Steep north face of the southern Picket Range. Small glaciers cling precariously to narrow chutes between towering spires. McMillan Creek behind the low ridge in foreground.

GEOLOGY AND MINERAL RESOURCES, NORTH CASCADES NATIONAL PARK, WASHINGTON

Geology and Mineral Resources of the Northern Part of the North Cascades National Park, Washington

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Reconnaissance geology of the 500-square-mile wilderness north of the Skagit River, and the mineral survey that was made before it became a park

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GEOLOGY AND MINERAL RESOURCES OF THE NORTHERN PART OF THE NORTH CASCADES NATIONAL PARK, WASHINGTON

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ABSTRACT

The northern part of the North Cascades National Park in northern Washington is north of the Skagit River between Mount Shuksan on the west and Ross Lake on the east. The area occupies approximately 500 square miles of steep mountains and thickly forested valleys centered on the precipitous Picket Range.

Old metamorphic rocks and young volcanic and sedimentary rocks are intruded by large masses of granitic rocks that together form a diverse, complicated, but well-exposed geologic section. The granitic rocks are the most abundant in the area; they intrude most of the other rocks, and they separate one suite of rocks in the eastern part of the area from a second suite in the western part. In the eastern part of the area, the oldest rocks are the Custer Gneiss of McTaggart and Thompson, a thick sequence of biotite and hornblende gneisses and schists. We have divided these rocks into three generalized units: light-colored gneiss, banded gneiss, and amphibole-rich gneiss. To the northeast of these rocks lies a metagabbro. This rock type is complex and is made up of several types of gabbro, diorite, amphibolite, ultramafic rocks, and quartz diorite that crop out along the Ross Lake fault zone. To the northeast of these rocks and also along the Ross Lake fault zone is the phyllite and schist of Ross Lake. These rocks are the highly sheared and metamorphosed equivalents of the plagioclase arkose and argillite sequence of Jurassic and Cretaceous age that is so widespread on the east side of Ross Lake. The Cretaceous Hozomeen Group of Cairnes lies along Ross Lake northeast of the phyllite and schist and consists mainly of slightly metamorphosed greenstones with subordinate chert and phyllite. The phyllite in this unit is similar to that in the underlying phyllite and schist of Ross Lake with which it appears to be interbedded. The youngest rocks in the eastern part of the area are the Skagit Volcanics, a thick sequence of welded tuff-breccia with some flows and air-laid tuffs. These rocks, which are probably early Tertiary in age, overlie the Hozomeen Group and the Custer Gneiss along the Canadian border.

In the western part of the area the oldest rocks are greenschist and phyllite of Mount Shuksan. These fine-grained foliated and crinkled rocks commonly contain narrow lenses or layers of quartz. They are unconformably overlain by the Chuckanut Formation in the southern part of the area. This formation, which is of Paleocene and Late Cretaceous age, is made up mainly of gently dipping plagioclase arkose with some interbedded black argillite and conglomerate. The Hannegan Volcanics overlie the Chuckanut in the northern part of the area and the greenschist and phyllite of Mount Shuksan in the central part. The Hannegan Volcanics, which are of early Tertiary age, consist principally of air-laid volcanic breccias and tuffs, but also include some flows and one small porphyry stock.

The Chilliwack composite batholith consists of several types of granitic rocks, which were intruded at different times in the Tertiary. The two principal rock types are granodiorite and quartz diorite, but small bodies of quartz monzonite, diorite, and alaskite are found in many parts of the area. Contacts between the various rock types may be either abrupt or gradational. All rocks of the Chilliwack batholith are younger than the other rock types except the Skagit and Hannegan Volcanics, which are in part younger than rocks of the batholith.

At least two periods of deformation are indicated by the tight folding of the older Custer Gneiss and the greenschist and phyllite of Mount Shuksan and the gentle folding of the younger Chuckanut Formation. At least three periods of faulting occurred, one before and two after the intrusion of the Chilliwack batholith. The two largest fault structures are the Ross Lake fault zone and a long northeast-striking fault that extends for 20 miles from Mount Shuksan down the Chilliwack Valley. The Ross Lake fault zone is probably the most important geologic structure in the area, for it is the boundary between a thick sequence of metamorphic rocks (Custer Gneiss) to the west and a thick sequence of clastic rocks to the east (phyllite and schist of Ross Lake).

Many areas of iron oxide-stained rocks are evidence of widespread sulfide mineralization in the northern part of the North Cascades National Park. The sulfides are principally pyrite and pyrrhotite, although in places chalcopyrite and molybdenite are present. To evaluate all possible mineral resources of this area, it was surveyed by the U.S. Geological Survey and the U.S. Bureau of Mines during the summers of 1966 and 1967. During this survey we collected 1,188 stream sediment samples, 64 panned concentrates, and 450 samples of iron oxide-stained zones and veins.

Although we examined many mineral occurrences in this area, only two appear to have economic potential. One is a zone of disseminated sulfides in the valley of Silver Creek containing copper and molybdenum minerals; the other is molybdenite-bearing quartz veins exposed at two places in Sulphide basin.

In the valley of Silver Creek the most promising showings are on the Weezie claim, where a zone measuring 200 by 240 feet contains disseminated iron, copper, and molybdenum sulfides. Although the metal content of parts of this zone is comparable to that of other deposits now being mined, total reserves appear to be too small to justify exploitation.

In Sulphide basin on the south side of Mount Shuksan, near the center of the west edge of the study area, a narrow zone containing molybdenite-bearing quartz veins crop out at two places about 0.3 mile apart. Here quartz veins as much as 2 inches thick occur in a zone about 80 feet wide. Massive seams of molybdenite as much as three-fourths inch thick are found along the veins. Molybdenum content of the individual veins is high in places, but the average grade across the whole zone is low.

INTRODUCTION

This report was started as part of a study of the North Cascade Primitive Area, an area of about 830,000 acres, which adjoined the Canadian border on the north and which extended from Mount Shuksan on the west to Rock Mountain on the east. In the fall of 1968, Public Law 90–544, 90th Cong., reclassified the North Cascade Primitive Area and certain other national forest lands and created the North Cascades National Park, the Ross Lake National Recreation Area, and the Pasayten Wilderness. Ross Lake National Recreational Area, a corridor 2½–4 miles wide along the Skagit River and its dammed portions, Ross, Diablo, and Gorge Lakes, separates the park into two parts and separates the northern part of the park from the Pasayten Wilderness.

The present study concerns those parts of North Cascades National Park and the Ross Lake National Recreation Area that are north of Skagit River and west of Ross Lake (fig. 1), as well as part of the Mount Baker National Forest west of the park (pl. 2).

LOCATION AND GEOGRAPHY

The northern part of the North Cascades National Park, Whatcom County, Wash., lies across the precipitous Picket Range and extends for about 22 miles along the Canadian border from Ross Lake on the east to Mount Shuksan on the west (fig. 1). The area covers approximately 500 square miles of steep mountains and densely forested valleys along the backbone of the Cascade Mountains. The highest peak is Mount Shuksan, whose ice-clad summit at 9,127 feet towers 7,000 feet above the broad forested Nooksack River valley to the north and 8,000 feet above the Baker River to the south. Other peaks, such as Glacier Peak, Mount Redoubt, Mount Challenger, Mount Fury, Luna Peak, Mount Terror, Crooked Thumb Peak, and Nooksack Tower, rise majestically above glacial-debris-filled cirques to elevations of more than 8,000 feet. Numerous small glaciers (fig. 2*A*, *B*) commonly occupy cirques along the higher ridges, especially on their north and east sides. Three glaciers, the Sulphide and East Nooksack glaciers on Mount Shuksan and the Challenger glacier on Mount Challenger, are more than 2 miles long and half a mile wide. Many small rivulets of melted water from the glaciers and snow banks coalesce into streams that cascade down the mountains in narrow V-shaped valleys or steep-walled chutes (fig. 16*C*). These streams join to form larger streams or rivers. The larger streams, such as the Chilliwack River, Little Beaver Creek, Big Beaver Creek, and the Baker River, occupy broad U-shaped valleys excavated by glaciers during the ice age. The upper parts of the ridges, above 5,500 feet, are generally bare of trees. The lower slopes and the

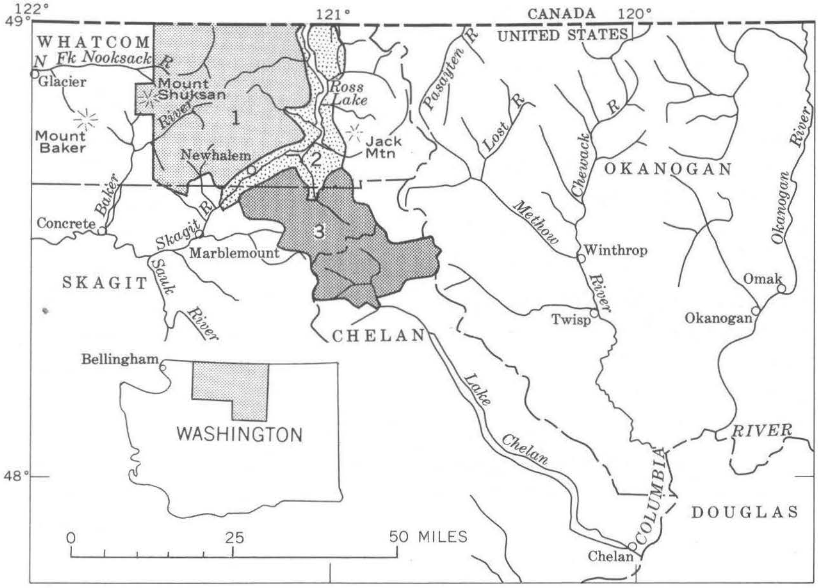
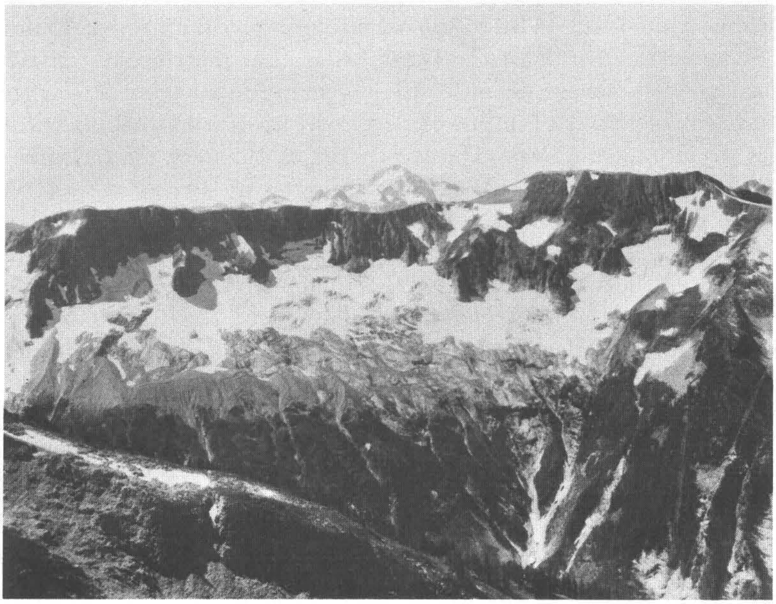


FIGURE 1.—Location of the North Cascades National Park, which is divided into a northern part (1) and a southern part (3) by the Ross Lake National Recreation Area (2). The area covered by this report includes the northern part of the park (1) and that part of the recreation area (2) that is north of the Skagit River and west of Ross Lake.

valleys are densely forested with dark-green conifers, and parts of most stream bottoms have light-green tangles of vine maple, alder, and devilsclub.

The climate is moderately cool and wet. Summer temperatures range from warm to cool; winter temperatures are cold. Precipitation ranges from about 70 to 110 inches a year, with a general increase from east to west. August is the driest month and generally the best time to visit the national park. Most of the precipitation comes as snow that in some of the higher areas accumulates to as much as 30 feet thick. Snow generally covers most of the area between mid-October and late May. Trails over some of the high passes, such as Hannegan and Whatcom Passes, may not be free of snow until mid-July.

Several roads approach the northern part of the park from the north, south, and west. Ross Lake, on the east border, may be reached from the north by 40 miles of secondary road from Hope, British Columbia, or from the south by 27 miles of road up the Skagit River from Marblemount, Wash. The latter road, which is part of the trans-state highway (Washington Highway 20), runs along the south shore of Ruby Arm of Ross Lake. The western part of the park may be ap-



A

B

Figure 2.—Glaciers in the North Cascades National Park. *A*, Small glaciers that hug the steep north slopes of Easy Ridge. Pioneer Ridge in background. *B*, Glacier at head of Depot Creek cirque on the northeast side of Mount Redoubt.

proached from Canada by following a logging road up Slesse (Silesia) Creek to within 1 mile of the U.S. border. The most used approach is from the west, where 48 miles of paved highway from Bellingham, Wash., connects with 5 miles of dirt road up Ruth Creek to within 4 miles of Hannegan Pass. The west edge of the area may also be approached from Concrete, Wash., by 20 miles of dirt road past Baker Lake to its end on Baker River. Many of these roads lead to trails that provide the main access to the area. Trails up Baker River and Silesia Creek enter the western and northern edges of the national park. A main trail into the area goes from the end of the Ruth Creek road across Hannegan Pass and down the Chilliwack River. A branch of this trail crosses the Picket Range at Whatcom Pass and continues down Little Beaver Creek to Ross Lake. In the upper part of Little Beaver Creek, another branch of the trail follows Big Beaver Creek to the dam on Ross Lake. A detailed outline of trails and climbing routes in this area is given by Tabor and Crowder (1968).

PREVIOUS GEOLOGIC STUDIES

Geologic work in the northern part of the North Cascades National Park has been mainly of a reconnaissance nature. Daly (1912), between 1901 and 1906, made a reconnaissance map of a strip about 2 miles wide along the Canadian border. Misch (1952, 1966) studied parts of this area and published two geologic maps, at scales of 1:713,940 and 1:533,550, that include this area. More detailed work includes a thesis by Shidler (1965), who described the geology on either side of Silver Creek, and a description of the copper-molybdenum property on Silver Creek by Purdy (1954, p. 87–88). This and two other molybdenum properties in Sulphide basin were described by Moen (1969, p. 76–78).

PRESENT STUDIES

The present study began in 1965 as a mineral survey of the North Cascade Primitive Area. The mineral survey was undertaken in response to the Wilderness Act (Public Law 88–577, Sept. 3, 1964) and the Conference Report on Senate Bill 4, 88th Cong. and had as its objective an appraisal of the mineral potential of the primitive area. The work consisted chiefly of reconnaissance geologic mapping and extensive sampling. Sediment samples were taken along the major streams and most of the tributaries. Areas of altered or mineralized rock that were found were sampled, as were all known prospects and accessible mine workings. County courthouse records were searched for information on recorded claims, and a further search for these claims was made in the field.

Public Law 90–544, Oct. 2, 1968, 90th Cong., abolished the North Cascade Primitive Area and established the North Cascades National Park, Ross Lake Recreation Area, and Pasayten Wilderness. The part of the former primitive area lying east of Ross Lake was included in the Pasayten Wilderness. Our studies of the Pasayten Wilderness and certain adjacent lands and of the eastern part of the Ross Lake Recreation Area are described in another report (Staatz and others, 1971). The present report concerns the part of the former primitive area west of Ross Lake, most of which is now part of the North Cascades National Park.

The geology of the northern part of the North Cascades National Park is shown on plate 1, and the sample localities are shown on plate 2. The area is covered by planimetric and topographic maps on several different scales. Two topographic maps at a scale of 1:24,000 (Ross Dam, Diablo Dam) cover the southeast corner of the area; all or parts of four topographic maps at a scale of 1:62,500 (Mount Shuksan, Mount Challenger, Lake Shannon, Marblemount) cover the western two-thirds of the area. Most of the eastern part of the area is not covered by a large-scale topographic map. The whole area is covered, however, by all or parts of six U.S. Forest Service planimetric maps at a scale of 1:62,500. These maps were used for plotting our sample localities (pl. 2) and for field mapping. The only topographic map that covers the entire area is the U.S. Geological Survey Concrete sheet at a scale of 1:250,000 which was enlarged to a scale of 1:200,000 and used as a base for the geologic map (pl. 1).

ACKNOWLEDGMENTS

The daily use of a helicopter made possible extensive coverage of the area in a short time, and we owe much to the skill of two pilots, Robert Nokes and Emery Lamunyon. Fieldwork was carried out from late June to early September of 1966 and 1967. We were assisted in the field during the summer of 1966 by B. O. Culp, R. G. Smith, E. E. Loeb, and Russell Robinson, Jr., and during the summer of 1967 by E. E. Loeb, D. O. McKeever, J. H. Hanley, and J. W. Harbuck. During both summers C. L. Whittington operated a mobile geochemical laboratory in the field. He was assisted by W. H. Raymond, Jr., in 1966 and by E. K. Ragsdale in 1967. For a week during the summer of 1967, D. J. Grimes, R. T. Hopkins, and R. P. Hannan operated a mobile spectrographic laboratory at our base camp.

Samples collected by the U.S. Bureau of Mines were analyzed for gold and silver by the atomic absorption method by W. A. Barry in the laboratory of the Bureau of Mines, Reno, Nev. Copper, molybdenum, lead, and zinc analyses of these samples were made by colorimetric methods by Peter Mack of Wallace, Idaho.

GEOLOGY

By MORTIMER H. STAATZ, ROWLAND W. TABOR, PAUL L. WEIS, and JACQUES F. ROBERTSON, U.S. Geological Survey

Great expanses of highly deformed metamorphic rocks, thick piles of weakly deformed volcanic rocks, and thin accumulations of sedimentary rocks are all intruded by the varied intrusive rocks of the Chilliwack composite batholith. The batholith forms a medial belt that separates metamorphic and volcanic rocks on the east from a different suite of rocks on the west.

ROCKS IN THE EASTERN PART OF THE AREA

CUSTER GNEISS OF McTAGGART AND THOMPSON (1967)

The Custer Gneiss of McTaggart and Thompson (1967) is the oldest rock unit known in the area. This unit, which is principally made up of biotite and hornblende gneisses, forms the bedrock in the southeast quarter of the area and from there northwestward is present as isolated remnants surrounded by batholithic rocks. These remnants indicate the approximate former extent of the gneiss. Unconformably overlying the gneiss are the Skagit Volcanics (fig. 3) in the northeast part of the area and the Hannegan Volcanics in a small area in the central part. The gneiss is bounded in the east-central part of the area by metagabbro. The structural and age relations of that contact are obscure.

Outcrops of the gneiss along the Canadian border were originally named the Custer Granite Gneiss by Daly (1912, p. 523–526). The name was modified to Custer Gneiss by McTaggart and Thompson (1967, p. 1205–1219), who mapped the rocks in British Colombia and traced them 30 miles north of the U.S. border. These or similar gneisses can be traced southeastward for at least 45 miles to Lake Chelan, where they have been correlated with the pre-Upper Cretaceous Swakane Biotite Gneiss (Cater and Wright, 1967). Misch (1952, p. 12–14) called these rocks Skagit Gneiss, but the name Skagit had been previously used by Daly (1912, p. 528–531) for the volcanic sequence along the Canadian border.

The Custer Gneiss of McTaggart and Thompson is a well-foliated rock, the foliation of which has a general northwesterly strike and a steep dip. The rock is made up principally of varying proportions of five rock types: (1) light-colored biotite and hornblende-biotite gneiss, (2) dark biotite and biotite-hornblende gneiss and schist, (3) amphibolite-gneiss, (4) marble and calc-silicate rocks, and (5) light-colored quartz diorite. The gneisses and marbles are commonly interlayered, and in many areas sills, dikes, and irregular masses of light-colored

FIGURE 3.—Custer Gneiss (cg) overlain by Skagit Volcanics (Ts) on west side of a spur of Glacier Peak.

quartz diorite are intimately intruded into the older rock types (fig. 5*B*). Combinations of these different rock types form three distinctive units within the Custer Gneiss (pl. 1). These units are (1) light-colored gneiss consisting predominantly of light-colored biotite and biotite-hornblende gneiss with abundant light-colored quartz diorite dikes, sills, and irregular masses, (2) banded gneiss consisting of alternating layers of light-colored biotite and hornblende-biotite gneiss with dark biotite and biotite-hornblende gneiss that is intruded by numerous dikes and sills of light-colored quartz diorite, and (3) amphibole-rich gneiss consisting of alternating layers of amphibolite with the light-colored biotite and biotite-hornblende gneiss. The marble and calc-silicate rocks occur in the amphibole-rich gneiss, and where the marble is thick enough it is delineated on plate 1.

The five rock types that make up these three units are first discussed, and then a general overall description of each unit is given.

The light-colored biotite and hornblende-biotite gneiss ranges from a strongly foliated rock, with thin anastomosing folia of biotite and (or) hornblende between lenses of plagioclase and quartz, to a faintly lineated granitoid rock (fig. 4*A*, *B*). Typically, this gneiss is composed of about 15–30 percent quartz, 45–60 percent andesine, 10–15 percent biotite, 0–10 percent hornblende, 1 percent or less potassium

FIGURE 4.—Custer Gneiss. *A*, Uniform biotite gneiss exposed on the north side of McMillan Spire. *B*, Closeup of uniform biotite gneiss. This is a layer in the banded gneiss unit on the south ridge of Davis Peak. *C*, Recrystallized

feldspar, and 1–2 percent garnet, apatite, allanite, sphene, magnetite, and zircon. Plagioclase tends to form larger zoned crystals set in a matrix of finer quartz and biotite. Recrystallized mylonite in the light-colored gneiss crops out in several places, including areas on Luna Peak and Mount Redoubt (fig. 4*C*). In these rocks, subrounded plagioclase grains, as much as 5 mm long, are set in a streaked-out matrix of very fine grained quartz and plagioclase with thin lenses of biotite-hornblende aggregate. The theoretical petrology of the gneisses is discussed by Misch (1968).

The dark biotite and biotite-hornblende gneiss and schist are generally brown or green and are finer grained and more schistose than the light biotite and hornblende-biotite gneiss. Although the rocks

mylonite in the banded gneiss unit northwest of Mount Redoubt. Large rounded white masses are of light-colored quartz diorite; small white masses are of feldspar.

range in composition from biotite-quartz schist to a biotite-hornblende gneiss, they are mostly made up of 20–50 percent biotite, 10–25 percent hornblende, 50–80 percent plagioclase, and 10–30 percent quartz. Some contain as much as 10 percent garnet. Potassium feldspar is rare. Magnetite, apatite, sphene, and zircon are minor accessory minerals.

The amphibolite is a dark-green rock with a well-defined lineation. It consists principally of hornblende and plagioclase and grades into biotite-hornblende gneiss by an increase of biotite and decrease in hornblende content. This rock consists of 25–55 percent hornblende, 30–70 percent plagioclase, and minor amounts of quartz, chlorite, magnetite, sphene, and ilmenite.

The marbles and related calc-silicate rocks form relatively thin layers or lenses that are rarely more than a few hundred feet thick. Marbles are white to gray, fine to coarse grained, and commonly banded. Marble layers in upper Pass Creek (east of Whatcom Pass) contain as much as 10 percent reddish-brown andradite that occurs in aggregates as large as an inch in diameter. The calc-silicate rocks consist principally of clinopyroxene, andradite, idocrase, calcic plagioclase, and epidote with accessory sphene, apatite, graphite, and magnetite.

The light-colored fine- to coarse-grained quartz diorite forms dikes, sills, and irregular masses (fig. 5) that are the most ubiquitous and distinctive rocks in the Custer Gneiss. Although this rock type is common, only locally does it make up more than about 30 percent of any unit. The quartz diorite is made up almost entirely of plagioclase and quartz, and it owes its white color to its very low content of mafic minerals, which seldom exceed 5 percent of the rock. The contacts with other rock types range from gradational (fig. 5*A*) to sharply crosscutting (fig. 5 *B*).

Two or more of these rock types make up the three units in the Custer Gneiss that are described in the following paragraphs.

LIGHT-COLORED GNEISS

Although the light-colored gneiss is predominantly light-colored biotite and biotite-hornblende gneiss and light-colored quartz diorite, it locally contains some dark biotite and biotite-hornblende gneiss.

The light-colored gneiss varies from place to place. In some areas, such as in the Crescent Creek and Terror Creek cirques, the rock is fairly uniform, consisting mainly of light-colored biotite and hornblende-biotite gneiss. In other areas, the light-colored biotite and biotite-hornblende gneiss forms a migmatite with the quartz diorite. The contacts of these two rock types may be either gradational or crosscutting. Some of this light-colored gneiss contains small irregular bodies of darker rock. Those bodies rich in biotite may have been derived from an older gneiss; those rich in hornblende may be pieces of metamorphosed dikes. Swirls and contortions of the light-colored gneiss suggest plastic deformation. Crosscutting contacts and rotated inclusions give evidence of movement.

A faint lineation formed by spindle-shaped aggregates of biotite and hornblende is the most consistent structural element. Foliation where detectable parallels this lineation. Divergent structural elements are also common, especially in areas of multiple intrusion. For instance, in the northern part of the Picket Range a conspicuous subhorizontal layering, made by swarms of light-colored quartz diorite dikes, crosscuts the steeply southwest dipping foliation.

BANDED GNEISS

The banded gneiss is the most common unit in this area. It is particularly conspicuous in the Mount Redoubt area, where hornblende-rich layers are commonly stained with iron oxides. In some areas, as on Luna Peak and in the Mount Redoubt area, the banded gneiss has been thoroughly granulated before or during metamorphism (fig. 4*C*). Multiple intrusion of quartz diorite into the gneissic rocks formed migmatites in the banded gneiss that are similar to but somewhat darker than those formed in the light-colored gneiss.

Foliation in the banded gneiss is parallel to the compositional layering; locally both are contorted. Fold axes of the contortions are relatively uniform, plunging gently southeast. They parallel both the lineation formed by several sets of joints and the alinement of sausage-shaped rods of light-colored quartz diorite that commonly are found along fold crests.

AMPHIBOLE-RICH GNEISS

The amphibole-rich gneiss is commonly banded and is gradational with the banded gneiss. The two were arbitrarily separated in mapping on the basis of the hornblende content. Light-colored quartz diorite intrusions are not common in this unit, although on the ridge west of Pierce Creek (east of Sourdough Lake) thin crisscrossed dikes of quartz diorite have produced a spectacular "breccia." The amphibole-rich gneiss is also somewhat limy, and it is in this unit that the marble and calc-silicate rocks occur. Limy rocks crop out sporadically in a belt from the head of Pass Creek (east of Whatcom Pass) to Ross Dam (pl. 1). Fine- to coarse-grained marble crops out in discontinuous lenses as much as 200 feet thick near the center of the unit. An anthophyllite-phlogopite schist in Arctic Creek may have been formed by metamorphism of dolomitic rocks.

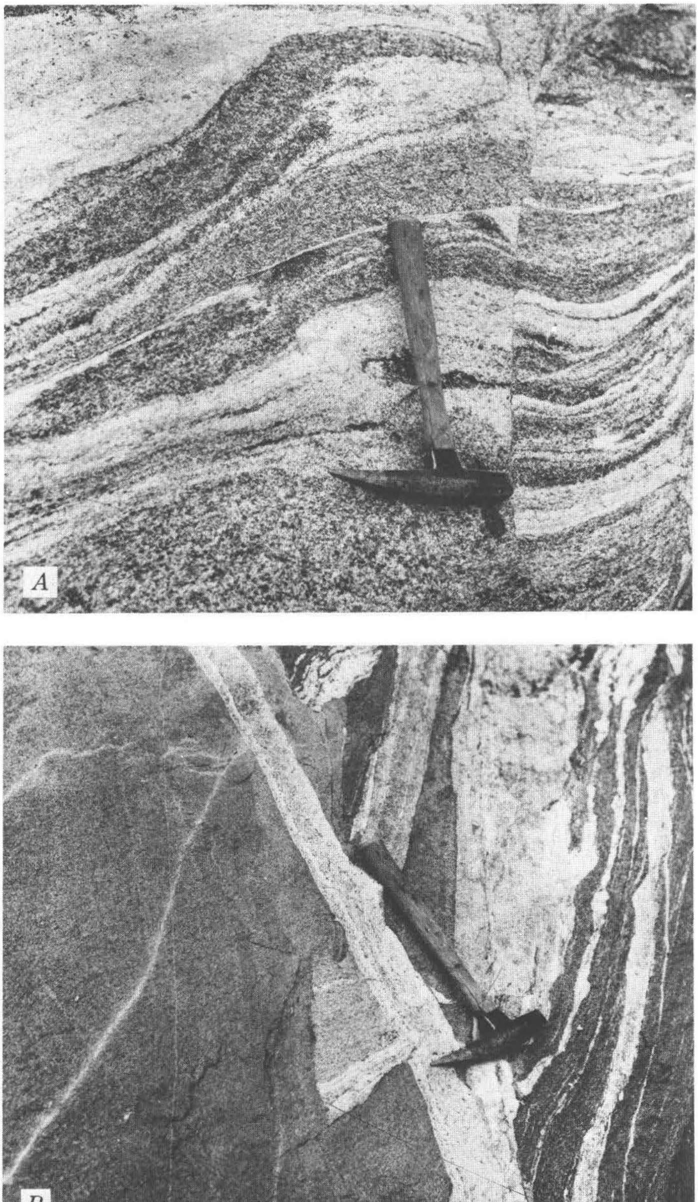


FIGURE 5.—Custer Gneiss. *A*, Swirled banded gneiss made up of layers of dark and light-colored biotite gneiss. White rock under pick handle and in upper left-hand corner is light-colored quartz diorite. Picture taken on south ridge of Davis Peak. *B*, Fairly uniform biotite gneiss crosscuts banded gneiss on

Like the banded gneiss, the amphibole-rich gneiss is characteristically well-foliated parallel to compositional layering. Although most of the folds plunge southeast, on the ridge north of Arctic Creek foliation and compositional layers are folded into broad northwest-plunging folds.

ORIGIN AND AGE

The history of the Custer Gneiss of McTaggart and Thompson has been long and involved. As Misch (1952, p. 12) previously noted, the rocks appear to have a sedimentary and volcanic origin. Some of the layers, such as marble, calc-silicate rock, and amphibolite, were obviously derived from such a source. Interlayered biotite and hornblende-

the south ridge of Davis Peak. Dikes and sills are light-colored quartz diorite. *C*, Banded gneiss made up of layers of dark biotite gneiss in light-colored biotite and hornblende gneiss on the south ridge of Davis Peak. Whitest layers are light-colored quartz diorite.

biotite gneiss and other rocks also appear to be primary compositional layers. The light-colored quartz diorite that is intimately intermixed with these layers may have been derived from an external igneous source or they may have formed during the intense metamorphism by being segregated from the gneiss itself.

Broken and granulated rocks indicate that the deformation was severe and that it occurred after most metamorphic crystallization. Most of the metamorphism preceded the intrusion of the Chilliwack batholith, although some recrystallization is due to heating by this underlying batholith. Obvious thermal metamorphism, such as the formation of fine-grained directionless aggregates of biotite, quartz, and plagioclase, is limited to a few hundred feet from the contact or to relatively small roof pendants or embayments, as on Pioneer Ridge or east of Wiley Lake (east of Whatcom Peak).

The Custer Gneiss is one of the oldest rock units in this area. Little, however, is known of its age. In the northern part of the area, it is cut by intrusions of the Chilliwack composite batholith that are of early Tertiary age. Near Lake Chelan, F. W. Cater (oral commun., 1967) noted that the correlative Swakane Biotite Gneiss is intruded by quartz monzonite of Late Cretaceous age. Hence, it is at least as old as Cretaceous and probably much older.

METAGABBRO

West of Ross Lake, along the northeast side of the Custer Gneiss, is an elongate mass of rock approximately 5,000 feet wide that is predominately metamorphosed hornblende gabbro. This rock body can be traced northwestward for 7½ miles from Ross Lake across the headwaters of Skymo and Noname Creeks to Arctic Creek.

The metagabbro lies between the Custer Gneiss and the phyllite and schist of Ross Lake; north of Arctic Creek it is cut off by quartz diorite of the Chilliwack batholith (pl. 1).

The metagabbro is along the Ross Lake fault zone, and continued movement since the emplacement of the metagabbro is indicated by extensive shearing within the unit. The contact with the Custer Gneiss is interpreted as an intrusive contact, but as it is not exposed and is in an area of shearing, it might well be a fault. Along its northeast side the metagabbro is faulted against the phyllite and schist of Ross Lake and in places is imbricated with it.

In addition to the predominant metamorphosed hornblende gabbro, the mass contains irregular bodies of pyroxene gabbro, hornblende diorite, schistose amphibolite, and ultramafic rock, all of which, at one place or another, have been intruded by dikes of light-colored quartz diorite and dark-gray porphyry. The close association of gradational contacts betwen these rocks indicates that they are probably all facies of the same gabbroic intrusive.

Most of the hornblende metagabbro is massive; locally, it is gneissose or schistose or sheared in zones a few inches wide. The gabbro consists of 50–60 percent labradorite (locally bytownite) surrounded by large pale-brown crystals of hornblende partially altered to actinolite. Relict clinopyroxene and hypersthene in the amphibole probably were the dominant mafic minerals in the original rock. Commonly the plagioclase is crushed and the amphibole squeezed into well-defined microshears.

The pyroxene gabbro is generally fine grained and consists of about 50 percent labradorite and 50 percent clinopyroxene. In many places the pyroxene is in part pseudomorphically replaced by pale-brownish-green hornblende and actinolite, and in other places it is replaced by clay minerals and calcite.

Hornblende diorite makes up most of the metagabbro along Ross Lake. This rock consists of plagioclase, brown hornblende (partially altered to actinolite), sphene, ilmenite, and chlorite. The rock is commonly sheared and crisscrossed by thin zones of mylonite. Zones of fine-grained schistose amphibolite occur in some of the crushed diorite.

Ultramafic rocks are found north of Noname Creek, where large pods of plagioclase-bearing pyroxenite several hundred feet across occur in the hornblende gabbro. North of Skymo Creek small pods of dunite a few inches to several feet across and larger irregular masses of dunite of unknown extent crop out near the eastern contact of the metagabbro. Olivine, minor phlogopite, ilmenite, and magnetite are primary minerals. Late alteration products are prehnite, cummingtonite, calcite, and chlorite.

Light-colored quartz diorite similar to that found in the Custer Gneiss cuts the metagabbro on the ridge southeast of Arctic Creek and contains inclusions of hornblende gabbro and metamorphosed dark-gray porphyry.

The age of the metagabbro is not known. It is older than the rocks of the Chilliwack batholith of Tertiary age, which cut it north of Arctic Creek. It is also older than the regional metamorphism and the light-colored metamorphosed quartz diorite dikes. These metamorphosed dikes cut only the Custer Gneiss and the metagabbro; thus the metagabbro is probably one of the older rock units in the area.

PHYLLITE AND SCHIST OF ROSS LAKE

Phyllite and schist crop out along the broad Ross Lake fault zone between the Hozomeen Group of Carines (1944) to the east and the metagabbro (pl. 1). These rocks form a belt, which for most of its length of 5.5 miles is 2,000–3,000 feet wide and which extends from Ross Lake northwest to the ridge south of Arctic Creek. The rocks are separated from the metagabbro and from most of the Hozomeen Group by faults. A fault within the unit separates the more phyllitic rocks to the northeast from the more schistose rocks to the southwest. Other parts of the unit also have been sheared by fault movement. South of Skymo Creek the schist and phyllite are in normal contact with the Hozomeen Group. There phyllites, similar to those seen in the phyllite and schist unit, are interbedded with the greenstones in the upper part of the Hozomeen. On the ridge south of Arctic Creek, the phyllite and schist are cut off by rocks of the Chilliwack batholith (pl. 1).

The phyllite and schist are principally metamorphosed sedimentary rocks that were cut by igneous rocks before both were metamorposed. Most of the sedimentary rocks were originally argillites with some arkose beds. Metamorphism is complex and appears to be in part dynamic and in part thermal. The grade of metamorphism gradually increases from northeast to southwest, with a change from phyllite to various types of schists. Across faults, however, changes are commonly abrupt.

Most of the phyllites along the northeast side of the belt are black and strongly foliated. Foliation generally parallels bedding, and both are tightly folded. Some rocks, however, have several crosscutting foliations. Typical phyllite contains mostly quartz and feldspar.

Near the center of the belt, biotite schist is commonly found with the phyllite. Both are brown to black and have strong foliation. The schist contains quartz, plagioclase, sericite, pale-green to brown biotite, chlorite, and magnetite. Although these rocks have been recrystallized, some rocks have rounded composite grains of quartz and feldspar that may be relict sand grains.

More thoroughly metamorphosed rocks in the southwestern part of the belt are separated by a major fault from phyllite and schist to the northeast. Here, fine-grained biotite and hornblende-biotite schist are made up of quartz, plagioclase, biotite, green hornblende, calcite, apatite, and magnetite. Biotite commonly occurs as large crystals, which are set in a finer grained matrix. Some of the rocks have been granulated and later recrystallized. Only a few of the rocks have relict sedimentary clastic textures.

Scattered along the southwest side or the belt are outcrops of cordierite(?)-garnet-sillimanite schist, andalusite-biotite schist, and sillimanite-garnet-biotite schist. Some of these high-rank schists are associated with quartz diorite intrusions. Most of these schists have also been granulated and partially recrystallized. During this process the sillimanite and garnet crystals were crushed and locally replaced by biotite; andalusite crystals are partially or completely pseudomorphically replaced by sericite and muscovite.

Amphibole-rich rocks on the ridge south of Arctic Creek range in composition from fine-grained hornblende-plagioclase schist that is rich in sphene and calcite to a fine-grained anthophyllite-rich rock.

Several bodies of foliated and nonfoliated metamorphosed quartz diorite intrude the schists and phyllites. The intrusive character of this rock is demonstrable in a body in the southern part of the area just west of Ross Lake that contains numerous schist inclusions and in a body on the ridge south of Noname Creek that has chilled margins and has metamorphosed porphyry dikes extending from the quartz diorite body into the surrounding schist. The quartz diorite is composed of 50 percent plagioclase, 30 percent quartz, 5 percent potassium feldspar, and 15 percent biotite and hornblende, as well as accessory sphene, apatite, magnetite, and zircon. The dike offshoots have essentially the same mineralogy and texture, but they are finer grained and more schistose. Nonfoliated quartz diorite within or intimately mixed with schist just west of Ross Lake contains cordierite, garnet, and sillimanite. Clots of white mica surrounding spinel dot the rocks.

Light-colored metaporphyry dikes and sills, ranging from rhyolite to dacite in composition, occur throughout the southwestern part of this unit. Although these rocks have been recrystallized, the dikes commonly contain relict phenocrysts that are either broken crystals of potassium feldspar, zoned plagioclase, or aggregates of quartz and plagioclase. The metaporphyry sills and surrounding schist are commonly tightly folded.

The phyllite and schist unit is also known east of Ross Lake, though no schist is present there (Staatz and others, 1971). From Ross Lake the unit can be traced eastward along Canyon Creek around the south end of the outcrop of the Hozomeen Group of Cairnes. Its metamorphic grade decreases eastward, and the rock gradually changes from a phyllite to an unmetamorphosed argillite, which is part of the thick "plagioclase arkose and argillite sequence" that underlies much of the Pasayten Wilderness (Staatz and others, 1971, pl. 1). Misch (1966, p. 115) also noted this gradual change from argillite to phyllite and referred to the phyllitic part of this sequence as the Jack Mountain Phyllite. The plagioclase arkose and argillite sequence has been traced northward into British Columbia, where Coates (1967) collected fossils from the sequence that ranged from Early Jurassic to latest Early Cretaceous in age.

The quartz diorite and metaporphyry intrusions are somewhat younger than the phyllite and schist, but they preceded the metamorphism.

HOZOMEEN GROUP OF CAIRNES (1944)

The Hozomeen Group of Cairnes (1944) consists of a thick sequence of slightly metamorphosed mafic lavas (greenstones) with subordinate chert, phyllite, argillite, and mafic intrusives. The Hozomeen characteristically forms rubbly dark-green cliffs, locally marked by white slashes where chert is present. Weathered outcrops are commonly yellowish brown. These rocks extend in a northwest-trending belt diagonally across Ross Lake, from about 1 mile north of Ruby Creek northward into Canada. The greater part of this unit lies on the east side of Ross Lake; west of Ross Lake it is exposed in a belt 2.5 miles wide for a distance of 8 miles (pl. 1).

This thick sequence of rocks was originally named the Hozomeen Series by Daly (1912, p. 500) after the prominent mountain of that name on the east side of Ross Lake. Later the name was modified to Hozomeen Group by Cairnes (1944). In British Columbia, the Hozomeen has been divided into four lithologic units by McTaggart and Thompson (1967, p. 1199–1205), who made the most detailed study of these rocks to date.

In the United States, the greater part of the Hozomeen Group of Cairnes is composed of greenstone that is generally dark green, but is locally greenish gray, dark purplish gray, reddish gray, or brown. In places differences in texture and composition produce a layering. The greenstone, which is mostly fine grained, is made up principally of plagioclase, hornblende, and actinolite, and lesser amounts of calcite, quartz, chlorite, zoisite, epidote, magnetite, and ilmenite. Prehnite is common in some places, and quartz, calcite, and zeolites fill veinlets. The greenstone on the west side of Ross Lake appears to be of a slightly higher metamorphic grade than that on the east side, for on the west side blue-green hornblende is found and actinolite is more common. Only a little of the original texture remains in the greenstones, inasmuch as many of these rocks are highly sheared and in some the original minerals have been entirely converted to hornblende or actinolite.

Here and there in the greenstone, gray to white banded chert forms layers and lenses that range in thickness from a quarter of an inch to several inches (fig. 6). North of Arctic Creek, near the contact with quartz diorite of the Chilliwack batholith, the chert is schistose and contains tiny red garnets. In addition to chert, lesser amounts of marble, metatuff, volcanic breccia, dark siltstone, and sandstone are part of this sequence. Also included in the greenstone along the west edge of Ross Lake are several masses of diabase and gabbro that may be sills. The coarser grained diabase and gabbro retain some of their original texture as well as such primary minerals as brown hornblende and clinopyroxene.

FIGURE 6.—Thin-bedded chert in the Hozomeen Group that crops out on the ridge between Noname and Skymo Creeks.

Bedding in most of the Hozomeen Group is obscure, but it can be defined by the chert (fig. 6), phyllite, metatuff, and argillite layers. As may be seen on plate 1, the Hozomeen rocks are folded into a broad northwest-plunging syncline. The Hozomeen is considered to lie conformably on the schist and phyllite of Ross Lake and hence to be younger than that unit, whose age is Jurassic to Early Cretaceous. The Hozomeen Group is clearly older than the Skagit Volcanics and the Chilliwack batholith, which are largely if not entirely of Tertiary age. The contact of the Hozomeen Group with the schist and phyllite of Ross Lake is a fault at most places; however, near Skymo Creek the contact appears to be normal, and the presence of phyllite in that area in both units suggests a depositional gradation of one into the other.

Inasmuch as few firm data are available on the age of the Hozomeen Group, several age correlations have been suggested. Some geologists (Smith and Calkins, 1904, p. 23; Daly, 1912, p. 502) have tentatively correlated the Hozomeen Group of Cairnes with the Cache Creek Series because of the presence of greenstones and fine-grained sedimentary rocks in both units. The Cache Creek, which occurs in southeastern British Columbia, has been dated as Permian, although the lower part may be Pennsylvanian (Armstrong, 1949, p. 50). Misch (1966, p. 133) considered the Hozomeen Group to be Permian in age, and he explained its position on top of the Cretaceous clastic rocks to be a result of thrusting. Daly (1912, p. 512) and Cairnes (1924, p. 42) also tentatively correlated the Hozomeen with the Chilliwack Series because of the presence of greenstones, pyroclastic rocks, and fine-grained sedimentary rocks in both units. The Chilliwack, which occurs 24 miles west of Ross Lake, ranges in age from Middle Devonian to Middle Permian (Danner, 1965; McGugan and others, 1964, p. 109). Misch (1966, p. 116), on the other hand, believes that only the pyroclastic and sedimentary rocks of the western part of the Hozomeen outcrop belt correlate with the Chilliwack and that these rocks underlie the Hozomeen Group. We believe that a post-Early Cretaceous age for the Hozomeen is supported by the synclinal position of the Hozomeen on top of the schist and phyllite of Ross Lake and by the presence of identical phyllite beds in both units.

SKAGIT VOLCANICS

An irregular elongate body of volcanic rocks extends for 6.5 miles along the Canadian border just west of Ross Lake (pl. 1). Flows, tuffs, and volcanic breccias form the precipitous Glacier Peak and part of the steep ridges on either side of Silver Creek. Daly (1912, p. 528–531) named the rocks Skagit Volcanic Formation after the Skagit River to the east, and we have modified this name to Skagit Volcanics.

On the east side of Depot Creek and south of Glacier Peak, the Skagit Volcanics overlie the Custer Gneiss (pl. 1), and southwest of the mouth of Silver Creek they overlie the Hozomeen Group. Dikes of quartz diorite of the Chilliwack composite batholith cut the Skagit Volcanics southwest of the mouth of Silver Creek and at the Weezie prospect on Silver Creek, 1.5 miles west of Ross Lake. However, a dike of volcanic rock cuts quartz diorite on the south side of Silver Creek.

The Skagit Volcanics are generally massive; their structure and thickness are poorly known. On the ridge north of Silver Creek, however, some thin-bedded tuffs dip from 50° NE. to 15° NW. The thickness of the Skagit from Silver Creek to the crest of the main ridge to the north is approximately 4,000 feet.

Most of the Skagit Volcanics along both sides of Silver Creek is massive gray ash-flow tuff-breccia. Lava flows also occur within the tuff-breccia and make up a great part of the unit in the Glacier Peak area. Thin-bedded light-colored air-fall tuffs are found along the ridgetop on the north side of Silver Creek.

The tuff-breccia is a hard welded rock with 5–30 percent angular rock fragments that range in width from about $\frac{1}{16}$ to 3 inches. The rock fragments are mainly of fine-grained volcanic rocks set in a matrix of ash and small mineral fragments. Plagioclase is by far the most abundant mineral. The flow rocks are all dark gray and consist of small crystals of plagioclase, generally with some hornblende, biotite, chlorite, and magnetite, set in a fine-grained groundmass of feldspar, quartz, and mafic minerals.

Air-fall tuffs are white, tan, light gray, or pale green; some are distinctly bedded. They consist of small angular fragments of volcanic rocks—commonly glass and minerals set in a matrix of ash. The mineral fragments are principally plagioclase, but quartz and epidote are also present. Glass shards are common in some of the ash.

Stain tests on the volcanic rocks showed the presence of potassium feldspar in the groundmass; thus, the composition of most of the rocks is probably that of a rhyodacite or dacite, although some may be andesite.

The Skagit Volcanics are probably early Tertiary in age. As they are only gently folded, they evidently were deposited after the more intense folding of the Lower Jurassic to Lower Cretaceous phyllite and schist of Ross Lake to the south. The Skagit is older than much of the quartz diorite of the Chilliwack batholith, as shown by the fact that it is cut by dikes of quartz diorite in several places. In one place on the ridge between Perry and Silver Creeks, however, a dike of Skagit Volcanics cuts the quartz diorite; thus, although the Skagit is for the most part younger than the Chilliwack batholith, it is in part older.

ROCKS IN THE WESTERN PART OF THE AREA

GREENSCHIST AND PHYLLITE OF MOUNT SHUKSAN

Fine-grained thinly foliated greenschist and black phyllite occur in a north-northwest-trending belt along the west edge of the area. The rocks are particulary conspicuous near Bacon Peak and in the vicinity of Mount Shuksan.

The greenschist is a bright to dark olive-green fine-grained generally evenly foliated rock with fine-scale compositional layering. In the vicinity of Bacon Peak most of this rock is an actinolite-chlorite schist with small amounts of epidote. On Mount Shuksan, epidote is more abundant and epidote-actinolite and actinolite-epidote schists are common. Other rock types noted in the greenschist unit are tremolite schist, stilpnomelane-muscovite schist, and crossite schist. In some areas thin quartz laminae are abundant (fig. 7). We did not find any relict texture except in a narrow irregular layer on the northeast side of Bacon Peak, where we found a conglomerate made up of white quartz pebbles set in a greenschist matrix.

The phyllite, on the other hand, is considerably more contorted and crinkled, with widespread development of lineation. Lenses and stringers of crinkled quartz are abundant (fig. 8). Much of this rock is a sericite-chlorite phyllite, but it ranges in composition from a garnet-sericite phyllite to a phlogopite phyllite. These minerals, except for garnet, form in thin wavy layers in a matrix of tiny quartz grains. Although relict sedimentary features are lacking in most of the phyllite, a metamorphosed layer of sandstone in the phyllite east of Berdeen Lake still has clastic textures.

FIGURE 7.—Well-foliated greenschist with numerous thin layers and lenses of quartz exposed on the north side of Sulphide basin.

This metamorphic unit is older than other adjacent rock types (Chuckanut Formation, Hannegan Volcanics, and rocks of the Chilliwack composite batholith) as evidenced by the following: (1) The greenschist and phyllite are metamorphosed, but the younger adjacent rocks are not metamorphosed, (2) the greenschist and phyllite are unconformably overlain by the Chuckanut Formation on the north side of Bacon Peak (fig. 9) and the south side of Hagan Mountain and by the Hannegan Volcanics on the ridge east of Sulphide Creek (fig. 10), (3) fragments and pebbles of greenschist and phyllite are found in the basal conglomerate of Chuckanut Formation on the north side of Bacon Peak and in the basal part of the Hannegan Volcanics on the ridge east of Sulphide Creek, and (4) the greenschist and phyllite are intruded by rocks of the composite Chilliwack batholith in Sulphide basin (fig. 10), in the headwaters of the North Fork of the Nooksack River, and along Crystal Creek. Nowhere is the greenschist and phyl-

FIGURE 8.—Crinkled phyllite containing numerous irregular white quartz lenses exposed south of Berdeen Lake.

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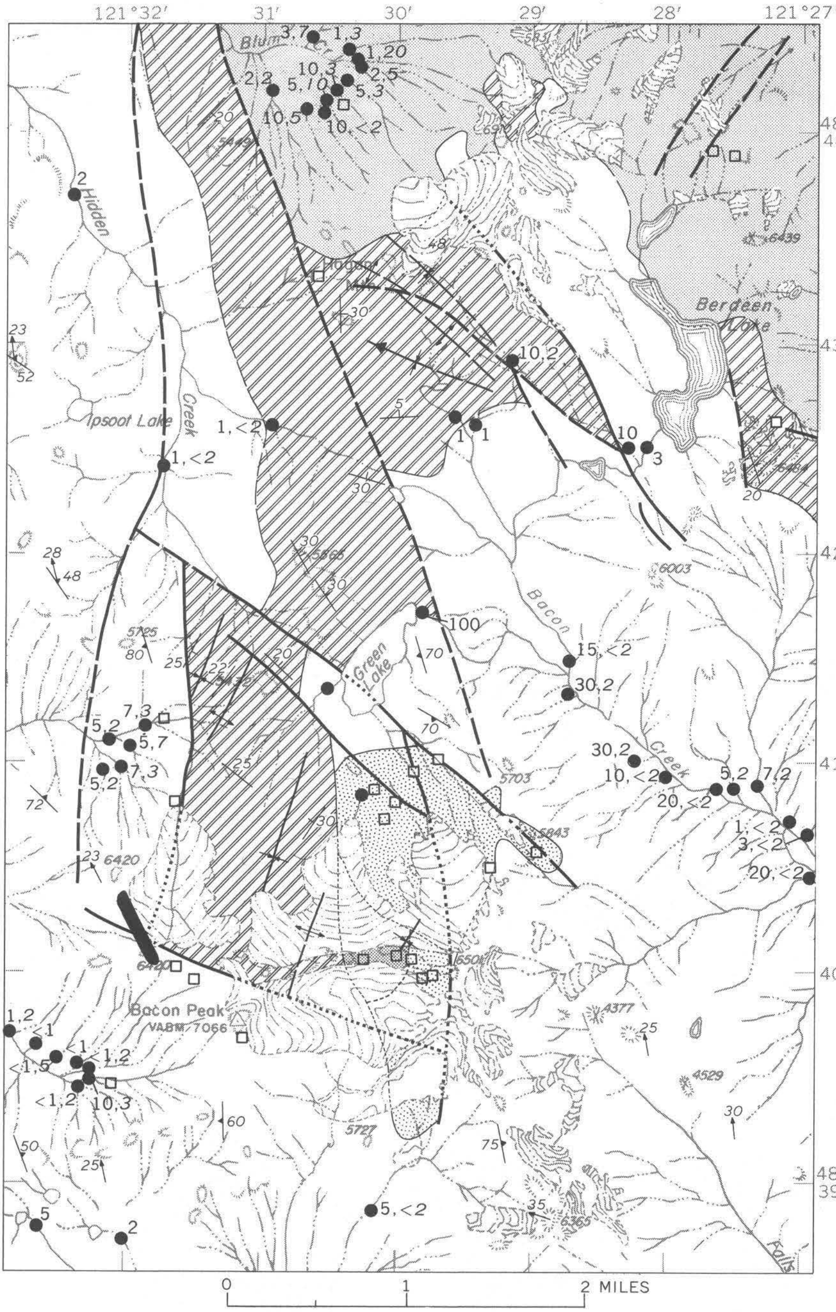


FIGURE 9.—Sample localities and general geology of the Bacon Peak–Hagan Mountain area.

lite of Mount Shuksan in contact with the metamorphic rocks of the eastern part of the study area, and their stratigraphic and structural relationship is not known.

The greenschist is distinct from the phyllite in part of the area, but in other parts the two are gradational and interlayered. Misch (1966, p. 109) divided the unit into the Shuksan Greenschist and the Darrington Phyllite. In the vicinity of Bacon Peak and Hagan Mountain, the two rock types are generally separated by faults that separate greenschist abruptly from phyllite. On Mount Shuksan, the two rock types, in addition to being faulted against one another, are interlayered and grade into one another. Misch (1966, p. 109) considered inliers of

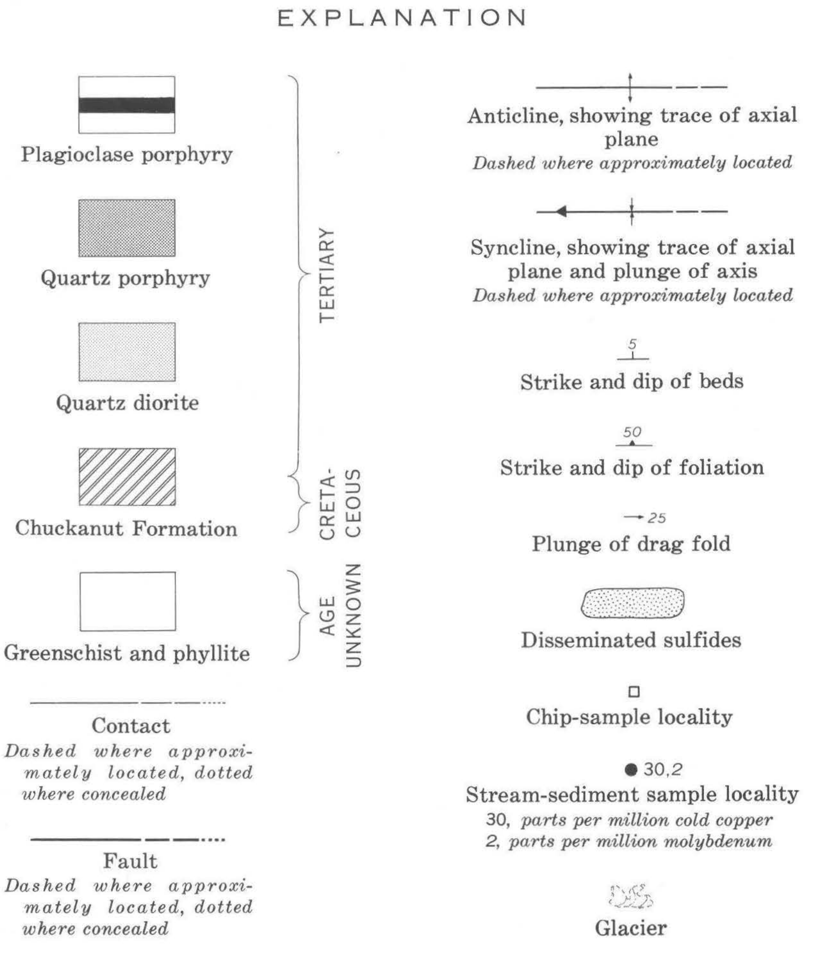


FIGURE 9.—Continued.

phyllite in the greenschist on the south slopes of Mount Shuksan to be the crests of tight anticlines. Many of these contacts, however, are high-angle faults. West of Mount Shuksan, just north of upper Curtis Glacier, greenschist layers occur in phyllite and phyllite layers in greenschist. Farther south, along the west branch of Sulphide Creek, rock to the west is clearly greenschist, and that to the east is clearly phyllite; between them a greenish-black rock with thin white quartz-rich layers appears to be gradational from phyllite to greenschist. Furthermore, on the ridge south of Sulphide Creek, greenschist grades into dark-gray phyllite irregularly across the strike of the foliation.

In most places the phyllite and the greenschist are of the same metamorphic grade, and the major difference between them is probably due to difference in original rock type. The greenschist may have formed

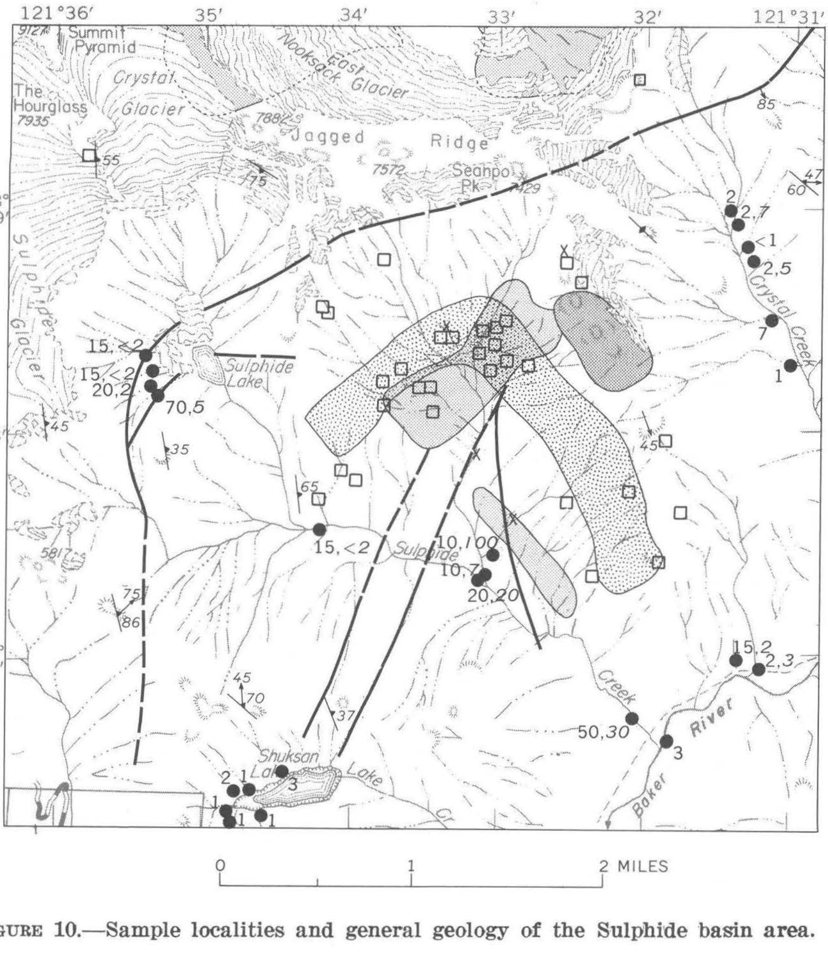


FIGURE 10.—Sample localities and general geology of the Sulphide basin area.

from metamorphism of a sedimentary rock such as graywacke. An alternate origin is put forth by Misch (1966, p. 109), who believes that the greenschist was formed by metamorphism of basaltic rocks. The phyllite most likely was formed by metamorphism of a sandy argillite. In the vicinity of Mount Shuksan some of the irregular changes may be due to thermal metamorphism by small granitic stocks after both the greenschist and phyllite were regionally metamorphosed. The later metamorphism is suggested by the abundance of epidote in some of the gradational type rocks and by unalined crystals of amphibole minerals, such as radial needles of actinolite or tremolite that are superimposed on other alined minerals.

Age of the greenschist and phyllite of Mount Shuksan is not known. It is the oldest rock unit in the western part of the study area and is older than the Chuckanut Formation of Cretaceous and Paleocene age. Two exploratory potassium-argon dates on crossite schist are reported by Misch (1966, p. 109). An age of 259±8 m.y. (million years) on a whole rock sample and an age of 218±40 m.y. on crossite are interpreted by Misch to indicate metamorphism no later than Late Permian time.

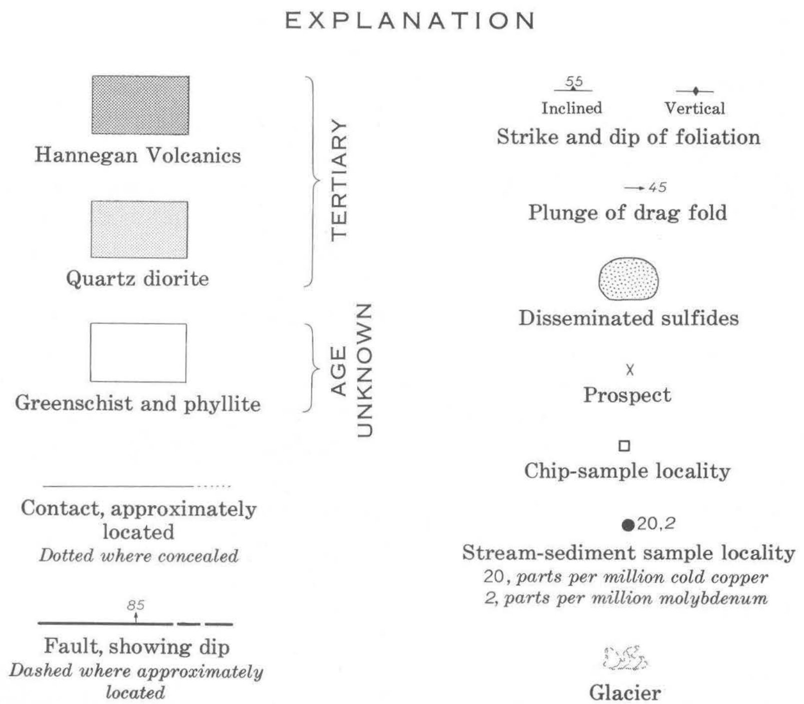


FIGURE 10.—Continued.

CHUCKANUT FORMATION

The Chuckanut Formation is composed mainly of plagioclase arkose and has lesser amounts of dark-gray argillite and conglomerate. Though widespread in northwest Washington, the Chuckanut occurs only in scattered patches in the study area, and these are mainly near the northwest and southwest corners. In the southwest, around Hagan Mountain and Bacon Peak, the Chuckanut lies with angular unconformity on the greenschist and phyllite of Mount Shuksan (pl. 1; fig. 9) and is intruded by quartz diorite of the Chilliwack batholith. In the northwest, in the Silesia Creek area, it is overlain by the Hannegan Volcanics and intruded by the Chilliwack batholith (pl. 1), which has baked the rocks to a spotted hornfels. In the Silesia Creek area, dikes and sills of the Hannegan Volcanics intrude the upper part of the Chuckanut Formation. About halfway between these two principal areas, on the ridge between Crystal and Pass Creeks, a small roof pendant (not shown on pl. 1) of metamorphosed Chuckanut surrounded by batholith suggests that the Chuckanut was once continuous along the west side of the study area.

The name Chuckanut Formation, herein adopted, was applied by McLellan (1927, p. 136–137) to rocks along Chuckanut Drive on the shore of Bellingham Bay. The formation has been traced east by Weaver (1937, fig. 11) and by Misch (1966, p. 136) to the west side of the Cascade Mountains.

Plagioclase arkose (fig. 11), the dominant rock type in the Chuckanut Formation, is typically gray and weathers to a light gray, but locally has a brownish tint. It is mostly medium grained, generally moderately well sorted, and commonly shows graded bedding and crossbedding. Poorly preserved fragmental plant remains appear on some bedding planes. Locally, concentrated layers of quartz are present, but all the sandstone seen was arkosic. Microscopic examination of the arkose shows it to consist of plagioclase (30–75 percent), quartz (15–50 percent), cherty and slaty rock fragments, brown detrital biotite, chlorite, and traces of zircon. No detrital potassium feldspar was found. Quartz, feldspar, and rock fragments are mostly angular to subangular.

Argillite layers (fig. 11) ranging in thickness from a fraction of an inch to more than 100 feet make up less than 10 percent of the Chuckanut Formation. The argillite is very fine grained, generally thin bedded, and black, dark gray, or dark grayish brown. Locally, it appears to be carbonaceous.

Conglomerate layers that range in thickness from a few inches to as much as 15 feet compose about 1 percent of the formation. Maximum pebble or boulder diameter is generally less than 4 inches, and in

FIGURE 11.—Arkoses interbedded with thin beds of black argillite of the Chuckanut Formation make up the north side of Bacon Peak. Glacier in foreground.

many layers it is less than 1 inch. Most of the conglomerate layers contain a high proportion of distinctive angular finely laminated chert pebbles, and all the layers are well cemented. Graded bedding is widespread. Basal conglomerate of variable thickness, exposed on the north side of Bacon Peak, consists principally of pebbles of the underlying greenschist, of quartz, and of a few pebbles of Custer Gneiss in a matrix of small greenschist fragments. Thus, the conglomerate was largely derived from the underlying greenschist.

At its type locality near Samish Bay, the Chuckanut Formation is over 11,000 feet thick (Weaver, 1937, p. 85–88), but in the western part of the study area most of the unit has been removed by erosion, and only about 700 feet remains of a much greater original thickness.

Fragmental plant fossils seen in the Chuckanut Formation in the study area are not diagnostic. However, fossil plants collected near the Puget Sound and south of the town of Glacier are believed to date the rocks as Late Cretaceous and Paleocene (Weaver, 1937; Miller and Misch, 1963). Thus, the Chuckanut is probably correlative with the Swauk Formation of the central Cascade Mountains and with part of the Nanaimo Group on Vancouver Island (Miller and Misch, 1963, p. 170).

HANNEGAN VOLCANICS

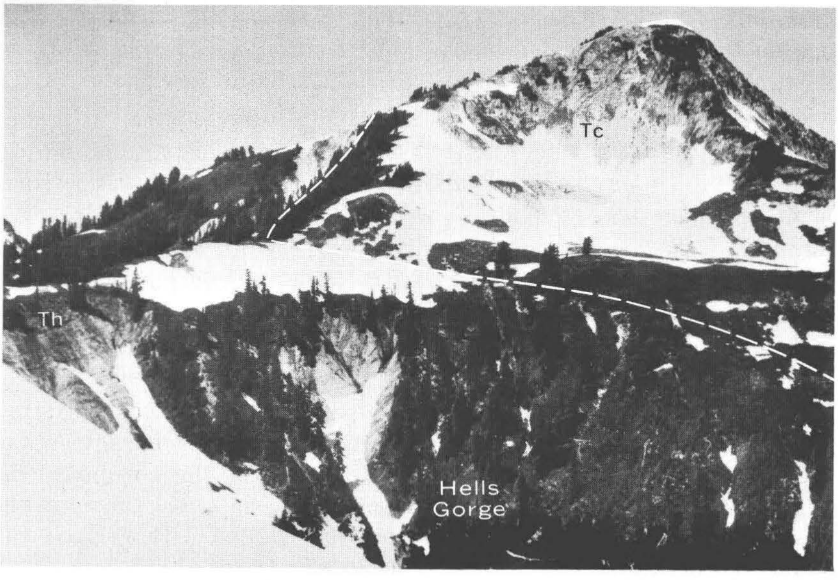
The Hannegan Volcanics (name adopted in this report) are present in several patches that extend from near the center of the area northwesterly for 17.5 miles to the Canadian border (pl. 1). The largest exposure has an outcrop area of 9.5 square miles and extends for about 6 miles from Hannegan Peak on the north to the headwater of Crystal Creek on the south. The unit was named by Misch (1952, p. 18) for the exposures in Hannegan Pass, which is in the northern part of the largest volcanic area; this location is the type area.

The upper part of the Hannegan Volcanics has been removed by erosion. The thickest remnant is along the headwaters of the Chilliwack River, where at least 2,500 feet of the unit is exposed.

The Hannegan Volcanics are composed mainly of volcanic breccias (fig. 12*A*) and tuffs ranging from rhyolite to andesite. Flows and (or) sills of rhyodacite, dacite, and andesite are common in many places. Dikes of similar rock cut the earlier volcanics in some places and are well exposed along the headwaters of the Chilliwack River. A small metaporphyry stock about 1 mile long on the Canadian border has also been included in the Hannegan.

The volcanic breccias and tuffs are partly ash flow and partly air fall, as in the area east of Hannegan Pass. The pyroclastic rocks are white, light gray, dark gray, greenish gray, or brown. Rock fragments make up 10–60 percent of the unit. In most places the fragments, which are

A



B

FIGURE 12.—Hannegan Volcanics. *A*, Volcanic breccia on Pioneer Ridge. Fragments are principally granodiorite, biotite schist, and dark-gray diorite. *B*, Hannegan Volcanics (Th) lap up against a hill of granodiorite (Tc) at the head of Hells Gorge, near the headwaters of the Chilliwack River.

as much as 1.5 feet in diameter, are of light- and dark-gray volcanic rocks, but in some places—such as the south side of Hannegan Peak, west of Sulphide Creek, and on Pioneer Range—they are mainly of the surrounding country rock. Small fragments of plagioclase (by far the most common), quartz, hornblende, and chlorite also may be present in the tuffs and breccias, the matrix of which is ash. The matrix of a welded rhyolite tuff on Hannegan Peak is composed almost entirely of flattened glass shards. Later alteration has formed clays in the matrix and epidote along fractures.

The flows are light to dark gray and are most commonly rhyodacite or dacite. They consist of as much as 50 percent small phenocrysts, mostly white rectangular crystals of plagioclase, set in a glassy or finely crystalline matrix. Magnetite, hornblende, and biotite are found in most rocks; quartz and clinopyroxene are sparse. The matrix is made up mainly of tiny crystals of quartz and feldspar. Chlorite, calcite, epidote, and prehnite are common secondary minerals in some of these rocks. Stain tests on some of the rocks show that potassium feldspar also occurs in the groundmass.

The small metaporphyry stock on the Canadian border on the west side of Middle Peak (pl. 1) may have been a feeder for the extrusive volcanic rocks to the west. The lenticular shape of this stock and the presence of near-vertical flow banding suggest that the stock is intrusive into metamorphosed granodiorite of the Chilliwack batholith that is exposed to the east (pl. 1). The stock is metamorphosed by a younger quartz diorite pluton of the Chilliwack that lies along its north and west sides. The metaporphyry is a black to dark-gray rock with altered plagioclase and hornblende phenocrysts set in a fine-grained matrix of quartz, plagioclase, potassium feldspar, and muscovite. Accessory minerals are apatite, sphene, and magnetite. Hornblende phenocrysts are generally replaced by aggregates of chloritized biotite and quartz. In one place adjacent to the quartz diorite, intense metamorphism has developed andalusite in the metaporphyry.

The Hannegan Volcanics overlie the Custer Gneiss along Pioneer Ridge, the greenschist and phyllite of Mount Shuksan on the east side of Sulphide Creek (fig. 10) and west of Hannegan Pass, and the Chuckanut Formation on both sides of Silesia Creek, and hence they are younger than these rocks. Furthermore, cobbles and fragments of these three units are found in the basal part of the volcanics (fig. 12*A*). Locally, as in the area adjacent to Silesia Creek, though, the lower parts of the volcanic rocks are interbedded with arkoses and argillites that may be part of the Chuckanut Formation. The Hannegan Volcanics are in part older and in part younger than the rocks of the Chilliwack composite batholith. An older age is indicated on the east side of the headwaters of Silesia Creek (near Egg Lake) and at the head of Picket Creek (north of Pioneer Ridge) where the volcanic rocks are cut by quartz diorite dikes. A younger age is indicated south of Hannegan Pass, east of Sulphide Creek, and on Pioneer Ridge where volcanic breccia contains fragments of quartz diorite. The volcanic rocks also unconformably overlie granodiorite and quartz diorite on Ruth Mountain, on the ridge north and northeast of Copper Creek (a tributary of the Chilliwack River east of Hells Gorge), and near the upper end of Hells Gorge (fig. 12*B*).

The age of the Hannegan Volcanics is Tertiary. As the base of the volcanic rocks in the Silesia Creek area is interbedded with the upper part of the Chuckanut Formation, the lower part of the volcanics in this area is most likely Paleocene.

The Hannegan Volcanics are apparently about the same age as the Skagit Volcanics, for both are in part older and in part younger than the adjacent granitic rocks. We have discussed them separately because, although they contain the same types of rocks, the proportion of air-fall to ash-flow deposits differs greatly from one to the other. Further detailed work on these two groups of volcanic rocks is needed to determine their relationship.

CHILLIWACK COMPOSITE BATHOLITH

The Chilliwack composite batholith consists of medium- to fine-grained granitic rock of various composition that was intruded during the Tertiary. Rocks of the Chilliwack batholith underlie approximately half the study area and extend continuously from the north to the south boundary (pl. 1). This batholith originally was named the Chilliwack granodiorite batholith by Daly (1912, p. 534–535) after exposures around Chilliwack Lake just north of the Canadian border. Misch (1966, p. 140–141) recognized the batholith as composed of several plutons of different ages and amended the name to the Chilliwack composite batholith.

The various intrusions that make up the Chilliwack composite batholith are clearly younger than most of the other rocks in the area and intrude the Custer Gneiss, the metagabbro, the phyllite and schist of Ross Lake, the Hozomeen Group, the greenschist and phyllite of Mount Shuksan (fig. 10), and the Chuckanut Formation (fig. 9). Some of the rocks of the Chilliwack, however, are younger and some are older than the Skagit Volcanics and the Hannegan Volcanics. The Skagit and the Hannegan Volcanics are cut by dikes of quartz diorite. The Chilliwack, in one place, is cut by a 25-foot dike of Skagit Volcanics, and in several places the Chilliwack batholith is overlain by the Hannegan Volcanics (fig. 12 B).

The batholith consists mostly of quartz diorite and granodiorite and has lesser amounts of quartz monzonite, diorite, gabbro, and alaskite. Differences in composition appear to be caused partly by differentiation within various plutons during cooling and partly by differences in the composition of the magmas.

Age differences between rock types of the Chilliwack composite batholith can be seen in many places. In general the diorite and gabbro bodies were the earliest formed and are commonly veined by the lighter quartz diorite and granodiorite. Inclusions of the diorite are also common in the lighter rocks (fig. 15*B*). In one place in the northwestern part of the area, banded diorite and gabbro grade into quartz diorite. On the south slopes of Mineral Mountain and on Easy Ridge, light-colored granodiorite intrudes quartz diorite, but on Bear Mountain the two rocks grade into each other. Quartz diorite is clearly younger than granodiorite in several other areas. On Pioneer Ridge intrusive breccia of the Hannegan Volcanics cuts granodiorite, but is in turn cut and metamorphosed by later quartz diorite. Similarly, on the west side of Middle Peak, metaporphyry intrudes an older granodiorite, but is metamorphosed by a younger quartz diorite. Dikes and small intrusives of alaskite cut the diorite, granodiorite, and quartz diorite in many places and are generally the youngest intrusive rocks. On the northwest side of the Chilliwack River northwest of the mouth of Easy Creek, however, alaskite grades into granodiorite. These relations indicate a complex history of multiple intrusions.

Although the various plutons that compose the composite Chilliwack batholith may have been intruded over a considerable time span, they are all believed to be late Tertiary in age. Field evidence that points to a Tertiary age is the intrusion of several of the plutons into the Chuckanut Formation of Late Cretaceous and Paleocene age. Isotopic age determinations of the intrusives likewise indicate a probable late Tertiary age. Misch (1966, p. 139–140) reported an age of 30 m.y. for biotite from the ridge between Perry and Silver Creeks and late Eocene ages for biotite and hornblende from several samples collected along the Skagit River. Biotite from two quartz diorite intrusives, believed to be part of the Chilliwack batholith, near Wahleach Lake, British Columbia, at least 20 miles north of the U.S. border, were dated at 18 m.y. (Baadsgaard and others, 1961, p. 697–698).

The earliest rocks in the Chilliwack batholith range from mafic olivine-pyroxene gabbro to mafic quartz diorite. The two largest bodies are each about 1 square mile in area. Olivine-pyroxene gabbro is exposed on Mount Sefrit, on the west border of the mapped area, and a mafic diorite stock containing 25 percent hornblende crops out northwest of the Chilliwack River and south of Copper Lake (1½ miles south-southeast of Copper Mountain). Most of the other bodies are much smaller and consist predominantly of hornblende-rich or chlorite-rich diorite. A small body of crudely layered gabbro at Chilliwack Pass (between Ruth and Mineral Mountains) contains clinopyroxene, and gabbro south of Whatcom Pass contains hypersthene.

Quartz monzonite (fig. 13) of the batholith is a light-gray to pink rock with about equal amounts of orthoclase and plagioclase, 25–30 percent quartz, and as much as 8 percent biotite and hornblende. This rock underlies several square miles west of Ensawkwatch Creek along the north border of the area, but is found in only a few small scattered areas elsewhere. Granodiorite and quartz diorite (fig. 14) commonly can be distinguished in the field by the pinkish cast of orthoclase that in the granodiorite composes 10–25 percent of the rock and in

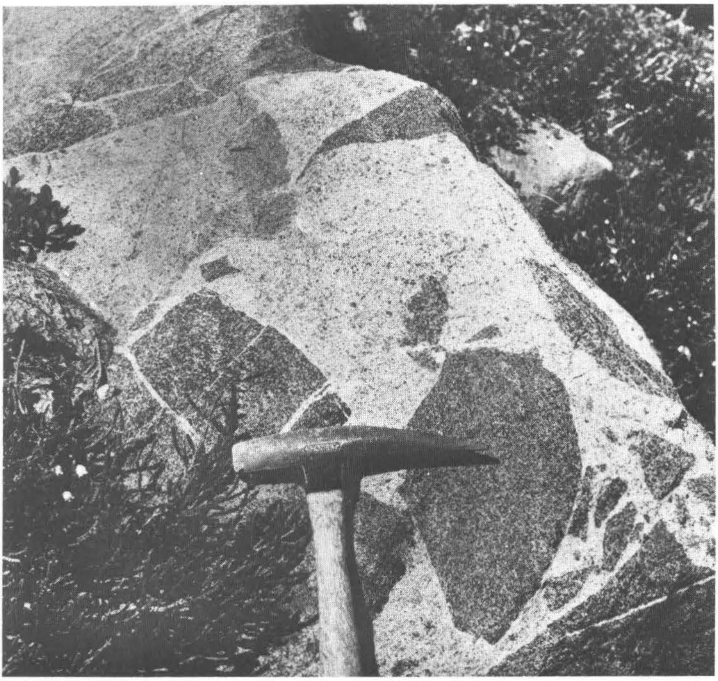
FIGURE 13.—Well-jointed quartz monzonite exposed on the north side of the peak northwest of Pocket Lake on the west side of Ensawkwatch Creek.

quartz diorite only 2.5 percent. Granodiorite and quartz diorite both contain 10–25 percent quartz. Some rocks contain principally biotite, others principally hornblende, and some contain equal amount of both minerals. In some areas the primary dark minerals have been largely altered to chlorite. Accessory minerals of both rock types are commonly magnetite, zircon, apatite, and sphene.

Light-tan to pink fine- to medium-grained bodies of alaskite are found on Hagan Mountain north of Berdeen Lake and on the north side of Bear Creek (fig. 15*A*). The alaskite is composed of 30–40 percent perthite, 20–35 percent sodic andesine, and 25–35 percent quartz. Dark minerals, principally biotite, make up <1–3 percent of the rock. Other minor accessory minerals, noted in some alaskite, are chlorite, magnetite, muscovite, sphene, and zircon.

FIGURE 14.—Sheared quartz diorite of the Chilliwack composite batholith forms the western buttress of Whatcom Peak to the northwest of Perfect Pass. Lighter colored granodiorite underlies mountain in left foreground.

A



B

FIGURE 15.—Rocks of the Chilliwack composite batholith. *A*, Alaskite body (white) intrudes granodiorite on the south side of Bear Mountain. *B*, Inclusions of hornblende diorite (dark pieces) in granodiorite near Copper Lake, 1½ miles south-southeast of Copper Mountain.

GLACIATION

Glaciation in the northern part of the North Cascades National Park has produced remarkable scenic features, such as deep, steep-sided to vertical-walled U-shaped valleys (fig. 16*A*), jagged horns (fig. 16*B*), narrow arêtes, and spectacular waterfalls (fig. 16*C*) that cascade hundreds of feet into the valleys below.

Although the large glaciers that produced these features are gone, many small glaciers (frontispiece) still cling to the high cirques. Of the more than 250 glaciers in the area, most are small, but several are more than 1 square mile in area (fig. 17). The largest glaciers are on Mount Shuksan (fig. 17*C*), Mount Challenger (fig. 17*B*), Bacon Peak (fig. 11), and Mount Redoubt, and smaller ones are on peaks and ridges higher than 6,500 feet. Most of the glaciers lie on the north or northeast sides of the peaks. These areas receive the greatest snow accumulation, inasmuch as they lie to the lee of the prevailing winds, and they receive the least sunlight. A notable exception is found on Mount Shuksan, where two of the mountain's largest glaciers, the Sulphide and Crystal Glaciers (fig. 17*C*), occur at a high elevation on its south side as a result of the heavy snowfall accumulation on extensive areas that have a relatively gentle gradient.

Although glaciation has been intense throughout the North Cascades, its effects vary widely from place to place. East of Ross Lake geologic features formed by several periods of major glaciation are found. West of Ross Lake, however, the last major glaciation obliterated evidence of earlier episodes, and thus the nature and effects of glaciation are relatively simple.

The intensity of the erosion of the last major glaciation in the northern part of the North Cascades National Park is apparently the result of abundant ice and large runoff. At present, prevailing winds are from the west, and hence, the westernmost part of the Cascade Mountains gets the heaviest precipitation. Similarly, during the period of major glaciation, snowfall and the formation of glaciers were probably greatest in this area. The greatest thicknesses of ice formed along the major drainages, which were deepened and widened into broad U-shaped valleys (fig. 16*A*) by the great masses of ice moving down them. Although most of the tributaries of these large streams contained glaciers during the Pleistocene, none of them were large enough to erode deep valleys, although sizable cirque basins were carved in many of them. Hence, the tributaries are now left hanging on the sides of the major valleys, whose bottoms they now reach through a series of falls or steep cascades (fig. 16*C*). The highest and one of the most beautiful of these falls, at the outlet of Green Lake on the north side of Bacon Peak, drops nearly 1,500 feet to Bacon Creek; many others have falls of several hundred feet. The glacial streams here occupied large, throughgoing valleys that led directly away from the centers of accumulation. Hence, drainage was good, and runoff was rapid. The combination of thick ice and rapid runoff was highly effective in carving the major valleys down to base level and in widening them to their present width.

Present-day drainage west of Ross Lake is roughly radial from an irregular area that centers on Mount Challenger, with secondary centers around Mount Redoubt, Hagan Mountain–Mount Blum, and Icy Peak–Mount Shuksan.

Except the Skagit River Valley, all major valleys are deep, steep-sided, U-shaped troughs that have undergone intense glacial erosion. All are essentially at base level for most of their lengths and have meandering streams and swamps on their flat alluvial floors.

Along most of its course the Skagit River flows through a broad, flat, U-shaped valley. A 25-mile stretch of the river along the east side of the area from the mouth of Big Beaver Creek to the mouth of Diobsud Creek flows through a narrow, steep-walled gorge that shows little effect of glacial erosion. North of Big Beaver Creek the flat, U-shaped glacial trough continues northward into British Columbia, where it crosses a low present-day drainage divide at the head of the tributary Klesilka River and then lies along the valley of Silverhope Creek to the Fraser River at Hope. The gradient is very low throughout this stretch. Downstream from Diobsud Creek the trough has a similar character. In contrast the narrow gorge in the intervening stretch has a steep gradient (nearly 1,000 feet in less than 20 miles) and a sharp V-shaped profile.

We conclude that the divide during the glacial period lay between the mouths of Big Beaver and Diobsud Creeks and that during this period the ice flowed both north and west from this area producing pronounced troughs in each direction.

The last major period of glaciation occurred in late Pleistocene time and eliminated all traces of earlier glaciation. Ice that formed during this glaciation extended well beyond the limits of the study area; thus end moraines related to Pleistocene ice are outside the area. Other smaller moraines, which formed during recurrent minor periods of glacier advance since the last major glaciation, can be found in a number of places. All the larger glaciers remaining in the area are marked by unweathered moraines that lie a few hundred feet to as much as half a mile downvalley from present-day ice margins. Moraines near the head of Luna Creek, which mark the former margin of the composite glacier, are perhaps the best example. Prominent lateral moraines are also present, as along the north side of Challenger Glacier and at the head of the North Fork of the Nooksack River below the East Nooksack Glacier.

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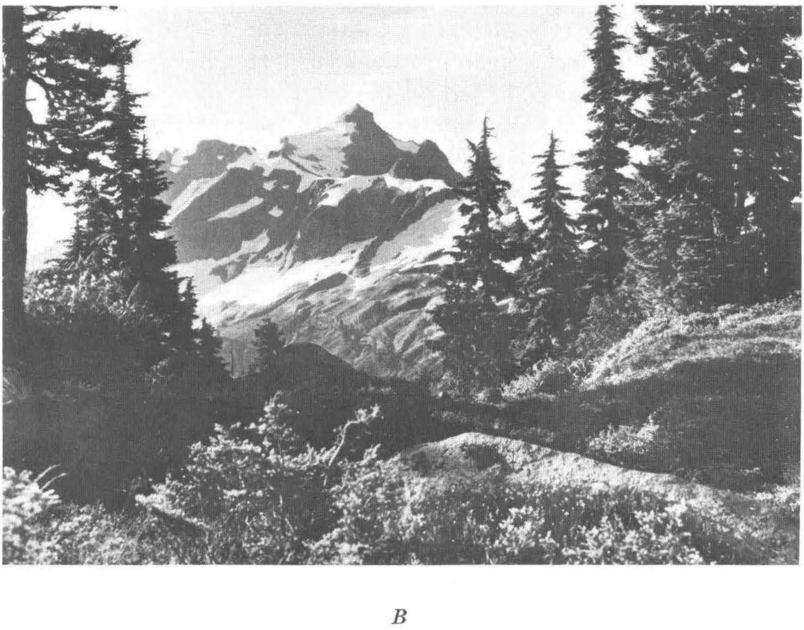
A



B

FIGURE 16.—Glacial features. *A*, U-shaped valley is formed along northwest-flowing tributary of Indian Creek. Indian Mountain lies to right of valley and a part of Red Face Mountain is to left. Small crescent-shaped lake in

Steplike divisions in many of the smaller cirque basins, now bare of ice, are the result of the plucking action of small glaciers after the Pleistocene glaciation.

Those streams which have been eroded to base level and which continue to have a large source of alluvium and glacial debris, such as Ruth Creek and the upper part of the North Fork of the Nooksack River, are braided, and their floors are buried. Where glaciers have been gone for a considerable period, streams have more nearly reached equilibrium, as shown by most of Baker River, Big and Little Beaver Creeks, and the Chilliwack River.

Alpine lakes are scarce and small, despite the intensity of glaciation and the formation of steplike surfaces in many cirques. Apparently, effective headward erosion and relatively rapid movement of large

C

valley is Lake Reveille. *B*, Mount Despair forms a jagged horn in the southern part of the area. *C*, Falls cascade down a narrow chute in phyllite just south of Berdeen Lake.

A

B

FIGURE 17.—Glaciers. *A*, Eastern part of the East Nooksack Glacier at the head of the North Fork Nooksack River. Ridge above is Jagged Ridge. Rocks above glacier are phyllite; those below are granodiorite. *B*, Numerous crevasses on the Challenger Glacier. Top of Mount Challenger is to the right, and

masses of ice led to the formation of long, wide, flat valleys and steep, short headwaters, rather than the formation of local rock basins, as occurred in the less intensely glaciated Pasayten Wilderness area east of Ross Lake. The sparsity of end moraines also accounts for the absence of lakes.

STRUCTURE

The northern part of the North Cascades National Park has undergone several periods of folding and faulting. Rocks of Cretaceous and Tertiary age, such as the Chuckanut Formation, the Hannegan Volcanics, and the Skagit Volcanics, are gently folded. The older, metamorphosed rocks, such as the Custer Gneiss of McTaggart and Thompson (1967) and the greenschist and phyllite of Mount Shuksan (fig. 10), are tightly folded; crinkles and small drag folds are common. Angular unconformities separate the metamorphic rocks from the younger Chuckanut, Hannegan Volcanics, and Skagit Volcanics.

The structure of the metamorphic rocks is not well known, but the general northwest trend of foliation, lithologic units, and fold axes

C

Luna Peak is prominent horn in left background. *C*, Sulphide Glacier to the left and Crystal Glacier to the right are separated by a narrow rock septum on the south side of Mount Shuksan.

suggests folding about axes of that trend. The major fold in the area is a large northwest-plunging syncline in the Hozomeen Group of Cairnes (1944). Minor folds and crinkles occur in the chert beds in the Hozomeen, the Custer Gneiss, and the greenschist and phyllite of Rose Lake. Small fold axes in the southeastern part of the Custer Gneiss plunge gently south; those in the northern part plunge gently either north or south (pl. 1).

Structure is simpler, although more diverse, in the unmetamorphosed rocks. The folding is fairly open in the Chuckanut Formation. Near Bacon Peak these folds trend north-northeast, but a couple of miles farther north on Hagan Mountain they trend west-northwest (fig. 9). In the northern part of the area the Chuckanut is tilted, but no folds are seen. Bedding was not well enough developed in the volcanic rocks for their structural pattern to be determined, but they clearly lie with angular unconformity on the metamorphic rocks.

Faulting appears to be of several ages: older faults are cut off by the Chilliwack batholith, and younger faults of two ages cut the batholith.

In the eastern part of this area a set of large northwest-trending steeply dipping faults is exposed between Arctic Creek and Ross Lake. This group of faults, which was named the Ross Lake fault zone by Misch (1966, p. 133–134), is part of a zone of shearing more than a half mile wide. On plate 1 we have shown three faults along most of this zone, but shearing in other parts of the phyllite and schist of Ross Lake and the metagabbro indicates that movement has not been confined to only three major faults. North of Arctic Creek the faults are cut off by the Chilliwack batholith. On the east side of Ross Lake the fault zone was traced approximately 12 miles south of Ruby Creek by Misch (1966, pl. 7–1; p. 133–134), where it is cut off by a large intrusion about 20 miles long. Southeast of the intrusion a major fault zone of similar trend has been noted by Barksdale (1958) and by Huntting, Bennett, Livingston, and Moen (1961) along the Twisp River. Thus, the Ross Lake fault zone was probably more than 55 miles long.

West of Ross Lake the southwest branch of the Ross Lake fault zone separates the Custer Gneiss on the southwest from the phyllite and schist of Ross Lake on the northeast. Displacement has been large, with the southwest side displaced upward. Numerous small intrusions are found along this fault zone both within and southeast of the study area. Metagabbro is intruded along this zone, although at least some of the fault movement occurred after the metagabbro was emplaced. Although the faults within this zone cross valleys several thousand feet deep, the straight surface trace of the faults indicates that they dip near vertically. The continuity of the zone, the steep dip of the individual faults, the presence of numerous intrusions, and the pronounced differences of rock type within and on either side of this zone indicate that it is a major fault system.

Two long northerly trending faults of different ages occur between the Ross Lake fault zone and the crest of the Picket Range. Both faults extend south of the Skagit River, but in the area mapped we have traced the easternmost one for 14 miles and the westernmost one for 9 miles. Both faults are near vertical and are marked by offset beds, fault valleys, and zones of granulation. Although the two faults are similar in some respects, the easternmost fault is cut off to the north by rocks of the Chilliwack batholith, whereas the westernmost fault cuts the granitic rocks; lateral movement on the two faults is in the opposite direction.

Faults of three ages were mapped in the Bacon Peak–Hagan Mountain vicinity in the southwest corner of the study area (pl. 1; fig. 9). The ten faults mapped here have a northerly to northwesterly trend and a near-vertical dip. Most of them formed after the intrusion of the Chilliwack batholith, but one northwesterly trending fault, which passes just southwest of Berdeen Lake, is cut off by quartz diorite of the batholith on the northeast shoulder of Hagan Mountain. Two faults that lie on the north side of Bacon Peak have a more westerly trend than the others. They are younger than the more northerly trending faults. As all the faults cut the Chuckanut Formation of Cretaceous and Paleocene age, they must have formed during the Tertiary.

In the northwestern part of the study area, the pattern of faulting changes. Here most of the faults have a northeast trend, though some have either a north or east trend. Many of the faults in this area are steep, and all cut rocks of the Chilliwack batholith. The longest of these is a curving fault, which we have traced for 20 miles from west of Shuksan Lake northeastward almost to Depot Creek (pl. 1; fig. 10). At different places, this fault displaces the greenschist and phyllite of Mount Shuksan, the Hannegan Volcanics, the Chilliwack batholith, and the Custer Gneiss. In its central part its course is straight and is marked by the north branch of Pass Creek and part of the Chilliwack River valley (pl. 1). The northwest side of this fault is downthrown relative to the southeast side.

MINERAL RESOURCES

By Mortimer H. Staatz, Rowland W. Tabor, Paul L. Weis, and Jacques F. Robertson, U.S. Geological Survey, and Ronald M. Van Noy and Eldon C. Pattee, U.S. Bureau of Mines

SETTING

The northern part of the North Cascade Mountains, which contains the North Cascades National Park, has numerous mineral occurrences of copper and molybdenum, but production has been relatively small except in the now-dormant Holden mine in Chelan County, about 40 miles southeast of the present study area. This property, the largest producer of copper in the history of the State of Washington during the 20 years it was in operation, produced about 106,000 tons of copper, or more than 83 percent of the total copper mined in Washington to 1963 (Vhay and Weissenborn, 1966, p. 72, 74). In addition, about 600,000 ounces of gold were recovered from this property (MacLaren and others, 1966, p. 86). About 12 miles west-northwest of the Holden mine, on Miners Ridge in the Glacier Peak Wilderness, is a large low-grade ore body consisting of a stockwork of quartz-pyrite-chalcopyrite-molybdenite veinlets (Vhay and Weissenborn, 1966, p. 79). Although this property has been extensively explored, it had not been mined by 1971.

Copper deposits larger than those in Washington are known in the North Cascade Mountains in Canada. The Copper Mountain mine, 34 miles northeast of the park, produced about 340,000 tons of copper, from a porphyry-type deposit averaging 1 percent copper, before it was shut down in 1957 (McTaggart and others, 1960, p. 38). At the Craigmont mine, about 82 miles north of the northeast corner of the park, mined ore and reserves of several ore bodies average 1.77 percent copper in grade and have a total copper content of 513,300 tons (Carr, 1966, p. 323). On the Bethlehem property in Highland Valley, 20 miles north of the Craigmont mine, four porphyry ore bodies have an average copper content of 0.70 percent and a total copper content of more than 490,000 tons (Carr, 1966, p. 321).

Gold has been recovered from several places in the North Cascade Mountains: the Mount Baker mining district, which lies adjacent to the northwest corner of the park, and the Slate Creek–Azurite mining district, which lies several miles east of the south end of Ross Lake. Ruby Creek drains the Slate Creek–Azurite district, and gold has been recovered from placers on this stream as far west as the part now flooded by Ruby Arm of Ross Lake. Production from the Mount Baker mining district was 43,300 ounces, and from the Slate Creek–Azurite district, 149,700 ounces (MacLaren and others, 1966, p. 86). The value of gold produced from these two dormant mining districts is approximately $5 million.

Because the geologic environment of some of the previously mentioned mines and mining districts is similar in part to that found in the northern part of the North Cascades National Park, we made a careful study of all prospects as well as a search for other mineralized localities. No ore has ever been shipped from any mining property in the area now occupied by the northern part of the park. Many mineralized deposits crop out in the northern part of the park, and according to Whatcom County records, 234 lode and 10 placer claims have been located there. Some of these claims may be relocations of older claims. Many of the claims were not found because of dense vegetation, lack of workings, or vaguely described locations. Commonly, relatively large iron oxide-stained zones are present in the general area of the lode claims.

The claims are in six principal areas: Silver Creek, Sulphide basin, headwaters of Chilliwack River, Whatcom Pass, Indian Creek, and Stetattle Creek. In the Silver Creek drainage, in the northeast corner of the study area, claims are on deposits that contain molybdenite and chalcopyrite. In the Sulphide basin area, claims are on molybdenite occurrences and on a large zone that contains disseminated iron sulfide. In the Chilliwack River area, lode claims were apparently staked on dike rocks that contain hematite and limonite stain resulting from decomposition of minor amounts of iron sulfides, and placer claims were also located in the same area along the river. In the Whatcom Pass area, the claims are on granitic rocks, pegmatites, and quartz veins that contain minor amounts of sulfides. The locations on Indian Creek were placer claims. In the Stetattle Creek area, we did not find the claims reported nor any likely areas that had workings, veins, or significant altered rocks.

Mineral occurrences in both the northern part of the North Cascades National Park and in the mines in adjacent parts of Washington and British Columbia are related to granitic intrusions. Within the park the Chilliwack composite batholith is interpreted as the source of anomalous copper, molybdenum, zinc, and lead. Almost all rock samples that contain anomalous amounts of these metals are either granitic rocks or country rock within 2 miles of exposures of the batholith. Mineralization is associated with several different plutons within the composite batholith, which is late Tertiary in age. The southeast fifth of the area, where the Chilliwack is not present, produced few anomalous samples.

GEOCHEMICAL EXPLORATION

Geochemical exploration in this area consisted of systematic sampling and analysis of rocks, gossan, stream sediments, and panned concentrates. These materials were analyzed by using modern chemical or spectrographic techniques which are capable of detecting minute quantities of various elements. A large number of samples, collected systematically over wide areas, provides information on the distribution of potentially valuable metals. Samples that contain unusual concentrations of the metals aid in pinpointing localities most likely to contain potential deposits.

Three types of samples were collected: (1) heavy mineral concentrates panned from stream gravels, (2) stream-sediment samples, and (3) rock samples from areas that contain visible sulfide minerals, iron oxide-stained rocks or other types of altered rock.

Minerals which are resistant to abrasion and chemical weathering and which have a high specific gravity can be concentrated from stream gravels with a gold pan. Gold, monazite, cassiterite, wolframite, and scheelite are most readily detected in this manner. Their presence in stream gravels, as shown by analysis of panned concentrates, indicates the existence of rocks containing them in the area upstream from the point where the sample was collected. Subsequent panning farther upstream may locate the source area of the mineral. Certain sulfide minerals such as pyrite, chalcopyrite, or galena also may be found in panned concentrates, but these minerals are much more vulnerable to chemical and mechanical degradation and are rarely found far from their source.

Part of our geochemical studies in the northern part of the North Cascades National Park consisted of panning stream gravels for heavy minerals (pl. 2). Placer deposits are few and small, because of recent and intense glaciation. The great streams of ice that occupied the valleys less than 12,000 years ago effectively removed all weathered rock that was present, leaving fresh, bare rock surfaces from the valley floors to the crests of the ridges. Valleys were scoured out by the ice, and stream-washed gravels were removed, to be replaced by a jumble of glacial debris that consists mostly of poorly sorted fragments of fresh rock. Consequently, panning in the streams of the North Cascades commonly produces only a very small amount of heavy mineral concentrates (generally less than 1 oz per pan). Very few of these concentrates contain gold, but even those that do are deceptive. A panned sample that contains gold in the ratio of 1 ounce per ton of heavy minerals is of no value if the heavy minerals themselves make up only a fraction of a percent of the stream gravels. It thus appears that none of the stream gravels we sampled contain significant reserves of placer gold.

Stream sediments of silt- and clay-sized particles carried by the stream or of material in contact with the stream water were sampled. A number of metals that commonly occur in bedrock as sulfides tend to weather rapidly under normal surface conditions and release metallic ions in solution. Copper, lead, zinc, cobalt, and molybdenum are among the metals that find their way into streams, where they are absorbed or adsorbed onto the silt- and clay-sized particles in the stream sediment. Analysis of the sample, using the citrate soluble heavy metals technique, can detect undifferentiated quantities of zinc, lead, copper, and cobalt, as small as 1 ppm (part per million). Another method, the "cold copper test," detects only the copper absorbed on the fine sedimentary particles. Both the cold copper and heavy metals tests are excellent guides to the presence of metalliferous ores in the drainage basin of the streams sampled. In general, sediment samples from the larger streams provide less useful information than those from smaller tributaries, for a concentration of metallic ions from small streams tends to become diluted when mixed with more water in larger streams.

We collected samples at intervals of 1 mile or less from the major streams and from most tributaries that contained running water at the time of our visit.

Minute amounts of copper and heavy metals are present in almost all stream sediment samples; we considered a sample to be anomalous if the heavy metals, cold copper, or molybdenum content of the sample was greater than 6 ppm. Anomalous amounts of potentially valuable elements in stream sediments indicate only that those elements occur in rocks somewhere upstream from the point of the sample.

Rock samples were collected for analysis wherever the appearance of the rock suggested the presence of potentially valuable ore minerals. These sampled localities included iron oxide-stained or otherwise altered rock, any rocks containing visible sulfides, and rocks from areas drained by streams that produced anomalous stream sediment samples. The rocks were analyzed spectrographically for 18 metals; where significant quantities of gold, silver, copper, lead, zinc, or molybdenum were suspected, chemical analyses also were made of the samples. The chemical analyses for gold, silver, and copper were done by atomic absorption; the molybdenum was analyzed colorimetrically. The atomic absorption and colorimetric determinations are quantitative and more accurate than the spectrographic determinations, which are semiquantitative and which will contain quantitative results only about 30 percent of the time. Thus in table 1, semiquantitative spectrographic values are not given for those samples that have been analyzed by quantitative chemical methods.

The results of the analyses on 1,188 stream-sediment samples, 64 panned concentrates, and 450 samples of iron oxide-stained zones and veins are shown in table 1, and the sample localities are shown on plate 2. Because of the large number of sediment samples, only those that contain 6 ppm or more of heavy metals, cold copper, or molybdenum are given in table 1, but all the sampled points are shown on plate 2. The localities of the samples listed are shown, by sample number, on the plate. In the sections "Mineral Resources" and "Description of Mineralized Areas," where disseminated zones or veins are discussed, the analytical data on gold and silver have been converted to ounces per ton, and those data of other metals to percent. This conversion is solely for convenience of the reader, to enable him to quickly make comparisons with assay results determined by other methods and with the grade of deposits in other areas. The reader should be aware, however, of the limitations of those analyses determined by semiquantitative spectrographic analyses and should make his comparisons accordingly.

MINERAL OCCURRENCES

Three types of mineral deposits are found in the study area: disseminated sulfides, veins, and placers. Whereas these occurrences are numerous in the area, none seems to have sufficient tonnage and grade to be mined at this time.

DISSEMINATED SULFIDES

Disseminated sulfide deposits, tiny grains of sulfide minerals scattered through country rock, represent the most common type of mineral occurrence. The sulfides commonly weather to brown iron oxides, and the stained rock stands out from the adjacent unaltered rock.

Although zones of disseminated sulfides are found in many places in this area, the contained copper and molybdenite is insufficient to form submarginal ore bodies in most places. One known exception is the Weezie claim on Silver Creek, where the rock in an area 200 by 240 feet contains disseminated molybdenum and copper minerals. The grade of this deposit, which is described in a later section, is comparable to that of ore deposits that have been mined, but the deposit is too small to be mined successfully at the present.

Hundreds of zones of disseminated sulfides are known in the study area. They range in size from a few inches wide by a few feet long to one in Sulphide basin (fig. 10) that is 2.5 miles long by 0.3 mile wide. Pyrite and pyrrhotite are the principal sulfides. Copper and molybdenum in these zones is generally erratic and low in content. Higher values of the metals are from narrow zones, generally along joints.

Three zones of disseminated sulfides, in addition to the one in Sulphide basin, are more than 1 mile long. These are in the Bacon Peak area (fig. 9) (2.2 miles long by 0.3–0.9 mile wide), Red Face Mountain area (fig. 19) (1.4 miles long by 0.4 mile wide), and Pass Creek area (fig. 19) (1.3 miles long by 0.5 mile wide). Samples from the outcrop over the Sulphide basin zone (fig. 10) contain as much as 0.02 percent copper and lesser quantities of molybdenum. The copper content of samples from the other three zones is Bacon Peak (fig. 9), <0.0003–0.03 percent, average about 0.01 percent; Red Face Mountain (fig. 19), 0.0001–0.03 percent, average about 0.007 percent; and Pass Creek (fig. 19), 0.007–0.015 percent, average about 0.01 percent. Molybdenum, lead, and zinc either were not detected or were of very low values in the latter three areas.

Higher grade concentrations of sulfides are generally small and commonly form adjacent to or within joints or fractures in the country rock. A sample (362, pl. 2) from a small zone along a fracture on the west side of upper Big Beaver Creek yielded >0.50 percent copper, >0.20 percent molybdenum, and 1.5 ounces of silver per ton. Chip samples from four other narrow zones, none of which was more than 2 feet wide, all yielded 0.05 percent copper. Samples 1021, 1022, and 1023, from three disseminated zones 20–100 feet across on the southwest side of Copper Mountain, yielded 0.05, 0.02, and 0.015 percent copper and 0.01, 0.03, and 0.02 percent molybdenum, respectively. Samples 1013, 1015, and 1014, from three small altered zones 5–20 feet across on the northeast side of Silesia Creek, yielded 0.30, 0.10, and 0.07 percent zinc, respectively. Fourteen 1- to 2-foot-thick zones of disseminated sulfides bounding pyrite-rich veinlets were sampled on Easy Ridge. Three of these samples (852, 856, 857, pl. 2) yielded 0.15 percent copper and ranged from 0.003 to 0.03 percent molybdenum; a fourth (858, pl. 2) had 0.30 percent copper and 0.007 percent molybdenum.

Other than the Weezie property, the most favorable occurrences of disseminated sulfides are around the east cirque of Pass Creek (fig. 19) north of the large Pass Creek sulfide zone. Here near the contact of Custer Gneiss of McTaggart and Thompson (1967) with granodiorite are several small- to medium-sized zones that contain zinc, copper, and lead. Marble bands are found in several places in the gneiss. Adjacent to these bands are two small skarn bodies, one a layer 2 feet wide and the other an oval-shaped body 5 feet across, containing 0.70 and 0.50 percent zinc, 0.05 and 0.20 percent copper, and 1.0 and 0.07 percent lead, respectively. Two poorly exposed zones in Custer Gneiss adjacent to the creek yielded 0.30 and 0.15 percent zinc, 0.02 and 0.15 percent copper, and 0.10 and 0.007 percent lead. Two disseminated zones in gneiss on the cirque wall had 0.15 and 0.20 percent zinc, 0.02 and 0.07 percent copper, and 0.10 and 0.15 percent lead. The first of these two zones is about 60 feet wide and 100 feet long; the second is about 200 feet wide and more than twice as long. None of these occurrences are minable.

VEINS

Veins are relatively rare in the northern part of the North Cascades National Park. Those found are generally narrow, short, and, except for thin veinlets associated with disseminated zones, low in metal content. Many veins are of barren quartz; others contain minor amounts of copper, still others contain some lead and zinc, and a few contain molybdenum minerals. Conspicuous of the veins that contain molybdenum are those on two claims located on the east side of Sulphide basin.

A few quartz veins also contain base metal sulfides. The largest and highest grade of these were three found near the crest of the Picket Range south of Crooked Thumb Peak. The three veins are undulative and range from ⅛ to 5 inches in thickness. They were traced for 250, 150, and 175 feet. Metal content of the veins is highly variable; five samples of sulfide-rich rock from the three veins ranged from 0.002 to 0.12 ounce gold, 0.09 to 2.92 ounces silver, 0.05 to 2 percent lead, 0.07 to 1 percent zinc, and 0.03 to 1 percent copper.

PLACERS

We collected 64 panned concentrates (pl. 2; table 1) from 33 streams. All were analyzed spectrographically for 18 elements, and all were assayed for gold.

Gold was detected in measurable amounts in only 14 of the 64 panned concentrates. Only six contained more than 0.008 ounce of gold per ton. Where detectable gold was found, we made an effort to locate the source, but no lode deposits were found that contained gold in minable quantities.

The highest gold content found (0.64 ounce per ton of panned concentrate) was in sample 578, from Lonesome Creek, a tributary of Bald Eagle Creek, on the east side of Mount Blum. The stream drains rocks of the Chilliwack batholith, here mainly alaskite and biotite-hornblende quartz diorite. The gold presumably was derived from rocks that contain disseminated sulfides. Samples of such rocks from the ridge crest to the southwest did not contain significant quantities of gold, and similar rocks at the head of Lonesome Creek crop out on a vertical cirque wall but could not be reached.

Of six panned concentrates collected in Big Beaver Creek drainage, only one, sample 391, contained measurable gold—0.24 ounce per ton. The source of this gold was not located.

Panned sample 836, from Brush Creek west of Whatcom Pass, contained 0.08 ounce of gold per ton. Brush Creek drains granodiorite of the Chilliwack batholith. Two more panned concentrates taken upstream from the gold-bearing sample on Brush Creek contained no detectable gold; thus this small amount of gold apparently comes from the lower part of Brush Creek basin.

A panned sample from a small east-flowing tributary of Silesia Creek and two panned samples from the West Fork of Silesia Creek contained measurable amounts of gold (table 1). The sources of this gold are believed to lie outside the National Park. One of these sources is in Winchester Creek basin, a tributary of West Fork, where veins have been known for many years. The other is from the east end of the ridge that contains the Red Mountain mine.

No other drainage basin produced samples that contain more than 0.008 ounce of gold per ton. Because of the small amount of gold found and the small proportion of heavy minerals concentrates found in our panning, we do not believe the northern part of the North Cascades National Park contains significant resources of placer gold.

DESCRIPTION OF MINERALIZED AREAS

Principal mineralized areas are described in this section of the report. For convenience, the mineralized areas are discussed by individual drainage basins. Some large zones of disseminated sulfides that lie in parts of several drainage basins are described under a single heading such as the name of an easily identified peak or ridge.

The description of each drainage basin or ridge may include not only a discussion of zones of disseminated sulfides and veins present but also a consideration of significant stream sediment anomalies. Zones of disseminated sulfides, which contained only iron sulfides, are not described, nor are drainage basins without known geochemical anomalies or evidence of mineralization.

SILVER CREEK AREA

Silver Creek flows for 6 miles down a deep, wide valley from its headwaters in a glacial tarn to its mouth on Ross Lake. Several prospects are known in the Silver Creek area, of which the Weezie, or Silver Creek, prospect is the most promising. In addition to the Weezie, other areas of interest are (1) the south side of the creek, where other prospects are reported, (2) an area of anomalous sediment samples west of the Weezie prospect, (3) two trenches on the ridge north of the west part of Silver Creek, and (4) a series of quartz veins containing chlorite, tourmaline, and sericite that are exposed for 1.5 miles along the ridge on the south side of the creek.

The Weezie claim lies on the north side of Silver Creek about 1.5 miles by steep trail from Ross Lake at an approximate elevation of 2,900 feet. Six claims were located in this general area in 1927 (Shideler, 1965, p. 83). Later four claims were relocated in this area, and in 1954 they were held by Roy Davis, George Hunt, and A. E. Blockberger (Purdy, 1954, p. 87). Between 1956 and 1958 the area was owned by the Coronado Copper Co. of Idaho (Shideler, 1965, p. 83). In 1965 seven claims were relocated by Robert Grant with the name Weezie No. 1 given to the one covering the principal disseminated sulfide deposit. This property was sold in 1966 to the Inland Cooper Co. of Washington.

Workings on the Weezie No. 1 claims (fig. 18) consist of an 80-foot adit and two groups of cuts on separate outcrops. The first group of cuts is adjacent to and north of the adit, and the second group is along a small ridge 200 feet to the west. Several diamond-drill holes were drilled during 1966 and 1967, but data on the holes were not available. The workings are mainly in a massive gray volcanic breccia of the Skagit Volcanics, which is cut to the northwest and to the northeast by quartz diorite of the Chilliwack batholith (fig. 18). Small dikes of quartz diorite cut the volcanic breccia in several places, and biotite granodiorite intrusive is exposed in the adit (fig. 18). Breccia near the northwest contact of the volcanics consists of fragments of volcanic rock enclosed in a quartz diorite matrix.

Disseminated sulfides, principally chalcopyrite and pyrite, occur erratically in areas outlined roughly by the workings and separated by a covered area. Rough dimensions of this total area is 200 by 240 feet. Molybdenite is common locally, and bornite and covellite were seen in a few places. In some pyrite-rich spots the rock is heavily stained with iron oxides. Kaolinite also occurs in places and is most common in a northerly trending zone north of the portal of the adit.

Chip samples 35 and 36 were taken in the adit, and five other chip samples (33, 34, 37, 43, 45, fig. 18; table 1) of the sulfide-bearing volcanic breccia were taken from small cuts in the adjacent (eastern) outcrop. The copper content of these samples ranged from 0.15 to 2.26 percent and averaged 0.72 percent, and the molybdenum content ranged from 0 to 0.5 percent and averaged 0.11 percent. Sample 35, which came from near the face of the adit, contained the most copper (2.26 percent), but it contained only 0.03 percent molybdenum. In five chip samples (32, 38, 42, 44, 46) taken from cuts in the western outcrop the copper content ranged from 0.09 to 0.15 percent and averaged 0.14 percent, and the molybdenum content ranged from a trace to 0.04 percent and averaged 0.007 percent. A fault southeast of the adit separates mineralized volcanic breccia from nonmineralized volcanic breccia. Two samples (39, 40) were taken along this fault, and both conntained a trace of copper but no molybdenum. A sample (41) of quartz diorite taken 100 feet northwest of the volcanic breccia contact also yielded a trace of copper but no molybdenum.

Although the grade of parts of this disseminated body is comparable with the grade of deposits that have been mined, the available data indicate that the deposit is too small to be economic and that the cost of mining would be more than twice the value of the mineralized material.

Molybdenum and copper minerals have been reported (Purdy, 1954, p. 87; Shideler, 1965, p. 84–85) on the south side of Silver Creek. Shideler (1965, p. 84) described the locality as being 300 feet south of Silver Creek and south of the Weezie adit. Although we searched this area, we were unable to find the deposits. The following brief description therefore is taken from Purdy (1954, p. 87):

> The deposits consist of ¼–1-inch stringers of quartz containing scattered chalcopyrite and clusters of molybdenite. The stringers, striking a few degrees west of north, are in granodiorite close to its contact with volcanic rock. At the outcrop the distance across the strike of the quartz stringers is about 10 feet. How far they may be traced along their strike is a question that could not be answered at the time of the examination because of the overburden and brush.

Five stream-sediment samples collected on tributaries upstream from the Weezie property contained 10–20 ppm cold copper. Three of these samples (29, 30, 31, pl. 2; table 1) were collected from tributaries on the north side of the creek, and two (25, 26) from the south side. The samples from the north side came from the three tributaries just west of the one that drains the Weezie property. All three tributaries drain a tongue of quartz diorite that intrudes the Hannegan Volcanics. By contrast, the next tributary to the west does not drain the quartz diorite, and it yielded a sample that contains only 5 ppm cold copper. Pyrite is found in the float of the volcanics from above the quartz diorite contact in the western two tributaries, and one sample (28) of this material contained 0.015 percent total copper. Samples 25 and 26, anomalous samples from the south side of Silver Creek, are from tributaries that also flow across a quartz diorite–volcanic rock contact. The north-facing slope is densely forested, and no attempt was made to trace the anomalous copper samples to their source.

Two trenches in light-greenish-gray welded tuff of the Skagit Volcanics are near the top of the ridge on the north side of Silver Creek 2.9 miles northeast of Glacier Peak. These trenches are probably the discovery pits on the Gold Top and Silver King claims. The Gold Top was located in 1918 by Ed Marshall and P. A. De Fries. Its north boundary is 40 feet southwest of Boundary Monument 69. A small north-trending trench 4 feet wide by 10 feet long is near the south

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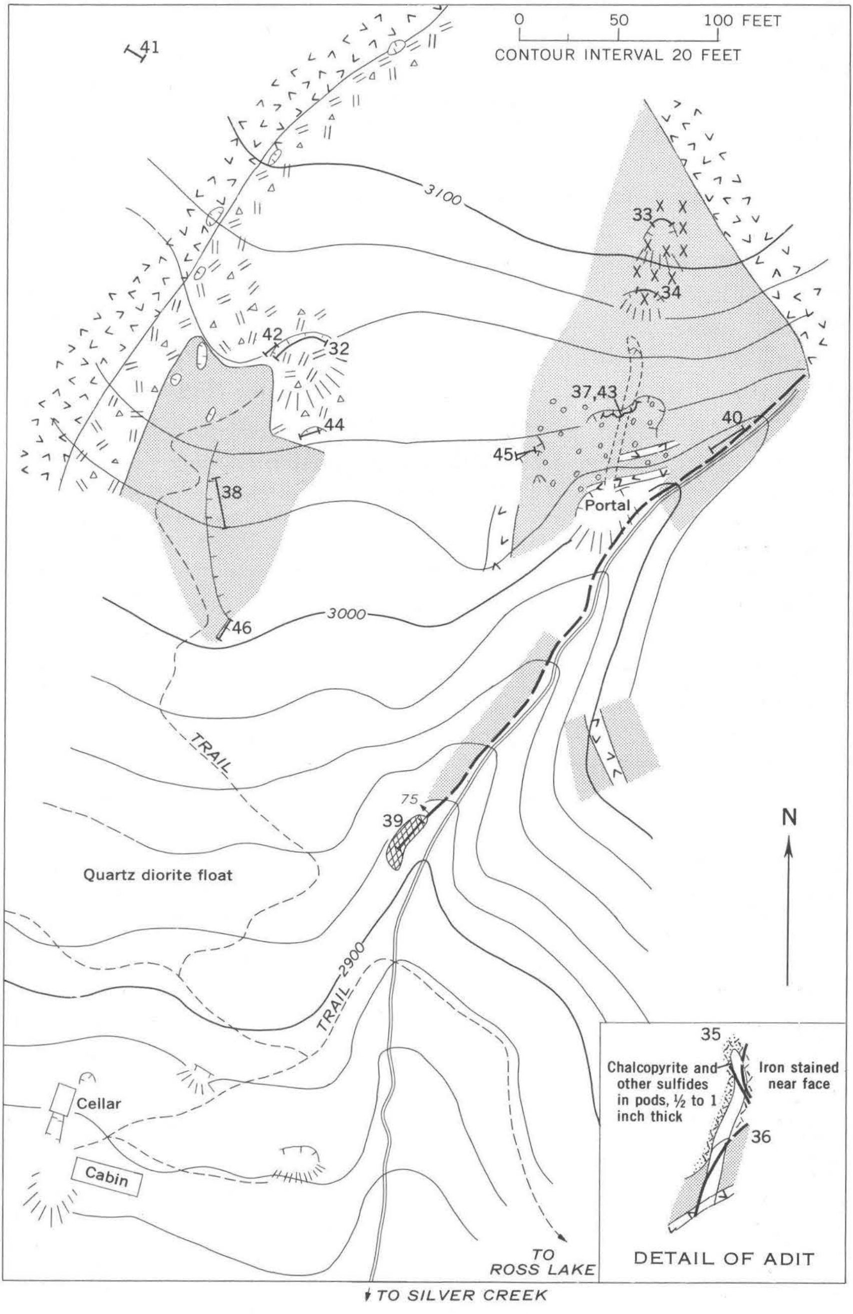


FIGURE 18.—Workings on the Weezie claim on Silver Creek. Mapped by R. M. Van Noy and E. C. Pattee, August 1967.

end of this property, about 200 feet south of the ridge crest. In the trench, an iron oxide-strained zone 8 feet long by 7 feet wide contains disseminated pyrite and pyrrhotite. Chip samples 7 and 8 (table 1) from this zone were low in copper, molybdenum, lead, and zinc, but sample 8 contained 0.02 ounce of gold per ton and a trace of silver.

The Silver King claim, which is south of the Gold Top claim, was located in 1918 by C. J. Howlett and Irie Town. A 5-foot-long trench has been dug 200–300 feet downslope from the trench on the Gold Top exposing a small quartz vein. A sample (9, table 1) from this vein contained no gold, silver, copper, or molybdenum. About 1,000 feet downslope from this trench, an iron oxide-stained zone, which is exposed in the bottom of a gully, is cut by a quartz vein that contains disseminated pyrite. Two samples (10, 11, table 1) of this vein were collected at localities 8 feet apart. One contained 0.60 ounce of silver per ton, and the other 0.06 ounce; both contained a trace of gold, but no other metals were found.

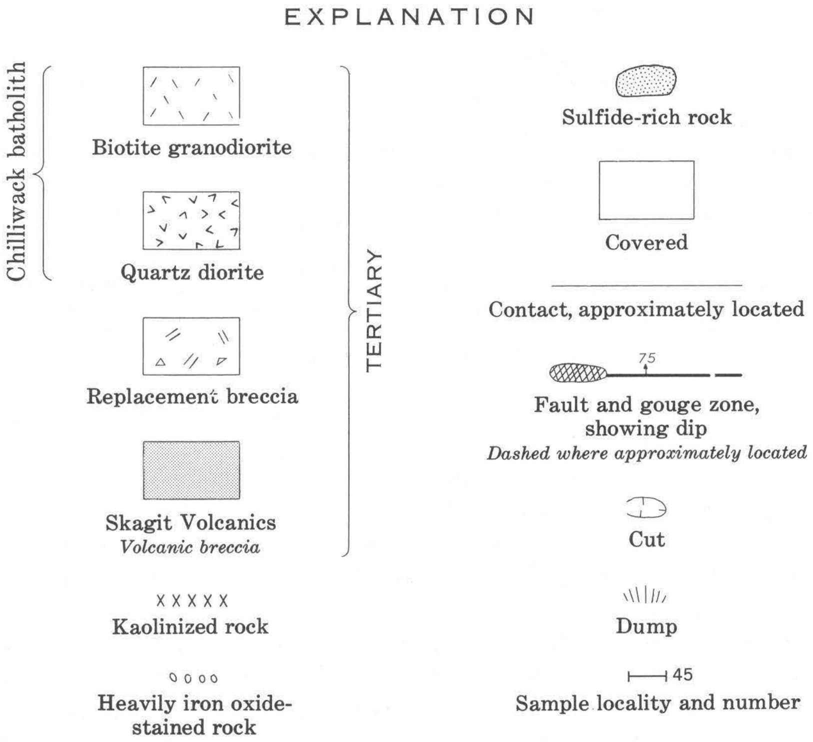


FIGURE 18.—Continued.

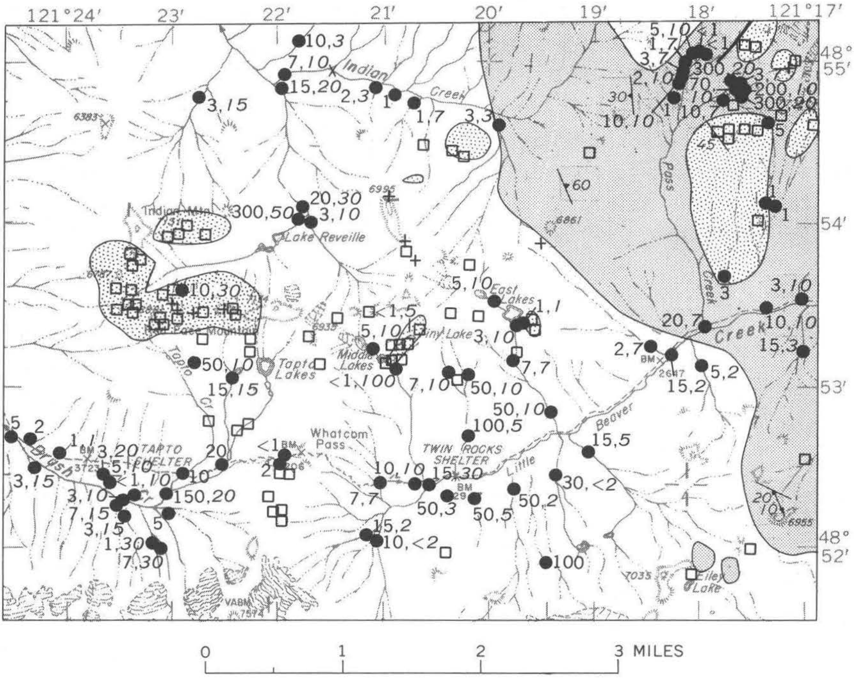
On the main ridge south of Silver Creek, 2.2–3.5 miles east-southeast of Glacier Peak, we found seven localities (13, 16, 17, 18, 19, 20, 22, pl. 2) in which one or more steeply dipping northeast-trending quartz veins occurred. One vein had been tested by a small prospect pit. These veins strike N. 10°–50° E. and dip 80° SE. to 75° NW. Their thickness ranges from a fraction of an inch to 10 feet and averages about 1 foot. Outcrops in this area are poor, and exposed vein lengths between scree and snow cover are 20–70 feet. All the veins contained, in addition to quartz, some limonite, and most of them also contained minor amounts of sericite, chlorite, pyrite, or tourmaline. All the veins are in quartz diorite except the easternmost vein (loc. 22) which is near the center of a 2,000-foot-wide roof pendant of Custer Gneiss of McTaggart and Thompson. Seven chip samples (13, 16, 17, 18, 19, 20, 22, table 1), taken across the width of the veins, contained 0.005–0.05 percent copper and <0.003–0.003 ounce of gold per ton. The sample from locality 22 also contained 0.02 percent lead and 0.03 ounce of silver per ton. The sample from locality 20 yielded 0.02 percent tin.

PASS CREEK AREA

Pass Creek flows south into Little Beaver Creek about 3 miles east of Red Face Mountain (fig. 19; pl. 2). Custer Gneiss of McTaggart and Thompson (1967) is the dominant rock exposed in the Pass Creek drainage, but granodiorite intrudes the gneiss near the head of the stream. Sulfide minerals are disseminated in the gneiss east of the creek and in the cirques at its head. Weathering of the sulfides to iron oxides causes them to be readily visible. The largest iron oxide-stained zone, 1.3 miles long by 0.5 mile wide, lies east of the central part of Pass Creek (fig. 19). The staining, which is not uniform, is strongest where pyrite is most common, along joints and in plagioclase porphyry dikes that cut the gneisses. Six chip samples (95–99, 103, pl. 2) of some of the more strongly stained parts of this zone yielded trace amounts of copper and molybdenum.

Two smaller iron oxide-stained zones north of the large zone contain visible scattered pyrrhotite and sphalerite in the gneiss. Chip samples 87 and 93 (pl. 2), from these two zones, had 0.15 and 0.30 percent zinc, 0.10 and 0.007 percent lead, and 0.15 and 0.02 percent copper, respectively.

Several marble bands in the gneiss have been metamorphosed to a epidote-garnet skarn near the granodiorite. Some of the skarn contains sulfide minerals. Two north-trending marble layers are high on the cirque wall northeast of the largest disseminated zone and interlayered with hornblende and biotite gneisses. The easternmost layer is about 100 feet wide and consists of coarse white grains of calcite



EXPLANATION

Granodiorite and minor amounts of diorite and alaskite of Chilliwack batholith — TERTIARY

Custer Gneiss of McTaggart and Thompson (1967) — CRETACEOUS(?) AND OLDER

Contact, approximately located

Fault, approximately located

10 20 Strike and dip of foliation and plunge of drag fold

Disseminated sulfides

x Prospect

\+ Vein or mineralized dike

□ Chip-sample locality

● 50,2 Stream-sediment sample locality
50, parts per million cold copper
2, parts per million molybdenum

Glacier

FIGURE 19.—Sample localities, stream-sediment analyses, and general geology of the Red Face Mountain and Pass Creek areas.

with scattered nodules of andradite. A chip sample (83, table 1) of this marble yielded 0.10 percent zinc, 0.02 percent lead, 0.025 percent copper, and 0.06 ounce of silver per ton. In the marble is an oval body of skarn 5 feet wide by 8 feet long. Ten feet west of the oval body is a 0.5–2-foot-thick layer about 10 feet long of similar epidote-andradite rock. Two skarn bodies have chrysocolla along fractures, and the layer contains visible galena, chalcopyrite, pyrite, and sphalerite. A 5-foot-long chip sample (84, table 1) across the oval body and a 1-foot-long chip sample (85, table 1) across the layer of epidote-andradite rock contain 0.50 and 0.70 percent zinc, 0.07 and 1.0 percent lead, 0.20 and 0.05 percent copper, and 0.06 and 0 ounce of silver per ton, respectively.

The western layer of marble is similar in mineralogy to the eastern layer, but no sulfides are visible; a chip sample (81, table 1) across the western layer contains insignificant amounts of metals.

Pyrite and pyrrhotite are disseminated through the rocks in several areas on the cirque wall in Pass Creek. Some chip samples across these sulfide-bearing rocks (82, 86, table 1) contain small amounts of lead, zinc, copper, and silver; others (73, 79, 80, 101, 102, table 1) contain trace amounts of copper, zinc, and molybdenum.

RED FACE MOUNTAIN AREA

Red Face Mountain (fig. 19) derives its name from the iron oxide-stained zone 0.4 mile wide and 1.4 miles long that caps it. The north side of this mountain is generally precipitous, but the south side is somewhat gentler, with several small tarns scattered along a discontinuous bench high on the side of the ridge. Pyrite is disseminated in varying proportion throughout this zone, impregnating the country rock, which is mainly granodiorite but also includes dikes and irregular bodies of alaskite and plagioclase porphyry. In the 18 chip samples that were taken of this iron oxide-stained zone, the copper content ranged from 0.001 to 0.03 percent and averaged about 0.007 percent. Only one sample (120, table 1) contained as much as 0.002 percent molybdenum. One small boxwork of quartz veinlets (122, pl. 2) and three quartz veins (123, 128, 130, pl. 2) cut the iron oxide-stained rocks. These veins vary in thickness, but have an overall range of from 0.1 to 3 feet. The largest is exposed for a little more than 100 feet. They have diverse strikes and steep dips. Chip samples (122, 123, 128, 130, table 1), which were cut across the veins, did not yield any detectable gold or silver.

North of this large iron oxide-stained zone, on the east flank of Indian Mountain, is a similar but smaller zone (fig. 19). Four samples (106–109, table 1) from this zone contained 0.005–0.03 percent total copper and $<$0.0005–0.005 percent molybdenum.

A stream that drains both of these altered areas flows into Lake Reveille. A stream-sediment sample (153, table 1) taken at the outlet of this lake (fig. 19) contained 300 ppm cold copper and 50 ppm molybdenum. These values, especially the one for cold copper, suggest that portions of the altered zones contain more copper and probably more molybdenum than was obtained in our sampling.

South of the large iron oxide-stained zone on Red Face Mountain are several small scattered zones (fig. 19) that contain small amounts of copper (133, pl. 2).

Another zone of disseminated sulfides is indicated on the lower part of the south slope of Red Face Mountain by a stream-sediment sample (143, pl. 2) taken near the mouth of a tributary of Brush Creek. Sample 143 contains 150 ppm cold copper, whereas sediment samples (141, 142) taken 1,000–2,000 feet upstream contained only 10–20 ppm cold copper (fig. 19), suggesting a separate source of copper on the heavily wooded area between them.

A highly fractured iron-oxide-stained zone containing abundant pyrite extends for 2,000 feet northeastward from lower Middle Lakes (fig. 19). Several chip samples (168–171, table 1) along it were low in copper and molybdenum. Water seeping through this fractured zone has leached out iron which has been redeposited, in an area 270 by 210 feet, as a yellowish-brown bog iron deposit in the swale on the east side of the stream that drains lower Middle Lake. Two chip samples (173, 174, table 1; pl. 2) of this limonite yielded only 0.0005 percent copper and <0.0002 percent molybdenum.

Several zones of disseminated sulfides occur near East Lakes. The largest one is on cliffs several hundred feet high southeast of the lower of the two lakes (fig. 19). This zone is made up of fractured, iron oxide-stained granodiorite with abundant pyrite and, locally, traces of molybdenite; however, two chip samples (183, 184, pl. 2) contained no detectable molybdenum and only very small amounts of copper and lead. Specks of molybdenite that were noted in another part of this zone indicate an erratic distribution of the element. On the steep mountainside on the west side of East Lakes, two other disseminated zones were sampled. Chip samples 167 and 180 (pl. 2), from these two zones, contained 0.005 and 0.02 percent total copper and <0.0002 and 0.02 percent molybdenum, respectively. The zone with the higher molybdenum content is about 1,000 feet west of the lower lake and is an irregular zone about 150 feet across. This zone contains disseminated pyrite, which is most concentrated adjacent to and along joints. Several pieces of molybdenite, as large as 1 inch across, were found erratically distributed on a few fracture planes.

Three quartz veins and a mineralized dike were examined on the ridge north of Middle Lakes and East Lakes. The three quartz veins

(162, 163, 165, pl. 2) have a N. 15°–40° E. strike and a steep dip, and two of the three veins are branched. These veins are irregular, range in thickness from 0.15 to 6 feet, and have a maximum exposed length of 150 feet. They cut granodiorite; quartz was the only mineral noted. Maximum gold content of chip samples across the three veins is 0.0006 ounce per ton.

The previously mentioned mineralized dike is near the top of the south side of a ridge west of Pass Creek and 500 feet west-southwest of peak 6861 (187, pl. 2). Here a dark irregular poorly exposed dike that strikes N. 75° E. cuts mafic granodiorite. At its principal exposure, the dike is 3–6 feet thick; at its only other exposure, 150 feet to the southwest, it is only a few tenths of a foot thick. This dike is heavily stained with iron oxides and contains scattered pyrrhotite. A 5-foot chip sample (187, table 1) yielded 1.0 percent zinc, 0.05 percent lead, 0.20 ounce of silver per ton, and 0.009 ounce of gold per ton.

LITTLE BEAVER CREEK AREA

Little Beaver Creek, one of the largest streams in the area, meanders down a wide, U-shaped, densely forested valley about 14 miles from Whatcom Pass to Ross Lake. In contrast to the main stream, the tributaries are generally small and plunge down cliffs and steep valley walls. As might be expected in a large stream, sediment samples from Little Beaver Creek did not yield anomalous amounts of metals. Anomalous values were obtained, however, from tributaries flowing into Little Beaver Creek from three areas (pl. 2): (1) the upper 3½ miles of Little Beaver Creek, (2) the north side of Little Beaver Creek west of the mouth of Perry Creek, and (3) the lower 2 miles of Little Beaver Creek. Sediment samples from near the mouth of tributaries on the north side of the upper part of Little Beaver Creek (fig. 19) contained 2–100 ppm cold copper and 2–30 ppm molybdenum. These tributaries drain brown iron oxide-stained areas that have been discussed. Sediment samples from near the mouths of the tributaries along the south side of Little Beaver Creek contained 5–50 ppm cold copper but only <2–5 ppm molybdenum. In the headwaters of Little Beaver Creek a chip sample was taken of talus from a zone of iron oxide-stained quartz diorite on the cliff above. This sample (195, pl. 2) contained 0.02 percent copper and 0.015 percent lead. A stream-sediment sample (199, pl. 2) from the stream below the glacier west of Wiley Lake had 100 ppm cold copper. Iron oxide-stained quartz diorite float along this stream contained chalcopyrite along the joints.

Stream-sediment samples from near the mouths of tributaries that drain the north side of Little Beaver Creek west of the mouth of Perry Creek had 5–100 ppm cold copper and 3–15 ppm molybdenum. Sediment samples taken farther up the steep south-facing mountainside contained as much as 300 ppm cold copper and 70 ppm molybdenum (239, pl. 2). These tributaries drain a poorly exposed area of quartz diorite and Custer Gneiss of McTaggart and Thompson. In several places in the eastern part of this area, joints in the quartz diorite are coated with pyrite and a little chalcopyrite. In the Custer Gneiss, just west of the quartz diorite contact, we found several small zones of disseminated sulfides. Nine chip samples (60, 61, 218–224, pl. 2; table 1) from these zones contained small amounts of copper and insignificant amounts of other metals. Two other chip samples (216, 217; pl. 2) were taken from a layer of pyrrhotite and magnetite-bearing biotite gneiss. This layer is 18 feet thick and can be traced for several hundred feet in a N. 70° W. direction. Pyrrhotite, quartz, and a little chalcopyrite are found in the upper 8 feet of the layer, and magnetite and quartz are abundant in the lower 10 feet. A grab sample (216, table 1) of pyrrhotite-rich material from the upper part contained 0.50 percent copper; a grab sample (217, table 1) of the lower part yielded only 0.05 percent copper.

Three sediment samples (245, 248, 249, pl. 2) that had from 10 to 30 ppm cold copper were collected from tributaries near the mouth of Little Beaver Creek. These tributaries all drained greenstone of the Hozomeen Group of Cairnes. Similar values for cold copper have been obtained in several other places that drained this greenstone. In the other localities the source of the copper had been many widely scattered, small, irregular zones of disseminated sulfides that formed along shears in the greenstone.

ARCTIC CREEK AREA

Sediment samples taken in two areas along Arctic Creek, which flows east into Ross Lake (pl. 2), were found to be high in cold copper, heavy metals, and molybdenum. One of these areas is on the south side of Arctic Creek 1½–2½ miles above its mouth. Samples 276–282, 285, 287, and 288 (pl. 2), collected from tributaries in this area, contained 5–15 ppm cold copper, 3–30 ppm heavy metals, and 3–10 ppm molybdenum. The fact that the metal content does not increase upstream suggests a broad diffuse source of the metals. Greenstone, which is drained by these tributaries, contains small scattered zones of disseminated sulfides. Samples of greenstone with minor pyrite have only 0.005–0.007 percent copper. Similar anomalies were also found in the greenstone east of Ross Lake, where they were caused by many small scattered weakly mineralized zones and veins.

The other anomalous area on Arctic Creek is in its headwaters. Samples from seven small rivulets that cascade down a cirque wall into the southwestern branch of this creek contain 1–700 ppm cold copper, 5–200 ppm heavy metals, and 10–70 ppm molybdenum. These rivulets all drain a zone of disseminated sulfides that lies on the near-vertical cirque wall close to the top of the ridge. This zone, which has a northwest trend, is about 200 feet wide and can be traced for about a quarter of a mile. The disseminated zone is in an irregular tongue of gneiss that is surrounded and metamorphosed—mostly to skarn—by quartz diorite of the Chilliwack batholith. The disseminated zone, which is marked by brown staining, contains as much as 5 percent sulfides, most of which are pyrite and pyrrhotite. A dark mineral, believed to be chalcocite, was noted in one place. In nine samples (250–252, 260–265, pl. 2; table 1) taken in this zone, the copper content ranged from 0.0007 to 0.05 percent and averaged about 0.016 percent, and the molybdenum content ranged from <0.0005 to 0.01 percent and averaged about 0.0025 percent. The copper and molybdenum contents are very erratic, as indicated by the sample data and by the cold copper analyses of a few of the stream-sediment samples collected from very small tributaries that are higher in copper than any of the sulfide-bearing rocks sampled. The most likely reason for this discrepancy is that material in the small tributaries came from a part of the zone that was a higher grade than that sampled. The total size of these richer zones, however, is probably not large, for a sediment sample taken 1½ miles downstream from the samples from the small tributaries in the cirque did not contain anomalous cold copper.

Small disseminated zones are scattered around the upper end of the cirque on the southeast branch of Arctic Creek. Six samples taken from five of these zones (266–270, 273, pl. 2; table 1) in the central and western part of the cirque contained 0.001–0.01 percent total copper. A sample (271, pl. 2; table 1) from an irregular disseminated zone 80 feet across on the ridge along the east side of this cirque contained 0.05 percent total copper.

LUNA CREEK AREA

Luna Creek originates in a steep-walled cirque carved in granitic rocks between Mount Challenger and Mount Fury. Sediment samples were collected along most of Luna Creek and many of the small tributaries that enter it, but samples containing the greatest amount of copper and molybdenum came from small tributaries that drain into the cirque at the head of the stream. Here, of 13 samples collected, all but three contained 30–50 ppm cold copper, and some of the samples also contained molybdenum. Many iron oxide-stained zones can be seen on the nearly vertical cirque walls. In the glacial till piled below the glaciers are boulders that contain disseminated pyrite and pyrrhotite. Fractures in a few boulders are also coated with chalcopyrite and molybdenite.

Small copper-bearing veins occur in two areas along the northwest wall of the cirque about 1½ miles northeast of its head. One area is 2,900 feet south-southeast of the southern tip of Wiley Lake, where, east of a broad watercourse, a nearly vertical cliff of biotite-quartz diorite is cut by mineralized joints. Epidote is the principal mineral, and in places it makes up the entire vein. Other minerals are quartz, pyrite, chalcopyrite, and chrysocolla. Copper minerals, as much as one-fourth inch thick, form a thin and generally erratic coating along parts of these joints. A grab sample (334, pl. 2) of vein material from one of the sulfide-rich parts of one joint contained 0.30 percent copper, 0.015 percent molybdenum, 0.20 ounce of silver per ton, and 0.002 ounce of gold per ton.

The second area of copper-bearing veins is on the west side of the same broad watercourse at an elevation of 5,850 feet, 4,200 feet south-southwest of the south tip of Wiley Lake and 7,100 feet northeast of Mount Challenger. On this steep mountainside, five joints that cut biotite-quartz diorite are coated with as much as one-eighth inch of quartz, pyrite, chalcopyrite, and chrysocolla.

Five samples were taken from five small zones containing disseminated sulfides high on Luna Peak. Sample 340 (table 1), selected for its sulfide content, contained 0.05 percent total copper; the rest (335–337, 339, table 1) yielded 0.002–0.03 percent copper.

BIG BEAVER CREEK AREA

Three areas in and adjacent to Big Beaver Creek contain noteworthy concentrations of metals. The first of these is a northward-flowing tributary whose headwaters are just west of Sourdough Lake. A sediment sample and a panned sample were taken at the mouth of this tributary. The sediment sample did not contain anomalous amounts of cold copper or heavy metals, but a panned concentrate from the locality (391, pl. 2) contained 0.24 ounce of gold per ton and 0.15 ounce of silver per ton.

The second area is on both sides of Big Beaver Creek 2–3½ miles above the mouth of McMillan Creek. Sediment samples collected from several tributaries in this area contained anomalous amounts of copper and molybdenum. Four samples (364–367, table 1; pl. 2) collected on a principal tributary on the west side contained 50–100 ppm cold copper and 5–15 ppm molybdenum. The source of the copper and molybdenum is about midway up the steep tributary, where joints in quartz diorite are coated with pyrite, chalcopyrite, and molybdenite.

These joints, which can be traced about 300 feet vertically along the tributary, are fairly widely spaced, and many have few or no sulfides along them. A composite sample (362, pl. 2) of the rock from along several of the mineralized joints contained 1.5 ounce of silver per ton, >0.50 percent copper, and >0.20 percent molybdenum. On the east side of Big Beaver Creek, samples from four tributaries had anomalous amounts of copper. Near the mouths of these tributaries, samples (360, 361, 375, 378, pl. 2; table 1) yielded 7–70 ppm cold copper; farther upstream, samples (373, 374, 376, pl. 2; table 1) contained 15–100 ppm cold copper. The copper in most of these samples comes from zones of disseminated sulfides containing a little chalcopyrite. Samples from four of the zones (370–372, 377, table 1) had from 0.002–0.05 percent copper. The richest sample (371) came from near the ridge and was a selected sample of sulfied-rich material from a rather patchy zone about 500 feet across. Rock sampling was not carried out above the sediment sample (376, pl. 2) with the highest cold copper content (100 ppm), for we were unable to climb any farther. On the cliffs above this sample, however, green malachite coatings could be seen on some of the fracture surfaces.

The third area along Big Beaver Creek is on the ridge a little over 1 mile southeast of Luna Peak. The ridge is made up of alaskite of the Chilliwack batholith that is stained a light brown. Joints, 0.2–1 foot apart, cut across the ridge at a slight angle and form a zone that is 4–10 feet wide. Seams of chrysocolla occur in places along these joints over a distance of 225 feet. Small crystals of pyrite, commonly altered to limonite, were also found scattered along this zone. A 2-foot-long chip sample (381, pl. 2) taken across one of the most chrysocolla-rich parts of this zone contained 0.05 percent copper and 0.0005 percent molybdenum. In comparison, a chip sample (382, pl. 2) of the slightly iron-stained alaskite from a point on the ridge 150 feet southeast of the mineralized joint system yielded 0.015 percent copper and 0.0015 percent molybdenum.

WEST SIDE OF PICKET RANGE BETWEEN MOUNT CHALLENGER AND MOUNT FURY

The west side of the Picket Range consists of jagged peaks and near-vertical towers; below the upper pinnacles it consists of steep rock faces separated from each other by rockslides and snowfields. Veins were found in three places in the northern part of this area, and in several zones of disseminated sulfides in the southern part (pl. 2). The most northerly vein area lies along the crest of the Picket Range 1,250 feet north of Crooked Thumb Peak. It consists of three quartz veins in a zone 60 feet wide of iron oxide-stained biotite gneiss. Veins in the zone strike N. 36° E. and dip vertically. They are ½–4 inches thick and in addition to quartz contain pyrite and arsenopyrite. Two chip samples were taken in the area: one (600, pl. 2) across the entire iron oxide-stained zone and one (101) of a 4-inch vein plus 2 inches of gneiss on either side of it. The two samples, 600 and 101, contained 0.02 and 0.07 percent copper, 0.15 and 0.07 percent lead, 0.1 and 0.05 percent zinc, 0.04 and 0.58 ounce of silver per ton, and <0.003 and <0.03 ounce of gold per ton, respectively.

Two other veins were found about 2,500 feet southeast of the first set of veins on a small spur 1,500 feet southwest of Crooked Thumb Peak at an elevation of 6,650 feet. The two veins, which are about 20 feet apart at their westernmost exposure, cut biotite gneiss. The northerly vein strikes N. 74° E., dips 70° SE., and is 1–4 inches thick. The vein can be traced uphill to the northeast for 250 feet, and near its northeast end it splits into several smaller veins. The vein consists of quartz with abundant pyrite, arsenopyrite, galena, and tetrahedrite(?). Two 4-inch channel samples, 602 and 603 (pl. 2), that were taken across the vein near its southwest end contained >2 and >4 percent lead, 0.07 and 1 percent zinc, >0.5 and >1 percent copper, 5.8 and 2.9 ounces of silver per ton, and 0.006 and 0.12 ounce of gold per ton, respectively.

The southerly vein strikes about N. 68° E., dips 70° SE.–70° NW., and is ¼–3 inches thick. The southern part of the vein appears to be mainly quartz with a little pyrite, chalcopyrite, and cerussite. Two 3-inch channel samples, 604 and 605 (pl. 2), taken across the southwest end of this vein contained 0.10 and 0.05 percent lead, 0.07 and 0.10 percent zinc, 0.05 and 0.04 percent copper, 0.58 and 0.09 ounce of silver per ton, and <0.003 ounce of gold per ton.

Another vein, approximately 2,200 feet southwest of Crooked Thumb Peak, at an elevation of 6,220 feet, strikes N. 78° E., dips 70° SE.–80° NW., and cuts biotite gneiss. The thickness ranges from ⅛ inch to 5 inches and averages about 1 inch. This vein, which was traced between snow patches for about 175 feet, is made up principally of quartz, with minor pyrite and arsenopyrite. A 5-inch channel sample (606, pl. 2) taken near its southwest end contained 0.07 percent lead, 0.10 percent zinc, 0.03 percent copper, 0.50 ounce of silver per ton, and 0.035 ounce of gold per ton.

South of the previously mentioned veins and clustered on the west side of Mount Fury are five iron oxide-stained zones that contain disseminated sulfides. Two of the zones were of mineralized intrusive breccias. Samples 435 and 437 (pl. 2; table 1), made up mainly of the matrix of these breccias, which constitutes 20–30 percent of the rock and contains most of the sulfides, yielded 0.02 and 0.03 percent zinc, 0.0015 and 0.01 percent lead, 0.01 and 0.15 percent copper, and 0.0005 and 0.01 percent molybdenum, respectively. The other three zones were along shears in quartz diorite and gneiss. Chip samples 436, 438, and 439 (pl. 2; table 1), taken across thicknesses of about 1 foot each from these three zones, contained 0.05, <0.02, and 0.02 percent zinc; 0.07, 0.015, and 0.005 percent lead; and 0.01, 0.03, and 0.020 percent copper, respectively.

PIONEER RIDGE

Pioneer Ridge rises abruptly more than 4,000 feet from adjacent valley bottoms. The ridge forms a massive buttress bounded by gray cliffs and is roughly triangular in shape having valleys on three sides. Picket Creek flows along the north side of Pioneer Ridge, and sediment samples (609–610, 612–614, pl. 2) from five tributaries of this creek, which descend the steep north face at Pioneer Ridge, contained 7–30 ppm heavy metals, 3–30 ppm cold copper, and 2–10 ppm molybdenum. The north face of the ridge was too steep to be climbed, and only the top of the ridge was examined. Small iron oxide-stained zones occur at several places along this ridge. On the ridgetop directly above the sediment-sample locality that contains the highest heavy metal and cold copper content is a fine-grained diorite dike that cuts volcanic rocks. Along the edge of this dike is a 2-inch-thick zone of iron oxide-stained rock. A sample (611, pl. 2) of the stained material yielded 0.10 percent zinc, 0.05 percent lead, 0.015 percent copper, and 2.92 ounces of silver per ton. This zone, even though relatively high in grade, is too small to produce the anomalous metal content in the sediment samples. Perhaps other similar zones occur on the steep mountain face.

About three-quarters of a mile south of this ridge, several iron oxide-stained zones occur near volcanic dikes in biotite gneiss. A chip sample (595, pl. 2) across a 1.5-foot-wide zone in one had 0.001 percent copper, <0.02 percent zinc, and 0.007 percent lead; a second chip sample (596) across a neighboring 5-foot zone yielded 0.01 percent copper, 0.03 percent zinc, and 0.02 percent lead.

BACON PEAK AREA

One of the largest disseminated sulfide zones in the North Cascades National Park is along the east flank of Bacon Peak (fig. 9.) This zone is 2.2 miles long, 0.3–0.9 mile wide, and is in part covered by the Bacon Peak glacier. The sulfide-bearing zone crops out on a high undulating upland surface, which to the east falls off into a series of nearly perpendicular cliffs to Bacon Creek more than 3,500 feet below. The disseminated zone is in greenschist, Chuckanut Formation, and a quartz diorite intrusive. It crosses and extends along several faults, which in part control its shape (fig. 9). Rocks in the disseminated zone have weathered on the surface to a dark brown, and most contain scattered grains of pyrrhotite and to a somewhat lesser extent pyrite. Chalcopyrite was noted only along some fracture surfaces, in a 5–12-foot-thick dike in the northern part of this zone. Sediment samples taken from tributaries that drain the western and southern parts of this zone are not anomalous in cold copper or molybdenum. Sediment samples from two tributaries of Bacon Creek that drain the northeast part of the zone contained 30 ppm cold copper (fig. 9), and one sediment sample taken at the mouth of Green Lake contained 100 ppm cold copper. Five chip samples (527–531, table 1; pl. 2) taken along the ridge east of Bacon Peak in the southern part of this zone of disseminated sulfides contained 0.007–0.02 percent copper, but no detectable molybdenum, lead, or zinc. Seven chip samples (519–521, 523–526, table 1; pl. 2) taken across the broad north end of the zone yielded <0.0003–0.03 percent copper and no detectable molybdenum. Sample 521, from the dike with the visible chalcopyrite, and 524, from the greenschist about 100 yards to the south, contained 0.15 and 0.03 percent zinc, respectively. Traces of gold and silver were found in several of these samples. Although this zone is large and the rocks in it contain at least several percent sulfides, most of these are iron sulfides. The copper and zinc content is low and erratic, and molybdenum, lead, gold, and silver, where detected, were in only negligible amounts.

SULPHIDE BASIN AREA

Sulphide basin is underlain mainly by phyllite and greenschist of Mount Shuksan, which has been intruded by two small quartz diorite stocks of the Chilliwack batholith (fig. 10). On top of the ridge that bounds the east side of Sulphide Creek is a small area of volcanic breccia of the Hannegan Volcanics. The basin is drained by several tributaries of Sulphide Creek which, in the headwaters area, cascade down near-vertical-walled cirques. Access to the basin from the end of the road up Baker River is by 3 miles of low-gradient trail to the mouth of Sulphide Creek and then 1 mile without trail up the creek.

The Dead Goat claim was located by Lester McCullough, Ben Hinkle, and Clarence Keplinger on a prominent westward-flowing tributary of the east branch of Sulphide Creek at an elevation of 1,600 feet. At the claim site a small quartz diorite stock intrudes black phyllite. Along the contact is a zone, at least 80 feet wide, which consists of fragments of a dark-gray diorite and partly assimilated phyllite surrounded by cream-colored quartz diorite. The zone is visible for only 30 feet along the watercourse. In this contact zone are numerous quartz veins as much as 2 inches thick. These veins have a variable but generally northward trend and dip 10°–30° E. Massive seams of molybdenite as much as three-fourths inch thick are found along these veins. Small flakes of molybdenite also were seen in the rock between the veins, but no molybdenite was seen in the water-scoured streambed.

An 80-foot chip sample (675, pl. 2) that was taken across the entire contact zone between the veins contained 0.09 ounce of silver per ton and a trace of gold, but no detectable molybdenum, copper, lead, or zinc. Two other samples taken by the claim owners in the lower third of the zone, in rock that did not have any obvious molybdenite, yielded 0.015 and 0.03 percent molybdenum and 0.04 and 0.02 percent copper. Even including the molybdenite-rich veinlets, the average tenor of the contact zone is very low.

The Molly claim is about 2,500 feet north of the Dead Goat prospect and lies across the east branch of Sulphide Creek. This claim has molybdenite-rich quartz veins similar to those of the Dead Goat prospect, but the occurrence appears to be less promising.

Many claims are staked on a large U-shaped iron oxide-stained zone that curves around the east branch of Sulphide Creek. This zone is 2.5 miles long and has an average width of about 0.3 mile (fig. 10). Much of this zone is exposed in the steep cliffs that form the headwalls of this tributary. Staining is due to oxidation of abundant disseminated pyrite and pyrrhotite. Chalopyrite and molybdenite were seen in a few places. Two of the three small pits found in Sulphide basin occur on the old Union claim in an upper basin at the head of the east fork of Sulphide Creek at an elevation of about 3,040 feet. Two pits were dug in a highly iron oxide-stained part of the zone (fig. 20). At this locality a pod of massive pyrite, 3–10 inches thick, is exposed for 7 feet in the lower pit (fig. 20). A 7-foot sample (637, fig. 20) cut along the pod did not contain any detectable gold, silver, lead, zinc, or molybdenum. A chip sample (638, fig. 20) across a pyrite-rich quartz vein exposed in the upper pit assayed 0.015 percent copper but no gold, silver, molybdenum, or zinc.

A total of 18 chip samples taken of the large disseminated zone contained minor but varying quantities of copper, molybdenum, silver, and gold. Copper content of two samples (640, 643, pl. 2) was as much as 0.05 percent, but the average indicated by the samples is probably near 0.02 percent. Molybdenum was not detected in most samples, although one sample (653) had 0.02 percent. A trace of silver was found in most samples; several had 0.04 ounce per ton. Gold was not detected in most samples, although several had a trace, and one (646) had 0.30 ounce per ton. The lack of access to large parts of this disseminated sulfide zone resulted in inadequate sampling of these areas. The general tenor of the samples taken, however, is so low that there is little indication of the presence of any minable deposits.

Near the crest of a ridge to the northwest of the large disseminated zone, about N. 60° E. of Sulphide Lake, is a 6-inch-wide vein containing manganese oxides and rhodonite. This vein is in a wide shear zone, in contorted phyllite, that strikes north and dips 60° S. From near

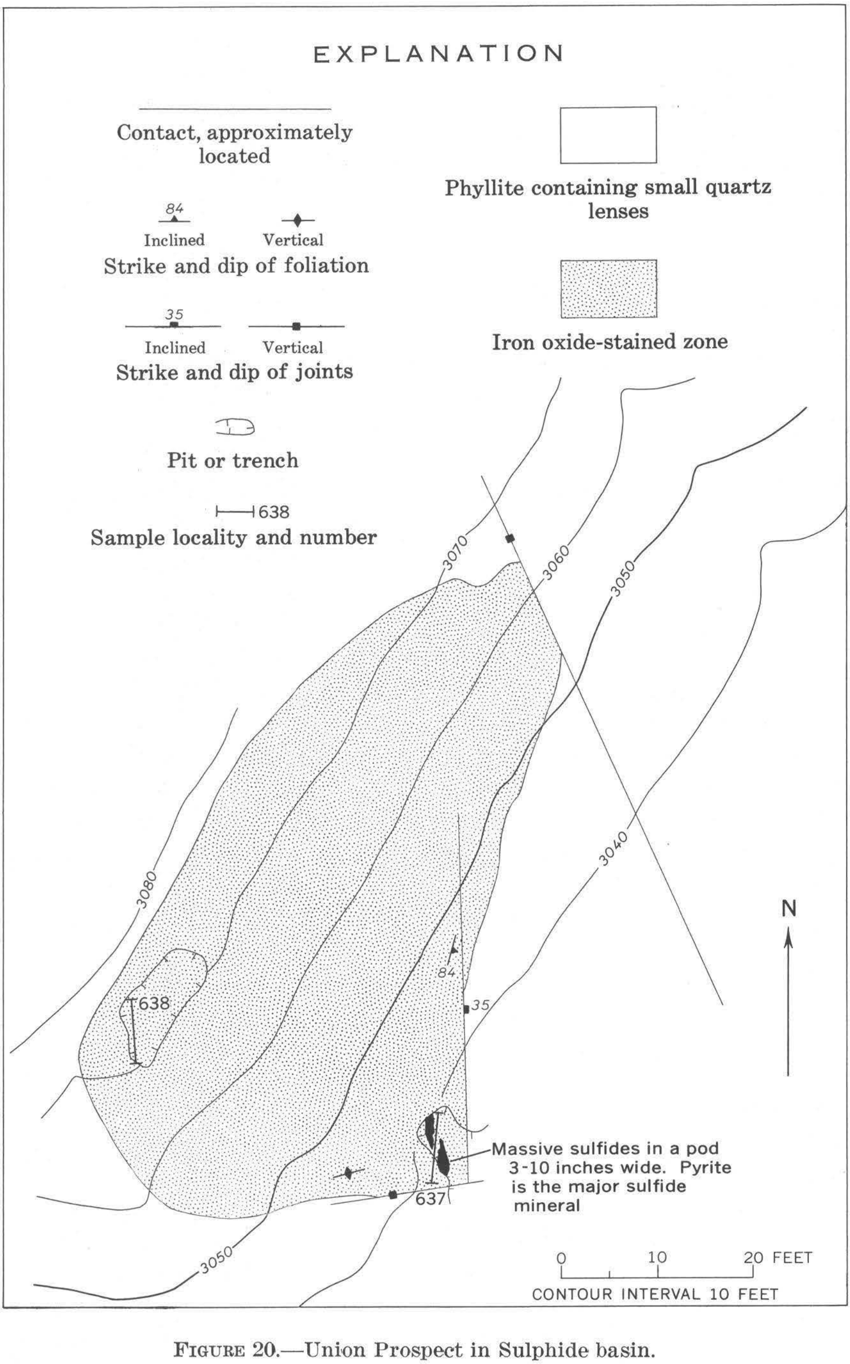


FIGURE 20.—Union Prospect in Sulphide basin.

the top of the ridge, the shear zone can be seen angling up the steep craggy ridge for about 150 feet; it probably extends to the west side of the ridge. Samples (650, 651, pl. 2) of the vein contained 4.2 and 7.8 percent manganese, but no detectable gold, silver, copper, or molybdenum.

Another prospect is on a small quartz vein on the crest of the steep ridge east of Sulphide Creek basin and a half mile south-southeast of Seahpo Peak. It consists of a small pit, 6 feet wide, 8 feet long, and about 1 foot deep, that has been dug in black phyllite. Along the back of the pit is a flat-lying iron oxide-stained quartz vein that has a general strike of N. 5° W. and a dip of about 15° NE. This vein, which is 0.1–0.8 foot thick, is exposed for about 20 feet. A channel sample (637, pl. 2) across the quartz vein in the back of the pit did not yield any detectable gold.

Panned samples were taken between the mouth and the main forks of Sulphide Creek, but no gold was found in them. The stream gravels contain less than 5 pounds of black sand per cubic yard. The black sand consists of pyrite, magnetite, garnet, epidote, and generally a few flakes of molybdenite.

DEPOT CREEK AREA

Sediment samples were collected from most of the tributaries that enter Depot Creek, which drains the north side of Mount Redoubt and flows north into Canada. Samples from two tributaries about 1½ miles below the headwaters had anomalous amounts of cold copper. Samples (736–739, pl. 2; table 1) from a tributary on the southwest side of Depot Creek contained as much as 30 ppm cold copper. This tributary drains a part of the big Redoubt Glacier. Several small, widely spaced, half-inch-thick veins of pyrite with a little chalcopyrite were found just below the glacier. Scattered glacial boulders in the same area contain disseminated pyrite and pyrrhotite, and several iron oxide-stained zones can be seen above the glacier on the near-vertical northeast fact of Mount Redoubt. The cold copper in this tributary probably comes from both the small veins and the disseminated zones on the cliff.

Samples (732–734, pl. 2; table 1) from a tributary on the northeast side of Depot Creek yielded 50–500 ppm cold copper. Several iron oxide-stained zones of disseminated sulfides crop out on the mountain above. Five chip samples (724–726, 729–730, pl. 2; table 1) were taken on the largest zone, which is about 1 mile long and lies mainly north of the area drained by the tributary containing the samples with the higher copper values. Samples from this large zone yielded 0.0003–0.005 percent copper. Molybdenum was detected in only one sample. Another chip sample was taken on a smaller disseminated zone directly east and above the tributary containing the high cold copper values. This sample (731, pl. 2) had 0.01 percent copper and 0.01 percent lead. The difference between the copper content of much higher stream samples and that of the rock samples suggests that part of the disseminated zone contains considerably more copper than the site that was sampled.

Nine other chip samples of disseminated sulfide zones were taken downstream in the Depot Creek drainage. These contained 0.0015–0.015 percent copper and <0.001–0.03 percent lead. Two samples (748, 749, pl. 2; table 1) that contain 0.01 and 0.03 percent lead came from west of a small lake that is 1.4 miles northwest of the top of Mount Redoubt. These two samples were among five collected from disseminated zones along and adjacent to a northeast-trending fault. The highest value came from a zone lying across a small fault.

BEAR CREEK AREA

Bear Creek flows down a heavily wooded valley and drains steep bare ridges that form the northeast side at Mount Redoubt and the southwest side of Bear Mountain. Sediment samples were collected from all flowing tributaries of Bear Creek, and anomalous amounts of copper and molybdenum were found in two areas. One of these is from near the middle part of Bear Creek, where samples from several tributaries on the northeast side of the creek contained 10–15 ppm cold copper and molybdenum. Iron oxide-stained zones, 1–180 feet wide, of disseminated pyrite occur on the ridge northeast of the sample localities. Most of these rocks contain only minor amounts of copper (0.002–0.01 percent) and molybdenum (<0.0005–0.0007 percent). One small iron oxide-stained zone, approximately 2,800 feet south-southwest of a peak at an altitude of 7,365 feet, lies adjacent to a quartz vein that cuts biotite-quartz diorite. This vein is 0.2 foot thick, is exposed for about 40 feet, and contains a few small scattered molybdenite crystals. Chip samples were taken of the quartz vein and of the adjacent iron oxide-stained country rock. Sample 763 (pl. 2; table 1) of the vein contained 0.004 percent molybdenum; sample 764 of the adjacent country rock, however, yielded 0.07 percent molybdenum, 0.03 percent copper, and 0.20 ounce of silver per ton.

The other anomalous area is near the upper end of Bear Creek, where several tributaries that drain the north side of Bear Mountain contain 15–20 ppm cold copper and 20–50 ppm molybdenum. These tributaries receive their high metal content from disseminated sulfide zones high on the northwest side of Bear Mountain. One of the largest of these is triangular in shape, roughly 150–200 feet on the sides. Sulfide content of this zone is erratic and is higher in the narrow borders along joints in granodiorite than in the rest of the zone. A chip sample (777, pl. 2; table 1) taken at random across the larger of the disseminated zones contained 0.015 percent total copper and 0.002 percent molybdenum. An 8-inch sample (778) across a joint within the larger zone contained 0.03 percent copper, 0.02 percent lead, and 0.01 percent molybdenum. Seven other samples taken across narrow disseminated zones, 1½–6 feet wide, yielded 0.007–0.03 percent copper and <0.0005–0.015 percent molybdenum.

INDIAN CREEK AREA

Indian Creek drains a deep valley between Bear Mountain on the north and Red Face Mountain on the south. All the Indian Creek drainage is discussed here except the tributary that drains Lake Reveille, which was included in the discussion of the Red Face Mountain area. Sediment samples from six tributaries that drain the south side of Bear Mountain contained anomalous amounts of cold copper or molybdenum, or both. Nine of these sediment samples (796, 798, 802, 805–807, 810–812, pl. 2; table 1) contained 7–70 ppm cold copper and 3–20 ppm molybdenum. The source of this anomalous metal content is a number of small iron oxide-stained zones in the granodiorite country rock. These zones are rarely more than 2 feet wide. Some are exposed for a length of only 15 feet or less, although a few are exposed for as much as 200 feet. Two chip samples (813, 814, pl. 2; table 1), one each from two of the longest of these narrow zones, just south of Bear Mountain, had 0.05 percent copper. In addition, one sample (813) contained 0.003 percent molybdenum, 0.06 ounce of silver per ton, and 0.003 ounce of gold per ton, and the other (814) yielded 0.44 ounce of silver per ton and 0.10 ounce of gold per ton. Two chip samples (794, 795, pl. 2; table 1), one each from two other small iron oxide-stained zones, contained 0.05 percent total copper. These samples were from adjacent pyrite-bearing zones along joints about half a mile west of the top of Bear Mountain. In addition to copper, one sample (794) contained 0.03 percent lead, 0.001 percent molybdenum, and 0.87 ounce of silver per ton; the other (795) yielded 0.007 percent lead, 0.0007 percent molybdenum, and 0.20 ounce of silver per ton.

The Packsaddle placer claims lie along the central part of Indian Creek, about 3 miles above its mouth and 2,000 feet east of its junction with a tributary that drains Lake Reveille. This property is reached by a narrow trail along the northeast side of Indian Creek that leaves the Chilliwack River trail at the Indian Creek shelter. Unconsolidated alluvium was placered in a sluice built in a high-water channel. Sand panned from a sandbar produced one-half ounce of heavy mineral concentrate from three 16-inch-diameter pans. This concentrate (808, pl.

2) did not yield any detectable gold. Sand samples 793 and 790 (pl. 2; table 1), panned about 1½ and 3 miles below Packsaddle placer claims, yielded 0.002 and 0.001 ounce of gold per ton, respectively.

EASY RIDGE

Easy Ridge is a broad, fairly flat topped, steep-sided ridge that trends northwest from Whatcom Peak to the Chilliwack River, a distance of about 5 miles. The ridge is underlain by granodiorite that is cut by numerous north-trending alaskite dikes and a few small diorite bodies. Several narrow zones that contain pyrite either in disseminated cubes or in veinlets occur in an area about 1½ miles long on the top of this ridge in the vicinity of Easy Peak. In a few places a little chalcopyrite is present in the zones. Although these zones contain abundant pyrite, the rocks were fresh and unstained. Fourteen samples of these zones (pl. 2) contained 0.005–0.30 percent copper and <0.0005–0.03 percent molybdenum. Of the six samples with the highest copper and molybdenum content, one (852), from near the top of Easy Peak, was cut across a 1-inch-wide pyrite veinlet and the adjoining silicified alaskite. This sample yielded 0.15 percent copper, 0.03 percent zinc, and 0.003 percent molybdenum. An adjacent sample (853, pl. 2; table 1) of silicified alaskite with disseminated pyrite had 0.007 percent copper, <0.02 percent zinc, and 0.03 percent molybdenum. About 1,400 feet southeast along the ridge from the top of Easy Peak, two other samples were collected from pyrite veinlets and the adjacent pyritized diorite. Both of these samples (856, 857, pl. 2; table 1) contained 0.15 percent copper, <0.02 percent zinc, and 0.007 percent molybdenum. The other two copper-rich samples came from an area 260 feet east of the two samples just described. One was cut across 2 feet of pyrite-bearing diorite and a ¼-inch-thick pyrite veinlet; the other was a sample of another area with a pyrite veinlet and accompanying pyrite-rich wallrock, about 2 feet from the first sample. These two samples, 858 and 859 (pl. 2; table 1) had 0.30 and 0.05 percent copper, <0.02 and <0.02 percent zinc, and 0.007 and 0.003 percent molybdenum, respectively. Although the copper content of these disseminated zones is one of the highest found in the study area, the individual zones are small, for they generally consist of rock containing disseminated sulfides that extends only a few feet from a small sulfide veinlet.

EASY CREEK AREA

Easy Creek is a northwestward-flowing 2-mile-long tributary of the Chilliwack River that heads in a cirque between Easy Peak and Mineral Mountain. Five sediment samples (837, 839, 841–843, pl. 2; table 1) collected from tributaries around the head of the cirque had 10–20 ppm molybdenum. Sample 842, which came from one of the two tributaries that drained Mineral Mountain, also had 15 ppm heavy metals; sample 843, from another tributary, had 10 ppm cold copper. We did not attempt to trace the source of the two samples from the tributaries that drain Mineral Mountain, for the tributaries cascade off a series of cliffs on the steep southwest face of the cirque, but the streams head 1 mile or less from the sample localities. The tributaries that drain the northeast side of the cirque flow for most of their courses down the thick talus that forms the west side of Easy Ridge. No samples of mineralized rock were collected in this area.

LITTLE FORK OF THE CHILLIWACK RIVER AREA

The Little Fork of the Chilliwack River, which is only a little more than 3 miles long, flows down a densely wooded valley that drains a quartz diorite terrain. Sediment samples were collected at the mouths of 20 tributaries that flow into this river (pl. 2). In the central and lower parts of the valley, sediment samples (870, 871, 873, 874, pl. 2; table 1) from four tributaries yielded 7–20 ppm cold copper, and a sample from a fifth tributary (869) yielded 500 ppm cold copper. The tributary from which the highest copper sample was obtained was traced up a heavily wooded mountainside, on which exposures are meager and widely separated. Iron oxide staining was not observed on any of the outcrops or on pieces of quartz diorite float. Three chip samples were taken at different elevations up the mountain from float specimens that contained scattered pyrite. In order of increasing elevation the samples, 866, 867, and 868 (pl. 2; table 1), contained 0.015, 0.007, and 0.015 percent total copper and 0.002, 0.0005, and 0.015 percent molybdenum, respectively. Although these zones undoubtedly furnished some copper, the higher value obtained at the tributary's mouth indicates that the principal source of the copper was not found.

At the headwaters of the Little Fork of the Chilliwack River, samples (861–863) from three tributaries draining the east and south sides of the valley contained 10–20 ppm molybdenum. As all these tributaries have a small flow and are 1 mile or less in length, the source of the molybdenum is most likely small or low grade. All three tributaries drain thickly forested slopes; therefore, no attempt was made to locate the source of the anomalous samples.

CHILLIWACK RIVER AREA

The Chilliwack River heads near Hannegan Pass and flows north into Canada. It is the major drainage in the northwest part of the study area, and many streams flow into it, including the previously mentioned Depot, Indian, Bear, and Easy Creeks and the Little Fork of the Chilliwack River.

Stream-sediment samples were collected from the small tributaries that enter the Chilliwack River. Chip samples of iron oxide-stained zones were also collected wherever found on the valley sides and ridges. Only a few stream sediment and chip samples contained anomalous amounts of metals. Three areas are of particular interest: the area on the ridge east of the Chilliwack River near the Canadian border and the areas west of the mouths of Indian and Easy Creeks.

In the first area, which is on a ridge crest 1–2 miles south of the Canadian border, eight iron oxide-stained zones, 1–4 feet wide, occur near the contact between granodiorite of the Chilliwack batholith and the Custer Gneiss of McTaggart and Thompson. The northern two zones are in the granodiorite; the other six are in the gneiss. All are along shears or small faults that strike N. 45° E. to east and dip 50°–60° S. Chip samples (893, 894, 896–898, 901–904, 906, pl. 2; table 1) across seven of these zones yielded 0.003–0.03 percent copper. A sample (895) across the third zone from the north had 0.10 percent copper (pl. 2). This zone, which is 2 feet wide, could be traced for about 200 feet. The northernmost sample (893), which was also across a 2-foot-wide zone, had 0.015 percent lead. Molybdenum was low in all samples.

The second area is a small tributary west of the mouth of Indian Creek (pl. 2). A sediment sample (919, pl. 2; table 1) from the mouth of this tributary, which flows over quartz diorite, had 50 ppm cold copper. A sediment sample (917) taken from a spring issuing out of the bank about a third of the way up the mountain had 200 ppm cold copper. Sediment samples 916 and 918, taken on the main tributary above this spring, contained 15 and 30 ppm cold copper, respectively. The source of the copper coming from the spring is not known.

The third area that contains anomalous amounts of metal is west of the mouth of Easy Creek, where sediment samples (928, 929, 935, 938, pl. 2; table 1) from the mouths of four small tributaries to the Chilliwack River contained 15–500 ppm heavy metals. These samples are unusual in that they have a low cold copper content. The lower part of the small tributary from which the sample (935) that contained 500 ppm heavy metals was obtained flows down a steep bouldery water-course between forested, soil-covered banks. A sediment sample (937) taken where the stream starts cascading down rock outcrops showed 70 ppm heavy metals; thus the source of much of the heavy metals is beneath the cover on the hillside. Samples (935, 929) taken at the mouths of two other tributaries contained 50 and 70 ppm heavy metals; these tributaries were traced upward into steep rocky gorges cut into alaskite. The alaskite is in places sheared and faintly stained with iron oxides. Two samples taken of the iron oxide-stained rock in each gorge had <0.02 percent zinc. Samples (931, 932) from the easternmost gorge had 0.001 percent lead; samples 943 and 940, from the westernmost gorge, had 0.003 and 0.015 percent lead, respectively. Sediment samples from the tributaries, above the faint iron oxide-stained zones, were not anomalous in heavy metals. As the lower limit of detection of the spectrographic analysis for zinc is high (200 ppm) and that for combined heavy metals by our geochemical method is relatively low (1 ppm), the presence of anomalous amounts of zinc below 200 ppm in the sheared iron oxide-stained rocks might be sufficient to account for the anomalies found in these two tributaries.

HANNEGAN PASS–RUTH MOUNTAIN AREA

The Hannegan Pass-Ruth Mountain area lies along the main north-trending ridge on the west boundary of the study area between Hannegan Peak and Ruth Mountain (pl. 2). This is one of the most easily reached parts of the area studied, for the principal east-west trail in the western part of the area crosses the ridge at Hannegan Pass, and hence it is one of the more thoroughly prospected areas. The Hannegan Pass group of six claims was located in and near Hannegan Pass in 1895, and several other claims were located in the vicinity between 1897 and 1909. Several sloughed pits and two adits, one of them caved, were found on the mountain on the north side of Hannegan Pass; another small adit lies to the west and 500 feet vertically below the pass.

This area for the most part is in the Hannegan Volcanics, although a small tongue of quartz diorite of the Chilliwack batholith is exposed within Hannegan Pass (pl. 1). The workings on the north side of Hannegan Pass are in quartz diorite near its contact with the volcanics. Several trenches, as much as 30 feet long, and an adit were dug in the lower soil-covered part of this slope. These workings are now sloughed in, but iron oxide-stained quartz diorite debris on the dumps indicates that bedrock was reached in most of them. Six grab samples (962, 963, 965, 966, 968, 969, pl. 2; table 1) were taken from dumps of the sloughed workings. Several samples yielded traces of gold and silver, but none contained anomalous copper or molybdenum. Above the trenches a 6-foot-long adit is driven into an outcrop of iron oxide-stained quartz diorite. A sample (961) containing disseminated pyrite from the back of this adit and three other samples (960, 964, 967) from this same iron oxide-stained outcrop did not yield any gold, silver, copper, or molybdenum.

The adit west of Hannegan Pass is on a small creek that drains a little meadow some 500 feet below the pass at an approximate elevation of 4,550 feet. The adit, which is only 6 feet long, is between two small waterfalls in an 80-foot-wide silicified iron oxide-stained zone that contains disseminated pyrite. This zone, which is in quartz diorite, trends N. 45° E. One chip sample (971, pl. 2; table 1) was taken along the sides and back of the adit, and another (970) was taken across 20 feet of the iron oxide-stained zone where it crosses the trail above the adit. Gold was not detected in either sample.

Several old claims are reported in the county courthouse records as being on or in the vicinity of Ruth Mountain. The descriptions of some of these claims, however, indicate that the name Ruth Mountain was used in the late 1890's and early 1900's for a different mountain, a peak on the ridge on the north side of Ruth Creek, west of the study area. Nevertheless, a careful examination was made of Ruth Mountain, as presently shown on the maps, and we found several iron oxide-stained zones in the Hannegan Volcanics. Samples were taken of zones on the north, west, and south flanks of this mountain (pl. 2). None contained anomalous amounts of gold, silver, or molybdenum. One sample (976, pl. 2; table 1) of a 2-inch-thick iron oxide-stained zone along a fracture on the north flank of Ruth Mountain had 0.03 percent copper.

SILESIA CREEK AREA

Silesia Creek is the major stream that drains the northwest part of the area. Thirty-six sediment samples were taken from tributaries that flow into this stream (pl. 2). Only samples from two tributaries that drain the west side of Copper Mountain were anomalous for copper or molybdenum, and these samples (1025, 1035, table 1) had 50 and 1 ppm cold copper and 30 and 50 ppm molybdenum, respectively. About a quarter of the way up the more northern of the two tributaries, we found several zones containing disseminated pyrite. A chip sample (1022) from the lowest of these zones, which is about 50 feet across, had 0.02 percent copper and 0.03 percent molybdenum. Just above this zone is a second zone, which is exposed for 100 feet up the creek bottom. A chip sample (1023) from this bleached zone, which is cut by drusy quartz seams, yielded 0.015 percent copper and 0.02 percent molybdenum. Farther upstream were irregular patches of iron oxide-stained quartz diorite cut by several alaskite dikes as much as 20 feet thick. Within the dikes were scattered pods of sulfides, mainly pyrite, but including some molybdenite. A chip sample (1021) of the iron oxide-stained quartz diorite contained 0.05 percent copper and 0.01 percent molybdenum. A stream-sediment sample on the tributary above this last sample was low in copper (pl. 2); thus the disseminated zones sampled are possibly the source of the copper and molybdenum obtained at the mouth of the tributary.

A sediment sample (1016, pl. 2; table 1) from a large tributary draining the northeast side of Silesia Creek yielded 15 ppm heavy metals. Six zones of iron oxide-stained rock were sampled (1010–1015, pl. 2; table 1) on the ridge north of this tributary. All were either in quartz diorite of the Chilliwack batholith or in the adjacent metamorphosed arkosic sandstone of the Chuckanut Formation. Three of these samples (1013–1015) contained 0.07 percent or more zinc. The sample (1013) with the highest zinc content, 0.30 percent, came from two small adjacent iron oxide-stained zones totaling about 5 feet across in sandstone inclusions surrounded by quartz diorite. The next highest sample (1015), which yielded 0.10 percent zinc, was a composite sample from several small irregular zones 2 inches to 20 feet across that lie adjacent to the north side of the tributary. Sample 1014, which had 0.07 percent zinc, was from a small iron oxide-stained zone, 5 by 15 feet in size, on the west end of the ridge. Although these zones are small, their zinc content is relatively high.

Several small calcite veins were found at two localities near the top of the high ridge on the southwest side of Silesia Creek between peaks 6839 and 7035 (pl. 2). The most northerly of these veins is 2,400 feet south of peak 6839 and 200 feet below and to the east of the top of the pinnacles that cap this part of the ridge. Here a calcite vein cuts sheared biotite-hornblende-quartz diorite. This vein strikes N. 42° E. and dips vertically. It is 0.3 feet thick and is exposed for approximately 40 feet. On either side of the vein is a 4-foot-wide zone of iron oxide-stained quartz diorite. A 0.3-foot channel sample (1004, pl. 2; table 1) was cut across the vein, and an 8-foot chip sample (1005) was taken of the altered rock on either side of the vein. Neither sample contained anomalous amounts of copper, lead, zinc, molybdenum, silver, or gold. The second locality is 800 feet south-southeast of the first zone and at about the same elevation. Several branching white calcite veins cut biotite-hornblende-quartz diorite on a cliff face area of 10 by 25 feet at this locality. These veins generally strike N. 35° E. and dip 75° NW.–75° SE. The quartz diorite on either side of these veins is bleached and stained with iron oxide. Three samples were taken from this exposure: (1) a 0.6-foot channel sample (1006, pl. 2; table 1) across a 0.3-foot calcite vein and the altered country rock adjacent to it at the south side of the exposure, (2) a 1-foot channel sample (1007) of a 0.3-foot calcite vein and the altered rock adjacent to it at the north side of the exposure, and (3) a 2-foot chip sample (1008) across several small veins and the intervening country rock in the center of the exposure. All three samples contained 0.02 percent zinc, but were low in other metals.

WEST FORK OF SILESIA CREEK AREA

The West Fork of Silesia Creek lies along the west boundary of the study area, but tributaries on its east side drain a ridge within the study area. Samples (1052, 1053, 1061) from three west-flowing tributaries about 1–1½ miles above the mouth of Winchester Creek contain 7–10 ppm heavy metals. Sample 1053 had the highest heavy metals value, and the tributary from which this sample was taken was traced upward. In the three sediment samples (1054, 1056, 1058, pl. 2; table 1) that were taken along this tributary, heavy metals increased to 30 ppm. Chip samples (1055, 1057, table 1) were also taken from several small iron oxide-stained areas along the way. None contained anomalous amounts of lead, zinc, copper, or molybdenum. Above the last sediment sample near the ridgetop, however, several small iron oxide-stained areas were found along joints in a dacite flow. A composite chip sample (1060, table 1) from a few of these areas had 0.02 percent lead.

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TABLE 1

TABLE 1.—*Analyses of samples from the northern*

[Dash leaders (---) indicate element not looked for. Results of the semiquantitative spectroscopic analyses are reported to the nearest number in a series 1, 0.7, 0.5, 0.3, 0.2, 0.15, and 0.1, which represent approximate midpoints of group data on a geometric scale. The assigned groups for the series will include the quantitative value about 30 percent of the time. The data should not be quoted without stating these limitations. Semiquantitative spectrographic analyses were made by Arnold Farley, Jr., D. J.

Sample	Semiquantitative spectrographic analyses (ppm)													
No.	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co
					International Creek drainage									
1	7,000	<200	700	150	500	<20	10	50	<10	50	10	10	<10	<5
2	5,000	<200	1,000	200	50	<20	5	20	150	100	15	<2	<10	<5
3	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
4	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
5	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
					Silver Creek drainage									
6	7,000	<200	1,000	300	50	<20	20	70	<10	<10	20	<2	<10	20
7	5,000	<200	300	200	100	<20	30	50	10	30	10	<5	<10	5
8	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
9	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
10	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
11	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
12	5,000	<200	1,000	150	200	<20	5	30	150	30	10	10	<10	<5
13	3,000	<200	2,000	150	500	<20	<2	50	100	500	5	<2	20	<5
14	3,000	300	200	100	100	<20	<2	200	50	50	10	<2	<10	<5
15	3,000	<200	1,000	100	70	<20	<2	30	10	70	5	<2	<10	<5
16	5,000	<200	1,000	100	50	<20	<2	150	20	150	20	<2	<10	<5
17	5,000	<200	500	100	50	<20	<2	150	20	500	<5	<2	<10	<5
18	3,000	<200	700	150	100	<20	<2	300	15	50	10	<2	100	<5
19	5,000	<200	2,000	100	50	<20	<2	500	70	50	10	5	150	<5
20	10,000	<200	5,000	100	200	<20	10	300	50	100	30	<2	200	<5
21	7,000	<200	1,000	150	50	<20	<2	200	15	<10	10	10	<10	<5
22	500	<200	500	10	50	<20	<2	300	200	70	<5	<2	<10	<5
23	3,000	<200	700	20	150	<20	<2	70	50	100	10	<2	<10	<5
24	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
25	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
26	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
27	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
28	5,000	<200	1,500	150	50	<20	10	150	<10	<10	15	<2	<10	<5
29	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
30	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
31	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
32	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
33	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
34	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
35	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
36	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
37	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
38	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
39	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
40	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
41	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
42	3,000	<200	500	70	150	30	15	---	30	20	30	---	<10	<5
43	1,000	<200	100	10	---	30	3	---	20	---	50	---	30	7
44	2,000	<200	300	50	---	50	5	---	20	---	30	---	<10	5
45	3,000	<200	200	70	---	<20	3	---	20	---	20	---	<10	7
46	2,000	<200	200	50	---	<20	3	---	20	---	15	---	<10	7
47	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
48	7,000	<200	1,000	2,000	1,000	50	20	30	<10	200	20	<2	<10	20
49	7,000	<200	200	150	50	<20	<2	50	<10	50	10	<2	<10	<5
50	5,000	<200	1,000	150	50	<20	10	100	<10	<10	15	<2	<10	5
51	10,000	<200	500	300	50	<20	<2	30	<10	70	10	<2	<10	<5
52	-----	---	---	---	---	---	---	---	---	---	---	---	---	--
53	10,000	<200	1,000	200	300	<20	5	7	<10	30	15	<2	<10	<5
54	>10,000	<200	1,000	1,500	>1,000	100	<2	70	<10	200	20	<2	<10	20

part of the North Cascades National Park

Grimes, H. G. Neiman, J. M. Motooka, and K. J. Watts, Jr. Chemical analyses were made by George Andrews, W. A. Barry, W. L. Campbell, Gary Dounay, J. G. Frisken, R. F. Hansen, Claude Huffman, Jr., H. D. King, E. E. Martinez, S. K. McDanal, J. D. Mensik, R. L. Miller, S. L. Noble, O. M. Parker, M. S. Richard, T. A. Roemer, J. A. Thomas, A. J. Toevs, R. B. Tripp, and J. E. Troxel]

	Semiquantitative spectrographic analyses--Continued (ppm)				Chemical analyses (ppm)						
Sample	Ag	As	Cr	Ba	cxHM	cxCu	Au	Ag	Cu	Mo	Sample description 1/
					International Creek drainage						
1	<0.5	<200	200	700	---	---	<0.1	---	---	---	Lim. tuff pyrite.
2	.7	<200	50	700	---	---	<.1	---	---	---	Do.
3	---	---	---	---	15.0	20	---	---	---	7	Stream sediment.
4	---	---	---	---	3	3	---	---	---	7	Do.
5	---	---	---	---	3	3	---	---	---	7	Do.
					Silver Creek drainage						
6	<.5	<200	70	700	---	---	<.1	---	---	---	Fg. vol. rock, sc. pyrite.
7	.7	<200	70	150	---	---	<.02	---	---	---	Lim. tuff, sc. pyr., pyrh.
8	---	---	---	---	---	---	.7	<0.05	0	0	Do.
9	---	---	---	---	---	---	0	0	0	0	Do.
10	---	---	---	---	---	---	<.05	20	0	---	Qtz. pyrite vein.
11	---	---	---	---	---	---	<.05	2	0	0	Do.
12	<.5	<200	70	1,000	---	---	.2	---	---	---	Tuff, locally FeOst.
13	2	<200	50	1,500	---	---	<.1	---	---	---	Tour. chl. qtz. vein.
14	<.5	<200	20	1,000	---	---	<.1	---	---	---	Lim. zone in qtz. di.
15	<.5	<200	30	1,500	---	---	<.1	---	---	---	Do.
16	<.5	<200	30	700	---	---	.1	---	---	---	Tour chl. qtz. vein.
17	<.5	<200	30	1,500	---	---	<.1	---	---	---	Tour. sericite-qtz. vein.
18	<.5	<200	30	700	---	---	<.1	---	---	---	Lim. ser. chl. qtz. vein.
19	<.5	<200	<20	1,000	---	---	<.1	---	---	---	Do.
20	<.5	<200	50	1,000	---	---	.1	---	---	---	Ser.-lim. tour.-qtz. vein.
21	<.5	<200	50	1,000	---	---	<.1	---	---	---	Lim hbd. gneiss, sc. sul.
22	10	<200	<5	1,000	---	---	.1	---	---	---	Lim.-chl.-tour.-qtz. vein.
23	<.5	<200	<5	700	---	---	<.1	---	---	---	Lim. sil. qtz. di. with py.
24	---	---	---	---	7	1	---	---	---	<2	Stream sediment.
25	---	---	---	---	7	20	---	---	---	10	Do.
26	---	---	---	---	3	15	---	---	---	10	Do.
27	---	---	---	---	7	2	---	---	---	2	Do.
28	<.5	<200	50	700	---	---	<.1	---	---	---	Lim. fg. vol. rock.
29	---	---	---	---	3	20	---	---	---	7	Stream sediment.
30	---	---	---	---	2	10	---	---	---	3	Do.
31	---	---	---	---	5	20	---	---	---	3	Do.
32	---	---	---	---	---	---	.27	<.05	1,500	<3	Sil. tuff brc.; sc. sul.
33	---	---	---	---	---	---	<.1	7	15,500	2,900	Do.
34	---	---	---	---	---	---	<.1	0	1,500	<3	Kaol. sil. tuff brc.; sc. sul.
35	---	---	---	---	---	---	1	1.4	22,600	300	Contact tuff and qtz di; sc sul.
36	---	---	---	---	---	---	0	0	2,300	0	Do.
37	---	---	---	---	---	---	.3	14	13,300	3,000	Sil. tuff brc.; sul.
38	---	---	---	---	---	---	.2	<.05	1,300	<3	Contact tuff and qtz. di.
39	---	---	---	---	---	---	0	0	<10	0	Sh. tuff breccia.
40	---	---	---	---	---	---	0	0	<10	0	Tuff.
41	---	---	---	---	---	---	0	0	<10	0	Quartz diorite.
42	7	<200	20	700	---	---	.05	---	900	150	Sil. tuff-brc.; sc. chp, mo.
43	30	<200	7	200	---	---	.2	---	>5,000	5,000	Lim. sh. brc.; sc. chp.
44	7	<200	10	500	---	---	<.05	---	1,500	160	Tuff breccia, sc. chp.
45	2	<200	10	700	---	---	.06	---	3,200	80	Do.
46	2	<200	7	500	---	---	<.05	---	1,200	400	Do.
47	---	---	---	---	>50	1,000	---	---	---	70	Stream sediment.
48	<.5	<200	700	70	---	---	<.1	---	---	---	Panned concentrate.
49	<.5	<200	50	700	---	---	<.5	---	---	---	Bld. lim. qtz. di., sc. py.
50	<.5	<200	50	500	---	---	<.1	---	---	---	Lim. welded tuff, sc. py.
51	2	<200	100	700	---	---	<.1	---	---	---	Lim. volcanic rocks.
52	---	---	---	---	1.5	7	---	---	---	3	Stream sediment.
53	<.5	<200	100	700	---	---	<.1	---	---	---	Lim. fg. vol. rock.
54	<.5	<200	300	70	---	---	<.1	---	---	---	Panned concentrate.

See footnote at end of table.

TABLE 1.—*Analyses of samples from the northern*

Sample No.	Semiquantitative spectrographic analyses (ppm) Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co
							Perry Creek drainage							
55	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
56	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
57	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
58	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
59	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
60	7,000	<200	1,000	300	150	<20	20	100	<10	10	30	<5	<10	10
61	150	<200	1,500	30	<10	<20	2,000	30	<10	15	<10	<5	<10	100
62	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
63	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
64	10,000	<200	200	200	100	<20	<2	100	50	500	<5	15	<10	<5
65	7,000	<200	20	200	70	<20	<2	5	<10	200	10	<2	<10	<5
66	5,000	<200	50	100	100	<20	<2	5	<10	70	<5	20	50	5
67	5,000	<200	500	200	70	<20	15	50	<10	700	15	15	<10	<5
68	10,000	<200	1,000	200	50	<20	20	30	<10	300	10	<2	<10	<5
							Redoubt Creek drainage							
69	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
70	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
71	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
72	>10,000	<200	2,000	1,000	>1,000	<20	50	50	10	70	20	<2	<10	30
							Pass Creek drainage (Tributary to Little Beaver Creek)							
73	7,000	<200	700	100	15	<20	20	300	20	<10	20	<5	<10	20
74	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
75	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
76	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
77	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
78	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
79	7,000	<200	700	150	150	<20	50	70	70	10	20	<5	<10	10
80	7,000	<200	1,000	200	70	<20	150	150	20	<10	15	<5	<10	30
81	700	<200	1,500	15	10	<20	5	10	50	100	7	<5	<10	<5
82	1,000	1,500	>5,000	30	15	<20	20	200	1,000	20	10	15	<10	30
83	1,500	1,000	5,000	30	30	<20	3	---	200	150	15	<5	<10	<5
84	1,500	5,000	>5,000	15	200	<20	15	2,000	700	20	10	<5	<10	30
85	700	7,000	5,000	50	20	20	3	500	10,000	15	10	<5	<10	<5
86	1,000	2,000	>5,000	15	100	<20	15	700	1,500	50	20	70	<10	30
87	3,000	1,500	1,000	150	150	20	30	200	70	30	15	5	<10	5
88	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
89	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
90	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
91	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
92	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
93	1,500	3,000	>5,000	30	10	<20	50	1,500	1,000	300	7	<5	<10	15
94	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
95	10,000	<200	1,000	150	100	<20	50	150	100	<10	30	<5	70	20
96	7,000	<200	500	200	150	<20	50	150	70	15	15	<5	10	10
97	7,000	<200	1,000	150	70	<20	50	70	100	100	20	5	20	10
98	3,000	<200	700	100	150	20	100	70	30	15	20	<5	<10	15
99	5,000	<200	1,500	100	100	20	20	150	100	10	15	7	<10	5
100	3,000	<200	7 700	70	100	<20	20	30	70	<10	7	<5	<10	5
101	3,000	300	>5,000	100	50	<20	30	70	70	10	15	5	<10	10
102	7,000	<200	1,500	700	30	<20	20	100	10	<10	15	<5	<10	20
103	3,000	<200	700	100	100	<20	15	70	100	10	15	7	10	<5
104	>10,000	<200	2,000	300	500	50	50	100	10	100	30	<2	<10	30
105	-----	---	---	---	---	---	---	---	---	---	---	---	---	---

part of the North Cascades National Park—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Ag	As	Cr	Ba	Chemical analyses (ppm) cxHM	cxCu	Au	Ag	Cu	Mo	Sample description 1/
					Perry Creek drainage						
55	---	---	---	---	7.0	5	---	---	---	<2	Stream sediment.
56	---	---	---	---	3	3	---	---	---	10	Do.
57	---	---	---	---	20	20	---	---	---	20	Do.
58	---	---	---	---	10	2	---	---	---	30	Do.
59	---	---	---	---	7	3	---	---	---	50	Do.
60	<0.5	<200	70	300	---	---	<0.02	---	---	---	Lim. bi. qtz. granulite.
61	<.5	<200	2,000	50	---	---	<.02	---	---	---	Lim. dark gneiss.
62	---	---	---	---	7	3	---	---	---	2	Stream sediment.
63	---	---	---	---	1.5	10	---	---	---	2	Do.
64	<.5	<200	100	700	---	---	.1	---	---	---	Lim. vol. brc., sc. py.
65	<.5	<200	50	700	---	---	<.1	---	---	---	Lim. sil. vol. rock, sc. py.
66	<.5	<200	70	500	---	---	<.1	---	---	---	Lim. tuff, sc. py.
67	<.5	<200	100	1,000	---	---	<.1	---	---	---	Do.
68	<.5	<200	200	700	---	---	<.1	---	---	---	Do.
					Redoubt Creek drainage						
69	---	---	---	---	1.5	10	---	---	---	5	Stream sediments.
70	---	---	---	---	10	15	---	---	---	2	Do.
71	---	---	---	---	7	7	---	---	---	3	Do.
72	<.5	<200	700	70	---	---	<.1	---	---	---	Panned concentrate.
					Pass Creek drainage (Tributary to Little Beaver Creek)						
73	<.5	<200	150	700	---	---	.02	---	---	---	Lim. bi. gneiss inclusion.
74	---	---	---	---	5	3	---	---	---	10	Stream sediment.
75	---	---	---	---	2	3	---	---	---	7	Do.
76	---	---	---	---	3	5	---	---	---	7	Do.
77	---	---	---	---	1	5	---	---	---	10	Do.
78	---	---	---	---	3	10	---	---	---	10	Do.
79	<.5	<200	150	700	---	---	<.02	---	---	---	Lim. hbd. grd.
80	<.5	<200	700	700	---	---	<.02	---	---	---	Lim. bi. gneiss.
81	<.5	<200	30	1,500	---	---	<.02	---	---	---	Impure marble.
82	3	<200	30	30	---	---	.04	---	---	---	Lim. qtz. chl. gneiss.
83	---	<200	20	7	---	---	<.05	2.2	250	---	Impure marble.
84	2	<200	20	30	---	---	.02	---	---	---	Epidote-gar. skarn.
85	---	<200	20	7	---	---	<.05	<.2	---	---	Do.
86	15	<200	15	150	---	---	---	---	---	---	Lim. light qtz. di.
87	<.5	<200	70	700	---	---	<.02	---	---	---	Lim. bi. gneiss
88	---	---	---	---	7	<1	---	---	---	<2	Stream sediment.
89	---	---	---	---	7	3	---	---	---	7	Do.
90	---	---	---	---	100	200	---	---	---	10	Do.
91	---	---	---	---	50	70	---	---	---	10	Do.
92	---	---	---	---	150	300	---	---	---	20	Do.
93	1.5	<200	<5	1,500	---	---	.03	---	---	---	Lim. bi. gneiss; sc. py. pyrh.
94	---	---	---	---	10	10	---	---	---	7	Stream sediment.
95	<.5	<200	150	700	---	---	<.02	---	---	---	Lim. bi. gneiss.
96	<.5	<200	200	700	---	---	<.02	---	---	---	Lim bi cut by lim dikes.
97	<.5	700	150	700	---	---	< 02	---	---	---	Lim. sil. bi. hbd. gn., sc. py.
98	<.5	<200	500	500	---	---	<.02	---	---	---	Lim. plag. po. dike.
99	.7	<200	70	1,500	---	---	<.02	---	---	---	Lim. hbd. bi. gneiss.
100	<.5	<200	70	700	---	---	<.02	---	---	---	Lim. aplite dike.
101	<.5	<200	150	700	---	---	<.02	---	---	---	Lim. bi. hbd. gneiss.
102	<.5	<200	300	100	---	---	<.1	---	---	---	Lim. hbd. gneiss.
103	<.5	<200	70	700	---	---	< 02	---	---	---	Do.
104	<.5	<200	500	100	---	---	<.1	---	---	---	Panned concentrate.
105	---	---	---	---	3	20	---	---	---	7	Stream sediment.

TABLE 1.—*Analyses of samples from the northern*

Semiquantitative spectrographic analyses

Sample No.	(ppm) Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co
							Red Face Mountain Area							
106	3,000	<200	500	200	100	<20	10	50	20	10	20	<5	<10	7
107	5,000	<200	700	200	150	<20	30	300	30	<10	15	10	<10	20
108	5,000	<200	2,000	300	70	<20	15	70	30	20	10	50	<10	15
109	1,500	<200	200	100	150	<20	5	50	15	<10	<10	<5	<10	5
110	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
111	5,000	<200	1,000	200	100	<20	5	30	10	<10	15	<5	<10	10
112	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
113	5,000	<200	1,000	200	20	<20	<2	10	<10	<10	20	<2	<10	<5
114	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
115	1,500	<200	200	50	70	20	<5	20	20	15	<10	5	<10	<5
116	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
117	7,000	<200	1,000	200	50	<20	<2	50	<10	<10	20	<2	<10	<5
118	2,000	<200	100	30	100	<20	<2	50	100	30	<5	<2	<10	<5
119	1,500	<200	300	70	150	20	<5	30	10	20	<10	<5	<10	<5
120	2,000	<200	500	100	100	20	7	70	30	<10	10	20	<10	<5
121	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
122	2,000	<200	30	15	150	20	<5	30	20	<10	<10	50	<10	<5
123	150	<200	70	15	---	---	<5	50	<10	---	<10	5	<10	<5
124	3,000	<200	700	50	100	<20	<2	50	20	<10	20	<2	<10	<5
125	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
126	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
127	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
128	100	<200	30	15	---	<20	3	30	<10	---	<10	<5	<10	<5
129	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
130	2,000	<200	50	150	---	<20	<2	70	30	---	15	50	<10	<5
131	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
132	1,000	<200	2,000	150	150	<20	50	300	20	<10	30	<2	<10	<5
133	3,000	<200	1,000	150	1,000	50	30	200	<10	200	<5	<2	<10	<5
134	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
135	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
136	5,000	<200	700	150	200	50	<2	50	<10	150	10	<2	<10	<5
137	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
138	5,000	<200	700	150	200	20	15	30	70	<10	15	20	<10	7
139	1,500	<200	150	30	150	20	5	7	10	<10	15	<5	<10	<5
140	1,500	<200	300	30	200	20	5	10	20	<10	20	<5	<10	<5
141	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
142	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
143	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
144	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
145	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
146	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
147	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
148	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
149	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
150	5,000	<200	700	100	100	<20	5	30	100	15	10	<5	70	7
151	1,000	<200	1,000	70	300	30	3	70	200	10	70	7	100	10
152	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
153	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
154	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
155	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
156	1,500	<200	300	70	100	<20	<2	20	50	30	<5	30	<10	<5
157	2,000	<200	300	100	150	<20	<2	20	10	<10	10	10	<10	<5
158	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
159	2,000	<200	500	70	100	<20	10	200	100	10	15	<2	<10	<5
160	2,000	<200	500	150	150	<20	5	30	30	15	<10	5	<10	5
161	2,000	<200	300	150	100	<20	7	30	20	20	<10	<5	<10	<5
162	500	<200	100	30	15	<20	2	15	10	10	<5	30	<10	<5
163	100	<200	100	15	<10	<20	<2	3	<10	<10	<5	<5	<10	<5
164	2,000	<200	200	70	300	<20	3	70	30	10	7	5	<10	<5
165	300	<200	150	15	30	<20	2	7	<10	<10	5	<5	<10	<5

part of the North Cascades National Park—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Ag	As	Cr	Ba	Chemical analyses (ppm) cxHM	cxCu	Au	Ag	Cu	Mo	Sample description 1/
							Red Face Mountain Area				
106	<0.5	<200	15	500	---	---	<0.02	---	---	---	Lim. hbd.-qtz. diorite.
107	.7	<200	70	700	---	---	<.02	---	---	---	Lim. hbd.-qtz. di., sc. py.
108	<.5	<200	50	300	---	---	<.02	---	---	---	Lim. hbd.-qtz. diorite.
109	<.5	<200	5	500	---	---	<.02	---	---	---	Lim. alaskite.
110	---	---	---	---	---	---	0	0	0	---	Lim. hbd.-qtz. di., sc. py.
111	<.5	<200	10	300	---	---	<.02	---	---	---	Do.
112	---	---	---	---	---	---	<.1	<0.05	0	0	Do.
113	<.5	<200	150	700	---	---	<.1	---	---	---	Lim. granodiorite.
114	---	---	---	---	---	---	<.1	<.05	0	---	Do.
115	<.5	<200	5	1,000	---	---	<.02	---	---	---	Do.
116	---	---	---	---	---	---	0	0	0	---	Do.
117	<.5	<200	100	1,000	---	---	<.1	---	---	---	Do.
118	<.5	<200	20	1,000	---	---	<.1	---	---	---	Do.
119	<.5	<200	7	300	---	---	<.02	---	---	---	Lim. grd. w/hornfels incl.
120	<.5	<200	15	700	---	---	<.02	---	---	---	Lim. dark hbd. grd.
121	---	---	---	---	10.0	30	---	---	---	---	Stream sediment.
122	<.5	<200	5	200	---	---	<.02	---	---	---	Quartz vein.
123	---	<200	1	70	---	---	<.05	<.1	---	---	Do.
124	<.5	<200	20	1,500	---	---	<.1	---	---	---	Lim. qtz.-feldspar po.
125	---	---	---	---	---	---	<.1	0	<10	---	Lim. qtz.-feld po., sc. py.
126	---	---	---	---	---	---	<.1	0	<10	---	Do.
127	---	---	---	---	---	---	0	0	0	---	Lim. hbd. dike, sc. py.
128	---	<200	1	50	---	---	<.05	<.1	---	---	Quartz vein.
129	---	---	---	---	---	---	<.05	<.1	---	---	Pegmatite.
130	---	<200	15	150	---	---	<.05	<.1	---	---	Limonitic quartz vein.
131	---	---	---	---	---	---	0	0	---	---	Do.
132	<.5	<200	500	1,000	---	---	<.1	---	---	---	Lim. hbd. porphyry.
133	<.5	<200	100	1,000	---	---	.6	---	---	---	Limonitic granodiorite.
134	---	---	---	---	20	50	---	---	---	7	Stream sediment.
135	---	---	---	---	---	---	0	0	0	0	Plag. porphyry; sc. py.
136	<.5	<200	500	1,000	---	---	<.1	---	---	---	Limonitic granodiorite.
137	---	---	---	---	20	15	---	---	---	15	Stream sediment.
138	1	<200	20	500	---	---	<.02	---	---	---	Lim. hbd. granodiorite.
139	<.5	<200	5	500	---	---	<.02	---	---	---	Lim. hbd. grd., abund. py.
140	<.5	<200	5	500	---	---	<.02	---	---	---	Lim. hbd. granodiorite.
141	---	---	---	---	7	10	---	---	---	---	Stream sediment.
142	---	---	---	---	20	20	---	---	---	---	Do.
143	---	---	---	---	70	150	---	---	---	20	Do.
144	---	---	---	---	10	<1	---	---	---	---	Do.
145	---	---	---	---	7	2	---	---	---	---	Do.
146	---	---	---	---	---	---	0	0	---	---	Pegmatite.
147	---	---	---	---	---	---	<.1	<.05	0	---	Lim. pegmatite.
148	---	---	---	---	---	---	<.1	0	0	---	Do.
149	---	---	---	---	---	---	0	<.05	<10	<3	Lim. flow rock.
150	<.5	<200	<5	1,500	---	---	<.02	---	---	---	Dark gray dike.
151	1	<200	1,500	500	---	---	<.02	---	---	---	Do.
152	---	---	---	---	7	20	---	---	---	30	Stream sediment.
153	---	---	---	---	>50	300	---	---	---	50	Do.
154	---	---	---	---	<.5	3	---	---	---	10	Do.
155	---	---	---	---	---	---	0	0	---	---	Lim. granodiorite.
156	<.5	<200	<5	1,000	---	---	.1	---	---	---	Do.
157	<.5	<200	20	1,000	---	---	<.1	---	---	---	Do.
158	---	---	---	---	---	---	<.1	0	0	---	Do.
159	<.5	<200	50	500	---	---	<.1	---	---	---	Lim. hbd. granodiorite.
160	<.5	<200	10	500	---	---	<.02	---	---	---	Do.
161	<.5	<200	30	700	---	---	<.02	---	---	---	Do.
162	<.5	<200	5	150	---	---	<.02	---	---	---	Quartz vein.
163	<.5	<200	5	70	---	---	.02	---	---	---	Do.
164	<.5	<200	10	1,000	---	---	.03	---	---	---	Lim. hbd. granodiorite.
165	<.5	<200	<5	300	---	---	.02	---	---	---	Quartz vein.

TABLE 1.—*Analyses of samples from the northern*

Sample No.	Semiquantitative spectrographic analyses (ppm)													
	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co
							Red Face Mountain Area--Continued							
166	3,000	<200	150	30	300	<20	2	15	70	15	15	<5	<10	5
167	3,000	<200	300	100	100	<20	<2	50	100	30	10	<2	<10	<5
168	10,000	<200	500	150	500	<20	20	30	10	30	15	20	<10	5
169	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
170	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
171	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
172	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
173	5,000	<200	500	100	200	<20	5	5	10	30	10	<2	<10	<5
174	7,000	<200	200	150	300	<20	10	5	<10	100	10	<2	<10	5
175	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
176	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
177	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
178	1,500	<200	700	30	100	<20	<2	150	70	100	30	<2	<10	<5
179	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
180	3,000	<200	500	100	70	<20	15	200	70	<10	5	200	<10	<5
181	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
182	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
183	5,000	<200	1,000	150	300	<20	<2	30	20	20	10	<2	<10	<5
184	10,000	<200	1,500	200	30	<20	2	50	70	<10	10	<2	<10	<5
185	3,000	<200	1,000	100	200	<20	<2	30	100	100	20	<2	<10	<5
186	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
187	5,000	10,000	5,000	300	100	<20	30	200	500	100	50	<5	<10	30
188	5,000	<200	1,500	150	100	<20	30	70	50	20	15	<5	<10	7
							Little Beaver Creek drainage							
189	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
190	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
191	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
192	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
193	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
194	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
195	3,000	<200	1,000	150	70	<20	10	200	150	15	15	10	<10	30
196	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
197	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
198	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
199	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
200	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
201	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
202	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
203	7,000	<200	500	2,000	700	<20	<2	30	70	100	20	150	<10	30
204	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
205	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
206	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
207	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
208	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
209	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
210	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
211	3,000	<200	300	70	70	20	5	50	20	<10	10	<5	<10	<5
212	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
213	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
214	7,000	<200	1,000	1,000	>1,000	20	30	30	<10	70	30	<2	<10	20
215	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
216	700	<200	1,000	20	10	<20	7	5,000	<10	<10	<10	<5	<10	200
217	3,000	<200	2,000	200	100	<20	5	500	10	<10	20	<5	20	10
218	5,000	<200	1,000	150	30	<20	5	100	<10	<10	10	<2	<10	<5
219	2,000	<200	5,000	50	20	<20	<2	500	<10	50	5	<2	100	<5
220	1,000	300	3,000	70	50	<20	7	150	<10	<10	20	<5	150	5
221	1,500	200	>5,000	70	100	<20	50	500	<10	<10	10	<5	70	30
222	7,000	<200	1,500	500	150	<20	30	100	<10	<10	50	<5	<10	10
223	3,000	<200	700	200	100	<20	20	100	<10	10	30	<5	<10	10

part of the North Cascades National Park—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Ag	As	Cr	Ba	Chemical analyses (ppm) cxHM	cxCu	Au	Ag	Cu	Mo	Sample description 1/
					Red Face Mountain Area--Continued						
166	<0.5	<200	5	700	---	---	<0.02	---	---	---	Lim. fine-grained dike.
167	<.5	<200	50	1,000	---	---	<.1	---	---	---	Lim. sil. grd. with py.
168	<.5	<200	200	1,000	---	---	<.1	---	---	---	Do.
169	---	---	---	---	---	---	<.1	0	<10	<3	Lim. grd. with qtz. veins.
170	---	---	---	---	---	---	0	0	0	0	Do.
171	---	---	---	---	---	---	0	0.05	0	---	Lim. sil. granodiorite.
172	---	---	---	---	3.0	5	---	---	---	10	Stream sediment.
173	<.5	<200	70	500	---	---	<.1	---	---	---	Bog iron (limonite).
174	<.5	<200	70	1,000	---	---	<.1	---	---	---	Do.
175	---	---	---	---	---	---	0	<.05	0	0	Do.
176	---	---	---	---	<.5	<1	---	---	---	100	Stream sediment.
177	---	---	---	---	30	7	---	---	---	10	Do.
178	<.5	<200	50	2,000	---	---	<.1	---	---	---	Lim. granodiorite with py.
179	---	---	---	---	20	50	---	---	---	10	Stream sediment.
180	<.5	<200	100	1,500	---	---	< 1	---	---	---	Lim. sil. grd. with py.
181	---	---	---	---	5	5	---	---	---	10	Stream sediment.
182	---	---	---	---	5	3	---	---	---	10	Do.
183	<.5	<200	70	700	---	---	<.1	---	---	---	Limonitic granodiorite.
184	<.5	<200	70	700	---	---	<.1	---	---	---	Do.
185	<.5	<200	30	500	---	---	<.1	---	---	---	Limonitic gouge.
186	---	---	---	---	5	7	---	---	---	7	Stream sediment.
187	7	<200	70	1,000	---	---	.30	---	---	---	Mineralized dark green dike.
188	<.5	<200	70	500	---	---	<.02	---	---	---	Lim. biotite gneiss.
					Little Beaver Creek drainage						
189	---	---	---	---	3	15	---	---	---	2	Stream sediment.
190	---	---	---	---	3	10	---	---	---	<2	Do.
191	---	---	---	---	15	7	---	---	---	7	Do.
192	---	---	---	---	30	10	---	---	---	10	Do.
193	---	---	---	---	3	15	---	---	---	30	Do.
194	---	---	---	---	10	50	---	---	---	3	Do.
195	<.5	<200	20	700	---	---	<.02	---	---	---	Lim. quartz diorite.
196	---	---	---	---	10	50	---	---	---	5	Stream sediment.
197	---	---	---	---	15	100	---	---	---	5	Do.
198	---	---	---	---	7	50	---	---	---	2	Do.
199	---	---	---	---	30	100	---	---	---	---	Do.
200	---	---	---	---	5	30	---	---	---	<20	Do.
201	---	---	---	---	10	50	---	---	---	10	Do.
202	---	---	---	---	10	15	---	---	---	5	Do.
203	<.5	<200	500	100	---	---	<.1	---	---	---	Panned concentrate.
204	---	---	---	---	2	15	---	---	---	2	Stream sediment.
205	---	---	---	---	2	2	---	---	---	7	Do.
206	---	---	---	---	15	1	---	---	---	---	Do.
207	---	---	---	---	10	1	---	---	---	---	Do.
208	---	---	---	---	30	10	---	---	---	10	Do.
209	---	---	---	---	5	3	---	---	---	10	Do.
210	---	---	---	---	2	15	----	---	---	3	Do.
211	<.5	<200	30	2,000	---	---	<.1	---	---	---	Lim. biotite gneiss.
212	---	---	---	---	5	7	---	---	---	2	Stream sediment.
213	---	---	---	---	1.5	10	---	---	---	3	Do.
214	<.5	<200	300	200	---	---	<.1	---	---	---	Panned concentrate.
215	---	---	---	---	1	7	---	---	---	<2	Stream sediment.
216	1.5	<200	50	<20	---	---	.2	---	---	---	Gneiss with pyrh.
217	.7	<200	50	150	---	---	.04	---	---	---	Magnetite-rich gneiss.
218	<.5	<200	70	700	---	---	.1	---	---	---	Lim. light-colored qtz. di.
219	5	<200	30	500	---	---	<.1	---	---	---	Limonitic amphibolite.
220	<.5	<200	20	100	---	---	<.02	---	---	---	Lim. hbd. qtz. gn. granulite.
221	.5	<200	50	100	---	---	.2	---	---	---	Do.
222	<.5	<200	150	150	---	---	<.02	---	---	---	Limonitic quartzite.
223	<.5	<200	70	70	---	---	<.02	---	---	---	Do.

TABLE 1.—*Analyses of samples from the northern*

Semiquantitative spectrographic analyses (ppm)

Sample No.	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co
							Little Beaver Creek drainage--Continued							
224	7,000	<200	1,000	300	150	<20	30	150	<10	15	50	<5	<10	15
225	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
226	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
227	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
228	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
229	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
230	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
231	5,000	<200	500	200	200	<20	15	70	<10	<10	20	<5	<10	10
232	3,000	<200	500	200	50	<20	5	50	<10	<10	10	5	<10	<5
233	5,000	<200	700	300	70	<20	20	150	<10	<10	30	30	<10	15
234	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
235	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
236	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
237	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
238	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
239	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
240	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
241	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
242	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
243	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
244	>10,000	<200	1,500	1,500	>1,000	50	<2	50	<10	100	50	<2	<10	30
245	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
246	5,000	<200	700	150	150	<20	15	20	10	<10	<20	<2	<10	5
247	7,000	<200	1,000	500	150	<20	15	50	10	<10	30	10	<10	10
248	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
249	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
							Arctic Creek drainage							
250	3,000	<200	300	150	150	20	10	150	<10	10	<10	20	<10	<5
251	3,000	<200	500	300	100	<20	30	100	10	<10	20	30	<10	15
252	3,000	<200	300	150	200	<20	5	20	<10	<10	<10	<5	<10	<5
253	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
254	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
255	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
256	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
257	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
258	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
259	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
260	5,000	<200	500	300	150	<20	10	7	<10	<10	15	10	<10	70
261	2,000	<200	1,000	200	150	20	30	200	30	10	30	5	<10	15
262	3,000	<200	1,500	200	150	20	30	300	20	<10	30	50	<10	20
263	1,500	<200	1,500	150	100	20	30	500	20	<10	20	100	<10	20
264	7,000	<200	500	300	150	<20	7	100	<10	<10	20	15	<10	30
265	5,000	<200	700	200	150	<20	7	50	10	<10	30	<5	<10	50
266	3,000	<200	300	200	150	<20	10	70	<10	<10	30	<5	<10	10
267	1,000	<200	1,500	10	150	30	5	10	<10	50	<10	70	<10	<5
268	70	<200	>5,000	<10	<10	<20	150	70	10	<10	70	<5	<10	100
269	5,000	<200	500	150	50	<20	20	100	10	<10	20	<5	<10	7
270	5,000	<200	700	100	70	<20	70	100	50	<10	15	<5	10	30
271	1,000	<200	1,500	500	<10	<20	150	500	<10	<10	<10	<5	<10	50
272	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
273	5,000	<200	700	100	70	<20	15	70	10	<10	30	<5	<10	7
274	>10,000	<200	1,500	300	500	<20	70	20	10	15	100	<2	<10	10
275	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
276	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
277	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
278	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
279	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
280	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
281	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
282	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
283	2,000	<200	700	100	70	<20	15	70	10	50	10	<5	<10	5
284	3,000	<200	300	100	100	<20	15	70	<10	20	15	5	<10	5

part of the North Cascades National Park—Continued

	Semiquantitative spectrographic analyses--Continued (ppm)				Chemical analyses (ppm)						
Sample	Ag	As	Cr	Ba	cxHM	cxCu	Au	Ag	Cu	Mo	Sample description 1/
					Little Beaver Creek drainage--Continued						
224	<0.5	<200	50	300	---	---	<0.02	---	---	---	Limonitic quartzite.
225	---	---	---	---	3.0	20	---	---	---	15	Stream sediment.
226	---	---	---	---	2	5	---	---	---	7	Do.
227	---	---	---	---	7	20	---	---	---	7	Do.
228	---	---	---	---	<.5	10	---	---	---	10	Do.
229	---	---	---	---	1.5	15	---	---	---	3	Do.
230	---	---	---	---	3	50	---	---	---	7	Do.
231	<.5	<200	70	300	---	---	<.1	---	---	---	Lim. hbd. gn. w/epidote layers.
232	<.5	<200	10	500	---	---	<.1	---	---	---	Limonitic brc. with py.
233	<.5	<200	100	300	---	---	<.1	---	---	---	Lim. sheared hbd. gneiss.
234	---	---	---	---	5	50	---	---	---	7	Stream sediment.
235	---	---	---	---	20	100	---	---	---	10	Do.
236	---	---	---	---	20	200	---	---	---	7	Do.
237	---	---	---	---	2	20	---	---	---	2	Do.
238	---	---	---	---	20	100	---	---	---	10	Do.
239	---	---	---	---	30	300	---	---	---	70	Do.
240	---	---	---	---	1	10	---	---	---	5	Do.
241	---	---	---	---	<.5	7	---	---	---	20	Do.
242	---	---	---	---	.5	2	---	---	---	7	Do.
243	---	---	---	---	1.5	10	---	---	---	5	Do.
244	<.5	<200	500	150	---	---	<.1	---	---	---	Panned concentrate.
245	---	---	---	---	10	15	---	---	---	<2	Stream sediment.
246	<.5	<200	30	700	---	---	.02	---	---	---	Lim. pyritic hornfels.
247	<.5	<200	50	700	---	---	<.1	---	---	---	Limonitic hornfels.
248	---	---	---	---	30	10	---	---	---	5	Stream sediment.
249	---	---	---	---	20	30	---	---	---	7	Do.
					Arctic Creek drainage						
250	<.5	<200	70	1,500	---	---	<.1	---	---	---	Lim. biotite gneiss.
251	<.5	<200	30	300	---	---	<.02	---	---	---	Limonitic gneiss.
252	<.5	<200	20	300	---	---	<.1	---	---	---	Limonitic hbd. bi. gneiss.
253	---	---	---	---	200	700	---	---	---	10	Stream sediment.
254	---	---	---	---	100	300	---	---	---	20	Do.
255	---	---	---	---	20	50	---	---	---	20	Do.
256	---	---	---	---	5	10	---	---	---	70	Do.
257	---	---	---	---	1	5	---	---	---	70	Do.
258	---	---	---	---	3	15	---	---	---	---	Do.
259	---	---	---	---	10	5	---	---	---	---	Do.
260	<.5	<200	70	300	---	---	<.02	---	---	---	Lim. light colored qtz. di.
261	.7	<200	20	150	---	---	< 02	---	---	---	Lim. bi. gneiss.
262	1	<200	50	100	---	---	<.02	---	---	---	Do.
263	1.5	<200	20	150	---	---	<.02	---	---	---	Do.
264	<.5	<200	30	300	---	---	<.02	---	---	---	Lim. bi. gn. sc. py. and pyrh.
265	<.5	<200	50	500	---	---	<.02	---	---	---	Lim. bi. gn. sc. py.
266	<.5	<200	30	500	---	---	<.1	---	---	---	Lim. bi. hbd. gneiss.
267	<.5	<200	<10	50	---	---	<.1	---	---	---	Vuggy epidote brc.
268	<.5	<200	<10	70	---	---	<.1	---	---	---	MnO-calcite, contact zone.
269	<.5	<200	150	700	---	---	<.02	---	---	---	Lim. biotite gneiss.
270	<.5	<200	150	300	---	---	<.02	---	---	---	Lim. qtz. diorite.
271	<.5	<200	700	30	---	---	<.1	---	---	---	Lim. metagabbro.
272	---	---	---	---	2	3	---	---	---	10	Stream sediment.
273	<.5	<200	30	500	---	---	<.1	---	---	---	Lim. biotite gneiss.
274	<.5	<200	150	300	---	---	<.1	---	---	---	Panned concentrate.
275	---	---	---	---	10	3	---	---	---	3	Stream sediment.
276	---	---	---	---	5	15	---	---	---	5	Do.
277	---	---	---	---	10	10	---	---	---	5	Do.
278	---	---	---	---	20	7	---	---	---	7	Do.
279	---	---	---	---	30	10	---	---	---	5	Do.
280	---	---	---	---	10	5	---	---	---	5	Do.
281	---	---	---	---	7	10	---	---	---	5	Do.
282	---	---	---	---	10	15	---	---	---	3	Do.
283	<.5	<200	10	2,000	---	---	<.1	---	---	---	Greenstone sc. pyrite.
284	<.5	<200	20	1,000	---	---	<.1	---	---	---	Iron-stained greenstone.

TABLE 1.—*Analyses of samples from the northern*

Sample No.	Semiquantitative spectrographic analyses (ppm) Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co
							Arctic Creek drainage--Continued							
285	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
286	1,500	<200	150	20	30	<20	10	50	<10	30	<10	<5	<10	<5
287	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
288	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
289	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
290	>10,000	<200	300	1,500	700	70	20	30	<10	50	15	<2	<10	20
							Noname Creek drainage							
291	2,000	<200	1,000	500	500	<20	20	100	<10	<10	<10	<5	<10	50
292	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
293	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
294	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
295	3,000	<200	300	150	50	<20	10	50	50	20	<10	<5	<10	<5
296	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
297	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
298	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
299	5,000	<200	1,500	200	100	<20	100	30	<10	15	7	<2	<10	70
300	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
301	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
302	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
303	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
304	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
305	5,000	<200	1,000	200	150	<20	50	70	10	70	30	<2	<10	30
306	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
							Skymo Creek drainage							
307	1,000	<200	500	200	150	<20	300	1,000	<10	20	<5	<2	<10	30
308	1,000	<200	500	200	150	<20	200	300	<10	<10	<5	<2	<10	30
309	5,000	<200	700	200	300	<20	20	300	<10	<10	10	<2	<10	<5
310	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
311	5,000	<200	1,000	300	100	<20	10	100	10	<10	20	<5	<10	15
312	10,000	<200	2,000	500	200	<20	10	150	<10	10	50	<5	<10	10
313	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
314	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
315	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
316	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
317	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
318	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
319	>10,000	<200	1,500	700	300	<20	300	70	<10	150	20	<2	50	70
							Luna Creek drainage							
320	5,000	<200	1,000	500	50	<20	20	50	10	<10	20	<5	<10	15
321	1,500	<200	150	20	150	<20	<5	70	<10	10	<10	<5	<10	5
322	3,000	<200	500	100	100	50	5	100	<10	10	<10	<5	<10	5
323	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
324	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
325	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
326	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
327	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
328	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
329	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
330	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
331	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
332	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
333	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
334	3,000	<200	700	100	70	<20	15	3,000	30	15	10	150	15	15
335	2,000	<200	100	50	30	<20	20	20	10	10	<10	<5	<10	<5
336	3,000	<200	500	200	200	<20	50	300	20	<10	20	<5	<10	20
337	5,000	<200	300	300	150	50	10	200	<10	<10	20	<5	<10	10
338	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
339	2,000	<200	500	200	100	<20	10	50	<10	<10	10	<5	<10	5

part of the North Cascades National Park—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm)				Chemical analyses (ppm)						Sample description [1]
	Ag	As	Cr	Ba	cxHM	cxCu	Au	Ag	Cu	Mo	
					Arctic Creek drainage--Continued						
285	---	---	---	---	3.0	10	---	---	---	10	Stream sediment.
286	<0.5	<200	10	1,000	---	---	<0.1	---	---	---	Greenstone, locally limonitic.
287	---	---	---	---	30	5	---	---	---	10	Stream sediment.
288	---	---	---	---	30	10	---	---	---	5	Do.
289	---	---	---	---	30	15	---	---	---	5	Do.
290	<.5	<200	15	70	---	---	<.1	---	---	---	Panned concentrate.
					Noname Creek drainage						
291	1.5	<200	200	300	---	---	<.1	---	---	---	Limonitic granulite.
292	---	---	---	---	3	10	---	---	---	<2	Stream sediment.
293	---	---	---	---	7	1	---	---	---	2	Do.
294	---	---	---	---	3	7	---	---	---	2	Do.
295	.5	<200	150	1,500	---	---	<.1	---	---	---	Limonitic biotite gneiss.
296	---	---	---	---	10	2	---	---	---	5	Stream sediment.
297	---	---	---	---	7	3	---	---	---	3	Do.
298	---	---	---	---	2	10	---	---	---	<2	Do.
299	<.5	<200	500	50	---	---	<.1	---	---	---	Panned concentrate.
300	---	---	---	---	3	10	---	---	---	5	Stream sediment.
301	---	---	---	---	10	1	---	---	---	5	Do.
302	---	---	---	---	3	10	---	---	---	3	Do.
303	---	---	---	---	3	10	---	---	---	5	Do.
304	---	---	---	---	10	10	---	---	---	3	Do.
305	<.5	<200	500	300	---	---	<.1	---	---	---	Panned concentrate.
306	---	---	---	---	20	3	---	---	---	5	Stream sediment.
					Skymo Creek drainage						
307	2	<200	500	200	---	---	<.1	---	---	---	Lim. hbd. plag. gneiss.
308	<.5	<200	500	100	---	---	<.1	---	---	---	Do.
309	<.5	<200	200	200	---	---	<.1	---	---	---	Do.
310	---	---	---	---	1.5	10	---	---	---	5	Stream sediment.
311	<.5	<200	50	1,000	---	---	<.1	---	---	---	Lim. hbd. diorite.
312	<.5	<200	50	150	---	---	<.1	---	---	---	Lim. pyroxene granulite.
313	---	---	---	---	2	15	---	---	---	<2	Stream sediment.
314	---	---	---	---	1.5	15	---	---	---	3	Do.
315	---	---	----	---	10	2	---	---	---	---	Do.
316	---	---	---	---	10	7	---	---	---	3	Do.
317	---	---	---	---	7	5	---	---	---	5	Do.
318	---	---	---	---	3	5	---	---	---	7	Do.
319	<.5	<200	>5,000	300	---	---	<.1	---	---	---	Panned concentrate
					Luna Creek drainage						
320	<.5	<200	15	300	---	---	<.1	---	---	---	Hbd. qtz. diorite dike sc. py.
321	<.5	<200	5	1,000	---	---	<.1	---	---	---	Intrusive breccia.
322	<.5	<200	5	500	---	---	<.1	---	---	---	Limonitic biotite gneiss.
323	---	---	---	---	10	50	---	---	---	10	Stream sediment
324	---	---	---	---	10	30	---	---	---	7	Do.
325	---	---	---	---	20	50	---	---	---	5	Do.
326	---	---	---	---	10	50	---	---	---	5	Do.
327	---	---	---	---	10	50	---	---	---	3	Do.
328	---	---	---	---	15	50	---	---	---	20	Do.
329	---	---	---	---	15	30	---	---	---	5	Do.
330	---	---	---	---	3	15	---	---	---	3	Do.
331	---	---	---	---	10	50	---	---	---	10	Do.
332	---	---	---	---	15	30	---	---	---	10	Do.
333	---	---	---	---	.5	50	---	---	---	<2	Do.
334	7	<200	20	700	---	---	.06	---	---	---	Ep. qtz. vein sc. py. and chp.
335	<.5	<200	<5	500	---	---	<.1	---	---	---	Lim. Biotite gneiss.
336	.5	<200	50	3,000	---	---	<.1	---	---	---	Sh. hbd. bi. gneiss.
337	<.5	<200	150	700	---	---	<.1	---	---	---	Lim. biotite gneiss.
338	---	---	---	---	2	7	---	---	---	---	Stream sediment.
339	<.5	<200	20	300	---	---	<.1	---	---	---	Lim. banded hbd. bi. gneiss.

TABLE 1.—*Analyses of samples from the northern*

Semiquantitative spectrographic analyses

Sample No.	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co
	(ppm)													
							Luna Creek drainage--Continued							
340	5,000	<200	500	150	200	<20	10	500	<10	<10	30	<5	<10	10
341	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
342	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
343	5,000	<200	1,000	700	700	70	15	50	15	20	20	<2	<10	5
344	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
345	3,000	<200	1,000	200	150	20	5	50	15	200	30	<5	<10	10
346	2,000	<200	700	150	100	<20	5	100	<10	10	7	<2	<10	5
							McMillan Creek drainage							
347	2,000	<200	200	70	100	<20	5	70	<10	<10	<10	<5	<10	<5
348	3,000	<200	150	100	100	<20	15	200	<10	<10	<10	<5	<10	10
349	3,000	<200	300	150	150	<20	5	50	<10	<10	10	<5	<10	<5
350	2,000	<200	200	100	150	<20	5	50	10	<10	<10	5	<10	<5
351	5,000	<200	500	150	150	<20	5	20	10	<10	<10	5	<10	<5
352	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
353	5,000	<200	1,000	500	70	<20	5	50	<10	<10	10	<5	<10	5
354	3,000	<200	300	100	100	<20	5	150	30	10	<10	<5	<10	<5
355	3,000	<200	200	100	100	<20	10	300	<10	<10	<10	<5	<10	<5
356	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
357	7,000	<200	1,500	1,000	1,000	100	100	200	20	50	30	<2	<10	10
358	3,000	<200	3,000	150	150	<20	100	50	<10	<10	10	<5	<10	15
359	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
							Big Beaver Creek drainage							
360	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
361	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
362	1,500	<200	200	50	20	70	10	>5,000	<10	10	15	>2,000	50	10
363	2,000	<200	300	100	150	<20	5	200	10	20	10	10	<10	<5
364	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
365	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
366	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
367	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
368	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
369	5,000	<200	1,000	1,500	>1,000	100	15	30	<10	50	30	<2	<10	15
370	3,000	<200	100	100	100	<20	<5	20	<10	<10	10	<5	<10	5
371	5,000	<200	1,500	500	100	<20	100	500	<10	10	30	<5	<10	20
372	1,500	<200	150	30	100	<20	5	100	10	10	10	50	<10	<5
373	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
374	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
375	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
376	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
377	5,000	<200	500	200	200	<20	10	50	20	50	50	50	<10	<5
378	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
379	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
380	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
381	700	<200	50	10	200	20	2	500	70	10	20	5	<10	5
382	1,000	<200	100	<10	70	<20	2	150	20	10	30	15	<10	<5
383	3,000	<200	300	700	70	<20	15	100	<10	<10	20	30	<10	5
384	>10,000	<200	1,000	1,500	>1,000	100	15	70	<10	100	30	<2	<10	20
385	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
386	5,000	<200	1,000	150	150	<20	5	30	<10	<10	<10	<5	<10	5
387	3,000	<200	500	100	150	<20	<2	50	<10	<10	<5	<2	<10	<5
388	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
389	>10,000	<200	3,000	500	1,000	50	700	30	<10	30	100	<2	20	70
390	10,000	<200	700	100	500	<20	15	50	<10	<10	20	<2	<10	<5
391	>10,000	<200	5,000	300	>1,000	150	300	70	<10	30	70	<2	<10	30
392	>10,000	<200	200	1,000	>1,000	500	<2	20	<10	50	30	<2	<10	20
393	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
394	5,000	<200	2,000	300	300	<20	30	300	<10	<10	15	<2	<10	5

part of the North Cascades National Park—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm)				Chemical analyses (ppm)						Sample description 1/
	Ag	As	Cr	Ba	cxHM	cxCu	Au	Ag	Cu	Mo	
					Luna Creek drainage--Continued						
340	0.5	<200	150	1,000	---	---	<0.1	---	---	---	Lim. banded hbd. bi. gneiss.
341	---	---	---	---	0.5	10	---	---	---	2	Stream sediment.
342	---	---	---	---	1.5	7	---	---	---	3	Do.
343	<.5	<200	100	500	---	---	<.1	---	---	---	Panned concentrate.
344	---	---	---	---	.5	10	---	---	---	5	Stream sediment.
345	<.5	<200	10	1,000	---	---	<.1	---	---	---	Lim. sh. qtz. diorite.
346	<.5	<200	7	300	---	---	<.02	---	---	---	Lim. qtz. di. sc. pyrite.
					McMillan Creek drainage						
347	<.5	<200	10	700	---	---	<.1	---	---	---	Bi. gn., hbd.gn., qtz.di.breccia.
348	<.5	<200	30	1,500	---	---	<.1	---	---	---	Lim. di. dike sc. pyrite.
349	<.5	<200	30	500	---	---	<.1	---	---	---	Limonitic gneiss.
350	<.5	<200	10	700	---	---	<.1	---	---	---	Lim. hbd. gneiss.
351	<.5	<200	20	1,000	---	---	<.1	---	---	---	Limonitic dike.
352	---	---	---	---	3	10	---	---	---	2	Stream sediment.
353	<.5	<200	10	300	---	---	<.1	---	---	---	Limonitic sh. gneiss.
354	1	<200	10	500	---	---	<.1	---	---	---	Lim. biotite gneiss.
355	1.5	<200	30	1,500	---	---	<.1	---	---	---	Lim. bi. gneiss w/sc. py.
356	---	---	---	---	3	20	---	---	---	5	Stream sediment.
357	10	<200	200	300	---	---	<.1	---	---	---	Panned concentrate.
358	<.5	<200	200	1,000	---	---	<.1	---	---	---	Lim. sh. bi. gneiss.
359	---	---	---	---	1.5	7	---	---	---	2	Stream sediment.
					Big Beaver Creek drainage						
360	---	---	---	---	5	20	---	---	---	2	Do.
361	---	---	---	---	1.5	7	---	---	---	2	Do.
362	50	<200	10	700	---	---	<.1	---	---	---	Lim. qtz. di. sc. pyrite.
363	<.5	<200	<10	1,000	---	---	<.1	---	---	---	Sh. lim. qtz. diorite.
364	---	---	---	---	10	70	---	---	---	5	Stream sediment.
365	---	---	---	---	15	100	---	---	---	10	Do.
366	---	---	---	---	10	50	---	---	---	10	Do.
367	---	---	---	---	15	100	---	---	---	15	Do.
368	---	---	---	---	1.5	15	----	---	---	3	Do.
369	<.5	<200	200	200	---	---	<.1	---	---	---	Panned concentrate.
370	<.5	<200	10	200	---	---	<.1	---	---	---	Limonitic qtz. diorite.
371	3	<200	1,000	300	---	---	.2	---	---	---	Lim. qtz.di. light colored gn.
372	.7	<200	<10	500	---	---	<.1	---	---	---	Sh. lim. granodiorite.
373	---	---	---	---	2	20	---	---	---	3	Stream sediment.
374	---	---	---	---	1	15	---	---	---	3	Do.
375	---	---	---	---	7	30	---	---	---	2	Do.
376	---	---	---	---	10	100	---	---	---	2	Do.
377	<.5	<200	15	300	---	---	<.1	---	---	---	Limonitic granodiorite.
378	---	---	---	---	10	70	---	---	---	<2	Stream sediment.
379	---	---	---	---	1	10	---	---	---	<2	Do.
380	---	---	---	---	1	7	---	---	---	3	Do.
381	1	<200	<5	700	---	---	<.02	---	---	---	Shear zone w/chrysocolla.
382	.7	<200	5	700	---	---	.02	---	---	---	Limonitic alaskite.
383	.5	<200	70	500	---	---	<.1	---	---	---	Lim.hbd. bi. qtz. diorite.
384	<.5	<200	300	200	---	---	<.1	---	---	---	Panned concentrate.
385	---	---	---	---	1.5	10	---	---	---	2	Stream sediment.
386	<.5	<200	20	300	---	---	<.1	---	---	---	Graphitic bi. gneiss.
387	<.5	<200	50	200	---	---	<.1	---	---	---	Hematitic hbd. gneiss.
388	---	---	---	---	3	15	---	---	---	2	Stream sediment.
389	<.5	<200	5,000	200	---	---	<.1	---	---	---	Panned concentrate.
390	<.5	<200	200	500	---	---	<.1	---	---	---	Iron-stained bi. gneiss.
391	5	<200	200	100	---	---	8.3	---	---	---	Panned concentrate.
392	<.5	<200	2,000	70	---	---	<.1	---	---	---	Do.
393	---	---	---	---	5	2	---	---	---	7	Stream sediment.
394	<.5	<200	500	500	---	---	<.1	---	---	---	Lim. hornblende gneiss.

TABLE 1.—*Analyses of samples from the northern*

Sample No.	Semiquantitative spectrographic analyses (ppm)													
	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co
					Big Beaver Creek drainage--Continued									
395	5,000	<200	2,000	150	200	<20	150	2,000	<10	20	5	20	<10	10
396	5,000	<200	700	200	300	<20	2	100	100	<10	20	<2	<10	<5
397	10,000	<200	2,000	150	700	200	20	30	<10	15	50	<2	<10	10
					West side of Ross Lake									
398	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
399	5,000	<200	1,000	150	50	<20	5	100	<10	<10	15	<2	<10	<5
400	10,000	<200	1,000	300	300	<20	10	10	<10	10	15	<2	<10	5
401	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
402	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
403	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
404	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
405	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
406	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
407	1,500	<200	1,500	200	10	<20	150	1,000	<10	<10	<10	<5	<10	20
408	1,500	<200	700	30	30	<20	>5,000	5,000	<10	15	<5	<2	<10	700
409	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
410	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
411	10,000	<200	1,500	500	20	<20	<2	200	15	<10	15	<2	<10	20
412	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
					Stetattle Creek drainage									
413	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
414	10,000	<200	2,000	150	1,000	300	30	50	<10	15	70	<2	<10	15
415	3,000	<200	300	100	150	20	10	10	<10	30	<10	<5	<10	<5
416	3,000	<200	300	100	150	<20	10	5	10	<10	<10	<5	<10	<5
417	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
418	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
419	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
420	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
421	>10,000	<200	3,000	300	1,000	30	30	20	<10	30	70	<2	<10	20
					Terror Creek drainage									
422	5,000	<200	200	150	150	50	5	50	15	10	10	<5	10	5
423	5,000	200	1,000	300	100	<20	15	20	10	30	10	<5	<10	5
424	5,000	<200	1,000	200	100	<20	15	50	15	15	10	<5	<10	5
425	2,000	<200	150	50	150	<20	<5	50	10	50	<10	<5	<10	<5
426	5,000	<200	300	100	200	20	<5	10	10	<10	<10	<5	<10	<5
427	2,000	<200	700	20	100	<20	5	5	<10	10	<10	<5	<10	<5
428	7,000	500	1,000	200	200	20	15	50	15	20	10	<5	15	5
429	3,000	200	700	70	100	<20	10	100	<10	<10	15	<2	<10	10
430	2,000	<200	200	20	100	150	5	50	<10	<10	<10	<5	<10	<5
431	5,000	<200	100	100	150	<20	10	10	<10	<10	<10	<5	<10	5
432	5,000	<200	700	70	200	70	50	100	15	10	15	<5	<10	15
433	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
434	>10,000	<200	1,500	150	1,000	1,000	10	30	10	30	70	<2	<10	15
					Goodell Creek drainage									
435	2,000	200	1,500	300	100	20	10	100	15	50	10	5	15	5
436	3,000	500	1,500	200	50	<20	5	100	700	>2,000	50	<5	15	20
437	2,000	300	2,000	150	50	<20	5	150	100	70	<10	100	20	15
438	3,000	<200	3,000	150	150	<20	10	300	150	300	10	<5	70	50
439	3,000	200	1,000	200	100	<20	5	2,000	50	<10	<10	<5	<10	<5
440	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
441	5,000	<200	300	200	100	<20	<5	50	10	<10	10	<5	<10	5
442	2,000	<200	150	150	100	<20	5	20	10	<10	50	<5	<10	<5
443	5,000	<200	300	200	150	30	10	70	<10	<10	20	<5	<10	10
444	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
445	5,000	<200	1,500	200	150	<20	20	70	10	<10	20	30	<10	15
446	5,000	<200	1,500	500	150	<20	10	70	<10	<10	15	<5	<10	10
447	3,000	<200	500	200	100	30	10	70	10	10	10	<5	<10	7

part of the North Cascades National Park—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm)				Chemical analyses (ppm)						Sample description 1/
	Ag	As	Cr	Ba	cxHM	cxCu	Au	Ag	Cu	Mo	
					Big Beaver Creek drainage--Continued						
395	1.0	<200	500	200	---	---	<0.1	---	---	---	Lim. hornblende gneiss.
396	<.5	<200	70	1,500	---	---	<.1	---	---	---	Do.
397	<.5	<200	200	150	---	---	<.1	---	---	---	Panned concentrate.
					West side of Ross Lake						
398	---	---	---	---	10.0	3	---	---	---	3	Stream sediment.
399	<.5	<200	70	700	---	---	<.1	---	---	---	Limonitic greenstone.
400	<.5	<200	200	500	---	---	<.1	---	---	---	Do.
401	---	---	---	---	30	10	---	---	---	2	Stream sediment.
402	---	---	---	---	20	10	---	---	---	7	Do.
403	---	---	---	---	15	10	---	---	---	5	Do.
404	---	---	---	---	20	10	---	---	---	10	Do.
405	---	---	---	---	10	10	---	---	---	7	Do.
406	---	---	---	---	7	20	---	---	---	10	Do.
407	1	<200	700	100	---	---	<.1	---	---	---	Limonitic metagabbro.
408	.7	<200	700	70	---	---	<.02	---	---	---	Ultramafic rock sc pyrh, chp.
409	---	---	---	---	7	20	---	---	---	---	Stream sediment.
410	---	---	---	---	3	15	---	---	---	---	Do.
411	<.5	<200	70	300	---	---	<.1	---	---	---	Lim. bi. gneiss sc. pyrite.
412	---	---	---	---	20	1	---	---	---	3	Stream sediment.
					Stetattle Creek drainage						
413	---	---	---	---	1	7	---	---	---	3	Do.
414	<.5	<200	70	150	---	---	<.1	---	---	---	Panned concentrate.
415	<.5	<200	10	1,000	---	---	<.1	---	---	---	Sh. lim. bi. gneiss.
416	<.5	<200	10	1,000	---	---	<.1	---	---	---	Do.
417	---	---	---	---	2	1	---	---	---	7	Stream sediment.
418	---	---	---	---	---	---	0	0	---	---	Lim. sil. gn. w/qtz. vein.
419	---	---	---	---	---	---	0	0	0	0	Lim. gneiss, sc. sulfides.
420	---	---	---	---	---	---	0	0	0	0	Iron-stained material.
421	<.5	<200	500	200	---	---	.1	---	---	---	Panned concentrate.
					Terror Creek drainage						
422	<.5	<200	30	1,500	---	---	.19	---	---	---	Lim. bi. gneiss, local pyrite.
423	<.5	<200	70	1,500	---	---	<.1	---	---	---	Do.
424	<.5	<200	50	1,000	---	---	<.1	---	---	---	Do.
425	1	<200	<10	1,000	---	---	<.1	---	---	---	Sil. lim. brecciated gn.
426	<.5	<200	10	2,000	---	---	<.1	---	---	---	Lim. brecciated gneiss.
427	<.5	<200	<10	1,500	---	---	<.1	---	---	---	Lim. gn. and tan dike.
428	<.5	<200	50	1,500	---	---	<.1	---	---	---	Lim. tan dike.
429	<.5	<200	20	150	---	---	<.02	---	---	---	Lim. light-colored qtz. di.
430	<.5	<200	<10	1,500	---	---	<.1	---	---	---	Do.
431	<.5	<200	10	700	---	---	<.1	---	---	---	Lim. sheared gneiss.
432	.5	<200	150	1,500	---	---	.04	---	---	---	Sulfide-bearing hbd.bi. gneiss.
433	---	---	---	---	---	5	---	---	---	10	Stream sediment.
434	<.5	<200	500	500	---	---	.1	---	---	---	Panned concentrate.
					Goodell Creek drainage						
435	<.5	<200	20	300	---	---	<.1	---	---	---	Intrusive breccia with pyrite.
436	2	3,000	20	500	---	---	4.3	---	---	---	Lim. quartz diorite.
437	1.5	<200	10	300	---	---	.1	---	---	---	Intrusive breccia with pyrite.
438	2	700	10	500	---	---	.3	---	---	---	Limonitic gneiss.
439	7	<200	10	500	---	---	<.1	---	---	---	Limonitic biotite gneiss.
440	---	---	---	---	---	---	<.02	---	---	---	Calcite vein.
441	<.5	<200	30	1,000	---	---	<.1	---	---	---	Lim. intrusive breccia.
442	<.5	<200	30	1,000	---	---	<.1	---	---	---	Do.
443	<.5	<200	30	1,000	---	---	<.1	---	---	---	Lim. bi. gneiss; sc. pyrite.
444	---	---	---	---	1.5	10	---	---	---	2	Stream sediment.
445	<.5	<200	100	500	---	---	<.1	---	---	---	Lim. hornfelsic vol. rock.
446	<.5	<200	70	200	---	---	<.1	---	---	---	Do.
447	<.5	<200	15	300	---	---	<.1	---	---	---	Lim. bi. gn. cut by qtz. di. dikes.

TABLE 1.—*Analyses of samples from the northern*

Semiquantitative spectrographic analyses

Sample No.	(ppm) Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co
							Goodell Creek drainage--Continued							
448	3,000	<200	300	150	150	<20	10	100	15	<10	<10	<5	<10	<5
449	3,000	<200	200	50	200	30	5	20	10	20	50	5	<10	<5
450	2,000	<200	300	70	200	20	20	20	10	10	30	7	<10	5
451	>10,000	<200	3,000	1,000	1,000	1,000	<2	100	10	50	100	<2	<10	10
452	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
453	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
454	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
455	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
456	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
457	5,000	<200	300	100	200	<20	<5	10	15	<10	30	<5	<10	<5
458	5,000	<200	300	100	200	<20	5	10	15	<10	10	<5	<10	5
459	5,000	<200	1,000	200	150	<20	<5	50	<10	<10	20	<5	<10	<5
460	3,000	300	300	70	200	<20	7	70	150	10	10	<5	<10	7
461	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
462	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
463	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
464	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
465	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
466	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
467	>10,000	<200	1,000	200	500	150	50	70	10	10	30	<2	<10	5
468	5,000	<200	700	200	100	<20	70	100	<10	<10	15	15	<10	30
469	>10,000	<200	1,500	100	>1,000	700	50	30	30	50	50	30	<10	20
							East Fork Bacon Creek drainage							
470	5,000	<200	300	150	70	<20	2	100	<10	20	10	<2	<10	<5
471	7,000	<200	700	200	200	<20	20	200	10	10	20	<2	<10	100
472	3,000	<200	500	150	70	<20	3	30	70	<10	15	30	10	<5
473	3,000	<200	700	70	150	<20	2	70	70	<10	10	30	70	<5
474	3,000	<200	200	70	70	<20	5	50	20	<10	20	70	30	<5
475	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
476	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
477	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
478	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
479	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
480	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
481	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
482	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
483	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
484	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
485	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
486	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
487	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
488	700	<200	150	20	70	20	2	70	100	<10	15	50	<10	<5
489	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
490	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
491	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
492	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
493	500	<200	100	70	10	<20	20	700	20	20	<10	5	<10	15
494	5,000	<200	700	300	150	<20	300	70	10	20	15	<5	<10	70
495	7,000	<200	5,000	300	150	20	5	30	300	<10	50	15	20	5
496	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
497	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
498	7,000	<200	700	150	700	200	15	70	10	10	70	<2	<10	5
499	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
500	>10,000	<200	1,500	2,000	1,000	>1,000	5	20	<10	70	100	<2	<10	15
							Bacon Creek drainage							
501	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
502	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
503	-----	---	---	---	---	---	---	---	---	---	---	---	---	---

part of the North Cascades National Park—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Ag	As	Cr	Ba	Chemical analyses (ppm) cxHM	cxCu	Au	Ag	Cu	Mo	Sample description [1]
					Goodell Creek drainage--Continued						
448	0.5	<200	15	300	---	---	<0.1	---	---	---	Lim bi gneiss sc pyrite.
449	<.5	<200	10	500	---	---	<.1	---	---	---	Lim tuff and arg. w/pyrite.
450	<.5	<200	70	1,000	---	---	<.1	---	---	---	Lim tuff and brc. w/pyrite.
451	<.5	<200	100	300	---	---	.2	---	---	---	Panned concentrate.
452	---	---	---	---	5	1	---	---	---	20	Stream sediment.
453	---	---	---	---	2	1	---	---	---	15	Do.
454	---	---	---	---	2	3	---	---	---	7	Do.
455	---	---	---	---	2	7	---	---	---	100	Do.
456	---	---	---	---	2	1	---	---	---	7	Do.
457	<.5	<200	10	1,000	---	---	<.1	---	---	---	Lim. bi.gn. cut by dike.
458	<.5	<200	10	1,000	---	---	<.1	---	---	---	Lim. bi.gn. w/pyrite.
459	<.5	<200	5	300	---	---	<.1	---	---	---	Lim. hbd. di. dike.
460	.5	<200	15	1,500	---	---	.07	---	---	---	Lim. gn. boulders w/pyrh.
461	---	---	---	---	5	3	---	---	---	7	Stream sediment.
462	---	---	---	---	10	3	---	---	---	10	Do.
463	---	---	---	---	1	15	---	---	---	2	Do.
464	---	---	---	---	1	3	---	---	---	20	Do.
465	---	---	---	---	7	7	---	---	---	20	Do.
466	---	---	---	---	15	7	---	---	---	20	Do.
467	<.5	<200	200	300	---	---	<.1	---	---	---	Panned concentrate.
468	<.5	<200	500	500	---	---	.08	---	---	---	Lim. biotite gneiss
469	<.5	<200	500	300	---	---	<.1	---	---	---	Panned concentrate.
					East Fork Bacon Creek drainage						
470	<.5	<200	20	1,000	---	---	<.1	---	---	---	Lim.qtz.di. w/qtz. veins.
471	<.5	<200	70	300	---	---	<.1	---	---	---	Lim. qtz. di. w/epidote.
472	.5	<200	15	700	---	---	<.02	---	---	---	Lim. bi. hbd. qtz. di.
473	1.5	<200	15	300	---	---	<.02	---	---	---	Do.
474	<.5	<200	15	2,000	---	---	<.02	---	---	---	Do.
475	---	---	---	---	2	3	---	---	---	7	Stream sediment.
476	---	---	---	---	2	2	---	---	---	15	Do.
477	---	---	---	---	2	3	---	---	---	30	Do.
478	---	---	---	---	3	5	---	---	---	50	Do.
479	---	---	---	---	3	5	---	---	---	30	Do.
480	---	---	---	---	15	20	---	---	---	50	Do.
481	---	---	---	---	3	7	---	---	---	10	Do.
482	---	---	---	---	2	3	---	---	---	15	Do.
483	---	---	---	---	3	1	---	---	---	7	Do.
484	---	---	---	---	5	2	---	---	---	10	Do.
485	---	---	---	---	7	<1	---	---	---	20	Do.
486	---	---	---	---	2	<1	---	---	---	10	Do.
487	---	---	---	---	2	1	---	---	---	7	Do.
488	15	1,000	<5	700	---	---	.1	---	---	---	Sh.lim. hbd.qtz. diorite.
489	---	---	---	---	20	3	---	---	---	15	Stream sediment.
490	---	---	---	---	5	1	---	---	---	10	Do.
491	---	---	---	---	15	<1	---	---	---	10	Do.
492	---	---	---	---	2	2	---	---	---	7	Do.
493	5	<200	30	70	---	---	.2	---	---	---	Malachite-stained arkose.
494	<.5	<200	1,000	500	---	---	<.1	---	---	---	Sh.lim. ark. and arg.
495	.5	<200	30	200	---	---	<.1	---	---	---	Iron-stained grd.
496	---	---	---	---	20	5	---	---	---	10	Stream sediment.
497	---	---	---	---	10	1	---	---	---	<2	Do.
498	<.5	<200	70	500	---	---	<.1	---	---	---	Panned concentrate.
499	---	---	---	---	3	---	3	---	---	7	Stream sediment.
500	<.5	<200	500	70	---	---	<.1	---	---	---	Panned concentrate.
					Bacon Creek drainage						
501	---	---	---	---	1	10	---	---	---	<2	Stream sediment.
502	---	---	---	---	5	10	---	---	---	---	Do.
503	---	---	---	---	15	20	---	---	---	<2	Do.

TABLE 1.—*Analyses of samples from the northern*

Semiquantitative spectrographic analyses

Sample No.	(ppm) Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co
Bacon Creek drainage--Continued														
504	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
505	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
506	>10,000	<200	2,000	2,000	1,000	20	10	50	15	150	70	<2	<10	70
507	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
Bacon Peak area														
508	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
509	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
510	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
511	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
512	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
513	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
514	5,000	<200	300	70	300	20	15	70	10	<10	20	<5	<10	10
515	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
516	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
517	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
518	5,000	<200	700	200	150	50	30	50	10	50	20	<5	<10	10
519	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
520	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
521	3,000	1,500	500	150	200	20	20	70	20	10	15	<5	<10	15
522	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
523	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
524	5,000	300	700	300	150	20	50	<10	70	70	20	<5	<10	15
525	>10,000	<200	1,000	300	70	150	70	200	<10	10	30	<2	<10	7
526	>10,000	<200	1,000	300	50	150	50	300	<10	10	30	<2	<10	10
527	5,000	<200	700	30	150	100	20	200	10	50	20	<2	<10	<5
528	5,000	<200	200	50	150	<20	20	150	50	20	15	<2	<10	<5
529	7,000	<200	200	50	150	<20	30	100	<10	30	20	<2	<10	<5
530	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
531	5,000	<200	200	30	300	<20	30	70	<10	<10	10	<2	<10	<5
Diobsud Creek drainage														
532	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
533	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
534	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
535	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
536	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
537	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
Noisy Creek drainage														
538	7,000	<200	700	150	500	<20	5	5	20	<10	15	<2	<10	<5
539	7,000	<200	500	150	300	<20	15	50	<10	<10	15	<2	<10	<5
540	>10,000	<200	3,000	1,000	200	<20	20	100	20	1,000	150	<5	<10	15
541	7,000	<200	1,000	150	200	30	100	70	30	200	50	<5	<10	30
542	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
543	10,000	<200	500	700	100	<20	100	100	<10	50	30	<5	<10	30
544	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
545	10,000	<200	2,000	500	70	<20	150	100	<10	70	20	<5	<10	20
546	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
547	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
548	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
549	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
550	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
551	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
Hidden Creek drainage														
552	5,000	<200	1,000	150	100	20	150	100	20	150	20	<5	<10	30
553	>10,000	<200	1,000	500	200	<20	70	70	10	50	70	<5	<10	50

part of the North Cascades National Park—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm)				Chemical analyses (ppm)						Sample description 1/
	Ag	As	Cr	Ba	cxHM	cxCu	Au	Ag	Cu	Mo	
					Bacon Creek drainage--Continued						
504	---	---	---	---	2.0	7	---	---	---	2	Stream sediment.
505	---	---	---	---	10	20	---	---	---	<2	Do.
506	<0.5	<200	200	30	---	---	<0.1	---	---	---	Panned concentrate.
507	---	---	---	---	1.5	7	---	---	---	---	Stream sediment.
					Bacon Peak area						
508	---	---	---	---	30	100	---	---	---	5	Stream sediment.
509	---	---	---	---	10	15	---	---	---	<2	Do.
510	---	---	---	---	15	30	---	---	---	2	Do.
511	---	---	---	---	10	30	---	---	---	2	Do.
512	---	---	---	---	3	10	---	---	---	<2	Do.
513	---	---	---	---	7	7	---	---	---	3	Do.
514	<.5	<200	30	1,500	---	---	.04	---	---	---	Lim. cgl., sc. pyrite.
515	---	---	---	---	7	5	---	---	---	.7	Stream sediment.
516	---	---	---	---	7	5	---	---	---	2	Do.
517	---	---	---	---	30	7	---	---	---	3	Do.
518	<.5	<200	70	300	---	---	<.02	---	---	---	Lim. phy. w/qtz. lenses.
519	---	---	---	---	---	---	0	2.0	0	0	Lim. chlorite schist.
520	---	---	---	---	---	---	<.1	<.05	<3	0	Do.
521	.7	<200	15	500	---	---	<.02	---	---	---	Lim. alaskite, sc. pyrh.
522	---	---	---	---	7	7	---	---	---	2	Stream sediment.
523	---	---	---	---	---	---	<.1	<.05	0	0	Lim. chl. schist; sc. py., pyrh.
524	<.5	<200	100	500	---	---	<.02	---	---	---	Do.
525	<.5	<200	2,000	300	---	---	<.1	---	---	---	Do.
526	<.5	<200	2,000	300	---	---	<.1	---	---	---	Do.
527	2	<200	50	2,000	---	---	.1	---	---	---	Lim. qtz. di. po.; abund. py., pyrh.
528	<.5	<200	200	1,000	---	---	<.1	---	---	---	Do.
529	<.5	<200	200	1,500	---	---	.4	---	---	---	Do.
530	---	---	---	---	---	---	0	<.05	0	0	Do.
531	<.5	<200	150	700	---	---	<.1	---	---	---	Lim. arkose, sc. py.
					Diobsud Creek drainage						
532	---	---	---	---	10	2	---	---	---	5	Stream sediment.
533	---	---	---	---	15	2	---	---	---	2	Do.
534	---	---	---	---	7	1	---	---	---	5	Do.
535	---	---	---	---	7	30	---	---	---	<2	Do.
536	---	---	---	---	5	10	---	---	---	2	Do.
537	---	---	---	---	3	7	---	---	---	<2	Do.
					Noisy Creek drainage						
538	<.5	<200	150	1,000	---	---	<.1	---	---	---	Lim. plag. por.; sc. pyrh.
539	<.5	<200	200	1,000	---	---	<.1	---	---	---	Do.
540	.5	<200	200	500	---	---	<.1	---	---	---	Lim. phy. w/qtz. lenses, sc. py.
541	<.5	<200	200	1,000	---	---	<.02	---	---	---	Lim. greenschist.
542	---	---	---	---	15	10	---	---	---	3	Stream sediment.
543	<.5	<200	500	150	---	---	<.1	---	---	---	Brc. sil. green sch., sc. py.
544	---	---	---	---	5	10	---	---	---	<2	Stream sediment.
545	<.5	<200	700	50	---	---	.3	---	---	---	Lim. green schist.
546	---	---	---	---	2	7	---	---	---	2	Stream sediment.
547	---	---	---	---	2	7	---	---	---	2	Do.
548	---	---	---	---	7	5	---	---	---	5	Do.
549	---	---	---	---	3	10	---	---	---	5	Do.
550	---	---	---	---	20	30	---	---	---	<2	Do.
551	---	---	---	---	3	7	---	---	---	<2	Do.
					Hidden Creek drainage						
552	<.5	<200	500	1,500	---	---	.04	---	---	---	Iron-stained arkose.
553	<.5	<200	300	500	---	---	<.05	---	---	---	Panned concentrate.

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TABLE 1.—*Analyses of samples from the northern*

Semiquantitative spectrographic analyses

Sample No.	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co
	(ppm)													
Blum Creek drainage														
554	1,000	<200	300	<10	30	<20	7	100	20	10	15	<5	<10	<5
555	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
556	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
557	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
558	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
559	3,000	<200	300	70	200	<20	10	30	20	<10	15	<5	<10	7
560	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
561	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
562	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
Scramble Creek drainage														
563	3,000	<200	300	100	200	<20	7	150	15	<10	20	7	<10	30
564	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
565	3,000	<200	700	150	300	20	5	10	20	<10	20	<5	<10	10
566	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
567	3,000	<200	700	150	150	20	20	7	20	<10	30	7	<10	5
568	3,000	<200	700	150	200	20	10	7	30	<10	15	<5	<10	10
569	1,500	<200	1,500	20	30	20	5	20	70	<10	10	<5	<10	<5
Lonesome Creek drainage														
570	3,000	<200	1,500	150	70	20	70	30	15	70	15	15	<10	15
571	300	<200	100	10	70	30	2	15	15	<10	15	15	<10	<5
572	300	<200	100	15	70	<20	<2	70	10	<10	15	30	<10	<5
573	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
574	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
575	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
576	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
577	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
578	>10,000	<200	1,000	200	>1,000	>1,000	5	70	50	50	>200	20	<10	50
579	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
580	500	<200	200	<10	50	20	<5	10	10	<10	30	5	<10	<5
581	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
582	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
583	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
584	1,500	<200	200	20	50	50	5	10	10	<10	20	<5	<10	<5
585	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
Bald Eagle Creek drainage														
586	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
587	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
588	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
589	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
590	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
591	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
592	>10,000	<200	2,000	700	>1,000	100	<2	70	50	30	100	<5	<10	30
593	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
594	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
595	3,000	<200	300	100	100	20	5	10	70	20	10	<5	<10	<5
596	3,000	300	1,500	150	100	<20	5	100	200	10	10	<5	<10	10
597	>10,000	<200	3,000	1,000	>1,000	1,000	<2	70	20	100	100	<2	<10	20
598	>10,000	<200	2,000	700	>1,000	500	2	30	<10	50	100	<5	<10	30
Picket Creek drainage														
599	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
600	3,000	1,000	>5,000	50	150	<20	5	200	1,500	300	<10	<5	<10	<5
601	2,000	500	1,000	20	100	<20	5	700	700	300	<10	<5	20	<5
602	50	700	>5,000	<10	<10	<20	<5	>5,000	>20,000	20	<10	<5	<10	10
603	150	10,000	500	<10	<20	<20	<2	---	20,000	30	<10	<5	<10	50

part of the North Cascades National Park—Continued

	Semiquantitative spectrographic analyses--Continued (ppm)				Chemical analyses (ppm)						
Sample	Ag	As	Cr	Ba	cxHM	cxCu	Au	Ag	Cu	Mo	Sample description 1/
					Blum Creek drainage						
554	0.05	≤200	<5	3,000	---	---	<0.02	---	---	---	Phyllite, local lim, sc. py.
555	---	---	---	---	7.0	3	---	---	---	7	Stream sediment.
556	----	---	---	---	7	1	---	---	---	3	Do.
557	---	---	---	---	7	1	---	---	---	20	Do.
558	---	---	---	---	3	10	---	---	---	3	Do.
559	<.5	<200	7	700	---	---	.02	---	---	---	Bi.qtz.di, lim.on joints.
560	---	---	---	---	7	5	---	---	---	10	Stream sediment.
561	---	---	---	---	5	10	---	---	---	<2	Do.
562	---	---	---	---	3	10	---	---	---	5	Do.
					Scramble Creek drainage						
563	.5	<200	15	1,500	---	---	<.02	---	---	---	Lim. qtz. di. boulders.
564	---	---	---	---	3	3	---	---	---	10	Stream sediment.
565	<.5	<200	30	700	---	---	.03	---	---	---	Lim. qtz. diorite.
566	---	---	---	---	10	3	---	---	---	20	Stream sediment.
567	<.5	<200	50	500	---	---	<.02	---	---	---	Alaskite, qtz. di. brc.; sc. py.
568	.5	<200	15	700	---	---	<.02	---	---	---	Qtz.di., alaskite, w/pyrite.
569	2	<200	<10	1,500	---	---	<.1	---	---	---	Lim. grd.; sc. py.
					Lonesome Creek drainage						
570	<.5	<200	300	300	---	---	<.02	---	---	---	Shear zone in grd.
571	<.5	<200	<5	500	---	---	<.02	---	---	---	Limonitic granodiorite.
572	<.5	<200	5	300	---	---	<.02	---	---	---	Bi. grd., lim. joints.
573	---	---	---	---	1	3	---	---	---	10	Stream sediment.
574	---	---	---	---	3	5	---	---	---	10	Do.
575	---	---	---	---	3	10	---	---	---	7	Do.
576	---	---	---	---	2	<1	---	---	---	20	Do.
577	---	---	---	---	.5	<1	---	---	---	50	Do.
578	<.5	<200	200	150	---	---	22	---	---	---	Panned concentrate.
579	---	---	---	---	2	2	---	---	---	10	Stream sediment.
580	<.5	<200	<10	1,000	---	---	<.1	---	---	---	Grd; lim. on joints.
581	---	---	---	---	2	2	---	---	---	10	Stream sediment.
582	---	---	---	---	3	1	---	---	---	10	Do.
583	---	---	---	---	3	<1	---	---	---	15	Do.
584	<.5	<200	<10	1,500	---	---	<.1	---	---	---	Grd; lim. on joints.
585	---	---	---	---	3	<1	---	---	---	10	Stream sediment.
					Bald Eagle Creek drainage						
586	---	---	---	---	7	<1	---	---	---	10	Do.
587	---	---	---	---	7	.1	---	---	---	7	Do.
588	---	---	---	---	7	1	---	---	---	10	Do.
589	---	---	---	---	3	1	---	---	---	10	Do.
590	---	---	---	---	3	3	---	---	---	10	Do.
591	---	---	---	---	15	2	---	---	---	---	Do.
592	<.5	<200	150	150	---	---	<.03	---	---	---	Panned concentrate.
593	---	---	---	---	2	3	---	---	---	15	Stream sediment.
594	---	---	---	---	7	1	---	---	---	---	Do.
595	<.5	<200	<10	1,000	---	---	<.1	---	---	---	Lim. bi. gneiss.
596	<.5	<200	<10	700	---	---	.1	---	---	---	Do.
597	<.5	<200	200	70	---	---	<.1	---	---	---	Panned concentrate.
598	<.5	<200	500	70	---	---	<.05	---	---	---	Do.
					Picket Creek drainage						
599	---	---	---	---	3	7	---	---	---	<2	Stream sediment.
600	1.5	<200	<10	700	---	---	<.1	---	---	---	Lim. bi. gneiss.
601	20	>10,000	<10	150	---	---	1	---	---	---	Qtz. vein and lim. gneiss.
602	200	>10,000	<10	<20	---	---	.20	---	---	---	Four-inch qtz. vein.
603	---	>10,000	5	30	---	---	4.2	100	10,000	---	Do.

TABLE 1.—*Analyses of samples from the northern*

Semiquantitative spectrographic analyses

Sample No.	Ti	Zn	Mn	V	Zr	La	Ni (ppm)	Cu	Pb	B	Y	Mo	Sn	Co
							Picket Creek drainage--Continued							
604	3,000	700	>5,000	70	150	<20	.5	500	1,000	150	<10	<5	10	20
605	2,000	1,000	5,000	30	100	20	2	---	500	200	<10	<5	30	<5
606	700	1,000	200	10	70	<20	<2	---	700	50	20	<5	30	5
607	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
608	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
609	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
610	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
611	1,500	1,000	300	20	150	<20	5	150	500	20	<2	15	<10	<5
612	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
613	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
614	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
615	10,000	<200	5,000	2,000	1,000	700	<2	150	30	100	50	<2	<10	50
							Pass Creek drainage (tributary to Baker River)							
616	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
617	2,000	<200	700	10	200	<20	7	50	10	<10	10	<5	<10	<5
618	3,000	<200	700	30	300	20	2	10	20	<10	20	<5	<10	10
619	5,000	<200	700	70	300	20	30	30	30	<10	20	<5	<10	20
620	2,000	<200	1,500	30	150	30	3	50	70	<10	30	5	20	30
621	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
622	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
623	>10,000	<200	1,500	1,500	>1,000	20	20	50	10	70	30	<2	<10	30
							Crystal Creek drainage							
624	3,000	<200	500	50	300	30	<5	100	<10	<10	30	<5	<10	5
625	3,000	<200	300	30	300	30	<2	70	200	<10	30	7	15	7
626	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
627	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
628	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
629	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
630	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
631	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
632	>10,000	<200	2,000	500	>1,000	300	70	100	30	70	150	<5	<10	50
633	10,000	<200	1,500	300	700	<20	70	70	200	70	70	<5	<10	30
634	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
635	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
636	>10,000	<200	1,500	300	>1,000	30	30	70	70	50	50	<5	<10	70
							Sulphide Creek drainage							
637	1,500	<200	500	70	30	<20	30	70	<10	10	10	<5	<10	7
638	7,000	<200	100	300	100	<20	70	150	70	200	30	<5	<10	15
639	5,000	<200	1,500	200	70	20	70	150	300	50	20	<5	<10	10
640	3,000	200	1,000	70	150	30	5	500	50	10	15	<5	50	7
641	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
642	3,000	<200	1,000	70	300	<20	15	100	50	<10	10	<5	15	7
643	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
644	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
645	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
646	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
647	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
648	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
649	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
650	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
651	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
652	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
653	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
654	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
655	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
656	-----	---	---	---	---	---	---	---	---	---	---	---	---	---

part of the North Cascades National Park—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Ag	As	Cr	Ba	Chemical analyses (ppm) cxHM	cxCu	Au	Ag	Cu	Mo	Sample description 1/
					Picket Creek drainage--Continued						
604	20.0	>10,000	10	70	---	---	<0.1	---	---	---	Three-inch qtz. vein.
605	---	7,000	<5	150	---	---	.06	3.0	420	---	Do.
606	---	>10,000	<5	70	---	---	1.2	17	300	---	Five-inch qtz. vein.
607	---	---	---	---	5.0	7	---	---	---	<2	Stream sediment.
608	---	---	---	---	5	15	---	---	---	---	Do.
609	---	---	---	---	7	3	---	---	---	7	Do.
610	---	---	---	---	7	7	---	---	---	10	Do.
611	100	200	10	200	---	---	<.1	---	---	---	Two-inch lim. zone.
612	---	---	---	---	15	7	---	---	---	5	Stream sediment.
613	---	---	---	---	30	30	---	---	---	5	Do.
614	---	---	---	---	7	30	---	---	---	2	Do.
615	<.5	<200	1,000	200	---	---	.2	---	---	---	Panned concentrate.
					Pass Creek drainage (tributary to Baker River)						
616	---	---	---	---	10	<1	---	---	---	2	Stream sediment.
617	<.5	<200	7	300	---	---	<.02	---	---	---	Sh. tuff, sc. green stain.
618	<.5	<200	30	700	---	---	<.02	---	---	---	Lim tuff and alaskite, sc py.
619	<.5	<200	50	700	---	---	<.02	---	---	---	Lim. sh. vol. rock.
620	<.5	<200	10	5,000	---	---	<.02	---	---	---	Lim. sil. aplite w/py.
621	---	---	---	---	7	1	---	---	---	5	Stream sediment.
622	---	---	---	---	10	3	---	---	---	3	Do.
623	<.5	<200	500	70	---	---	<.1	---	---	---	Panned concentrate.
					Crystal Creek drainage						
624	1	<200	<5	700	---	---	.02	---	---	---	Lim. plag. po. flow.
625	<.5	<200	<5	1,500	---	---	<.02	---	---	---	Coarse lim. vol. brc.
626	---	---	---	---	10	<1	---	---	---	<2	Stream sediment.
627	---	---	---	---	10	1	---	---	---	<2	Do.
628	---	---	---	---	20	1	---	---	---	<2	Do.
629	---	---	---	---	20	1	---	---	---	<2	Do.
630	---	---	---	---	30	<1	---	---	---	<2	Do.
631	---	---	---	---	1	2	---	---	---	7	Do.
632	1.5	<200	700	70	---	---	.3	---	---	---	Panned concentrate.
633	<.5	<200	700	300	---	---	<.1	---	---	---	Do.
634	---	---	---	---	7	7	---	---	---	---	Stream sediment
635	---	---	---	---	15	1	---	---	---	2	Do.
636	<.5	<200	500	150	---	---	<.06	---	---	---	Panned concentrate.
					Sulphide Creek drainage						
637	<.5	<200	30	200	---	---	<.02	---	---	---	Quartz vein.
638	<.5	<200	300	1,000	---	---	<.02	---	---	---	Iron-stained phyllite.
639	1.5	300	300	700	---	---	<.02	---	---	---	Do.
640	1.5	<200	20	700	---	---	.02	---	---	---	Iron-stained qtz.di.; sc. py.
641	---	---	---	---	---	---	0	<.05	<3	0	Do.
642	1.5	<200	30	700	---	---	.02	---	---	---	Iron-stained qtz. diorite.
643	---	---	---	---	---	---	0	9	500	0	Qtz. vein, sc. pyrite.
644	---	---	---	---	---	---	0	9	0	0	Iron-stained qtz. diorite.
645	---	---	---	---	---	---	0	<.05	0	0	Qtz. diorite, minor pyrite.
646	---	---	---	---	---	---	10	<.05	0	0	Sh. qtz. di., abund. pyrite.
647	---	---	---	---	---	---	<.05	<.05	0	0	Phyllite, abund. pyrite.
648	---	---	---	---	---	---	<.05	0	0	0	Limonitic phyllite.
649	---	---	---	---	---	---	<.05	0	0	0	Quartz vein.
650	---	---	---	---	---	---	0	0	0	0	Manganese-rich vein.
651	---	---	---	---	---	---	0	0	0	0	Do.
652	---	---	---	---	---	---	<.05	<.05	0	0	Qtz diorite, sc. pyrite.
653	---	---	---	---	---	---	0	0	0	200	Do.
654	---	---	---	---	---	---	<.05	2	0	0	Sil. phyllite.
655	---	---	---	---	---	---	0	<.05	0	0	Do.
656	---	---	---	---	---	---	0	<.05	0	0	Do.

TABLE 1.—*Analyses of samples from the northern*

Sample	Semiquantitative spectrographic analyses (ppm)													
No.	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co
							Sulphide Creek drainage--Continued							
657	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
658	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
659	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
660	7,000	<200	1,500	200	70	<20	70	300	10	30	30	<5	<10	30
661	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
662	3,000	<200	500	200	100	20	50	20	<10	70	20	<5	<10	10
663	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
664	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
665	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
666	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
667	10,000	<200	1,500	200	70	<20	70	70	<10	<10	30	<5	<10	30
668	7,000	<200	1,000	150	50	<20	70	70	300	<10	20	<5	<10	30
669	7,000	<200	1,000	200	50	<20	70	70	300	<10	30	<5	<10	30
670	3,000	<200	500	150	70	<20	70	70	30	70	15	<5	<10	10
671	3,000	<200	500	150	100	<20	50	70	30	100	15	<5	<10	7
672	150	<200	30	20	<10	<20	<2	7	<10	<10	5	<5	<10	<5
673	3,000	<200	500	100	150	<20	15	30	15	15	15	5	<10	7
674	7,000	<200	700	200	70	<20	100	70	<10	20	30	<5	<10	30
675	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
676	10,000	500	2,000	200	50	<20	70	100	700	10	30	<5	70	20
677	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
678	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
679	>10,000	<200	3,000	300	50	<20	70	150	300	15	50	<5	70	30
680	>10,000	500	2,000	300	70	<20	70	300	30	<10	70	<5	50	50
681	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
682	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
683	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
684	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
685	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
686	7,000	<200	2,000	500	150	20	300	300	70	100	50	<2	<10	100
687	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
688	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
689	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
690	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
691	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
692	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
693	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
694	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
							Baker River drainage							
695	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
696	7,000	<200	1,000	1,500	>1,000	150	20	50	15	70	30	<2	<10	20
697	1,500	<200	150	<10	300	<20	<2	15	15	<10	15	<5	<10	<5
698	7,000	<200	1,000	2,000	>1,000	70	20	30	<10	100	30	<2	<10	20
699	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
700	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
701	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
702	2,000	<200	500	100	150	20	5	70	15	<10	15	<5	<10	<5
703	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
704	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
705	>10,000	<200	1,500	1,000	<1,000	500	20	30	<10	70	50	<2	<10	30
							Shuksan Creek drainage							
706	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
707	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
708	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
709	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
710	-----	---	---	---	---	---	---	---	---	---	---	---	---	---

part of the North Cascades National Park—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Ag	As	Cr	Ba	Chemical analyses (ppm) cxHM	cxCu	Au	Ag	Cu	Mo	Sample description 1/
											Sulphide Creek drainage--Continued
657	---	---	---	---	---	---	<0.05	10.0	0	0	Phyllite with pyrite veinlet.
658	---	---	---	---	---	---	0	0	0	0	Green schist, sc. pyrite.
659	---	---	---	---	---	---	0	0	<3	<3	Green sch. and dike, sc. py.
660	0.5	<200	200	500	---	---	.05	---	---	---	Green sch. w/py., pyrh.
661	---	---	---	---	7.0	15	---	---	---	<2	Stream sediment.
662	<.5	<200	70	300	---	---	<.02	---	---	---	Lim. phy. sc. py., pyrh.
663	---	---	---	---	50	70	---	---	---	5	Stream sediment.
664	---	---	---	---	5	20	---	---	---	2	Do.
665	---	---	---	---	7	15	---	---	---	2	Do.
666	---	---	---	---	15	15	---	---	---	<2	Do.
667	<.5	<200	500	15	---	---	<.02	---	---	---	Lim. green sch.sc. py., pyrh.
668	2	<200	300	20	---	---	<.02	---	---	---	Do.
669	.7	<200	300	30	---	---	<.02	---	---	---	Lim. green schist.
670	<.5	<200	150	300	---	---	<.02	---	---	---	Limonitic phyllite.
671	<.5	<200	150	500	---	---	<.02	---	---	---	Do.
672	<.5	<200	5	15	---	---	<.02	---	---	---	Qtz. veins in phyllite.
673	<.5	<200	30	700	---	---	<.02	---	---	---	Lim. grd, sc. pyrite.
674	<.5	<200	700	500	---	---	<.02	---	---	---	Lim. green sch. and phyllite.
675	---	---	---	---	---	---	<.05	3	0	0	Qtz. di. contact zone.
676	1.5	<200	300	150	---	---	<.02	---	---	---	Brc. zone in green schist.
677	---	---	---	---	---	---	0	0	0	0	Qtz. di. contact zone.
678	---	---	---	---	---	---	0	<.05	0	0	Do.
679	.5	<200	500	70	---	---	<.02	---	---	---	Lim. greenschist.
680	.7	<200	700	300	---	---	<.02	---	---	---	Do.
681	---	---	---	---	---	---	0	<.05	<3	0	Qtz. veins in phy., sc. py.
682	---	---	---	---	30	20	---	---	---	20	Stream sediment.
683	---	---	---	---	7	10	---	---	---	100	Do.
684	---	---	---	---	10	10	---	---	---	7	Do.
685	---	---	---	---	15	30	---	---	---	30	Do.
686	<.5	<200	700	150	---	---	<.1	---	---	---	Panned concentrate.
687	---	---	---	---	15	3	---	---	---	---	Stream sediment.
688	---	---	---	---	30	1	---	---	---	---	Do.
689	---	---	---	---	15	2	---	---	---	---	Do.
690	---	---	---	---	30	1	---	---	---	---	Do.
691	---	---	---	---	7	1	---	---	---	---	Do.
692	---	---	---	---	20	1	---	---	---	---	Do.
693	---	---	---	---	---	---	0	0	0	0	Phyllite.
694	---	---	---	---	7	10	---	---	---	<2	Stream sediment.
											Baker River drainage
695	---	---	---	---	3	5	---	---	---	7	Do.
696	<.5	<200	500	100	---	---	<.1	---	---	---	Panned concentrate.
697	<.5	<200	<5	300	---	---	<.02	---	---	---	Lim aplite; sc. pyrite.
698	<.5	<200	500	70	---	---	<.1	---	---	---	Panned concentrate.
699	---	---	---	---	3	10	---	---	---	20	Stream sediment.
700	---	---	---	---	15	3	---	---	---	20	Do.
701	---	---	---	---	---	---	0	<.5	0	0	Quartz diorite.
702	<.5	<200	7	700	---	---	<.02	---	---	---	Iron-stained alaskite.
703	---	---	---	---	15	7	---	---	---	10	Stream sediment.
704	---	---	---	---	30	15	---	---	---	2	Do.
705	<.5	<200	500	70	---	---	<.1	---	---	---	Panned concentrate.
											Shuksan Creek drainage
706	---	---	---	---	7	1	---	---	---	5	Stream sediment.
707	---	---	---	---	2	15	---	---	---	2	Do.
708	---	---	---	---	2	10	---	---	---	<2	Do.
709	---	---	---	---	20	70	---	---	---	15	Do.
710	---	---	---	---	15	7	---	---	---	3	Do.

TABLE 1.—*Analyses of samples from the northern*

Semiquantitative spectrographic analyses

Sample No.	(ppm) Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co
							Shuksan Creek drainage--Continued							
711	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
712	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
713	7,000	<200	700	150	200	<20	15	150	30	<10	30	<5	<10	20
714	10,000	<200	1,500	200	70	<20	70	300	50	150	50	<5	<10	50
715	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
716	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
717	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
718	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
719	5,000	<200	700	300	100	<20	50	70	<10	100	30	10	<10	15
720	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
721	5,000	<200	700	150	100	<20	30	70	<10	15	20	7	<10	10
722	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
723	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
							Depot Creek drainage							
724	5,000	<200	500	150	100	<20	5	50	<10	<10	15	<2	<10	<5
725	5,000	<200	1,000	70	200	<20	2	3	10	<10	10	<2	<10	<5
726	10,000	<200	200	150	200	50	<2	50	40	150	10	<2	<10	<5
727	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
728	5,000	<200	700	200	100	<20	<5	10	<10	15	15	<5	<10	<5
729	5,000	<200	500	150	150	<20	5	20	10	20	10	20	<10	<5
730	5,000	<200	200	200	150	<20	20	30	<10	<10	30	<5	<10	10
731	1,500	<200	500	50	150	20	<5	100	100	300	15	<5	<10	<5
732	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
733	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
734	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
735	>10,000	<200	2,000	700	>1,000	50	50	50	<10	50	20	15	<10	70
736	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
737	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
738	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
739	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
740	5,000	<200	700	200	70	<20	20	150	<10	<10	20	20	<10	10
741	3,000	<200	500	100	150	<20	30	50	<10	<10	10	<5	<10	10
742	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
743	3,000	<200	150	100	150	20	15	15	<10	200	15	<5	<10	<5
744	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
745	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
746	2,000	<200	150	70	200	<20	5	70	70	30	5	<5	<10	<5
747	3,000	<200	700	100	30	<20	20	15	10	<10	15	<5	<10	20
748	1,500	300	700	30	200	<20	15	70	300	200	<5	<5	<10	30
749	5,000	<200	700	70	200	<20	30	70	100	<10	20	<5	<10	7
750	3,000	<200	700	100	150	<20	50	70	10	<10	10	<5	<10	10
751	2,000	<200	200	50	100	<20	15	20	15	15	7	<5	<10	10
							Bear Creek drainage							
752	>10,000	<200	700	1,500	>1,000	100	10	50	<10	70	70	<5	<10	30
753	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
754	3,000	<200	500	70	300	<20	7	30	<10	<10	20	<5	<10	7
755	3,000	<200	200	150	100	<20	7	70	30	10	15	<5	<10	<5
756	2,000	<200	150	70	70	<20	3	70	200	20	10	7	<10	<5
757	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
758	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
759	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
760	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
761	2,000	<200	700	100	150	<20	<5	20	30	150	20	<5	30	<5
762	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
763	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
764	2,000	<200	300	100	150	<20	5	300	20	<10	30	700	10	10
765	7,000	<200	1,000	300	200	<20	50	100	<10	<10	30	<5	<10	10
766	7,000	<200	1,500	300	200	<20	30	100	<10	<10	30	<5	<10	10

part of the North Cascades National Park—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Ag	As	Cr	Ba	Chemical analyses (ppm) cxHM	cxCu	Au	Ag	Cu	Mo	Sample description 1/
					Shuksan Creek drainage--Continued						
711	---	---	---	---	7.0	2	---	---	---	---	Stream sediment.
712	---	---	---	---	7	5	---	---	---	---	Do.
713	<0.5	<200	50	1,000	---	---	<0.02	---	---	---	Lim. quartz diorite.
714	<.5	<200	500	700	---	---	<.01	---	---	---	Limonitic hornfels.
715	---	---	---	---	10	2	---	---	---	---	Stream sediment.
716	---	---	---	---	2	7	---	---	---	3	Do.
717	---	---	---	---	3	7	---	---	---	5	Do.
718	---	---	---	---	3	7	---	---	---	3	Do.
719	<.5	<200	70	1,000	---	---	.05	---	---	---	Lim. green schist.
720	---	---	---	---	2	7	---	---	---	2	Stream sediment.
721	<.5	<200	30	500	---	---	.10	---	---	---	Lim. green schist.
722	---	---	---	---	3	7	---	---	---	20	Stream sediment.
723	---	---	---	---	7	3	---	---	---	3	Do.
					Depot Creek drainage						
724	<.5	<200	50	700	---	---	<.1	---	---	---	Lim. volcanic rock.
725	<.5	<200	50	2,000	---	---	<.1	---	---	---	Do.
726	<.5	<200	150	2,000	---	---	<.1	---	---	---	Lim. quartz diorite.
727	---	---	---	---	1	1	---	---	---	20	Stream sediment.
728	<.5	<200	30	200	---	---	<.02	---	---	---	Lim. vol. rock.
729	<.5	<200	10	500	---	---	<.02	---	---	---	Do.
730	<.5	<200	20	300	---	---	<.02	---	---	---	Do.
731	1	<200	5	500	---	---	<.02	---	---	---	Lim. vol. rock w/pyrh.
732	---	---	---	---	15	50	---	---	---	---	Stream sediment.
733	---	---	---	---	200	500	---	---	---	---	Do.
734	---	---	---	---	20	100	---	---	---	---	Do.
735	<.5	<200	1,000	150	---	---	<.03	---	---	---	Panned concentrate.
736	---	---	---	---	7	30	---	---	---	7	Stream sediment.
737	---	---	---	---	15	30	---	---	---	---	Do.
738	---	---	---	---	10	20	---	---	---	---	Do.
739	---	---	---	---	2	7	---	---	---	---	Do.
740	2	<200	200	1,000	---	---	.05	----	---	---	Lim. biotite gneiss.
741	<.5	<200	50	700	---	---	<.02	---	---	---	Do.
742	---	---	---	---	2	3	---	---	---	15	Stream sediment.
743	<.5	<200	30	500	---	---	.02	---	---	---	Lim. biotite gneiss.
744	---	---	---	---	27	3	---	---	---	---	Stream sediment.
745	---	---	---	---	7	2	---	---	---	---	Do.
746	<.5	<200	15	500	---	---	<.02	---	---	---	Lim. biotite gneiss.
747	<.5	<200	7	1,500	---	---	.02	---	---	---	Dark dike with pyrite.
748	.7	200	5	150	---	---	.03	---	---	---	Lim. bi. gneiss.
749	<.5	<200	150	300	---	---	.03	---	---	---	Lim. qtz. diorite gneiss.
750	<.5	<200	70	500	---	---	<.02	---	---	---	Lim. hornblende gneiss.
751	<.5	<200	30	200	---	---	<.02	---	---	---	Lim.bi. and hbd.gneiss, sc.py.
					Bear Creek drainage						
752	<.5	<200	300	100	---	---	<.03	---	---	---	Panned concentrate.
753	---	---	---	---	7	2	---	---	---	10	Stream sediment.
754	<.5	<200	15	700	---	---	<.02	---	---	---	Limonitic quartz diorite.
755	<.5	<200	15	1,500	---	---	<.02	---	---	---	Do.
756	<.5	<200	10	700	---	---	.04	---	---	---	Do.
757	---	---	---	---	.5	1	---	---	---	7	Stream sediment.
758	---	---	---	---	2	10	---	---	---	10	Do.
759	---	---	---	---	2	15	---	---	---	10	Do.
760	---	---	---	---	7	20	---	---	---	---	Do.
761	<.5	<200	10	200	---	---	<.02	---	---	---	Lim. sh. qtz. diorite.
762	---	---	---	---	20	70	---	---	---	---	Stream sediment.
763	---	---	---	---	---	---	<.02	---	---	40	Two-inch quartz vein.
764	7	<200	7	1,500	---	---	.04	---	---	---	Slightly lim. qtz. diorite.
765	<.5	<200	200	500	---	---	<.1	---	---	---	Lim. banded bi. gneiss.
766	<.5	<200	150	200	---	---	<.1	---	---	---	Lim. hbd. gneiss.

TABLE 1.—*Analyses of samples from the northern*

Semiquantitative spectrographic analyses

Sample No.	(ppm) Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co
					Bear Creek drainage--Continued									
767	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
768	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
769	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
770	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
771	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
772	3,000	<200	150	150	300	20	<2	70	30	1,500	15	15	15	<5
773	3,000	<200	150	50	150	<20	2	100	<10	<10	7	<5	15	<5
774	3,000	<200	300	150	200	<20	10	300	<10	15	15	20	<10	50
775	150	<200	150	200	<10	<20	<2	150	10	<10	7	150	<10	<5
776	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
777	3,000	<200	150	70	300	<20	<2	150	20	700	10	20	30	<5
778	3,000	<200	1,500	150	300	<20	<2	300	200	70	<5	100	30	<5
779	3,000	<200	1,500	200	300	<20	2	50	<10	>2,000	15	<5	50	<5
780	3,000	<200	300	150	200	<20	2	100	<10	100	10	150	50	<5
781	3,000	<200	300	100	150	<20	<2	300	30	20	15	100	20	<5
782	3,000	<200	700	150	100	<20	7	150	100	30	15	30	10	<5
783	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
784	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
785	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
786	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
787	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
788	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
					Indian Creek drainage									
789	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
790	>10,000	<200	700	700	>1,000	200	30	70	<10	100	70	<5	<10	50
791	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
792	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
793	>10,000	<200	1,500	1,000	>1,000	200	5	70	30	100	150	<5	<10	50
794	3,000	<200	700	200	200	<20	3	500	300	200	30	10	30	<5
795	3,000	<200	700	500	100	<20	10	500	70	100	20	7	<10	5
796	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
797	3,000	<200	150	150	100	<20	2	70	15	20	15	70	10	7
798	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
799	1,500	<200	150	30	100	30	5	30	50	300	15	50	<10	5
800	1,000	<200	100	30	70	<20	5	15	<10	15	10	200	<10	<5
801	1,500	<200	200	30	150	30	2	150	<10	50	15	70	15	5
802	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
803	2,000	<200	300	70	150	<20	5	70	30	10	20	20	<10	5
804	1,500	<200	300	100	100	<20	2	20	10	150	15	<5	<10	<5
805	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
806	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
807	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
808	>10,000	<200	1,000	1,000	>1,000	200	5	70	70	70	150	70	<10	50
809	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
810	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
811	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
812	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
813	5,000	<200	700	150	200	<20	20	500	100	>2,000	30	30	20	10
814	1,000	<200	150	50	50	<20	2	500	70	1,000	<5	<5	<10	<5
815	1,500	<200	200	100	150	<20	5	50	<10	<10	10	<5	<10	<5
816	3,000	<200	300	50	70	<20	15	200	50	1,500	10	70	<10	15
817	7,000	<200	1,500	200	150	<20	50	100	20	200	20	<5	<10	20
818	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
819	-----	---	---	---	---	---	---	---	---	---	---	---	---	---

part of the North Cascades National Park—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm)				Chemical analyses (ppm)						Sample description 1/
	Ag	As	Cr	Ba	cxHM	cxCu	Au	Ag	Cu	Mo	
					Bear Creek drainage--Continued						
767	---	---	---	---	2.0	5	---	---	---	10	Stream sediment.
768	---	---	---	---	2	10	---	---	---	15	Do.
769	---	---	---	---	2	2	---	---	---	10	Do.
770	---	---	---	---	2	15	---	---	---	50	Do.
771	---	---	---	---	2	20	---	---	---	20	Do.
772	1.5	<200	7	500	---	---	<0.02	---	---	---	Lim. qtz. di. small qtz. veins.
773	<.5	<200	7	700	---	---	<.02	---	---	---	Lim. hbd. qtz. diorite.
774	<.5	<200	10	700	---	---	<.02	---	---	---	Do.
775	.5	<200	<5	30	---	---	<.02	---	---	---	Small quartz vein.
776	---	---	---	---	7	10	---	---	---	100	Stream sediment.
777	.7	<200	30	700	---	---	<.02	---	---	---	Lim. hbd. qtz. diorite.
778	<.5	<200	<5	500	---	---	<.02	---	---	---	Do.
779	<.5	<200	10	300	---	---	<.02	---	---	---	Dk.green dike; qtz. vein.
780	<.5	<200	7	300	---	---	<.02	---	---	---	Lim. hbd. qtz. diorite.
781	1	<200	15	700	---	---	<.02	---	---	---	Do.
782	.7	<200	15	500	---	---	<.02	---	---	---	Do.
783	---	---	---	---	2	1	---	---	---	7	Stream sediment.
784	---	---	---	---	15	20	---	---	---	---	Do.
785	---	---	---	---	2	15	---	---	---	---	Do.
786	---	---	---	---	10	30	---	---	---	---	Do.
787	---	---	---	---	2	7	---	---	---	---	Do.
788	---	---	---	---	2	15	---	---	---	---	Do.
					Indian Creek drainage						
789	---	---	---	---	2	7	---	---	---	---	Do.
790	<.5	<200	500	70	---	---	.04	---	---	---	Panned concentrate.
791	---	---	---	---	5	3	---	---	---	15	Stream sediment.
792	---	---	---	---	1	5	---	---	---	15	Do.
793	<.5	<200	500	150	---	---	.06	---	---	---	Panned concentrate.
794	30	300	10	300	---	---	.05	---	---	---	Sheared lim. granodiorite.
795	7	<200	15	700	---	---	<.02	---	---	---	Do.
796	---	---	---	---	20	20	---	---	---	10	Stream sediment.
797	<.5	<200	7	1,500	---	---	<.02	---	---	---	Lim. bi. granodiorite.
798	---	---	---	---	15	50	---	---	---	10	Stream sediment.
799	<.5	<200	<5	1,500	---	---	<.02	---	---	---	Lim. alaskite.
800	<.5	<200	<5	700	---	---	<.02	---	---	---	Do.
801	<.5	<200	7	700	---	---	<.02	---	---	---	Do.
802	---	---	---	---	10	10	---	---	---	5	Stream sediment.
803	1	<200	15	1,000	---	---	<.02	---	---	---	Lim. sh. granodiorite.
804	.5	<200	5	200	---	---	<.02	---	---	---	Do.
805	---	---	---	---	20	70	---	---	---	3	Stream sediment.
806	---	---	---	---	5	20	---	---	---	20	Do.
807	---	---	---	---	7	10	---	---	---	3	Do.
808	<.5	<200	500	70	---	---	<.03	---	---	---	Panned concentrate.
809	---	---	---	---	2	7	---	---	---	10	Stream sediment.
810	---	---	---	---	3	15	---	---	---	7	Do.
811	---	---	---	---	7	30	---	---	---	20	Do.
812	---	---	---	---	1	7	---	---	---	7	Do.
813	2	<200	30	2,000	---	---	.09	---	---	---	Lim.sil.granodiorite; w/py.
814	15	<200	5	300	---	---	3.41	---	---	---	Do.
815	<.5	<200	5	500	---	---	<.02	---	---	---	Lim.po. dike; sc. py.
816	.7	<200	15	1,000	---	---	<.02	---	---	---	Lim. sil. granodiorite.
817	<.5	<200	200	300	---	---	<.02	---	---	---	Lim. po. dike.
818	---	---	---	---	5	15	---	---	---	20	Stream sediment.
819	---	---	---	---	5	3	---	---	---	15	Do.

TABLE 1.—*Analyses of samples from the northern*

Semiquantitative spectrographic analyses

Sample No.	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co
	(ppm)													
Brush Creek drainage														
820	3,000	<200	1,500	150	100	20	15	30	50	<10	15	15	<10	30
821	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
822	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
823	10,000	<200	1,000	700	>1,000	70	10	70	70	100	30	<5	<10	50
824	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
825	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
826	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
827	-----	---	---	---	----	---	---	---	---	---	---	---	---	---
828	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
829	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
830	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
831	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
832	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
833	>10,000	<200	1,500	500	>1,000	150	20	70	30	100	70	<5	<10	30
834	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
835	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
836	>10,000	<200	1,500	700	>1,000	70	15	70	15	70	70	<5	<10	50
Easy Creek														
837	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
838	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
839	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
840	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
841	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
842	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
843	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
844	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
845	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
846	>10,000	<200	1,500	300	>1,000	150	50	70	70	70	100	70	<10	70
Easy Ridge														
847	5,000	<200	100	150	200	20	10	150	<10	10	15	20	<10	10
848	2,000	<200	70	50	150	20	<5	50	30	50	10	70	<10	<5
849	2,000	<200	200	50	200	30	3	70	20	<10	15	7	<10	5
850	1,000	<200	100	20	150	30	3	70	20	<10	15	<5	<10	<5
851	2,000	<200	150	30	100	30	5	50	30	<10	7	<5	<10	5
852	700	300	200	30	50	30	7	1,500	<10	70	15	30	<10	30
853	1,000	<200	150	30	150	30	3	70	20	20	10	300	<10	7
854	5,000	200	700	150	150	20	<5	300	200	10	20	<5	<10	7
855	2,000	<200	300	30	300	30	7	70	50	30	20	<5	<10	<5
856	3,000	<200	200	50	150	<20	20	1,500	20	30	15	70	<10	50
857	3,000	<200	500	100	100	50	30	1,500	<10	20	20	70	<10	30
858	3,000	<200	300	100	150	<20	50	3,000	20	50	15	70	<10	150
859	5,000	<200	500	100	200	<20	20	500	15	<10	15	30	<10	30
860	2,000	<200	300	30	300	30	5	70	20	<10	15	7	<10	<5
Little Fork of the Chilliwack River drainage														
861	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
862	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
863	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
864	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
865	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
866	2,000	<200	700	70	100	<20	7	150	<10	<10	15	150	<10	10
867	2,000	<200	500	70	200	<20	5	70	<10	<10	10	5	<10	5
868	3,000	<200	500	150	200	<20	7	150	10	<10	15	20	<10	7
869	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
870	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
871	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
872	7,000	<200	1,500	1,500	>1,000	50	5	30	<10	50	100	<5	<10	50
873	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
874	-----	---	---	---	---	---	---	---	---	---	---	---	---	---

part of the North Cascades National Park—Continued

	Semiquantitative spectrographic analyses--Continued (ppm)				Chemical analyses (ppm)						
Sample	Ag	As	Cr	Ba	cxHM	cxCu	Au	Ag	Cu	Mo	Sample description 1/
					Brush Creek drainage						
820	<0.5	<200	30	700	---	---	0.02	---	---	---	Lim. qtz. diorite.
821	---	---	---	---	2.0	7	---	---	---	30	Stream sediment.
822	---	---	---	---	10	2	---	---	---	---	Do.
823	<.5	<200	500	70	---	---	<.5	---	---	---	Panned concentrate.
824	---	---	---	---	2	3	---	---	---	15	Stream sediment.
825	---	---	---	---	5	7	---	---	---	15	Do.
826	---	---	---	---	1	<1	---	---	---	10	Do.
827	---	---	---	---	2	3	---	---	---	10	Do.
828	---	---	---	---	2	5	---	---	---	10	Do.
829	---	---	---	---	3	3	---	---	---	20	Do.
830	---	---	---	---	2	1	---	---	---	7	Do.
831	---	---	---	---	2	3	---	---	---	15	Do.
832	---	---	---	---	10	2	---	---	---	---	Do.
833	<.5	<200	300	150	---	---	<.2	---	---	---	Panned concentrate.
834	---	---	---	---	10	1	---	---	---	---	Stream sediment.
835	---	---	---	---	20	3	---	---	---	5	Do.
836	<.5	<200	700	150	---	---	2.9	---	---	---	Panned concentrate.
					Easy Creek						
837	---	---	---	---	7	5	---	---	---	20	Stream sediment.
838	---	---	---	---	---	---	0	2.0	0	0	Lim. qtz. diorite, sc. py.
839	---	---	---	---	5	3	---	---	---	15	Stream sediment.
840	---	---	---	---	---	---	<.05	<.05	<3	0	Lim. qtz. diorite, sc. py.
841	---	---	---	---	2	1	---	---	---	10	Stream sediment.
842	---	---	---	---	15	1	---	---	---	10	Do.
843	---	---	---	---	1	10	---	---	---	10	Do.
844	---	---	---	---	---	---	0	0	0	0	Lim. qtz. diorite.
845	---	---	---	---	---	---	0	<.05	0	0	Lim. qtz. di., sc. py.
846	<.5	<200	700	150	---	---	<.6	---	---	---	Panned concentrate.
					Easy Ridge						
847	<.5	<200	15	500	---	---	<.02	---	---	---	Sil. py. zone w/diorite.
848	<.5	<200	5	700	---	---	<.02	---	---	---	Lim. qtz. di., sc. py.
849	<.5	<200	<5	1,000	---	---	<.02	---	---	---	Lim. alaskite.
850	<.5	<200	10	1,000	---	---	<.02	---	---	---	Lim. alaskite, sc. py.
851	<.5	<200	5	1,000	---	---	.03	---	---	---	Lim. py. qtz. diorite.
852	.7	<200	5	150	---	---	.03	---	---	---	Sil. alaskite w/pyrite vein.
853	<.5	<200	5	700	---	---	.03	---	---	---	Sil. alaskite, sc. py.
854	.7	300	10	300	---	---	<.02	---	---	---	Sil. hbd. diorite, sc. py.
855	<.5	<200	15	1,000	---	---	<.02	---	---	---	Alaskite, sc. pyrite.
856	1	<200	20	1,000	---	---	.03	---	---	---	Sil. grd.; py. veinlets.
857	.7	<200	30	700	---	---	.05	---	---	---	Do.
858	3	<200	30	1,000	---	---	.05	---	---	---	Do.
859	.7	<200	15	700	---	---	<.02	---	---	---	Do.
860	<.5	<200	15	1,500	---	---	<.02	---	---	---	Do.
					Little Fork of the Chilliwack River drainage						
861	---	---	---	---	2	<1	---	---	---	20	Stream sediment.
862	---	---	---	---	2	<1	---	---	---	10	Do.
863	---	---	---	---	2	<1	---	---	---	30	Do.
864	---	---	---	---	3	3	---	---	---	10	Do.
865	---	---	---	---	.5	1	---	---	---	7	Do.
866	<.5	<200	7	700	---	---	.04	---	---	---	Qtz. diorite, sc. pyrite.
867	<.5	<200	5	700	---	---	<.02	---	---	---	Do.
868	<.5	<200	15	1,500	---	---	<.02	---	---	---	Do.
869	---	---	---	---	200	500	---	---	---	30	Stream sediment.
870	---	---	---	---	3	10	---	---	---	20	Do.
871	---	---	---	---	10	10	---	---	---	20	Do.
872	<.5	<200	500	150	---	---	<.03	---	---	---	Panned concentrate.
873	---	---	---	---	15	20	---	---	---	10	Stream sediment.
874	---	---	---	---	3	7	---	---	---	15	Do.

TABLE 1.—*Analyses of samples from the northern*

Semiquantitative spectrographic analyses

Sample No.	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co
	(ppm)													
						Little Chilliwack River drainage								
875	10,000	<200	5,000	300	100	<20	2	100	70	15	30	10	<10	30
876	2,000	1,000	3,000	15	200	30	2	15	200	200	15	<5	<10	<5
877	2,000	<200	300	30	200	20	2	200	30	10	50	30	<10	15
878	2,000	<200	700	30	200	30	<2	20	50	10	20	<5	<10	<5
879	2,000	<200	500	30	150	30	3	7	15	<10	20	15	<10	<5
880	8,000	<200	700	30	200	30	5	30	30	<10	20	10	<10	<5
881	3,000	<200	700	70	150	<20	5	30	30	<10	20	<5	<10	<5
882	5,000	<200	1,500	150	150	<20	2	30	15	<10	20	<5	<10	7
883	2,000	<200	700	50	150	20	<5	<5	<10	<10	15	<5	<10	<5
884	5,000	<200	700	200	10	<20	20	30	<10	20	7	<5	<10	7
885	5,000	<200	700	300	15	<20	20	10	<10	20	10	<5	<10	15
886	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
887	5,000	<200	700	150	70	20	70	50	30	20	15	<5	<10	20
888	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
889	>10,000	<200	1,000	1,000	>1,000	20	5	50	<10	50	30	<5	<10	70
						Chilliwack River drainage								
890	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
891	>10,000	<200	3,000	700	>1,000	300	5	70	<10	100	100	<5	<10	70
892	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
893	3,000	<200	300	200	70	<20	10	30	150	500	5	<5	<10	20
894	3,000	1,000	700	70	100	<20	5	200	50	15	30	<5	<10	7
895	2,000	<200	300	100	70	<20	30	1,000	30	1,500	15	<5	<10	30
896	5,000	<200	150	200	70	<20	30	50	<10	1,000	15	<5	<10	5
897	2,000	<200	150	70	100	<20	20	30	10	>2,000	5	10	<10	<5
898	3,000	<200	3,000	100	70	<20	50	150	20	150	7	<5	<10	30
899	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
900	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
901	3,000	<200	700	100	70	<20	30	70	20	<10	10	<5	<10	5
902	5,000	<200	50	150	150	<20	20	70	20	15	15	<5	<10	7
903	5,000	<200	700	200	200	<20	20	150	10	<10	15	5	<10	7
904	3,000	<200	1,000	150	100	<20	10	300	20	<10	15	7	<10	7
905	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
906	5,000	300	2,000	200	100	<20	50	200	30	<10	15	<5	<10	15
907	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
908	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
909	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
910	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
911	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
912	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
913	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
914	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
915	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
916	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
917	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
918	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
919	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
920	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
921	>10,000	<200	2,000	500	>1,000	70	15	50	20	50	50	<5	<10	50
922	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
923	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
924	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
925	10,000	<200	2,000	100	50	<20	30	300	150	20	30	<5	<10	300
926	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
927	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
928	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
929	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
930	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
931	1,000	<200	700	15	200	20	<5	<5	10	15	15	5	<10	<10
932	700	<200	1,000	15	70	30	<5	<5	10	10	30	<5	<10	<10
933	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
934	>10,000	<200	3,000	700	>1,000	200	30	70	15	50	100	<5	<10	50

part of the North Cascades National Park—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Ag	As	Cr	Ba	Chemical analyses (ppm) cxHM	cxCu	Au	Ag	Cu	Mo	Sample description 1/
											Little Chilliwack River drainage
875	<0.5	<200	5	700	---	---	<0.02	---	---	---	Lim. biotite hornfels.
876	7	<200	<5	700	---	---	.04	---	---	---	Do.
877	1.5	<200	5	700	---	---	.02	---	---	---	Do.
878	<.5	<200	5	1,500	---	---	.03	---	---	---	Do.
879	<.5	<200	<5	1,500	---	---	<.02	---	---	---	Lim. qtz. diorite.
880	<.5	<200	7	1,000	---	---	.02	---	---	---	Lim. hornfels.
881	<.5	<200	10	700	---	---	<.02	---	---	---	Lim. sil. quartz diorite.
882	<.5	<200	5	1,000	---	---	<.02	---	---	---	Lim. hbd. gneiss.
883	<.5	<200	<5	1,000	---	---	<.02	---	---	---	Lim. qtz. diorite.
884	<.5	<200	15	70	---	---	<.02	---	---	---	Lim. hbd. qtz. diorite.
885	<.5	<200	30	70	---	---	<.02	---	---	---	Do.
886	---	---	---	---	7	2	---	---	---	---	Stream sediment.
887	<.5	<200	150	700	---	---	<.02	---	---	---	Lim. hbd. qtz. diorite.
888	---	---	---	---	5	10	---	---	---	---	Stream sediment.
889	<.5	<200	500	70	---	---	<.03	---	---	---	Panned concentrate.
											Chilliwack River drainage
890	---	---	---	---	1	<1	---	---	---	10	Stream sediment.
891	<.5	<200	700	100	---	---	<.06	---	---	---	Panned concentrate.
892	---	---	---	---	3	7	---	---	---	7	Stream sediment.
893	1	<200	15	300	---	---	<.02	---	---	---	Lim. alaskite.
894	<.5	<200	<5	700	---	---	<.02	---	---	---	Lim. sh. qtz. di. gneiss.
895	<.5	<200	150	300	---	---	.02	---	---	---	Lim. banded bi. and hbd. gneiss.
896	<.5	<200	200	100	---	---	<.02	---	---	---	Banded hbd. gneiss; qtz. pods.
897	.7	<200	150	150	---	---	.04	---	---	---	Gouge in banded hbd. gneiss.
898	3	<200	150	700	---	---	<.02	---	---	---	Lim. sh. hbd. gneiss.
899	---	---	---	---	1	3	---	---	---	7	Stream sediment.
900	---	---	---	---	2	2	---	---	---	7	Do.
901	<.5	<200	70	300	---	---	<.02	---	---	---	Lim. bi. gneiss.
902	<.5	<200	70	200	---	---	<.02	---	---	---	Do.
903	<.5	<200	70	200	---	---	<.02	---	---	---	Do.
904	<.5	<200	70	300	---	---	<.02	---	---	---	Lim. bi. and hbd. gneiss.
905	---	---	---	---	5	15	---	---	---	---	Stream sediment.
906	<.5	<200	200	700	---	---	<.02	---	---	---	Lim. bi. and hbd. gneiss.
907	---	---	---	---	3	20	---	---	---	---	Stream sediment.
908	---	---	---	---	5	15	---	---	---	5	Do.
909	---	---	---	---	7	20	---	---	---	7	Do.
910	---	---	---	---	1	7	---	---	---	10	Do.
911	---	---	---	---	3	20	---	---	---	---	Do.
912	---	---	---	---	2	7	---	---	---	---	Do.
913	---	---	---	---	2	7	---	---	---	---	Do.
914	---	---	---	---	15	70	---	---	---	70	Do.
915	---	---	---	---	15	2	---	---	---	50	Do.
916	---	---	---	---	10	15	---	---	---	---	Do.
917	---	---	---	---	100	200	---	---	---	---	Do.
918	---	---	---	---	15	30	---	---	---	---	Do.
919	---	---	---	---	7	50	---	---	---	10	Do.
920	---	---	---	---	1	2	---	---	---	7	Do.
921	<.5	<200	300	100	---	---	.06	---	---	---	Panned concentrate.
922	---	---	---	---	10	<1	---	---	---	---	Stream sediment.
923	---	---	---	---	20	3	---	---	---	---	Do.
924	---	---	---	---	20	3	---	---	---	---	Do.
925	3	<200	15	500	---	---	<.02	---	---	---	Lim. diorite, sc. py.
926	---	---	---	---	---	---	0	0	0	0	Lim. breccia.
927	---	---	---	---	---	---	0	0	0	0	Do.
928	---	---	---	---	15	1	---	---	---	7	Stream sediment.
929	---	---	---	---	70	<1	---	---	---	5	Do.
930	---	---	---	---	20	2	---	---	---	---	Do.
931	<.5	<200	<5	700	---	---	<.02	---	---	---	Lim. sh. qtz. diorite.
932	<.5	<200	<5	700	---	---	<.02	---	---	---	Do.
933	---	---	---	---	15	3	---	---	---	---	Stream sediment.
934	<.5	<200	700	150	---	---	<.03	---	---	---	Panned concentrate.

TABLE 1.—*Analyses of samples from the northern*

Semiquantitative spectrographic analyses

Sample No.	(ppm) Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co
					Chilliwack River drainage--Continued									
935	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
936	2,000	<200	1,000	30	100	<20	7	<5	<10	10	15	<5	<10	5
937	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
938	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
939	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
940	700	<200	200	10	150	<20	<5	5	150	<10	20	100	<10	<5
941	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
942	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
943	1,000	<200	200	15	50	<20	<5	<5	30	10	15	15	<10	<5
944	1,500	<200	200	20	50	30	<2	30	15	<10	7	<5	<10	<5
945	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
946	>10,000	<200	2,000	300	>1,000	300	15	100	50	30	150	<5	<10	50
947	3,000	<200	1,000	200	150	20	50	7	20	<10	20	10	<10	15
948	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
949	10,000	<200	2,000	700	100	20	15	7	300	<10	30	<5	<10	30
950	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
951	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
952	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
953	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
954	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
955	3,000	<200	700	30	100	<20	3	20	70	<10	15	<5	20	5
956	5,000	<200	500	100	150	<20	15	15	30	<10	15	<5	<10	5
957	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
958	3,000	<200	150	70	300	20	3	20	15	<10	10	7	<10	5
959	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
					Hannegan Pass-Ruth Mountain area									
960	5,000	<200	300	150	150	<20	5	20	30	<10	15	<5	<10	5
961	5,000	<200	500	200	100	<20	10	30	50	<10	20	<5	<10	10
962	7,000	<200	300	200	150	20	<5	7	30	<10	30	<5	<10	<5
963	5,000	<200	500	300	150	<20	10	30	20	<10	20	<5	<10	7
964	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
965	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
966	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
967	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
968	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
969	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
970	7,000	<200	500	200	150	20	20	7	<10	<10	20	<5	<10	5
971	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
972	7,000	<200	700	150	500	<20	50	15	20	<10	20	<5	<10	15
973	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
974	3,000	<200	700	30	500	30	<2	30	30	<10	30	5	<10	<5
975	3,000	<200	700	30	300	20	<2	50	70	<10	30	7	<10	<5
976	3,000	<200	700	30	200	20	15	300	30	<10	15	<5	15	5
977	5,000	<200	300	50	200	20	<2	70	30	<10	15	<5	<10	<5
978	7,000	<200	700	70	200	<20	30	70	20	<10	15	7	<10	10
979	7,000	<200	700	150	100	<20	70	70	30	<10	20	5	10	15
980	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
981	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
982	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
983	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
					Ensawkwatch Creek drainage									
984	>10,000	<200	1,500	1,000	>1,000	150	5	30	<10	30	50	<5	<10	50
985	1,500	<200	300	20	150	<20	2	10	15	<10	15	<5	<10	<5
986	>10,000	<200	1,000	500	>1,000	50	70	30	<10	70	15	<5	<10	50
987	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
988	>10,000	<200	1,000	700	>1,000	50	10	30	10	70	150	<5	<10	50

part of the North Cascades National Park—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Ag	As	Cr	Ba	Chemical analyses (ppm) cxHM	cxCu	Au	Ag	Cu	Mo	Sample description [1]
					Chilliwack River drainage--Continued						
935	---	---	---	---	500.0	1	---	---	---	15	Stream sediment.
936	<0.5	<200	10	700	---	---	<0.02	---	---	---	Lim. alaskite.
937	---	---	---	---	70	3	---	---	---	---	Stream sediment.
938	---	---	---	---	50	1	---	---	---	10	Do.
939	---	---	---	---	50	2	---	---	---	---	Do
940	1.5	<200	<5	300	---	---	<.02	---	---	---	Lim. granodiorite.
941	---	---	---	---	7	.1	---	---	---	---	Stream sediment.
942	---	---	---	---	10	<1	---	---	---	---	Do.
943	1.5	<200	<5	300	---	---	<.02	---	---	---	Lim. alaskite, sc. py.
944	<.5	<200	7	1,500	---	---	<.02	---	---	---	Lim. sh. granodiorite.
945	---	---	---	---	---	---	0	<0.05	0	0	Lim. granodiorite.
946	1.5	<200	150	300	---	---	<.02	---	---	---	Panned concentrate.
947	<.5	<200	150	300	---	---	<.02	---	---	---	Hbd. grd.; sc. py.
948	---	---	---	---	15	1	---	---	---	---	Stream sediment.
949	<.5	<200	50	<20	---	---	<.02	---	---	---	Hbd. grd.; sc. py.
950	---	---	---	---	---	---	<.05	<.05	0	0	Granodiorite-volcanic contact.
951	---	---	---	---	---	---	0	0	0	0	Lim. granodiorite.
952	---	---	---	---	---	---	0	0	0	0	Diorite, sc. sulfides.
953	---	---	---	---	---	---	0	<.05	0	0	Do.
954	---	---	---	---	15	1	---	---	---	5	Stream sediment.
955	<.5	<200	15	700	---	---	<.02	---	---	---	Lim. vol. rocks.
956	<.5	<200	50	700	---	---	<.02	---	---	---	Lim. tuff; sc. pyrite.
957	---	---	---	---	---	---	0	<.05	0	0	Lim. volcanics.
958	.7	<200	15	700	---	---	.03	---	---	---	Lim. vol. breccia.
959	---	---	---	---	2	<1	---	---	---	7	Stream sediment.
					Hannegan Pass-Ruth Mountain area						
960	<.5	<200	30	300	---	---	<.02	---	---	---	Lim. quartz diorite.
961	<.5	<200	30	500	---	---	<.02	---	---	---	Do.
962	<.5	<200	30	200	---	---	<.02	---	---	---	Do.
963	<.5	<200	50	500	---	---	<.02	---	---	---	Do.
964	---	---	---	---	---	---	0	0	0	0	Do.
965	---	---	---	---	---	---	0	0	0	0	Do.
966	---	---	---	---	---	---	0	<.05	0	0	Do.
967	---	---	---	---	---	---	0	0	0	0	Do.
968	---	---	---	---	---	---	<.05	<.05	0	0	Do.
969	---	---	---	---	---	---	0	0	0	0	Do.
970	<.5	<200	50	500	---	---	<.02	---	---	---	Do.
971	---	---	---	---	---	---	<.02	---	---	---	Sil. qtz. diorite; pyrite.
972	<.5	<200	50	1,000	---	---	<.02	---	---	---	Lim. qtz. diorite.
973	---	---	---	---	---	---	0	<.05	0	0	Vol. rock; sc. py.
974	<.5	<200	5	1,000	---	---	<.02	---	---	---	Lim. tuff; sc. py.
975	<.5	<200	<5	1,000	---	---	<.02	---	---	---	Lim. white tuff.
976	<.5	<200	30	700	---	---	<.02	---	---	---	Lim. vol. breccia.
977	.7	<200	<5	150	---	---	<.02	---	---	---	Do.
978	<.5	<200	100	1,000	---	---	<.02	---	---	---	Lim. welded tuff; sc. py.
979	<.5	<200	150	300	---	---	<.02	---	---	---	Do.
980	---	---	---	---	---	---	0	0	---	---	Lim. qtz. latite.
981	---	---	---	---	---	---	0	<.05	---	---	Do.
982	---	---	---	---	---	---	0	<.05	0	0	Lim. vol. breccia.
983	---	---	---	---	---	---	0	<.05	<3	<3	Do.
					Ensawkwatch Creek drainage						
984	<.5	<200	150	150	---	---	.2	---	---	---	Panned concentrate.
985	<.5	<200	7	1,000	---	---	<.02	---	---	---	Sh. black dike.
986	<.5	<200	150	150	---	---	<.1	---	---	---	Panned concentrate.
987	---	---	---	---	1	<1	---	---	---	7	Stream sediment.
988	<.5	<200	300	100	---	---	<.04	---	---	---	Panned concentrate.

TABLE 1.—*Analyses of samples from the northern*

Semiquantitative spectrographic analyses

Sample No.	(ppm) Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co
							Ensawkwatch Creek drainage--Continued							
989	1,500	200	150	30	300	20	2	<2	<10	15	20	<5	<10	<5
990	1,500	<200	70	30	150	30	2	15	50	15	15	7	<10	7
991	1,500	<200	200	20	150	20	3	20	20	10	15	<5	<10	<5
992	1,500	<200	300	20	100	20	3	15	30	10	7	<5	<10	<5
							Silesia Creek drainage							
993	1,500	200	700	30	100	<20	3	100	70	30	15	<5	<10	5
994	>10,000	<200	1,500	500	>1,000	200	10	70	20	50	70	<5	<10	50
995	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
996	3,000	<200	700	150	200	<20	70	30	<10	<10	15	<5	<10	10
997	3,000	<200	1,000	100	100	<20	70	70	<10	<10	15	<5	<10	15
998	1,000	<200	70	15	150	<20	5	7	<10	10	15	10	<10	<5
999	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1000	3,000	<200	500	150	70	<20	30	50	70	15	10	<5	<10	7
1001	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1002	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1003	5,000	<200	700	100	50	<20	15	50	10	<10	10	<5	<10	<5
1004	1,500	<200	2,000	100	15	<20	30	3	20	10	100	<5	<10	15
1005	3,000	<200	1,000	150	150	<20	50	30	20	15	30	<5	<10	15
1006	1,500	200	2,000	100	15	<20	30	70	20	50	20	<5	<10	20
1007	2,000	200	2,000	100	70	<20	15	20	20	30	20	<5	<10	10
1008	3,000	200	2,000	200	70	<20	50	30	20	150	20	<5	<10	15
1009	3,000	<200	700	200	100	20	50	70	<10	<10	15	5	<10	15
1010	3,000	200	1,000	200	100	<20	20	300	300	150	15	<5	<10	30
1011	3,000	<200	1,500	100	150	<20	20	10	<10	200	15	<5	<10	15
1012	3,000	<200	1,500	100	200	<20	15	30	<10	150	15	<5	<10	20
1013	3,000	3,000	1,500	100	300	<20	30	30	30	100	15	<5	<10	30
1014	5,000	700	>5,000	100	100	<20	50	150	30	10	15	<5	<10	30
1015	5,000	1,000	2,000	150	100	<20	30	70	30	10	<10	15	<10	7
1016	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1017	3,000	<200	2,000	100	30	<20	30	150	<10	10	10	30	<10	15
1018	3,000	<200	700	70	300	20	20	10	<10	70	15	<5	<10	7
1019	3,000	<200	700	150	150	<20	15	70	<10	<10	15	<5	<10	15
1020	5,000	<200	700	150	150	<20	50	70	10	<10	15	<5	<10	20
1021	3,000	<200	150	150	50	<20	15	500	10	20	<5	100	<10	30
1022	3,000	<200	300	150	30	<20	7	200	10	30	5	300	<10	5
1023	3,000	<200	100	200	50	<20	15	150	10	300	<5	200	<10	15
1024	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1025	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1026	3,000	<200	1,000	150	70	<20	15	30	<10	<10	15	10	<10	10
1027	2,000	<200	300	100	70	<20	5	100	15	<10	10	100	<10	5
1028	3,000	<200	700	70	150	<20	2	100	<10	<10	15	7	<10	7
1029	3,000	<200	700	70	300	<20	2	100	<10	<10	15	7	<10	<5
1030	3,000	<200	500	70	300	<20	3	30	<10	<10	20	70	<10	7
1031	3,000	<200	700	70	150	<20	3	100	10	<10	15	30	<10	5
1032	5,000	<200	500	70	200	<20	3	15	<10	70	15	<5	<10	<5
1033	3,000	<200	200	100	70	<20	7	30	30	700	10	<5	<10	<5
1034	3,000	<200	700	100	100	<20	3	50	150	20	15	5	<10	15
1035	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1036	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1037	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
							Middle Fork of Silesia Creek drainage							
1038	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1039	7,000	<200	1,500	150	100	<20	50	70	50	20	30	<5	<10	30
1040	3,000	<200	700	150	50	<20	2	100	<10	<10	10	5	<10	<5
1041	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1042	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1043	3,000	<200	200	150	50	<20	7	150	20	<10	15	15	<10	5
1044	5,000	<200	700	150	100	<20	20	20	20	10	30	<5	<10	20
1045	7,000	<200	2,000	200	150	30	30	15	30	<10	30	<5	<10	5

part of the North Cascades National Park—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Ag	As	Cr	Ba	Chemical analyses (ppm) cxHM	cxCu	Au	Ag	Cu	Mo	Sample description 1/
											Ensawkwatch Creek drainage--Continued
989	<0.5	<200	5	700	---	---	0.02	---	---	---	Lim. sh. granodiorite.
990	.7	<200	5	3,000	---	---	<.02	---	---	---	Lim. sh. grd.; sc. py.
991	<.5	<200	<5	700	---	---	<.02	---	---	---	Lim. grd.; w/dk. dikes.
992	<.5	<200	<5	700	---	---	<.02	---	---	---	Lim. sh. granodiorite.
											Silesia Creek drainage
993	.5	<200	5	1,000	---	---	<.02	---	---	---	Lim. bi. grd.; qtz. veins.
994	<.5	<200	500	70	---	---	4.4	---	---	---	Panned concentrate.
995	---	---	---	---	15.0	5	---	---	---	3	Stream sediment.
996	<.5	<200	150	300	---	---	<.02	---	---	---	Lim. ark. and arg.
997	<.5	<200	200	300	---	---	<.02	---	---	---	Lim. qtz. diorite.
998	<.5	<200	<5	1,000	---	---	<.02	---	---	---	Lim. granodiorite.
999	---	---	---	---	3	1	---	---	---	10	Stream sediment.
1000	<.5	<200	100	700	---	---	<.02	---	---	---	Lim. vol. breccia.
1001	---	---	---	---	30	5	---	---	---	7	Stream sediment.
1002	---	---	---	---	7	1	---	---	---	5	Do.
1003	<.5	<200	70	1,000	---	---	<.02	---	---	---	Lim. ark. and arg.
1004	<.5	<200	30	5,000	---	---	<.02	---	---	---	Calcite vein.
1005	<.5	<200	700	500	---	---	<.02	---	---	---	Lim. bi. hbd. qtz. diorite.
1006	<.5	<200	20	500	---	---	<.02	---	---	---	Calcite vein.
1007	<.5	<200	7	700	---	---	<.02	---	---	---	Calcite vein in lim. qtz. di.
1008	<.5	<200	100	500	---	---	.04	---	---	---	Do.
1009	<.5	<200	150	700	---	---	<.02	---	---	---	Lim. bi. qtz. diorite.
1010	.5	700	20	500	---	---	<.02	---	---	---	Lim. qtz. di.
1011	<.5	<200	30	1,500	---	---	<.02	---	---	---	Do.
1012	<.5	<200	30	700	---	---	<.02	---	---	---	Do.
1013	<.5	<200	30	700	---	---	<.02	---	---	---	Lim. arkose.
1014	3	<200	200	2,000	---	---	<.02	---	---	---	Do.
1015	.7	<200	70	500	---	---	<.02	---	---	---	Lim. ark. and arg.
1016	---	---	---	---	15	5	---	---	---	5	Stream sediment.
1017	<.5	<200	150	700	---	---	<.02	---	---	---	Lim. arkose.
1018	<.5	<200	150	200	---	---	<.02	---	---	---	Lim. argillite.
1019	<.5	<200	30	200	---	---	<.02	---	---	---	Lim. sh. arkose; sc. py.
1020	<.5	<200	150	1,000	---	---	<.02	---	---	---	Do.
1021	<.5	<200	10	700	---	---	<.02	---	---	---	Lim. qtz. di.; w/py.
1022	<.5	<200	20	700	---	---	<.02	---	---	---	Lim. qtz. diorite.
1023	<.5	<200	15	700	---	---	<.02	---	---	---	Lim. qtz. di.; with py.
1024	---	---	---	---	15	50	---	---	---	---	Stream sediment.
1025	---	---	---	---	7	50	---	---	---	30	Do.
1026	<.5	<200	7	300	---	---	<.02	---	---	---	Lim. bi. qtz. diorite.
1027	<.5	<200	<5	700	---	---	.03	---	---	---	Lim. qtz. di., w/qtz. veins.
1028	<.5	<200	5	700	---	---	<.02	---	---	---	Lim. bi. qtz. diorite.
1029	<.5	<200	7	700	---	---	<.02	---	---	---	Do.
1030	<.5	<200	7	700	---	---	<.02	---	---	---	Do.
1031	<.5	<200	7	700	---	---	<.02	---	---	---	Lim. bi. hbd. qtz. di.
1032	<.5	<200	15	700	---	---	<.02	---	---	---	Lim. qtz. di.; sc. py.
1033	<.5	<200	15	700	---	---	<.02	---	---	---	Do.
1034	.7	<200	10	700	---	---	<.02	---	---	---	Do.
1035	---	---	---	---	2	1	---	---	---	50	Stream sediment.
1036	---	---	---	---	3	1	---	---	---	10	Do.
1037	---	---	---	---	---	---	<.05	0	0	---	Granodiorite.
											Middle Fork of Silesia Creek drainage
1038	---	---	---	---	2	1	---	---	---	7	Stream sediment.
1039	<.5	<200	70	700	---	---	.04	---	---	---	Lim. sh. diorite.
1040	<.5	<200	5	700	---	---	<.02	---	---	---	Lim. alaskite dike.
1041	---	---	---	---	---	---	0	<0.05	---	---	Quartz vein.
1042	---	---	---	---	---	---	0	<.05	---	---	Do.
1043	<.5	<200	15	700	---	---	<.02	---	---	---	Lim. plag. po. dike.
1044	<.5	<200	70	700	---	---	<.02	---	---	---	Lim. qtz. diorite.
1045	.7	<200	70	150	---	---	<.02	---	---	---	Do.

TABLE 1.—*Analyses of samples from the northern*

Semiquantitative spectrographic analyses

Sample No.	(ppm) Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co
						Middle Fork of Silesia Creek drainage--Continued								
1046	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1047	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1048	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1049	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
						West Fork of Silesia Creek drainage								
1050	>10,000	<200	1,500	300	>1,000	200	70	70	20	70	50	<5	<10	50
1051	>10,000	<200	2,000	100	>1,000	300	100	70	30	70	150	<5	<10	70
1052	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1053	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1054	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1055	3,000	<200	700	300	150	<20	70	30	<10	30	20	<5	<10	30
1056	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1057	1,500	<200	1,000	70	70	30	7	3	<10	<10	15	<5	<10	5
1058	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1059	2,000	<200	1,500	100	70	<20	70	30	<10	10	7	<5	<10	10
1060	1,000	<200	300	30	50	20	3	3	200	10	15	<5	<10	<5
1061	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1062	3,000	<200	300	70	200	20	50	30	20	<10	15	<5	<10	20
1063	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1064	>10,000	<200	3,000	300	>1,000	50	10	50	<10	30	70	<5	<10	70
1065	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
						Ruth Creek drainage								
1066	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1067	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1068	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1069	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1070	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1071	3,000	<200	500	100	150	20	70	200	10	70	20	<5	<10	10
						North Fork of Nooksack River drainage								
1072	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1073	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1074	3,000	<200	700	200	200	<20	70	100	10	70	20	<5	<10	20
1075	5,000	<200	700	300	300	20	70	150	20	100	30	<5	<10	30
1076	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1077	5,000	<200	700	300	300	<20	100	70	<10	70	30	<5	<10	30
1078	5,000	<200	700	300	300	<20	150	150	10	150	50	<5	<10	30
1079	5,000	<200	700	300	300	<20	200	100	15	70	30	<5	<10	30
1080	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1081	7,000	<200	700	200	200	<20	70	70	15	150	30	<5	<10	20
1082	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1083	3,000	<200	700	30	300	30	3	10	20	50	30	70	<10	<5
1084	7,000	300	1,500	150	300	<20	50	50	300	<10	70	10	<10	10
1085	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1086	3,000	<200	300	70	300	20	15	70	10	<10	20	5	<10	10
1087	3,000	<200	500	70	150	<20	20	70	10	<10	15	15	<10	10
1088	3,000	<200	300	70	150	30	10	30	70	<10	15	7	<10	7
1089	5,000	200	1,000	200	300	20	10	150	500	<10	50	30	<10	30
1090	7,000	<200	500	50	300	30	15	50	50	<10	20	<5	<10	10
1091	7,000	<200	700	150	200	<20	50	30	10	<10	15	<5	<10	30
1092	5,000	200	1,000	150	200	20	15	20	50	<10	20	<5	<10	5
1093	2,000	<200	300	30	200	30	<5	<5	70	<10	15	7	<10	<5

part of the North Cascades National Park—Continued

Sample	Semiquantitative spectrographic analyses--Continued (ppm) Ag	As	Cr	Ba	Chemical analyses (ppm) cxHM	cxCu	Au	Ag	Cu	Mo	Sample description [1]
											Middle Fork of Silesia Creek drainage--Continued
1046	---	---	---	---	3.0	1	---	---	---	10	Stream sediment.
1047	---	---	---	---	7	<1	---	---	---	5	Do.
1048	---	--	---	---	---	---	0	<0.05	0	---	Lim. vol. breccia.
1049	---	---	---	---	---	---	<0.05	<.05	<3	0	Lim. tuff; sc. pyrite.
											West Fork of Silesia Creek drainage
1050	<0.5	<200	2,000	200	---	---	.8	---	---	---	Panned concentrate.
1051	<.5	<200	5,000	200	---	---	3.4	---	---	---	Do.
1052	---	---	---	---	7	3	---	---	---	5	Stream sediment.
1053	---	---	---	---	10	1	---	---	---	5	Do.
1054	---	---	---	---	15	1	---	---	---	3	Do.
1055	<.5	<200	150	700	---	---	<.02	---	---	---	Limonitic argillite.
1056	---	---	---	---	20	1	---	---	---	5	Stream sediment.
1057	<.5	<200	<5	500	---	---	<.02	---	---	---	Lim. dacite.
1058	---	---	---	---	30	2	---	---	---	5	Stream sediment.
1059	<.5	<200	100	700	---	---	<.02	---	---	---	Lim. dacite and vol. brc.
1060	.7	<200	<5	700	---	---	<.02	---	---	---	Lim. sh. diorite.
1061	---	---	---	---	7	2	---	---	---	5	Stream sediment.
1062	<.5	<200	70	1,500	---	---	<.02	---	---	---	Gray dike, sc. py.
1063	---	---	---	---	1	2	---	---	---	20	Stream sediment.
1064	<.5	<200	1,000	50	---	---	<.04	---	---	---	Panned concentrate.
1065	---	---	---	---	.5	3	---	---	---	10	Stream sediment.
											Ruth Creek drainage
1066	---	---	---	---	2	1	---	---	---	7	Do.
1067	---	---	---	---	2	2	---	---	---	7	Do.
1068	---	---	---	---	10	1	---	---	---	3	Do.
1069	---	---	---	---	15	1	---	---	---	7	Do.
1070	---	---	---	---	7	1	---	---	---	10	Do.
1071	<.5	<200	150	300	---	---	<.02	---	---	---	Lim. phyllite; sc. py.
											North Fork of Nooksack River drainage
1072	---	---	---	---	2	7	---	---	---	7	Stream sediment.
1073	---	---	---	---	3	10	---	---	---	3	Lake sediment.
1074	<.5	<200	200	500	---	---	<.02	---	---	---	Limonitic phyllite.
1075	<.5	<200	200	700	---	---	<.02	---	---	---	Lim. phy.; sc. pyrh.
1076	---	---	---	---	7	7	---	---	---	2	Stream sediment.
1077	<.5	<200	200	700	---	---	<.02	---	---	---	Lim. phyllite, sc. py.
1078	<.5	<200	200	700	---	---	<.02	---	---	---	Limonitic phyllite.
1079	<.5	<200	700	700	---	---	<.02	---	---	---	Lim. phy.; sc. py.; pyrh.
1080	---	---	---	---	3	20	---	---	---	5	Stream sediment.
1081	<.5	<200	150	500	---	---	<.02	---	---	---	Lim. phy., sc. py., pyrh.
1082	---	---	---	---	2	7	---	---	---	---	Stream sediment.
1083	<.5	<200	5	1,000	---	---	<.02	---	---	---	Lim. granodiorite.
1084	<.5	<200	70	100	---	---	<.02	---	---	---	Do.
1085	---	---	---	---	3	1	---	---	---	7	Stream sediment.
1086	<.5	<200	30	1,000	---	---	<.02	---	---	---	Lim. hbd. granodiorite.
1087	<.5	<200	15	700	---	---	<.02	---	---	---	Lim. sh. hbd. grd.
1088	<.5	<200	7	700	---	---	<.02	---	---	---	Lim. hbd. granodiorite.
1089	7	<200	5	700	---	---	.02	---	---	---	Lim. incl. in grd.
1090	<.5	<200	20	700	---	---	<.02	---	---	---	Lim. sil. qtz. diorite.
1091	<.5	<200	100	700	---	---	<.02	---	---	---	Lim. dk. qtz. diorite.
1092	<.5	<200	50	500	---	---	<.02	---	---	---	Lim. qtz. di. breccia.
1093	<.5	<200	20	500	---	---	<.02	---	---	---	Lim. welded tuff.

TABLE 1.—*Analyses of samples from the northern*

Sample No.	Semiquantitative spectrographic analyses (ppm)													
	Ti	Zn	Mn	V	Zr	La	Ni	Cu	Pb	B	Y	Mo	Sn	Co
	White Salmon Creek drainage													
1094	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1095	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1096	-----	---	---	---	---	---	---	---	---	---	---	---	---	---
1097	-----	---	---	---	---	---	---	---	---	---	---	---	---	---

part of the North Cascades National Park—Continued

	Semiquantitative spectrographic analyses--Continued (ppm)				Chemical analyses (ppm)						
Sample	Ag	As	Cr	Ba	cxHM	cxCu	Au	Ag	Cu	Mo	Sample description 1/
					White Salmon Creek drainage						
1094	---	---	---	---	7.0	10	---	---	---	5	Stream sediment.
1095	---	---	---	---	7	1	---	---	---	3	Do.
1096	---	---	---	---	7	3	---	---	---	3	Do.
1097	---	---	---	---	3	2	---	---	---	2	Do.

1/ Abbreviations used in Tables:

abund	abundant	feld	feldspar	po	porphyry
arg	argillite	FeOst	iron oxide-stained	py	pyrite or pyritic
ark	arkose	fg	fine-grained	pyrh	pyrrhotite
bi	biotite	gar	garnet	qtz	quartz
bld	bleached	gn	gneiss or gneissic	sc	scattered
brc	breccia or brecciated	grd	granodiorite	sch	schist
cgl	conglomerate	hbd	hornblende	ser	sericite
chl	chlorite	incl	inclusion	sh	sheared
chp	chalcopyrite	kaol	kaolinized	sil	silicified
chrys	chrysocolla	lim	limonite or limonitic	sul	sulfides
di	diorite	mo	molybdenite	tour	tourmaline
dk	dark	phy	phyllite	vol	volcanic
ep	epidote	plag	plagioclase	w/	with

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