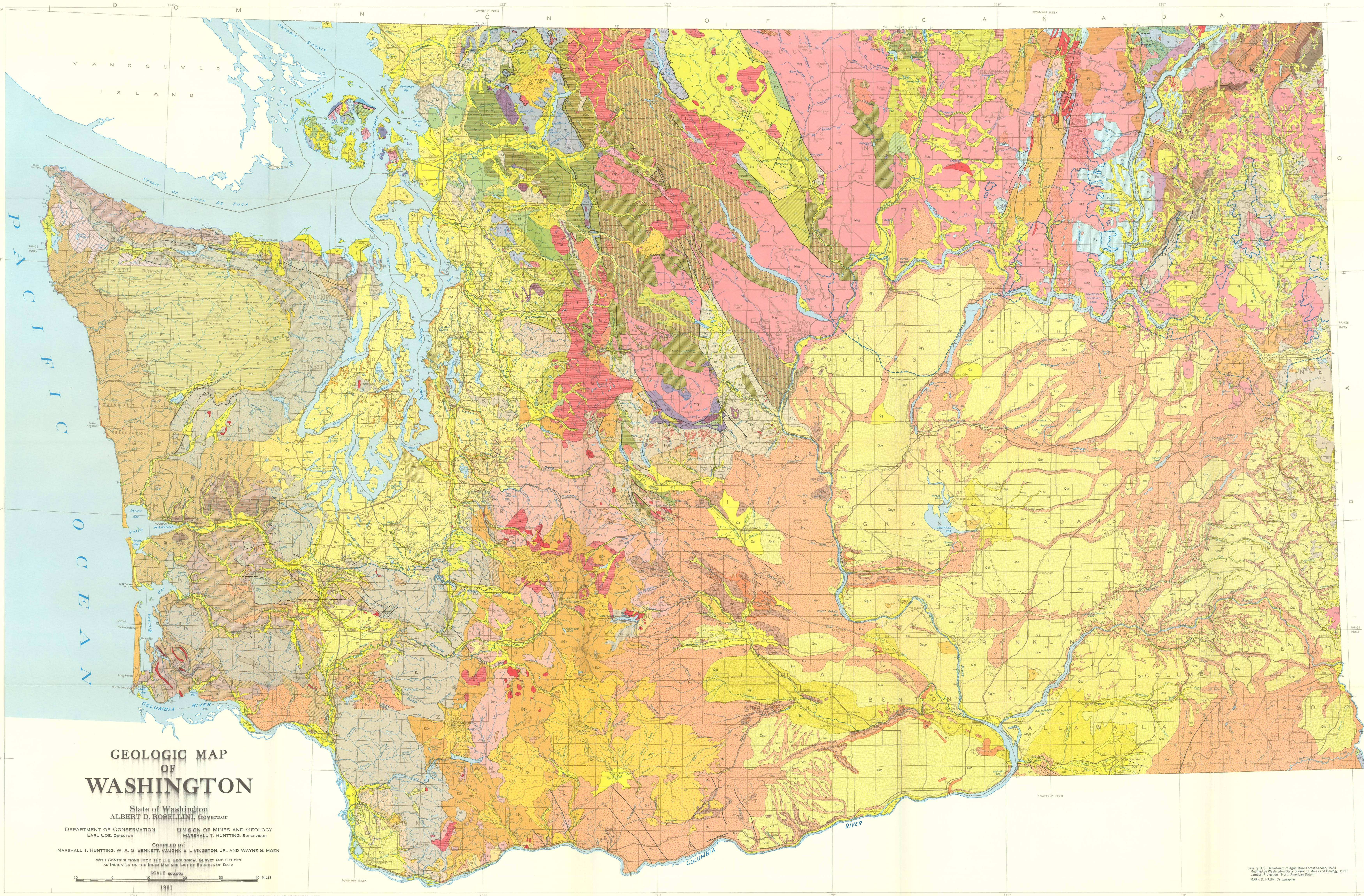


GEOLOGIC MAP OF WASHINGTON

State of Washington
ALBERT D. ROSELLINI, Governor

DEPARTMENT OF CONSERVATION
EARL COE, DIRECTOR

DIVISION OF MINES AND GEOLOGY
MARSHALL T. HUNTTING, SUPERVISOR

COMPILED BY:
MARSHALL T. HUNTTING, W. A. G. BENNETT, VAUGHN E. LIVINGSTON, JR., AND WAYNE S. MOEN

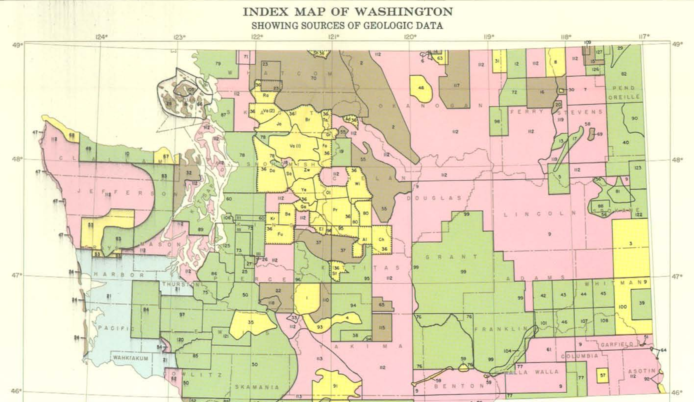
WITH CONTRIBUTIONS FROM THE U. S. GEOLOGICAL SURVEY AND OTHERS AS INDICATED ON THE INDEX MAP AND LIST OF SOURCES OF DATA

SCALE 1:500,000

10 0 10 20 30 40 MILES

1961

INDEX MAP OF WASHINGTON
SHOWING SOURCES OF GEOLOGIC DATA



EXPLANATION

U. S. GOVERNMENT AGENCIES
Published and unpublished reports

WASHINGTON STATE DIVISION OF MINES AND GEOLOGY
1936 Geologic map, published and unpublished reports and maps

MISCELLANEOUS REPORTS AND MAPS
Published and unpublished

OIL COMPANIES
Unpublished maps

STUDENT THESES
Unpublished

Numbers refer to accompanying list of authors.

SOURCES OF DATA USED IN COMPILING THE GEOLOGIC MAP OF WASHINGTON
Numbers and letters correspond to those shown on index map.

DESCRIBED FORMATIONS INCLUDED UNDER FOLLOWING UNITS
Only published descriptions are listed. Number before author's name refers to "Sources of Data" list.

EXPLANATION

SEDIMENTARY AND METASEDIMENTARY ROCKS

QUATERNARY — Recent

Qs — Landslide and mudflow deposits
Predominantly landslide debris. Includes till-like mudflow deposits of andesitic rock fragments in clayey sand matrix in Buckley-Enumclaw area of King and Pierce Counties.

Qa — Alluvium
Mostly unconsolidated silt, sand, and gravel valley fill with some clay; includes low-level terrace, marsh, peat, artificial fill, and glacial deposits locally.

Qe — Eolian deposits
Active dune sand; includes beach sand along southwestern Washington coast.

Pleistocene

Qg₁, Qg₁t, Qg₁o — Younger glacial drift
Qg₁—Younger glacial drift, undivided. Till, outwash, and associated deposits; sorted and unsorted sand, gravel, silt, and clay. Includes some alluvium.
Qg₁t—Till. Hard, blue-gray to gray concrete-like mixture of clay, silt, sand, and gravel deposited as end or recessional moraine. Principally Wisconsin in age.
Qg₁o—Advance and recessional outwash, stratified drift, and associated deposits. Primarily silt, sand, and gravel with some clay. Includes alluvium locally and scabland deposits of eastern Washington.

Qgl — Glaciolacustrine deposits
Fine-grained sand and silt, well-stratified, with some gravel, clay, and diatomaceous earth. Contains clastic dikes in Walla Walla area.

Qg — Glacial drift, undivided
Glacial and glaciofluvial sand, gravel, and till; includes alpine glacier outwash and till as well as some Recent alluvium.

Qg₂ — Older glacial drift
Till, outwash, and associated interglacial deposits; sorted and unsorted sand, gravel, silt, and clay. Includes peat beds and non-glacial sediments locally. Mostly pre-Wisconsin in age.

Qc, Qce, Qcl — Quaternary nonmarine deposits
Mostly early and middle Pleistocene.
Qc—Predominantly a well-cemented heterogeneous mixture of volcanic gravel, sand, silt, and clay. Contains some till and in western Washington is commonly deeply weathered.
Qce—Periglacial eolian deposits. Buff to light-brown, massive, homogeneous, unconsolidated loessial silt; some water-laid material locally. Probably early Pleistocene.
Qcl—Periglacial lacustrine deposits. Light-brown, well-sorted and bedded clayey sandstone and sandy clay with interbeds of volcanic ash and calcareous cemented gravels.

TERTIARY

Qt — Terrace deposits
Unconsolidated to partly consolidated fluvial and glaciofluvial sand and gravel with minor amounts of silt and clay. Includes marine terrace along west coast of the Olympic Peninsula.

Pliocene

P — Pliocene marine rocks
Coarse conglomerate, shale, and minor sandstone; along ocean beaches in Grays Harbor County.

Pc — Pliocene nonmarine rocks
Conglomerate, sandstone, shale, and mudstone. Tuffaceous in part; contains alluvial fan type material locally.

MP — Miocene-Pliocene marine rocks
Brown-gray, coarse-grained, moderately consolidated, commonly cross-bedded sandstone. Grades locally into gritstone and conglomerate lenses; includes minor shale beds; sandstone often shaly and in some areas grades into claystone.

MPc — Miocene-Pliocene nonmarine rocks
Tuffaceous and pumiceous andesitic sandstone and siltstone with claystone. Conglomerate beds chiefly andesitic, but also quartzite, granitic, and basaltic; includes basalt flows locally.

Miocene

M — Miocene marine rocks
Massive to thin-bedded, friable, basaltic to feldspathic sandstone, with shale, siltstone, and local pebble conglomerate interbeds.

Mc — Miocene nonmarine rocks
Poorly to moderately consolidated tuffaceous sandstone, conglomerate, siltstone, and claystone in western Washington. Chiefly clay and shale with minor sand, gravel, and diatomaceous earth near Spokane. Includes diatomite beds near Yakima and Quincy, and some marine beds in western Washington.

ΦM — Oligocene-Miocene marine rocks
Massive to thin-bedded, coarse-grained sandstone, conglomerate, conglomeratic sandstone, shale, and sandy shale.

Ts — Tertiary marine and nonmarine rocks
Predominantly light-gray to olive-gray, fine- to coarse-grained sandstone with laminae to thick beds of medium dark gray siltstone, in northern Olympic Peninsula. Probably late Eocene to Miocene.

Tc — Tertiary nonmarine rocks, undivided
Sandstone, shale, conglomerate, agglomerate, and tuff; includes some lava flows. Massive conglomerate, sandstone, siltstone, and ferruginous shale in northwestern Whatcom County.

Oligocene

Φ — Oligocene marine rocks
Massive, tuffaceous and nontuffaceous sandstone and siltstone; locally concretionary; includes conglomerate along the north coast of Olympic Peninsula and basaltic sandstone east of Chehalis.

Φc — Oligocene nonmarine rocks
Andesite conglomerate, tuff beds, and mudflow material. Includes some interbedded andesite flows in Columbia River Gorge. Lake sediments with Oligocene flora in Republic area in Ferry County. Massive tuffaceous sandstone and siltstone with beds of coal and high-alumina clay in Castle Rock-Toledo coal district in Cowlitz and Lewis Counties; include local interbedded basalt flows and some marine and late Eocene rocks.

Eocene

E₃ — Upper upper Eocene nonmarine and marine rocks
Massive to thin-bedded, feldspathic to arkosic sandstone, siltstone, shale, and carbonaceous shale; becomes mostly nonmarine in the western foothills of Cascade Mountains where coal beds are abundant. Basaltic sandstone and siltstone in northern Olympic Peninsula.

E₂ — Lower upper Eocene marine and nonmarine rocks
Predominantly massive to well-bedded tuffaceous marine siltstone with interbedded arkosic and basaltic sandstone. Includes conglomerate in King County and along north side of Olympic Peninsula. Minor lava flows and breccia in western Lewis County and eastern Grays Harbor County. Coal seams in central Lewis County and north-central Pierce County.

pE₂ — Pre-upper Eocene rocks
Argillite and graywacke between inner and outer volcanic belts in Olympic Peninsula. Sheared carbonaceous argillite, graywacke, and minor conglomerate lenses and altered lava flows in western Yakima County.

Ec — Eocene nonmarine rocks
Predominantly sandstone and shale. Includes some conglomerate in the Cle Elum area in Kittitas County. Contains extensive coal seams near Roslyn and carbonaceous shale and coal beds in White Pass and Blewett Pass areas in Kittitas and Chelan Counties.

Paleocene

MzT — Mesozoic-Tertiary marine rocks, undivided
Dark-gray, massive to poorly bedded graywacke of the interior Olympic Peninsula; commonly with interbedded slate, argillite, volcanic rocks, and minor arkosic sandstone. Includes rocks both older and younger than E₂, some of which may be Paleozoic.

TKc — Paleocene-Cretaceous nonmarine rocks
Brown-gray to light-gray, medium- to coarse-grained massive cross-bedded arkose with interbedded conglomerate and siltstone. Contains several coal seams in Whatcom County. Iron-rich laterite at base near Cle Elum and Blewett Pass in Kittitas and Chelan Counties.

CRETACEOUS

K, Ku, Kl — Cretaceous sedimentary rocks, mostly marine
K—Cretaceous conglomerate, sandstone, shale, breccia, limestone, and gritstone in San Juan Islands.
Ku—Upper Cretaceous black siltstone, graywacke, and silica pebble conglomerate in western Okanogan County.
Kl—Lower Cretaceous greenish-gray massive arkosic sandstone and light-grey sandy shale in western Okanogan County. Includes phyllite in eastern Whatcom County.

pT — Pre-Tertiary sedimentary and metasedimentary rocks, undivided
Graywacke, argillite, phyllite, chert, talc, and graphite schist; some faulted-in blocks of serpentinite and greenstone. Includes minor limestone on San Juan Island.

Kc — Cretaceous nonmarine rocks
Redbeds of thick-bedded sandstone, shale, and pebble conglomerate in upper Methow River area of Okanogan County.

JK, JKs — Upper Jurassic-Lower Cretaceous sedimentary and volcanic rocks
JK—Sedimentary and volcanic rocks, undivided. Graywacke, argillite, siltstone, slate, volcanic rocks, phyllite, greenschist, and greenstone.
JKs—Predominantly sedimentary rocks. Graywacke, argillite, and siltstone with some slate and phyllite; includes graywacke breccia and ribbon chert with minor local limestone lenses and basalt flows.

JURASSIC

J — Lower and Middle Jurassic marine rocks
Dark-gray, massive to thick-bedded, siliceous argillite, siltstone, and shale; includes minor graywacke and limestone. Confined to northwestern Whatcom County.

ŦJ — Upper Triassic and/or Lower Jurassic marine rocks
Conglomerate, gritstone, graywacke, and carbonaceous argillite of northwestern Whatcom County.

pJ, pJs — Pre-Middle Jurassic sedimentary and volcanic rocks
pJ—Sedimentary and volcanic rocks, undivided. Graywacke, argillite, slate, greenstone, and spilitic volcanic rocks.
pJs—Predominantly sedimentary rocks. Graywacke, argillite, and slate; includes minor marble, siltstone, arkose, conglomerate, ribbon chert, and volcanic rocks.

TRIASSIC

Ŧ — Triassic sedimentary rocks, undivided
Predominantly limestone, marble, and dolomite near Riverside in Okanogan County. Conglomerate, shale, graywacke, gritstone, and limestone on San Juan Island. Siltstone with greenstone locally on Orcas Island. Graywacke conglomerate, cherty greenstone, and limestone in northern Ferry County.

PERMIAN

P — Permian rocks
Conglomerate, graywacke, siltstone, argillite and interbedded fossiliferous limestone, greenstone, and minor angular conglomerate in northwestern Stevens and Ferry Counties. Impure quartzite, sandstone, graywacke, chert, greenstone, ribbon chert, chert breccia, and limestone in Snohomish County and on San Juan Island. Lower Permian limestone on Black Mountain in northwestern Whatcom County. Middle Permian rocks in northeastern Washington.

CP, CPs — Carboniferous-Permian sedimentary and volcanic rocks
CP—Sedimentary and volcanic rocks, undivided. Cherty and slaty argillite, siltstone, graywacke, chert, greenstone, tuff, andesite, and spilitic volcanics.
CPs—Predominantly sedimentary rocks. Graywacke, argillite, and slate; includes minor marble, siltstone, arkose, conglomerate, ribbon cherts, and volcanic rocks. Some Devonian rocks may be included in northwestern Washington.

Pu — Upper Paleozoic rocks, undivided
Mostly graywacke, interbedded quartzite and phyllite, greenstone and serpentine, and black shale with minor limestone. Some quartz-mica schist in Bald Knob area of Ferry County. Schist, gneiss, and amphibolite in other parts of Ferry County. Some rocks of lower Paleozoic age, possibly Precambrian, and Mesozoic may be included.

CARBONIFEROUS

C — Carboniferous rocks
Thin-bedded graywacke, shale, argillite, slate, schist, volcanic breccia, gritstone, conglomerate, and limestone on northeast shore of Orcas Island. Limestone or dolomitic limestone, apparently interbedded with limy argillite and graywacke, forms belt of small separate outcrops between Springdale and Valley in southeastern Stevens County. Late Devonian to Early Pennsylvanian in age.

DEVONIAN

D — Devonian rocks
Thin alternating beds of cherty quartzite and argillite, occasional limestone lenses, volcanic rocks, sandstone, and graywacke on northwest shore of Orcas Island. Small outcrops of Devonian limestone included under Pu in southeastern Stevens County and under CPs in northwestern Whatcom County.

SILURIAN AND DEVONIAN

SD — Silurian-Devonian rocks
Mainly black argillite; some limestone, thin beds of conglomerate, sandstone, quartzite, and dolomite. Rocks confined to northeastern Pend Oreille County and adjacent Stevens County. Silurian age based on Monograptus and corals of several unusual genera; Devonian age based on coral fauna.

ORDOVICIAN

O — Ordovician rocks
Mainly black to gray slate or slaty argillite, argillite, black to dark-gray limestone, and some black to gray quartzite. Includes dark-gray siltstone in north-central Stevens County and grayish olive-green silty argillite in west-central Stevens County. Many occurrences of Early and Middle Ordovician graptolites; also rare conodonts.

PRECAMBRIAN (Cambrian)

Cls — Cambrian limestone and dolomite
Mostly massive dolomite, with a basal unit of gray to dark-gray limestone interbedded with limy shale, and an upper unit of fine-grained massive limestone with some marble; Pend Oreille and northern and central Stevens Counties. Three-fold division less evident in Colville area. Dolomite, with minor basal unit of interbedded limestone and phyllite in the Addy-Dunn Mountain area of Stevens County. Marble, dolomite, limestone, and limy slate in Hunters district. Dolomitic marble in southern Stevens and northern Lincoln Counties. Middle Cambrian fossils near base in Metaline district, and Bathyuriscus-Elrathina fauna in lower unit in Leadpoint district. Phosphatic brachiopods in upper unit in Leadpoint district tentatively assigned to Middle and Upper Cambrian.

Pl — Lower Paleozoic rocks, undivided
Predominantly gneiss and schist in northern Ferry County. Quartzite, partly interbedded with dolomitic and calcitic marble, lime-silicate gneiss, and amphibolite; including in places forsterite marble and diopside marble, quartz-biotite-sillimanite schist and sillimanite-cordierite gneiss in northeastern Ferry County. Quartzite with overlying limestone in southeastern Stevens County. Some rocks of Paleozoic and Precambrian rocks may be included.

Cph — Cambrian phyllite
Predominantly gray-green, banded phyllite, some sericite schist, abundant thin beds of quartzite, especially in lower part of unit, and limestone in upper part; northern Pend Oreille County. Much the same lithology but more conspicuous subunits of quartzite, limestone, and schist in northeastern Stevens County. Gray phyllite, greenish argillite, andalusite schist, minor interbedded quartzite and siliceous dolomite, especially in lower part, and much gray limestone in upper part; north-central Stevens County. Limestone bed in lower part of unit contains Lower Cambrian fossils (Archaeocyathus).

Cq — Cambrian quartzite
Gritstone with conglomerate in lower part and gray, white, and buff platy quartzite in upper part grading upward into phyllite; northern Pend Oreille County. Light-gray, platy, medium- to thick-bedded quartzite in upper part and darker impure quartzite with some interbedded argillite or phyllite in lower part; north-central Stevens County. White, gray, and reddish, medium- to thick-bedded quartzite in lower part and thin interbeds of quartzite and argillite in upper part, with very low Lower Cambrian fossils (Nevadia, Hyolithellus, and three genera of brachiopods) near base of upper part; Addy district of central Stevens County. Thick argillite and thin quartzite units form an uppermost zone in southwestern Stevens County. Conspicuous phyllite units near base in north-central Lincoln County.

PRE-CAMBRIAN (?)

pCph — Precambrian (?) phyllite
Mostly phyllite with interbedded carbonate rocks, quartzite, and gritstone; some tuffile beds and conglomerate at the base. Rocks confined to northeastern Pend Oreille County and central Stevens County.

PRECAMBRIAN

pCc — Precambrian conglomerate
Gray-brown, coarse, poorly sorted pebbles and cobbles of limestone, dolomite, reddish-brown quartzite, black slate or phyllite, and rarely granitic rocks in a gray sandy phyllite matrix; northeastern Pend Oreille County and northeastern Stevens County. Rocks become finer grained and more schistose and the unit becomes thinner toward the southwest, where there is included an isolated subunit which may be a tillite, consisting of cobbles, boulders, and blocks of argillite and carbonate rocks in a fine silty matrix.

UNCONFORMITY

pC, pCd — Precambrian rocks, undivided
Predominantly phyllite with some schist, limestone, dolomite, quartzite, and volcanic rocks; northeastern Pend Oreille County. Mainly quartzitic sandstone in upper part, dark-gray argillite with sandstone and limestone in middle part, and sandstone with argillite in lower part; southeastern Pend Oreille County. Banded slate with quartzite and dolomite; magnesite-bearing Stensgar dolomite shown as pCd; southwestern Stevens County. Quartzite, siliceous argillite, and argillaceous quartzite grading into argillite and quartz-mica schist from south to north; southeastern Stevens County. Quartzite, argillite, quartz-feldspar gneiss, and other metamorphic rocks in northeastern Whitman and southeastern Spokane Counties are partly if not all extensions of the Belt strata.

EXTRUSIVE IGNEOUS ROCKS

Qv — Pleistocene-Recent volcanic rocks
Predominantly dark-gray to black vesicular basalt; olivine-rich in part. Includes andesite flows and pyroclastic rocks of Mount Baker, Glacier Peak, Mount Rainier, Mount Adams, Mount St. Helens, and all cinder cones in southern part of the State. Also includes some Recent flows southeast of Mount St. Helens.

PQv — Pliocene-Pleistocene volcanic rocks
Light-gray andesite, andesite porphyry, and open-textured basalt flows with minor associated mudflows and breccia. Includes restricted areas of valley flow basalt in Snake River Canyon in southeastern Washington and in Spokane area.

MPv — Miocene-Pliocene volcanic rocks
Dark-gray, fine-grained, dense, porphyritic in part, basalt flows in central and south-central part of State; commonly with interbedded conglomerate, sandstone, and siltstone. Includes small areas of rhyolite north of Cle Elum in Kittitas County, and andesite north of Leavenworth in Chelan County.

Mv — Miocene volcanic rocks
Dark-gray to black, dense aphanitic basalt flows; commonly columnar jointed, less commonly irregularly and platy jointed; some flows vesicular, grading to scoriaceous; includes minor pillow lava, palagonite beds, and soil profiles and sedimentary beds; contains diatomite beds locally. Maximum thickness in south-central Washington may be in excess of 10,000 feet; much thinner in western Washington, where flows are mostly associated with marine sedimentary rocks. Includes acidic and intermediate volcanic rocks in northern Cascade Mountains.

ΦMv — Oligocene-Miocene volcanic rocks
Andesite flow breccia, andesite flows, and minor tuff beds; includes some basalt flows and flow breccia. Commonly more massive and less altered than similar-appearing Eocene-Oligocene volcanic rocks. Clastic flows and flows of black glass, and coarse- to fine-grained clastic and pyroclastic rocks in the Republic and Curlew areas of Ferry County.

Tv, uTv, lTv — Tertiary volcanic rocks, undivided
Tv—Tertiary volcanic rocks, undivided. Includes andesite, basalt, and rhyolite flows, flow breccia, and associated pyroclastic rocks. In isolated areas across the northern part of State.
uTv—Upper Tertiary volcanic rocks, undivided. Mostly massive andesite flows, flow breccia, and associated pyroclastic rocks; includes some basalt flows and sedimentary rocks.
lTv—Lower Tertiary volcanic rocks, undivided. Predominantly andesite flows and flow breccia; includes basalt flows, minor rhyolitic rocks, and some sedimentary rocks.

Φv — Oligocene volcanic rocks
Andesitic and rhyodacitic flows, tuff, and tuffaceous sandstones of northern Lincoln County and southwestern Stevens County.

EΦv — Eocene-Oligocene volcanic rocks
Predominantly light-green, bedded andesite breccia with interbedded andesite and basalt flows, mudflows, and tuff beds; becomes more tuffaceous near top of unit. Includes tuffaceous and arkosic sandstone and shale. Found in the western slopes of central and southern Cascade Mountains. Rhyodacite and andesite flows in northwestern Ferry County.

Ev₃, Ev₃a, Ev₃b, Ev₃r — Upper Eocene volcanic rocks
Ev₃—Andesite and basalt flows and associated breccia in central Lewis County. Pyroclastic rocks, basalt flows, flow breccia, and volcanic-rich sedimentary rocks in King and Pierce Counties.
Ev₃a—Predominantly andesite flows and breccia; includes some basalt flows. Contains basaltic conglomerate, pyroclastic rocks, coal beds, and sandstone in the Chehalis-Centralia coal district, Lewis County.
Ev₃b—Predominantly basalt flows and flow breccia; includes some pyroclastic and andesitic rocks. Chiefly in southern Washington.
Ev₃r—Rhyolite flows and some interbedded tuff beds in Cle Elum area, Kittitas County.

Ev — Eocene volcanic rocks
Predominantly andesite flows and breccia; includes interbedded sedimentary rocks south of Startup in Snohomish and King Counties.

Ev₂ — Middle and lower Eocene volcanic rocks
Dark-gray, coarse- to fine-grained, strongly chloritized basalt flows and breccia; includes pillow lava, deeply altered palagonite beds, amygdaloidal and vesicular flows, and, locally, sedimentary rocks. Comprises outer volcanic belt in Olympic Peninsula, where manganese ore is associated with some submarine lavas.

MzTv — Mesozoic-Tertiary volcanic rocks, undivided
Altered basalt, pillow lava, and flow breccia of inner volcanic belt of Olympic Peninsula; includes minor interbedded red limy argillite and associated manganese ore.

TKv — Upper Cretaceous-lower Tertiary volcanic rocks
Dark-gray to green andesite tuff, breccia, and flows in Methow River area of Okanogan County.

pTv — Pre-Tertiary volcanic rocks, undivided
Andesite and basalt flows, and greenstone; includes minor interbedded limestone, arkose, quartzite, and chert beds.

JKv — Upper Jurassic-Lower Cretaceous volcanic rocks
Predominantly volcanic rocks, mostly metamorphosed to greenstone and greenschist; includes some sedimentary rocks.

Mzv — Mesozoic volcanic rocks, undivided
Includes latite, andesite and basalt flows, tuff, and agglomerate. Interbedded sedimentary rocks in Orient area of Stevens County.

Jv — Middle Jurassic volcanic rocks
Andesite, dacite, and minor basalt with slate and graywacke interbeds in the Nooksack River region of Whatcom County.

pJv — Pre-Middle Jurassic volcanic rocks, undivided
Predominantly greenstone and spilitic volcanic rocks; includes some slate, argillite, and graywacke.

CPv — Carboniferous and Permian volcanic rocks
Predominantly altered andesite, basalt, and diabase with interbedded chert and argillite; includes some tuff, greenstone, and spilitic volcanic rocks; northern Cascade Mountains. Mostly schistose greenstone, some agglomerate, and rarely lapilli; includes minor beds of limestone with associated argillite and graywacke; northwestern Stevens County.

pCv — Precambrian volcanic rocks
Mostly homogeneous schistose greenstone; in places massive, mottled, and containing conspicuous calcite and epidote. Tuffaceous chlorite schist in upper part in northern Pend Oreille County. Amphibolite and plagioclase amphibolite in Little Pend Oreille Lakes district. Massive to sheared or schistose greenstone with dark-green ovoid spots; agglomeratic and amygdaloidal in places; sheared pillows near Blue Creek, central Stevens County; minor intrusive phase and probable center of eruption west of Finch magnesite quarry; central to southwestern Stevens County.

METAMORPHIC AND INTRUSIVE IGNEOUS ROCKS

CENOZOIC

Ti — Tertiary dikes, sills, and small intrusive bodies
Dikes are commonly diabase; plugs and sills are generally andesite porphyry and dacite.

Tg — Tertiary granitic rocks
Granite, quartz monzonite, quartz diorite, granodiorite, and trondhjemite. Includes dacite porphyry and granite breccia near Bumping Lake, Yakima County.

Tas — Tertiary alkali intrusive rocks
Syenite sills in Phalen Lake area, northwestern Stevens County. Porphyritic syenite in Danville area of Northern Ferry County.

Td — Tertiary dunite intrusive rocks
An intimate mixture of saxonite and dunite, partly serpentinized; Twin Sisters mountain area of Whatcom and Skagit Counties. Predominantly dunite and associated serpentinite in Jumbo Mountain area of central Snohomish County.

bi — Basic intrusive rocks, undivided
Predominantly gabbro; includes some serpentine. Age undetermined.

TKg — Tertiary-Cretaceous granitic intrusive rocks
Granite, granodiorite, trondhjemite, and quartz diorite. Late Cretaceous and/or early Tertiary.

TKbi — Tertiary-Cretaceous basic intrusive rocks
Diorite and gabbro in western Snohomish County.

MESOZOIC

pTm — Pre-Tertiary metamorphic rocks, undivided
Schist, gneiss, marble, quartzite, amphibolite, greenstone, metaconglomerate, and migmatite. In Nighthawk district and near 49th Parallel in Okanogan County includes metasedimentary, volcanic, and intrusive rocks. Some areas, as San Juan Islands, show little if any metamorphism.

pTbi — Pre-Tertiary basic intrusive rocks
Predominantly gabbro and metagabbro; includes hornblendite, peridotite, and pyroxenite. In Nighthawk district and near 49th Parallel in Okanogan County and in Orient district of Stevens County.

pTb — Pre-Tertiary ultrabasic intrusive rocks
Peridotite and pyroxenite; generally altered partly or completely to serpentine. Includes serpentinite and saxonite on Sumas Mountain, Whatcom County.

pTd — Pre-Tertiary dunite intrusive rocks
Dunite associated with serpentine on Cypress Island in San Juan Islands and on Mount Chopaka near Oroville in Okanogan County.

Mzg — Mesozoic granitic rocks, undivided
Granite, quartz monzonite, quartz diorite, granodiorite, and trondhjemite. Includes diorite in southeastern Washington; diorite and gabbro near Conconully in Okanogan County; gneiss, schist, and migmatites in areas of Chelan, Colville, and Okanogan batholiths. Includes high-grade metamorphic rocks of Precambrian age in Spokane area.

Mzag, Mzas — Mesozoic alkali intrusive rocks
Mzag—Albite granite as small plugs and sills near Boundary in Stevens County.
Mzas—Syenite in Nighthawk and Buckhorn Mountain areas of Okanogan County; malignite on Kruger Mountain near Nighthawk.

pJph — Pre-Upper Jurassic metamorphic rocks of the low-grade zone
Greenschist, phyllite, and slate; includes some limestone, quartzose phyllite, schistose metaconglomerate, breccia, and basic igneous rocks. Includes schist locally. Greenschist of central Whatcom and Skagit Counties, pJgs.

pJsc — Pre-Upper Jurassic metamorphic rocks of the medium and high-grade zones
Schist, amphibolite, and minor lime-silicate rocks, marble, quartzite, and metaconglomerate.

pJgn — Pre-Upper Jurassic gneiss
Biotite, quartz diorite, trondhjemite, and hornblende gneisses, many of which are migmatitic; includes small granitic bodies locally. Small areas of mica schist, marble, amphibolite, and lime-silicate rocks in Entiat Mountains area of Chelan County.

PALEOZOIC

pCg — Pre-Carboniferous intrusive rocks
Meta-quartz diorite, hypersthene diorite, and gneissose and directionless quartz diorite of eastern Skagit County. Quartz diorite and diorite in the San Juan Islands. Includes amphibolite and gneiss locally.

pCm — Pre-Carboniferous crystalline complex
Metahornblendite, amphibolite, gneiss, metadiorite, meta-quartz diorite, and trondhjemite. As klippes along western slope of northern Cascade Mountains.

PRECAMBRIAN

pCi — Precambrian intrusive rocks
Dark-gray diorite sills from 3 to 1,200 feet thick. Confined to Bead Lake district, southeastern Pend Oreille County. Tentatively assigned to the Precambrian.

MAP SYMBOLS

Contact
Known, approximate, and inferred are undifferentiated.

Scratch boundary
Contact uncertain, or edge of specific mapped area.

Fault
Character not designated; dashed where approximately located.

Concealed fault

Thrust fault
Saw-teeth on upper plate.

Border of continental ice sheet
Sources of data for border are 9, 41, 112a, 112gg, 114 (see data list).

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