STATE OF OREGON
WATER RESOURCES DEPARTMENT
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Generalized Geologic Compilation Map of the Harney Basin

2021

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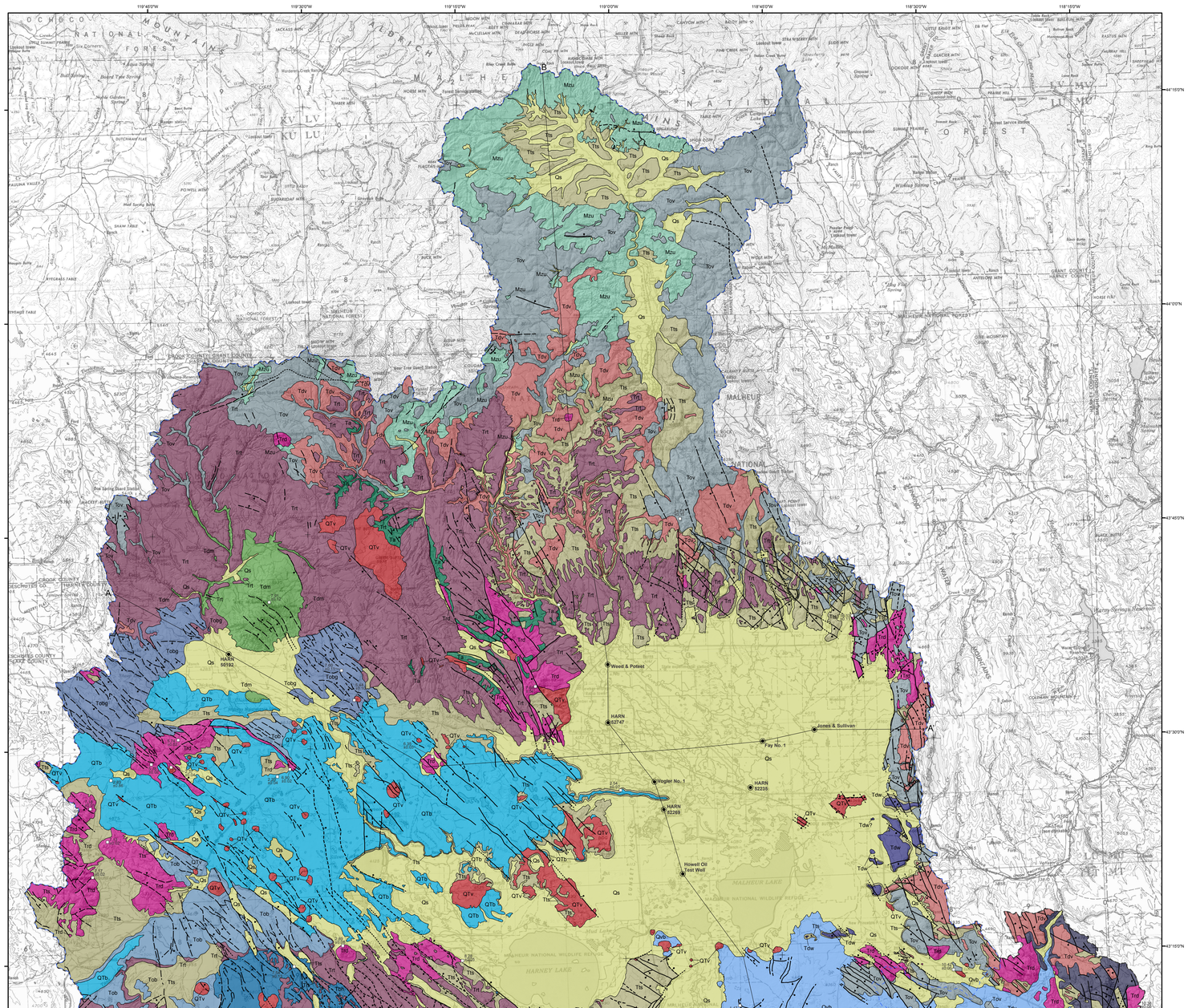
Generalized Geologic Compilation Map of the Harney Basin
Compiled By Darrick E. Boschmann
PLATE 1



DESCRIPTION OF MAP UNITS

Qs — **Quaternary sedimentary deposits (Holocene and Pleistocene) –** Unconsolidated to poorly consolidated clay, silt, sand, and gravel of Quaternary age. The deposits originated as alluvium, alluvial fan deposits, colluvium, floodplain deposits, lacustrine deposits, talus, landslide, and other recent sedimentary deposits. This unit includes glacial deposits on Steens Mountain.

Qdc — **Diamond Craters basalt and tephra (Holocene) –** Fine- to medium-grained olivine and plagioclase phyric basalt lava flows and juvenile tephra including agglomerate, cinders and ash. The basalt is medium to dark gray and mostly vesicular, forming thin flows with ropy pahoehoe surfaces (Brown and others, 1980b; Greene and others, 1972; Russell and Nicholls, 1987). Many small craters are rimmed with lava spatter, cinders and bombs. The lava field was emplaced sometime between about 7,320 to 7,790 years ago on the basis of radiocarbon ages and paleomagnetic constraints (Sherrod and others, 2012).

QTv — **Mafic vent complexes (Pleistocene to late Miocene) –** Basaltic to andesitic scoria, cinders, agglomerate, thin flows, and intrusive masses forming lava cones, domes, and small shield volcanoes associated with eruptive centers of mafic and intermediate volcanic units in the basin. Locally this unit includes partly consolidated subaqueous deposits of palagonitized basaltic ejecta occurring as tuff and breccia cones and rings, and reworked volcanic sediments (Brown and others, 1980b; Brown and others, 1980a; Greene and others, 1972).

Qvb — **Voltage basalt (Pleistocene) –** Medium-gray, vesicular olivine basalt erupted as thin lava flows from numerous vents south and east of Malheur Lake (Brown and others, 1980b; Brown and others, 1980a; Greene and others, 1972). The lava field contains abundant well-preserved tumuli and pressure ridges. The unit is over 300 feet thick in the central part of the Voltage lava field, however elsewhere the thickness is generally less than 200 feet. $^{40}Ar/^{39}Ar$ ages of 1.23±0.10 Ma and 1.47±0.16 Ma are reported by Jordan and others (2004).

QTb — **Basalt (early Pleistocene and late Pliocene) –** Medium-gray, fine-grained, diktytaxitic, olivine-bearing vesicular basalt occurring as a series of thin flows locally separated by thin layers of sedimentary rock (Brown and others, 1980b; Brown and others, 1980a; Greene and others, 1972); includes the Wrights Point member of the Harney Formation (Walker, 1979). The Pleistocene–Pliocene age assignment is based on $^{40}Ar/^{39}Ar$ ages of 2.83±0.89 Ma, 2.54±0.07 Ma, and 2.2±0.08 Ma (Jordan and others, 2004; Streck and Grunder, 2012).

Tts — **Tuffaceous sedimentary rocks and tuff (Pliocene to Miocene) –** White to buff and pale-brown to yellowish-gray, semi- to well-consolidated lacustrine and fluviatile tuffaceous mudstone, siltstone, sandstone and conglomerate with numerous air-fall ash beds and tuffs, and occasional thin carbonate and chert beds. Commonly consists of a poorly sorted mixture of pumice, scoria, other rock fragments, plagioclase grains, and glass shards in a clay matrix (Brown and others, 1980b; Brown and others, 1980a; Greene and others, 1972). Locally, the tuffaceous sedimentary rocks and tuffs are diagenetically altered to clay minerals, zeolites, and potassium feldspar (Sheppard, 1994; Walker and Nolf, 1981; Walker and Swanson, 1968). This unit includes all tuffaceous sediments and tuff interbedded with the Rattlesnake Ash-flow Tuff and Devine Canyon Ash-flow Tuff, and includes the 8.41±0.32 Ma Prater Creek Ash-flow Tuff (Jordan and others, 2004; Walker, 1979). The upper section of the unit is partially equivalent to the Harney Formation of Walker (1979).

Trd — **Silicic lava flows and domes (Pliocene and Miocene) –** Medium- to light-gray, pale-red, and reddish-brown, commonly streaked and flow-banded rhyolite, rhyodacite and dacite with associated vitrophyre and obsidian. The unit occurs as exogenous domes and related flows and plugs (Brown and others, 1980b; Brown and others, 1980a; Greene and others, 1972).

Tob — **Olivine basalt (late Miocene) –** Dark-gray to black, fine-grained olivine basalt with some andesite. Locally includes thin interbeds of tuffaceous sedimentary rock (Greene and others, 1972) that overlies Rattlesnake Ash-flow Tuff in the southwest part of the basin. A late Miocene age assignment is based on stratigraphic position and a K-Ar age of 6.2±0.8 Ma (Feibelkorn and others, 1982; Parker and Armstrong, 1972).

Tobg — **Olivine basalt and andesite of Gum Boot Canyon (late Miocene) –** Medium- to dark-gray, fine- to medium-grained, aphyric and diktytaxitic basalt with groundmass olivine, and medium-gray aphanitic and nonporous andesite with less than 1 percent plagioclase and olivine phenocrysts. Several flows, each a few feet to a few tens of feet thick with a maximum thickness of about 300 feet are exposed along fault scarps southeast of Dry Mountain (Greene and others, 1972). As mapped by Greene and others (1972), the unit overlies the Rattlesnake Ash-flow Tuff, but an $^{40}Ar/^{39}Ar$ age of 7.60±0.22 Ma from a basalt flow southeast of Dry Mountain (Jordan and others, 2004) indicates part of the unit may be older.

Trt — **Rattlesnake Ash-flow Tuff (late Miocene) –** Light-brown to red-brown to gray, nonwelded to densely welded, pumice-rich rhyolite tuff that forms a single cooling unit and represents an important stratigraphic marker bed throughout much of the basin. The tuff sheet typically ranges from 30–100 feet thick with a maximum reported thickness of about 240 feet and an estimated original extent of 13,500 mi² (Brown and others, 1980b; Streck and Grunder, 1995). Streck and Grunder (1995) proposed a source caldera in the western Harney Basin on the basis of outcrop, pumice size, and facies distribution as well as flow-direction indicators. An $^{40}Ar/^{39}Ar$ age of 7.09±0.03 Ma is reported by Jordan and others (2004).

Tdw — **Drinkwater Basalt (late Miocene) –** Medium- to dark gray diktytaxitic basaltic rocks with locally abundant phenocrysts and glomerocrysts of plagioclase and olivine. Forms ridge-capping basalt flows along the eastern margin of the basin near Crane and south and east of Diamond Craters. Commonly one flow, but locally several flows with a total thickness ranging from 20–200 feet (Greene and others, 1972). An $^{40}Ar/^{39}Ar$ age of 7.25±0.09 Ma is reported for exposures of this unit east of the basin near the South Fork Malheur River (Meigs and others, 2009).

Tbh — **Basalt of Harney Lake (late Miocene) –** Black to dark-gray olivine-bearing basaltic rocks with common yellowish devitrified glass and pillow structures. Consists of several flows, each 10–20 feet thick with a total thickness of about 150 feet (Brown and others, 1980b; Greene and others, 1972). The unit is located south and west of Harney Lake where it underlies Rattlesnake Ash-flow Tuff and overlies Devine Canyon Ash-flow Tuff. May intertongue locally with sedimentary rocks of unit Tts. Included in this unit are Basalt of Hog Wallow (Johnson, 1994) and Basalt of Black Rim (Sherrod and Johnson, 1994) on the basis of stratigraphic position. A late Miocene age is based on stratigraphic position and $^{40}Ar/^{39}Ar$ ages of 7.68±0.16 Ma and 7.54±0.26 Ma (Jordan and others, 2004).

Tdm — **Basalt and andesite of Dry Mountain (late Miocene) –** Numerous flows of dark-gray, aphanitic to fine-grained andesite with rare olivine, and high-alumina olivine basalt erupted from a large shield volcano at Dry Mountain at about 7.9 Ma (Greene and others, 1972; Streck and Grunder, 2012). A thickness of 535 feet is penetrated by a well on the flanks of Dry Mountain, and a 700+ foot section is exposed at the summit scarp; the total thickness is unknown.

Ta — **Andesite (late Miocene) –** Fine grained, dense and commonly flow-banded andesite and basaltic-andesite lava flows occur as multiple thin flows with a total thickness of a few tens to locally over 200 feet. These flows erupted from several vent complexes in the uplands northwest of Burns (Brown and others, 1980a; Brown, 1982; Greene and others, 1972; McClaughry and others, 2019). The age of these lava flows is bracketed by the 8.41 Ma Prater Creek Ash-flow Tuff and 7.1 Ma Rattlesnake Ash-flow Tuff (Jordan and others, 2004; McClaughry and others, 2019).

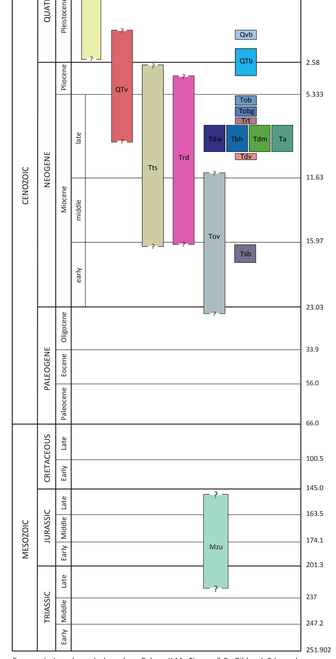
Tdv — **Devine Canyon Ash-flow Tuff (late Miocene) –** Light-gray to greenish-gray, nonwelded to densely welded, crystal-rich (up to 30%) rhyolite tuff that forms a single cooling unit and represents an important stratigraphic marker bed throughout much of the basin. The tuff sheet ranges from a few feet to over 200 feet thick, with an estimated original extent of over 7,000 mi² (Greene, 1973; McClaughry and others, 2019; Walker, 1979). Greene (1973) proposed a source caldera in the central Harney Basin near Burns based on unit thickness and crystal content distribution. An $^{40}Ar/^{39}Ar$ age of 9.74±0.04 Ma is reported by Jordan and others (2004).

Tsb — **Steens Basalt (early Miocene) –** Dark- to medium-gray, vesicular to massive, aphanitic to coarsely plagioclase -phyric, intergranular to diktytaxitic olivine basalt. The continental flood basalt lavas of the Steens Basalt were erupted from a low, elongate shield volcano centered near the Steens Mountain escarpment where numerous north- and northeast-striking dikes are exposed. The Steens Basalt includes more than 100 individual flows with an average composite thickness of about 2,000 feet and maximum reported thickness of 4,300 feet. The sequence was largely erupted as compound flows ranging in thickness from 30–150 feet, although individual flow lobes rarely exceed 6 feet (Camp and others, 2013; Johnson and others, 1998; Minor and others, 1987). The initial eruption of Steens Basalt occurred by 16.97±0.06 Ma as the earliest pulse of Columbia River Flood Basalt volcanism (Camp and others, 2013; Moore and others, 2018).

Tov — **Older volcanic rocks (Miocene and late Oligocene) –** A thick section of late Oligocene and Miocene volcanic rocks underlie the Devine Canyon Ash-flow Tuff in the northern and eastern uplands. Primarily basalt and andesite lava flows, but also includes rhyolite lava flows and tuffs, rhyodacite and dacite lavas, and interbedded tuffaceous sedimentary deposits. In the northern uplands, this unit includes undifferentiated Columbia River Basalt Group lavas, Strawberry Volcanics, and Dinner Creek Tuff (Brown and Thayer, 1966a; Greene and others, 1972; Houston and others, 2018; Niewendorp and others, 2018). The unit may also include undifferentiated Steens Basalt in some areas (Camp and others, 2013). Age assignment based on stratigraphic position and $^{40}Ar/^{39}Ar$ ages, including an andesite age of 24.75±0.15 Ma (Houston and others, 2018).

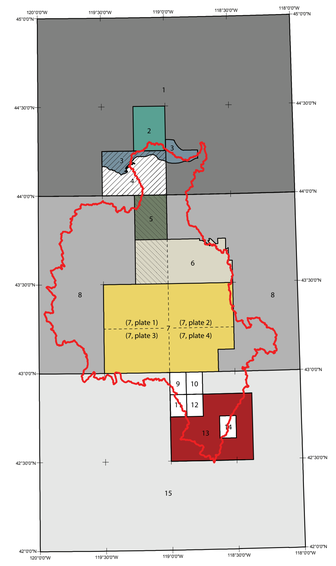
Mzu — **Mesozoic rocks (Late Jurassic to Late Triassic) –** The oldest rocks exposed in the basin are variably deformed and metamorphosed, Upper Jurassic to Upper Triassic marine deposits of the accreted Izee terrane, including interbedded volcanic and tuffaceous mudstone, siltstone, shale, graywacke, calcareous sandstone, conglomerate, limestone, tuff, and minor andesite lavas (Brooks and Vallier, 1978; Brown and Thayer, 1977; Dickinson, 1979; Dickinson and Thayer, 1978; Silberling and Jones, 1984). Minor areas of Miocene intrusive rocks, as well as Permian to pre-Permian(?) metamorphic rocks of limited extent associated with the Canyon Mountain Complex (Brown and Thayer, 1977; Wallace and Calkins, 1956) are also included with this unit. Exposures of Mesozoic rocks in the basin are limited to the northern uplands, however they are presumed to form the basement underlying much of the basin (McClaughry and others, 2019; Streck, 2002). The aggregate thickness of Upper Triassic to Upper Jurassic rocks in the region is estimated at nearly 50,000 feet (Brooks, 1979; Dickinson, 1979).

TIME-ROCK CHART



Eras, periods and epochs based on: Cohen, K.M., Finney, S.C., Gibbard, P.L., and Fan, J.X., 2013 (updated), The ICS International Chronostratigraphic Chart: Episodes, v. 36, no. 3, p. 199–204.

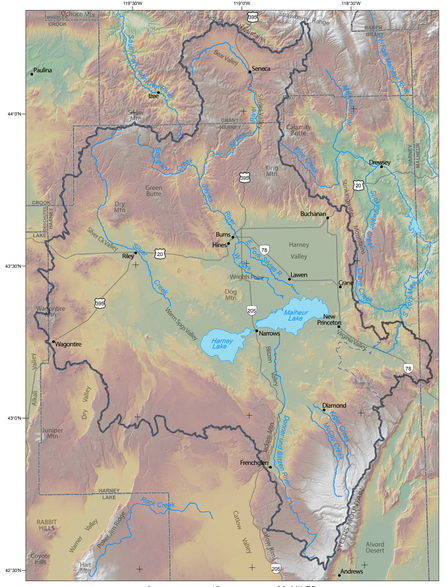
SOURCES OF MAPPING



1. Brown and Thayer, 1966a
2. Brown and Thayer, 1966b
3. Brown and Thayer, 1977
4. Wallace and Calkins, 1956 (full extent of plate hachured)
5. Greene, 1972 (full extent of plate stippled)
6. Brown and others, 1980a
7. Brown and others, 1980b
8. Greene and others, 1972
9. Sherrod and Johnson, 1994
10. Johnson, 1994
11. D.R. Sherrod, in Evans and Geisler, 2001
12. Johnson, 1996
13. Evans and Geisler, 2001
14. Minor and others, 1987
15. Walker and Repenning, 1965

(See report references for complete citations)

GEOGRAPHIC OVERVIEW



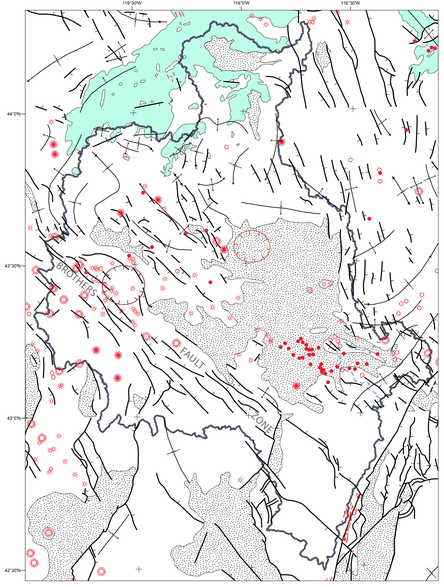
0 15 30 MILES

OREGON

Counties
Rivers
Highways
Harney Basin
Compilation Area
Populated Places
Lakes
Elevation (ft AMSL)
9687 ft
2856 ft

Base from: U.S. Geological Survey, 2015, USGS National Elevation Dataset (NED) 1/9 arc-second Downloadable Data Collection from The National Map 3D Elevation Program (3DEP) - National Geospatial Data Asset (NGDA) National Elevation Data Set (NED): U.S. Geological Survey. Hydrography modified from National Hydrography Dataset (NHD), 2001: USGS Unnumbered Series; U.S. Geological Survey

TECTONIC OVERVIEW



EXPLANATION

Features modified from tectonic overview maps of:
- Brown and Thayer, 1966a
- Greene and others, 1972
- Walker and Repenning, 1965

0 15 30 MILES

Large structural and physiographic basins
Pre-Tertiary rocks
Fault — Bar on downthrown side
Anticline — Large arrowhead shows direction of plunge
Syncline — Large arrowhead shows direction of plunge
Monocline
Large mafic volcanoes
Cinder cones, plugs, palagonite tuff rings
Large silicic domes
Small silicic domes
Small mafic vents
Feeder dikes for CRBG flows
Inferred source location for Rattlesnake Ash-flow Tuff (Streck and Grunder, 1995)
Probable source location for Devine Canyon Ash-flow Tuff (Greene, 1973)
Physiographic Province Boundaries
Harney Basin
Compilation Area

GEOLOGIC CROSS SECTIONS

5x vertical exaggeration (horizontal 1:250,000)
Selected Quaternary surficial units not shown in cross section.