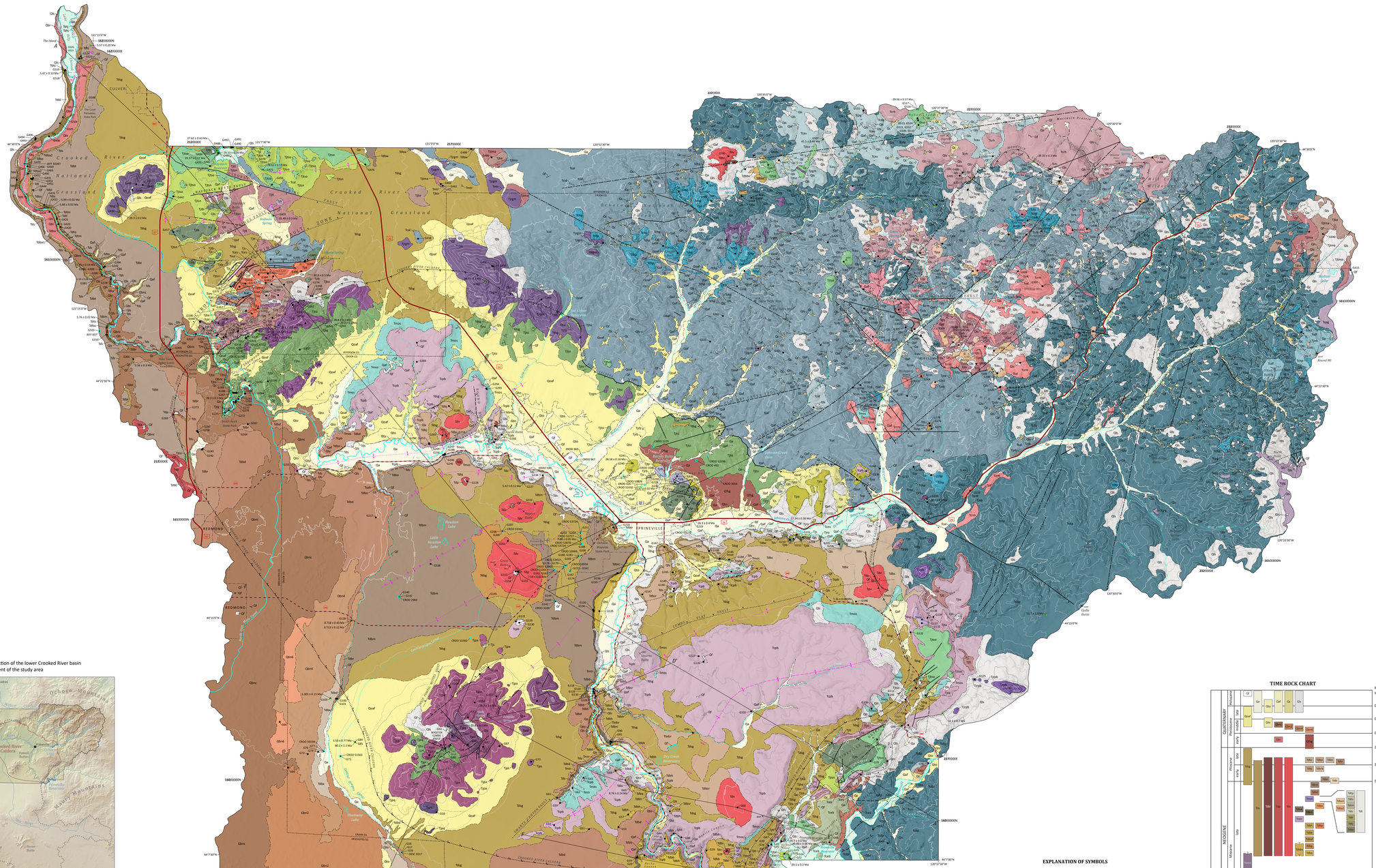
STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
BRAD AVY, STATE GEOLOGIST
https://www.oregongeology.org

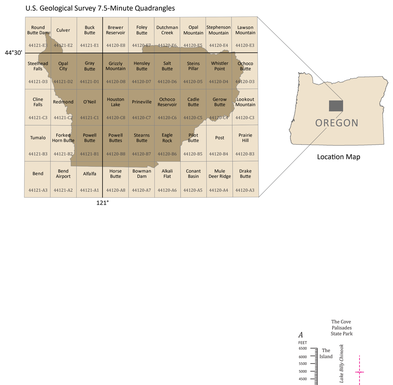
Geologic Map of the North Half of the Lower Crooked River Basin, Crook, Deschutes, Jefferson, and Wheeler Counties, Oregon

2021



The northern section of the lower Crooked River basin showing the extent of the study area

U.S. Geological Survey 7.5-Minute Quadrangles



SCALE 1: 63,360 (1 inch equals 1 mile)
Contour interval 200 feet

APPROXIMATE MEAN DECLINATION, 2021

MILES

KILOMETERS

NOTICE: This map cannot serve as a substitute for site-specific investigations by qualified practitioners. Site-specific data may give results that differ from those shown on the map. 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.

INTRODUCTION TO THE GEOLOGIC MAP OF THE NORTH HALF OF THE LOWER CROOKED RIVER BASIN

The Geologic map of the north half of the lower Crooked River basin encompasses an area of ~2,338 km² (903 mi²) east of the Cascade Range in central Oregon. The geology of the lower Crooked River basin was mapped by the Oregon Department of Geology and Mineral Industries (DOGAMI), with the primary objective to provide an updated and spatially accurate geologic framework for the area. Detailed field mapping, integrated with a number of detailed geologic data sets, has enabled us to reveal a long-lived and complex history of volcanism and sedimentation in this part of central Oregon.

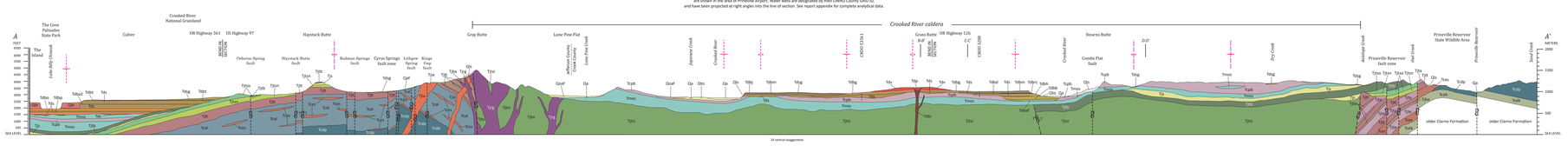
The lower Crooked River basin has been a locus of magmatism for the past 47 million years, including the formation of two large-scale Paleogene rhyolite calderas, deposition of volcaniclastic sedimentary rocks and tuff, and eruption and emplacement of Neogene and Quaternary basaltic lava flows. The earliest magmatism in the lower Crooked River basin is recorded by 46.4 Ma high-MgO alkali-olivine basalt and ~44- to 39-Ma intermediate to silicic calc-alkaline volcanic and intrusive rocks that are part of the Eocene Clarno Formation. Clarno volcanism, focused in the Ochoco volcanic field in the eastern half of the lower Crooked River basin, peaked at 41.8 Ma with the eruption of the tuff of Steins Pillar and formation of the ~16 x 11 km (10 x 7 mi) Wildcat Mountain caldera. The Clarno Formation is overlain in the western half of the lower Crooked River basin by a bimodal assemblage of tholeiitic mafic lava flows and intrusions, rhyolitic tuffs, lava flows and domes, and volcaniclastic sedimentary rocks that are part of the upper Eocene to Oligocene John Day Formation. John Day rocks in the lower Crooked River basin make up the lower Crooked volcanic field and include the Crooked River caldera, a large-scale ~41 × 27 km (25.5 x 17 mi) multicyclic caldera formed between 29.7 and 27.6 m.y.a.

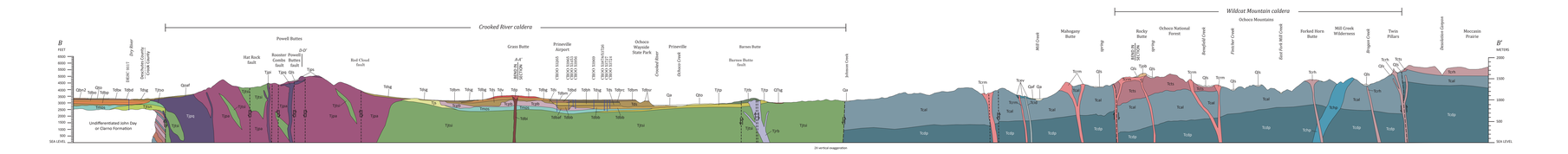
Sedimentary rocks of the lower Miocene Simtustus Formation and ~17- to 16-Ma lava flows of the lower Miocene Columbia River Basalt Group unconformably overlie Paleogene rocks in the lower Crooked River basin. In the western part of the basin these rocks infill the central depression of the Crooked River caldera, recording the earliest development of the Crooked River drainage. Upper Miocene and Pliocene volcaniclastic sedimentary rocks, ash-flow tuff, and lava flows of the Deschutes Formation cropping out across the western part of the lower Crooked River basin record the onset of late High Cascades volcanism, early development of the central Oregon segment of the High Cascades intra-arc graben, and sedimentary and volcanic infilling of the Deschutes Basin on the west. Mafic Deschutes Formation lava flows mapped across the western part of the lower Crooked River basin erupted from vents in the Bowman volcanic field between 8.8 and 3.3 m.y.a. Intracanyon Deschutes Formation mafic lava flows, following channels incised into older rock, record late Neogene development of ancestral Deschutes and Crooked River channels, closely approximating present-day river courses. Pliocene and older rocks are overlain in the western part of the lower Crooked River basin by a broad plain of Quaternary basaltic lavas erupted from Newberry Volcano between 720 and 400 k.y.a. Bedrock units are locally covered across the lower Crooked River basin by Upper Pleistocene and Holocene surficial deposits.

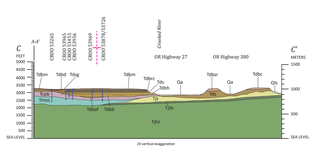
For a complete explanation of map units, structure, geologic history, resources, hazards, and analytical data, please refer to the accompanying text report, data tables, and Esri™ geodatabase.

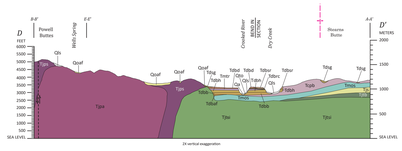
GEOLOGIC CROSS SECTIONS

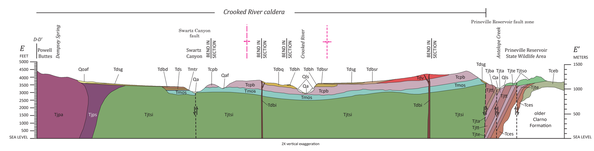
Some Quaternary units not shown in cross section.
Selected water wells, providing subsurface control through geochemical and geochronological data, are shown in the area of Prineville Airport. Water wells are designated by their OWRD County GRID ID, and have been projected at right angles into the line of section. See report appendix for complete analytical data.

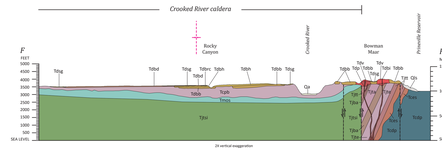












Source Data: Oregon Lidar Consortium, 2015, 3-foot bare earth lidar digital elevation model for Allfalls (4121-A1), Alfalfa (4120-A6), Bend Airport (4121-B3), Bowman Dam (4120-B3), Cadle Butte (4120-C3), Cline Falls (4121-C1), Deschutes Creek (4120-E6), Eagle Rock (4120-B6), Foley Butte (4120-C7), Forked Horn Butte (4121-B2), Gerow Butte (4120-C4), Gray Butte (4121-D1), Grizzly Mountain (4120-D8), Hensley Butte (4120-D7), Horse Butte (4120-A8), Houston Lake (4120-C8), Lawson Mountain (4120-E2), Lookout Mountain (4120-C2), Ochoco Butte (4120-D3), Ochoco Reservoir (4120-C6), O'Neil (4121-C1), Opal City (4121-C2), Paisley Butte (4120-E7), Post (4120-B4), Prairie Hill (4120-D2), Powell Butte (4121-B1), Powell Buttes (4120-B6), Prineville (4120-C7), Redmond (4121-C2), Round Butte Dam (4121-A3), Salt Butte (4120-D6), Stearns Butte (4120-B7), Steelhead Falls (4121-D3), Steins Pillar (4120-D5), Stephenson Mountain (4120-E4), and Whistler Point (4120-D4) quadrangles. Water features from USGS National Hydrography Dataset (2015). Highways and signed routes from Oregon Department of Transportation (2013).

Projection: Oregon Statewide Lambert Conformal Conic Unit: International Feet. Horizontal Datum: NAD 1983 HARN. UTM Coordinates: Zone 10N, NAD83.

Software: Esri ArcGIS® 10.7.1 and Adobe® Illustrator® 2021.

Field Work: Jason D. McClaughry and Mark L. Ferns (2005-2014), with assistance from Caroline L. Gordon, Karyn A. Patridge (2000), and Angela Seligman (2013).

Time-Rock Chart References:
Gradstein, F.M., Ogg, J.G., and Smith, A.G., 2004, A geologic time scale 2004, Cambridge University Press, 589 p.

Ogg, J.G., Ogg, G., and Gradstein, F. M., 2008, The concise geologic time scale: Cambridge University Press, 177 p.

Cohen, K.M., Finney, S.C., Gibbard, P.L., and Fan, J.-X., 2013 (updated 2015), The ICS International Chronostratigraphic Chart: Episodes 36, p. 199-204.

Geology Reviewers: Marshall Gannett (USGS), Dennis McKay (USFS Cascades), David Sherrod (USGS), Clark Niewendorp (DOGAMI-retired), Carlie Annegarn (DOGAMI), and Bob Houston (DOGAMI).

Cartography: Joe I. Franczyk

BULLETIN 108

Geology of the North Half of the Lower Crooked River Basin, Crook, Deschutes, Jefferson, and Wheeler Counties, Oregon

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PLATE

LIST OF MAP UNITS

See Explanation of Map Units *in the accompanying pamphlet for complete unit descriptions.*

UPPER CENOZOIC SURFICIAL DEPOSITS

- Qf — **modern fill and construction material (upper Holocene)**
- Qa — **alluvium (Holocene and Upper Pleistocene)**
- Qfy — **younger terrace deposits (Holocene and Upper Pleistocene)**
- Qaf — **alluvial fan deposits (Holocene and Upper Pleistocene)**
- Qc — **colluvium (Holocene and Upper Pleistocene)**
- Qls — **landslide deposits (Holocene and Upper Pleistocene)**
- Qoaf — **older alluvial fan deposits and colluvium (Upper and Middle Pleistocene)**
- Qto — **older terrace deposits (Upper and Middle Pleistocene)**

Disconformity

UPPER CENOZOIC VOLCANIC AND SEDIMENTARY ROCKS

QUATERNARY BASALT FROM NEWBERRY VOLCANO

- Qbrc — **basalt of Crooked River Gorge (Middle Pleistocene) – 0.4 Ma (⁴⁰Ar/³⁹Ar)**
- Qbrp2 — **porphyritic basalt (Middle Pleistocene)**
- Qbrp1 — **large-feldspar basalt (Middle Pleistocene) 0.713 ± 0.12 Ma (⁴⁰Ar/³⁹Ar); 0.718 ± 0.43 Ma (K-Ar)**
- Qbrvf — **very fine-grained basalt (Middle Pleistocene)**

QUATERNARY INTRACANYON BASALT

- Qbi — **basalt of The Island (lower Pleistocene) 1.59 ± 0.08 Ma (⁴⁰Ar/³⁹Ar)**

QUATERNARY OR UPPER PLIOCENE SEDIMENTARY ROCKS

- QTsg — **sedimentary rocks (lower Pleistocene or upper Pliocene)**

Disconformity

LOWER PLIOCENE AND UPPER MIOCENE VOLCANIC AND SEDIMENTARY ROCKS OF THE EARLY HIGH CASCADES

DESCHUTES FORMATION

- Tdsg — **sand and gravel (Pliocene and upper Miocene)**
- Tds — **sedimentary rocks and tuff (Pliocene and upper Miocene)**

BOWMAN VOLCANIC FIELD

- Tdba — **basalt of Alfalfa (upper Pliocene) 3.31 ± 0.15 Ma (K-Ar)**
- Tdbsr — **basalt of Stearns Ranch (upper Pliocene)**
- Tdbcc — **basalt of Combs Flat (upper Pliocene) 3.36 ± 0.08 Ma (K-Ar)**
- Tdbr — **basalt of Redmond (upper Pliocene) 3.56 ± 0.30 Ma (⁴⁰Ar/³⁹Ar)**
- Tdbrb — **basalt of Round Butte (lower Pliocene)**
- Tdbj — **basalt of Japanese Creek (lower Pliocene)**
- Tdbtc — **basalt of Tetherow Butte (lower Pliocene or upper Miocene) 5.17 ± 0.03 Ma (⁴⁰Ar/³⁹Ar; outside map area); 5.57 ± 0.20 Ma (⁴⁰Ar/³⁹Ar)**
- Tdbm — **basalt of Meyers Butte (upper Miocene) 5.42 ± 0.11 Ma (⁴⁰Ar/³⁹Ar)**
- Tdbd — **basaltic andesite of Dry River (upper Miocene)**
- Tdbo — **basalt of Opal Springs (upper Miocene) 5.85 ± 0.14 Ma (⁴⁰Ar/³⁹Ar)**
- Tdbw — **basalt of Willow Creek (upper Miocene) 6.30 ± 0.09 Ma (⁴⁰Ar/³⁹Ar)**
- Tdbrc — **basalt of Rocky Canyon (upper Miocene)**
- Tdbp — **basalt of Pelton Dam (upper Miocene) (cross sections A-A' and B-B' only) 7.52 ± 0.45 Ma (⁴⁰Ar/³⁹Ar; outside map area)**
- Tdbh — **basalt of Hoffman Dam (upper Miocene) 7.54 ± 0.02 Ma (⁴⁰Ar/³⁹Ar)**
- Tdbb — **basalt of Bowman Maar (upper Miocene) 7.88 ± 0.05 Ma (⁴⁰Ar/³⁹Ar)**
- Tdbaf — **basalt of Alkali Flat (upper Miocene) (cross sections C-C' and D-D' only)**
- Tdbg — **basaltic andesite of Grass Butte (upper Miocene)**
- Tdbq — **basalt of Quail Valley Ranch (upper Miocene) 8.76 ± 0.24 Ma (⁴⁰Ar/³⁹Ar)**
- Tdbbs — **basalt of Buttlemeck Spring (upper Miocene)[?]**
- Tdv — **basalt vents (Pliocene and upper Miocene)**
- Tdvp — **vent pyroclastic rocks (Pliocene and upper Miocene)**
- Tdbi — **basalt intrusions (Pliocene and upper Miocene)**

DESCHUTES FORMATION LAVA FLOWS IN THE WESTERN PART OF THE LOWER CROOKED RIVER BASIN NOT ASSIGNED TO THE BOWMAN VOLCANIC FIELD

- Tdbl — **basalt of Lower Desert (lower Pliocene or upper Miocene) 5.47 ± 0.10 Ma (⁴⁰Ar/³⁹Ar)**

Porphyritic basaltic andesite lava flows subdivided into:

- Tdbla1 — **rimrock-forming basaltic andesite (upper Miocene)**
- Tdbla2 — **olivine-augite and hypersthene-bearing basaltic andesite (upper Miocene)**

DESCHUTES FORMATION ASH-FLOW TUFFS IN THE WESTERN PART OF THE LOWER CROOKED RIVER BASIN NOT ASSIGNED TO THE BOWMAN VOLCANIC FIELD

- Tdt — **ash-flow tuff, undivided (upper Miocene)**
- Tdtp — **Peninsula ignimbrite member (upper Miocene)**
- Tdts — **Steelhead Falls ignimbrite member (upper Miocene) 5.68 ± 0.02 Ma (⁴⁰Ar/³⁹Ar)**
- Tdtm — **McKenzie Canyon ignimbrite member (upper Miocene) 5.76 ± 0.02 Ma (⁴⁰Ar/³⁹Ar)**
- Tdtc — **Cove ignimbrite member (upper Miocene)**
- Tdtl — **Lower Bridge ignimbrite member (upper Miocene) 5.93 ± 0.02 Ma (⁴⁰Ar/³⁹Ar; outside map area)**
- Tdtj — **Jackson Buttes ignimbrite member (upper Miocene) 5.98 ± 0.01 Ma (⁴⁰Ar/³⁹Ar; outside map area)**
- Tdto — **Osborne Canyon ignimbrite member (upper Miocene) 5.99 ± 0.02 Ma (⁴⁰Ar/³⁹Ar)**

DESCHUTES FORMATION ASH-FLOW TUFFS IN THE EASTERN PART OF THE LOWER CROOKED RIVER BASIN NOT ASSIGNED TO THE BOWMAN VOLCANIC FIELD

- Tmpt — **pumice tuff (upper Miocene)**
- Tdpt — **tuff (upper Miocene)[?]**

LATE MIOCENE ASH-FLOW TUFFS IN THE LOWER CROOKED RIVER BASIN NOT ASSIGNED TO THE DESCHUTES FORMATION

- Tmrr — **Rattlesnake Tuff (upper Miocene) 7.05 ± 0.01 Ma (⁴⁰Ar/³⁹Ar; outside map area); 7.093 ± 0.015 Ma (⁴⁰Ar/³⁹Ar; outside map area)**

Angular unconformity to disconformity

COLUMBIA RIVER BASALT GROUP

- Tcpb — **Prineville Basalt (lower Miocene)**
- Tcpg — **Picture Gorge Basalt (lower Miocene)**

Disconformity

SIMTUSTUS FORMATION

- Tmsu — **tuffaceous sedimentary rocks and tuff (lower Miocene)**

Angular unconformity to disconformity

LOWER CENOZOIC VOLCANIC AND SEDIMENTARY ROCKS

JOHN DAY FORMATION

LOWER CROOKED VOLCANIC FIELD

- Tjrb — **trachyandesite (upper Oligocene)**
- Tjra — **andesite (upper Oligocene)**
- Tjrb — **basaltic andesite (upper Oligocene) 27.00 ± 0.06 Ma (⁴⁰Ar/³⁹Ar)**
- Tjr — **tuffaceous sedimentary rocks (Oligocene)**

Crooked River caldera

- Tjrb — **rhyolite breccia and dacite tuff (upper Oligocene)**
- Tjrb — **rhyolite of Barnes Butte (upper Oligocene) 27.97 ± 0.32 Ma (⁴⁰Ar/³⁹Ar)**
- Tjrt — **tuff of Barnes Butte (upper Oligocene) 27.62 ± 0.63 Ma (⁴⁰Ar/³⁹Ar); 28.3 ± 0.4 Ma (²³⁸U/²³⁰Th zircon)**
- Tjrp — **tuff of Peppermint Lane (lower Oligocene) 28.18 ± 0.16 Ma (⁴⁰Ar/³⁹Ar)**
- Tjro — **rhyolite of Ochoco Reservoir (lower Oligocene) 27.54 ± 0.36 Ma (⁴⁰Ar/³⁹Ar)* *stratigraphically discordant radiometric age**

Rhyolite of Powell Buttes subdivided into:

- Tjrpa — **quartz- and sanidine-phyric rhyolite (upper Oligocene)**
- Tjrpt — **sanidine-phyric rhyolite (upper Oligocene) 25.8 ± 0.2 Ma (K-Ar)**
- Tjrpz — **aphyric rhyolite (lower Oligocene) 28.3 ± 1.0 Ma (K-Ar)**
- Tjrpi — **aphyric rhyolite dikes (lower Oligocene)**
- Tjrsh — **rhyolite of Pilot Butte (lower Oligocene)**
- Tjrgm — **rhyolite of Grizzly Mountain (lower Oligocene) 28.9 ± 0.2 Ma (²³⁸U/²³⁰U zircon)**
- Tjrk — **rhyolite of Hi-Tor Butte (lower Oligocene) 29.2 ± 0.9 Ma (²³⁸U/²³⁰U zircon)**
- Tjrg — **rhyolite of Gray Butte (lower Oligocene) 28.82 ± 0.23 Ma (⁴⁰Ar/³⁹Ar); 29.2 ± 0.2 Ma (²³⁸U/²³⁰U zircon); 28.4 ± 0.3 Ma (²³⁸U/²³⁰U zircon)**
- Tjrj — **rhyolite of Juniper Butte (lower Oligocene) 29.3 ± 0.2 Ma (²³⁸U/²³⁰U zircon)**

Disconformity to nonconformity

- Tjrsf — **tuff of Smith Rock, intracaldera unit (lower Oligocene) 29.3 ± 0.2 Ma (²³⁸U/²³⁰U zircon); 29.3 ± 0.2 Ma (²³⁸U/²³⁰U zircon); 28.3 ± 0.5 Ma (²³⁸U/²³⁰U zircon)**
- Tjrsf — **tuff of Smith Rock, welded outflow unit (lower Oligocene) Haystack Reservoir lobe – 29.57 ± 0.17 Ma (⁴⁰Ar/³⁹Ar); 29.51 ± 0.11 Ma (²³⁸U/²³⁰U zircon); McKay Saddle lobe – 29.56 ± 0.17 Ma (⁴⁰Ar/³⁹Ar) Prineville Reservoir lobe – 29.5 ± 0.2 Ma (²³⁸U/²³⁰U zircon)**
- Tjrsf — **tuff of Smith Rock, nonwelded outflow unit (lower Oligocene) Haystack Reservoir lobe – 29.53 ± 0.09 Ma (⁴⁰Ar/³⁹Ar)**

Angular unconformity to disconformity

- Tjra — **tuff of Antelope Creek (lower Oligocene)**
- Tjrc — **tuff of Eagle Rock (lower Oligocene) 29.7 ± 0.6 Ma (²³⁸U/²³⁰U zircon)**
- Tjrb — **basalt, basaltic andesite, and andesite lava flows (lower Oligocene and upper Eocene) 30.1 ± 1.1 Ma (K-Ar); 30.8 ± 0.5 Ma (K-Ar)**
- Tjrbi — **basaltic andesite and andesite intrusions (lower Oligocene and upper Eocene)**

JOHN DAY FORMATION UNITS NOT ASSIGNED TO THE LOWER CROOKED VOLCANIC FIELD

- Tjr — **tuff of Rodman Spring (lower Oligocene) 32.49 ± 0.30 Ma (⁴⁰Ar/³⁹Ar)**
- Tjr — **tuffaceous sedimentary rocks and tuff (lower Oligocene and upper Eocene)**
- Tjrn — **tuff of North Unit Canal (lower Oligocene or upper Eocene)**
- Tjrm1 — **Member A tuff (middle Eocene) 39.72 ± 0.03 Ma (⁴⁰Ar/³⁹Ar; outside map area); 39.22 ± 0.03 Ma (⁴⁰Ar/³⁹Ar; outside map area); 39.17 ± 0.15 Ma (⁴⁰Ar/³⁹Ar; outside map area)**

Unconformity

CLARNO FORMATION

OCHOCO VOLCANIC FIELD

- Tcen — **volcaniclastic sedimentary rocks (upper and middle Eocene)**

Wildcat Mountain caldera

- Tcrh — **rhyolite of Brennan Palisades (middle Eocene)**
- Tcrd — **rhyolite breccia pipes and dikes (middle Eocene)**
- Tcba — **andesite and dacite breccia pipes and dikes (middle Eocene)**
- Tcrk — **rhyolite of Kidnap Spring (middle Eocene)**
- Tcrm — **rhyolite of Mill Creek (middle Eocene)**
- Tcrh — **rhyolite of Hash Rock (middle Eocene) 39.35 ± 0.30 Ma (⁴⁰Ar/³⁹Ar)**
- Tcrd — **dacite of Green Mountain (middle Eocene)**
- Tcrs — **tuff of Steins Pillar, intracaldera unit (middle Eocene) 41.8 ± 0.2 Ma (²³⁸U/²³⁰U zircon)**
- Tcao — **andesite of Little McKay Creek (middle Eocene) 41.51 ± 0.48 Ma (⁴⁰Ar/³⁹Ar)**
- Tcid — **andesite and dacite intrusive rocks (middle Eocene) 42.79 ± 0.44 Ma (⁴⁰Ar/³⁹Ar)**
- Tcev — **vent deposits (middle Eocene)**
- Tcqb — **quartz-bearing basalt dikes (middle Eocene)**
- Tcrf — **breccia (middle Eocene)**
- Tcbp — **plagioclase- and hornblende-phyric andesite and dacite (middle Eocene)**
- Tcbh — **hornblende-phyric andesite (middle Eocene)**
- Tcbl — **basalt, basaltic andesite, andesite, and dacite lava flows (middle Eocene)**
- Tcbb — **porphyritic andesite, dacite, and rhyolite lava flows, domes, and intrusions (middle Eocene) 43.86 ± 0.89 Ma (⁴⁰Ar/³⁹Ar)**

Unconformity

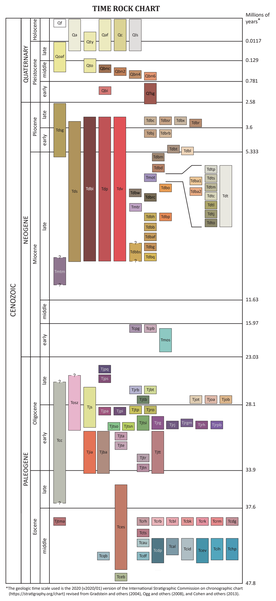
ROCKS OF THE EARLY CLARNO FORMATION

- Tcpb — **alkali olivine basalt (lower Eocene) 46.40 ± 0.12 Ma (⁴⁰Ar/³⁹Ar)**

OTHER ROCKS

- Tcsz — **sheared rock zone (Oligocene)**
- Tcc — **clay in alteration zones (Oligocene and/or Eocene [?])**

TIME ROCK CHART



The geologic time scale used is the 2020 (v2020/01) version of the International Stratigraphic Commission on chronographic chart (https://stratigraphy.org/chart) revised from Gradstein and others (2004), Ogg and others (2008), and Cohen and others (2013).

EXPLANATION OF SYMBOLS

- Lake or large river — Lidar-derived elevation
- River, creek, or canal — Location of whole-rock XRF geochemical analysis sample
- Road — Location of radiometric age in millions of years (Ma)
- State highway — Water well, as shown on topographic maps or on general-purpose or smaller-scale maps. Well ID combined county code and OWRD well identification code
- U.S. highway
- Cross section — Spring
- City/town boundary — Mine, as shown on smaller scale or general-purpose maps
- State park boundary — Airport
- County boundary — Inclined bedding showing strike and dip
- Lineament — Water well (cross section only)
- Caldera margin — solid line where accurately located, short-dashed where inferred, dotted where concealed. Tick point into caldera.
- Contact — solid line where accurately located, long-dashed where approximate, short-dashed where inferred, dotted where concealed, queried where uncertain.
- Fault — solid line where accurately located, long-dashed where approximate, short-dashed where inferred, dotted where concealed, queried where uncertain.
- Normal fault — ball and bar on downthrown block. Solid line where accurately located, long-dashed where approximate, short-dashed where inferred, dotted where concealed, queried where uncertain.
- Normal fault (in cross section) — Absence of question mark indicates inferred. Arrows show relative motion.
- Normal fault (in cross section) — question mark indicates approximate. Arrows show relative motion.
- Anticline — solid line where accurately located, long-dashed where approximate, short-dashed where inferred, dotted where concealed, queried where uncertain.
- Syncline — solid line where accurately located, long-dashed where approximate, short-dashed where inferred, dotted where concealed, queried where uncertain.