WASHINGTON DIVISION OF GEOLOGY AND EARTH RESOURCES
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GEOLOGIC MAP OF THE HOOD RIVER QUADRANGLE, WASHINGTON AND OREGON

Compiled by

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WASHINGTON DIVISION OF GEOLOGY AND EARTH RESOURCES

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This report has not been edited or reviewed for conformity with Division of Geology and Earth Resources standards and nomenclature.

WASHINGTON STATE DEPARTMENT OF
Natural Resources
Brian Boyle · Commissioner of Public Lands
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INTRODUCTION

This map is one of a series of 1:100,000-scale geologic maps compiled by staff geologists of the Division of Geology and Earth Resources. Other maps in the series are available for all 1:100,000-scale quadrangles within the southwest quadrant, that is, south of 47°15' north latitude and west of 120°30' west longitude, except for the Wenatchee and Snoqualmie Pass Quadrangles which are available as U.S. Geological Survey maps.

The 1:100,000-scale maps in this series that have been released to date are:

Korosec, M. A., compiler, 1987, Geologic map of the Mount Adams quadrangle, Washington: Washington Division of Geology and Earth Resources Open File Report 87-5, 41 p., 1 pl., scale 1:100,000

Logan, R. L., compiler, 1987, Geologic map of the Chehalis River and Westport quadrangles, Washington: Washington Division of Geology and Earth Resources Open File Report 87-8, 18 p., 1 pl., scale 1:100,000

Logan, R. L., compiler, 1987, Geologic map of the south half of the Shelton and the south half of the Copalis Beach quadrangles, Washington: Washington Division of Geology and Earth Resources Open File Report 87-9, 17 p., 1 pl., scale 1:100,000

Phillips, W. M., compiler, 1987, Geologic map of the Mount St. Helens quadrangle, Washington and Oregon: Washington Division of Geology and Earth Resources Open File Report 87-4, 63 p., 1 pl., scale 1:100,000

Phillips, W. M., compiler, 1987, Geologic map of the Vancouver quadrangle, Washington and Oregon: Washington Division of Geology and Earth Resources Open File Report 87-10, 32 p., 1 pl., scale 1:100,000

Phillips, W. M.; Walsh, T. J., compiler, 1987, Geologic map of the northwest part of the Goldendale quadrangle, Washington: Washington Division of Geology and Earth

Resources Open File Report 87-13, 9 p., 1 pl., scale 1:100,000

Schasse, H. W., compiler, 1987, Geologic map of the Centralia quadrangle, Washington: Washington Division of Geology and Earth Resources Open File Report 87-11, 27 p., 1 pl., scale 1:100,000

Schasse, H. W., compiler, 1987, Geologic map of the Mount Rainier quadrangle, Washington: Washington Division of Geology and Earth Resources Open File Report 87-16, 43 p., 1 pl., scale 1:100,000

Walsh, T. J., compiler, 1986, Geologic map of the west half of the Toppenish quadrangle, Washington: Washington Division of Geology and Earth Resources Open File Report 86-3, 8 p., 1 pl., scale 1:100,000

Walsh, T. J., compiler, 1986, Geologic map of the west half of the Yakima quadrangle, Washington: Washington Division of Geology and Earth Resources Open File Report 86-4, 12 p., 1 pl., scale 1:100,000

Walsh, T. J., compiler, 1987, Geologic map of the Astoria and Ilwaco quadrangles, Washington and Oregon: Washington Division of Geology and Earth Resources Open File Report 87-2, 30 p., 1 pl., scale 1:100,000

Walsh, T. J., compiler, 1987, Geologic map of the south half of the Tacoma quadrangle, Washington: Washington Division of Geology and Earth Resources Open File Report 87-3, 12 p., 1 pl., scale 1:100,000

This text consists of unit descriptions, a table of age dates, a table of major element geochemistry, correlation diagram, source of mapping diagram, and a list of cited references. The conventions used in describing and classifying rocks are from the following sources: Igneous rocks are classified according to Travis (1955). If geochemical data are available, volcanic rocks are classified according to the current classification of the International Union of Geological Sciences (Zanettin, 1984). Most of the geologic units are informal, including all of the Quaternary volcanic rocks. The only formal units are Evans Creek Drift, Hayden Creek Drift, Troutdale Formation, Dalles Formation, Ellensburg Formation, Eagle Creek Formation, and the formations and members of the Columbia River Basalt Group.

Acknowledgments

Brent Barnett's reconnaissance geologic mapping east of Big Lava Bed added detail to an essentially unmapped area; his work was supported by Contract DE-AC07-79ET27014 of the U.S. Department of Energy Geothermal Program. Paul Hammond, Portland State University, provided unpublished mapping of the Indian Heaven area. Hammond's rock unit descriptions form the basis for most of the descriptions of the Quaternary volcanic units on this map. James Anderson (Pomona College) made available his geologic mapping of the Klickitat quadrangle prior to its publication. Reviews by Hammond, Anderson, James E. Smith (USGS), and Terry L. Tolan (Rockwell International) significantly improved this map, and the author greatly appreciates their efforts.

DESCRIPTION OF MAP UNITS
HOOD RIVER QUADRANGLE, WASHINGTON

Quaternary Sediments

Qal

Alluvium--Well to poorly sorted and stratified clay, silt, sand, and gravel. The unit consists of stream-channel, side stream, overbank, fan, and lacustrine deposits and may include some glacial deposits and postglacial terrace gravels.

Qoa

Older alluvium--Well to poorly sorted and stratified clay, silt, sand, and gravel deposited by streams, forming terraces and benches above the present flood plain. In the Wind River valley, the unit includes lacustrine and deltaic deposits from the temporary damming of the Wind and Columbia Rivers by the basalt of Trout Creek about 340,000 years ago.

Qls

Landslide deposits--Consists of poorly sorted blocks, boulders, gravel, and finer sediments produced by the gravitational failure and rotational-translational slide of bedrock and/or unconsolidated sediments above the bedrock; surfaces are usually hummocky. Most slides are of Holocene age.

Qdet
Qoe

Evans Creek Drift--Glacial till, moraines, and outwash deposits (Qoe) from alpine glaciation (Hammond, 1980). The till is bouldery, loosely compacted, and complexly interbedded with poorly sorted silt, sand, and gravel. A yellowish-brown, oxidized zone extends to a depth of 0.6-0.9 m, and cobbles within the zone do not usually have weathering rinds. The outwash deposits are loosely consolidated, stratified, poorly to well-sorted silts, sands, and gravels. The ice accumulation area for this unit was probably the Indian Heaven area. Evans Creek Drift in the Mount Rainier area has an age of 13,000-24,000 years and is probably time equivalent to the drift in the Indian Heaven area.

Qdht

Hayden Creek Drift (?)--Glacial till and moraines from alpine glaciation (Hammond, 1980). The till is stony and weathered to a depth of about 2 m. Clasts are partly decomposed, with weathering rinds from 0.5 to 2.5 mm thick. This unit was deposited by glaciers with ice accumulation areas at Indian Heaven and Mount Adams and is probably correlative with the Hayden Creek Drift in the Mount Rainier area which is believed to be 130,000-150,000 years old (Porter, 1976; Waitt, 1977).

Qmt

Trout Lake mudflow--Unsorted mixture of subangular to subrounded boulders in a matrix of sand, silt, and clay, derived from Mount Adams (Hopkins, 1976). The boulders, up to 20 m in diameter, become finer upward and are primarily andesite from Mount Adams with lesser olivine basalt. The mudflow originated on the southwestern flank of Mount Adams at the head of the White Salmon Glacier and flowed down the White Salmon River valley for 40 km. A radiocarbon age of 5,070 $\pm$ 260 years was obtained from a tree stump near the base of the unit (Hopkins, 1976).

Qfs

Missoula flood deposits, silts and sands--Interstratified, horizontally bedded fine sand, silt, and clay deposited in backwater canyons along the course of the Missoula floods. The floods occurred between 15,300 and 12,700 years ago (Waitt, 1985).

Qfg

Missoula flood deposits, gravel--Crossbedded gravel and coarse sand from the Missoula floods along the Columbia River through the Cascade Mountains. The unit is generally less than 30 m thick, forming benches and slopes along the river. Locally, the unit is poorly sorted and unstratified. Bedded silt forms minor, commonly lensoidal interbeds. The floods occurred between 15,300 and 12,700 years ago (Waitt, 1985).

Quaternary Volcanic Rocks
(Named units are in alphabetical order)

Qvb

Basalt flows, unnamed--Basalt flows, flow breccia, and scoria forming isolated monogenetic volcanic cones. These units have not yet been described in any detail.

Qvba

Basaltic andesite and basalt--Fine-grained olivine-bearing microporphyritic basaltic andesite and basalt, forming intracanyon flows and associated flow breccias. In Oregon, they form remnant ledges along Fivemile Creek, South Fork Mill Creek, Mosier Creek, Snakehead Creek, and West Fork Neal Creek and ridge tops at Blowndown Ridge, the north side of Waucoma Ridge, and west of West Branch Falls Creek. The Fivemile and Mill Creek flows originated near or at Mount Hood.

Qvab

Basalt of Alice Butte--Gray, phyric, olivine basalt (Hammond, written commun., 1983). Olivine phenocrysts are set in a fine-grained granular groundmass. The flows form a 122-m-high butte south of Red Mountain. The unit's informal name is derived from a hill in sec. 28, T. 5 N., R. 8 E., which is locally called Alice Butte; the name does not appear on the most recent U.S. Geological Survey quadrangle maps. The butte is a volcanic center, with an age stratigraphically confined to be 150,000-500,000 years old.

Qvbc

Andesite of Black Creek--Medium-gray, sparsely phyric, plagioclase-olivine andesite and basaltic andesite (Hammond, written commun., 1983). Slabby, blocky to columnar-jointed aa and block lava flows form a broad field fanning to the south and west from a buried or eroded source near Red Mountain. Individual flows are 2-18 m thick, with a cumulative thickness of 60-120 m. The volume is estimated to be 4.7 km^3. A whole-rock K-Ar age date of 3.3 +/- 0.25 m.y.b.p. (Hammond and Korosec, 1983; sample no. 6, Table 1) may be too old, suggested by normal remanent magnetism, a lack of reversed magnetic flows stratigraphically above these flows, and models based on rates of volcanism in the region; however, a Pliocene age cannot be ruled out.

Qvbh

Basaltic andesite north of Big Huckleberry Mountain--Dark-gray quartz-olivine basaltic andesite flow (Wise, 1961). Phenocrysts of olivine and xenocrysts of quartz are in a fine-grained groundmass of plagioclase, olivine, and opaque minerals. The massive basaltic andesite has no flow tops or bottoms exposed in the limited outcrops. Wise (1961) believed that the rounded hill represented an eroded flow remnant, but Hammond (1980) maps the hill as a vent. The basaltic andesite may be the same as or related to the basaltic andesite of Bill Butte (Qvbi), 1.5 km to the north. No direct age control exists for these flows, but the thick soil cover suggest an early Pleistocene age.

Qvbi

Basaltic andesite of Bill Butte--Dark-gray, phyric, olivine basaltic andesite. Phenocrysts of olivine and rare xenocrysts of quartz are in a fine-grained crystalline groundmass. The flow forms the cone southwest of the Big Lava Bed crater. The unit's informal name is derived from a hill in sec. 27, T. 5 N., R. 8 E., which is locally called Bill Butte, but the name does not appear on the most recent U.S. Geological Survey maps.

Qvbl

Basalt of Big Lava Bed (Holocene)--Multiple dark-gray, vesicular to dense, phyric, olivine basalt flows (Hammond, written commun., 1983). Flows are 0.5-9 m thick, blocky jointed, with slab pahoehoe to scoriaceous tops, with pits 2-6 m deep and wide, furrowed pressure ridges 6-12 m high, fractures up to 5 m wide, and sinuous channels up to 14 m deep and 30 m wide. The lava was erupted as sheet flows, inflated by internally fed lava. The flows cover the valley floor south of Indian Heaven, extending for 59 km^2. The total volume is about 0.9 km^3. A cone near the north center of the bed is 300 m high, with a crater at the top 195 m wide and 66 m deep. Scoriaceous tephra from this crater formed a blanket up to 3 m thick, extending 8 km east of the cone. The tephra overlies pumice of the S-tephra of Mount St. Helens (13,500 yr old); carbonized leaves underlying the Big Lava tephra give a ^{14}C age of 8,200 +/- 100 years (Hammond and Korosec, 1983).

Qvby

Basalt of Berry Mountain--At least five lava flows erupted from vents near Gifford Peak and on Berry Mountain (Hammond, written commun., 1983). From oldest to youngest, they are light- to dark-gray, sparsely to moderately phyric, olivine basalt, augite-olivine basalt, hornblende-plagioclase andesite, augite plagioclase-olivine basalt, and hornblende-augite-olivine basaltic andesite. The flows are blocky and platy jointed, 1-12 m thick with a cumulative thickness of 50-100 m. The total volume is estimated to be about 1.7 km^3. Basalt of Berry Mountain is late Pleistocene, erupted after the Hayden Creek and before the Evans Creek alpine glacial periods, between about 130,000 and 25,000 years ago.

Qvcc

Basalt of Cedar Creek--Dark-gray, olivine basalt and eroded cinder cone in the upper drainage of Cedar Creek (Wise, 1961). The basalt consists of phenocrysts of olivine in a groundmass of plagioclase, clinopyroxene, and minor amphibole, olivine, and magnetite. The basalt forms a small intracanyon flow along the west side of the creek up to 60 m thick and 2 1/4 km long. The cone forms a low, rounded hill of soft, loose, red cinders and large blocks of basalt. The preservation of the flow and cone within the present-day drainage suggest a late Pleistocene age.

Qvcl/Qls

Basaltic andesite of Cascade landslide--Light-gray, platy, olivine basaltic andesite (Wise, 1961). Basaltic andesite flows and a cinder cone are breached and disrupted by a section of the composite Bonneville landslide. Above the slide scarp along the east edge of Greenleaf Basin, the flow remains intact. The basin is the result of a volcanic cone and intracanyon flow erupting in and blocking the upper drainage of Greenleaf Creek, diverting the creek to the south. In the face of the scarp, along Red Bluffs, oxidized cinders, flows overlying Eagle Creek Formation, and cross-cutting feeder dikes are exposed. At the head of the slide, a well preserved intact cinder cone and undisturbed flows demonstrate large block sliding. Broken, hummocky exposures of platy flows east of the cinder cone, "down slide", represents the greatest volume and areal extent of the flows. The unit was called "Red Bluffs volcano" by Wise (1961). It is older than the 700-year-old landslide and probably of late Pleistocene age.

Qvcp

Basalt of Camas Prairie--Medium- to dark-gray olivine-plagioclase basalt (Sheppard, 1964). Intracanyon pahoehoe lava flows, generally 3-6 m thick, were erupted from several vents of the shield volcano at King Mountain, north of the map area. The lava flows are blocky jointed, with basal breccia and vesicular to scoriaceous tops (Hammond, 1980). In thin section, the basalt is holocrystalline, diktytaxitic, and porphyritic, with plagioclase and olivine phenocrysts in a groundmass of plagioclase, clinopyroxene, olivine, and opaque minerals. The olivine is commonly glomeroporphyritic with partial replacement by iddingsite. At Camas Prairie, the flows are partly covered with sporadic patches of silt and sand, up to 30 cm thick. In the Klickitat River canyon, numerous nested flows of 3-10 m thickness have an accumulative thickness of more than 120 m (Anderson, written commun., 1985). A whole-rock K-Ar age date from these flows outside of the map area is 300,000 $\pm$ 80,000 years (Shannon and Wilson, 1973).

Qvdc

Basalt of Dry Creek--Medium-gray, vesicular to dense, sparsely to moderate phyric, augite-olivine basalt. Numerous pahoehoe flows 1-10 m thick, with blocky jointing, are commonly separated by 0.2-2-m-thick interbeds of scoria and have a total maximum thickness of 370 m. The volume is approximately 9.2 km^3. The source is unknown, but a dike at south East Crater is a possibility. The basalt of Dry Creek is similar to the basalt of Rush Creek and may be its correlative. The stratigraphic position of the flow suggests a probable middle Pleistocene age.

Qvel

Basaltic andesite of Eunice Lake--Light- to medium-gray, vesicular to dense, phyric, olivine basaltic andesite and aphyric andesite. Phenocrysts of plagioclase and olivine are in a fine-grained flow-layered groundmass. Numerous blocky to platy-jointed flows 1-12 m thick are commonly separated by scoria interbeds of 0.5 m thick, attaining a maximum thickness of 140 m, and have an approximate volume of 2.0 km^3. The flows may have erupted from a zone of east-west-trending dikes on the north side of Gifford Peak. The stratigraphic position of the flows suggests a probable middle Pleistocene age.

Qvfl

Andesite of Forlorn Lake--Light-gray, sparsely phyric, two pyroxene-olivine andesite flows and flow breccia (Hammond, written commun., 1983). The andesite consists of phenocrysts of plagioclase, olivine, augite, and hypersthene in a dense, flow-layered groundmass. It forms block lava flows, 10-30 m thick, with flow-folded interiors. Individual flows are separated by breccia zones up to 30 m thick, with a cumulative thickness of about 100 m and total volume of about 1 km^3. The flows were erupted from a vent east of Gifford Peak in the middle Pleistocene. They are partially eroded by alpine glaciers and are overlain by the andesite of upper Forlorn Lake (Qvfu).

Qvfm

Basalt of Flattop Mountain--Light-gray, aphyric, olivine basalt (Hammond, 1980). Vesicular to scoriaceous blocky lava flows, originated from the base of a cinder cone on Flattop Mountain north of the map area. They have a maximum thickness of 50 m. The age is probably middle Pleistocene.

Qvfu

Upper andesite of Forlorn Lake--Light-gray, sparsely phyric, two pyroxene-olivine andesite flows and flow breccia (Hammond, written commun., 1983). The andesite consists of plagioclase, olivine, augite, and hypersthene phenocrysts in a dense, flow-layered groundmass. Blocky lava flows 15-30 m thick are separated by breccia zones 30-40 m thick. The total thickness is 60-90 m, and the approximate volume is 0.12 km^3. The lava was derived from a low scoria and breccia cone just east of Gifford Peak. The stratigraphic position of the unit suggests a probable late Pleistocene age.

Qvgb

Basalt of Grouse Butte--Medium-gray, moderately phyric, olivine basalt flows and cone (Hammond, written commun., 1983). Flows are blocky jointed pahoehoe lava, 2-6 m thick, with a cumulative thickness of 6-10 m and an estimated volume of 0.009 km^3. They were erupted from the northeast base of the glacially molded, craterless scoria cone at Grouse Butte, about 5 km northwest of Mann Butte. The cone is 100 m high and has a diameter of about 640 m. The basalt is of probable middle to late Pleistocene age.

Qvgc

Basalt of Gilmer Creek--Gray, aphyric to very fine-grained, olivine basalt flows (Sheppard, 1964). In thin section, the texture is intergranular to diktytaxitic, with phenocrysts of plagioclase and olivine in a holocrystalline groundmass of plagioclase, clinopyroxene, olivine, and opaque minerals. The olivine phenocrysts are commonly resorbed and partially altered to iddingsite. The flows are dense and blocky to columnar jointed and have interbeds of breccia and scoria 3-5 m thick. The cumulative thickness is about 85 m. The flows form a large, isolated shield volcano south and southeast of Gilmer, capped by a scoria cone consisting of red to dark-gray, poorly sorted, unconsolidated, and stratified scoria. The basalt has a whole-rock K-Ar age of 1.76 +/- 0.5 m.y.b.p. and has a reversed remanent magnetic polarity (Hammond and Korosec, 1983; sample no. 5, Table 1).

Qvgl

Basalt of Goose Lake--Light- to medium-gray, fine-grained, phyric, olivine basalt (Hammond, written commun., 1983). The basalt forms blocky to platy-jointed pahoehoe flows, 2-10 m thick, and has local interbeds of airfall scoria up to 2 m thick. The cumulative thickness is 46 m, and the volume is approximately 1.8 km^3. The flows overlap a 120-m-high scoria cone exposed in Spring Camp Creek northwest of Goose Lake. The age of the unit is probably middle Pleistocene, suggested by its stratigraphic position.

Qvgm

Basalt of Guler Mountain--Medium- to dark-gray, phyric, olivine basalt, (Hammond, 1980). Several scoriaceous, blocky lava flows 2-3 m thick form an isolated cone. Flows erupted from a vent near the top of Guler Mountain and flowed east into the White Salmon River valley. The surfaces of the flows are covered by up to 2.4 m of silty loess. The basalt is probably of middle Pleistocene age.

Qvgp

Basalt of Gifford Peak--Light- to medium-gray, phyric, olivine basalt flows (Hammond, written commun., 1983). In thin section, phenocrysts of plagioclase and olivine are set in a fine-grained, flow-banded groundmass. The basalt forms blocky to platy-jointed lava flows 1-12 m thick, commonly with scoria interbeds up to 0.5 m thick, with a cumulative thickness of 90 m and a volume of approximately 1.9 km^3. The flows were probably erupted from a zone of east-west-trending dikes on the north side of Gifford Peak. It has a probable early to middle Pleistocene age, suggested by its stratigraphic position.

Qvhb

Basalt of Hauk Butte--Light- to medium-gray, fine-grained aphyric, olivine basalt. In thin section the basalt is micro-porphyritic with phenocrysts of olivine ringed by iddingsite in a groundmass of flow-aligned plagioclase, olivine, and opaque minerals. Flows erupted from a vent on the southwest flank of Hauk Butte and flowed west and north into Lost Creek valley. The degree of preservation suggests that the unit has a probable middle to late Pleistocene age.

Qvhc

Basalt of Herman Creek (Oregon)--Light-gray, diktytaxitic, phyric, olivine basalt (Hammond, 1980). A single blocky jointed flow 3- 30 m thick partially filled the paleocanyon of Herman Creek at a level several tens of meters above the present creek level. The geomorphology of the flow and its setting suggest that the unit is of probable early to middle Pleistocene age.

Qvic

Basalt of Ice Caves--Gray, abundantly phyric, olivine basalt (Hammond, written commun., 1983). In thin section, phenocrysts of plagioclase and olivine are in a diktytaxitic, holocrystalline groundmass of plagioclase, olivine and opaque minerals. The plagioclase phenocrysts are generally glomerocrysts of radiating laths. The basalt forms blocky jointed pahoehoe lava flows 0.5-6 m thick. They were erupted from the crater at Lake Wapiti of Lemei Rock volcano and flowed down the east flank. One lobe flowed northeast, up Trout Lake Creek. Most of the lava went south and east into the White Salmon River canyon at Trout Lake and down the canyon at least 43 km to Husum. The flow is 10-12 m thick, and its volume is about 1.2 km^3. It is younger than Hayden Creek glaciation (130,000-150,000 yr b.p.) but older than Evans Creek glaciation (22,000-14,000 yr b.p.).

Qvih

Basalt of Indian Heaven--Light-gray, abundantly phyric, olivine basalt (Hammond, written commun., 1983). Phenocrysts consist of randomly oriented plagioclase crystal plates, isolated glomerocrysts of radiating plagioclase plates, and olivine. The groundmass is diktytaxitic, with plagioclase, olivine, and opaque minerals. The basalt forms blocky jointed pahoehoe lava flows 1-3 m thick, with 1-3-m-thick interbeds of scoria. Numerous flows erupted from a bocca on the west side of the 120 m high East Crater, and flowed down the west slope, reaching the upper Wind River valley. The flows have a cumulative maximum thickness of 24 m and a total volume of about 0.5 km^3. The age is late Pleistocene, with the East Crater activity postdating the basalt of Lake Comcomly, a 29,000-yr-old flow (Hammond, written commun., 1985).

Qvjc

Basaltic andesite of Juice Creek--Light-gray, sparsely phyric, augite basaltic andesite and augite-olivine basaltic andesite (Hammond, written commun., 1983). The groundmass is dense, fine-grained, and equigranular, with flow-layered plagioclase laths.

The lava flows are platy, blocky, and columnar jointed and are 4-60 m thick. The estimated volume is 2 km^3. A broad, dissected shield volcano, about 170 m high, and about 5 km west of Berry Mountain, marks the source of most of the lava. A possible second vent is located on a butte about 5 km west-southwest of Red Mountain. A whole-rock K-Ar age date of 1.40 +/- 0.06 m.y.b.p. was determined for this unit (Hammond and Korosec, 1983; and sample no. 4, Table 1).

Qvla

Andesite at Laurel--Light-gray, porphyritic, augite-hornblende andesite (Sheppard, 1964). Phenocrysts of oxyhornblende, oscillatory zoned plagioclase, and augite are in a groundmass of flow-aligned plagioclase, clinopyroxene, opaque minerals, and pale-brown glass. The oxyhornblende is commonly rimmed or replaced by opaque minerals. Rare olivine phenocrysts and quartz xenocrysts are also present. The flows are platy jointed and up to 6 m thick, with a cumulative thickness of 50 m. The source is probably the hill 3 km south of Quigley Butte. The unit is probably of early Pleistocene age.

Qvlc

Basalt of Lake Comcomly--Dark-gray, sparsely phyric, olivine basalt (Hammond, written commun., 1983). Glomerocrysts of plagioclase phenocrysts surrounding olivine phenocrysts are in a fine-grained groundmass of plagioclase, olivine, and opaque minerals. The basalt forms pahoehoe lava flows, 0.5-12 m thick, with scoriaceous margins, pillow lava, breccia, and abundant tumuli. The cumulative thickness is 2-30 m, and the estimated volume is about 1.3 km^3. The source of the lava was the southeast crater of the Lemei Rock volcano (north of the map area), marked by a 120-m-high scoria and spatter cone. Flows descended the east and west "flanks" of Indian Heaven, partially covering the broad slope formed by the basalt of Ice Caves (Qvic). The eruptions occurred in late Pleistocene time, probably during an unnamed glaciation about 30,000 years ago.

Qvll

Basalt of Lost Lake Butte (Oregon)--Basalt flows and flow breccia. The lava erupted from Lost Lake Butte and covered the valley between Laurel Creek and the West Fork Hood River.

Qvlo

Basalt of Lost Creek--Light- to medium-gray, fine-grained phyric, olivine basalt flows. In thin section, phenocrysts of olivine, replaced or rimmed by iddingsite, are in a groundmass of flow-aligned plagioclase laths, olivine, opaque minerals, and granular plagioclase. Flows erupted from at least two centers on the ridge on the south side of Lost Creek valley and partially filled the valley. The age is probably middle Pleistocene, suggested by the geomorphology of the cones and flows.

Qvlp

Basalt of Lapham Creek--Olivine basalt. It forms a flow and cinder cone. The unit has a probable middle Pleistocene age.

Qvlw

Basalt of Little White Salmon--Gray, phyric, olivine basalt. Pahoehoe lava flows occupy the valley of the Little White Salmon River and underlie much of the basalt of Big Lava Bed (Qvbl). They erupted from vents in the southern Indian Heaven area and reached the Columbia River. The age is middle to late Pleistocene, possibly post-Hayden Creek glaciation (about 130,000-150,000 years ago).

Qvmb

Basalt of Mowich Butte--Dark-gray olivine basalt (Wise, 1970). Phenocrysts of olivine and rare augite are in a groundmass of plagioclase, clinopyroxene, olivine, magnetite, and glass. The basalt forms an intracanyon flow in the upper Rock Creek drainage. It erupted from a vent on Mowich Butte, about 3 km west of the map area.

Qvmd

Basalt of Mount Defiance (Oregon)--Light-gray, blocky jointed, vesicular to diktytaxitic, phyric, olivine-clinopyroxene basalt and lesser dark-gray platy jointed, dense, porphyritic pyroxene andesite (Hammond, 1980). The basalt forms the base of a partially dissected shield volcano, and andesite caps the summit. The cumulative thickness is estimated to be about 300 m. Age is probably early Pleistocene.

Qvmf

Andesite of McCoy Flat--Gray, aphyric andesite (Hammond, 1980). Very fine-grained, dense to highly vesicular andesite forms a single 20-m-thick block lava flow with platy, slabby, to blocky jointing along Jewett Creek north of White Salmon. The flow erupted from a vent on the north side of McCoy Flat and flowed down the creek valley to White Salmon, possibly reaching the Columbia River. Because the flow is well preserved, its age is probably late Pleistocene and post-Hayden Creek glaciation (less than about 130,000-150,000 years).

Qvmh

Andesite of Mount Hood--Light- to medium-gray andesite and basaltic andesite flows originating at the Mount Hood stratovolcano south of the map. In the map area, the older flows cap the flat-topped ridge of Fir Mountain. A younger flow forms a bench along part of the west side of the upper Hood River valley.

Qvml

Basalt of McClellan Meadows--Medium-gray, phyric, olivine basalt. Phenocrysts of plagioclase and olivine are in a diktytaxitic groundmass of plagioclase, olivine, and clinopyroxene. The flows form part of the western margin of the Indian Heaven volcanic field and are partially lapped by flows of the basalt of Indian Heaven (Qvih). The source and age of the McClellan Meadows flows are not known.

Qvns

Basalt north of South Prairie--Gray, phyric, olivine basalt (Hammond, written commun., 1983). Lava and scoria form a partially eroded cone and small shield. The cone is 183 m high and has been modified by middle Pleistocene glaciation. The unit has a probable age of early to middle Pleistocene.

Qvpa

Andesite of Petite Mountain (andesite northeast of Red Mountain) --Light-gray, aphyric, olivine andesite (Hammond, written commun., 1983). Blocky to platy jointed aa lava flows were extruded from the base of an irregular shaped, craterless, scoria cone, 135 m high and 1,300 m long. Individual flows are 2-3 m thick and have a cumulative thickness of 10 m. The volume is estimated to be about 0.03 km^3. These flows erupted in the late

Pleistocene, probably after Hayden Creek alpine glaciation (130,000-150,000 years ago) but before Evans Creek alpine glaciation. The unit's informal name is derived from a hill northeast of Red Mountain which is locally called Petite Mountain, but the name does not appear on the most recent U.S. Geological Survey quadrangle map.

Qvpb

Basalt of Peterson Butte--Small olivine basalt cone. The unit has not been described. It may be similar to the basalt of Grouse Butte, 1.5 km to the south.

Qvpm

Basalt of Papoose Mountain (basalt southeast of Red Mountain)--Medium-gray, moderately phyric, olivine basalt (Hammond, written commun., 1983). Phenocrysts of plagioclase and olivine are in a fine-grained groundmass. The basalt forms an eroded, craterless cone of agglutinated scoria, 195 m high and 2,000 m wide. Blocky jointed pahoehoe lava flows, 2-6 m thick, partially cover the eastern and southern slopes. The individual flows are commonly separated by scoria interbeds 0.2-0.5 m thick. The cumulative thickness is 75 m, and the estimated volume is 2.7 km^3. The unit is probably of middle Pleistocene age. The unit's informal name is derived from the butte 2 km southeast of Red Mountain, known locally as Papoose Mountain, but the name does not appear on the most recent U.S. Geological Survey quadrangle map.

Qvps

Basalt of Peterson Ridge--An isolated volcanic center and basalt flows on the south side of Peterson Ridge, 3 km north of Mann Butte. The unit has not been described. The southern extension of the flows have been buried by the basalt of Ice Caves (Qvic).

Qvpt

Basalt of Petite Mountain (basalt northeast of Red Mountain)--Gray olivine basalt (Hammond, written commun., 1983). The flows were extruded from the eastern side of the butte 1 km northeast of Red Mountain. The butte is locally known as Petite Mountain, but the name does not appear on the most recent U.S. Geological Survey quadrangle map.

Qvqb

Basaltic andesite of Quigley Butte--Light-gray, aphyric, olivine basaltic andesite (Sheppard, 1964; Hammond, 1980). Dense, very fine-grained, platy to slabby jointed basaltic andesite flows up to 4 m thick form a broad shield volcano centered at Quigley Butte. Individual flows are commonly separated by scoriaceous breccias of the flow bases. The cumulative thickness is at least 25 m. The west and north flanks are mostly covered by basalt of Camas Prairie (Qvcp). The unit is of probable middle or possible early Pleistocene age.

Qvrc

Basalt of Rush Creek--Medium-gray, sparsely to moderately phyric, augite-olivine basalt (Hammond, written commun., 1983). Pahoehoe lava flows, 1-10 m thick, are commonly separated by interbeds of scoria 0.2-2 m thick. The flows have a total maximum thickness of 370 m and an estimated volume of 4.75 km^3. The exact source of these flows is unknown, probably concealed by the younger flows near the center of the Indian Heaven volcanic field. The basalt of Rush Creek is petrographically and morphologically similar to and may correlate with the basalt of Dry Creek (Qvdc). The unit's stratigraphic position suggests a middle Pleistocene age.

Qvrk

Basalt of Rock Creek--Dark-gray, platy, olivine basalt (Wise, 1970). The basalt forms a small plug on the ridge north of Rock Creek. Remnants of the flow extend a short distance south of the plug. The degree of erosion suggests an early Pleistocene age.

Qvrs

Andesite of Rattlesnake Creek--Medium- to dark-gray, phyric, olivine basaltic andesite and andesite (Hammond, 1980). Phenocrysts consist of plagioclase and olivine. Dense, blocky-jointed flows, 4-6 m thick, with vesicular tops, were erupted from a cluster of vents near the confluence of Rattlesnake Creek and the White Salmon River. They have a cumulative thickness of 145 m. The fresh appearance of the basalt suggests an age of late Pleistocene, probably post-Hayden Creek glaciation (130,000-150,000 years ago).

Qvrt

Andesite of The Race Track--Medium-gray, sparsely phyric, olivine andesite (Hammond, written commun., 1983). Phenocrysts of olivine and plagioclase are in a fine-grained groundmass. The andesite forms slabby lithic clasts in agglutinated lithic scoria surrounding a denuded plug or dome west of The Race Track on the northwest side of Red Mountain. The unit has a total thickness of 75 m. Its age is unknown.

Qvsa

Basalt of Sahalee Tyee--Dark-gray, moderately phyric, olivine basalt (Hammond, written commun., 1983). Basaltic tephra, consisting of coarse scoria and bombs, form a broad cone, 12 m high, north of Gifford Peak and Blue Lake. The cone has a central crater 365 m in diameter, partially filled by a small lake named Sahalee Tyee. A single, small lava flow makes up a part of the cone. The unit is of late Pleistocene age, younger than Hayden Creek alpine glaciation (130,000-150,000 years ago).

Qvsd

Basalt of Sheridan Point--Light- to medium-gray, microphyric, olivine basalt. The flow is located at the foot of the Bonneville landslide, is blocky jointed, and about 10 m thick, and forms a 400-m-long ridge parallel to the Columbia River. The flow appears to overlie landslide debris or poorly sorted talus, but is likely much older than the 700-yr-old main Bonneville landslide. A late Pleistocene age is probable.

Qvsl

Basalt of Sheep Lakes--Medium-gray, moderately phyric, olivine basalt (Hammond, written commun., 1983). The basalt forms blocky jointed, 2-4-m-thick pahoehoe and aa lava flows, separated by scoria interbeds 0.2-0.5 m thick. The total thickness ranges from 5 to 25 m, and the volume is approximately 0.08 km^3. The flows were erupted from the east base of Red Mountain in middle to late Pleistocene.

Qvsr

Basalt cone southeast of Red Mountain--Black to red scoriaceous tephra (Hammond, written commun., 1983). The tephra forms a cone 70 m high on the west side of the Big Lava Bed. The unit is of late Pleistocene age, probably not much older than the Evans Creek Drift which mantles much of the north side of the cone. It may have been the source of valley-filling basalts, including the basalt of Little White Salmon (Qvlw) now mostly covered by basalt of Big Lava Bed (Qvbl).

Qvsu

Basalt of Sugar Bowl Butte--Poorly known volcanic center and basalt flow on the southeast side of Peterson Ridge, 6 km west of Trout Lake. The southern extension of the flows has been covered by the basalt of Ice Caves (Qvic).

Qvth

Basalt of Thomas Lake--Light-gray, abundantly phyric, augite-olivine basalt (Hammond, written commun., 1983). Phenocrysts consist of randomly oriented platelets of plagioclase and granular augite and olivine, in a diktytaxitic groundmass. The basalt forms blocky jointed pahoehoe lava flows 1-7 m thick, erupted from fissures at the south end of East Crater. Erosion has partially exposed the dikes. The unit has an average cumulative thickness of 37 m and an estimated volume of 4.0 km^3. A whole-rock K-Ar age date of 3.7 +/- 0.5 m.y.b.p. was determined for this unit north of the map area (Hammond and Korosec, 1983). The basalt of Thomas Lake is one of the oldest units of the Indian Heaven volcanic field, but may not be as old as the age date indicates.

Qvtr

Basalt of Trout Creek Hill--Dark-gray, phyric, olivine basalt. Phenocrysts of subhedral labradorite, light-green olivine with rims of iddingsite, and megascopic clots of glass are in a diktytaxitic groundmass of plagioclase microliths, granular pyroxene, and glass (Berri and Korosec, 1983). The vesicular to dense, blocky jointed flows are 1.5-10 m thick and form a series of intracanyon lava flows in the Wind River valley. In the Wind River gorge at "High Bridge" (age date site no. 2 on the map), the flows have a cumulative thickness of 760 m. They erupted from at least three vents at Trout Creek Hill and probably make up the majority of the volume of Trout Creek Hill. Flows reached the Columbia River, temporarily damming it. Two whole-rock K-Ar age dates for this unit give very similar results, 340,000 +/- 70,000 yr (Hammond and Korosec, 1983; and sample no. 2 in Table 1) and 338,000 +/- 75,000 yr (Berri and Korosec, 1983; and sample no. 1 in Table 1).

Qvtw

Basalt of The Wart--Gray, sparsely phyric, olivine basalt (Hammond, written commun., 1983). Phenocrysts of plagioclase and olivine are in a partly glassy, vesicular to densely crystalline groundmass. The basalt forms a slaggy pahoehoe lava flow 1-5 km thick, and a 145 m high craterless cone of interlayered scoria, lithic fragments, and spatter. The total volume is estimated to be 0.04 km^3. The northeastern flank of the cone is mantled by 2 m of till from Evans Creek alpine glaciers. The probable age is middle to late Pleistocene.

Qvuw

Basalt of Underwood Mountain--Light-gray, phyric, olivine basalt (Hammond, 1980). Phenocrysts consist of plagioclase and olivine. The basalt forms a broad shield volcano with two cinder cones at the top. The flanks are built up by fine- to medium-grained, dense to vesicular, blocky jointed flows 3-10 m thick, with scoria interbeds. The maximum thickness is at least 180 m. Palagonite tuff breccia and pillow basalt form basal deposits where the basalt flowed into and partially blocked the Columbia River. A whole-rock K-Ar age date of 850,000 +/- 20,000 years was determined for this unit (Hammond and Korosec, 1983; and sample no. 3, Table 1).

Qvwn

Basalt north of White Salmon--Dark-gray, phyric, olivine basalt (Hammond, 1980). Basalt forms fine-grained, dense to diktytaxitic, blocky jointed flows 3-35 m thick and a lava cone north-northwest of the town of White Salmon. The basalt flowed to the west, reaching the White Salmon River. The age is unknown, but the unit may be related to the basalt of White Salmon (Qvws) and the Underwood volcano (Qvuv), about 850,000 years old.

Qvws

Basalt of White Salmon--Gray to medium-gray, phyric, olivine basalt (Hammond, 1980). Vesicular, blocky jointed lava flows, 1-6 m thick, separated by scoria interbeds 1.5-3 m thick, form a shield volcano west of the town of White Salmon. A single cinder cone marks the top of the volcano. The total thickness of the unit is at least 90 m. The basal zone includes palagonite tuff grading upward into pillow lava and blocky subaerial lava where the flows entered the White Salmon and Columbia Rivers. Near the confluence of the rivers, the basal zone of subaqueous volcanic material has a thickness of 40 m. The age is unknown, but the unit may be contemporaneous with the Underwood volcano (Qvuw), about 850,000 years old.

Pliocene-Pleistocene Sediments

QTg

Pliocene-Pleistocene gravels; Swale Creek valley sedimentary deposits (Newcomb, 1969)--Gravel and lesser sand, silt, and clay forming poorly sorted unconsolidated channel deposits, with a thickness of as much as 70 m. The material was eroded from the adjacent basaltic terrain and is overlain by several meters of loess. The clasts are about 80% subrounded to subangular volcanic rocks, primarily basalt from the Wanapum Basalt, and about 20% well-rounded quartzite clasts derived from the Ellensburg Formation. East of the map area, an olivine basalt flow from Haystack Butte, with a K-Ar age date of 0.9 m.y.b.p. (Shannon and Wilson, 1973), overlaps the sediments.

QTs

Pliocene-Pleistocene sediments--Older alluvium of uncertain age forming remnant terraces.

Pliocene-Pleistocene Volcanic Rocks

QTv

Pliocene-Pleistocene volcanic rock, undifferentiated--Volcanic rocks, primarily basalt, basaltic andesite, and andesite flows, forming ridges and plateaus south of the Columbia River.

QTvb

Pliocene-Pleistocene basalt flows--Basaltic flows and flow breccia forming plateaus and remnant valley fillings south of the Columbia River. At Benson Plateau, medium-gray, phyric, olivine basalt forms blocky jointed, 5-15-m-thick lava flows with a total thickness of about 150 m (Hammond, 1980). West of the Hood River Valley, undifferentiated basalt includes isolated lava flows, layered flows from shield volcanoes, and flows mapped on the east side of the Hood River Valley as basalt porphyry of Hood River Valley (QTvh), an olivine basalt.

QTvh

Basalt porphyry of Hood River Valley--Gray and blue-gray, porphyritic, olivine basalt underlying much of the lower Hood River valley. The phenocrysts consist of aggregates of labradorite, olivine, and magnetite. The groundmass ranges from finely crystalline to glassy. On the west side of the lower Hood River valley, flows mapped as basalt at Ruthon Point by Hammond (1980) and Crag Rat and Marble Cake flows of Goff (1977) are included in this unit. These flows are described as interstratified blocky jointed, vesicular pahoehoe flows 2-8 m thick, with foreset-bedded palagonitic tuff breccia 20-35 m thick that contains detached and fragmented pillows. An eroded vent between Meno and Post Canyons is a probable source for at least part of this unit (Hammond, 1980).

QTvsd

Dacite of Snowden--Light-gray to purplish-tan hyalopilitic and porphyritic, oxyhornblende dacite flows and domes (Sheppard, 1964). The dacite contains oscillatory zoned plagioclase and zoned oxyhornblende phenocrysts with a groundmass of plagioclase, clinopyroxene, opaque minerals, and partly crystallized pale tan glass. The flows erupted through the Frenchman Springs Member of the Wanapum Basalt and covered Frenchman Springs and Grande Ronde Basalt flows.

QTvbh

Basalt of Booth Hill--Gray basalt flows and flow breccia erupted from a cluster of cones at Booth Hill, separating the lower and upper Hood River Valley. The flows are block jointed and deeply weathered (Hammond, 1980).

QTvbl

Basalt porphyry of Balch Lake--Black to dark-gray, porphyritic, olivine basalt flows and flow breccia (Newcomb, 1969). Evenly spaced plagioclase phenocrysts (labradorite) up to 2 cm long form 10-40% of the rock. The matrix is microcrystalline to glassy. The basalt is probably a single flow with a thickness of 3-18 m, and it may have originated in the Simcoe Mountains volcanic field to the northeast. It overlies volcanic sedimentary rock of the Dalles Formation with a slight angular unconformity and has been warped by the late Pliocene to early Pleistocene regional tectonics.

QTvlb

Basalt of Lenz Butte--Gray basalt flows and flow breccia, forming hills south of the lower Hood River Valley. The flows were erupted from a single cone at Lenz Butte and are overlain by the basalt of Booth Hill.

QTsb

Basalt of the Simcoe Mountains (Pliocene to lower Pleistocene)--Gray to gray-black, fine-grained, aphyric to slightly porphyritic, olivine basalt flows and flow breccia (Sheppard, 1960, 1967; Anderson, written commun., 1985). Surfaces weather to light brown to pale yellowish brown. Flows are occasion- ally glassy. Thin sections commonly show a trachytic texture, with rare to abundant plagioclase and olivine phenocrysts in a nearly holocrystalline groundmass of plagioclase, clinopyroxene, olivine, magnetite, and apatite. Individual flows are 1-13 m thick and form stacked flow sequences with thicknesses up to 220 m. Older intracanyon flows usually have well developed colonnades and entablatures. Younger flows are thinner with columnar jointing. The flows erupted from vents on the flanks of shield volcanoes. Cinder cones, up to 45-90 m high, consist of poorly sorted, generally unconsolidated, stratified scoria. They often are aligned along northwest-trending zones. Remanent mag- netism has both reversed and normal polarity. K-Ar age dates for flows outside the map area and to the east range from 1.0 to 4.7 m.y. b.p., with most flow ages confined to 2.5-4.5 m.y.b.p. A flow filling a canyon cut into earlier flows on the northwest side of Horseshoe Bend has a whole-rock K-Ar age date of 2.88 +/-0.05 m.y.b.p. (Phillips and others, 1986; and sample no. 7, Table 1).

Pliocene-Pleistocene Intrusive Rocks

QTid

Dacite dome of Gross Mountain--Light-gray porphyritic hypersthene dacite plug dome (Sheppard, 1964). The hypersthene phenocrysts are partially to completely altered to saponite. The dome is poorly exposed on the southeast side of Gross Mountain. It intrudes the Frenchman Springs Member of the Wanapum Basalt.

Tertiary Stratified Rocks

Ttd

Troutdale Formation (Pliocene)--Moderately consolidated conglomerate with lesser lenticular sandstone and siltstone interbeds. The conglomerate is poorly bedded and is commonly crossbedded and channeled. The clasts are dominantly volcanic, especially basaltic, but distinctive light-orange quartzite pebbles form a significant component of the clasts and are often used to distinguish the Troutdale. The medium sands are cross-bedded and micaceous. In the map area, the formation is represented by a single mappable outcrop on the northwest side of Nick Eaton Ridge, just south of the Columbia River. The formation probably underlies part of the extensive Pliocene to Pleistocene volcanic rocks south and east of the outcrop. The most extensive outcrops of the formation are just west of the map boundary. The Troutdale represents the deposits of an ancestral Columbia River. The unit is primarily Pliocene, but stratigraphic evidence suggests that the Troutdale was deposited from the late Miocene through early Pleistocene. See Tolan and Beeson (1984) for a detailed description of the formation and its age.

Tdl

Dalles Formation (upper Miocene)--Thickly bedded gray and buff volcaniclastic and sedimentary deposits of breccia, pumiceous tuff, tuff breccia, lithic tuff, ash, conglomerate, sandstone, siltstone, and mudstone (Newcomb, 1969). Most of the formation occurs west, south, and east of The Dalles, reaching a maximum thickness of about 600 m in the Mill Creek valley, thinning to the north and east. Near The Dalles, the formation is 150 m thick. Newcomb (1966) describes the formation as the interfingering of two separate facies, an andesitic debris fan of agglomerate, tuff, and tuff breccia deposited by debris flows and mud flows, and a nonvolcanic sedimentary facies of clastic materials deposited by west-flowing rivers. The agglomerate consists of hornblende and pyroxene andesite clasts in a matrix of pumice shards, partly altered volcanic glass, and plagioclase crystals. The degree of consolidation and induration varies throughout the volcanic unit. The sedimentary facies is mostly restricted to the Dalles Formation east of the map area, but minor interfingering of this unit with the volcanic unit does occur along Fifteenmile Creek in the southeast map area. Fine-grained tuff, silt, and sand are interbedded with river-laid conglomerate. Individual conglomerate layers are lenticular, range from 3-15 m thick, and consist of well rounded cobbles from earlier Tertiary units in the region, but do not include any of the metamorphic clasts which characterize the Ellensburg Formation and Troutdale Formation (Newcomb, 1966). The Dalles Formation overlies the Columbia River Basalt Group, including the

Pomona Member of the Saddle Mountains Basalt, with slight angular unconformity. Vertebrate and leaf fossil data summarized by Newcomb (1966) suggest a late Miocene to early Pliocene age, but age dates of 10.6 and 15.2 m.y.b.p. on a lava flow within the sedimentary facies just east of the map area, near the top of the unit, suggests just a late Miocene age. The Dalles Formation is a time correlative of the Ellensburg Formation, but the sources of material for the two formations are dissimilar.

Tel

Ellensburg Formation (middle to upper Miocene)--Weakly to moderately indurated, interstratified light-gray to pale-brown fluvial and volcaniclastic deposits. The unit includes laharic breccia, volcaniclastic sandstone, felsite- and pumice-pebble conglomerate, fluvial conglomerate, and air-fall tuff. Clasts of the conglomerate are predominantly basaltic and andesitic, but include quartzite and other metamorphic clasts. Pumiceous material is predominantly dacitic. The sandy matrix of the volcaniclastic conglomerates is mostly nonmicaceous. The maximum total thickness of the unit is 15 m in the map area (Anderson, written commun., 1985). Near the head of Indian Creek southeast of McCoy Flat, a mudflow deposit consists of gray to light-purple, angular to subangular hypersthene-oxyhornblende dacite in a yellow fine-grained matrix (Sheppard, 1964). The Ellensburg probably represents deposits of the ancestral Columbia River systems, especially deposits of the tributary streams draining the late Miocene Cascade Mountains. The deposits conformably overlie the Frenchman Springs and Priest Rapids Members of the Wanapum Basalt and are unconformably overlain by the basalt of the Simcoe Mountains. Consequently, the Ellensburg accumulated between 5 and 15 m.y.b.p. Age dates on the Ellensburg outside of the map area fall in this range.

Telc

Snipes Mountain conglomerate member of the Ellensburg Formation (upper Miocene)--Weakly consolidated river gravel and sand. Clasts include abundant quartzite, metavolcanic rock, and basalt of the Columbia River Basalt Group in a micaceous sandy matrix. The unit has been interpreted as a channel deposit of the ancestral Columbia River, tracing a course from Snipes Mountain through the Goldendale and White Salmon areas towards Hood River, Oregon, in post-Elephant Mountain Member time, after 10.5 m.y.b.p. (Swanson and others, 1979).

Tvb_4

Middle Miocene basalt flows--Dark-gray porphyritic basalt flows. The rock contains abundant phenocrysts of plagioclase, clinopyroxene, and altered olivine with a hypocrystalline, trachytic groundmass of plagioclase, clinopyroxene, opaque minerals, and glass. The basalt caps hills and ridges north of Lost Creek. The flows overlie tuff breccias and volcanic sediments of upper Oligocene to lower Miocene age. A whole-rock K-Ar age date of 12.9 +/- 0.3 m.y.b.p. was determined for basalt from a quarry on the northwest side of the Lost Creek valley (Table 1, sample no. 12).

Tsp

Saddle Mountain Basalt, Pomona Member (middle Miocene)--Dark-gray to blue-black, fine-grained, abundantly to slightly plagioclase phyric olivine flood basalt. Surfaces weather to light brownish gray to light olive gray. The basalt was erupted from vents and fissures in southeast Washington, northern Oregon, and western Idaho, as a single sheet flow and intracanyon flow 5-50 m thick. Colonnade and entablature are generally well developed. North of Grayback Mountain, it occupies a paleochannel at least 120 m deep, representing the ancestral Columbia River(?) (Bentley and others, 1980). The basalt has reversed remanent magnetic polarity (Choinier and Swanson, 1979) and has been K-Ar-dated at 12 m.y.b.p. outside the map area (McKee and others, 1977).

Twp

Wanapum Basalt, Priest Rapids Member (middle Miocene)--Gray-black, fine- to coarse-grained, sparsely phyric flood basalt. The rock weathers to light brown, yellowish gray, and rusty brown. Phenocrysts include plagioclase glomerocrysts 0.5-1.0 cm long and olivine (Anderson, written commun., 1985). Olivine is a common component of the groundmass. The flows have well developed colonnades, with vertically platy sections, and are locally pillowed at the base. The unit overlies the Roza Member and is overlain by the Pomona Member of the Saddle Mountains Basalt between White Salmon and the mouth of the Klickitat River, by the Dalles Formation south of the Columbia River, and by the basalt of the Simcoe Mountains in the northeast map area. Priest Rapids flows have reversed magnetic polarity, with an age of 14.5 m.y.b.p.

Twr

Wanapum Basalt, Roza Member (middle Miocene)--Dark-gray, fine- to medium-grained, phyric flood basalt. The rock weathers light brown and yellowish gray. The phenocrysts are single crystals of plagioclase up to 1.0 cm long with more numerous glomerocrysts of plagioclase. Locally, the flow tops are aphyric and bases are pillowed. The colonnade is well developed, with columns reaching 1 m in diameter. Where the flow thins near its margin, entablature is present (Anderson, written commun., 1985). The magnetic polarity has been reported as both normal and transitional (Rietman, 1966; Choiniere and Swanson, 1979). Its age is bracketed by the 15.6-m.y.-old Frenchman Springs Member below and 14.5-m.y.-old Priest Rapids Member above.

Twf

Wanapum Basalt, Frenchman Springs Member (middle Miocene)--Gray to black, medium- to coarse-grained, very sparsely to highly plagioclase phyric flood basalt. The rock weathers light brown or yellowish gray and brown. In the map area, the Frenchman Springs Member consists of 3-5 individual flows distinguished by phenocryst distribution and geochemistry (Anderson, written commun., 1985). The upper flow is generally aphyric but has rare plagioclase phenocrysts up to 1.5 cm long and irregularly columnar to vertically platy jointing. The middle flow is aphyric to phyric, containing rare to abundant plagioclase clusters up to 2.5 cm across, 60 m thick, and well-developed blocky to platy lower colonnade and vertically platy center. The lower sequence of flows is phyric, containing abundant phenocrysts and glomerocrysts of plagioclase 1-1.5 cm across, and has a collective thickness of up to 60 m. The lowest flow has well-developed colonnade and entablature and is locally pillowed at its base. Blocky to platy columnar jointing characterize the "upper" flows. The Frenchman Springs flows have normal magnetic polarity. They overlie Grande Ronde Basalt (15.6-16.5 m.y.b.p.) and are overlain by the Roza and Priest Rapids Members (14.5 m.y.b.p.) of the Wanapum, except along the northwest margin of the Frenchman Springs. Tuffaceous sediments below the Frenchman Springs (the Vantage Member of the Ellensburg Formation) are dated at 15.6 m.y.b.p. outside the map area.

Tgr

Grande Ronde Basalt (middle Miocene)--Dark-gray to black, aphyric to very sparsely plagioclase phyric flood basalts, comprising the thickest, most voluminous formation of the Columbia River Basalt Group. The rocks weather light brown to yellowish brown. The flows are generally fine-grained and petrographically nondistinctive. The chemical composition varies within a broad field referred to as the Grande Ronde chemical type. This chemical composition classifies the rock as a basaltic andesite by many classification systems. Age dates on these flows and tuffaceous sediments between the Grande Ronde and overlying Frenchman Springs Member of the Wanapum Basalt (Vantage Member of the Ellensburg Formation) restrict the age to 15.6-16.5 m.y.b.p. The Grande Ronde flows can be divided into four magnetostratigraphic units, three of which occur within the map area:

Tgn_2

Upper flows with normal magnetic polarity occurring over the southeast 2/3 of the map.

Tgr_2

Upper flows with reversed magnetic polarity, underlying most, if not all of the Tgn_2.

Tgn_1

Lower flows with normal magnetic polarity, underlying the Tgr_2 and with known outcrops restricted to the area along the Columbia River at Dog Mountain and north of Mount Defiance.

Tec

Eagle Creek Formation (lower Miocene)--Interstratified light-brown to gray conglomerate, debris flow breccia-conglomerate, pebbly volcaniclastic sandstone, tuffaceous sandstone and siltstone, and minor airfall tuff (Wise, 1961; Hammond, 1980). The unit was deposited in a predominantly fluvial sedimentary environment draining a volcanic terrain, and it includes deposits from floods, mudflows, debris flows, and moderate- to low-energy stream systems. Boulder and cobble conglomerate consists of abundant well rounded dark porphyritic andesite clasts up to 2 m in diameter in a matrix of clay, typically white montmorillonite, and forms 2-3-m-thick channel fills cut into finer gravel conglomerate and sandstone. The breccia conglomerate forms single beds up to 3.5 m thick that lack internal structure, are very poorly sorted, and contain angular to subrounded boulders and cobbles in a matrix of white to buff clay and pumice fragments. The sandstones are thin bedded, well sorted, and form lensoidal deposits up to 4 m thick. Near Greenleaf Peak northwest of the Bonneville landslide, 370 m of the formation is exposed in the slide scarp. The Eagle Creek rests unconformably on late Oligocene volcaniclastic rocks and is unconformably overlain by middle Miocene Grande Ronde Basalt and Quaternary basalt flows.

Tcb

Volcanic rocks of Council Bluff (lower Miocene)--Dark-brown to black interstratified porphyritic hypersthene-clinopyroxene andesite and basaltic andesite flows, flow breccia, and minor volcaniclastic rock. North of the map area, the Council Bluff unit ranges in age from about 26 m.y. to about 17 m.y.b.p. The unit was called lava flows of Council Bluff by Hammond (1980) and includes the Council Bluff unit of Harle (1974). A whole-rock K-Ar age date on a flow west of McClellan Meadows (just north of the map boundary) is 19.9 +/- 0.4 m.y.b.p. (Table 1, sample MK85-5-46).

Tvb_3

Lower Miocene basalt flows--Dark-gray to black, aphyric to microphyric and porphyritic, pyroxene basalt. Flows cap the ridge at Sedum Point and occur on the southeast flank of Big Butte. Phenocrysts of plagioclase and clinopyroxene are in a groundmass of plagioclase, opaque minerals, and brown, weakly birefringent material which probably represents altered glass. At Big Butte, the glass is unaltered. The basalt flows average about 10 m thick. A whole-rock K-Ar age date of 23.6 +/- 1.2 m.y.b.p. (Phillips and others, 1986, and Table 1, sample 17) determined for the Sedum Point flow may be too old by about 10%, suggested by the local stratigraphy and other age date control. (See discussion for Tst, volcanic rocks of Stevenson Ridge.) A basalt with similar chemistry and mineralogy northeast of Sedum Point on Big Butte has an age of 20.8 +/- 1.2 m.y.b.p. (Phillips and others, 1986, and Table 1, sample 14).

Tst

Volcanic rocks of Stevenson Ridge (lower Miocene)--Brown to dark-gray porphyritic pyroxene basaltic andesite flows and flow breccia and very minor volcaniclastic rocks (Berri and Korosec, 1983). The individual flows are platy to massive with columnar jointing and reach thicknesses of up to 40 m. The pyroxenes are typically augite, but some flows have both augite and hypersthene. Alteration is slight to moderate. Much of the unit is relatively flat lying or dips gently to the southwest. It overlies late Oligocene to early Miocene volcaniclastic rocks with angular unconformity and is overlain by the early Miocene Eagle Creek Formation with a slight angular unconformity and by a black, fine-grained, slightly phyric basalt at Sedum Point. A whole-rock K-Ar age date of 15.7 +/- 1.5 m.y.b.p. (Berri and Korosec, 1983; and Table 1, sample no. 15) is too young. An age of 24.2 +/- 1.2 for the basalt at Sedum Point (Table 1, sample no. 17) is probably too old. Given the 22.7 +/- 0.3 m.y.b.p. age date for a dacite within the volcaniclastic unit below the basaltic-andesite flows (Berri and Korosec, 1983), an age range of about 22 to 16.5 m.y.b.p. for the Eagle Creek Formation, and a K-Ar date of 20.8 +/- 1.2 m.y.b.p. (Table 1, sample no. 14, a probable extension of the Sedum Point basalt) for the basalt at Big Butte, the volcanic rocks of Stevenson Ridge are at least restricted to about 21-24 m.y.b.p. The unit is equivalent to lava flows of Three-Corner Rock (Hammond, 1980) west of the map, and partly correlative with volcanic rocks of Council Bluff, (Tcb).

Tvt_3

Upper Miocene tuff -- Andesitic to dacitic tuff and tuff breccia, occurring in three areas. (1) In the northwest map area, a silicic crystal lithic to pumiceous tuff overlies upper Oligocene andesite and basaltic andesite flows and underlies lower Miocene andesite flows of the volcanic rocks of Council Bluff. Northwest of the map area, the lower basaltic andesite has a whole-rock K-Ar age date of 28.5 +/- 1.8 m.y.b.p. (Phillips and others, 1986; and Table 1, sample MK85-8-6). Just north of the map boundary, the upper flows have a whole-rock K-Ar date of 19.9 +/- 0.4 m.y.b.p. (Table 1, sample MK85-5-46). (2) Southwest of the Indian Heaven volcanic field, pumiceous tuff and very coarse lithic and pumiceous tuff breccia overlie zeolitized Oligocene volcaniclastic rock mapped as Tvc_2. The tuff is relatively flat lying, giving it an apparent angular unconformity with the underlying southwest-dipping volcaniclastic rocks. Quaternary basalt overlies the unit. The tuffs here may be as old as late Oligocene and may be equivalent to the tuff described above. (3) The third Tvt_3 unit is present along the southwest side of the Wind River valley, overlying volcanic sedimentary rocks mapped as Tvs_3 and underlying the lower Miocene volcanic rock of Stevenson Ridge (Tst). This tuff may also be as old as upper Oligocene.

Tvs_3

Lower Miocene volcanic sedimentary rocks--Fine-grained, generally well-sorted and bedded, lithified sediments consisting of rounded andesite and altered pumice particles generally less than 2 cm in diameter, in a matrix of altered glass, crystals, clay, and organic grains (Berri and Korosec, 1983). The sediments are the result of fluvial reworking and deposition of volcaniclastic material. Thin interbeds of airfall tuff suggest quiet water and lacustrine depositional settings. The unit is restricted to the southwest side of the Wind River valley, where it underlies a tuff and tuff breccia unit (Tvt_3) and is interbedded with dacite and basaltic andesite flows. The probable base of the Tvs_3 unit is Tvc_2, which crops out on the northwest side of the valley. Tvs_3 is indistinguishable from the sedimentary volcaniclastic beds in the upper Oligocene unit. Tvs_3 is shown as lower Miocene because of its stratigraphic position and a whole-rock K-Ar age date of 22.7 +/- 0.3 on an interbedded dacite flow (Tvd_3) (Berri and Korosec, 1983; and Table 1, sample no. 15).

Tvd_3

Lower Miocene dacite flows--Dark-gray to black porphyritic pyroxene dacite. The flow averages about 3 m thick and is platy to blocky jointed. It is interbedded with volcanic sedimentary rock (Tvs_3). A whole-rock K-Ar age date of 22.7 +/- 0.3 m.y.b.p. (Berri and Korosec, 1983; and Table 1, sample no. 15) is the basis for its early Miocene age, but the date may be too young by 10% or more. Stratigraphically, the flows may be as old as upper Oligocene.

$Tvba_3$

Lower Miocene basaltic andesite flows--Lava flows, sills, and plugs(?) of intermediate composition, interbedded with and intruding(?) sedimentary volcaniclastic rocks (Tvs_3) southwest of the Wind River valley.

Tva_2
$Tvba_2$

Upper Oligocene andesite and basaltic andesite flows--Gray, porphyritic to glomeroporphyritic pyroxene and hornblende andesite, basaltic andesite, and flow breccia associated with these flows. The flows weather tan and brown. The rocks have phenocrysts of plagioclase, pyroxene (hypersthene and augite), and hornblende in a groundmass of plagioclase, augite, and glass, typically altered (Wise, 1960; McGowan, 1985). In the Middle Butte-Paradise Ridge area, a stacked sequence of flat to gently dipping flows has a total thickness of at least 100 m. Some sections of the Paradise Ridge andesites lack breccia, suggesting that this area may include a shallow sill complex. This, along with numerous sills and dikes cutting both the underlying volcaniclastic rocks and the flows, suggests that the area was a major volcanic center. Several ridge-capping flows and single flows interbedded with the Tvc_2 unit are mapped as Tva_2 and $Tvba_2$, but some of these flows may be younger than Oligocene.

Tvc_2

Upper Oligocene volcaniclastic rocks--Tuffs, tuff breccia, volcaniclastic breccia, volcanic sandstone, lapillistone, and conglomerate (Wise, 1961, 1970). Tuffs and tuff breccia, the most abundant components, are massively bedded with little or no stratification, are as much as 12 m thick, and are composed of angular clasts of andesite and pumice. They are interbedded with fine-grained sandstone, claystone, and airfall ashbeds. Some tuffs have been partially welded, and most have had reworked upper sections. In the upper Wind River area (northwest map area), the tuffs are crystal lithic lapilli tuff and olive-green to tan, fine-grained, vitric-crystal tuff with accretionary lapilli and airfall ash. These units are interbedded with andesite flows and extensively cut by sills and dikes (McGowan, 1985). Volcaniclastic breccias 8-15 m thick contain a variety of volcanic material probably representing pyroclastic flows, as well as deposits from debris flows, surge deposits from explosive eruptions, and low-energy mudflows. The volcanic sandstones are typically thinly bedded and well to poorly sorted. They consist of volcanic debris, dominantly andesite clasts and altered pumice particles, and represent the deposits of fluvial reworking of volcaniclastics. Carbonized and partially silicified wood is common in thicker beds. The lapilli stone is composed of well-sorted pumice lapilli and rounded andesite, and it occurs in beds up to 12 cm thick. The conglomerates contain clasts of porphyritic and aphanitic andesite and basaltic andesite. Most of the volcaniclastic rocks of this unit are altered, with extensive replacement by zeolites and clay minerals; Wise (1961) gives a detailed description of the zeolite alteration. In the Wind River area, Wise named this unit the Weigle Formation, but he later applied the name Ohanapecosh Formation, equating it to the volcaniclastics described by Fiske and others (1963). While both units are similarly zeolitized middle Tertiary volcaniclastic rocks of multiple origins, the Ohanapecosh is generally older, more silicic, and less tuffaceous at its type section than the rocks in the Wind River area. The base of this unit, which is not exposed, is probably correlative to the lower sections of the Ohanapecosh.

Tvt

Tertiary tuff and tuff breccia (Oligocene or lower Miocene)--Andesitic to dacitic tuff and tuff breccia; partially to highly altered. The tuff is very poorly exposed west of Willard and south and east of Hauk Butte. The unit may be equivalent to the tuffaceous volcaniclastic rocks (Tvc_2), which would make it upper Oligocene to lower Miocene.

Tertiary Intrusive Rocks

Pid

Pliocene dacite--Light-tan, porphyritic hornblende dacite stocks and domes at Hauk Butte, north of Augsburger Mountain (Little Wind River plug), and north of Wind Mountain. At Hauk Butte, the dacite is fine-grained, porphyritic, grading to diorite porphyry with subhedral granular texture. The plagioclase is zoned, and the green hornblende is well preserved. A whole-rock K-Ar age date of 4.8 +/- 0.1 m.y.b.p. was determined on a fine-grained phaneritic phase (Phillips and others, 1986; and Table 1, sample no. 8). The Little Wind River plug is petrographically and chemically similar to the dacite at Hauk Butte, but generally finer-grained, and is probably the result of the same intrusive/volcanic event. North of Wind Mountain, a hornblende dacite which in hand specimen appears similar to Hauk Butte rocks, had zoned plagioclase and hornblende phenocrysts in a groundmass of plagioclase laths with quartz and orthoclase (Wise, 1961). All three dacite porphyries may be related to the Wind Mountain and Shell Rock quartz diorites, also of late Miocene to Pliocene age.

Piqd

Pliocene quartz diorite; Wind Mountain and Shell Rock quartz diorites--Light-gray to brownish-gray, porphyritic hypersthene-biotite-quartz diorite, hornblende-quartz diorite, and hornblende diorite stocks. The varied textures and mineralogies are the result of multiple intrusions. Along the margins, inclusions of fine-grained black Grande Ronde Basalt give the intrusion an age of post-middle Miocene. Some included blocks are greater than 1 m across. A hypersthene-hornblende diorite porphyry collected on the northwest side of Wind Mountain gave a whole-rock K-Ar age date of 4.9 +/- 0.1 m.y.b.p. (Phillips and others, 1986; and Table 1, sample no. 9). T. L. Tolan (personal commun., 1985) reports K-Ar ages of 6.6 +/- 0.7 m.y.b.p. for Wind Mountain and 5.7 +/- 0.6 m.y.b.p. for Shell Rock (Table 1, sample nos. 10 and 11).

Tiqd

Upper Miocene to Pliocene quartz diorite--Discontinuous plugs and sills along the south shore of the Columbia River near Government Cove. Light greenish-gray to yellowish-gray, fine- to medium-grained porphyritic augite-hypersthene-quartz diorite (Free, 1976). Phenocrysts of plagioclase, clinopyroxene, and hypersthene and blebs of quartz are in a groundmass of felted plagioclase laths, prismatic and granular pyroxenes, interstitial quartz, and fine-grained magnetite and ilmenite. Patches of zeolites, secondary amphibole, and biotite are the most common alteration products. The rock is very similar to the Wind

Mountain and Shell Rock quartz diorites and may have formed at about the same time.

Tib

Miocene intrusive basalt--Isolated dikes of fine-grained augite basalt. South of Table Mountain and at Bonneville, Oregon, the dikes have diabase texture and are slightly altered. They cut the Eagle Creek Formation and are possibly younger than the Columbia River Basalt Group. At Shingle Mountain, a dike of fine-grained basalt cuts upper Oligocene volcanic sediments, is relatively unaltered, has only a thin zone of weathering at several outcrops, and may be younger than Miocene.

Tir

Rhyolite of Mann Butte (upper Oligocene or lower Miocene)--Grayish-yellow aphanitic rhyolite forming a pervasively brecciated and argillized plug or dome at Mann Butte, southwest of the town of Trout Lake (Hammond, 1980). Zircons from the rhyolite produced uranium fission-track ages of 1.5-35.5 m.y.b.p., with clusters at ages of 3-4 m.y.b.p. and 25-26 m.y.b.p. (G. A. Clayton, Univ. of Washington, personal commun., 1983).

Tiba

Upper Miocene to Pliocene intrusive basaltic andesite--Fine-grained to porphyritic sills, dikes, and stocks of pyroxene basaltic andesite. At Termination Point, a plug and sill cut volcanic rocks of Council Bluff and appear to be an early Miocene source of Council Bluff flows.

Tia

Miocene to Pliocene intrusive andesite--Sill of porphyritic andesite on the south shore of the Columbia River west of Shell Rock. The two outcrops have been called Airway Beacon sill and "landslide knob" by Free (1976). They may be associated with the intrusive events which produced Shell Rock, Wind Mountain, and/or Government Island quartz diorites, which are upper Miocene to Pliocene.

Tid

Upper Oligocene to Miocene intrusive dacite--Small sills, dikes, and plugs of hypersthene dacite and hornblende dacite in the upper Wind River drainage area. The dacites are typically porphyritic and hydrothermally altered. They cut upper Oligocene tuffs and andesite flows.

Tidi

Upper Oligocene to Miocene diorite--Dikes, sills, and small stocks of fine- to medium-grained augite and/or hypersthene diorite and hornblende diorite. Most are diorite porphyries, commonly partially altered to kaolinite, chlorite, other clays, and quartz. The Buck Mountain intrusion, exposed along the Wind River east of Carson, is light gray to bluish gray, with large phenocrysts of plagioclase, hypersthene embayed by augite, and augite in a groundmass of plagioclase, quartz, magnetite, ilmenite, and very minor zircon (Free, 1976). The other intrusions of this unit in the Wind River area are mostly augite-hypersthene sills petrographically similar to the Buck Mountain intrusion but more porphyritic and with amygdaloidal tops. They are described by Berri and Korosec (1983). At Little Huckleberry Mountain, a light-gray to light-greenish-gray, medium-grained hornblende diorite forms a 300-m-wide northeast-trending dike. The phenocrysts are primarily plagioclase, with some hornblende and minor clinopyroxene. The dike has blocky jointing and has been partly saussuritized and argillized (Hammond, 1983). A whole-rock K-Ar age date of 23.2 +/- 1.0 m.y.b.p. was determined for diorite from Warren Ridge 1.5 km north of Warren Gap (Berri and Korosec, 1983; and Table 1, sample no. 16).

Tigb

Upper Oligocene to Miocene gabbro--Black, coarse-grained, porphyritic, augite gabbro and diabase plugs at Bunker Hill and north of Wind Mountain. The outer shell of the Bunker Hill plug has a diabase texture; the core is coarser, with a gabbroic texture. Phenocrysts of plagioclase and subhedral augite are in a groundmass of anhedral-zoned plagioclase, magnetite, and pyroxene. Clay alteration is prevalent (Berri and Korosec, 1983). The plug cuts upper Oligocene volcaniclastic rocks and has metamorphosed the country rock to a hornfels zone extending 90 m from the contact. It may be a source for the volcanic rocks of Stevenson Ridge or the volcanic rocks of Council Bluff, which would suggest an early Miocene age.

Ti

Tertiary intrusive rocks, undifferentiated--Sills and plugs of undetermined composition and uncertain age south of the Columbia River. The outcrops are surrounded by QTv volcanic rocks that obscure contacts. The plugs may represent volcanic centers responsible for part of the late Miocene Dalles Formation.

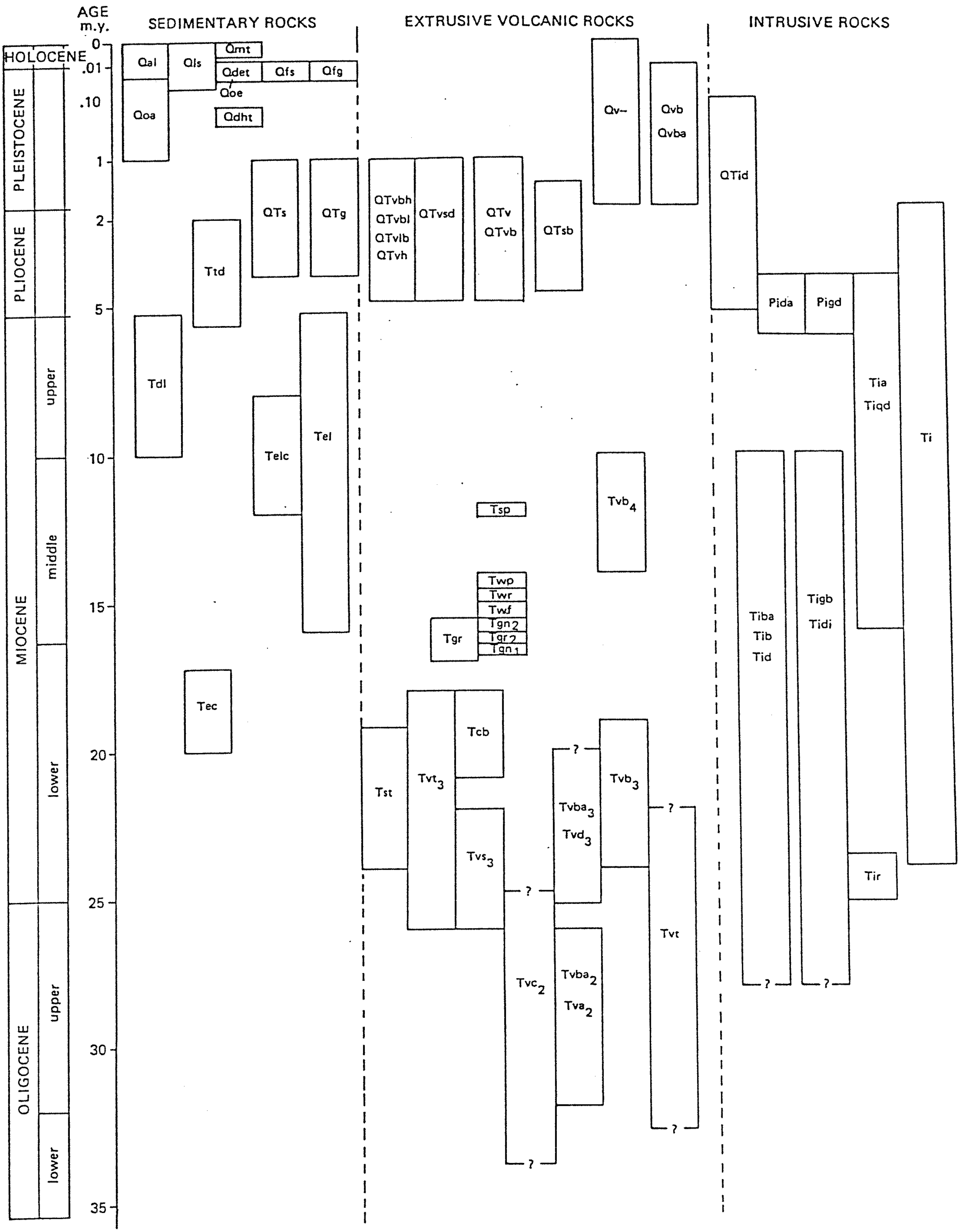

Figure 1. Correlation - Duration Diagram —— Hood River Quadrangle

TABLE 1. AGE DATES FOR THE HOOD RIVER 1:100,000 QUADRANGLE

MAP NO.	ORIGINAL SAMPLE NO.	NAME	MAP SYMBOL	LATITUDE N. o, ', "	LONGITUDE W. o, ', "	TOWNSHIP	RANGE	1/4 1/4 SECTION	MATERIAL DATED	PER CENT K2O	40AR, MOLES/ GM x 10E12	PER CENT 40AR/ TOTAL AR	AGE (m.y.)	LAB	REF
01	017	basalt of Trout Creek Hill	Qvtr	45 43 00	121 47 50	03 N.	08 E.	SE, SE, 28	Whole Rock				0.338+/- 0.075	1	b
02	155	basalt of Trout Creek Hill	Qvtr	45 45 14	121 49 58	03 N.	08 E.	SE, SE, 07	Whole Rock				0.34 +/- 0.07	1	a
03	061	basalt of Underwood Mountain	Qvum	45 43 43	121 36 20	03 N.	08 E.	NE, SW, 09	Whole Rock				0.85 +/- 0.02	1	a
04	128	basaltic andesite of Juice Creek	Qvjc	45 56 46	121 53 17	05 N.	07 E.	NE, SW, 12	Whole Rock				1.40 +/- 0.06	2	a
05	051	basalt of Gilmer Creek	Qvgc	45 51 16	121 30 00	04 N.	10 E.	NW 12	Whole Rock				1.76 +/- 0.50	3	a
06	017	andesite of Black Creek	Qvbc	45 53 37	121 50 02	05 N.	08 E.	NE, SE, 30	Whole Rock				3.30 +/- 0.25	2	a
07	JA84057	Simcoe olivine basalt	Tsb	45 50 05	121 03 47	04 N.	14 E.	SE, NW, 16	Whole Rock	0.963	39.99	67.1	2.08 +/- 0.05	4	c
08	MK85-5-23	Hauk Butte diorite	Tidi	45 47 00	121 40 25	04 N.	09 E.	SE, SE, 33	Whole Rock	0.996	6.689	62.3	4.8 +/- 0.1	4	c
09	MK85-5-1	Wind Mountain quartz diorite	Tiqd	45 43 07	121 45 35	03 N.	08 E.	NW, SE, 26	Whole Rock	0.994	7.084	46.6	4.9 +/- 0.08	4	c
10	R-7277	Wind Mountain quartz diorite	Tiqd	45 42 15	121 44 40	03 N.	09 E.	35	Whole Rock	0.811, 0.828	8.075, 7.525	16.6, 9.2	6.6 +/- 0.7	5	d
11	R-7276	Shell Rock diorite	Tiqd	45 41 24	121 44 38	02 N.	09 E.	06	Whole Rock	1.031, 1.028	9.15, 7.78	25.5, 30.7	5.7 +/- 0.6	5	d
12	MK85-5-5	Lost Creek basalt	Tvb(4)	45 47 35	121 43 55	04 N.	08 E.	NW, SE, 25	Whole Rock	0.648	12.12	34.7	12.9 +/- 0.3	4	c
13	013	volcanic rocks of Stevenson Ridge	Tsr	45 44 32	121 50 21	03 N.	08 E.	SE, SE, 18	Whole Rock				15.7 +/- 1.5	3	b
14	MK85-9-7	Big Butte basalt	Tvb(3)	45 51 45	121 55 25	04 N.	07 E.	NE, NE, 03	Whole Rock	1.158, 1.177	35.08, 35.35	53.8, 53.5	20.8 +/- 1.2	6	c
15	002	dacite flow	Tvd(3)	45 47 44	121 56 08	04 N.	07 E.	SW, SW, 27	Whole Rock				22.7 +/- 0.3	1	b
16	004	Warren Ridge diorite	Tid	45 50 14	121 53 36	04 N.	07 E.	NW, 23	Whole Rock				23.2 +/- 1.0	3	b
17	MH0904851	Sodum Point basalt	Tvb(3)	45 47 39	121 59 53	04 N.	07 E.	NW, NW, 31	Whole Rock	0.952, 0.952	32.58, 32.58	79.0, 73.3	23.6 +/- 1.2	6	c
	O U T S I D E M A P A R E A														
	MK85-5-46	andesite west of McClellan Meadow	Tcb	46 00 10	121 53 20	06 N.	07 E.	NW, NW, 23	Whole Rock	0.427	12.29	47.9	19.43 +/- 0.4	4	c
		(volcanic rocks of Council Bluff)											19.9 +/- 0.4	4	c
	MK85-8-6	andesite of Swift Reservoir	Tva(3)	46 02 30	122 02 03	07 N.	06 E.	SW, SW, 35	Whole Rock	0.756, 0.729	30.73, 30.63	54.3, 56.0	28.5 +/- 1.8	5	c

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2. E. H. McKee, U. S. Geological Survey, Menlo Park, CA, 1982
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4. K. R. McElwee, Oregon State University, 1985
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a. Hammond and Korosec, 1983
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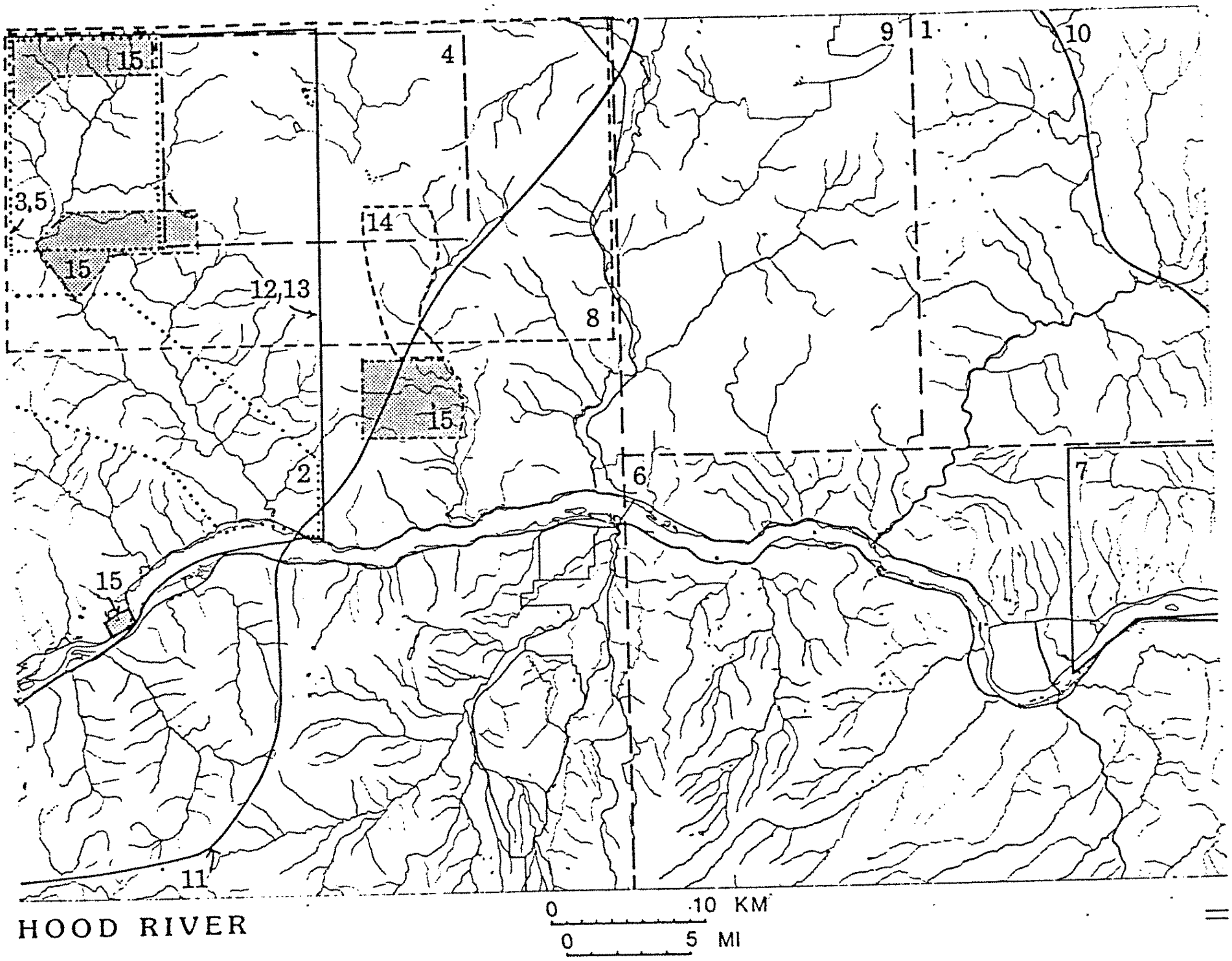
c. Phillips and others, 1986
d. Terry Tolan, personal communication, 1985

TABLE 2. MAJOR ELEMENT ANALYSES FOR IGNEOUS ROCKS OF THE HOOD RIVER QUADRANGLE

SAMPLE NO.	RUN DATE	GEOLOGIC UNIT	SiO2	Al2O3	TiO2	FE2O3	FEO	MnO	CaO	MgO	K2O	Na2O	P2O5	TOTAL	1/4,	1/4	SEC	TWP	RGE	COMMENTS
BB07243	85-08-23	Tib	48.10	15.23	1.44	5.71	6.54	0.19	10.75	9.13	0.48	2.18	0.24	99.99	NW/4	NW/4	27	04N	09E	
BB0619854	85-08-14	(Tvb)	50.48	16.91	1.67	5.67	6.50	0.21	9.57	5.34	0.71	2.75	0.18	99.99	NW/4	NE/4	17	04N	09E	
MK88416	84-12-06	Ovhb	50.92	20.64	1.88	5.02	5.75	0.18	5.86	6.20	0.60	2.48	0.47	100.00	SE/4	NW/4	04	03N	09E	Hauk Butte basalt
BB07246	85-08-23	Tgr	51.82	15.71	1.75	5.28	6.05	0.19	10.67	5.46	0.14	2.70	0.24	100.01	SW/4	SE/4	21	04N	09E	
BB072515	85-08-23	Tiba	51.83	13.93	2.89	6.79	7.78	0.24	8.96	4.15	0.20	2.82	0.42	100.01	SW/4	SE/4	09	04N	09E	
BB06197	85-08-14	Tib	51.89	14.63	2.15	6.08	6.96	0.19	10.13	5.03	0.25	2.44	0.25	100.00	NE/4	NW/4	09	04N	09E	
BB06196	85-08-14	Tib	52.20	14.97	2.23	6.17	7.06	0.20	9.07	4.60	0.65	2.52	0.32	99.99	SW/4	SW/4	16	04N	09E	
MK85510	85-07-30	Tib	52.42	18.39	1.45	4.52	5.18	0.15	9.22	4.99	0.85	2.61	0.22	100.00	SE/4	SE/4	04	03N	08E	Dike
MK8597	85-10-25	Tvb(3)	52.68	17.03	2.13	2.00	9.16	0.18	8.90	4.27	0.85	2.50	0.31	100.01	NE/4	NE/4	03	04N	07E	SE of Big Butte
MK85540	85-07-30	Tvb	52.77	16.78	2.00	5.33	6.11	0.17	8.53	4.29	0.95	2.73	0.33	99.99	SE/4	NW/4	02	04N	07E	SE of Big Butte
MK88412	84-12-06	Tvb(4)	52.96	17.85	1.44	4.46	5.11	0.16	9.77	4.17	0.56	3.27	0.25	100.00	NW/4	SE/4	25	04N	08E	Lost Creek Butte
MM0904851	85-10-25	Tvb(3)	53.22	16.52	2.31	2.00	9.76	0.18	8.06	4.24	0.76	2.65	0.30	100.00	NW/4	NW/4	31	04N	07E	Sedum Point
MK85513	85-07-30	Tiba	54.12	17.72	1.44	4.33	4.96	0.15	9.46	4.22	0.55	2.81	0.24	100.00	NW/4	NW/4	11	04N	08E	Big Huckleberry Mtn.
MK85544	85-07-30	(Tvba(2))	54.42	15.53	1.59	5.39	6.17	0.18	8.70	4.66	0.48	2.68	0.20	100.00	NW/4	NE/4	05	04N	08E	flow at Panther Creek
MK85548	85-07-30	Ovcl	54.52	17.39	1.13	3.71	4.25	0.13	8.20	6.44	0.79	3.13	0.30	99.99	NE/4	NW/4	14	02N	07E	on Bonneville landslide
MK8584	85-10-07	(Tvba(2))	54.82	16.88	1.30	4.80	5.50	0.19	8.60	4.26	0.59	2.82	0.23	99.99	NE/4	SE/4	25	06N	06E	Paradise Hills
MK85710	85-10-07	Tiba	54.82	16.77	1.36	4.20	4.81	0.15	9.41	4.76	0.47	3.07	0.20	100.02	NW/4	NW/4	20	06N	07E	Termination Point
MK85539	85-07-30	Tiba	55.09	14.96	2.41	5.44	6.23	0.18	7.74	3.83	1.21	2.53	0.39	100.01	NW/4	NW/4	02	04N	07E	SE of Big Butte
MK85535	85-07-30	Tiba	55.26	17.97	1.43	4.34	4.97	0.16	6.52	3.86	1.14	4.12	0.23	100.00	NE/4	NW/4	13	04N	07E	Warren Hill
MK8558	85-07-30	(Tvba(2))	55.39	16.53	1.34	4.76	5.45	0.18	8.08	4.37	0.50	3.22	0.18	100.00	NW/4	SW/4	21	04N	08E	flow SW of Big Huckleberry
MK85525	85-07-30	Tva(2)	55.61	17.47	1.33	4.15	4.75	0.16	8.87	3.99	0.68	2.68	0.32	100.01	N/2	SW/4	17	05N	07E	Dry Creek
BB07254	85-08-23	Tiba	55.68	14.62	2.35	5.79	6.63	0.23	6.91	3.05	0.82	3.33	0.57	99.98	SW/4	SW/4	10	04N	09E	
MK8552B	85-07-16	Tgr	56.63	14.23	1.92	5.52	6.32	0.19	7.66	4.10	0.72	2.44	0.29	100.02	NW/4		37	03N	08E	Inclusion in qtz. diorite
MK85546	85-07-30	Tcb	56.99	18.51	1.09	3.91	4.48	0.23	7.92	2.98	0.53	3.19	0.19	100.02	NW/4	NW/4	23	06N	07E	W. of McClellan Meadow
MK85531	85-07-30	Tva(2)	57.97	17.30	1.26	4.09	4.69	0.17	7.23	3.08	1.36	2.61	0.23	99.99	SW/4	SW/4	06	05N	07E	Big Hollow Creek
MK85524	85-07-30	Tva(2)	58.13	16.69	1.35	4.45	5.10	0.15	7.78	2.94	0.38	2.78	0.25	100.00	NW/4	SW/4	21	05N	07E	Paradise Ridge
MK85534	85-07-30	Tia	58.16	15.69	2.02	4.62	5.29	0.16	6.20	2.99	1.32	3.10	0.45	100.00	SW/4	NE/4	13	04N	07E	Dike on Warren Hill
MK85542	85-07-30	Tia	58.49	15.15	1.98	4.77	5.46	0.18	6.46	3.13	1.24	2.80	0.34	100.00	SE/4	SE/4	36	05N	07E	Dike E. of Ten Mile Creek
MK8557	85-07-30	Tia	58.97	16.60	1.46	4.09	4.69	0.18	6.45	2.79	1.03	3.43	0.31	100.00	NW/4	NW/4	15	04N	08E	dike W. of Big Huckleberry
MK85547	85-07-30	Tia	59.70	16.15	1.31	4.26	4.88	0.16	6.28	2.81	1.56	2.66	0.24	100.01	SE/4	NW/4	16	05N	07E	dike W. of Middle Butte
BB07252	85-08-23	Tva	60.02	11.88	2.33	6.16	7.05	0.17	4.88	2.45	0.89	3.53	0.63	99.99	SW/4	SE/4	08	04N	09E	
MK85526	85-07-30	Tva(2)	61.30	17.01	1.16	4.10	4.70	0.12	5.07	2.07	1.64	2.60	0.24	100.01	SW/4	NE/4	06	05N	07E	Dry Creek
MK85517	85-07-16	Tid	63.51	18.55	0.66	2.27	2.60	0.09	5.69	1.81	0.81	3.79	0.23	100.01	NW/4	NE/4	05	03N	09E	Wind River intrusive
MK85518	85-07-30	Tid	63.80	18.69	0.64	2.23	2.56	0.08	5.49	1.73	0.79	3.77	0.21	99.99	NW/4	NW/4	05	03N	09E	Wind River intrusive
MK85532	85-07-30	Tva(2)	64.42	16.44	0.77	3.59	4.11	0.13	4.29	1.29	2.26	2.45	0.25	100.00	NW/4	NW/4	17	05N	07E	N. of Big Hollow Creek
MK85523	85-07-16	Tid	65.83	17.39	0.61	2.05	2.34	0.08	5.56	1.71	0.95	3.31	0.16	99.99	SE/4	SE/4	33	04N	09E	Hauk Butte quarry
MK8552A	85-07-16	Tiqd	66.65	17.26	0.50	1.99	2.28	0.08	5.10	1.58	1.10	3.30	0.16	100.00	NW/4		37	03N	08E	Wind Mtn., SE quarry
MK8551	85-07-16	Tiqd	67.22	17.05	0.49	1.89	2.16	0.08	4.94	1.48	0.92	3.61	0.16	100.00	NW/4	SE/4	26	03N	08E	Wind Mtn., N. quarry
MK8847	84-12-07	Tidi	67.45	16.66	0.47	1.90	2.17	0.08	4.93	1.40	0.99	3.81	0.15	100.01	SE/4	NE/4	32	04N	09E	N. side of Lost Creek
MK85538	85-07-30	Tid	67.52	17.08	0.48	1.80	2.06	0.08	4.96	1.35	0.90	3.61	0.15	99.99	SW/4	NW/4	01	04N	07E	N. of Warren Hill

Analyses by XRF, Department of Geology, Washington State University. All analyses are normalized on a volatile free basis with the oxidation state of iron set at the arbitrary ratio of Fe_2O_3/FeO = 0.87. When the geologic unit for a sample is shown within the parentheses, it indicates that the unit is too small to show on the map.



Key to Map Sources

1. Anderson, written communication, 1985
2. Berri and Korosec, 1983
3. Hammond, 1980
4. Hammond, written communication, 1983
5. McGowan, 1985
6. Newcomb, 1969
7. Powell, 1982
8. Schuster and others, 1978
9. Sheppard, 1964
10. Sheppard, 1967
11. Swanson and others, 1979
12. Wise, 1961
13. Wise, 1970
14. 1985 reconnaissance mapping by Brent Barnett
15. 1984-1985 reconnaissance mapping by Michael Korosec

Figure 2. Source of Data Map —— Hood River Quadrangle

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