WASHINGTON STATE DEPARTMENT OF
NATURAL RESOURCES
WASHINGTON GEOLOGICAL SURVEY

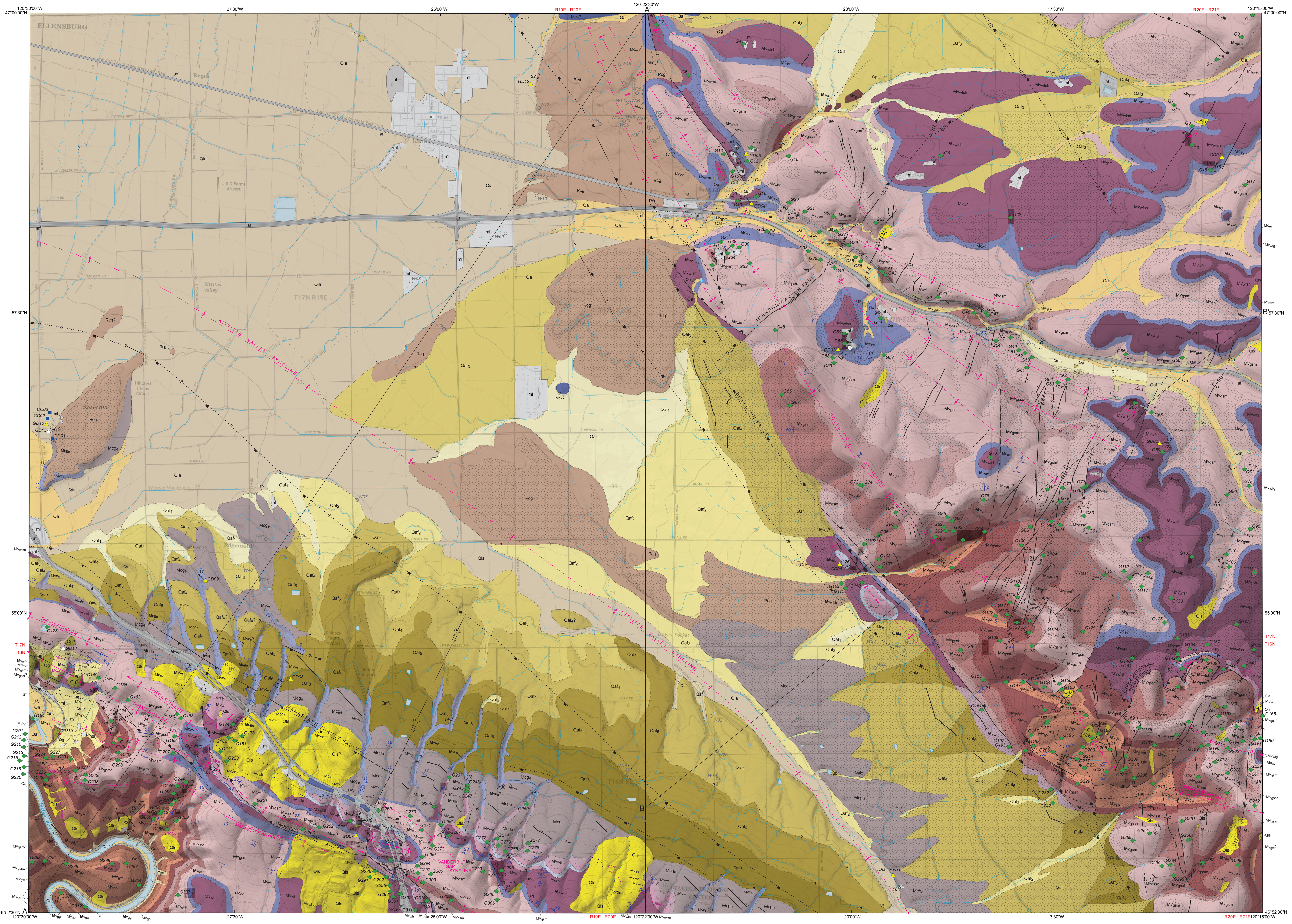
Geologic Map of the Kittitas and East Kittitas 7.5-minute Quadrangles, Kittitas County, Washington

Andrew J. Sadowski, Logan R. Wetherell, Megan L. Anderson, and Jack E. Powell

December 2023

WASHINGTON GEOLOGICAL SURVEY
MAP SERIES 2023-05
Geologic Map of the Kittitas and East Kittitas 7.5-minute Quadrangles

©2023 Washington Geological Survey
www.dnr.wa.gov/geology



Lambert conformal conic projection
North American Datum of 1983
Base map from U.S. Geological Survey Kittitas and East Kittitas 7.5-minute quadrangles, 2020
Shaded relief generated from a lidar bare-earth digital elevation model (available from the Washington Geological Survey, https://lidarportal.dnr.wa.gov/)
GIS by Andrew J. Sadowski and Logan R. Wetherell
Digital cartography by Daniel E. Coe and J. Eric Schuster
Editing and production by Susan R. Schnur and Nikolas Midttun

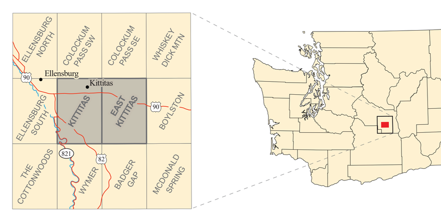
Disclaimer: Neither the State of Washington, nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the State of Washington or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the State of Washington or any agency thereof.

SCALE 1:24,000
1 MILE — 1,000 FEET 7,000 FEET — 1 KILOMETER
contour interval 20 feet

This geologic map was funded in part by the U.S. Geological Survey National Cooperative Geologic Mapping Program under USGS award number G22AC00364.

14.5° TRUE NORTH MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 2023

Research supported by the U.S. Geological Survey, National Cooperative Geologic Mapping Program, under USGS award number G22AC00364. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.



State of Washington
Licensed Geologist
3277
ANDREW JOHN SADOWSKI
December 2023

ABSTRACT

New geological and geophysical investigations of the Kittitas and East Kittitas quadrangles refine Neogene stratigraphy and characterize geologic structures in southern Kittitas Valley. New whole rock geochemistry (n=329) locally refines the middle Miocene chemostratigraphic framework of the Columbia River Basalt Group (CRBG). These strata are tilted toward Kittitas Valley by faulting and folding at the mountain front. Abundant suprabasalt late Miocene to Pliocene volcaniclastic strata are less steeply tilted.

From twelve U-Pb analyses, we interpret eruptive ages of ~15.95 Ma for a tuff at the top of the Vantage Member and ~8.72 Ma for a pumice within the upper Ellensburg Formation. Younger sedimentary interbeds of the Ellensburg Formation are more common and thicker compared to older interbeds, suggesting a migrating and (or) deepening depositional center. Between ~5.4 and ~3.3 Ma, deposition transitioned from largely Cascade-sourced sediments of the Ellensburg Formation to basalt-derived sediments of overlying Pliocene(?)–Quaternary deposits.

We identify reverse and thrust faults with oblique-slip on the flanks of bedrock highs. We interpret these range front faults as young, in-sequence thrust-type structures in a compressional or transpressional regime. Fault-related folds are associated with these structures, including several plunging, northwest- through west-trending anticlines and synclines. We map numerous northerly striking oblique-slip faults with varying offsets, especially where the folds of the Boylston Mountains bend northward.

Geophysical modeling of gravity and aeromagnetic data suggests laterally abrupt thickness changes in basaltic units. These thickness changes may be related to (1) ramp-flat geometries under uplifts; and (or) (2) periods of syn-eruptive development of local accommodation space, where CRBG rocks experienced concurrent footwall thickening (growth strata) and hanging-wall thinning (uplift-related erosion).

LIST OF MAP UNITS

Holocene to Pleistocene Nonglacial Deposits

af — **Artificial fill (Holocene)**—Cobbles, pebbles, sand, and boulders; poorly sorted and unconsolidated; placed to elevate home sites, highways, or other infrastructure.

ml — **Modified land (Holocene)**—Sand- through boulder-sized material redistributed to modify topography for industrial, agricultural, and residential uses; including, but not limited to, gravel pits, rock quarries, aggregate mines, and home sites.

Qp — **Peat (Holocene to Pleistocene)**—Organic and organic-rich sediment; includes peat, gyttja, muck, silt, and clay; typically in closed depressions; mapped in natural or man-made wetlands, bog areas, and ephemeral water bodies.

Qls — **Landslide deposits (Holocene to Pleistocene)**—Clastic aggregate and scree; generally loose and poorly consolidated; clay- to boulder-sized material; angular to subangular, typically matrix supported, and less commonly clast supported near talus piles; unstratified and structureless; unit contains rubble of sand, silt, clay, cobbles, pebbles, boulders, and diamicton of mostly basalt clasts.

Holocene to Pliocene Alluvial and Colluvial Deposits

Stream channel and stream flood (overbank) deposits and terraces. Deposits include pebbles, cobbles, sand, silt, clay, peat, and boulders, all in varying amounts and thicknesses. Colors range from light tannish gray to medium brown. The deposits are fresh to mildly weathered and are uncompacted to weakly compacted and poorly to moderately cemented. The clasts are typically cobbles with sand and pebbles, well rounded, and moderately to well sorted. The deposits are polymict near the Yakima River and mostly basaltic in the East Kittitas quadrangle.

Qa — **Alluvium (Holocene)**—Stream channel deposits on active flood plains and commonly flanking creeks; unit is narrowly distributed throughout low elevations of the map area.

Qia — **Intermediate-age alluvium (Holocene to Pleistocene)**—Stream-flood (overbank) and old channel deposits near active flood plains; deposited where ongoing alluvial deposition from overland flow is possible but less evident compared to unit Qa; surfaces of unit Qia are slightly elevated relative to surfaces of unit Qa. Unit Qia is commonly indistinguishable from alluvial fan unit Qaf$_1$ based on lithology and height relative to unit Qa. However, unit Qia tends to be found (1) closer to unit Qa than unit Qaf$_1$, and (2) at slightly lower elevations than unit Qaf$_1$.

Qaf, Qaf$_1$, Qaf$_2$, Qaf$_3$, Qaf$_4$, Qaf$_5$, Qaf$_6$ — **Alluvial fan deposits (Holocene to Pliocene?)**—Sand, gravel, and relict debris flows deposited in alluvial fans; generally brown; uncompacted to poorly consolidated; silt- to boulder-sized clasts; angular to subrounded; unsorted to moderately sorted; clast composition is generally basalt of the Columbia River Basalt Group (CRBG); unit thickness is generally less than 15 m but varies with age, where older units tend to be thicker. Unit is subdivided and numbered from 1 (lowest and youngest) to 6 (highest and oldest) based on relative elevation above the modern stream level and differences in surface morphologies.

Qg — **Terrace gravel deposits (Pleistocene)**—Gravel deposited in fluvial setting in Yakima canyon; light to medium gray, greenish gray, light to medium brown; loose, poorly cemented; pebbles and cobbles with boulders and medium sand; rounded to subrounded; poorly sorted, matrix supported. Polymictic clasts are from Cascade Range. Mapped in detail by Kelsey and others (2017) and Bender and others (2016).

Rcg — **Cobble gravel (Pliocene)**—Angular to well-rounded cobble gravel with clay to sand interbeds deposited in alluvial fans and the paleo-Yakima River channels, and conglomerates flanking Manastash Ridge and the Boylston Mountains. The unit forms flat incised surfaces, polymictic near the Yakima River corridor and basaltic dominated elsewhere; poorly to mildly consolidated; mildly to moderately cemented; thickness ranges from several meters to more than 30 m; coeval with Thorp Gravel.

Tertiary Sedimentary and Volcanic Bedrock

SEDIMENTARY ROCKS OF THE ELLENSBURG FORMATION

Mc$_e$ — **Ellensburg Formation, undivided (middle Miocene to early Pliocene?)**—Feldsarenite and conglomerate of fluvial, lacustrine, volcaniclastic, and colluvial origin underlying, intercalated with, and overlying rocks of the CRBG; light to medium brown to light to medium gray; mildly to strongly weathered; moderately indurated; where interbedded in the CRBG, unit is generally fine to coarse-grained sandstone; where unconformably overlying the CRBG, unit is locally volcaniclastic mudstones and sandstones overlain by conglomeratic colluvium on the northern flank of Manastash Ridge. Rounded to angular; well to moderately sorted; grain supported; lower Ellensburg Formation interbeds are typically <35 m thick, whereas upper Ellensburg units overlying CRBG can be >120 m thick; upper Ellensburg Formation units commonly lack white mica, whereas older members interbedded with basalts commonly have white mica in varying amounts. Locally subdivided into:

Mcg$_e$ — **Conglomeratic rocks of the upper Ellensburg Formation (late Miocene)**—Conglomerate with fine sedimentary lenses and paleosols that overlie the CRBG; light brownish gray to medium brown, mild to moderately weathered; mild to moderately cemented; pebbles, cobbles with few boulders, also containing coarse to fine sands; subangular to well rounded; poorly sorted, matrix supported. Structureless to laminated; polymict dominated by Cascade-sourced volcanic clasts near Yakima River corridor and basaltic dominated in East Kittitas.

Mvc$_e$ — **Volcaniclastic rocks of the upper Ellensburg Formation (late Miocene)**—Volcaniclastic sandstone, siltstone, and mudstone with some conglomerate directly overlying the Wanapum Basalt; gray, pinkish brown, or light brown, moderately weathered; moderately indurated to friable, mildly to moderately cemented; lithology varies from fine ashy mudstone to coarse-grained sandstone with pumice and lenses of accretionary lapilli ash fall tuff; subangular to rounded, poorly sorted, matrix supported; common paleosols and pedogenic sediments in central map area. Unit is >20 m thick and found in canals and ravines at mid elevations on Manastash Ridge.

Mc$_{elc}$ — **Lmuma Creek Member of the lower Ellensburg Formation (middle Miocene)**—Tuffaceous sandstone, that can be micaceous and rarely diatomaceous; light gray to white, mildly to moderately weathered, mildly to moderately cemented, medium grained, well sorted and matrix supported with common planar crossbedding; rare polymict pebble layers; less than 15 m thick. Member was formerly known by a derogatory term for Indigenous women that has since been replaced by the name Lmuma Creek. Includes the Quincy diatomite.

Mc$_{ev}$ — **Vantage Member of the lower Ellensburg Formation (middle Miocene)**—Micaceous and volcaniclastic sandstone and siltstone; light brownish gray to light gray or white; moderately to strongly weathered; mildly to moderately indurated, weakly cemented; subangular; fine to coarse grained; commonly well sorted, grain supported. The unit is less than 30 m thick and is stratigraphically between the basalt of Museum of the Sentinel Bluffs Member, unit Mv$_{gsm}$, and the overlying Wanapum Basalt.

Mc$_{ec}$ — **Coleman member of the lower Ellensburg Formation (middle Miocene) (line unit only)**—Sandstone and siltstone underlying the Sentinel Bluffs Member of the CRBG; medium brown to light gray; generally fine- to medium-grained micaceous sandstone; estimated to be less than 20 m thick and mapped as a line unit in Yakima canyon in the southwestern corner of the map area.

VOLCANIC ROCKS OF THE COLUMBIA RIVER BASALT GROUP (CRBG)

Mv$_w$ — **Wanapum Basalt, undivided (middle Miocene) (cross section only)**—Basalt, described in detail in the following units; dark gray to grayish brown; well indurated; microporphyritic to weakly porphyritic, or weakly glomerocrystic; commonly with groundmass crystals at least 1.0 mm in size; less commonly aphyric than GRB units; <100 m thick. The formation unconformably overlies the Vantage Member (unit Mc$_{ev}$), and upper Ellensburg units—especially unit Mvc$_e$, which unconformably onlaps onto unit Mv$_w$. Locally subdivided into:

Mv$_{wp}$ — **Priest Rapids Member (middle Miocene)**—medium- or very coarse-grained basaltic andesite with groundmass crystals <2 mm in size; dark gray to grayish brown, weathers to light orangish brown; well indurated; mostly aphyric to weakly porphyritic, typically very coarse grained, sometimes with a gabbro-like texture (basaltic pegmatoid); unit is ~15 m thick at Vanderbilt Gap and poorly exposed in the canals on northern flank of Manastash Ridge.

Mv$_{wr}$ — **Roza Member (middle Miocene)**—Porphyritic basalt and basaltic andesite with medium to fine groundmass; dark gray to grayish brown, weathers dark to medium brown; diagnostically porphyritic (~2–10% total phenocrysts) with common centimeter-scale plagioclase phenocrysts (typically >10 phenocrysts per hand sample); top of flow is more aphyric. The unit is ~15–30 m thick and invaded the Lmuma Creek Member (unit Mc$_{elc}$), where Roza lava flow(s) entered wet sediments that would become unit Mc$_{elc}$, thereby the rocks of unit Mc$_{elc}$ underlie, intermingle, and overlie the Roza Member.

Mv$_{wf}$ — **Frenchman Springs Member, undivided (middle Miocene)**—Medium-grained basalt to basaltic andesite that is sparsely porphyritic to weakly glomerocrystic or aphyric; dark gray to greenish brown; well indurated; commonly sparsely porphyritic to glomerocrystic with <3% total phenocrysts to aphyric; total thickness is <90 m thick (combined Ginkgo and Sand Hollow) but may thicken into valley. Less porphyritic than the Roza Member and finer grained than the Priest Rapids Member.

Mv$_{wfsh}$ — **Basalt of Sand Hollow (middle Miocene)**—Medium-grained basalt and basaltic andesite that is weakly porphyritic, with ~1% total phenocrysts, to aphyric, typically contains about two plagioclase phenocrysts per hand sample, and may contain glomerocrysts; medium to dark gray, weathers to dark reddish brown or reddish gray; well indurated; ~1 m wide columns can internally exhibit flat to curved platy foliation. Pillow breccia and palagonite are locally common. The unit is less than ~60 m thick and well exposed on north flank of the Boylston Mountains and summit of Manastash Ridge. The unit commonly overlies the Vantage Member in the western map area.

Mv$_{wfg}$ — **Basalt of Ginkgo (middle Miocene)**—Medium-grained basalt that is weakly porphyritic or glomerocrystic; medium to dark gray, weathers to medium or dark brown; well indurated; typically contains about four plagioclase phenocrysts per hand sample (~1–2% total phenocrysts); ~30 m thick and pinches out west of the Boylston Mountains. In the eastern map area, the unit can overlie the Vantage Member (unit Mc$_{ev}$) and contains some local pillow breccia.

Mv$_g$ — **Grande Ronde Basalt (GRB), undivided (middle Miocene) (cross section only)**—Basaltic andesite, described in detail in the following units. The Meridian well contains ~2,029 m of total basalt thickness (S. Reidel, written commun., 2020), presumably all Grande Ronde Basalt. The unit contains reverse (R) and normal (N) magnetostratigraphic units (MSU), from oldest to youngest: R1, N1, R2, and N2. Unit Mv$_g$ is mapped where a lack of geochemistry prevented us from identifying a specific subunit, and in the cross section where the subunits are grouped at depth. Locally subdivided into:

Mv$_{gs}$ — **Sentinel Bluffs Member, undivided (middle Miocene)**—Basaltic andesite; aphyric. The map area contains five subunits, from oldest to youngest: basalts of McCoy Canyon, California Creek, Spokane Falls, Stember Creek, and Museum. Cumulatively, the Sentinel Bluffs Member is at least ~140 m thick, with the Meridian well showing a thickness range of 93–126 m (S. Reidel, written commun., 2020). We map unit Mv$_{gs}$ as undivided (grouped) where geochemical results are unavailable to divide exposures into subunits but where we remain reasonably confident that the exposure belongs to the Sentinel Bluffs Member based on interpolations with nearby stratigraphic relationships; found in the northeastern portion of the map area. With available geochemistry, we subdivide the Sentinel Bluffs Member into:

Mv$_{gsm}$ — **Basalt of Museum (middle Miocene)**—Fine-grained basaltic andesite with groundmass crystals ranging in size from 0.05 to 0.6 mm and very rare phenocrysts of plagioclase up to 3.5 mm in size; most commonly aphyric. The unit is ~38–60 m thick, contains at least two flows, and is locally the top of the Sentinel Bluffs Member.

Mv$_{gssc}$ — **Basalt of Stember Creek (middle Miocene)**—Fine-grained basaltic andesite with groundmass crystals ranging in size from 0.05–0.4 mm and very rare phenocrysts of plagioclase as large as 1.6 mm; most commonly aphyric. The unit is less than ~55 m thick and it contains at least two flows. The unit is sparsely mapped and less common than unit Mv$_{gssf}$, and consistently overlies flows with Spokane Falls-type compositions in the eastern map area.

Mv$_{gssf}$ — **Basalt of Spokane Falls (middle Miocene)**—Fine-grained basaltic andesite with groundmass crystals ranging in size from 0.1–0.4 mm and very rare phenocrysts of plagioclase as large as 1.2 mm; most commonly aphyric. The unit is very common and <65 m thick and contains at least two flows. The unit may interfinger with Stember Creek-type compositions in the southwest map area.

Mv$_{gscc}$ — **Basalt of California Creek (middle Miocene)**—Fine-grained basaltic andesite; medium gray, strongly weathered; moderately to well indurated; aphyric; <50 m thick; found only at geochemistry site G204; found along the Boylston Fault in the southern portion of the map area.

Mv$_{gsmc}$ — **Basalt of McCoy Canyon (middle Miocene)**—Fine-grained basaltic andesite with groundmass crystals ranging in size from ~0.1–0.5 mm and very rare phenocrysts of plagioclase as large as 1.2 mm; most commonly aphyric. The unit is ~65–90 m thick, contains two or three flows, and is locally the base of the Sentinel Bluffs Member.

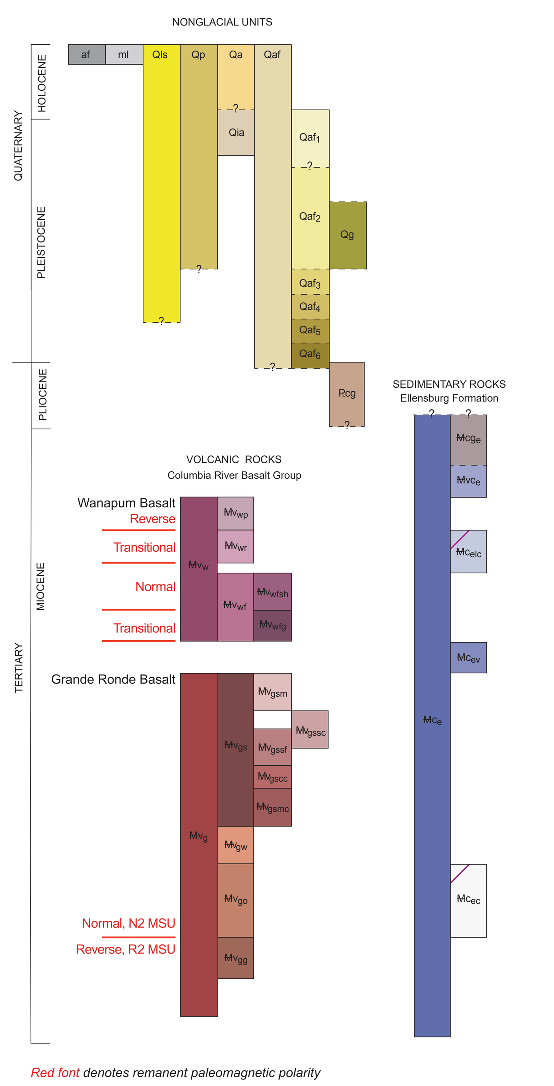
Mv$_{gw}$ — **Winter Water Member (middle Miocene)**—fine to medium-grained basaltic andesite; locally aphyric, but may be sparsely to abundantly glomerocrystic or less commonly porphyritic; medium to dark gray, weathers medium to dark brown; well indurated; ~40–100 m thick and thickens eastward. The Meridian well shows a thickness range of 58–98 m for unit Mv$_{gw}$ (S. Reidel, written commun., 2020). The unit contains at least two flows with well-developed middle entablature and a conspicuous basal colonnade composed of stacks of segmented and tilted columns. Synonymous with the 'Umtanum flow.'

Mv$_{go}$ — **Ortley member (middle Miocene)**—Fine- to medium-grained basaltic andesite with groundmass crystals up to 1 mm in size; aphyric. The unit is at least ~46 m thick in Yakima canyon and may thicken eastward at depth to ~230 m in the BISSA well and ~215–251 m in the Meridian well (S. Reidel, written commun., 2020); contains at least two to four flows. The unit is part of the N2 MSU, representing the base of N2 MSU in the map area, and is invasive into the Coleman member of the Ellensburg Formation.

Mv$_{gg}$ — **Grouse Creek member (middle Miocene)**—Medium- to fine-grained basaltic andesite with groundmass crystals less than 1.5 mm in size; aphyric; groundmass crystal sizes slightly greater than those of unit Mv$_{gs}$. Base of unit is not observed. From map patterns, the unit is >140 m thick, but may be considerably thicker north of the map area; at depth the unit is ~90 m thick in the BISSA well and ~46–91 m thick at the Meridian well (S. Reidel, written commun., 2020). The unit contains at least one flow and is well exposed in Yakima canyon.

CORRELATION OF MAP UNITS

PERIODS AND EPOCHS BASED ON USGS FACT SHEET 2010-3059



Red font denotes remanent paleomagnetic polarity

GEOLOGIC SYMBOLS

Mass Wasting (overlay mw)—Mapped where hummocky landforms suggest mass movement on unstable slopes, but evidence for landslide deposits is inconclusive.

Quaternary loess (overlay Ql)—Light brown to medium brown eolian loess; moderately weathered; low density, poorly compacted; silt to very-fine-grained sand; angular; moderately to poorly sorted, matrix supported; internally structureless; forms 1-meter-tall irregularly spaced mounds.

Miocene hyaloclastite (overlay hy)—Volcaniclastic aggregate in or between basalt flows; pillow breccia with volcanic glass (tachylyte ± sideromelane) and its alteration product palagonite; light yellowish brown to orange brown or tan and generally strongly weathered; less dense than basalt, moderately well consolidated; generally composed of sand- to boulder-sized clasts in a very-fine-grained matrix; angular to subangular; poorly sorted; some exposures may contain cobble- to boulder-size fragments of basalt pillows (centimeter to meter scale) that are matrix supported. Where pillows are absent, exposures are convoluted and structureless. Hyaloclastite forms from the quenching of hot lava in water, and where the lava forced its way into saturated sediments this is called peperitic hyaloclastite or peperite. Thickness varies but is generally less than 30 m. Overlay is common near the base of unit Mv$_{gsmc}$, near the top of unit Mv$_{go}$, and throughout unit Mv$_{wr}$.

Contact—Solid where location accurate; long-dashed where approximate; short-dashed where inferred; dotted where concealed; queried where identity or existence questionable

Gradational contact—Identity and existence certain; location accurate

Geologic boundary—Identity and existence certain; solid where location accurate; long-dashed where approximate; short-dashed where inferred; In this map, symbol shows internal contacts between lava flows of the same unit, or boundaries between alluvial fans of similar ages

Fault—Solid where location accurate; long-dashed where approximate; short-dashed where inferred; dotted where concealed; queried where identity or existence questionable

Thrust fault—Solid where location accurate; long-dashed where approximate; short-dashed where inferred; dotted where concealed; queried where identity or existence questionable; sawteeth on upper plate

Reverse fault—Solid where location accurate; long-dashed where approximate; short-dashed where inferred; dotted where concealed; queried where identity or existence questionable; rectangles on upthrown block

Strike-slip fault, right lateral offset—Solid where location accurate; short-dashed where inferred; dotted where concealed; arrows show relative motion

Oblique-slip fault, reverse right lateral offset—Solid where location accurate; long-dashed where approximate; short-dashed where inferred; dotted where concealed; queried where identity or existence questionable; arrows show relative motion; rectangles on upthrown block

High-angle dip-slip fault—Solid where location accurate; long-dashed where approximate; short-dashed where inferred; dotted where concealed; queried where identity or existence questionable; relative motion shown by U and D

Oblique-slip fault, high-angle right-lateral offset—Solid where location accurate; long-dashed where approximate; short-dashed where inferred; dotted where concealed; relative horizontal motion shown by arrows; relative vertical motion shown by U and D

Oblique-slip fault, high-angle left-lateral offset—Solid where location accurate; long-dashed where approximate; short-dashed where inferred; dotted where concealed; queried where identity or existence questionable; relative motion shown by U and D

Anticline—Solid where location accurate; long-dashed where approximate; short-dashed where inferred; dotted where concealed; queried where identity or existence questionable; arrow on line indicates plunge direction

Syncline—Solid where location accurate; long-dashed where approximate; short-dashed where inferred; dotted where concealed; queried where identity or existence questionable; arrow on line indicates plunge direction

Monocline, anticlinal bend—Short-dashed where inferred; dotted where concealed; arrows show direction of dip; shorter arrow on steeper limb; arrow on line indicates plunge direction

Monocline, synclinal bend—Long-dashed where approximate; dotted where concealed; arrows show direction of dip; shorter arrow on steeper limb; arrow on line indicates plunge direction

Geologic unit too thin to show as a polygon—Solid where location accurate; long-dashed where approximate; short-dashed where inferred; dotted where concealed; queried where identity or existence questionable

Scarp of unknown origin—Hachures point down slope

Dike—Identity or existence questionable; location accurate

Lineament of unknown origin

Cross section line

Perennial stream

Intermittent stream

Surface data collected by Washington Geological Survey except for those shown as **blue symbols** (compiled surface data from R. Bentley and J. Powell, Central Washington University, unpub. mapping, 1980–1989).

Inclined bedding—showing strike and dip

Overturned bedding—showing strike and dip

Inclined bedding, where top direction of beds is known from local features—showing strike and dip

Small, minor inclined joint—showing strike and dip

Inclined fold hinge of small, minor syncline—showing bearing and plunge

Small, minor vertical or near-vertical joint—showing strike

Small, minor inclined fault—showing strike and dip

Small, minor vertical or near-vertical fault—showing strike

Inclined slickenline, groove, or striation on fault surface—showing bearing and plunge

Inclined bedding in unconsolidated sedimentary deposits or unconsolidated fragmental deposits of volcanic origin—showing strike and dip

Inclined foreset bedding in unconsolidated sedimentary deposits or unconsolidated fragmental deposits of volcanic origin—showing strike and dip

Inclined contact—showing dip value and direction

Inclined flow banding, lamination, layering, or foliation in igneous rock—showing strike and dip

Shear—showing strike and dip

Spring

GD13 Age site, radiometric

F1 Age site, fossil

GD03 Age site, U-Pb, uranium-lead

GD15 Age site, infrared stimulated luminescence

G275 Geochemistry sample location

W04 Water well

BH1 Drill hole for hydrocarbon exploration or exploitation

CC02 Clast count sample

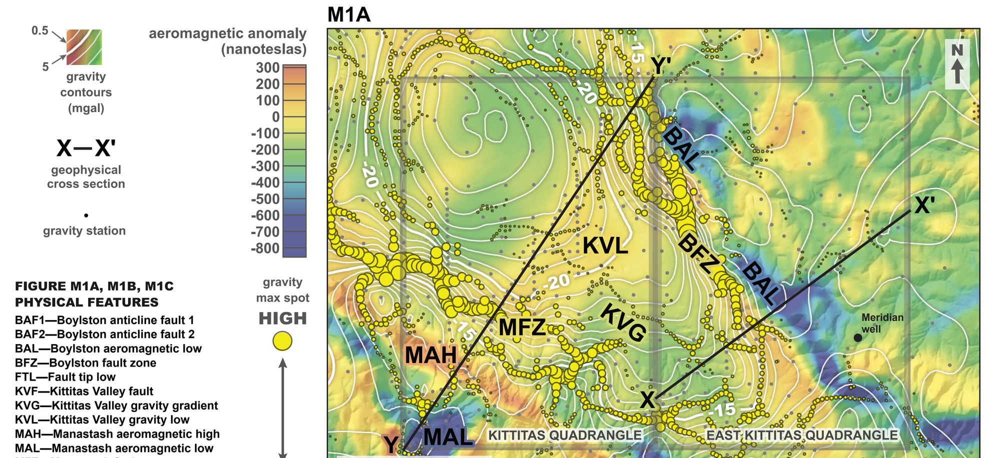


FIGURE M1A, M1B, M1C PHYSICAL FEATURES
BAF1—Boylston anticline fault 1
BAF2—Boylston anticline fault 2
BAL—Boylston aeromagnetic low
BFZ—Boylston fault zone
FTL—Fault tip low
KVF—Kittitas Valley fault
KVG—Kittitas Valley gravity gradient
KVL—Kittitas Valley gravity low
MAH—Manastash aeromagnetic high
MAL—Manastash aeromagnetic low
MFZ—Manastash fault zone
NEAH—Northeast aeromagnetic high
WAL—Wanapum aeromagnetic low

Figure M1A. Combined isostatic gravity, aeromagnetic (reduced-to-pole), and hillshade topography map. Gravity contours are 0.5 mGal. Gravity stations are light gray dots. Yellow dots are gravity max-spots (explained in Pamphlet). X–X' and Y–Y' show the end points of the geophysical models in Figures M1B and M1C, respectively. Gray boxes mark the limits of the Kittitas and East Kittitas quadrangles.

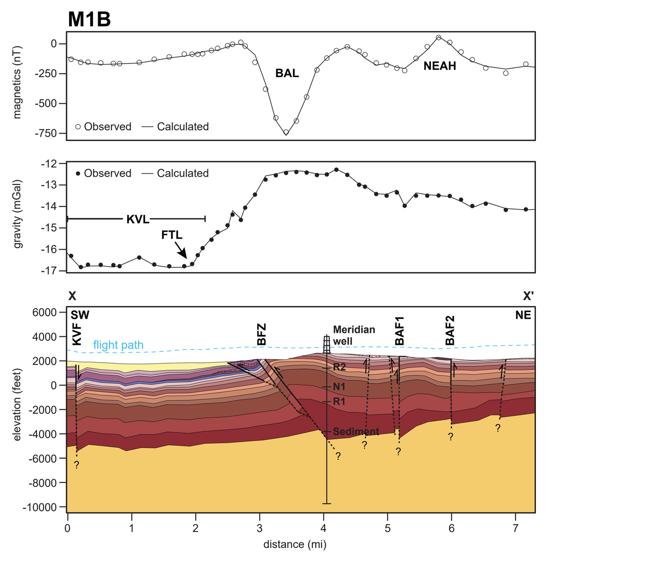


Figure M1B. Two-dimensional potential-fields forward model of profile X–X'. Units and properties shown in the bottom panel predict gravitational and magnetic anomalies shown in the top two panels (ρ–saturated bulk density in kg/m³; χ–magnetic susceptibility in SI x 10³). Gravity data shown are no more than 750 m in map view from the model line. The diameters for the gravity data points are equal to the data error; magnetic data error is too small to show at print scale. "Flight path" shows the elevation of the airplane that flew the aeromagnetic survey. We produced only one averaged property set for all members of Ellensburg Formation, and for all brecciated formations, due to small sample sizes within each member. We show maximum values where we used those in our model instead of the average properties. We have no direct measurements for the Priest Rapids member of the Wanapum Basalt, therefore, we use average Wanapum properties in our model for that unit. Densities for the Wapshilla and Grande Ronde R1 used in the model are adjusted based on well data described in the Pamphlet. Magnetic remanence properties follow Staisch and others (2018). The Meridian well is not directly on the model line, therefore depths of the top of Grande Ronde units and Oligocene sediment are slightly shallower than in our model.

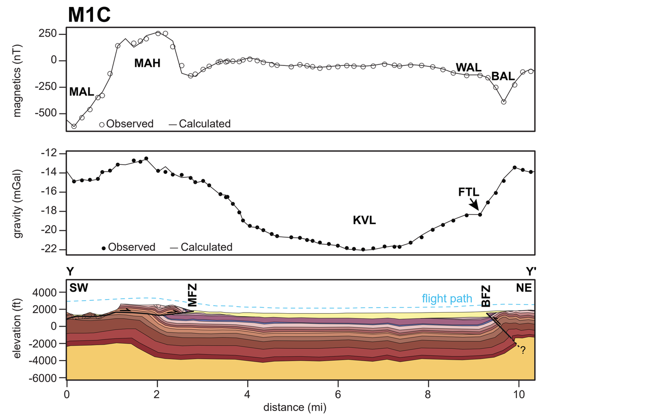


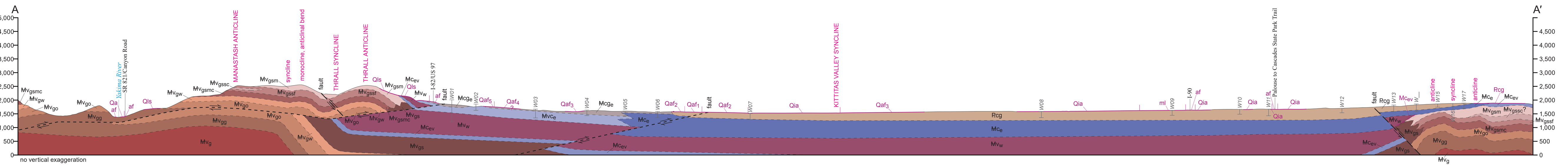
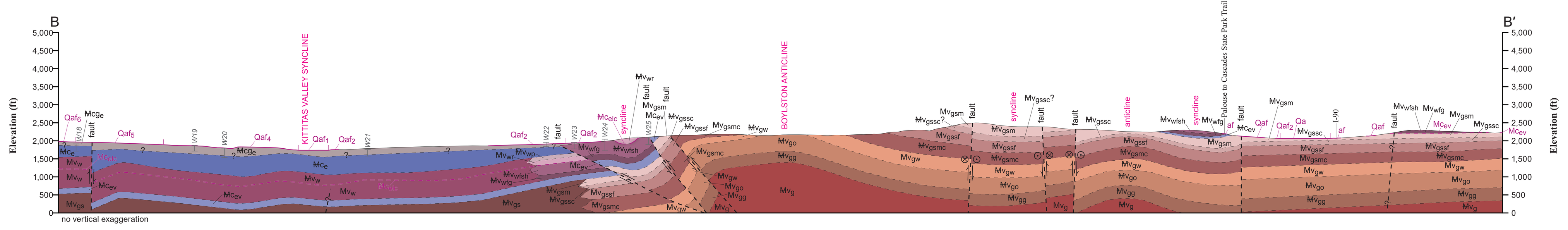
Figure M1C. Two-dimensional potential-fields forward model of profile Y–Y'. See geophysical figure table and legend for symbology and labeling explanation.

	Model Properties		Magnetic Remanence			Average Measured Rock Properties	
	ρ	χ	Mr	Incl	Decl	ρ	χ
Quaternary/Ellensburg Formation	1,800	0-6	0	---	---	1,810	6
Priest Rapids member (reversed)	2,770	8	2.5	-65	191	---	---
Ellensburg Formation-Lmuma Creek	1,810	0	0	---	---	1,810	6
Roza member (reversed)	2,870	18	2.5	-28	198	2,870	9 (18 max)
Basalt of Sand Hollow	2,760	16	2.5	58	0	2,760	6 (16 max)
Basalt of Sand Hollow breccia	2,240	6	1–2.5	58	0	2,240	6
Basalt of Ginkgo	2,850	2	2.5	44	158	2,850	2
Ellensburg Formation-Vantage	1,810	0-6	0	---	---	1,810	8
Basalt of Museum	2,720–2,770	2	1.5	58	16	2,720	2
Basalt of Museum breccia	2,300	2	0–1.5	58	16	2,240	6
Basalt of Stember Creek	2,620	10	1.5	58	16	2,620	10
Basalt of Spokane Falls	2,650	4	1.5	58	16	2,650	4
Basalt of Spokane Falls breccia	2,300	4	1.5	58	16	2,240	6
Basalt of McCoy Canyon	2,660	3	1.5	58	16	2,660	3
Winter Water member	2,800	7	1.5	58	16	2,800	7
Ortley member	2,520	7	1.5	58	16	2,520	7
Grouse Creek member (reversed)	2,560	11	4.0	-72	219	2,560	5 (11 max)
Grouse Creek member breccia (rev.)	2,100	11	4.0	-72	219	2,240	6
Wapshilla Ridge member (reversed)	2,590	15	4.0	-72	219	2,650	13 (15 max)
Grande Ronde N1	2,770	6	2.5	58	355	---	---
Grande Ronde R1 (reversed)	2,700–2,780	6	2.5	-66	171	---	---
Eocene/Oligocene sediment	2,450	0	0	---	---	2,420	<1

CROSS SECTION EXPLANATION

Geologic units too thin to show as polygons at the scale of the cross section—Solid where location accurate; long-dashed where approximate; short-dashed where inferred; queried where identity or existence questionable; vertical tics mark separate units.

Arrows show relative fault movement in the plane of the cross section.

Arrow point shows fault movement toward the viewer; arrow feathers show fault movement away from the viewer.

Water well or boring