UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Geology and mineral resource potential map of the Mount Washington Wilderness, Deschutes, Lane, and Linn Counties, Oregon

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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 Mount Washington Wilderness (NF086), Deschutes and Willamette National Forests, Deschutes, Lane, and Linn Counties, Oregon. The Mount Washington Wilderness was established by Public Law 88-577, September 3, 1964.

SUMMARY

The Mount Washington Wilderness is devoid of mines, claims, and mineral prospects. The results of this survey further indicate that the area does not contain any metallic-mineral deposits or mineral fuels. Over 200 million yd^3 of cinder resources occur in the wilderness, but no future demand for the deposits is anticipated owing to numerous other nearby sources. The area may have geothermal resources, but available data are insufficient to define either their existence or magnitude.

INTRODUCTION

The Mount Washington Wilderness (fig. 1) encompasses 46,655 acres (73 mi^2) along the crest of the Cascade Range, between McKenzie and Santiam Passes, in the Deschutes and Willamette National Forests, 32 mi northwest of Bend, Oregon.

The mineral resource potential survey of the Mount Washington Wilderness included geologic mapping, a geochemical survey of stream-sediment samples, and gravity and aeromagnetic surveys by the U.S. Geological Survey. The U.S. Bureau of Mines was responsible for analysis and evaluation of identified mineral resources in the wilderness.

Large scale geologic maps of the Mount Washington Wilderness have not been published previously, although the geology of parts of the wilderness is presented by Taylor (1968, 1981) and most of the area in theses by Brown (1941) and Taylor (1967). Reconnaissance geologic maps of the central part of the Cascade Range by Williams (1957) and of Deschutes County by Peterson and others (1976) include the area. Regional gravity anomaly and aeromagnetic maps, which cover the Mount Washington Wilderness, have been published by Pitts and Couch (1978), Couch and others (1981), and U.S. Geological Survey (1982). Results of geothermal gradient drilling immediately west of the wilderness are discussed by Youngquist (1980).

LOCATION AND GEOGRAPHY

The Mount Washington Wilderness is the smallest of three nearly contiguous wilderness areas that occupy most of a 65-mile-long north-south segment of the High Cascade Range in central Oregon (fig. 1). The wilderness is separated from the Three Sisters Wilderness, to the south, by the narrow corridor along the McKenzie Highway (Oregon State Highway 242), and from the Mount Jefferson Wilderness, to the north, by a wide corridor occupied by the Santiam Highway (U.S. 20). Access to the Mount Washington Wilderness is provided by these highways and by gravel roads that lead from them. The crest of the Cascade Range has a thick snowpack in winter and the McKenzie Highway is not passable from late fall to late spring; the Santiam Highway is an all-weather road. The Pacific Crest National Scenic Trail extends north-south through the wilderness.

The nearest town is Sisters, 12 mi east of the wilderness. Hoodoo Butte, 3 mi north of the wilderness, is the site of a small ski resort. Dee Wright Observatory, at McKenzie Pass, is a popular tourist stop for spectacular views of stark young lava flows, Mount Washington, and the Three Sisters stratovolcanoes.

Mount Washington, rising to an elevation of 7794 ft, is one of the smaller of the stratovolcanoes that form the prominent peaks of the Cascade Range in Oregon. Other volcanoes in the wilderness are all small, ranging from cinder cones a few tens of feet high to broad lava cones, such as Belknap Crater, which rises about 1600 ft above the surrounding terrain. The lava platform on which the volcanoes rest, mostly at an elevation of 4000 to 5000 ft, slopes gently westward to the McKenzie River and merges eastward with the Deschutes Plateau.

GEOLOGY

The Mount Washington Wilderness is in the High Cascade physiographic province of the Cascade Range, Oregon. This province is a narrow north-south-trending belt of Pliocene and Quaternary lava flows and related cinder cones and fissure vents that is studded by large stratovolcanoes spaced at irregular intervals. Most of the volcanic rocks in this belt were erupted during the last four million years. Faults bound the High Cascades both east and west of the Mount Washington Wilderness (Williams, 1957; Brown and others, 1980; Taylor, 1981). The graben resulting from these faults has been filled by flows and related vent deposits that comprise the Mount Washington Wilderness. The oldest part of the sequence is composed dominantly of basalt, and younger, overlying rocks are basalt and basaltic-andesite (fig. 2). Although andesite and more silicic volcanic rocks occur both south and north, they do not crop out in the wilderness.

All rocks within the wilderness are Quaternary in age. With the exception of the oldest flows at the westernmost margin of the wilderness, all flows show normal magnetic polarity and thus are likely less than 0.7 m.y. old. The flows and vents are readily divisible into Pleistocene and Holocene sequences.

The Pleistocene flows are glaciated and commonly covered by several feet of ground moraine or outwash deposits. These older flows were derived from cinder cones, fissure vents, and small composite volcanoes which have been modified by glacial scouring; in the cores of some cones the feeder dikes and plugs are exposed.

Mount Washington is a glacially-gutted Pleistocene stratovolcano composed of basaltic andesite flows and pyroclastic rocks (cinders, scoria, palagonite tuff, and breccia). A plug forms the summit and the upper flanks are cut by a north-south-trending swarm of basaltic andesite dikes. Mount Washington has no Holocene flows or pyroclastic rocks and probably is no longer active. The volcano is similar in erosional form to

Mount Thielsen farther south in the Cascade Range, which has yielded a K/Ar age of 0.3 m.y. (J. G. Smith, oral coummunication, 1983).

Glacial deposits within the wilderness consist mostly of ground moraines and glacial outwash. Terminal, recessional, and lateral moraines are locally present, but are better developed east and west of the wilderness. Most glacial deposits in the wilderness formed during the last major glacial advance (Cabot Creek glaciation of Scott, 1977) in the late Pleistocene. Older glacial deposits beyond the wilderness probably formed during the earlier Jack Creek glaciation of Scott (1977). Holocene neoglacial deposits occur locally on Mount Washington.

Holocene flows cover approximately half of the Mount Washington Wilderness and extend beyond it several miles to the northwest and south. Few other areas in the Cascade Range have such areally extensive young flows. Earlier flows from individual vents are commonly basalt, and later flows basaltic andesite. Charcoal from beneath many of the flows has yielded ^{14}C ages of about 1,500 to 3,000 ^{14}C years (Taylor, 1965, 1981). The rugged surfaces of flows are mostly free of vegetation, but even the youngest flows where covered by cinders from nearby vents have trees growing on them. The flows were erupted from a series of alined cinder cones and composite vents that probably were fed by enechelon fissures. The cinder cones are typically 150 to 300 ft high and consists of gray to red cinders, scoria, and agglutinate (welded spatter). The largest of the volcanic edifices is Belknap Crater, a lava shield with summit cinder cone.

MINERAL RESOURCES

No evidence of metallic-mineral deposits was found in the Mount Washington Wilderness. The young volcanic rocks of the High Cascade province in Oregon, of which the wilderness is a part, have no known deposits of metallic minerals. The wilderness has no recorded mineral production, mining districts, or claims. The nearest mines (for gold, silver, copper, and lead) occur in older rocks of the Western Cascades about 20 miles west of the wilderness in the Blue River District (Brooks and Ramp, 1968).

As part of this mineral investigation, stream-sediment samples were collected from small intermittent streams near the border of the wilderness and analyzed for their content of base metals and other elements. Sample locations are shown on Figure 2 and analytical data given in Table 1. Two samples of sand- and silt-size sediment were collected at most sites, one of bulk sediment, the other a pan-concentrate of the heavy-mineral fraction of the sediment. Pan-concentrate samples could not be obtained from some streams owing to the paucity of fine sediment. In the laboratory each sample was dried, sieved to minus-80 mesh, and split. The heavy minerals in the pan-concentrate sample were further concentrated by settling in bromoform (specific gravity, 2.8) and separated into magnetic and nonmagnetic fractions. Stream sediment and nonmagnetic heavy-mineral concentrate samples were then pulverized before analysis by standard semiquantitative emission spectrography for 31 elements. The analyzed sediments from streams draining the wilderness show concentrations of metallic elements similar to those commonly found in basaltic volcanic rocks. No anomalous concentrations of any elements were found.

The only mineral resource identified by this study is volcanic cinders. Estimates of the minimum volume of cinders at cinder cones within the wilderness are: Belknap Crater - 75 million yd^3; Twin Craters - 15 million yd^3; Scott Mountain - 20 million yd^3; Sand Mountain Craters - 50 million yd^3. An additional 50 million yd^3 may be obtained from other small cinder cones. Cinders are presently being quarried from deposits that occur near the wilderness. Little Nash Crater, about 4 mi north of the area, supplies about 80,000 yd^3 of cinders per year for local use in road construction. An estimated 30 million yd^3 remain at this site. Some past production has been reported from a source near Little Cache Mountain, 1.5 mi northeast of the wilderness. Because large quantities of cinders are more accessible elsewhere, utilization of cinder deposits from within the wilderness is unlikely. "Lava rock" for building stone is of low quality even though the study area is extensively covered with basalt and basaltic andesite flows. Building stone is abundantly available in other nearby areas which are closer to markets.

Hydrocarbon deposits, such as oil, gas and coal, do not occur within the wilderness. Upper Eocene to Pliocene volcanic rocks, similar to those exposed in the adjacent Western Cascades, underlie the Pleistocene and Holocene flows and vents of the Mount Washington Wilderness. The volcanic rocks have a thickness of many thousands of feet and have no hydrocarbon potential.

The High Cascade province of the Cascade Range in Oregon is of interest for geothermal exploration, but the magnitude of the geothermal resource is not known. Hot springs are rare in the High Cascades, but occur locally along or just beyond its margins, particularly on the west side. The hot springs emerge mostly along valley floors and commonly occur along or near faults. Belknap Hot Springs, about 4 miles southwest of the wilderness, yields about 75 gallons of water per minute with a temperature of 180°F (Bowen and Peterson, 1970). These hot springs are interpreted to be the result of lateral flow of hot water from heat sources beneath the High Cascades (Blackwell and others, 1978). No hot springs, fumaroles, or recently active thermal areas exist within the wilderness. The lava flows and interbedded breccias and other pyroclastic rocks are so permeable and porous that shallow lateral flow of cold ground water probably masks any deep geothermal anomalies that may exist.

Scattered relatively shallow heat flow holes drilled mostly along the margins of the High Cascades suggest that this part of the Cascade Range has higher than normal heat flow (Blackwell and others, 1978; Riccio, 1979). The nearest geothermal drill hole is about 2 mi northwest of the wilderness and yielded a temperature of only 77°F at a depth of 1837 feet (Youngquist, 1980). Owing to the paucity of deep holes drilled within the High Cascades, it is not possible to realistically extrapolate possible geothermal potential on the basis of results of deep drilling in similar environments. The areally extensive Holocene basalt and basaltic andesite flows of the Mount Washington area may lead to falsely optimistic estimates of geothermal resources. These flows are derived mostly from alined vents that likely are the surface manifestations of buried feeder dikes. In areas of intensive glaciation in the Cascade Range where surface rocks are deeply eroded, most exposed basaltic feeder dikes are only 3 to 10 ft wide. The dikes for the Holocene flows in the

Mount Washington Wilderness likely did not contribute major amounts of heat to the shallow crust and this heat likely has been lost by conduction and ground water flow since they formed. In contrast to the Mount Washington area, some parts of the High Cascade province contain relatively abundant silicic rocks. These areas likely have a higher geothermal potential because silicic intrusive bodies commonly are larger in the shallow crust than are mafic bodies (Smith and Shaw, 1975). Other areas in the world where geothermal resources are associated with basaltic volcanism, such as Iceland and Hawaii, have much greater rates of lava production than in the Mount Washington Wilderness.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

More than 200 million yd^3 of cinder resources occur in the wilderness. No future demand for these cinders is anticipated because other large unmined deposits are more accessible. There is no evidence of a potential for metallic mineral resources, building stone, or mineral fuels.

Geothermal resources may occur in the wilderness, but available information is insufficient to confirm their existence or magnitude. The High Cascade province is a favorable geologic environment for geothermal resources, but few deep holes have been drilled from which meaningful extrapolations of potential can be made. The most favorable areas within the High Cascades are likely those in which there are abundant young silicic rocks, none of which occur in the Mount Washington Wilderness.

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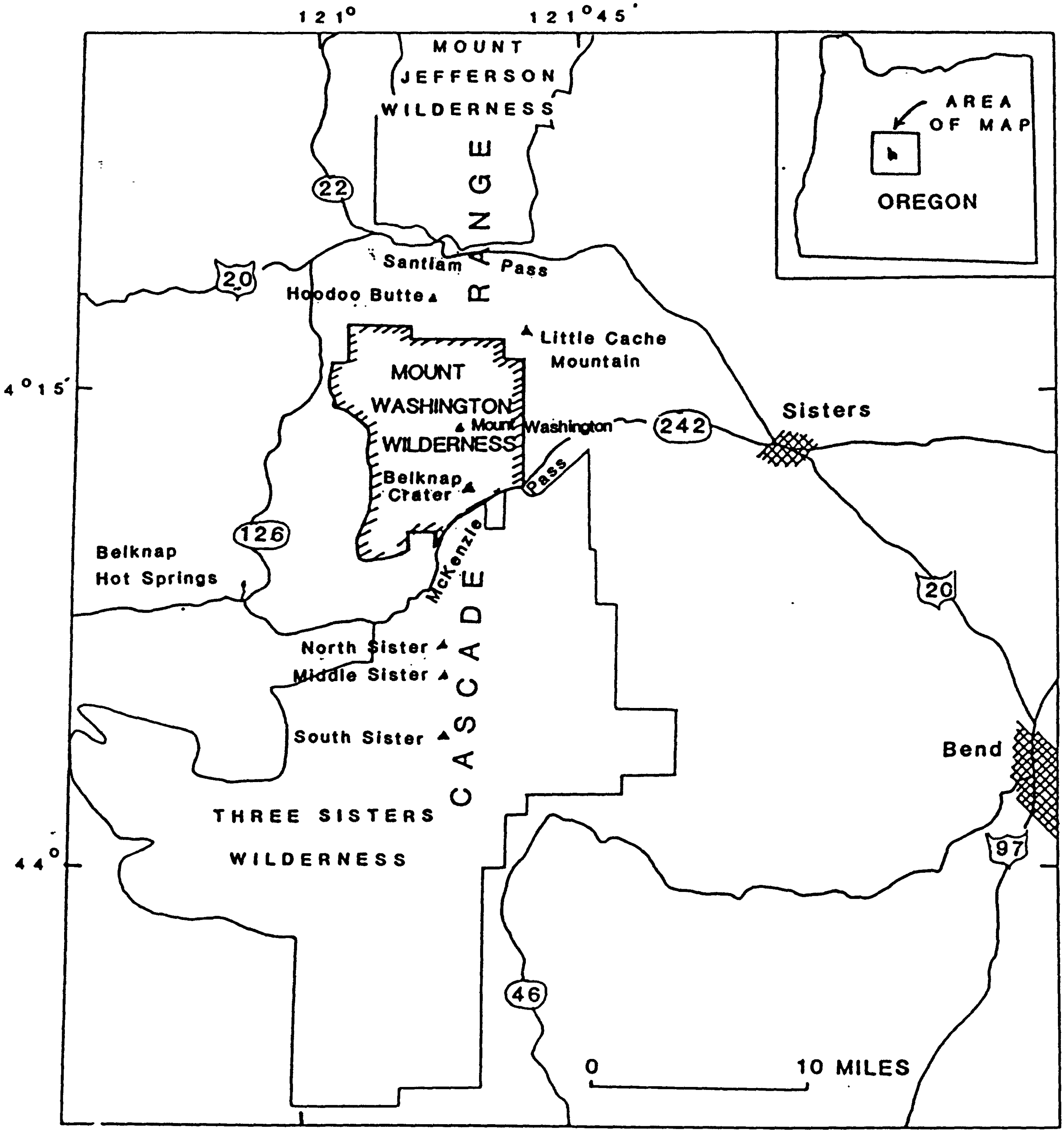
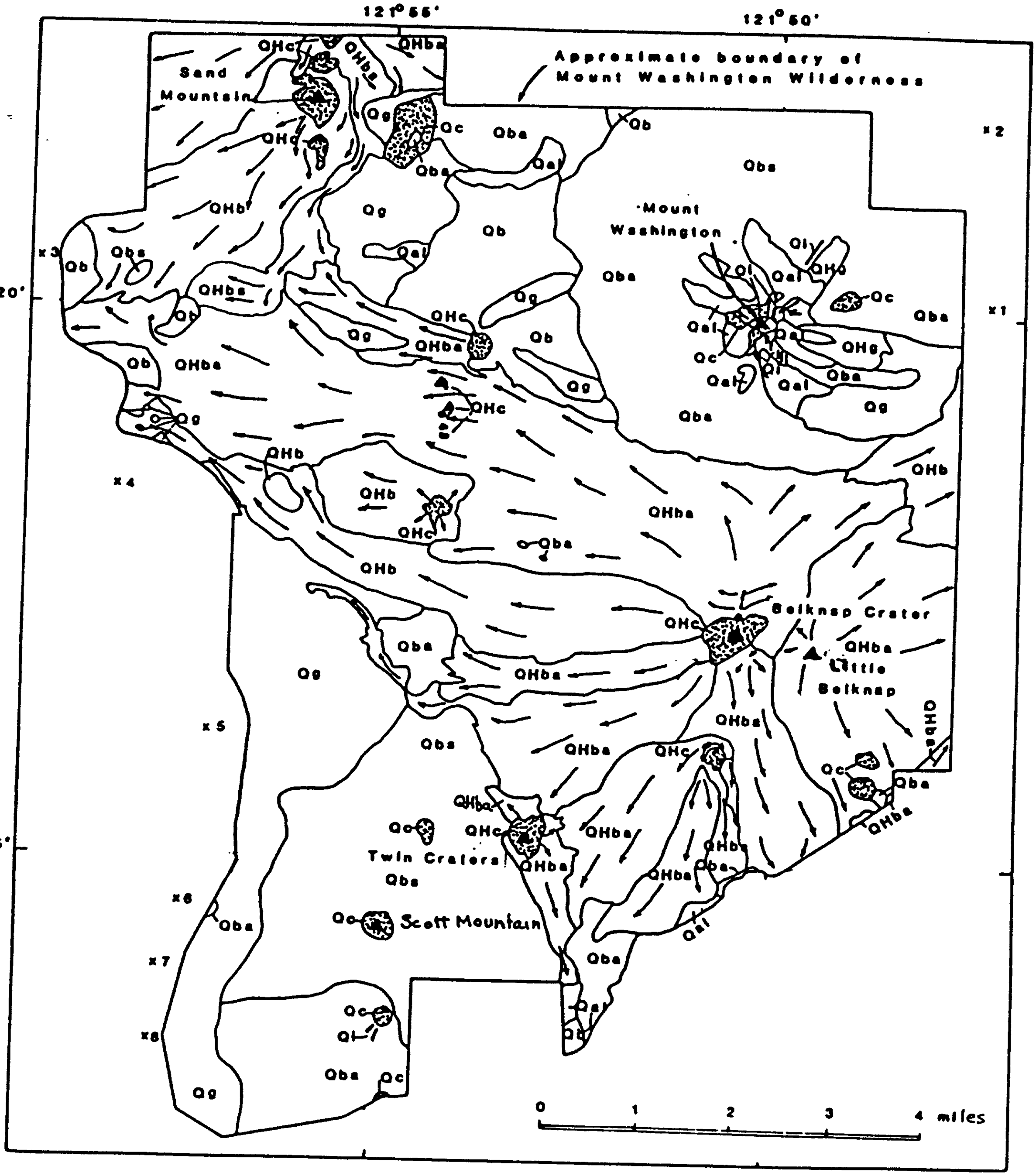


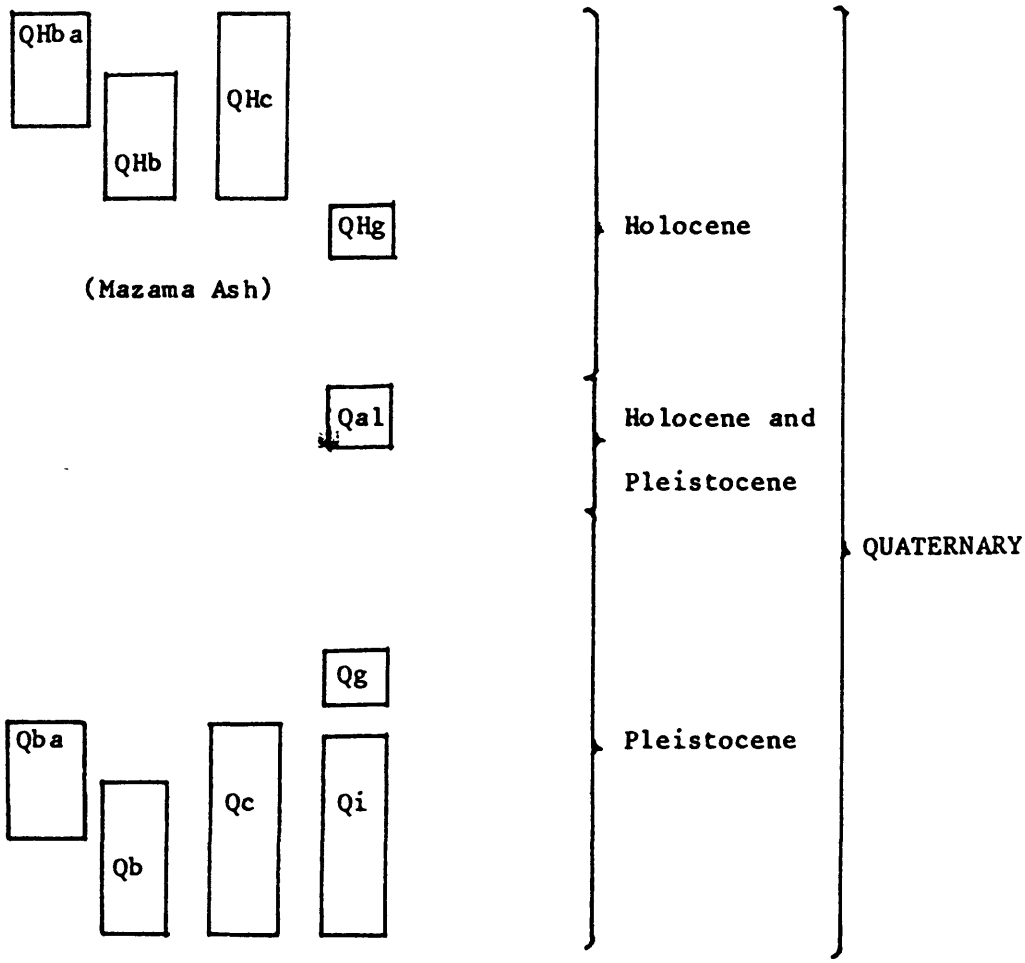
Figure 1.--Location of the Mount Washington Wilderness (NF086) in the Cascade Range, Deschutes, Lane, and Linn Counties, Oregon.



121°55'
121°50'
Approximate boundary of Mount Washington Wilderness
Sand Mountain
Mount Washington
Belknap Crater
Little Belknap
Twin Craters
Scott Mountain
44°20'
44°15'
0 1 2 3 4 miles

EXPLANATION FOR FIGURE 2

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

(Geologic map unit symbols may not necessarily conform to U.S. Geological Survey standards)

QHba YOUNGER BASALTIC ANDESITE FLOWS (HOLOCENE)--Fresh, unglaciated basaltic andesite flows derived from vents at Belknap Crater, Little Belknap, south of Belknap Crater, Twin Craters, unnamed vents southwest of Mount Washington, and Sand Mountain cinder cone chain. Younger than the Mazama ash, except those from unnamed vents southwest of Mount Washington. Age of 1,500 to 3,000 ^{14}C years on basis on dates of carbonized vegetation from beneath flows (Taylor, 1968, 1981)

QHb YOUNGER BASALT FLOWS (HOLOCENE)--Fresh, unglaciated basalt flows derived from vents at Belknap Crater, unnamed cinder cones northwest of Belknap Crater, and Sand Mountain cinder cone chain. Younger than the Mazama ash. Flows from Sand Mountain chain of vents are 3,000 - 3,800 ^{14}C years old (Taylor, 1981)

QHc YOUNGER CINDER DEPOSITS (HOLOCENE)--Rudely bedded bombs, blocks, lapilli, and ash of basalt or basaltic andesite composition which form cinder cones and fissure vent deposits

QHg YOUNGER GLACIAL DEPOSITS (HOLOCENE)--Terminal and lateral moraines on Mount Washington. Consists of deposits from both neoglacial and active glaciation

MAZAMA ASH (HOLOCENE)--Unit not shown on map. Pumiceous air-fall ash deposit derived from climactic eruption of Mount Mazama (Crater Lake) about 90 mi south of map area. Thin discontinuous deposit; forms useful time marker with which to distinguish relative ages of young deposits. ^{14}C age is about 6,845 years (Bacon, 1983)

Qal UNCONSOLIDATED ALLUVIUM (HOLOCENE AND PLEISTOCENE)--Glacial outwash, fluvial sand and gravel, and talus deposits

Qg OLDER GLACIAL DEPOSITS (PLEISTOCENE)--Terminal, lateral, recessional, and ground moraines composed of angular to subrounded cobbles and boulders in a poorly sorted sand- to clay-size matrix. Probably formed during the Cabot Creek glaciation of Scott (1977)

Qba OLDER BASALTIC ANDESITE FLOWS (PLEISTOCENE)--Nearly aphyric to moderately porphyritic basaltic andesite. Glaciated. Includes flows on the flanks of Mount Washington

Qb OLDER BASALT FLOWS (PLEISTOCENE)--Nearly aphyric to moderately porphyritic basalt; commonly diktytaxitic. Glaciated.

Qc OLDER CINDER DEPOSITS (PLEISTOCENE)--Bombs, blocks, lapilli, and ash of basalt or basaltic andesite composition in well preserved to deeply eroded cinder cones. Locally invaded by dikes (unit Qi) of similar composition. Deposits near summit of Mount Washington include palagonite tuff

Qi INTRUSIVE ROCKS (PLEISTOCENE)--Basalt and basaltic andesite dikes, small plugs, and irregular shaped bodies associated with eroded vents at Mount Washington and southwest corner of map area.

CONTACT-- Approximately located

VENT DEPOSITS

FLOW DIRECTION OF HOLOCENE LAVA FLOWS

x 4 STREAM SEDIMENT SAMPLE SITE (Analyses listed in Table 1)

Table 1. Analyses of stream-sediment samples from the Mount Washington Wilderness, Oregon. Analyses were performed by G. W. Day, U.S. Geological Survey, Denver, Colorado. Sample locations are shown on Figure 2. (Fe, Mg, Ca, and Ti in percent; all other elements in parts per million; N, not detected; L, detected, but below limit of determination; * identifies analyses of non-magnetic heavy-mineral sample)

Field No.	Map No. (fig. 2)	Fe	Mg	Ca	Ti	Mn	B	Ba	Co	Cr	Cu	La	Ni	Pb	Sc	Sr	V	Y	Zr
MW1A*	1	7	5	5	1	1500	L	1500	100	500	L	N	700	200	L	1000	200	L	7000
MW1B	1	10	10	20	1	5000	70	700	50	500	150	30	150	30	30	2000	200	50	200
MW2A*	2	5	5	10	0.2	1500	20	300	100	200	15	N	200	20	10	1500	70	L	1500
MW2B	2	10	10	20	1	3000	70	700	50	200	100	30	100	30	30	2000	200	30	200
MW3A*	3	5	2	3	.7	1000	L	700	10	200	L	N	150	N	20	1000	150	L	1000
MW3B	3	10	5	15	1	3000	50	500	30	200	100	30	100	50	15	1000	200	30	200
MW4B	4	10	2	10	1	2000	70	500	30	200	100	30	100	20	15	700	500	30	200
MW5B	5	10	10	10	1	3000	50	500	50	200	100	30	100	20	20	700	200	30	200
MW6B	6	15	10	10	1	2000	70	500	50	300	150	30	100	50	20	700	300	30	200
MW7A*	7	5	5	5	.3	1500	L	1500	50	200	100	N	300	70	L	1500	70	N	700
MW7B	7	10	10	10	1	2000	30	500	50	300	150	20	150	15	15	500	200	30	200
MW8A*	8	1	0.5	5	.2	300	L	500	N	N	10	N	150	L	L	1500	20	N	150
MW8B	8	10	10	10	1	3000	50	700	70	300	150	20	200	30	15	700	200	30	200
Lower limit of detection:		.05	.02	.05	.002	10	10	20	5	10	5	20	5	10	5	100	10	10	10

Analyzed for but below limit of detection (ppm indicated in parentheses): antimony (100), arsenic (200), beryllium (2), bismuth (20), cadmium (50), gold (10), molybdenum (10), niobium (50), silver (1), thorium (200), tin (10), tungsten (100), and zinc (200)