UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

MINERAL RESOURCE POTENTIAL OF THE GLACIER VIEW ROADLESS AREA, PIERCE COUNTY, WASHINGTON

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STUDIES RELATED TO WILDERNESS

Under the provisions of the Wilderness Act (Public Law 88-577, September 3, 1964) and related acts, the U.S. Geological Survey and the U.S. Bureau of Mines have been conducting mineral surveys of wilderness and primitive areas. Areas officially designated as "wilderness," "wild," or "canoe" when the act was passed were incorporated into the National Wilderness Preservation System, and some of them are presently being studied. The act provided that areas under consideration for wilderness designation should be studied for suitability for incorporation into the Wilderness System. The mineral surveys constitute one aspect of the suitability studies. The act directs that the results of such surveys are to be made available to the public and be submitted to the President and the Congress. This report discusses the results of a mineral survey of the Glacier View Roadless Area (A6061), Mount Baker-Snoqualmie National Forest, Pierce County, Washington. The Glacier View Roadless Area was classified as a further planning area during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

SUMMARY

The results of geological, geochemical, and mining activity surveys in the Glacier View Roadless Area revealed no evidence of a potential for metallic and nonmetallic mineral resources in the area. Coal exposed to the west of the roadless area is impure and occurs in faulted beds that dip too steeply for low-cost mechanical mining. No coal is exposed inside the roadless area. Although nearly half the area is covered by recent oil and gas leases, there is no record of past exploration, and the resource potential for these commodities remains unknown.

INTRODUCTION

The Glacier View Roadless Area (A6061) comprises 4.7 mi^2 within Mount Baker-Snoqualmie National Forest on the western slope of the Cascade Range, about 38 mi southeast of Tacoma, Wash. (fig. 1). It is bounded on the east by Mount Rainier National Park. The summit of Glacier View, in the northwestern corner of the roadless area, is the highest point, at 5,450 ft above sea level; the lowest point, 3,320 ft above sea level, is along the northern boundary about 1.5 mi east of Glacier View. Access to the roadless area is from the southwest via Forest Service Road 59, a graded gravel road that joins Washington State Highway 706 approximately 3 mi east of Ashford (fig. 3). Mountainous terrain, a dendritic drainage pattern, and heavy vegetative cover of subalpine Canadian-zone trees and scrubs characterize the Glacier View area. The forest is locally interrupted by lakes, grassy meadows, and swamps, and the higher peaks are usually barren. Temperatures range from subzero in January to 80° F. in July. Average annual rainfall is approximately 140 in. On May 18, 1980, the area received up to 0.25 in. of fine ash from the eruption of Mount St. Helens, about 45 mi to the southwest (Rigby, 1980).

The only previous geologic mapping within the Glacier View Roadless Area is unpublished reconnaissance work by Hammond (1960). However, the geology of Mt. Rainier National Park immediately to the east was mapped by Fiske and others (1963) and the region to the west and south was mapped by Fisher (1961). Reports dealing with the coal resources of the region were published by Willis (1898), Daniels (1914), and Beikman and others (1961). For the present study, the U.S. Geological Survey conducted geologic mapping and geochemical stream-sediment and bedrock sampling in and adjacent to the roadless area during July and August 1980. The U.S. Bureau of Mines, Western Field Operations Center, reviewed Pierce County and Bureau of Land Management records and other available data concerning mineral deposits, claims, leases, production, and mining activity in the area. Bureau of Mines personnel conducted a field survey in 1982 to locate mining claims, prospects, and mineralized zones, and collected coal samples for analysis.

GEOLOGY

The Glacier View Roadless Area (fig. 2) is underlain chiefly by east-dipping sedimentary and volcanic rocks of the Eocene Ohanapecosh Formation (Fiske and others, 1963) forming the eastern limb of the Christine anticline of Hammond (1980). Near the western boundary of the roadless area, the Ohanapecosh Formation conformably overlies sedimentary rocks of the upper(?) Eocene Spiketon Formation (Gard, 1968; Buckovic, 1979). Both the Spiketon and Ohanapecosh Formations are intruded by widespread mafic dikes and sills; a larger more complex intrusion of granodioritic composition occurs within the Ohanapecosh in the northern part of the roadless area. Although no major faults have been recognized in the Glacier View area, the rocks are cut by numerous minor faults, which makes tracing of individual beds difficult.

In the map area, the Spiketon Formation consists of light-gray to brown nonmarine micaceous arkosic sandstone interstratified with siltstone, mudstone, carbonaceous shale, and coal. In the Glacier View Roadless Area, the sandstone varies from thinly bedded or laminated fine-grained beds to thick-bedded massive or crossbedded medium- to coarse-grained units. The sandstone beds are typically well sorted and consist of angular to well-rounded grains of quartz, plagioclase, minor potassium feldspar, detrital muscovite and biotite, opaque minerals, and various types of lithic clasts, the most common of which are chert, quartzite, and granitic rocks. Calcite and clay minerals are the dominant cement components. Finer grained beds in the Spiketon are typically somewhat carbonaceous and, with increasing organic content, grade into shaly coal. The coaly beds are a very minor constituent of the Spiketon Formation in the Glacier View area and are rarely more than 6 in. thick. The Spiketon Formation was interpreted by Buckovic (1979) as part of a large Mississippi-type deltaic system that extended westward from a broad granitic highland during late Eocene time. Plant fossils collected from the Spiketon approximately 1.5 mi west of Lake Christine are of probable late Eocene age (Fisher, 1961).

Along the western boundary of the Glacier View Roadless Area the Spiketon Formation grades upward, over a 400-ft stratigraphic interval, into volcanogenic rocks of the Ohanapecosh Formation (fig. 2). The Ohanapecosh consists predominantly of a wide variety of andesitic and silicic volcaniclastic rocks. Local accumulations of lava flows and coarse laharic breccias such as that of Mount Wow, immediately east of the Glacier View area, evidently represent isolated volcanic centers within the Ohanapecosh depositional basin (Fiske and others, 1963). Approximately 3,000 ft of Ohanapecosh strata are exposed in the roadless area; the most common rock types are light-grayish-green to dark-green well-bedded sandstone, tuff, conglomerate, and massive well-indurated poorly sorted tuff breccia. Thick beds (up to 100 ft) of coarse conglomerate are especially resistant to erosion and form the prominent topographic features of Mt. Beljica, Glacier View, and the north-trending ridge east of Lake Christine. The clasts of these units are generally well rounded boulders and cobbles of porphyritic andesite, dacite, basalt, and diabase; wood fragments occur locally. Ohanapecosh sandstone and siltstone, like the conglomerate, are virtually entirely derived from volcanic rocks, and consist of grains of plagioclase, pyroxene, magnetite, occasional hornblende, abundant volcanic lithic framgents, but little or no quartz or mica. Pumiceous pyroclastic rocks are subordinate to epiclastic strata in the roadless area, but are generally more common at higher stratigraphic levels in the eastern part of the area. Lava flows are rare in the Glacier View area; the most extensive, a thick canyon-filling flow of two-pyroxene andesite, underlies the peak just southwest of Lake Christine. Much of the volcanic material is metamorphosed to low-grade zeolite-facies assemblages dominated by smectitic clay minerals, chlorite, calcite, and laumontite. Although no fossils were found in the Glacier View Roadless Area during this study, fossils elsewhere suggest a late Eocene age for the lower part of the Ohanapecosh Formation (Fiske and others, 1963) which records initiation of the Cascade volcanic arc along the continental margin of Washington.

Two groups of intrusive rocks are present in the Glacier View area: fine-grained mafic rocks and medium-grained felsic rocks. These groups are correlative with similar rocks mapped in Mount Rainier National Park by Fiske and others (1963). Mafic rocks equivalent to the "pre-Tatoosh intrusions" of Fiske and others (1963) are widespread in the Glacier View Roadless Area as small hypabyssal dikes and sills. Most are too small to portray on the geologic map (fig. 2), but a relatively large composite sill has intruded the Spiketon-Ohanapecosh contact near the western boundary of the study area, and a north-northwest-trending dike swarm centered on Mount Wow extends into the northern part of the area. These rocks include porphyritic basalt, diabase, and quartz diabase consisting of plagioclase, augite, and iron-titanium oxide minerals accompanied by variable amounts of hypensthene, quartz, and rare minor potassium feldspar. The rocks are generally moderately to extensively recrystallized to secondary assemblages similar to those in the Ohanapecosh host rocks.

A large plutonic body in the northern part of the Glacier View Roadless Area (fig. 2) displays affinities with the Miocene Tatoosh pluton in Mount Rainer National Park described by Fiske and others (1963) and Mattinson (1977). The pluton is a complex composite intrusion that varies from pyroxene quartz diorite to quartz monzonite in composition; the average composition is probably granodiorite. Rock textures vary from hypidiomorphic to porphyritic, with phenocrysts of plagioclase, augite, and hypersthene in a groundmass of granophyrically to spherulitically intergrown quartz and potassium feldspar. Minor brown hornblende occurs locally, but biotite is absent. The intrusion is poorly exposed and the contacts shown on the geologic map (fig. 2) are only very approximately located. Scattered outcrops along the western margin of the body, however, demonstrate complex relationships, with dikes of diverse granitic rocks alternating with screens of the Ohanapecosh Formation recrystallized to albite-epidote or hornblende hornfels. The intrusive body is perhaps more aptly described as a dike and sill complex typical of the roof zones of the Tatoosh pluton (Fiske and others, 1963). Pervasive deuteric alteration has yielded saussuritized feldspar, uralitized or chloritized pyroxenes, and sporadic calcite. Traces of pyrite and (or) limonite are widespread and more intense pyrite+sericite alteration was encountered near the southern margin of the body.

The Glacier View area was extensively glaciated during Pleistocene time, and the present topography is largely attributable to the Fraser Glaciation of late Pleistocene age (Crandell and Miller, 1974). Thick glacial deposits mantle most lower areas and much of the present stream debris is reworked till.

About 3,500 to 4,000 years ago, a major eruption of Mount St. Helens blanketed the Glacier View area with approximately 1 ft of pumice lapilli and ash (Mullineaux and others, 1975). Material from this event is abundant in surficial deposits of the area.

GEOCHEMISTRY

As an integral part of the mineral resource appraisal of the Glacier View Roadless Area, a geochemical reconnaissance of the area was undertaken. Stream-sediment samples constituted the primary medium and were supplemented by rock sampling in altered areas. Sample localities are shown in figure 2. A total of 11 stream-sediment and 7 rock samples were collected.

Stream-sediment samples were collected from active streams draining areas as large as 4 mi^2. Sediment samples were air dried and sent to the laboratory for analysis. In the laboratory, the stream sediments were sieved through an 80-mesh (177-micron) stainless steel sieve and the minus-80-mesh fraction was ground for spectrographic analysis. Rock samples were pulverised and a three ounce split was ground for analysis.

Analytical methods

Analytical results for this study were obtained using direct-current emission spectrometry. The analytical data from the stream-sediment and rock samples were obtained by visual comparison of spectra derived from the unknown sample against spectra obtained from standards made from pure oxides or carbonates (Grimes and Marranzino, 1968). The concentrations of up to 31 elements are rountinely determined. The concentrations of standard samples are geometrically spaced over any given order of magnitude of concentration and are prepared in such a way that the range of concentrations normally found in naturally occurring samples are bracketed. When comparisons are made with sample films for semiquantitative use, reported values are rounded to 100, 50, 20, 10, and so forth. Those samples whose concentrations are estimated to fall between the above values are arbitrarily given values of 70, 30, 15, 7, and so forth. The precision of the method is approximately plus or minus one reporting unit at the 83-percent confidence level and plus or minus two reporting units at the 96-percent confidence level (Motooka and Grimes, 1976). Values determined for the major elements (calcium, iron, magnesium, and titanium) are given in weight percent; all others are given in parts per million. Table 1 gives the limits of determination for all elements.

Results

Results of analytical work on the stream sediments and bedrock samples are given in tables 2 and 3, respectively. In order to evaluate these data, information is needed regarding threshold (lowest anomalous) values for each element in rock units cropping out in the study area. Table 4 shows mean and threshold values calculated from analyses of a suite of rocks collected from the Ohanapecosh Formation in the Tatoosh Roadless Area and Goat Rocks Wilderness (fig 1; Evarts and others, 1983; Church and others, 1983) as well as from Glacier View Roadless Area. Threshold values have been calculated from these data using the formula: threshold value equals the mean plus two times the standard deviation (Hawkes and Webb, 1962, p. 30). Contributions to the stream-sediment values are also made by the mafic dikes that intrude the Ohanapecosh in this area (fig. 2; Fiske and others, 1963). The only analysis of these dikes available is sample number GV 14 in table 3.

Stream-sediment data for all elements are below the defined threshold values except for boron in sample G06 and for nickel in samples G07, G09, G32, and G33 (fig. 2, table 2). The high boron value from the northern part of the roadless area probably reflects the presence of tourmaline in the underlying plutonic bedrock. Tourmaline is a widespread, though generally minor, secondary mineral in the Tatoosh pluton and affiliated rocks (Fiske and others, 1963, p. 45-46).

The anomalous nickel values in stream-sediment samples G07, G09, G32, and G33 are not indicative of nickel mineralization, but rather reflect the occurrence of mafic igneous rocks in the drainage basins sampled. The nickel in samples G07, G09, and G33 is attributable to the basalt dike swarm of the Mount Wow-Gobblers Knob area (fig. 2). The other anomalous sample, G32, is in the same drainage basin as GV15 (table 2), a lava flow that exhibits the highest nickel value of any rock analyzed. Mafic rocks are a minor component of the Ohanapecosh Formation (Fiske and others, 1963), and are evidently somewhat more abundant in the Glacier View area than in the other areas sampled for background geochemistry (table 3).

MINING ACTIVITY

The Coal Creek and Copper Creek mining districts lie mainly west of, but extend into, the Glacier View Roadless Area. Mining district boundaries are vague and were inferred from mining claim records at the Pierce County Auditor's office in Tacoma, Wash. The mining claim records indicate that prospecting for coal began in 1905 and lasted until 1907, during which time six claims were located inside the roadless area boundary. There is no record of production from these claims. A foot search to locate these claims, based on vague descriptions in county records, was unsuccessful.

About 1,000 tons of coal were produced in 1909 from the Mashell mine, 6 mi west of the roadless area. The mine is in the Ashford coal field, which covers about 40 mi^2 immediately west of the roadless area (Huntting, 1960, v. 1, p. 31, and v. 2, plate 9). Daniels (1914, p. 67) suggests that production from the Mashell mine may have been much higher, despite the lack of other records. Two coal prospects in the Ashford Coal Field, the H. O. Lamming claim and Floyd Rice claim (fig. 3), are within 0.5 mi of the roadless area and were examined during this study. No workings were observed; however, two coal beds in the upper(?) Eocene Spiketon Formation are exposed at the Rice claim, and one at the Lamming claim. The coal beds, near the eastern edge of the Ashford coal field, strike N. 21° W. to N. 5° E. and dip 25° NE. to 45° SE. The coal seams range from 3 to 5 ft thick and are traceable for up to 110 ft along strike. Five samples from these prospects were analyzed for heat values and sulfur, moisture, fixed carbon and ash contents. The results (table 5) indicate that the coal is impure and has a low average heat value of 2,767 BTU per pound.

The Fairfax-Montezuma coal area lies about 20 mi north of the roadless area in the Puyallup mining district; coal production from that area began prior to 1909, lasted until 1957, and totaled approximately 700,000 tons (Beikman and others, 1961, p. 79-85).

Prospecting activity for gold and silver began in the late 1800's in the Tahoma mining district adjoining the east boundary of the study area, but there is no known production.

Trinity Resources of Houston, Texas, on March 1, 1982 leased 1,404.35 acres inside and 1,020.6 acres adjacent to the roadless area (fig. 3) for oil and gas (Paul Priggy, U.S. Forest Service, Vancouver, Washington, oral commun., 1982). Trinity Resources considers their lease a long term project and does not foresee any exploration activity until at least 1986 (Jerry Bembary, Trinity Resources of Houston, Texas, oral commun., 1982).

MINERAL RESOURCE POTENTIAL

Geologic and geochemical studies and a survey of mining activity in the Glacier View Roadless Area produced no evidence of resource potential for metallic or non-metallic minerals in the area. There are no zones of mineralized rock nor any geochemical anomalies attributable to mineralization. Pierce County records show that six coal claims were located in the roadless area between 1905 and 1907; however, no coal was found at the described locations or anywhere else inside the roadless area.

Two coal prospects, the H. O. Lamming claim and the Floyd Rice claim, are within 0.5 mi of the western boundary of the of the Glacier View Roadless Area. At these prospects, beds of impure bituminous coal strike approximately north and dip steeply east toward the roadless area. Analyses of coal samples from the prospects indicate that the heat value is low (table 5). Furthermore, recovery by conventional coal mining techniques would be difficult due to ubiquitous minor faulting. Trinity Resources of Houston, Texas has leased approximately 2,425 acres inside and adjacent to the roadless area for oil and gas exploration. The geology is permissive for the occurrence of oil and gas, but no wells are known to have been drilled in the vicinity, and the resource potential is unknown.

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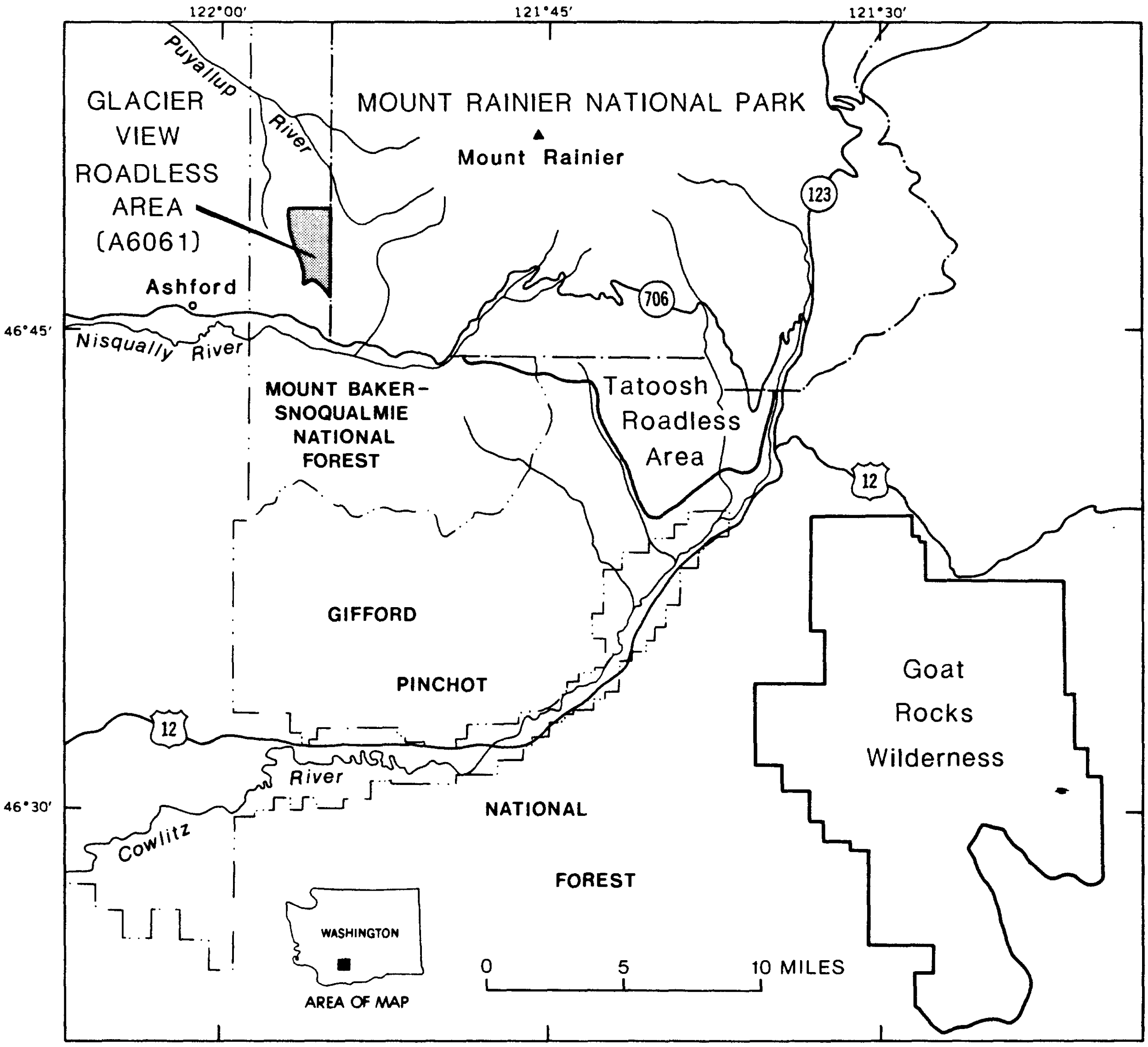

Figure 1.--Location of Glacier View Roadless Area (A6061), western Cascade Range, Pierce County, Washington.

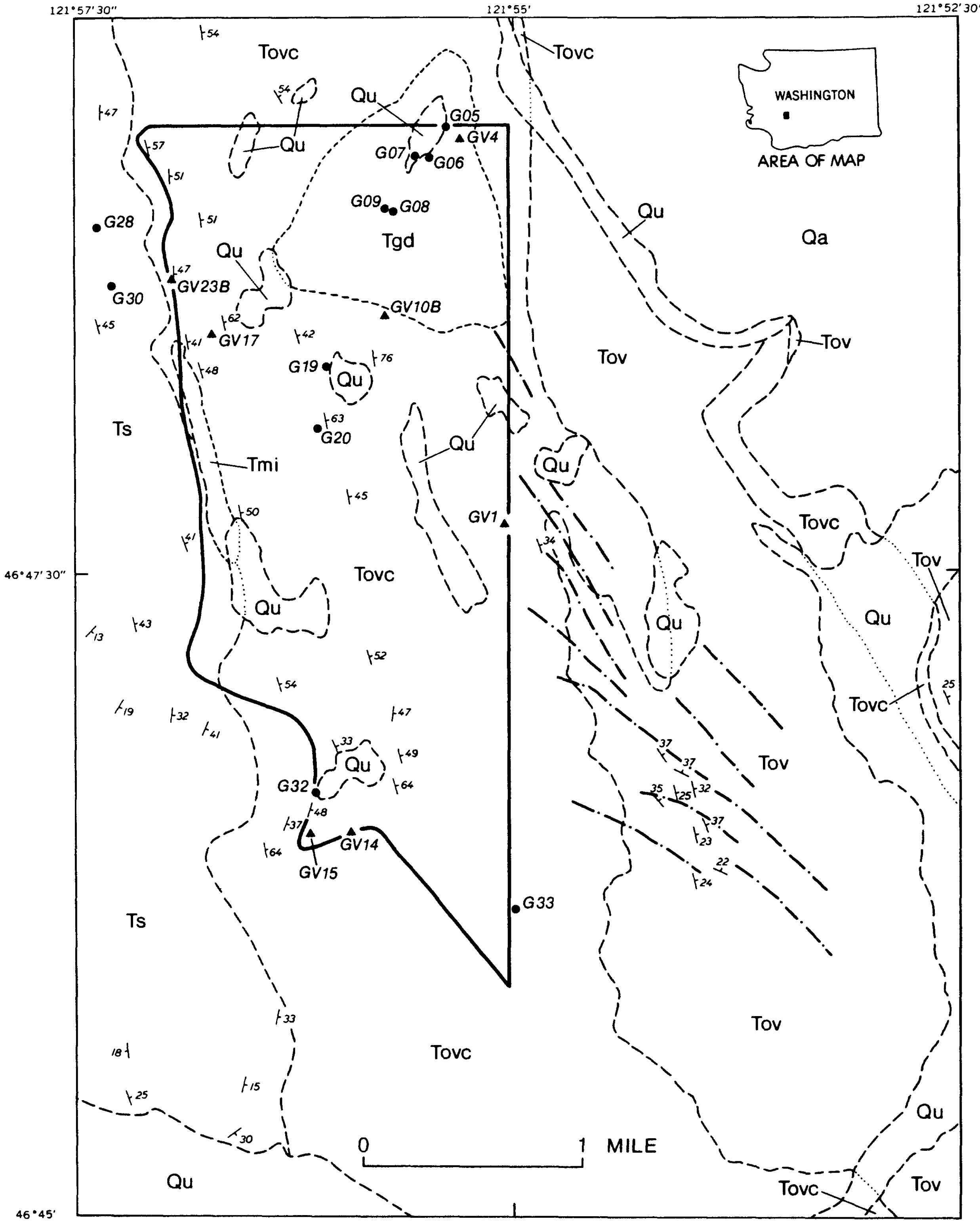

Figure 2.--Geologic map of part of the Mount Wow 7-1/2' quadrangle and Glacier View Roadless Area (A6061), Washington. Geology modified from Fiske and others (1963), Fisher (1961), and Hammond (1960). Rock and stream-sediment sample locations shown. (See following page for explanation).

EXPLANATION FOR FIGURE 2

CORRELATION OF MAP UNITS

Surficial deposits	Qu	Holocene and Pleistocene	QUATERNARY
Rocks of Mount Rainier volcano	Qa	Holocene and Pleistocene	QUATERNARY
Intrusive rocks	Tgd	Miocene	TERTIARY
	Tmi	Miocene or Oligocene	TERTIARY
Sedimentary and volcanic rocks	Tovc, Tov	Eocene	TERTIARY
	Ts	Eocene	TERTIARY

DESCRIPTION OF MAP UNITS

Surficial deposits

Qu — ALLUVIAL, GLACIAL AND MUDFLOW DEPOSITS, UNDIVIDED (HOLOCENE AND PLEISTOCENE)--Alluvium and glacial deposits, and mudflow deposits in the South Puyallup, Tahoma, and Nisqually River drainages

Rocks of Mount Rainier volcano

Qa — ANDESITE (HOLOCENE AND PLEISTOCENE)--Chiefly hypersthene-augite andesite flows and associated laharic breccias

Intrusive rocks

Tgd — GRANODIORITE, QUARTZ DIORITE, AND QUARTZ MONZONITE (MIOCENE)--Medium-grained porphyritic to equigranular plutonic rocks forming a complex intrusive body in northern part of roadless area; identical to some phases of the Tatoosh pluton (Fiske and others, 1963) to the east

Tmi — MAFIC INTRUSIVE ROCKS (MIOCENE OR OLIGOCENE)--Augite and hypersthene-augite diabase, quartz diabase and diorite in sill northwest of Beljica Meadows and dike swarm in Mount Wow-Gobblers Knob area; equivalent to "pre-Tatoosh intrusive rocks" of Fiske and others, (1963); numerous small and poorly exposed dikes and sills not shown

Sedimentary and volcanic rocks

OHANAPECOSH FORMATION (EOCENE)--In this area, divided into:

Tovc — Volcaniclastic rocks--Rocks of diverse origin including epiclastic conglomerate, sandstone, and siltstone, pyroclastic tuff and breccia, and laharic breccia; includes minor andesite lava flows

Tov — Volcanic rocks--Thick accumulations of andesitic lava flows and coarse laharic breccia on Mount Wow

Ts — SPIKETON FORMATION (EOCENE)--Micaceous arkosic sandstone, siltstone, mudstone, carbonaceous shale, and coal

CONTACT--Dashed where approximately located, short dashed where gradational or inferred; dotted where concealed

33 — STRIKE AND DIP OF BEDDING

MAFIC DIKE SWARM OF MOUNT WOW

● G32 — STREAM-SEDIMENT SAMPLE LOCATION AND NUMBER

▲ GV15 — ROCK SAMPLE LOCATION AND NUMBER

APPROXIMATE BOUNDARY OF ROADLESS AREA

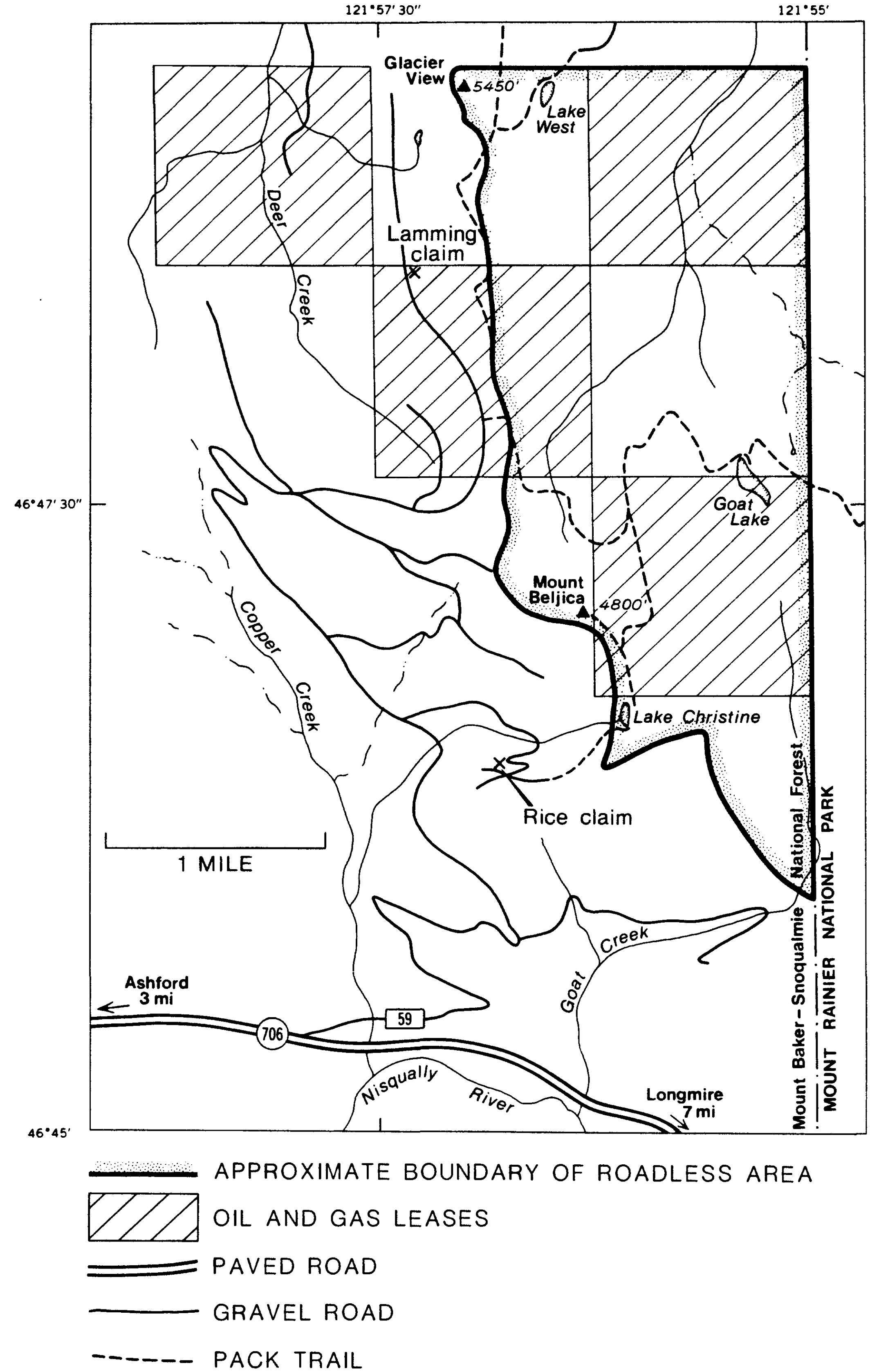

Figure 3.--Location map of coal prospects (claims) and oil and gas leases in and near Glacier View Roadless Area, Washington.

Table 1.--Lower limits of analytical determination for rock, stream-sediment and stream-sediment concentrate samples from Glacier View Roadless Area
[Limits of determination of elements are in parts per million (ppm) except where noted. All analyses are by spectrographic methods; --, not analyzed]

Element	Determination limit rocks	Determination limit stream sediments	Determination limit stream sediment concentrates
Calcium (Ca)	0.05 percent	0.05 percent	0.1 percent
Iron (Fe)	.05 percent	.05 percent	.1 percent
Magnesium (Mg)	.02 percent	.02 percent	.05 percent
Titanium (Ti)	.002 percent	.002 percent	.005 percent
Silver (Ag)	.5	--	1
Arsenic (As)	200	--	500
Gold (Au)	--	--	20
Boron (B)	10	10	20
Barium (Ba)	20	20	50
Beryllium (Be)	1	1	2
Bismuth (Bi)	10	--	20
Cobalt (Co)	5	5	10
Chromium (Cr)	10	10	20
Copper (Cu)	5	5	10
Lanthanum (La)	20	--	50
Manganese (Mn)	10	10	20
Molybdenum (Mo)	5	--	10
Niobium (Nb)	20	--	50
Nickel (Ni)	5	5	10
Lead (Pb)	10	10	20
Scandium (Sc)	5	5	10
Tin (Sn)	10	--	20
Strontium (Sr)	100	100	200
Vanadium (V)	10	10	20
Tungsten (W)	50	--	100
Yttrium (Y)	10	10	20
Zinc (Zn)	200	--	--
Zirconium (Zr)	10	10	20

Table 2.--Results of spectrographic analyses of stream sediments from Glacier View Roadless Area. See table 1 for element names
[N, not detected; pct, percent; ppm, parts per million]

Sample number (see fig 2)	Latitude	Longitude	Ca-pct	Fe-pct	Mg-pct	Ti-pct	B-ppm	Ba-ppm	Be-ppm	Co-ppm	Cr-ppm
G05	46°49'15"	121°55'20"	1.5	5	1.0	.3	10	200	1.5	15	70
G06	46°49'07"	121°55'26"	1.0	5	1.0	.5	100	300	1.5	20	70
G07	46°49'08"	121°55'31"	1.5	7	1.5	.5	20	300	1.5	20	70
G08	46°48'54"	121°55'41"	2.0	5	1.5	.5	15	300	1.5	20	70
G09	46°48'54"	121°55'45"	2.0	7	2.0	.5	20	300	1.5	30	100
G19	46°48'17"	121°56'02"	1.0	5	1.0	.5	20	200	1.5	15	50
G20	46°48'04"	121°56'04"	1.5	5	1.0	.5	20	200	1.5	20	50
G28	46°48'52"	121°57'19"	.5	2	.5	.2	30	200	1.5	N	20
G30	46°48'36"	121°57'16"	.5	5	.7	.3	20	200	1.5	10	30
G32	46°46'38"	121°56'08"	2.0	7	2.0	.7	10	200	1.5	30	100
G33	46°46'13"	121°55'01"	1.0	7	1.5	.5	20	200	1.5	20	50

Sample number (see fig. 2)	Cu-ppm	Mn-ppm	Ni-ppm	Pb-ppm	Sc-ppm	Sr-ppm	V-ppm	Y-ppm	Zr-ppm
G05	20	1,000	20	10	10	300	100	20	100
G06	50	2,000	30	10	15	300	100	20	100
G07	50	1,500	50	10	15	500	150	20	150
G08	20	2,000	30	15	10	500	100	20	100
G09	70	1,000	50	15	20	500	150	20	100
G19	50	700	20	10	15	300	100	20	100
G20	50	1,000	20	10	15	300	150	20	100
G28	20	700	10	15	7	100	70	20	100
G30	70	500	20	15	15	200	100	30	150
G32	30	1,500	50	15	20	500	150	20	100
G33	100	1,500	50	15	20	200	150	30	100

Elements not detected in any samples: Ag, As, Au, Bi, Cd, Mo, Ni, Pb, Sb, Sn, Th, W, Zn

Table 3.--Results of spectrographic analyses of rock samples from Glacier View Roadless Area. See table 1 for element names
[N, not detected; pct, percent; ppm, parts per million]

Sample number (see fig. 2)	Latitude	Longitude	Ca-pct	Fe-pct	Mg-pct	Ti-pct	B-ppm	Ba-ppm	Be-ppm	Co-ppm	Cr-ppm
GV1	46°47'43"	121°55'02"	0.5	5	1.0	0.5	30	200	2.0	10	15
GV4	46°49'12"	121°55'17"	1.5	5	1.5	.5	15	500	2.0	15	50
GV10B	46°48'29"	121°55'42"	.3	2	.5	.2	30	700	2.0	7	N
GV14	46°46'32"	121°56'01"	2.0	7	2.0	1.0	10	200	1.0	20	15
GV15	46°46'31"	121°56'09"	2.0	7	2.0	.7	15	200	1.5	30	30
GB17	46°48'28"	121°56'38"	3.0	7	2.0	.7	10	50	N	30	10
GV23B	46°48'58"	121°56'45"	2.0	5	2.0	.7	20	30	1.5	30	50

Sample number (see fig. 2)	Cu-ppm	La-ppm	Mn-ppm	Ni-ppm	Sc-ppm	Sr-ppm	V-ppm	Y-ppm	Zr-ppm
GV1	50	N	1,000	5	15	150	70	30	150
GV4	5	20	700	20	10	200	100	30	200
GV10B	50	N	150	10	10	200	50	30	150
GV14	100	N	1,500	10	20	200	200	30	100
GV15	100	N	1,000	30	20	300	150	30	150
GV17	150	N	1,000	15	20	200	200	20	70
GV23B	150	N	1,000	20	20	200	150	20	100

Elements not detected in any samples: Ag, As, Au, Bi, Cd, Mo, Nb, Pb, Sb, Sn, Th, W, Zn.

Table 4.--Mean, standard deviation, and threshold values for elements determined from a suite of typical rocks of the Ohanapecosh Formation*
[pct, percent; ppm, parts per million]

	Ca-pct	Fe-pct	Mg-pct	Ti-pct	B-ppm	Ba-ppm	Be-pppm	Co-ppm	Cr-ppm
Mean	1.93	5.93	1.15	0.53	22	410	1.8	20	34
Standard Deviation	±1.32	±2.31	±0.65	±0.28	±24	±370	±0.7	±13	±50
Threshold value	4.57	10.55	2.45	1.09	70	1,150	3.2	4	134

	Cu-ppm	Mn-ppm	Ni-ppm	Pb-ppm	Sc-ppm	Sr-ppm	V-ppm	Y-ppm	Zr-ppm
Mean	66	1,150	13	19	19	220	95	34	148
Standard Deviation	±49	±540	±12	±18	±10	±100	±67	±13	±60
Threshold value	164	2,230	37	55	70	420	229	60	268

*number of samples =15; see text for sources

See table 1 for element names

Table 5.--Analyses of coal samples from the Floyd Rice and H. O. Lamming claims [N/A, not applicable]

Claim (see fig. 3 for location)	Sample: Chip no.	Sample: Length, in feet	Across bed condition	Proximate analysis (percent): Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Ultimate analysis (percent): Total carbon	Nitrogen	Oxygen	Sulfur	Heating value (Btu per lb)
Lamming	1	5	As received	17.36	15.39	18.10	49.15	3.59	21.16	0.75	25.15	0.20	3,320
			Moisture-free	N/A	18.63	21.90	59.47	2.01	25.61	.90	11.77	.24	4,017
			Moisture-and ash-free	N/A	45.96	54.04	N/A	4.96	63.19	.23	29.03	.59	9,913
	2	5	As received	11.41	18.39	29.98	40.22	3.18	35.24	.75	20.38	.23	5,300
			Moisture-free	N/A	20.76	33.84	45.40	2.16	39.78	.85	11.56	.26	5,983
			Moisture-and ash-free	N/A	38.03	61.97	N/A	3.95	72.85	1.56	21.16	.48	10,958
Rice	3	2.8	As received	5.29	6.10	7.23	81.38	2.13	8.30	.56	7.52	.10	865
			Moisture-free	N/A	6.44	7.63	85.93	1.63	8.77	.59	2.98	.10	913
			Moisture-and ash-free	N/A	45.75	54.25	N/A	11.58	62.31	4.21	21.18	.71	6,488
	4	2.8	As received	6.56	7.69	26.39	59.36	1.29	24.16	.85	13.58	.14	3,386
			Moisture-free	N/A	8.23	28.25	63.52	1.27	25.86	.91	8.29	.15	3,624
			Moisture-and ash-free	N/A	22.55	63.52	N/A	3.48	70.90	2.49	22.72	.41	9,936
	5	3.4	As received	8.11	9.49	6.27	76.13	1.51	9.07	.45	12.76	.08	962
			Moisture-free	N/A	10.33	6.82	82.85	.66	9.87	.48	6.04	.09	1,047
			Moisture-and ash-free	N/A	60.21	39.79	N/A	3.85	57.56	2.83	35.23	.53	6,104