WASHINGTON DIVISION OF GEOLOGY AND EARTH RESOURCES
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GEOLOGIC MAP OF THE CENTRALIA QUADRANGLE, WASHINGTON

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

Korosec, M. A., compiler, 1987, Geologic map of the Hood River quadrangle, Washington and Oregon: Washington Division of Geology and Earth Resources Open File Report 87-6, 42 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

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).

The geologic time scale for this map is basically that used for the "Correlation of Stratigraphic Units of North America (COSUNA)" project of the American Association of Petroleum Geologists (Salvador, 1985). Additions and modifications were made following Armentrout and others (1983), Montanari and others (1985), Prothero and Armentrout (1985), and Aquirre and Giancario (1985). These modifications entailed addition of regional floral and faunal zonations, placing the Eocene-Oligocene boundary at 35.7 m.y. B.P. and within the Refugian foraminiferal stage, and setting the Pliocene-Pleistocene boundary to 1.6 m.y. B.P.

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DESCRIPTION OF MAP UNITS
CENTRALIA QUADRANGLE, WASHINGTON

QUATERNARY UNCONSOLIDATED DEPOSITS

HOLOCENE NONGLACIAL DEPOSITS

Qal

Alluvium--Silt, sand, and gravel deposited in streambeds and fans; surface relatively undissected; includes some low-level terraces and some lacustrine deposits

Qp

Peat--Organic and mineral sediments deposited in closed depressions; includes peat, muck, silt, and clay

Qls

Landslide debris--Rock fragments, colluvium, soil, and locally, organic matter deposited by mass wasting; unstratified and poorly sorted; surface commonly hummocky

Qme

Electron Mudflow--Unsorted mixture of andesitic rock fragments in a clayey sand matrix; rock fragments chiefly of Mount Rainier provenance; radiocarbon age of contained wood is 530 +/- 200 yr b.p. (Crandell, 1963); confined to Puyallup River valley

PLEISTOCENE GLACIAL DEPOSITS

DEPOSITS OF CONTINENTAL GLACIERS--CORDILLERAN ICE SHEET

Vashon Stade of Fraser Glaciation

Qdv

Vashon drift, undifferentiated--Chiefly recessional and proglacial stratified outwash sand and gravel; locally containing silts and clay; contains lacustrine deposits and ice-contact stratified drift; also contains moraines and mixtures of till and outwash not separately mappable

Qdvo

Vashon undifferentiated outwash--Recessional and proglacial stratified sand and gravel; locally contains silt and clay

Qdvg

Vashon outwash gravel--Recessional and proglacial, stratified pebble, cobble, and boulder gravel deposited in meltwater streams and their deltas; locally contains ice-contact deposits. Includes Steilacoom Gravel.

Qdvs

Vashon outwash sand--Recessional and proglacial stratified sand; locally contains silt, clay, and gravel

Qdvt

Vashon till--Gray, unsorted, unstratified, highly compacted mixture of clay, silt, sand, gravel, and boulders deposited directly by glacier ice; locally contains outwash sand and gravel both within and overlying till; age of maximum advance in this area estimated to be approximately 14,000 yr (Porter, 1970) to 12,600 yr (Carson, 1970)

Qdvm

Vashon moraines--Ridges of unsorted and unstratified glacial drift; composed chiefly of till with lesser outwash

Qdva

Vashon advance outwash--Outwash sand and gravel and lacustrine clay, silt, and sand deposited during glacial advance; sands commonly thick, well-sorted, and fine-grained, with lenses of coarser sand and gravel; locally contains nonglacial sediments

Pre-Fraser Glaciation

Qdp

Pre-Fraser drift, undifferentiated--Till, outwash sand and gravel, and loess; represents the penultimate glaciation in the south Puget Sound area; called "Salmon Springs?" by Noble and Wallace (1966); correlated with Double Bluff Drift or Possession Drift by Easterbrook (1985)

DEPOSITS OF ALPINE GLACIERS

Fraser Glaciation

Qde

Evans Creek Drift, undifferentiated--Coarse, bouldery, unoxidized till and pebble- to boulder-outwash gravel of Cascade provenance; consists chiefly of lateral or end moraines and till along the upper Carbon, Puyallup, Nisqually, and Cowlitz River valleys; till is complexly interbedded with poorly sorted gravel, sand, and silt; moraines retain much original constructional topography. Age between 12,500 and 20,000 yr b.p. (Crandell and Miller, 1974)

Qdet
Qdem

Evans Creek Drift, till and moraine deposits--Till deposits (Qdet) in the southeast corner of the quadrangle that mark the westernmost extent of the Cowlitz River glacier; end moraine of till (Qdem) forms a belt composed of three distinct ridges 450 to 1,000-m-wide crossing the Cowlitz River valley floor in T. 12 N., R. 6 E. (Mineral quadrangle) (Crandell and Miller, 1974)

Qoe

Evans Creek Drift, outwash deposits--Sand and pebble to boulder gravel forming a broad outwash terrace in the Nisqually River valley for a distance of 8 km west of Ashford; gravel deposits along the Cowlitz River generally 3 to 8 m thick mantled with 0.3 to 2 m of fine sand and silt; deposits oxidized to a depth of about 1 meter (Dethier and Bethel, 1981)

Qohe

Pre-Evans Creek, post-Hayden Creek outwash deposits--Gravel deposits 3 to 5 m thick; mantled with about 0.5 to 1.5 m of silt and fine sand; oxidized to a depth of 1.0 to 1.5 m (Dethier and Bethel, 1981)

Pre-Fraser Glaciations

Qdh

Hayden Creek Drift, undifferentiated--Yellowish brown to brown stony till and boulder gravel outwash deposits of extensive ice cap in Cascade Range but exposed in valleys only at elevations above that reached by younger glaciation; stones near top of the till have weathering rinds which range in thickness from 0.5 to 2.5 mm; original topography considerably modified but many large moraines still recognizable; age older than 38,000 yr b.p. (Crandell and Miller, 1974); probably as old as 130,000 to 140,000 yr b.p. (Porter, 1976; Waitt, 1977)

Qdht

Hayden Creek drift, till deposits--Till distributed in Cowlitz River valley from east edge of quadrangle to the community of Silver Creek at its terminal moraine and in the Tilton River valley from Morton to Silver Creek; till covered with 1.5 to

3.0 m of weathered silt, thin sand, and gravel deposits; base generally not exposed; Oxidation generally extends to a depth of 2.5 to 3.5 m (Dethier and Bethel, 1981)

Qoh

Hayden Creek drift, outwash deposits--Sand and gravel deposits along the Cowlitz River mapped by Weigle and Foxworthy (1962) and Dethier and Bethel (1981), and extended westward to include terrace deposits extending to Chehalis along the south fork of the Newaukum River; Oxidation extends to a depth of 2 to 3 m.

Qdw

Wingate Hill drift, undifferentiated--Chiefly dark brown, compact till widespread on the interfluve between the Nisqually and Mashel River drainage basins; oxidation generally extends to a depth of 2.0 to 3.6 m, and stones near the ground surface have weathered rinds 2 to 5 mm thick and averaging 4 mm thick; original topography extensively modified and moraines are only rarely recognized; age older than 38,000 yr b.p. (Crandell and Miller, 1974); probably older than 130,000 to 140,000 yr b.p. (Porter, 1976; Waitt, 1977)

Qdwt

Wingate Hill drift, till deposits--Occurs in a small upland area south of the Puyallup River and in the hills east of Salkum (3.2 km west of Mayfield Lake); average thickness of weathered rinds on stones is 4 mm (ranging from 1 to 8 mm) (Crandell and Miller, 1974)

Qow

Wingate Hill drift, outwash deposits--Gravel deposits more than 30 m thick near Salkum, and of unknown thickness elsewhere; deposits mantled with 1.0 to 3.0 m of weathered silt; oxidation commonly extends to depths of 5.0 to 10.0 m (Dethier and Bethel, 1981)

Qlh

Logan Hill Formation--Early(?) to middle(?) Pleistocene alpine outwash sand and gravel with minor interbedded silt and clay; stained reddish to yellowish brown; completely weathered to clay near the surface and moderately weathered at depth (Noble and Wallace, 1966); contains volcanic rocks of the Northcraft Formation and reworked material from other adjacent Tertiary rocks (Snavely and others, 1958); mantled with 2.0 to 4.0 m of silt and clay in many exposures; thickness variable from greater than 45 m near Chehalis (Snavely and others, 1958), to 75 m near Castle Rock and Toledo south of the Centralia quadrangle

(Roberts, 1958); apparently thins south of the Cowlitz River (Dethier and Bethel, 1981)

QUATERNARY VOLCANIC DEPOSITS

Qlc

Lily Creek Formation (Pleistocene)--Deeply weathered, compact mudflows of Mount Rainier provenance interbedded with stream gravel; inferred to be correlative with Puyallup and Alderton Formations by Crandell (1963), although Hopson <u>in</u> Crandell (1963) suggests a Pliocene age

Qvmr

Andesite of Mount Rainier volcano (upper Pleistocene)--Chiefly gray porphyritic hypersthene-augite pyroxene andesite; detailed descriptions of Mount Rainier lavas are in Fiske and others (1963); exposures of unit within the Centralia quadrangle represent the northwestern extent of thick, intracanyon flows of an early stage of Mount Rainier volcano; early flows, which originated east of the quadrangle, form massive 300-ft-(90-m-) high cliffs exposing columnar and platy jointed flows that crop out along the Mowich and Puyallup Rivers; at St. Paul Lookout flows are microphyric andesite; flows exposed in the quadrangle predate Hayden Creek Stade as they are covered by Hayden Creek drift; other early flows along highway to Yakima Park (Sunrise) east of Centralia quadrangle dated at 600,000 yr b.p. (K-Ar, plagioclase) and 320,000 yr b.p. (K-Ar, whole rock) (Crandell and Miller, 1974)

TERTIARY STRATIFIED ROCKS

<u>MIDDLE TO UPPER MIOCENE SEDIMENTARY AND VOLCANIC ROCKS</u>

Twk

Wilkes Formation--Chiefly blue-gray and blue-green massive, semi-consolidated siltstone and sandstone with intercalated beds of conglomerate and water-laid tuff exposed in the valley of the Newaukum River in the southwest part of the Centralia quadrangle; beds containing carbonized wood are common; unit weathers to an iron-stained, mottled, yellowish-orange to reddish-orange color; these strata were called "nonmarine sedimentary rocks" by Snavely and others (1958) who said they were equivalent to rocks mapped as Wilkes Formation to the south of the quadrangle by Roberts (1958); unit contains fossil flora assigned to the Homerian (middle to upper Miocene) megafloral stage (Jack Wolfe, oral commun., 1985); unit restricted to axial region of a broad, shallow, northwest-southeast elongate depression, the Napavine syncline (Roberts, 1958; Phillips, 1987)

Tmh

Mashel Formation--Unconsolidated, light-colored fluvial and lacustrine sediments exposed along the lower Mashel River, Ohop Valley, Tanwax Creek, and the Nisqually River valley in the east-north central part of the quadrangle; lower part consists of 30 m of poorly cemented pebble conglomerate of dark-colored volcanic clasts and lesser amounts of decomposed granitic clasts, with intercalated lenses of sand; upper part consists of 120 m of interstratified clay, volcaniclastic sand with pumice and ash, and lignite (detailed description of unit in Walters and Kimmel, 1968); flora collected at four localities were assigned a late middle to late Miocene age (Homerian) by Jack Wolfe (written commun. in Walters and Kimmel, 1968)

Tgr

Grande Ronde Basalt of the Columbia River Basalt Group--Middle Miocene flood "basalt" with basaltic andesite chemistry; dark gray, aphanitic to microphyric; erupted from vents in southeastern Washington and adjacent Idaho and Oregon; eastern edge of a huge sheet of flows which filled channels of ancestral Columbia River, reached the Pacific Ocean, and invaded soft marine sediments of middle Eocene to Miocene age (Beeson and others, 1979; Wells and Niem, 1987); K-Ar (plagioclase) dated at 15.3 +/- 0.8 m.y.b.p. (Turner, 1970); basalt is normally magnetized and probably represents the N_2 unit of Swanson and others (1979)

LOWER MIOCENE SEDIMENTARY AND VOLCANIC ROCKS

Tva_3

Andesite flows--Chiefly dark-colored augite-hypersthene andesite flows restricted to the Alder Lake-Mineral Lake area; fresh-looking, platy, non-vesicular flows occasionally displaying columnar jointing; interbedded with tan to dark brown basaltic andesitic clast- and matrix-supported volcanic breccia (unit Mvc?) in the Hiawatha syncline south of Alder Lake (Hagen, 1987); lower Miocene(?) age assigned to this unit on the basis of two K-Ar age dates: (1) 20.7 +/- 0.3 m.y.b.p., (2) 23.2+/- 1.7 m.y.b.p. (Table 2, this report; Phillips and others, 1986); unit is queried on map because age date (2) is possibly too young and does not readily fit the regional stratigraphic framework (Hagen, 1987), and because of a lack of detailed geologic mapping, particularly of isolated Mva? map units trending southeast-northwest from Mineral Lake to Alder Lake which were assigned a Pliocene(?) age by Fisher (1957); assigned to the Northcraft Formation (middle to late Eocene) by Hammond (1980); assigned (in part) a Pleistocene age by Gower (1958)

Tvc_3

Volcaniclastic rocks--Tan to dark-brown basaltic andesite clast- and matrix-supported volcanic breccia believed to be of epiclastic origin (Hagen, 1987); interbedded with andesite flows (unit Tva_3?) in the Hiawatha Creek syncline; both varieties of volcanic breccia contain fossilized organic material; minimum thickness of the Tva_3/Tvc_3 package is greater than 900 m (Hagen, 1987)

Tvb_3

Basalt flows--Black to dark gray-green, aphyric to sparsely porphyritic, massive to vesicular, olivine-augite basalt lava flows and flow breccia; locally includes interbedded mafic tuff, lahars, and minor sedimentary rocks (Evarts and Ashley, 1984)

LOWER MIOCENE TO UPPER OLIGOCENE VOLCANIC ROCKS

Tvta

Altered tuff--Very fine grained white to very light-gray felsite, confined in a 4-mi long by 1/2-mi wide area from the headwaters of Lynch Creek to The Divide (between the Puyallup and Mashel River drainages in townships 16 N., R. 5 E., and 16 N., R. 6 E.); in outcrop is expressed as a hard, platy, vitric tuff that appears to be in subparallel contact with underlying volcaniclastics and lavas (units Tva and Tvc) believed to be Eocene to Oligocene in age; petrographically appears to be a recrystallized vitric tuff containing felty plagioclase, quartz, and possible zeolites

OLIGOCENE VOLCANIC ROCKS

Tva_2

Andesite flows--Dark-colored, massive to platy, porphyritic two-pyroxene andesite flows and flow breccia in a flow-dominated, homoclinally dipping sequence with minor interbedded volcaniclastic breccia and conglomerate in the Kiona Peak-Kiona Creek area; believed to be equivalent to the Ohanapecosh lavas (unit Tohl, Mount Rainier quadrangle) mapped by Fiske and others (1963) in Mount Rainier National Park; age dated near the upper part of the sequence at 27.0 +/- 1.8 m.y.b.p. (whole rock, sample location 6, Table 2, this report; and Phillips and others, 1986)

Toh

Ohanapecosh Formation--Volcaniclastic-dominated unit composed of a series of undifferentiated volcanic breccias, conglomerates, sandstones, and lava flows interbedded with shale; rocks vary widely in color but are chiefly green and grayish-green and consist of andesitic to basaltic lithic breccia, tuff, tuff breccia, and volcanic siltstone, sandstone, and conglomerate; interbedded with basalt and andesite flows and rare dacite to rhyolite flows and tuffs; also includes locally interbedded Puget-type (unit Tpg) sediments; rocks are generally well-stratified, well-indurated, and pervasively altered to zeolite, smectite clays, chalcedony, carbonate, and iron oxides; strata deposited in part subaqueously and in part subaerially; includes Unit A of the Middle Keechelus Group of Fisher (1957); age dated between 36.5 +/- 3.6 m.y.b.p. and 28.3 +/- 2.9 m.y.b.p. in the Mount Rainier-Summit Creek area east of the Centralia quadrangle (Vance and others, in press)

OLIGOCENE-EOCENE SEDIMENTARY AND VOLCANIC ROCKS

Tlc

Lincoln Creek Formation--Upper Eocene to Oligocene marine sedimentary rocks; indistinctly bedded to massive, commonly concretionary, light-gray, tuffaceous siltstone and fine-grained tuffaceous sandstone; lower strata contain discontinuous beds of basaltic and glauconitic sandstone; dominantly offshore-marine occurring west of the Centralia quadrangle, but grades into nonmarine volcaniclastic rocks east of the Chehalis River which consist of deltaic, nearshore, and continental deposits of basaltic sandstone with interbeds of pyroclastic rocks ("basaltic sandstone member" of Snavely and others, 1958); "basaltic sandstone member" contains foraminifers(?) of the Refugian Stage; unit is correlative and probably gradational to the Toutle Formation (Roberts, 1958) which crops out in the Mount St. Helens quadrangle to the south (Phillips, 1987)

Tva

Basaltic andesite and andesite flows--Upper Eocene to lower Oligocene platy to massive, vesicular to dense, porphyritic to aphyric basaltic andesite and andesite, with lesser dacite flows and flow breccia; flows, where exposed, commonly have oxidized, wavy bases and thin interbeds of shale, tuff, or volcanic sandstone and conglomerate; forms complexes of numerous, thin, irregularly shaped flows of limited areal extent; most flows are plagioclase-clinopyroxene phyric; two-pyroxene or olivine phyric flows also present; zeolites and calcite common in amygdules and fractures; unit has been mapped variously as the Northcraft Formation by Hammond (1980), by Roberts (1958)(south of the Centralia quadrangle), and by Buckovic (1974); Fisher (1957) included most of it in his Unit A of the Middle Keechelus Group and a small portion of it east of Mineral Lake in his younger (Pliocene?) volcanic rocks; Gower (1958) mapped portions of the unit occurring in the Mineral 15-minute quadrangle between Morton and Ashford as Eocene volcanic rocks (equivalent to Hammond's Northcraft Formation); Erdman and Bateman (1951) included rocks of this unit in the Keechelus volcanics, which are exposed in the valley of the Cowlitz River between Mayfield Lake and Mossyrock, and Snavely and others (1958) extended the Northcraft Formation which they described in the Centralia-Chehalis Coal District to include these rocks; unit apparently overlies and is interbedded with volcaniclastic and tuffaceous rocks assigned to the same general time period (units Tvc, Tvt); unit apparently underlies volcanic laharic breccias, lapilli tuffs, sandstones, and siltstones (unit Tvc) preserved in the syncline northwest of Glenoma and along the north shore of Riffe Lake in T. 12 N., R. 4 E., and T. 12 N., R. 5 E.; overlies sediments of the Puget Group (unit Tpg) on the east limb of the Morton anticline and west limb of the Carbon River anticline (Gard, 1968); on the basis of slightly divergent rock attitudes in the two units (Tva and Tpg) and cross sections drawn by Fisher (1957), which indicate a rapid thinning of the Puget Group from west to east across the axis of the Morton anticline, unit Tva is believed to lie unconformably above unit Tpg (although exposures of the contact relations are rare and not definitive); regional mapping by the author and assistants in the Centralia quadrangle and K-Ar age determinations (Table 2 and Phillips and others, 1986) suggest a late Eocene to early Oligocene age for this unit

Tvc

Volcaniclastic rocks--Upper Eocene to lower Oligocene volcaniclastic rocks; massive to well-bedded, lapilli and ash-pumice lithic tuff, volcanic sandstone, and poorly sorted, unstratified, matrix-supported conglomerate or breccia with abundant wood fragments; interbedded with thin basaltic andesite and andesite flows (unit Tva) and at base of unit on west limb of the Carbon River anticline (Gard, 1968), with feldspathic sandstone, shale, and coal (unit Tpg); apparently overlies unit Tva in the southeast corner of the Centralia quadrangle (see unit Tva description); mapped by Buckovic (1974), Hammond (1980), Noble and Wallace (1966), and Thorsen and Othberg (1978) as volcanic rocks of the Northcraft Formation; based on its interbedded relationship with unit Tva, an Eocene to early Oligocene age is suggested for this unit

Tvt

Tuff--Welded and non-welded, moderately to highly altered tuff and tuff breccias of dacitic(?) composition; fine-grained texture and generally highly altered nature make it difficult to differentiate rocks occurring in this unit which may include highly altered versions of units Tva and Tvc; found in the Clay City area east of Ohop Lake, and in the Charles Lathrop Pack Demonstration Forest 2 to 3 mi north of Alder Lake; mapped as Northcraft Formation by Hammond (1980); based on its association with units Tva and Tvc, an Eocene to early Oligocene age is suggested for this unit

Tgo_2

Basaltic andesite lava flow member of the Goble Volcanics--Porphyritic pyroxene basaltic andesite and lesser olivine basalt, pyroxene andesite, and platy to irregularly jointed dacite flows and flow breccia with thin interbeds of red-brown siltstone, sandstone, conglomerate, and tuff; flows are typically thin, with wavy top and bottom contacts; for detailed description of this unit see Phillips (1987, p. 35); in the Centralia quadrangle includes rocks mapped as Hatchet Mountain Formation by Roberts (1958) at Mayfield Lake dam in the Cowlitz River valley; basal portions of this unit are interbedded with a regionally extensive volcaniclastic unit (unit Tgo_1) occurring south of the quadrangle in the Mount St. Helens quadrangle (Phillips, 1987); age ranges from 38 to 35 m.y.b.p. (latest Eocene to early Oligocene) (Phillips, 1987, Table 4; Phillips and others, 1986)

Tgo_1

Volcaniclastic sedimentary and volcanic rock member of the Goble Volcanics--Light-colored volcanic-lithic sandstone, siltstone, conglomerate, lapilli and ash tuff, breccia, and minor carbonaceous shale and coal; see Phillips (1987, p. 38) for a more detailed discussion of unit; locally contains interbedded lava flows similar to unit Tgo_2; upper Eocene-lower Oligocene age assigned to unit on the basis of its interbedded relationship with unit Tgo_2; indistinguishable from unit Tvc where it is exposed along the south shore of Riffe Lake in T. 12 N., R. 4 E.

EOCENE SEDIMENTARY AND VOLCANIC ROCKS

Tno

Northcraft Formation--Chiefly porphyritic augite basaltic andesite, andesite, and olivine-augite basalt lava flows, flow breccia, and sills; interbedded with pyroclastic rocks and feldspathic sandstone, especially near the base; mapped by Snavely and others (1958) in the Centralia-Chehalis Coal District, where the unit consists of lava flows and flow breccias in the upper part and a lower part chiefly of matrix-supported breccia, water laid lapilli tuff and tuff breccia, basaltic sandstone, and tuffaceous siltstone; to the east, Hagen (1987) has mapped two Northcraft volcanic centers in T. 14 N., R. 3 E. and has shown the unit to be flow dominated with steep primary dips to most lava flows; regional mapping by the author in the Centralia quadrangle, K-Ar age determinations (Table 2 and Phillips and others, 1986), and interbedded relationships with the underlying sediments of the middle to upper Eocene Puget Group suggest a middle to upper Eocene age for this unit

Tno_g

Northcraft Formation of Gard--"Dark-reddish-brown to dark-greenish-gray andesitic and basaltic pyroclastic breccia, volcanic mudflow breccia, flow (?) breccia, and minor interbeds of volcanic sandstone, conglomerate, and tuff" (Gard, 1968); unit designates rocks that crop out north of the Puyallup River and correlate with rocks mapped as Northcraft Formation by Gard in the Lake Tapps 15-minute quadrangle; may be the same rocks mapped as unit Tvc at St. Paul Lookout (Hammond, 1960); middle to upper Eocene age

Tva_o

Andesite and basaltic andesite flows--Massive aphanitic to porphyritic pyroxene andesite or basaltic andesite; minor interbedded matrix-supported volcanic breccia; generally poorly exposed in both limbs of the Morton Anticline; these rocks appear to follow the regional structural pattern of the sedimentary rocks (unit Tpg) but some may be sills (Fisher, 1957); these rocks are considered to be middle to upper Eocene on the basis that they are interbedded with rocks of the Puget Group which are middle to upper Eocene

Tvc_o

Volcaniclastic rocks--Volcanic breccia, sandstone and siltstone, tuff, conglomerate, and thin beds of coaly material which intertongue with rocks of the Puget Group (unit Tpg) and of the Northcraft Formation (unit Tno); North of Ashford includes Keechelus tongues (units 2 and 4) mapped by Fisher (1961) and mapped as the Northcraft Formation by Hammond (1980) and Beeson (1980) where unit consists of volcaniclastic rocks interbedded with Puget Group rocks and minor porphyritic andesite flows; north of the Skookumchuck River unit consists of andesitic to basaltic sandstone which intertongues with sandstones of the Puget Group and basaltic andesite lavas and sills of the Northcraft Formation (Hagen, 1987); north of the Tilton River in T. 13 N., R. 2 E., and T. 13 N., R. 3 E., consists of volcanic sandstones, siltstones, and volcanic breccias interbedded with rocks of the Puget Group; based on its interbedded relationship with rocks of the Puget Group and the Northcraft Formation the unit is assigned a middle to upper Eocene age.

Tpg

Rocks of the Puget Group--Middle to upper Eocene continental sedimentary rocks which consist of feldspathic sandstone and litho-feldspathic sandstone interbedded with siltstone, shale, claystone, and coal; locally interbedded with lava flows, tuffs, volcaniclastic breccias and pebble conglomerates, and brackishwater deposits; within the Centralia quadrangle includes rocks assigned to the Carbonado Formation by Buckovic (1974), Hammond (1980), and Gard (1968) for rocks exposed in the Carbon River Anticline and in the Morton Anticline and to rocks assigned to the McIntosh Formation (Snavely and others, 1958) and Skookumchuck Formation (Huntting and others, 1961) for exposures east of the Centralia-Chehalis Coal District, north of the communities of Alpha and Cinebar

Tsk

Skookumchuck Formation--Middle to upper Eocene nearshore marine to nonmarine micaceous feldspathic sandstone, siltstone, shale, carbonaceous siltstone, claystone, and thick coal seams (Snavely and others, 1958); locally interbedded with tuffaceous and volcanic rocks near the base of the unit; conglomerate, although uncommon, occurs locally near the base of the Formation at the eastern edge of the unit's exposure within the Centralia quadrangle; contains foraminiferal fauna referable to the Narizian Stage; K-Ar age dates from the middle of the unit averaged about 40 m.y.b.p. (Triplehorn and others, 1980)

Tmc

McIntosh Formation--Middle to upper Eocene offshore marine siltstone and nearshore sequences of feldspathic and basaltic sandstone (Snavely and others, 1958); upper part consists of marine to crossbedded, micaceous, feldspathic sandstone and laminated to massive tuffaceous siltstone, claystone, and shale (often carbonaceous); lower part consists of basaltic sandstone interbedded with feldspathic sandstone and locally interbedded with basalt flows, tuffs, tuff breccias, and conglomerates; contain formaminiferal fauna referable to the Narizian Stage

Tcr

Crescent Formation--Fine-grained, dominantly submarine tholeitic basalt flows and flow breccia, typically zeolitized, chloritized, and commonly pillowed; locally contains thin interbeds of basaltic-tuff and siltstone with foraminiferal faunas referable to the Ulatisian Stage; K-Ar ages of Crescent Formation in the Black Hills just west of the Centralia quadrangle (Duncan, 1982) range from 51 to 57 m.y.b.p. and from 43 to 50 m.y.b.p. northwest and southwest of the quadrangle; on the basis of both K-Ar and foraminiferal age dates the Crescent Formation is lower to middle Eocene in age

Tcrs

Crescent Formation sedimentary rocks--Lower to middle Eocene basaltic siltstone and sandstone interbeds found within the Crescent Formation that contain foraminiferal assemblages referable to the Ulatizian and possible Penutian Stages (Rau, 1986)

TERTIARY INTRUSIVE ROCKS

MIOCENE INTRUSIVE ROCKS

Tir

Rhyolite dike--Gray, quartz- and plagioclase-phyric rhyolite dike cutting upper Oligocene andesite flows in the Kiona Creek area of T. 12 N., R. 6 E.

MIOCENE-OLIGOCENE INTRUSIVE ROCKS

Tidi

Diorite dikes, sills, or plugs--Augite and/or augite-hypersthene diorite dikes, sills, or plugs with fine- to medium-grained phaneritic texture; age uncertain, but cuts Eocene rocks of the Puget Group and Northcraft Formation (unit Tnog); could have been feeders to Miocene volcanic rocks (Gard, 1968)

Tid

Dacite dikes, sills, or plugs--Plagioclase-quartz-hornblende-phyric and fine-grained, chloritized-silicified andesite or dacite bodies of uncertain geometry; age uncertain, but these intrusives cut Oligocene and Eocene-Oligocene rocks respectively; could have been feeders to Miocene volcanic rocks

Tia

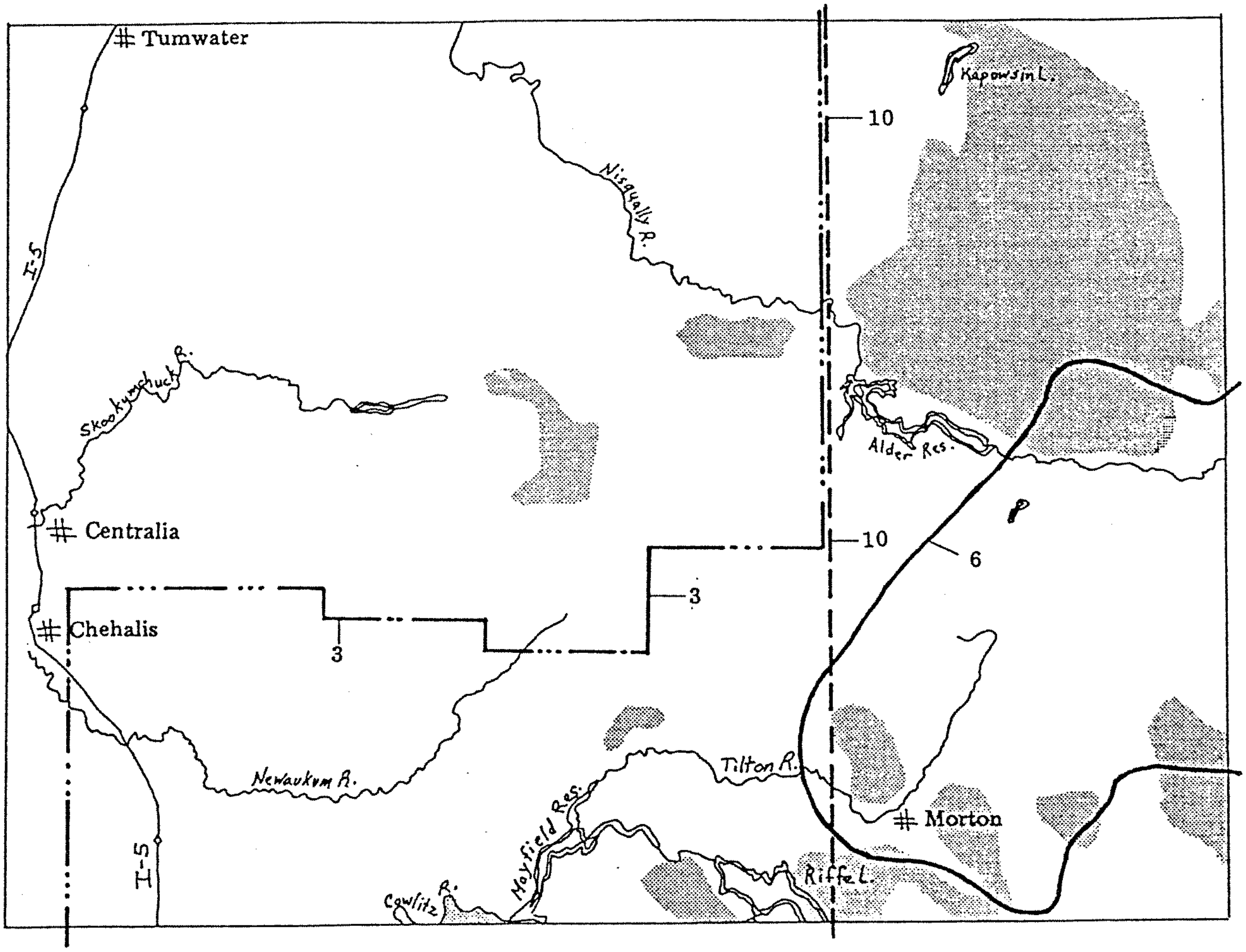
Andesite and andesite porphyry dikes, sills, or plugs--Abundant dark-colored plagioclase-pyroxene and hornblende-phyric andesite dikes, small plugs, and sills; grades locally into andesite porphyry and pyroxene diorite; commonly chloritized and argillitized; age uncertain, but unit cuts rocks of Eocene through lower Oligocene age; could have been feeders to Miocene volcanic rocks

Tib

Basalt dikes or sills--Dark-greenish-gray, plagioclase-augite phyric basalt with amygdules of zeolites and chlorite; olivine sometimes present; forms dikes and sills mostly in the southeast part of the Centralia-Chehalis Coal District; age uncertain, but unit cuts rocks of Eocene through Oligocene age; rocks of this unit were tentatively assigned a late Oligocene age by Snavely and others (1958); could have been feeders to Miocene volcanic rocks

Tigb

Gabbro dikes or sills--Intrusive bodies of gabbro porphyry found chiefly in the northeastern part of the Centralia-Chehalis Coal District; medium-gray, massively jointed, granular and porphyritic (plagioclase and augite phenocrysts); intrude rocks of the McIntosh, Northcraft, and Skookumchuck Formations; unit tentatively assigned a late Oligocene age by Snavely and others (1958); could have been feeders to Miocene volcanic rocks



Division of Geology and Earth Resources original mapping

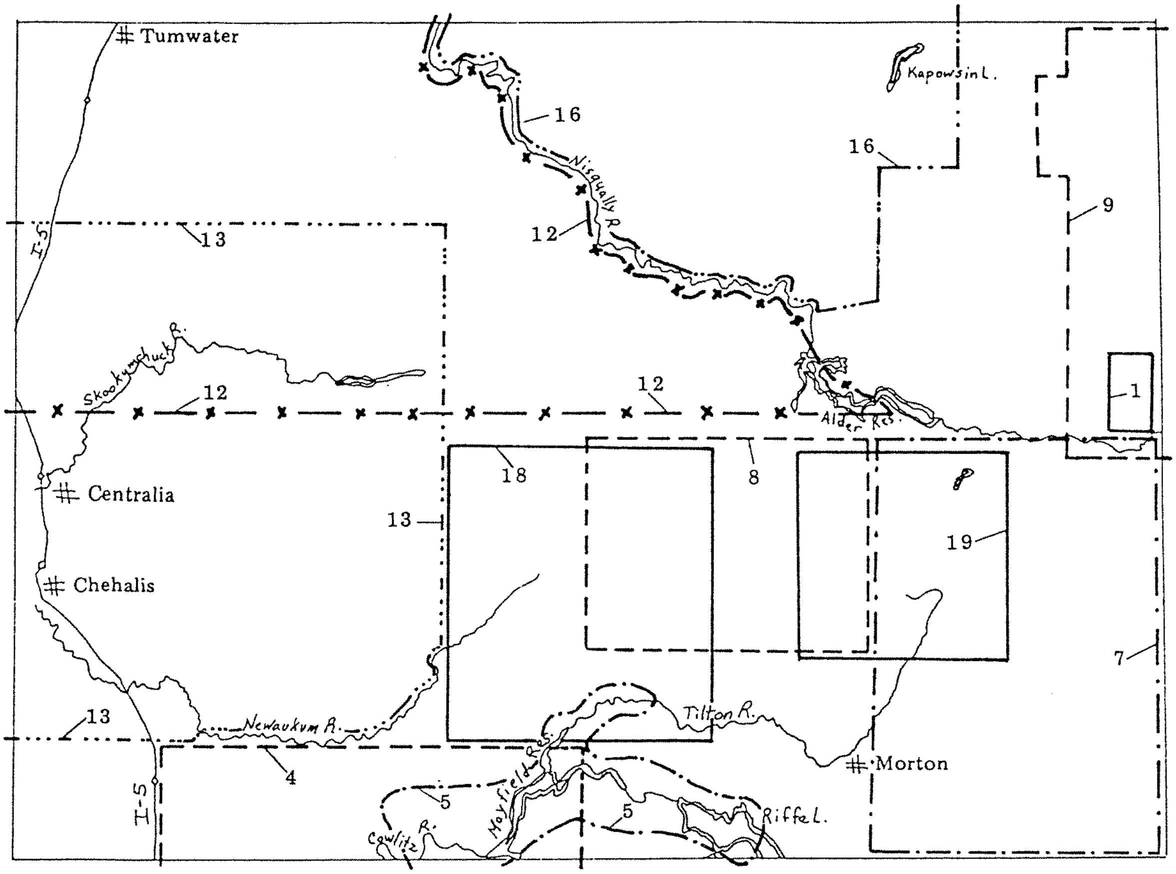
Location

1. Beeson, 1980.
2. Buckovic, 1974.
3. Crandell and Miller, 1974.
4. Dethier and Bethel, 1981.
5. Erdman and Bateman, 1951.
6. Fisher, 1957.
7. Gower, 1958.
8. Hagen, 1987.
9. Hammond, 1960.
10. Hammond, 1980.
11. Lea, 1984.

Location

12. Noble and Wallace, 1966.
13. Snavely and others, 1958.
14. Thorsen and Othberg, 1978.
15. U.S. Forest Service
    Gifford Pinchot National Forest
    Packwood Ranger District, 1984,
    written commun., scale 1:62,500.
16. Walters and Kimmel, 1968.
17. Weigle and Foxworthy, 1962.
18. Weyerhaeuser Company, unpublished data.
19. Weyerhaeuser Company, unpublished data.

Figure 1a. – Sources of map compilation data for Centralia 1:100,000-scale quadrangle.



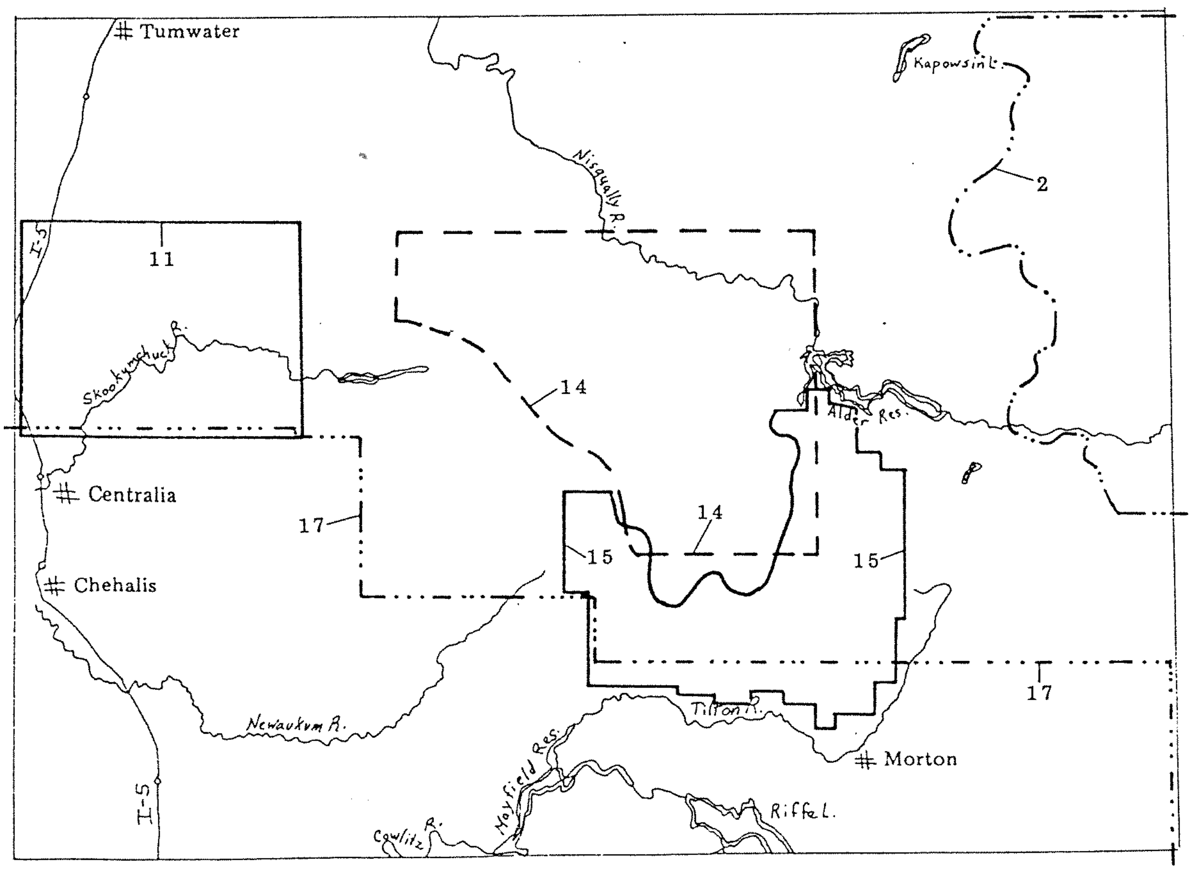


Figure 1b. -- Sources of map compilation data for Centralia 1:100,000-scale quadrangle.

Table 1. WHOLE-ROCK MAJOR ELEMENT ANALYSES FOR THE CENTRALIA QUADRANGLE, WASHINGTON

Sample	Unit	SiO2	Al2O3	TiO2	Fe2O3	MnO	CaO	MgO	K2O	Na2O	P2O5	QSec	Sec	Twp	Rge
KK0911851	Qvmr	61.73	16.96	0.77	6.15	0.09	6.16	3.39	0.91	3.62	0.23	NW/4 SE/4	24	17N	05E
HS0409854	Tid	72.82	14.56	0.74	3.09	0.11	2.33	0.43	1.81	3.95	0.16	SW/4 SW/4	35	17N	01W
MK85824	Tid	70.15	14.43	0.48	3.72	0.09	4.78	0.88	2.38	2.99	0.09	SE/4 NW/4	23	13N	06E
HS0409851A	Tigb	52.96	17.04	1.55	10.04	0.14	9.29	4.97	0.74	2.93	0.34	SW/4 NW/4	17	16N	01E
MK85815	Tir	74.35	14.42	0.16	3.65	0.09	2.18	0.00	1.44	3.64	0.08	NW/4 SW/4	03	12N	06E
HS0612851	Tva3	62.94	16.59	0.93	6.22	0.10	6.11	2.64	1.22	3.07	0.18	SE/4 SW/4	21	15N	05E
HSRH16316	Tva3?	59.73	17.91	0.83	7.49	0.12	6.53	2.94	1.04	3.22	0.20	CENTER	05	14N	04E
HSRH14623	Tva3?	59.49	17.68	0.95	7.91	0.13	6.90	3.14	0.50	3.13	0.19	NWCOR.SE/4	15	14N	04E
MK85821	Tva2	60.73	17.73	0.56	9.44	0.14	5.99	1.75	0.41	3.10	0.18	NW/4 NE/4	23	13N	06E
MK85823	Tva2	57.79	16.68	1.46	10.04	0.18	6.54	2.89	0.56	3.62	0.22	NE/4 SW/4	27	13N	06E
MK85814	Tva2	59.29	18.38	1.05	7.85	0.14	7.08	2.05	0.55	3.41	0.20	SE/4 NW/4	03	12N	06E
HS0514852A	Tva(dike)	58.92	16.74	1.62	9.06	0.16	6.38	2.44	0.67	3.55	0.46	NW/4 NW/4	09	12N	03E
BP0710851	Tva	53.56	17.31	1.61	10.47	0.15	8.60	4.58	0.61	2.84	0.27	NE/4 NE/4	27	12N	04E
HS0618858	Tva	56.49	18.32	1.31	8.63	0.12	7.84	2.99	0.88	3.17	0.25	NE/4 SW/4	02	16N	05E
HS06198510	Tva	55.19	17.29	1.08	8.74	0.13	7.28	6.42	0.72	2.90	0.24	CENTER	03	16N	05E
CC0712852	Tva	65.89	13.78	0.84	5.83	0.11	4.99	2.52	2.63	3.12	0.30	CENTER	11	16N	05E
TW061885B	Tva	60.37	17.68	0.79	6.45	0.10	7.07	3.36	1.16	2.85	0.17	SW/4 NW/4	35	16N	05E
TW061985D	Tva	63.62	16.92	1.03	5.96	0.10	5.12	1.71	2.25	2.92	0.35	SE/4 SE/4	07	15N	05E
HS0117854	Tva	58.10	18.08	1.21	8.00	0.12	7.45	3.08	0.82	2.89	0.25	CENTER	17	13N	03E
HS0514852B	Tva	52.00	17.64	1.59	10.03	0.17	9.77	5.19	0.53	2.74	0.33	NW/4 NW/4	09	12N	03E
HS0514853	Tva	55.93	17.61	1.81	9.57	0.14	7.61	2.98	0.82	3.16	0.36	CENTER	10	12N	03E
HS1002841	Tva	57.49	18.46	1.22	7.90	0.11	6.63	2.84	1.13	3.98	0.24	NE/4 SW/4	12	12N	03E
HS0117856	Tva	54.97	15.73	2.00	11.38	0.17	7.72	4.20	0.77	2.73	0.32	CENTER	03	12N	04E
HS0117859	Tva	56.22	17.86	1.55	9.02	0.14	6.99	3.33	1.42	3.13	0.34	NE/4 NE/4	07	12N	04E
HS0515852	Tva	62.08	15.70	1.35	8.59	0.15	4.65	1.83	1.63	3.53	0.49	SE/4 NW/4	05	12N	05E
HS0515853	Tva	60.64	15.61	1.32	8.77	0.13	5.67	2.78	1.27	3.41	0.40	NE/4 NE/4	17	12N	05E
HS0823841	Tva	55.53	20.64	1.21	8.77	0.07	6.07	2.39	0.72	4.39	0.22	CENTER	21	12N	05E
MK85610	Toh(dike)	56.97	17.05	1.20	8.76	0.15	7.85	3.80	1.07	2.87	0.28	SE/4 NE/4	21	12N	05E
MK85611	Toh	63.26	19.04	1.10	4.10	0.12	6.73	1.08	0.57	3.78	0.24	SW/4 NE/4	21	12N	05E
HS0514851	Tgo2	54.52	15.91	2.04	11.78	0.17	7.85	3.41	0.86	3.08	0.38	NW COR.	29	12N	02E
HS0117851B	Tno(dike)	56.59	16.31	1.29	8.93	0.13	8.19	4.91	0.45	2.91	0.30	SE/4 NW/4	33	13N	04E
HS0409851B	Tno	57.80	16.11	1.45	10.29	0.17	6.58	3.08	0.73	3.49	0.29	NW/4 NW/4	17	16N	01E
HS0116851	Tno	58.54	15.71	1.57	9.43	0.13	6.81	3.08	1.16	3.25	0.31	NW/4 NE/4	03	15N	01W
BP0320862	Tno	60.89	16.02	1.46	8.21	0.16	5.45	2.47	0.90	4.14	0.30	SW COR.	06	15N	01E
BP0320861	Tno	56.56	15.27	1.82	11.27	0.17	6.91	3.25	0.92	3.53	0.30	N/2 NW/4	18	15N	01E
HS0116853	Tno	55.45	16.70	1.41	10.95	0.15	7.87	3.57	0.47	3.20	0.22	SW/4 NW/4	12	13N	01E
CC0730853	Tno	61.99	17.84	0.78	7.42	0.13	5.33	2.06	0.89	3.28	0.30	NE/4 NE/4	18	13N	03E
HS0116854	Tno	54.54	17.65	1.32	9.43	0.15	8.58	4.50	0.71	2.90	0.23	CENTER	30	13N	04E
HS0117851A	Tno	57.03	17.42	1.28	8.58	0.12	7.74	3.45	0.90	3.18	0.31	SE/4 NW/4	33	13N	04E
HS1220842	Tno	56.18	15.75	1.95	10.88	0.20	6.99	3.26	0.97	3.41	0.42	SW/4 SW/4	07	12N	03E
HS1220843	Tno	52.76	19.65	1.11	8.43	0.14	9.85	4.37	0.32	3.14	0.23	NW/4 SW/4	10	12N	03E
CC0814852	Tva0	57.19	16.68	1.25	8.39	0.12	7.65	4.18	1.07	3.19	0.28	NE/4 SW/4	13	14N	04E

Analyses by XRF, Department of Geology, Washington State University
All analyses normalized to 100% on a volatile-free basis. Iron expressed as Fe2O3
All samples analyzed with international standards and a double-fusion sample preparation method

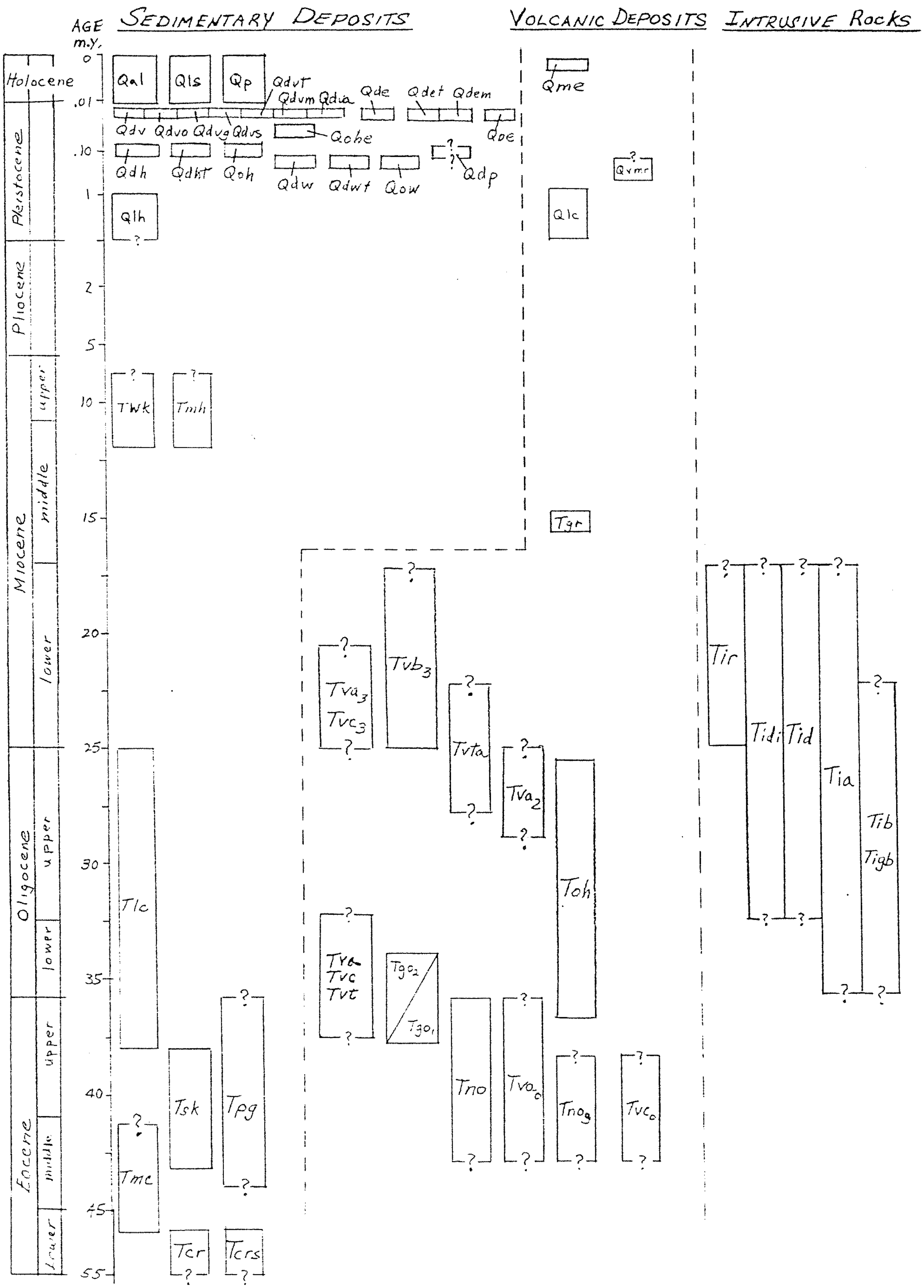


Figure 2.-- Correlation - Duration diagram of geologic units, Centralia quadrangle.

TABLE 2. AGE DATES FOR THE CENTRALIA QUADRANGLE

MAP NO.	MAP SYMBOL	MEAN PER CENT K2O	MEAN PER CENT 40AR/TOTAL AR	AGE (mybp)	LAB	REF	MATERIAL DATED	TWP	RGE	1/4 1/4 SECTION
K-AR 1	Tva3	1.193	43.7	20.7 +/- 0.3	3	a	Whole Rock	15 N.	05 E.	SE, SW, 21
K-AR 2	Tva3	0.669	16.6	23.2 +/- 1.7	1	a	Whole Rock	14 N.	04 E.	NW, SE, 15
K-AR 3	Tva	2.564	65.2	32.7 +/- 1.5	1	a	Whole Rock	15 N.	05 E.	SE, SE, 07
K-AR 4	Tva	2.704	82.4	35.5 +/- 1.6	1	a	Whole Rock	16 N.	05 E.	Center, 11
K-AR 5	Tva	1.958	77.4	35.8 +/- 1.7	1	a	Whole Rock	12 N.	05 E.	SE, NW, 05
K-AR 6	Tva2	0.691	45.0	27.0 +/- 1.8	1	a	Whole Rock	12 N.	06 E.	SE, NW, 03
K-AR 7	Tno	1.205	76.8	38.3 +/- 1.9	2	a	Whole Rock	13 N.	04 E.	SE, NW, 33
K-AR 8	Tno	0.596	53.4	38.8 +/- 1.9	2	a	Whole Rock	13 N.	01 E.	SW, NW, 12
K-AR 9	Tia *	1.315	53.8	33.3 +/- 1.7	2	b	Whole Rock	13 N.	04 E.	NE, SE, 11

* Unit is too small to show on map

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2. Teledyne Isotopes, 1983, 1985
3. Oregon State University (K. McElwee)

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