	150	1,000	700	7	1.5	10	-----	-----	<.1	---	Limonitic phyllite.
770	30	300	1,000	700	5	1	7	-----	-----	<.1	---	Limonitic gneiss.

TABLE 2.—*Analyses of samples from veins and shear*

[Leaders (__) indicate element not looked for; <, less than

Semiquantitative spectrographic analyses

Field No.	Locality No.	Percent							
		Cu	Pb	Zn	Mo	W	Sn	Co	Ni
					Horseshoe Basin area				
MHS-159-65	2	---	<0.001	<0.02	---	<0.005	<0.001	<0.0005	0.0002
H-1-60	2	---	---	---	---	---	---	---	---
MHS-156-65	3	.005	<.001	<.02	.0005	<.005	<.001	.005	.0002
MHS-153-65	4	---	<.001	<.02	<.0002	<.005	<.001	.005	.015
P-NC-8	4	---	---	---	---	---	---	---	---
P-NC-7	4	---	---	---	---	---	---	---	---
P-NC-9	4	---	---	---	---	---	---	---	---
					Tungsten Creek area				
W-NC-8	5	---	---	---	---	---	---	---	---
W-NC-9	5	---	---	---	---	---	---	---	---
W-NC-10	5	---	---	---	---	---	---	---	---
W-NC-11	5	---	---	---	---	---	---	---	---
W-NC-12	5	---	---	---	---	---	---	---	---
W-NC-14	5	---	---	---	---	---	---	---	---
W-NC-15	5	---	---	---	---	---	---	---	---
W-NC-16	5	---	---	---	---	---	---	---	---
W-147	6	---	---	---	---	---	<.001	<.0005	.0003
Z-1	6	---	---	---	---	---	---	---	---
Z-2	6	---	---	---	---	---	---	---	---
W-NC-6	6	---	---	---	---	---	---	---	---
W-152	7	---	---	---	---	---	.001	<.0005	<.0003
W-150	7	---	---	---	---	---	.003	<.0005	<.0003
W-148	9	---	---	---	---	---	<.001	<.0005	<.0003
					Sheep Mountain area				
86-R-65	10	---	---	---	---	---	---	---	---
WR-66-6A	10	.05	---	---	---	---	---	---	---
WR-66-5A	10	---	---	---	---	---	---	---	---
WR-66-1A	10	---	---	---	---	---	---	---	---
WR-66-2A	10	---	---	---	---	---	---	---	---
WR-66-3A	10	---	---	---	---	---	---	---	---
WR-66-4A	10	---	---	---	---	---	---	---	---
RV-66-24A	10	---	---	---	---	---	---	---	---
RV-66-23A	10	.003	---	---	---	---	---	---	---
RV-66-21A	10	.003	---	---	---	---	---	---	---
RV-66-22A	10	---	---	---	---	---	---	---	---
RV-66-25A	10	---	---	---	---	---	---	---	---
RV-66-26A	10	---	---	---	---	---	---	---	---
					Billy Goat Mountain area				
EVK-67-13B	11	---	---	---	---	---	---	---	---
EVK-67-14B	11	---	---	---	---	---	---	---	---
EVK-67-15B	11	---	---	---	---	---	---	---	---
RV-66-12A	12	---	---	---	---	---	---	---	---
RV-67-1A	12	---	---	---	---	---	---	---	---
JM-67-2A	12	---	---	---	---	---	---	---	---
JM-67-3A	12	---	---	---	---	---	---	---	---
JM-67-4A	12	---	---	---	---	---	---	---	---
14-R-65	12	---	---	---	---	---	<.001	.0005	.0007
RV-67-2A	12	---	---	---	---	---	---	---	---
1602	13	.007	---	---	.002	<.005	.005	<.0005	<.0002
1603	13	.02	---	---	<.0002	<.005	.0015	<.0005	<.0002
RV-66-10A	13	---	---	---	---	---	---	---	---
3R-65	14	---	---	---	---	---	---	---	---
RV-66-11A	14	---	---	---	---	---	---	---	---
RV-66-12A	14	---	---	---	---	---	---	---	---
RV-66-13A	14	---	---	---	---	---	---	---	---
RV-66-14A	15	---	---	---	---	---	---	---	---
4R65-1	16	---	---	---	---	---	---	---	---
4R65-2	16	---	---	---	---	---	---	---	---

zones in the Pasayten Wilderness Area, Washington

the amount shown. Footnotes are given at end of table.]

Quantitative analyses

Field No.	oz/ton		Percent						
	Au	Ag	Cu	Pb	Zn	Mo	Co	Ni	W
				Horseshoe Basin area					
MHS-159-65	---	---	7/ 0.039	---	---	2/ 0.039	---	---	---
H-1-60	3/ .00	3/ .00	3/ .00	---	---	3/ .67	---	---	---
MHS-156-65	4/ .00	1/ .03	---	---	---	---	---	---	---
MHS-153-65	4/ .00	1/ .06	1/ .019	---	---	---	---	---	---
P-NC-8	6/ <.005	6/ .10	---	---	---	---	---	---	---
P-NC-7	6/ <.005	6/ .10	---	---	---	---	---	---	---
P-NC-9	6/ <.005	6/ <.005	---	---	---	---	---	---	---
				Tungsten Creek area					
W-NC-8	6/ <.005	6/ .65	---	---	---	---	---	---	7/ 0
W-NC-9	6/ <.005	6/ 1.10	---	---	---	---	---	---	7/ .87
W-NC-10	6/ <.005	6/ .50	---	---	---	---	---	---	7/ 2.76
W-NC-11	6/ <.005	6/ 1.60	---	---	---	---	---	---	7/ <.02
W-NC-12	6/ <.005	6/ .30	---	---	---	---	---	---	7/ .33
W-NC-14	6/ <.005	6/ .30	---	---	---	---	---	---	7/ .31
W-NC-15	6/ <.005	6/ 1.00	---	---	---	---	---	---	7/ .07
W-NC-16	6/ <.005	6/ <.005	---	---	---	---	---	---	7/ 1.17
W-147	4/ .00	1/ .85	1/ .030	1/ .009	1/ .10	2/ <.003	---	---	2/ .39
Z-1	---	---	---	---	---	---	---	---	5/ .34
Z-2	---	---	---	---	---	---	---	---	6/ .49
W-NC-6	6/ .01	6/ .1	---	---	---	---	---	---	7/ 1.90
W-152	4/ .00	1/ <.09	1/ .0010	1/ <.005	1/ .012	2/ .0007	---	---	2/ .15
W-150	4/ .00	1/ <.09	1/ .0050	1/ <.005	1/ .013	2/ <.0003	---	---	2/ .19
W-148	4/ .00	1/ 1.38	1/ .0010	1/ .010	1/ .0018	2/ <.0003	---	---	2/ .010
				Sheep Mountain area					
86R-65	4/ <.02	---	---	---	---	2/ .014	---	---	---
WR-66-6A	6/ <.005	6/ <.005	---	---	---	7/ <.01	---	---	---
WR-66-5A	6/ <.005	6/ <.005	---	---	---	7/ .00	---	---	---
WR-66-1A	6/ <.005	6/ <.005	---	---	---	7/ .01	---	---	---
WR-66-2A	6/ <.005	6/ <.005	---	---	---	2/ .01	---	---	---
WR-66-3A	6/ <.005	6/ <.005	---	---	---	7/ .02	---	---	---
WR-66-4A	6/ <.005	6/ <.005	---	---	---	7/ .02	---	---	---
RV-66-24A	6/ <.005	6/ <.005	7/ .02	---	---	7/ <.01	---	---	---
RV-66-23A	6/ <.005	6/ <.005	---	---	---	7/ .01	---	---	---
RV-66-21A	6/ <.005	6/ <.005	---	---	---	---	---	---	---
RV-66-22A	6/ <.005	6/ <.005	---	---	---	7/ <.01	---	---	---
RV-66-25A	6/ <.005	6/ <.005	---	---	---	7/ .02	---	---	---
RV-66-26A	6/ <.005	6/ <.005	---	---	---	7/ <.01	---	---	---
				Billy Goat Mountain area					
EVK-67-13B	9/ 0	9/ <.005	7/ 0	---	---	7/ 0	---	---	---
EVK-67-14B	9/ <.1	9/ .05	7/ 0	---	---	7/ 0	---	---	---
EVK-67-15B	9/ <.1	9/ <.005	7/ 0	---	---	7/ 0	---	---	---
RV-66-12A	6/ <.005	6/ 20.6	7/ 10.2	8/ .00	7/ .01	---	---	---	---
RV-67-1A	6/ .00	6/ .00	7/ .00	---	---	---	---	---	---
JM-67-2A	6/ <.005	6/ 4.6	7/ 2.89	---	---	---	---	---	---
JM-67-3A	6/ .00	6/ 2.1	7/ 1.11	---	7/ .2	---	---	---	---
JM-67-4A	6/ .00	6/ 9.9	7/ 4.20	---	7/ .0	---	---	---	---
14-R-65	6/ .05	9/ 5.83	9/ .33	9/ 2.2	9/ .30	---	---	---	---
RV-67-2A	6/ .00	6/ .00	7/ <.02	---	---	---	---	---	---
1602	1/ <.003	---	---	2/ .03	2/ <.005	---	---	---	---
1603	1/ <.003	---	---	2/ .03	2/ .01	---	---	---	---
RV-66-10A	6/ <.005	6/ <.005	7/ <.02	---	---	---	---	---	---
3R-65	4/ .04	1/ 6.71	---	1/ 31	---	---	---	---	---
RV-66-11A	6/ .01	6/ 4.3	7/ .37	---	---	---	---	---	---
RV-66-12A	6/ <.005	6/ 20.6	7/ 10.2	---	---	---	---	---	---
RV-66-13A	6/ <.005	6/ 12.4	7/ .90	8/ 7.85	7/ .90	---	---	---	---
RV-66-14A	6/ <.005	6/ .2	7/ <.02	---	---	---	---	---	---
4R65-1	4/ .40	1/ .70	1/ 3.4	---	---	2/ .0003	---	---	---
4R65-2	4/ .14	1/ .17	1/ 1.9	---	---	2/ .0003	---	---	---

TABLE 2.—*Analyses of samples from veins and shear zones*

Semiquantitative spectrographic analyses

Field No.	Locality No.	Percent							
		Cu	Pb	Zn	Mo	W	Sn	Co	Ni
					Billy Goat Mountain area--Continued				
4R65-3	16	---	---	---	---	---	---	---	---
JJ-67-1A	18	---	---	---	---	---	---	---	---
JJ-67-2A	18	---	---	---	---	---	---	---	---
EVK-67-6A	18	---	---	---	---	---	---	---	---
EVK-67-7A	18	---	---	---	---	---	---	---	---
EVK-67-8A	18	---	---	---	---	---	---	---	---
EVK-67-9A	18	---	---	---	---	---	---	---	---
					Lost River area				
RWT-49-65	19	---	---	---	---	---	---	---	---
EVK-67-1A	19	---	---	---	---	---	---	---	---
EVK-67-2A	19	---	---	---	---	---	---	---	---
EVK-67-4A	19	---	---	---	---	---	---	---	---
JJ-67-3A	19	---	---	---	---	---	---	---	---
JJ-67-4A	19	---	---	---	---	---	---	---	---
JJ-67-5A	19	---	---	---	---	---	---	---	---
JJ-67-6	19	---	---	---	---	---	---	---	---
RV-67-3A	19	---	---	---	---	---	---	---	---
					Robinson Creek area				
MHS-55-65	21	.003	<.001	---	.0005	<.0	<.001	.0005	.0003
NC-P-71	21	---	---	---	---	---	---	---	---
NC-P-72	21	---	---	---	---	---	---	---	---
MHS-75-65	22	---	.001	---	---	<.005	<.001	.001	<.0002
JM-67-1A	22	---	---	---	---	---	---	---	---
JC-66-16A	22	---	---	---	---	---	---	---	---
JC-66-17A	22	---	---	---	---	---	---	---	---
RV-67-21B	22	---	---	---	---	---	---	---	---
RV-67-22B	22	---	---	---	---	---	---	---	---
RV-67-23B	22	---	---	---	---	---	---	---	---
RWT-24-65	24	---	---	---	---	---	---	---	---
RWT-225-65	25	---	---	---	---	---	---	---	---
MHS-65-65	26	---	---	---	---	---	---	---	---
MHS-79-65	27	---	---	---	---	---	---	---	---
MHS-83-65	28	---	.0015	---	.0007	<.005	<.001	<.0005	<.0002
RV-66-16A	29	---	---	---	---	---	---	---	---
RWT-142-65	30	---	---	---	---	---	---	---	---
RWT-144-65	31	---	---	---	---	---	---	---	---
RWT-145-65	32	---	---	---	---	---	---	---	---
RV-66-20A	32	---	---	---	---	---	---	---	---
NC-P-65	33	---	---	---	---	---	---	---	---
NC-P-69	34	---	---	---	---	---	---	---	---
NC-P-70	34	---	---	---	---	---	---	---	---
MHS-68-65	35	---	.005	<.02	.0002	<.005	<.001	.001	.0015
NC-P-66	35	---	---	---	---	---	---	---	---
NC-P-63	36	---	---	---	---	---	---	---	---
MHS-71-65	36	.02	.0015	<.02	<.0002	<.005	<.001	.003	.0030
MHS-72-65	37	---	.001	<.02	<.0002	<.005	<.001	.001	.0020
NC-P-64	37	---	---	---	---	---	---	---	---
MHS-74-65	38	.003	.0015	<.02	<.0002	<.005	<.001	.0015	.0015
NC-P-62	39	---	---	---	---	---	---	---	---
NC-P-61	39	---	---	---	---	---	---	---	---
					Buckskin Ridge area				
MHS-100-65	40	---	---	---	---	<.005	<.001	.007	.0050
MHS-107-65	41	---	.001	<.02	<.0002	<.005	<.001	---	.0020
MHS-105-65	41	---	.003	<.02	<.0002	<.005	<.001	---	.0050
MHS-108-65	41	---	.001	<.02	<.0002	<.005	<.001	---	.0020
MHS-110-65	41	---	---	<.02	<.0002	<.005	<.001	<.0005	<.0002
JJ-66-18A	41	---	---	---	---	---	---	---	---
JC-66-19A	41	---	---	---	---	---	---	---	---

in the Pasayten Wilderness Area, Washington—Continued

Quantitative analyses

Field No.	oz/ton		Percent						
	Au	Ag	Cu	Pb	Zn	Mo	Co	Ni	W
			Billy Goat Mountain area--Continued						
4R65-3	4/ 0.26	1/ 0.17	1/ 1.5	---	---	2/ 0.0002	---	---	---
JJ-67-1A	9/ 0	9/ 0	7/ 0	7/ 0	7/ 0	6/ 0	---	---	---
JJ-67-2A	9/ 0	9/ 0	7/ 0	7/ 0	7/ 0	7/ 0	---	---	---
EVK-67-6A	9/ 0	9/ <.005	---	---	---	---	---	---	---
EVK-67-7A	9/ 0	9/ <.005	---	---	---	---	---	---	---
EVK-67-8A	9/ <.1	9/ 0	---	---	---	---	---	---	---
EVK-67-9A	9/ 0	9/ <.05	---	---	---	---	---	---	---
			Lost River area						
RWT-49-65	4/ .002	1/ .09	---	---	---	2/ .0003	---	---	---
EVK-67-1A	9/ 0	9/ <.05	---	---	---	---	---	---	---
EVK-67-2A	9/ 0	9/ <.05	---	---	---	---	---	---	---
EVK-67-4A	9/ 0	9/ <.05	---	---	---	---	---	---	---
JJ-67-3A	9/ 0	9/ <.05	---	---	---	---	---	---	---
JJ-67-4A	9/ 0	9/ 0	---	---	---	---	---	---	---
JJ-67-5A	9/ <.1	9/ 0	---	---	---	---	---	---	---
JJ-67-6A	9/ <.1	9/ <.05	---	---	---	---	---	---	---
RV-67-3A	9/ 0	9/ 0	---	---	---	---	---	---	---
			Robinson Creek area						
MHS-55-65	4/ .00	1/ .06	1/ ---	---	1/ .0035	---	---	---	---
NC-P-71	6/ <.005	6/ <.005	---	---	---	---	---	---	---
NC-P-72	6/ <.005	6/ .005	---	---	---	---	---	---	---
MHS-75-65	4/ <.02	2/ .12	1/ .13	---	1/ .071	2/ .009	---	---	---
JM-67-1A	6/ .01	6/ .25	7/ .06	---	7/ .10	---	---	---	---
JC-66-16A	6/ .01	6/ .03	---	---	---	---	---	---	---
JC-66-17A	6/ <.005	6/ .3	---	---	---	---	---	---	---
RV-67-21B	9/ <.05	6/ .045	7/ .00	---	---	---	---	---	---
RV-67-22B	9/ .00	6/ .05	7/ .00	---	---	---	---	---	---
RV-67-23B	9/ .00	9/ .05	7/ .00	---	---	---	---	---	---
RWT-24-65	1/ <.002	1/ .06	---	---	---	---	---	---	---
RWT-225-65	1/ .002	1/ 2.36	1/ 10.6	1/ .006	1/ .0085	2/ .0007	---	---	---
MHS-65-65	4/ <.02	1/ .09	1/ .006	1/ .004	1/ .0085	---	---	---	---
MHS-79-65	4/ .00	---	---	---	---	---	---	---	---
MHS-83-65	4/ <.02	1/ .12	1/ .007	---	1/ .0086	---	---	---	---
RV-66-16A	6/ <.005	6/ .10	---	---	---	---	---	---	---
RWT-142-65	4/ .02	1/ .15	1/ 1.2	---	---	---	---	---	---
RWT-144-65	4/ .06	1/ 3.06	1/ 4.0	---	---	---	---	---	---
RWT-145-65	4/ .72	1/ 1.37	1/ .060	---	---	---	---	---	---
RV-66-20A	6/ .93	6/ .5	7/ <.02	7/ .50	7/ .05	---	---	---	---
NC-P-65	6/ .80	6/ .40	---	---	---	---	---	---	---
NC-P-69	4/ <.1	4/ <.05	---	---	---	---	---	---	---
NC-P-70	4/ <.1	4/ <.05	---	---	---	---	---	---	---
MHS-68-65	4/ .00	1/ .09	1/ .008	---	---	---	---	---	---
NC-P-66	6/ <.005	6/ <.005	---	---	---	---	---	---	---
NC-P-63	6/ .26	6/ .30	---	---	---	---	---	---	---
MHS-71-65	4/ .00	1/ .09	---	---	---	---	---	---	---
MHS-72-65	4/ .05	1/ .23	1/ .039	---	---	---	---	---	---
NC-P-64	6/ .17	6/ .40	---	---	---	---	---	---	---
MHS-74-65	4/ .00	1/ .06	---	---	---	---	---	---	---
NC-P-62	6/ .68	6/ .70	---	---	---	---	---	---	---
NC-P-61	6/ .06	6/ .30	---	---	---	---	---	---	---
			Buckskin Ridge area						
MHS-100-65	4/ .05	1/ .67	1/ 11.7	1/ .0040	1/ .044	2/ <.0002	---	---	---
MHS-107-65	4/ .05	1/ .06	1/ 1.1	---	---	---	2/ .09	---	---
MHS-105-65	4/ .08	1/ .06	1/ .14	---	---	---	2/ .03	---	---
MHS-108-65	4/ <.02	1/ .09	1/ .27	---	---	---	2/ .03	---	---
MHS-110-65	4/ <.02	1/ .06	1/ .16	1/ .001	---	---	---	---	---
JJ-66-18A	6/ .04	6/ .30	7/ .60	---	---	---	---	---	---
JC-66-19A	6/ .48	5/ .30	---	---	---	---	---	---	---

TABLE 2.—*Analyses of samples from veins and shear zones*

Semiquantitative spectrographic analyses

Field No.	Locality No.	Percent Cu	Pb	Zn	Mo	W	Sn	Co	Ni
		Buckskin Ridge area--Continued							
RW-66-1B	41	---	---	---	---	---	---	---	---
MHS-91-65	42	---	.002	<.02	.0003	<.005	<.001	.003	.003
1739	43	.02	<.001	.05	<.0002	<.005	<.001	.0003	.0015
1740	43	.005	<.001	<.02	<.0002	<.005	<.001	<.0003	<.0002
1741	43	.07	.007	.2	<.0002	<.005	<.001	<.0003	.0003
1742	43	.015	.03	.5	.0005	<.005	<.001	.001	.002
MHS-90-65	43	---	---	---	---	<.005	<.001	.0007	.001
RV-66-7B	43	---	---	---	---	---	---	---	---
MHS-88-65	44	---	---	---	<.0002	<.005	<.001	<.0005	.0002
MHS-62-65	45	---	<.001	<.02	<.0002	.01	<.001	.002	.001
MHS-61-65	45	---	---	---	.0002	<.005	<.001	<.0005	<.0002
MHS-60-65	45	.005	---	---	<.0002	<.005	<.001	<.0005	<.0002
MHS-58-65	45	---	---	---	<.0002	<.005	<.001	<.0005	<.0002
MHS-57-65	45	---	.001	---	<.0002	<.005	<.001	.0005	.0003
RW-NC-60	45	---	---	---	---	---	---	---	---
RW-NC-62	45	---	---	---	---	---	---	---	---
RW-NC-61	45	---	---	---	---	---	---	---	---
JR-NC-34	45	---	---	---	---	---	---	---	---
JR-NC-35	45	---	---	---	---	---	---	---	---
RW-NC-64	45	---	---	---	---	---	---	---	---
RW-NC-63	45	---	---	---	---	---	---	---	---
RW-NC-71	45	---	---	---	---	---	---	---	---
RW-NC-73	45	---	---	---	---	---	---	---	---
RW-NC-72	45	---	---	---	---	---	---	---	---
RW-NC-74	45	---	---	---	---	---	---	---	---
MHS-147-65	46	---	---	---	---	---	---	---	---
MHS-149-65	47	.0015	.005	---	<.0002	<.005	<.001	.002	.003
MHS-148-65	47	---	---	---	---	---	---	---	---
RW-NC-91	47	---	---	---	---	---	---	---	---
JR-NC-45	47	---	---	---	---	---	---	---	---
		Jim Peak-Windy Pass area							
MHS-150-65	48	---	.001	<.02	<.0002	<.005	<.001	.001	.0003
MHS-111-65	49	---	.001	<.02	<.0002	<.005	<.001	.001	.001
1738	50	---	<.001	<.02	---	<.005	<.001	<.0005	<.0002
MHS-140-65	51	.007	.003	<.02	<.0002	<.005	<.001	<.0005	<.0002
JR-NC-41	51	---	---	---	---	---	---	---	---
JR-NC-42	51	---	---	---	---	---	---	---	---
MHS-136-65	52	---	.005	---	<.0002	<.005	<.001	.0007	.0002
1730	52	.007	<.001	<.02	<.0002	<.005	<.001	.001	.001
1731	52	.015	<.001	<.02	<.0002	<.005	<.001	.0005	.0005
1732	52	.015	.001	.05	<.0002	<.005	<.001	.0005	.001
MHS-138-65	52	---	.001	---	<.0002	<.005	<.001	.0007	.0002
JC-66-1A	52	---	---	---	---	---	---	---	---
JC-66-4A	52	---	---	---	---	---	---	---	---
JC-66-5A	52	---	---	---	---	---	---	---	---
JJ-66-6A	52	---	---	---	---	---	---	---	---
JC-66-3A	52	---	---	---	---	---	---	---	---
MHS-134-65	53	---	---	---	<.0002	<.005	<.001	<.0005	.0002
RW-NC-57	53	---	---	---	---	---	---	---	---
RW-NC-58	53	---	---	---	---	---	---	---	---
RW-NC-59	53	---	---	---	---	---	---	---	---
MHS-131-65	54	.003	---	---	<.0002	<.005	<.001	.001	.0007
MHS-133-65	54	---	---	---	<.0002	<.005	<.001	.0005	.0002
MHS-121-65	54	---	---	---	<.0002	<.005	<.001	.0007	<.0002
RW-NC-80	54	---	---	---	---	---	---	---	---
RW-NC-81	54	---	---	---	---	---	---	---	---
RW-NC-55	54	---	---	---	---	---	---	---	---
RW-NC-69	54	---	---	---	---	---	---	---	---
RW-NC-65	55	---	---	---	---	---	---	---	---
RW-NC-67	55	---	---	---	---	---	---	---	---
RW-NC-68	55	---	---	---	---	---	---	---	---
RW-NC-66	55	---	---	---	---	---	---	---	---

in the Pasayten Wilderness Area, Washington—Continued

Quantitative analyses

Field No.	oz/ton		Percent						
	Au	Ag	Cu	Pb	Zn	Mo	Co	Ni	W
				Buckskin Ridge area--Continued					
RW-66-1B	6/ <0.005	6/ <0.005	7/ 0.13	---	---	---	---	7/ 0.00	---
MHS-91-65	4/ <.02	1/ .12	1/ .010	---	---	---	---	---	---
1739	1/ .09	1/ <.003	---	---	---	---	---	---	---
1740	1/ <.0015	1/ <.003	---	---	---	---	---	---	---
1741	1/ .79	1/ .17	---	---	---	---	---	---	---
1742	1/ .12	1/ <.003	---	---	---	---	---	---	---
MHS-90-65	4/ .77	1/ 1.63	1/ .036	1/ .11	1/ .093	2/ .0003	---	---	---
RV-66-7B	6/ .25	6/ <.005	---	---	---	---	---	---	---
MHS-88-65	4/ .00	1/ .70	1/ .006	1/ .023	1/ .0035	---	---	---	---
MHS-62-65	4/ <.02	1/ .06	1/ .040	---	---	---	---	---	---
MHS-61-65	4/ .10	1/ .15	1/ .011	1/ <.0025	1/ .0075	---	---	---	---
MHS-60-65	4/ .03	1/ .15	---	2/ .010	1/ .054	---	---	---	---
MHS-58-65	4/ .10	1/ 1.08	1/ .064	1/ 1.1	1/ 1.	---	---	---	---
MHS-57-65	4/ .00	1/ .06	1/ .018	---	1/ .036	---	---	---	---
RW-NC-60	6/ .08	6/ 2.0	7/ <.02	7/ 2.5	7/ 1.55	---	---	---	---
RW-NC-62	6/ <.005	6/ 1.4	7/ <.02	7/ 1.1	7/ <.02	---	---	---	---
RW-NC-61	6/ .14	6/ 1.9	7/ <.02	7/ 2.1	7/ 2.0	---	---	---	---
JR-NC-34	6/ .60	6/ .25	7/ <.02	7/ .00	7/ .15	---	---	---	---
JR-NC-35	6/ .03	6/ .10	7/ <.02	7/ .00	7/ .05	---	---	---	---
RW-NC-64	6/ <.005	6/ .10	7/ .00	7/ <.02	7/ <.02	---	---	---	---
RW-NC-63	6/ <.005	6/ .20	7/ .06	7/ <.02	7/ .85	---	---	---	---
RW-NC-71	6/ .28	6/ .30	7/ .08	7/ .00	7/ .00	---	---	---	---
RW-NC-73	6/ .05	6/ <.005	---	---	---	---	---	---	---
RW-NC-72	6/ <.005	6/ <.005	8/ .00	8/ .00	8/ <.02	---	---	---	---
RW-NC-74	6/ <.005	6/ <.005	---	---	---	---	---	---	---
MHS-147-65	4/ .00	1/ .09	---	---	---	---	---	---	---
MHS-149-65	4/ <.02	1/ .12	---	---	1/ .011	---	---	---	---
MHS-148-65	4/ <.02	1/ .06	---	---	---	---	---	---	---
RW-NC-91	6/ <.005	6/ <.005	---	---	---	---	---	---	---
JR-NC-45	6/ <.005	6/ <.005	---	---	---	---	---	---	---
				Jim Peak-Windy Pass area					
MHS-150-65	4/ .02	1/ <.03	1/ .056	---	---	---	---	---	---
MHS-111-65	4/ <.02	1/ .09	1/ .021	---	---	---	---	---	---
1738	1/ <.0015	---	1/ .004	---	---	4/ <.0002	---	---	---
MHS-140-65	4/ <.02	1/ .06	---	---	---	---	---	---	---
JR-NC-41	6/ .16	6/ <.005	7/ <.02	7/ .00	7/ .00	---	---	---	---
JR-NC-42	6/ .08	6/ <.005	7/ <.02	7/ .00	7/ .00	---	---	---	---
MHS-136-65	4/ .48	1/ .03	1/ .025	---	1/ .074	---	---	---	---
1730	1/ <.0015	1/ <.003	---	---	---	---	---	---	---
1731	1/ .21	1/ <.003	---	---	---	---	---	---	---
1732	2/ .009	1/ <.003	---	---	---	---	---	---	---
MHS-138-65	4/ .16	1/ .09	1/ .034	---	1/ .18	---	---	---	---
JC-66-1A	6/ <.005	6/ .1	---	---	---	---	---	---	---
JC-66-4A	1/ .06	6/ <.005	---	---	---	---	---	---	---
JC-66-5A	6/ <.005	6/ .10	---	---	---	---	---	---	---
JJ-66-6A	6/ <.005	6/ <.005	---	---	---	---	---	---	---
JC-66-3A	6/ .12	6/ .10	---	---	---	---	---	---	---
MHS-134-65	4/ .00	1/ <.03	---	1/ .0030	1/ .029	---	---	---	---
RW-NC-57	6/ <.005	6/ <.005	7/ .00	7/ .00	7/ .00	---	---	---	---
RW-NC-58	6/ <.005	6/ <.005	7/ <.02	7/ .00	7/ .00	---	---	---	---
RW-NC-59	6/ <.005	6/ .1	7/ <.02	7/ .00	7/ .00	---	---	---	---
MHS-131-65	4/ <.02	1/ .06	---	1/ .035	1/ .046	---	---	---	---
MHS-133-65	4/ .08	1/ 1.08	1/ .009	1/ .37	1/ .36	---	---	---	---
MHS-121-65	4/ .13	1/ 5.34	1/ .083	1/ 2.1	1/ .67	---	---	---	---
RW-NC-80	6/ .13	6/ 1.1	---	7/ .50	7/ <.02	---	---	---	---
RW-NC-81	6/ .24	6/ 3.4	---	7/ 1.75	7/ .15	---	---	---	---
RW-NC-55	6/ .01	6/ .40	7/ <.02	7/ <.02	7/ 2.2	---	---	---	---
RW-NC-69	6/ .05	6/ .90	7/ <.02	7/ .60	7/ <.02	---	---	---	---
RW-NC-65	6/ .12	6/ .4	7/ <.02	7/ .1	7/ .35	---	---	---	---
RW-NC-67	6/ .08	6/ 2.5	7/ <.02	7/ .85	7/ 2.8	---	---	---	---
RW-NC-68	6/ <.005	6/ <.005	---	---	---	---	---	---	---
RW-NC-66	6/ <.005	6/ .20	7/ <.02	7/ <.02	7/ .2	---	---	---	---

TABLE 2.—*Analyses of samples from veins and shear zones*

Semiquantitative spectrographic analyses

Field No.	Locality No.	Percent							
		Cu	Pb	Zn	Mo	W	Sn	Co	Ni
					Jim Peak-Windy Pass area--Continued				
JR-NC-36	55	---	---	---	---	---	---	---	---
JR-NC-37	55	---	---	---	---	---	---	---	---
MHS-43-65	56	---	---	---	<.0002	<.005	<.001	.0007	<.0002
MHS-44-65	56	---	---	---	<.0002	<.005	<.001	.0015	.0015
MHS-167-65	57	---	---	---	---	---	---	---	---
MHS-116-65	57	.002	---	---	.0002	<.005	<.001	<.0005	<.0002
MHS-118-65	57	---	---	---	---	---	---	---	---
MHS-115-65	57	---	---	---	<.0002	<.005	<.001	.001	.0005
JR-NC-40	57	---	---	---	---	---	---	---	---
JR-NC-39	57	---	---	---	---	---	---	---	---
RW-NC-76	57	---	---	---	---	---	---	---	---
RW-NC-77	57	---	---	---	---	---	---	---	---
RW-NC-78	57	---	---	---	---	---	---	---	---
JR-NC-44	57	---	---	---	---	---	---	---	---
RW-NC-88	57	---	---	---	---	---	---	---	---
					Canyon Creek area				
MHS-49-66	58	.003	.001	<.02	<.0002	<.005	<.001	.001	.002
1263	58	.01	<.001	<.02	<.0002	<.005	<.001	.0005	.007
MHS-170-65	59	---	---	---	---	---	---	---	---
MHS-171-65	59	---	---	---	---	---	---	---	---
MHS-146-65	59	.001	---	<.02	.0002	<.005	<.001	<.0005	<.0002
MHS-145-65	59	.0015	.005	<.02	.0015	<.005	<.001	<.0005	.0002
MHS-142-65	59	.002	.003	<.02	<.0002	<.005	<.001	<.0005	<.0002
MHS-143-65	59	.002	.002	<.02	.0003	<.005	<.001	.0005	.0007
MHS-144-65	59	.002	.003	<.02	.0015	<.005	<.001	.001	.001
MHS-50-66	59	.005	.003	<.02	.015	<.005	<.001	.0005	.002
RV-66-3A	59	---	---	---	---	---	---	---	---
RV-66-2A	59	---	---	---	---	---	---	---	---
RV-66-1A	59	---	---	---	---	---	---	---	---
P-NC-50	59	---	---	---	---	---	---	---	---
P-NC-51	59	---	---	---	---	---	---	---	---
P-NC-52	59	---	---	---	---	---	---	---	---
JC-66-12A	59	---	---	---	---	---	---	---	---
JC-66-13A	59	---	---	---	---	---	---	---	---
JC-66-4A	59	---	---	---	---	---	---	---	---
JC-66-12A	59	---	---	---	---	---	---	---	---
JC-66-15A	59	---	---	---	---	---	---	---	---
JC-66-9A	59	---	---	---	---	---	---	---	---
JC-66-11A	59	---	---	---	---	---	---	---	---
JC-66-10A	59	---	---	---	---	---	---	---	---
WR-66-19A	59	---	---	---	---	---	---	---	---
WR-66-20A	59	---	---	---	---	---	---	---	---
WR-66-18A	59	---	---	---	---	---	---	---	---
RV-66-6A	60	---	---	---	---	---	---	---	---
RV-66-8A	60	---	---	---	---	---	---	---	---
RV-66-9A	60	---	---	---	---	---	---	---	---
1687	61	.003	.001	<.02	<.0002	<.005	<.001	<.0005	.0007
1688	61	.003	.003	<.02	<.0002	<.005	<.001	.0005	.0005
WR-66-10A	62	---	---	---	---	---	---	---	---
WR-66-11A	62	----	---	---	---	---	---	---	---
WR-66-12A	62	---	---	---	---	---	---	---	---
1719	63	.005	.0015	<.02	<.0002	<.005	<.001	.001	.003
1720	64	.003	<.001	<.02	<.0002	<.005	<.001	.001	.002
1610	65	.007	.001	<.02	<.0002	<.005	<.001	.001	.003
1611	66	.007	<.001	<.02	<.0002	<.005	<.001	.0005	.002
RV-67-24B	67	---	---	---	---	---	---	---	---
RV-67-25B	67	---	---	---	---	---	---	---	---
RV-67-1C	67	---	---	---	---	---	---	---	---
RV-67-2C	67	---	---	---	---	---	---	---	---
MHS-53-66	68	.003	.001	<.02	<.0002	<.005	<.001	.0005	.0015
MHS-55-66	68	.015	.002	<.02	<.0002	<.005	<.001	.0007	<.0002

in the Pasayten Wilderness Area, Washington—Continued

Field No.	Quantitative analyses								
	oz/ton		Percent						
	Au	Ag	Cu	Pb	Zn	Mo	Co	Ni	W
				Jim Peak-Windy Pass area--Continued					
JR-NC-36	6/ 0.32	6/ 12.8	7/ <0.02	7/ 6.35	7/ 0.2	---	---	---	---
JR-NC-37	6/ .2	6/ 8.7	7/ .02	7/ 4.95	7/ .3	---	---	---	---
MHS-43-65	4/ .04	1/ .03	1/ .082	1/ <.0025	1/ .0015	---	---	---	---
MHS-44-65	4/ .05	1/ .26	1/ .39	1/ .033	1/ 2.2	---	---	---	---
MHS-167-65	4/ .06	1/ .29	1/ .035	1/ .31	1/ .10	---	---	---	---
MHS-116-65	4/ .02	1/ .06	---	1/ .0077	1/ .035	---	---	---	---
MHS-118-65	4/ .25	1/ 1.92	---	1/ 3.8	1/ 8.0	---	---	---	---
MHS-115-65	4/ .02	1/ .06	1/ .010	1/ .0030	1/ .015	---	---	---	---
JR-NC-40	6/ .03	6/ .10	7/ <.02	7/ .00	7/ <.02	---	---	---	---
JR-NC-39	6/ .17	6/ .95	7/ <.02	7/ 1.8	7/ 6.1	---	---	---	---
RW-NC-76	6/ .02	6/ .10	7/ .00	7/ .00	7/ <.02	---	---	---	---
RW-NC-77	6/ <.005	6/ <.005	7/ .00	7/ .00	7/ .00	---	---	---	---
RW-NC-78	6/ <.005	6/ <.005	---	---	---	---	---	---	---
JR-NC-44	6/ <.005	6/ <.005	---	---	---	---	---	---	---
RW-NC-88	6/ <.005	6/ <.005	---	---	---	---	---	---	---
				Canyon Creek area					
MHS-49-66	1/ <.0015	1/ <.003	---	---	---	---	---	---	---
1263	1/ <.003	1/ <.003	---	---	---	---	---	---	---
MHS-170-65	4/ .10	1/ .09	---	---	---	---	---	---	---
MHS-171-65	4/ <.02	1/ .09	---	---	---	---	---	---	---
MHS-146-65	4/ <.02	1/ .06	---	7/ .0055	---	---	---	---	---
MHS-145-65	4/ .12	1/ .09	---	---	---	---	---	---	---
MHS-142-65	4/ .00	1/ .03	---	---	---	---	---	---	---
MHS-143-65	4/ <.02	1/ .12	---	---	---	---	---	---	---
MHS-144-65	4/ .00	1/ .09	---	---	---	---	---	---	---
MHS-50-66	1/ .0	1/ <.003	---	---	---	---	---	---	---
RV-66-3A	6/ <.005	6/ <.005	---	---	---	---	---	---	---
RV-66-2A	6/ <.005	6/ <.005	---	---	---	---	---	---	---
RV-66-1A	6/ <.005	6/ <.005	---	---	---	---	---	---	---
P-NC-50	6/ .40	6/ .30	---	---	---	---	---	---	---
P-NC-51	6/ <.005	6/ <.005	---	---	---	---	---	---	---
P-NC-52	6/ <.005	6/ .10	---	---	---	---	---	---	---
JC-66-12A	6/ .02	6/ .10	---	---	---	---	---	---	---
JC-66-13A	6/ <.005	6/ .15	---	---	---	---	---	---	---
JC-66-4A	6/ .06	6/ <.005	---	---	---	---	---	---	---
JC-66-12A	6/ .02	6/ .10	---	---	---	---	---	---	---
JC-66-15A	6/ .50	6/ .30	---	---	---	---	---	---	---
JC-66-9A	6/ .78	6/ 1.4	---	---	---	---	---	---	---
JC-66-11A	6/ <.005	6/ <.005	---	---	---	---	---	---	---
JC-66-10A	6/ .06	6/ .15	---	---	---	---	---	---	---
WR-66-19A	6/ <.005	6/ <.005	---	---	---	---	---	---	---
WR-66-20A	6/ <.005	6/ <.005	-----	---	---	---	---	---	---
WR-66-18A	6/ .01	6/ .20	---	---	---	---	---	---	---
RV-66-6A	6/ .03	6/ .10	7/ <.02	---	---	---	---	---	---
RV-66-8A	6/ <.005	6/ <.005	---	---	---	---	---	---	---
RV-66-9A	6/ <.005	6/ <.005	---	---	---	---	---	---	---
1687	1/ .003	---	---	---	---	---	---	---	---
1688	1/ .006	1/ <.003	---	---	---	---	---	---	---
WR-66-10A	6/ <.005	6/ <.005	---	---	---	---	---	---	---
WR-66-11A	6/ <.005	6/ <.005	---	---	---	---	---	---	---
WR-66-12A	6/ <.005	6/ <.005	---	---	---	---	---	---	---
1719	1/ <.003	---	---	---	---	---	---	---	---
1720	1/ .003	1/ .006	---	---	---	---	---	---	---
1610	1/ <.0015	1/ <.003	---	---	---	---	---	---	---
1611	1/ <.0015	1/ <.003	---	---	---	---	---	---	---
RV-67-24B	9/ .00	9/ <.02	9/ .00	---	---	---	---	---	---
RV-67-25B	9/ .00	9/ .00	9/ .00	---	---	---	---	---	---
RV-67-1C	9/ .00	9/ .00	9/ <.02	---	---	---	---	---	---
RV-67-2C	9/ .00	9/ .00	9/ .00	---	---	---	---	---	---
MHS-53-66	1/ <.0015	1/ <.003	---	---	---	---	---	---	---
MHS-55-66	1/ .006	1/ <.003	---	---	---	---	---	---	---

TABLE 2.—*Analyses of samples from veins and shear zones*

Semiquantitative spectrographic analyses

Field No.	Locality No.	Percent							
		Cu	Pb	Zn	Mo	W	Sn	Co	Ni
Canyon Creek area--Continued									
MHS-54-66	63	0.003	0.002	<0.02	<0.0002	<0.005	<0.001	<0.0005	<0.0015
WR-66-14A	69	---	---	---	---	---	---	---	---
South Canyon Creek area									
WR-66-13A	70	.003	---	---	---	---	---	---	---
1272	72	.01	<.001	<.02	<.0002	<.005	<.001	<.0005	.0005
1273	73	.0005	<.001	<.02	<.0002	<.005	<.001	<.0005	.002
1274	73	.02	<.001	<.02	<.0002	<.005	<.001	<.0005	.001
1279	74	.015	<.001	<.02	<.0002	<.005	<.001	<.0005	.0005
Jack Mountain area									
RV-66-4A	76	---	---	---	---	---	---	---	---
2244	77	---	---	---	<.0002	<.005	<.001	.0005	.0015
2291	77	---	---	---	<.0002	<.005	<.001	.0005	.0020
2253	78	---	---	---	<.0002	<.005	<.001	.01	.007
2254	78	---	---	---	.0005	<.005	<.001	.0007	.001
Ross Lake area									
2272	79	.007	<.001	<.02	<.0002	<.005	<.001	.0003	.0015
2272A	79	.005	<.001	<.02	<.0002	<.005	<.001	<.0003	.0005
Devils Dome area									
RWT-268-65	80	---	---	---	---	---	---	---	---
Cinnamon Creek area									
1337	81	---	---	---	---	---	---	---	---
1334	82	---	---	---	---	---	---	---	---
Boundary Creek-Lightning Creek									
JJ-67-15A	83	---	---	---	---	---	---	---	---
EVK-67-21A	83	---	---	---	---	---	---	---	---
EVK-67-22A	83	---	---	---	---	---	---	---	---
EVK-67-23A	83	---	---	---	---	---	---	---	---
EVK-67-20A	83	---	---	---	---	---	---	---	---
JM-67-16A	83	---	---	---	---	---	---	---	---
JM-67-15A	83	---	---	---	---	---	---	---	---
JM-67-14A	83	---	---	---	---	---	---	---	---
JJ-67-18A	83	---	---	---	---	---	---	---	---
JM-67-13A	83	---	---	---	---	---	---	---	---
JJ-67-17A	83	---	---	---	---	---	---	---	---
VM-67-10A	83	---	---	---	---	---	---	---	---
EVK-67-18A	83	---	---	---	---	---	---	---	---
JJ-67-13A	83	---	---	---	---	---	---	---	---
JM-67-9A	83	---	---	---	---	---	---	---	---
EVK-67-19A	84	---	---	---	---	---	---	---	---
JJ-67-16A	84	---	---	---	---	---	---	---	---
JM-67-11A	84	---	---	---	---	---	---	---	---
JM-67-12A	84	---	---	---	---	---	---	---	---
RV-67-20A	85	---	---	---	---	---	---	---	---
1690	85	.007	---	---	.002	0	0	.0007	.0003
1693	85	.007	---	---	.002	0	0	0	0
1694	85	.002	---	---	.0015	0	.001	0	0
1649	86	---	---	---	---	---	---	---	---
RV-67-23A	87	---	---	---	---	---	---	---	---
RV-67-24A	87	---	---	---	---	---	---	---	---
JJ-67-20	88	---	---	---	---	---	---	---	---
EVK-67-25A	88	---	---	---	---	---	---	---	---
EVK-67-24A	88	---	---	---	---	---	---	---	---
JJ-67-19A	88	---	---	---	---	---	---	---	---

1/ Atomic absorption analysis by the U.S. Geological Survey.
2/ Colorimetric analysis by the U.S. Geological Survey.
3/ Analysis from Huntting (1956, p. 270).
4/ Fire assay by the U.S. Geological Survey.
5/ Analyses from S. W. Hobbs (1942, written communication).

in the Pasayten Wilderness Area, Washington—Continued

Quantitative analyses

Field No.	oz/ton Au	Ag	Percent Cu	Pb	Zn	Mo	Co	Ni	W
			Canyon Creek area--Continued						
MHS-54-66	1/<0.0015	1/<0.003	---	---	---	---	---	---	---
WR-66-14A	6/<.005	6/ .20	---	---	---	---	---	---	---
			South Canyon Creek area						
WR-66-13A	6/<.005	6/ <.005	---	---	---	---	---	7/ .12	---
1272	1/ .003	---	---	---	---	---	---	---	---
1273	1/<.003	---	---	---	---	---	---	---	---
1274	1/<.003	---	---	---	---	---	---	---	---
1279	1/ .003	---	---	---	---	---	---	---	---
			Jack Mountain area						
RV-66-4A	6/<.005	6/ .10	7/ <.02	---	---	---	---	---	---
2244	1/<.003	---	1/ .0035	1/ <.0025	1/ .025	---	---	---	---
2291	1/ .08	1/ .009	1/ .014	1/ .02	1/ .21	---	---	---	---
2253	1/ .003	---	1/ .03	1/ <.0025	1/ .12	---	---	---	---
2254	1/<.003	---	1/ .028	1/ <.0025	1/ .006	---	---	---	---
			Ross Lake area						
2272	1/<.0015	1/ <.003	---	---	---	---	---	---	---
2272A	1/<.0015	1/ <.003	---	---	---	---	---	---	---
			Devils Dome area						
RWT-268-65	4/ .00	1/ .06	---	---	---	---	---	---	---
			Cinnamon Creek area						
1337	4/ .00	---	---	---	---	---	---	---	---
1334	4/ .00	---	---	---	---	---	---	---	---
			Boundary Creek-Lightning Creek						
JJ-67-15A	9/<.1	9/ <.02	7/ .14	7/ 0	---	---	---	---	---
EVK-67-21A	9/<.1	9/ 0	7/ 0	---	---	7/ 0	---	---	---
EVK-67-22A	9/<.1	9/ 0	7/ 0	---	---	7/ 0	---	---	---
EVK-67-23A	9/<.1	9/ <.02	7/ 0	---	---	7/ 0	---	---	---
EVK-67-20A	9/<.1	9/ 0	7/ 0	---	---	7/ 0	---	---	---
JM-67-16A	9/ 0	9/ <.02	7/ <.02	---	---	7/ 0	---	---	---
JM-67-15A	9/<.1	9/ <.02	---	7/ 0	---	---	---	---	---
JM-67-14A	9/ 0	9/ 0	7/ <.02	---	---	7/ 0	---	---	---
JJ-67-18A	9/ 0	9/ 0	7/ 0	---	---	7/ 0	---	---	---
JM-67-13A	9/<.1	9/ <.02	7/ 0	---	---	7/ 0	---	---	---
JJ-67-17A	9/ 0	9/ 0	7/ 0	---	---	7/ 0	---	---	---
VM-67-10A	9/<.1	9/ <.02	7/ <.02	---	---	7/ 0	---	---	---
EVK-67-18A	9/ 0	9/ 0	7/ 0	7/ 0	---	7/ 0	---	---	---
JJ-67-13A	9/<.1	9/ <.02	7/ 0	7/ 0	---	---	---	---	---
JM-67-9A	9/<.1	9/ <.02	7/ <.02	---	---	7/ 0	---	---	---
EVK-67-19A	9/<.1	9/ 0	7/ 0	---	---	7/ 0	---	---	---
JJ-67-16A	9/<.1	9/ <.02	7/ 0	7/ 0	---	---	---	---	---
JM-67-11A	9/<.1	9/ <.02	7/ <.02	---	---	7/ 0	---	---	---
JM-67-12A	9/ 0	9/ <.02	7/ 0	---	---	7/ 0	---	---	---
RV-67-20A	9/<.1	9/ <.1	7/ 0	7/ 0	---	7/ 0	---	---	---
1690	1/<.05	<.02	---	.03	.0075	---	---	---	---
1693	1/<.05	.02	---	.0025	<.0025	---	---	---	---
1694	1/<.05	<.02	---	.025	<.0025	---	---	---	---
1649	1/<.05	<.02	---	---	---	---	---	---	---
RV-67-23A	9/ 0	9/ <.02	---	---	---	7/ 0	---	---	---
RV-67-24A	9/ 0	9/ <.02	---	---	---	7/ 0	---	---	---
JJ-67-20A	9/ 0	9/ 0	7/ 0	7/ 0	---	7/ 0	---	---	---
EVK-67-25A	9/ 0	9/ 0	7/ 0	---	---	7/ 0	---	---	---
EVK-67-24A	9/ 0	9/ 0	7/ 0	---	---	7/ 0	---	---	---
JJ-67-19A	9/ 0	9/ 0	7/ 0	---	---	7/ 0	---	---	---

6/ Fire assay by Peter Mack of Wallace, Idaho.
7/ Colorimetric analysis by Peter Mack of Wallace, Idaho
8/ Electrolytic analysis by Peter Mack of Wallace, Idaho.
9/ Atomic absorption analysis by the U.S. Bureau of Mines.

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TABLE 3.—*Analyses of placer sample concentrates from the Canyon Creek drainage (figs. 64, 65)*

[Gold and silver content determined by fire assay; Tr=<0.005 mg Au; <0.05 mg Ag is not reported]

Sample No.	Type of sample	Depth sampled (feet)		Gold (mg)	Gold (cents per cu yd)	Silver (mg)	Gold colors	Remarks
		From	To					
1–1	Grab	0	2	Tr				Bar in stream channel; 50 percent >3-in.-diameter gravel.
1–2	Test pit	0	3	Tr			2	Bar; 50 percent >3-in.-diameter gravel. Two small colors of gold and some pyrite.
1–3	Drill hole	0	1½	Tr				Overburden.
1–4	do	1½	2	Tr				Fine sand and gravel.
1–5	do	2	3	Tr		0.10		Medium gravel and boulders; some pyrite.
1–6	do	3	3½	Tr				Boulders and gravel.
1–7	do	3½	4	Tr				Do.
1–8	do	4	5	Tr				Large boulders.
1–9	Test pit	0	2	Tr			10	Bar in stream; pyrite and fine colors.
1–10	do	0	1	Tr				Fine colors at 1 to 3 ft; 40 percent 3- to 16-in. diameter consisting of argillite, quartzite, slate, conglomerate, and granitic rock. Pit abandoned because of water.
1–11	do	1	2	0.02	0.2		3	
1–12	do	2	3	Tr			6	
1–13	do	3	4	.02	.1			
1–14	do	0	1	Tr			2	Boulders with medium gravel and fine sand; 60 percent 3-in. to 3 ft. in diameter consisting of quartzite, granodiorite, slate, and argillite. Pit abandoned because of water depth and boulders.
1–15	do	1	2	Tr			3	
1–16	do	2	3	.33	1.0		8	
1–17	do	3	4	.01	.1		6	
1–18	do	4	4½	.42	4.2			
1–19	do	0	1	.05	1.0		2	Bar in stream; fine sand and gravel.
1–20	do	0	1	.035	.6		1	Duplicate of 1–19.
1–21	do	1	2	Tr				Gravel and sand to bedrock.
1–22	Grab	0	1	Tr				Old bench placer; sampled to bedrock.
1–23	do	0	2	.02	.05		1	Stream channel; 75 percent> 10-in. diameter.
1–24	do	0	2	Tr				50 percent>3-in. diameter.

TABLE 3.—*Analyses of placer sample concentrates from the Canyon Creek drainage (figs. 64, 65)*—Continued

Sample No.	Type of sample	Depth sampled (feet) From	Depth sampled (feet) To	Gold (mg)	Gold (cents per cu yd)	Silver (mg)	Gold colors	Remarks
1–25	Test pit	0	1	.025	.13			Test pit in old stream channel; 60 percent from 6-in. to 4-ft diameter consisting of argillite, serpentine, conglomerate, granodiorite, and arkose. (1–25 and 1–26)
1–26	do	1	2½	.07	.2		3	
1–27	do	0	3	.16	1.6		2	Do.
1–28	do	0	2	Tr				Do.
1–29	do	0	2	.22	2.2		3	Stream bar; sampled to bedrock; fine colors.
1–30	do	0	2	Tr				Unworked gravel and clay from edge of mined-out bench placer; sampled to bedrock.
1–31	Grab	0	2	Tr				Unworked gravel and clay from edge of mined-out bench placer; sampled to bedrock. 25 ft N. 45°W. of 1–30.
1–32	do	0	2	.73	3.0	.05	15	90 percent>3-in. diameter; sampled to bedrock in stream.
1–33	do	0	2½	.41	2.0		12	Same as 1–32, 200 ft upstream.
1–34	do	0	2					Elk Creek area; 1-cu-ft sample; fine sand.
1–35	do	0	2					Elk Creek area; 1-cu-ft sample; coarse gravel.

TABLE 4.—*Analyses of placer sample concentrates from the Lightning Creek–Three Fools Creek drainage (fig. 66)*

[Gold and silver content determined by fire assay; Tr=<0.005 mg Au; <0.05 mg Ag is not reported]

Sample No.	Type of sample	Depth sampled (feet) From	Depth sampled (feet) To	Gold (mg)	Gold (cents per cu yd)	Silver (mg)	Gold colors	Remarks
2–1	Grab	0	1½					Stream bar in Upper Cinnamon Creek; concentrates only a trace of original sample.
2–2	do	0	1½	Tr				Stream bar in Middle Creek; concentrates only a trace of original sample.
2–3	do	0	1½	Tr				Sampled to bedrock; six pans from various locations over 600-foot streambed. 5 percent material <3-in. diameter.
2–4	do	0	3	Tr				Fine sand and some gravel; 50 cu yd reserves.
2–5	Trench	0	6	Tr				Bank cut; 75 percent >3-in. diameter; concentrates only a trace of original sample.
2–6	Test pit	0	3	Tr				Edge of stream; coarse gravel and sand; concentrates only a trace of original sample.
2–7	do	0	4½	Tr				Composite of three samples; coarse gravel as much as 12-in. diameter; concentrates only a trace of original sample.
2–8	do	0	3	Tr				Edge of stream; medium gravel and sand; concentrates only a trace of original sample.
2–9	do	0	2	Tr			1	Bank cut above 2–8; 50 percent >3-in. diameter; concentrates only a trace of original sample.
2–10	Grab	0	2	0.035	0.2		2	Bar at junction of Cinnamon and Three Fools Creeks; 1,500 cu yd. reserves; 60 percent >3-in diameter.
2–11	do	0	2	Tr				90 percent >6-in. diameter; 200 ft above junction of Three Fools and Castle Creeks.

TABLE 4.—*Analyses of placer sample concentrates from the Lightning Creek–Three Fools Creek drainage (fig. 66)*—Continued

Sample No.	Type of sample	Depth sampled (feet) From	Depth sampled (feet) To	Gold (mg)	Gold (cents per cu yd)	Silver (mg)	Gold colors	Remarks
2–12	Grab	0	3	Tr				Predominantly large boulders; Upper Three Fools Creek.
2–13	do	0	3	Tr				Bar at junction of Three Fools and Shull Creeks; concentrates only a trace of original sample.
2–14	do	0	3	Tr				Taken 150 yd above the mouth of Shull Creek; medium gravel; concentrates only a trace of original sample.
2–15	do	0	2	Tr				Bar 100 yd below junction of Shull and Three Fools Creeks.
2–16	do	0	2	Tr				Less than 5 percent <3-in.-diameter gravel; concentrates only a trace of original sample.
2–17	do	0	2	Tr				Do.
2–18	Test pit	0	3	Tr			1	Coarse gravel; 75 percent >6-in. diameter. Trace of pyrite.
2–19	do	0	3	Tr			2	Fine gravel built up behind logjam; 450 ft above junction Elbow and Three Fools Creeks. Trace of pyrite and gold found in 2 lb concentrate.
2–20	Grab	0	2	Tr				Fish Creek shelter; 95 percent boulders, ranging from 3-in. to more than 15-ft diameter; concentrates only a trace of original sample.
2–21	do	0	2	Tr				Same as 2–20, 1,000 ft downstream.
2–22	do	0	2	.02	.01			Bar at tributary junction; 90 percent >3-in. diameter.
2–23	do	0	2	Tr				Junction Three Fools and Lightning Creeks; 50 cu yd reserve; concentrates only a trace of original sample.

TABLE 4.—*Analyses of placer sample concentrates from the Lightning Creek–Three Fools Creek drainage (fig. 66)*—Continued

Sample No.	Type of sample	Depth sampled (feet) From	Depth sampled (feet) To	Gold (mg)	Gold (cents per cu yd)	Silver (mg)	Gold colors	Remarks
2–24	Grab	0	2	Tr				Coarse boulders and gravel from bar; concentrates only a trace of original sample.
2–25	do	0	2	Tr				Stream bar ⅛ mile below Deer Lick cabin; large boulders, narrow canyon.
2–26	do	0	3	Tr				Deep hole sampled to bedrock; 300 ft below Deer Lick cabin on west side of stream.
2–27	do	0	2	Tr				Sampled to bedrock; 275 ft below Deer Lick cabin on east side of stream.
2–28	Test pit	0	3	.02	.07		2	Sampled in stream; gravel 50 percent >3-in diameter. Trace of fine gold and pyrite.
2–29	do	0	3	.03	.08		1	Same as above; 20 ft north of sample 2–28.
2–30	do	0	1	Tr				Pit 160 ft northeast of Deer Lick cabin; medium gravel; 50 percent >3-in diameter; abandoned after encountering 4-ft-diameter boulder and water. Trace of pyrite and gold in 2–32.
2–31	do	1	2					
2–32	do	2	3	Tr			1	
2–33	do	3	4	Tr				
2–34	Trench	5	13	Tr				Bench deposit east of creek; angular rock fragments, gravel and decomposed granitic material; possibly glacial origin.
2–35	Test pit	0	3	.04	0.2		2	Coarse gravel and sand; trace of pyrite, ilmenite, gold, and 1.2 percent magnetite.
2–36	do	0	3	Tr				Sample of bar and streambed; 30 percent >3 in. on bar, 90 percent in streambed; concentrates only a trace of original sample.

TABLE 4.—*Analyses of placer sample concentrates from the Lightning Creek—Three Fools Creek drainage (fig. 66)*—Continued

Sample No.	Type of sample	Depth sampled (feet) From	Depth sampled (feet) To	Gold (mg)	Gold (cents per cu yd)	Silver (mg)	Gold colors	Remarks
2–37	Grab	0	2	Tr				Bar; 200 ft north of 2–36; 30 percent >3 inch; concentrates only a trace of original sample.
2–38	do	0	1	Tr				Small stream about 2 miles north of Deer Lick cabin; concentrates only a trace of original sample.
2–39	do	0	1	Tr				Bar, where trail crosses Lightning Creek.
2–40	do	0	2					Taken at bridge below Nightmare Camp consisting of angular rocks and boulders with medium gravel; pyrite found in quartz fragments.
2–41	do	0	1	Tr				Taken 1½ miles below Canadian border; ½-cu-ft sample.
2–42	do	0	1	Tr				Taken ½ mile below Canadian border; ½-cu-ft sample.

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