Geologic compilation map of the Harney Basin

Groundwater Study Advisory Committee
Burns, Oregon
March 21, 2019

OREGON WATER RESOURCES DEPARTMENT

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Quick Reminder - Why Do We Care About Rocks?

- Aquifers are made up of rocks & sediments
- Groundwater recharge, flow, and discharge are fundamentally controlled by the geology
- Porosity, permeability, and storage potential vary widely between different rock types
- A wide variety of rock types exist in the Harney Basin
- Understanding the distribution of rock types is crucial for understanding the GW flow system

Presentation Note

- This presentation outlines the general procedures for compiling the basin-wide geologic map of the Harney Basin for the Harney Basin Groundwater Study
- The presentation is formatted as a stand-alone document – access to the slides will be provided on the OWRD website:

https://www.oregon.gov/OWRD/programs/GWWL/GW/HarneyBasinStudy/Pages/GWSAC.aspx

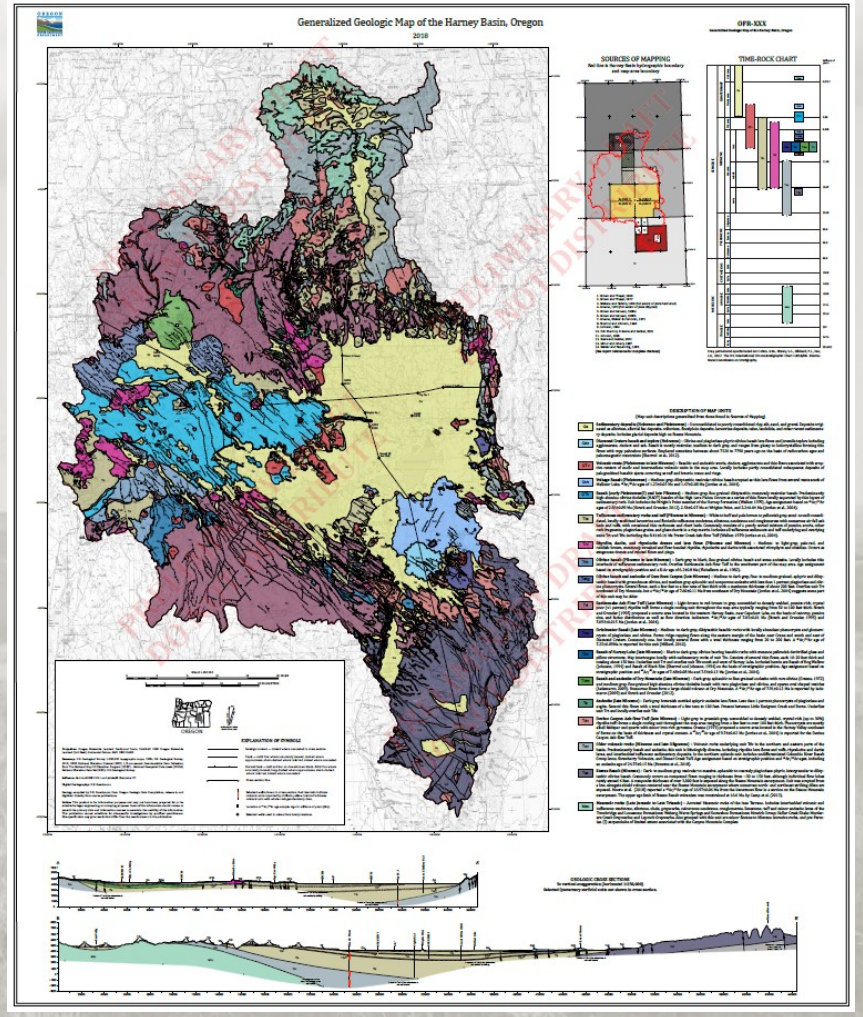
- Many of the slides here will be skipped through rapidly to provide a general overview, and subsequent review of the presentation slides is encouraged
- The best way to communicate the information in the geologic map compilation is with the geologic map itself – additional discussion around the map plate is encouraged
- Please feel free to ask questions!

Compiling Geologic Data

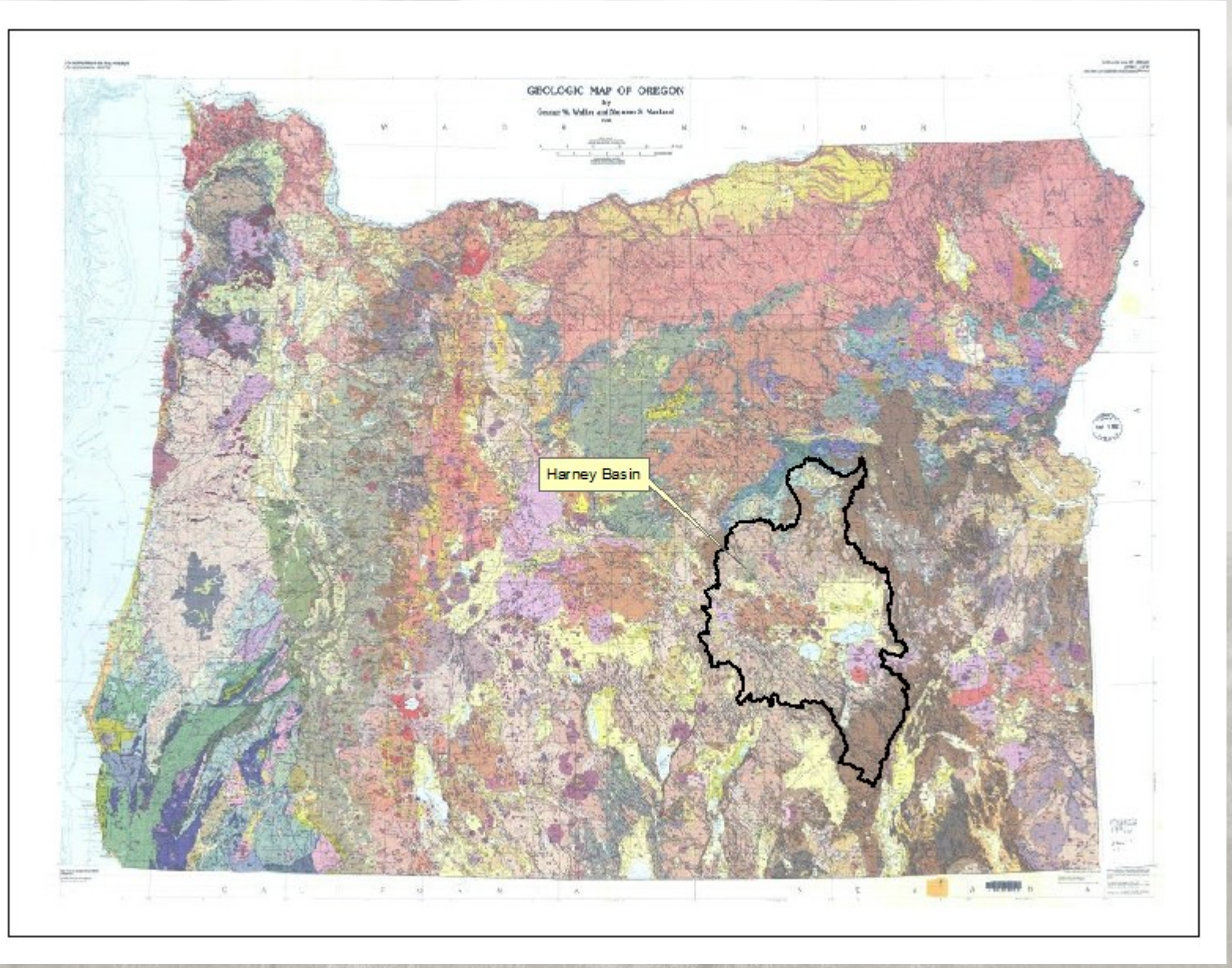
Basin-Scale Stratigraphic and Structural Framework

- A basin-wide geologic map compilation is a critical component of the Harney Basin Groundwater Study
- Data must be detailed enough to address the questions of the study, yet generalized enough to encompass the entire basin at an appropriate scale
- Existing geologic mapping at a variety of scales is compiled from published reports
- Map unit correlation supported by remote sensing, geochemistry, and radiometric age dating
- Subsurface interpretations presented as regional cross sections supported by historic O&G well records and recent OWRD drilling program

- So how do we go about compiling maps…?

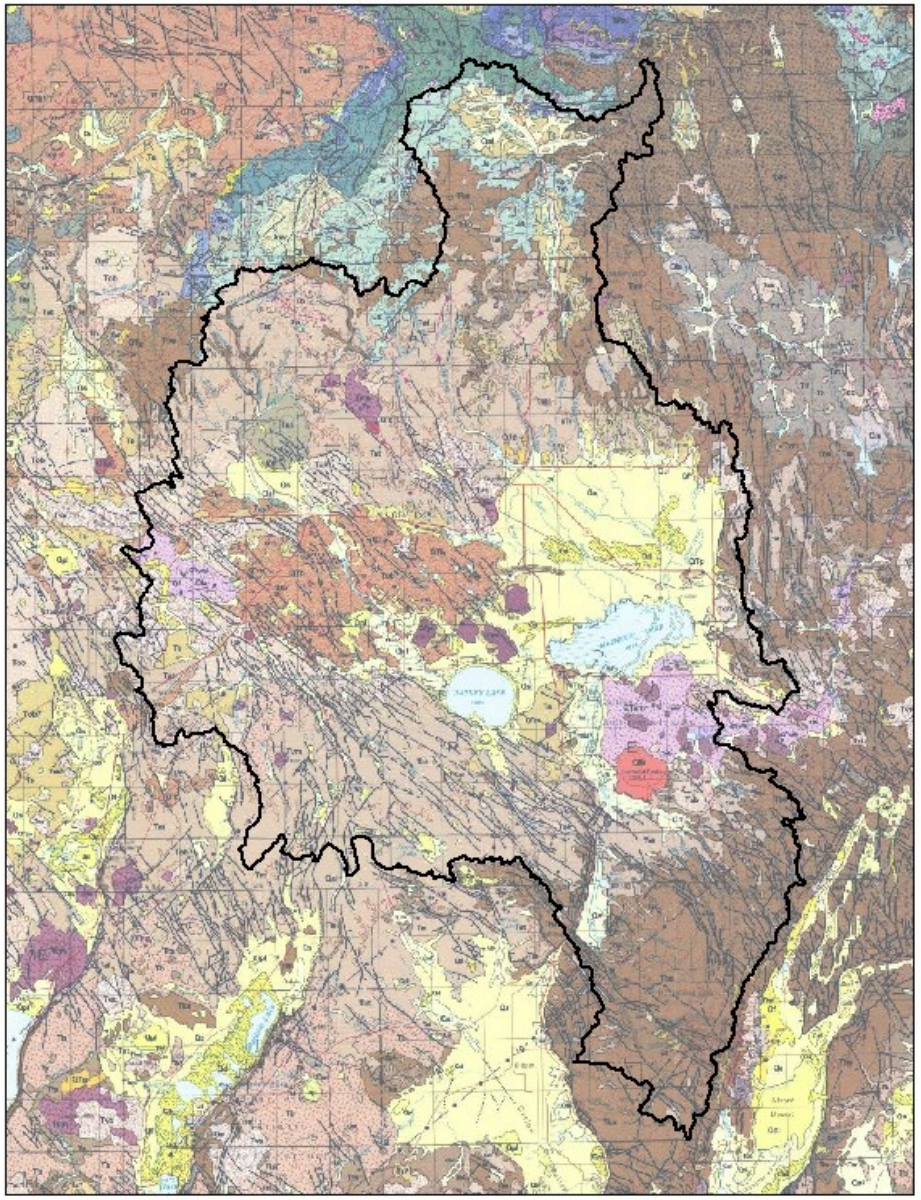


Statewide Map 1:500k - Walker & MacLeod, 1991



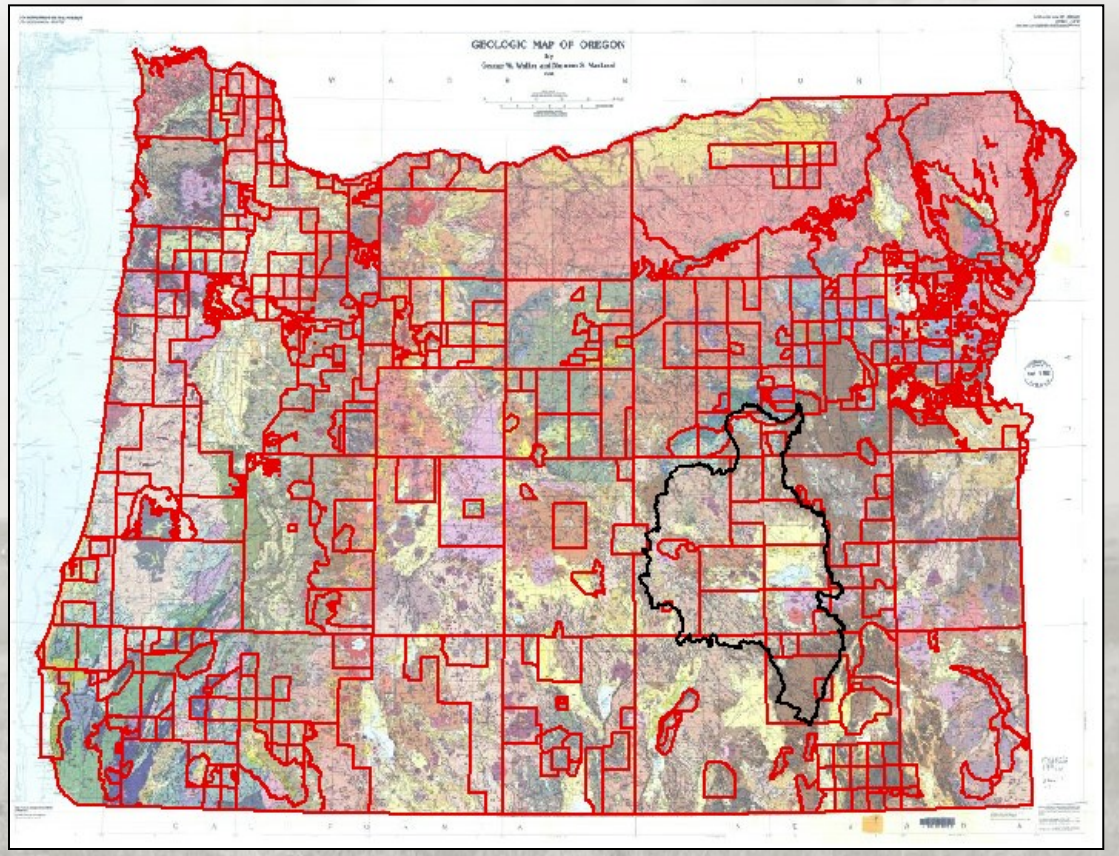
Statewide Geologic Map 1:500k

- Great product for state-scale analysis/discussion. However…
  - Insufficient for use at larger scales
  - Shows limited detail
  - Map units are generalized
  - Important local stratigraphic units absent
  - More detailed mapping exists!



Oregon Geologic Data Compilation (OGDC)

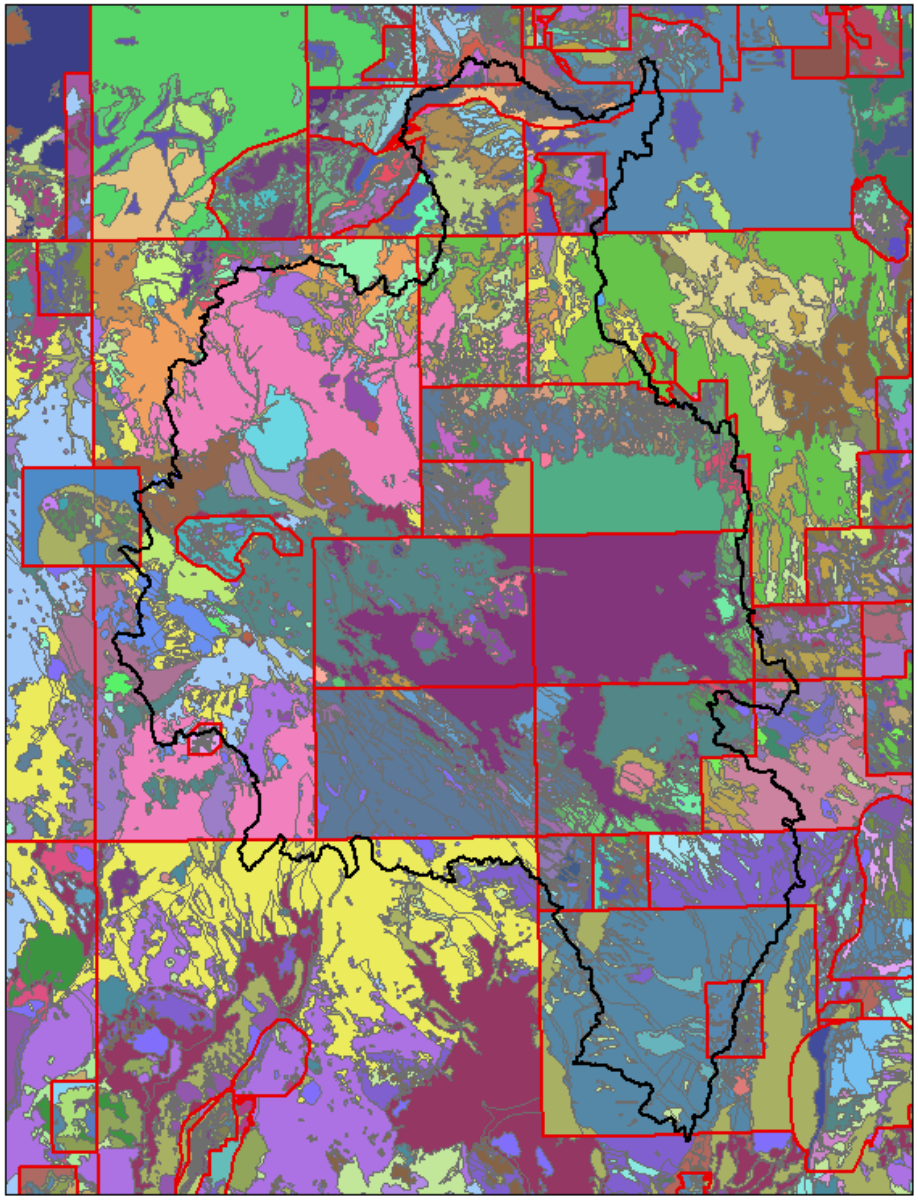
- **Department of Geology and Mineral Industries**
- Digital compilation of best available geologic data in Oregon at a variety of scales
- Includes unpublished and published works
- Updated periodically as new mapping becomes available
- Great resource for access to statewide geology data
- Difficult to work with at the basin scale due to many map boundary effects



Oregon Geologic Data Compilation (OGDC)

Source publications in the Harney Basin

	First Author	Date	Scale
1.	Wallace, RE	1956	62,500
2.	Crowley, KC	1960	55,000
3.	Dickinson, WR	1965	63,360
4.	Walker, GW	1965	250,000
5.	Brown, CE	1966	250,000
6.	Greene, RC	1972	250,000
7.	Greene, RC	1972	62,500
8.	Brown, CE	1977	62,500
9.	Brown, DE	1980	62,500
10.	Brown, DE	1980	62,500
11.	Thayer, TP	1981	62,500
12.	Brown, DE	1982	24,000
13.	Minor, SA	1987	24,000
14.	Johnson, JA	1994	24,000
15.	MacLean, JW	1994	24,000
16.	MacLean, JW	1994	12,000
17.	Sherrod, DR	1994	24,000
18.	Evans, JG	2001	100,000
19.	Camp, VC	unpublished	24,000



Selected Source Publications (OGDC)

	First Author	Date	Scale
1.	Wallace, RE	1956	62,500
~~2.~~	~~Crowley, KC~~	~~1960~~	~~55,000~~
	– unpublished thesis		
~~3.~~	~~Dickinson, WR~~	~~1965~~	~~63,360~~
	– very small portion of map within basin		
4.	Walker, GW	1965	250,000
5.	Brown, CE	1966	250,000
6.	Greene, RC	1972	250,000
7.	Greene, RC	1972	62,500
8.	Brown, CE	1977	62,500
9.	Brown, DE	1980	62,500
10.	Brown, DE	1980	62,500
~~11.~~	~~Thayer, TP~~	~~1981~~	~~62,500~~
	– very small portion of map within basin		
~~12.~~	~~Brown, DE~~	~~1982~~	~~24,000~~
	– overly detailed for 1:250k compilation		
13.	Minor, SA	1987	24,000
14.	Johnson, JA	1994	24,000
~~15.~~	~~MacLean, JW~~	~~1994~~	~~24,000~~
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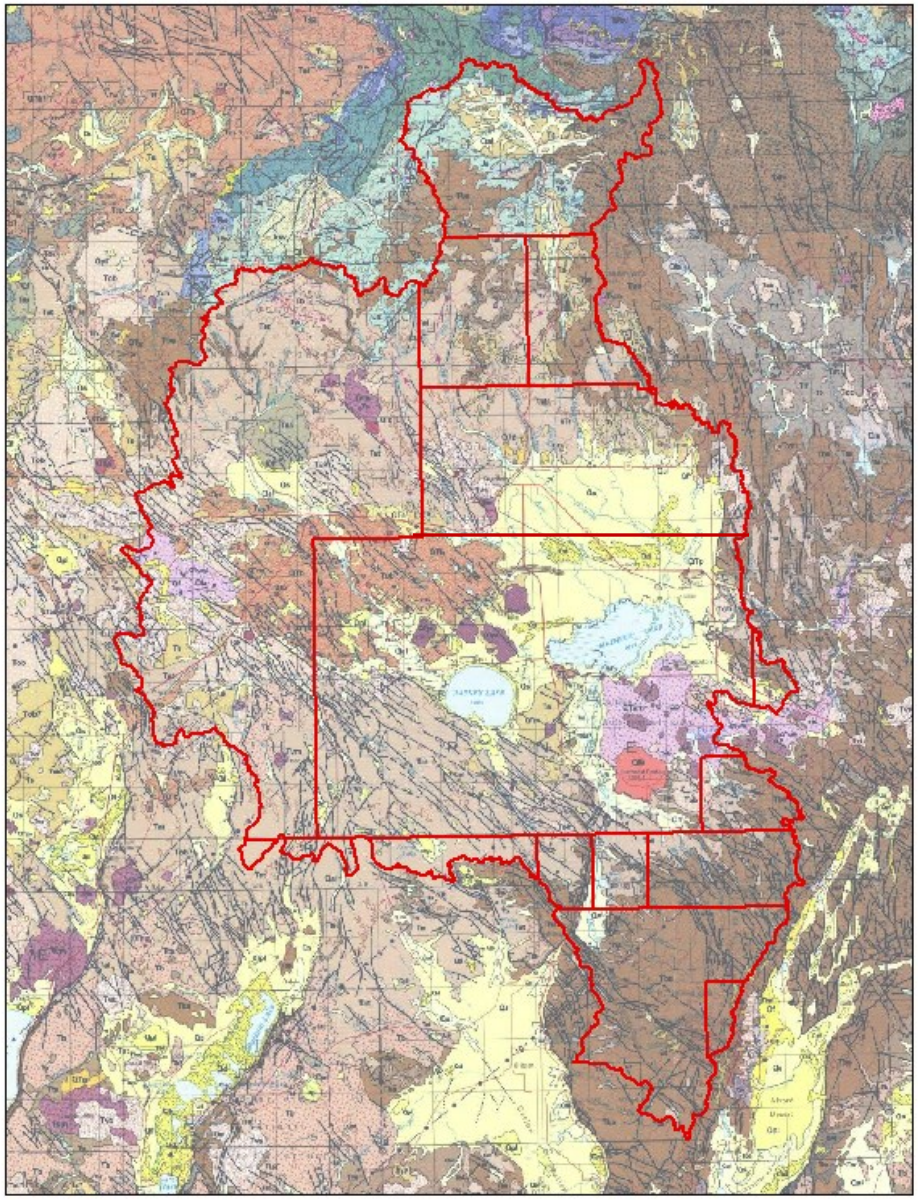
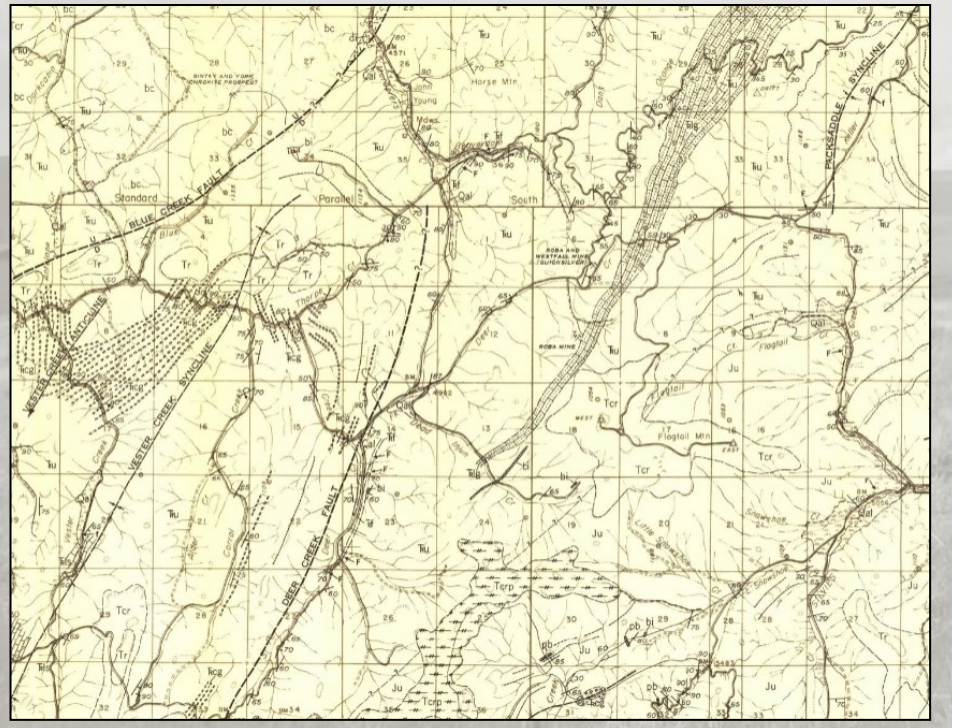
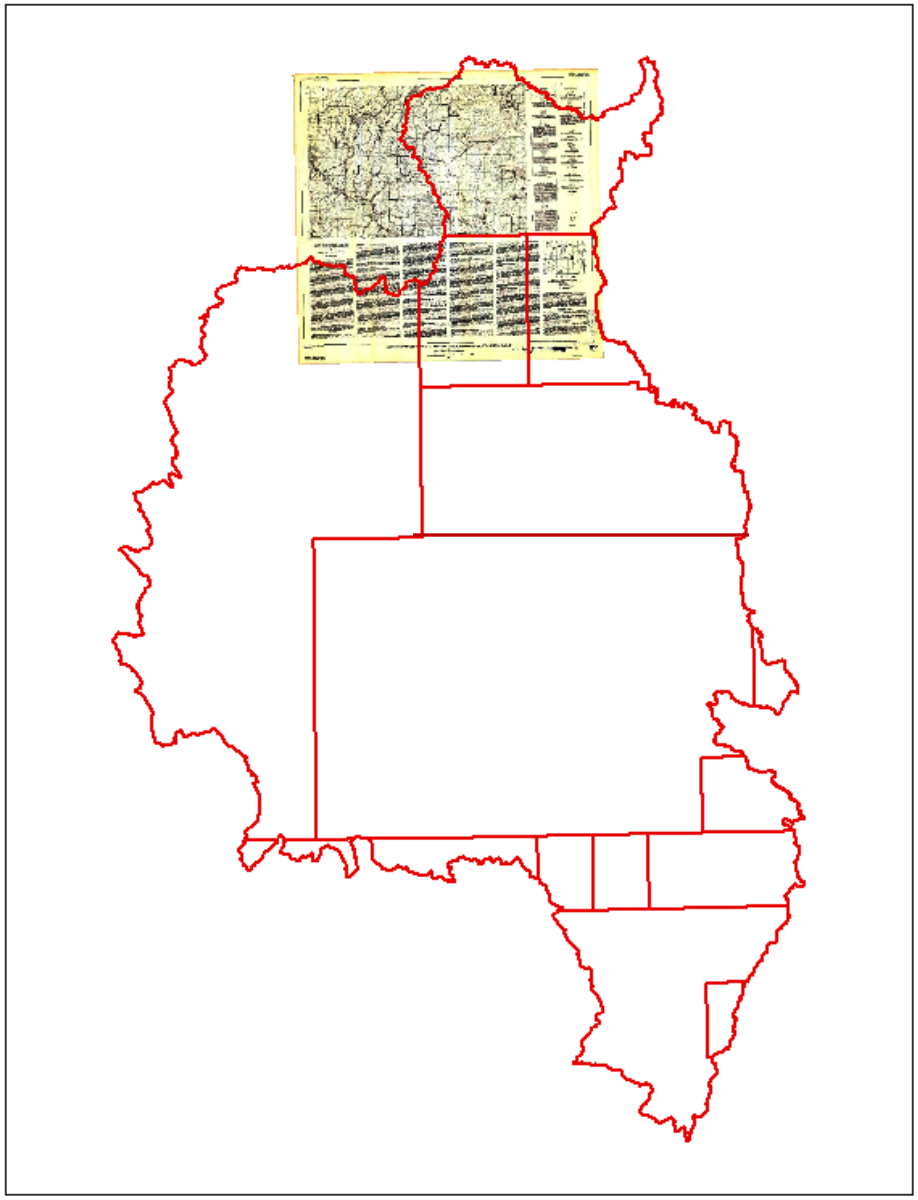


Source Data

Wallace & Calkins, 1956

- Reconnaissance geologic map of the Izee and Logdell quadrangles, Oregon
- 1:62,500

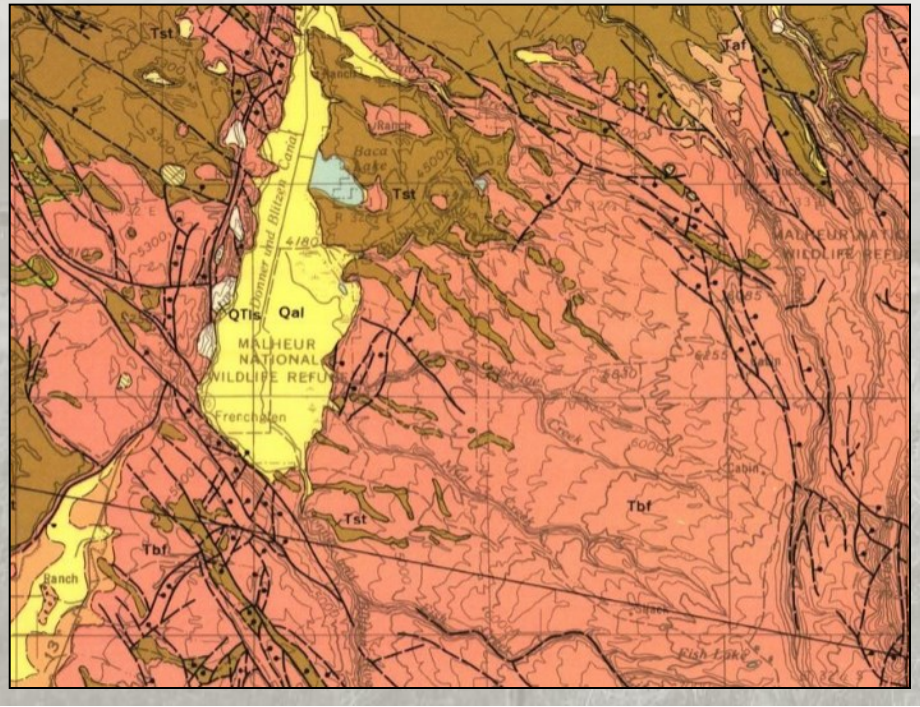


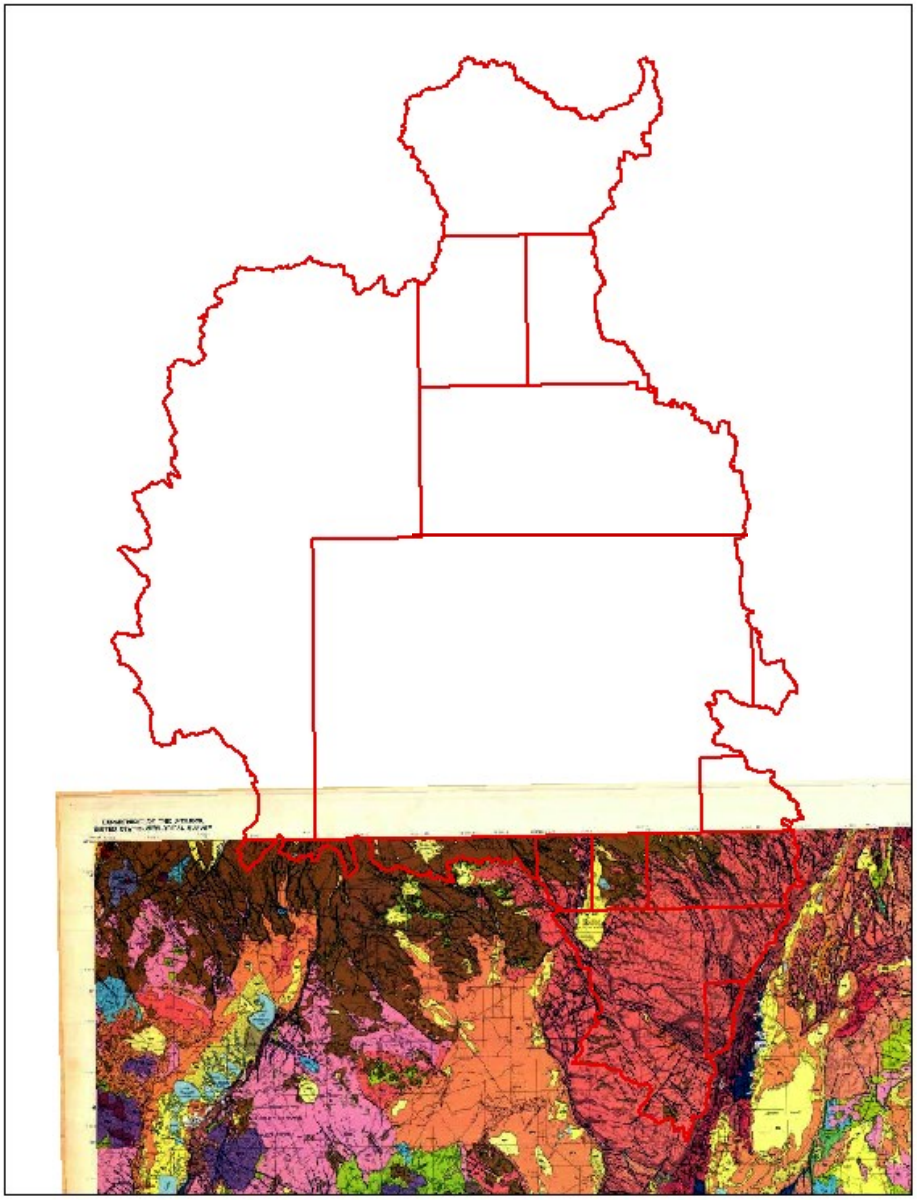


Source Data

Walker & Repenning, 1965

- Reconnaissance geologic map of the Adel quadrangle, Lake, Harney, and Malheur Counties, Oregon
- 1:250,000





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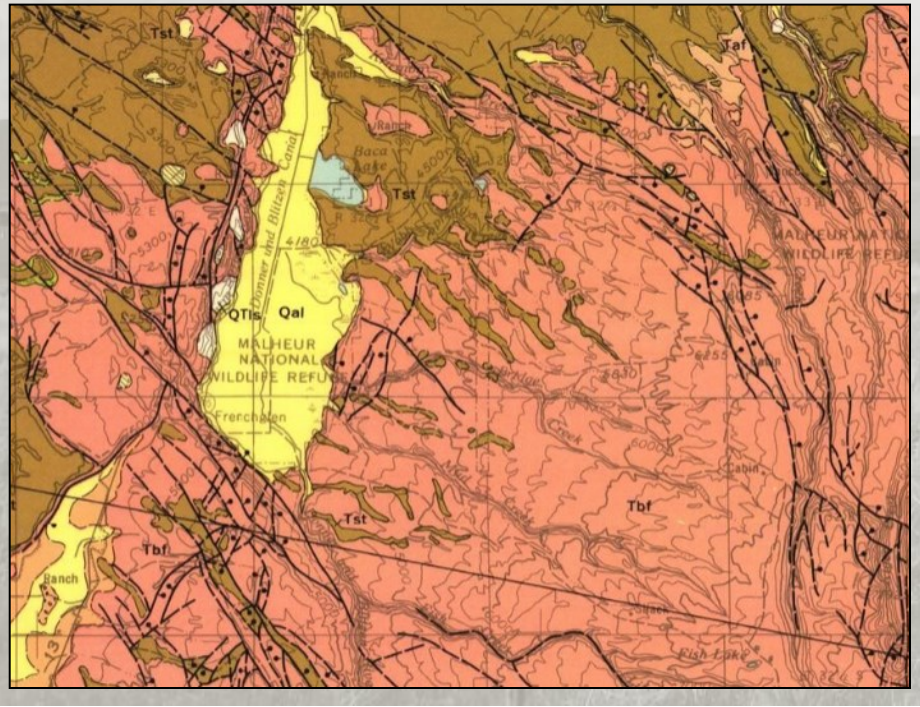
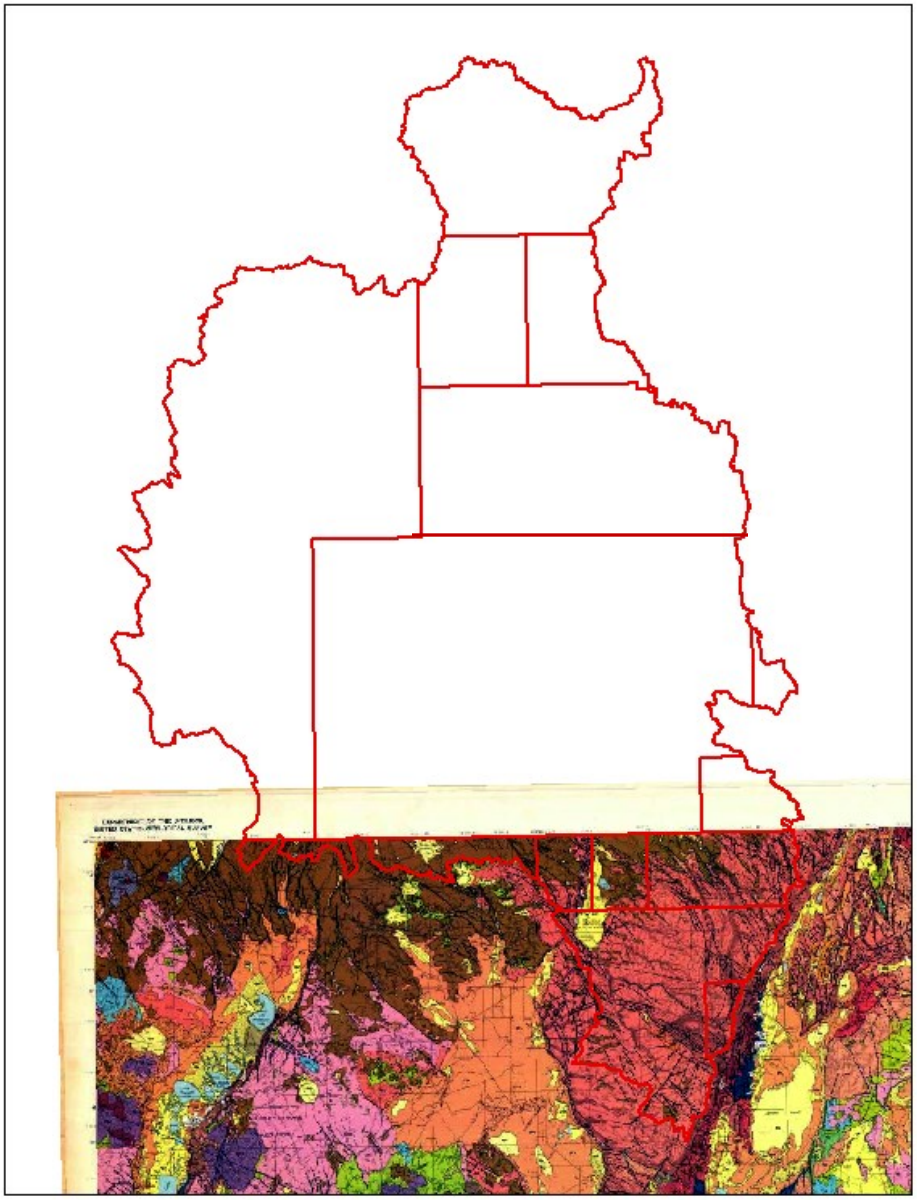
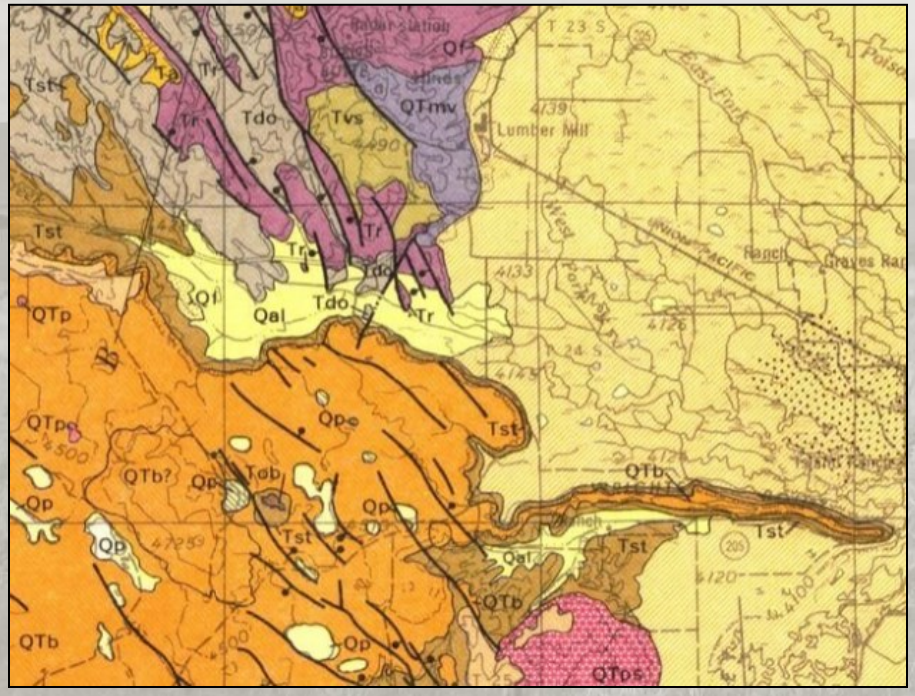


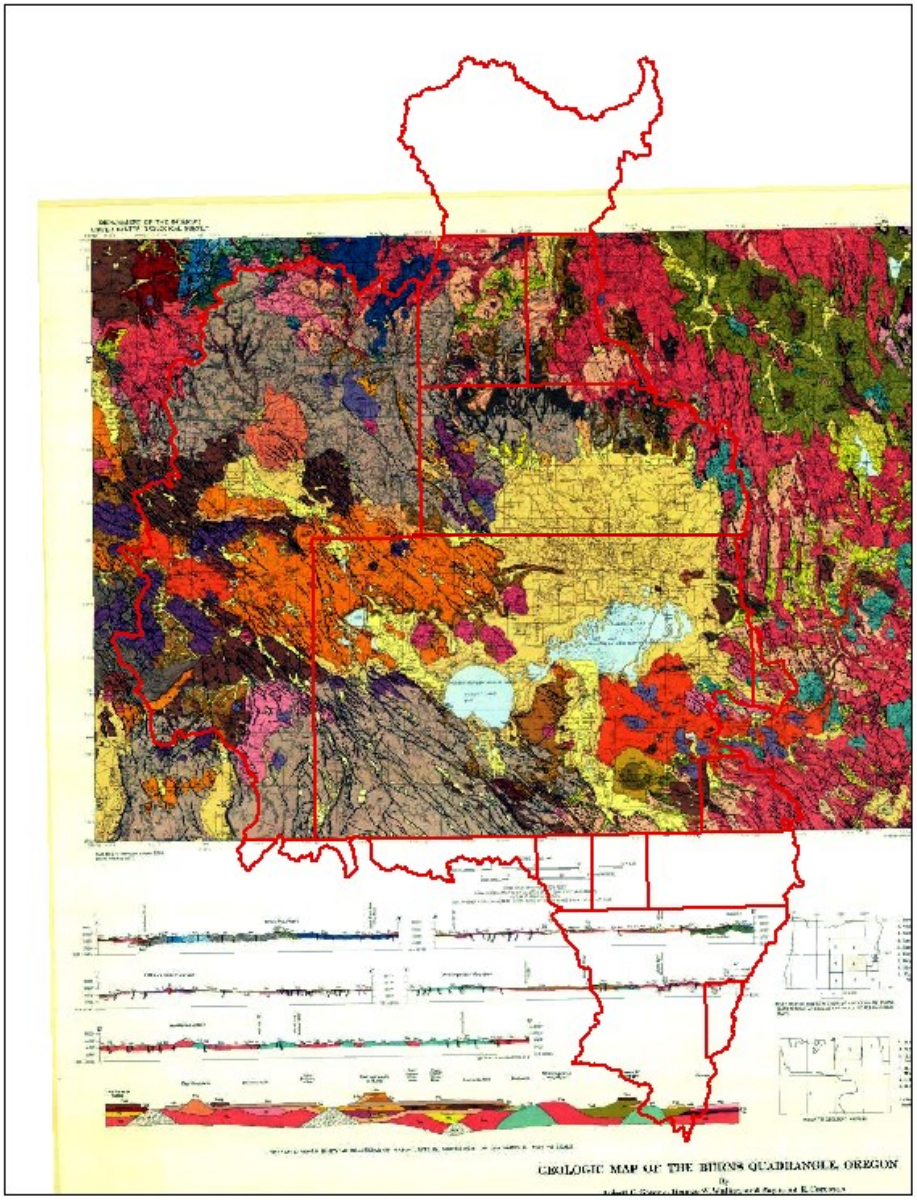


Source Data

Greene et al., 1972

- Geologic map of the Burns quadrangle, Oregon
- 1:250,000

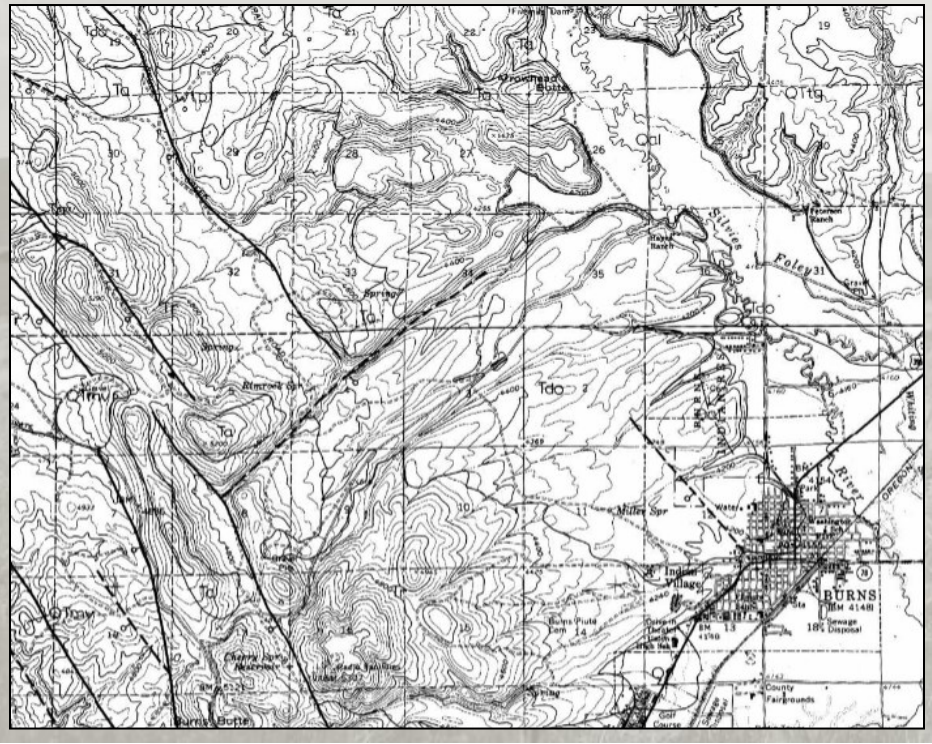


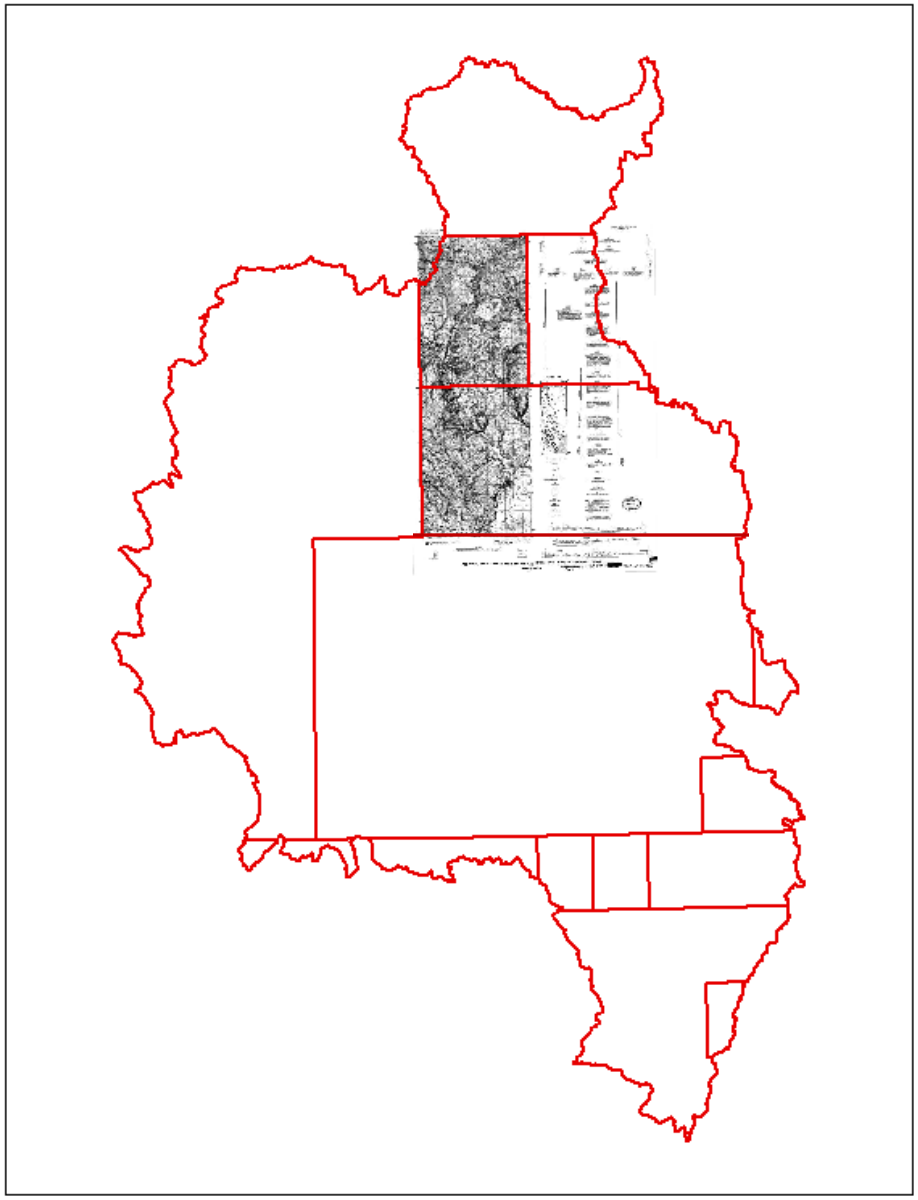


Source Data

Greene, 1972

- Preliminary geologic map of the Burns and West Myrtle Butte 15-minute quadrangles, Oregon
- 1:62,500

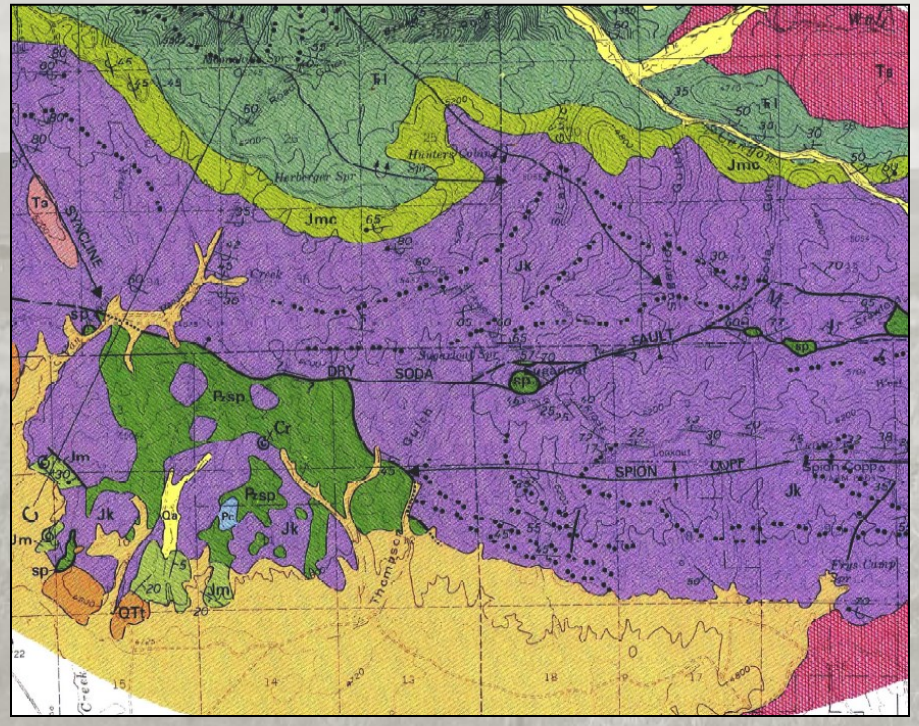


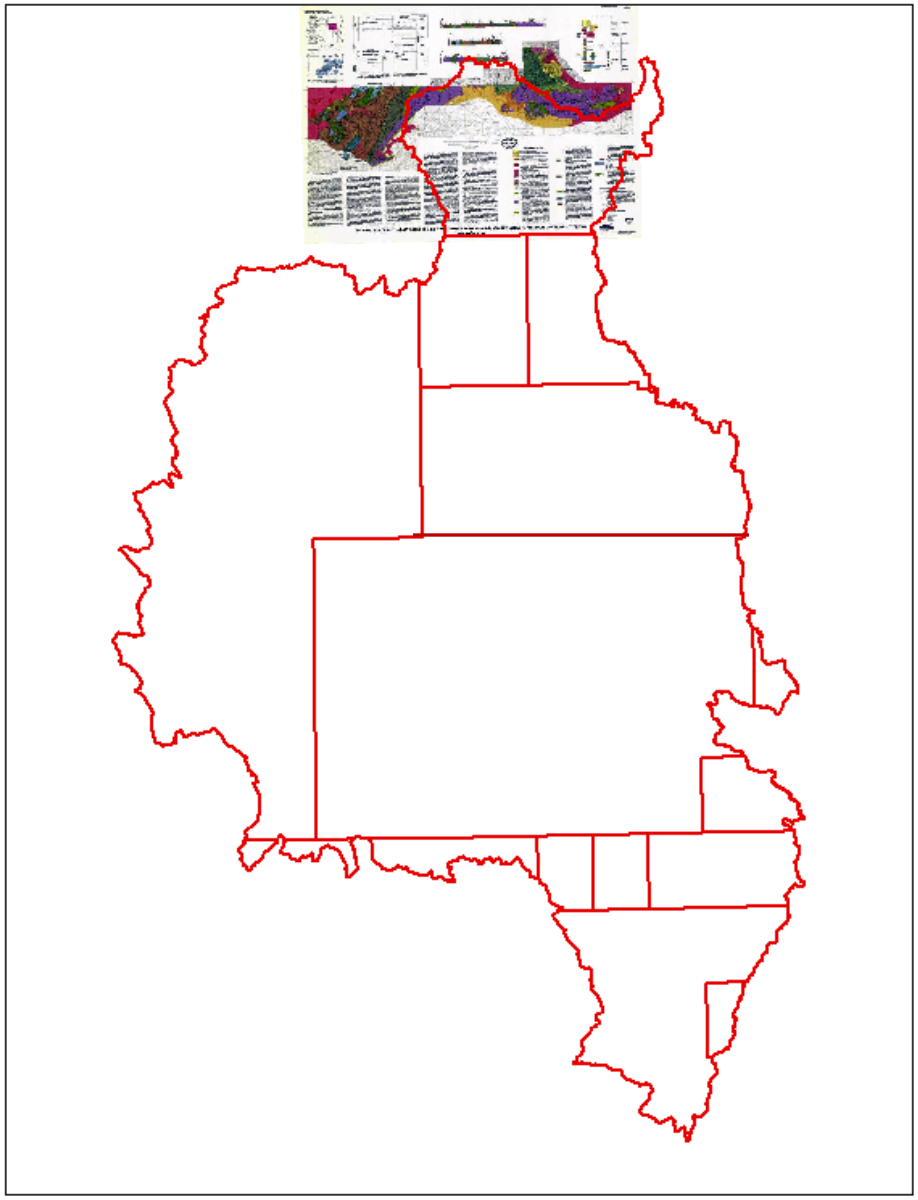


Source Data

Brown & Thayer, 1977

- Geologic map of pre-Tertiary rocks in the eastern Aldrich Mountains and adjacent areas to the south, Grant County, Oregon
- 1:62,500

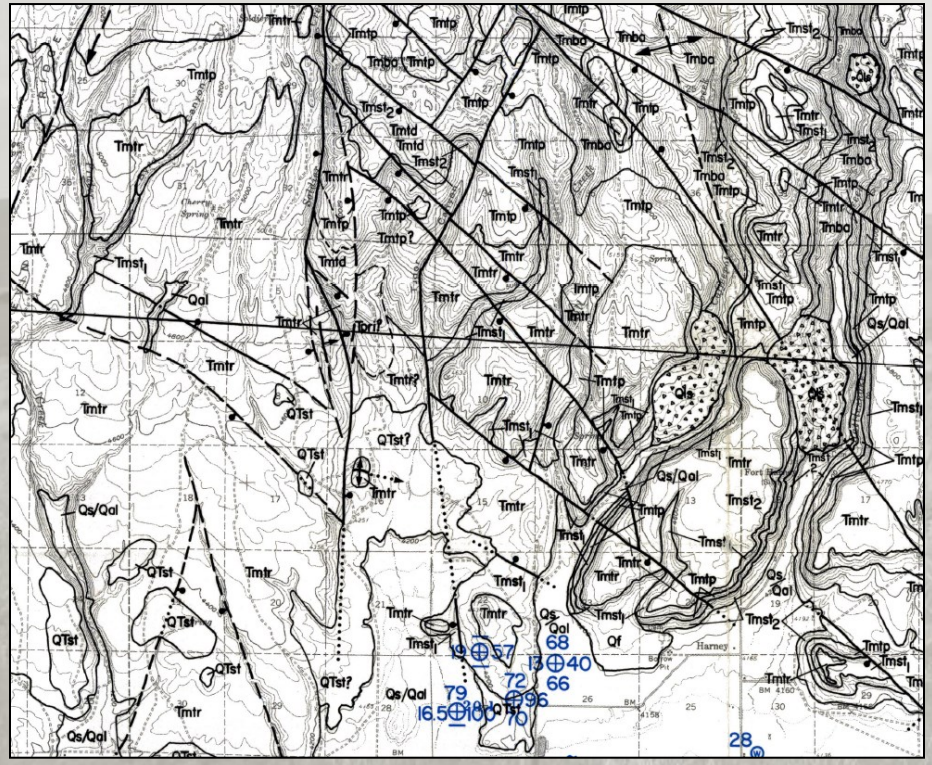


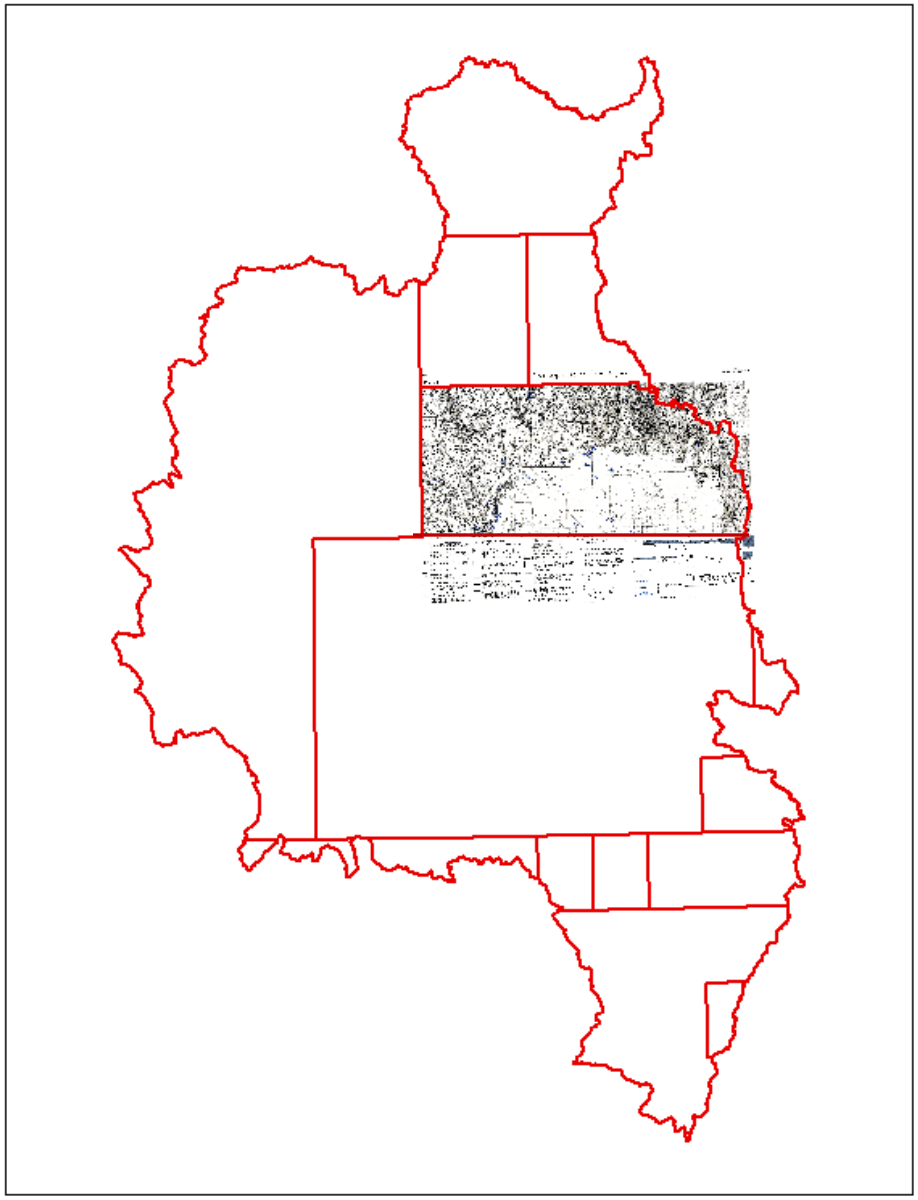


Source Data

Brown et al., 1980 (Northern Basin)

- Preliminary geology and geothermal resource potential of the northern Harney Basin, Oregon
- 1:62,500

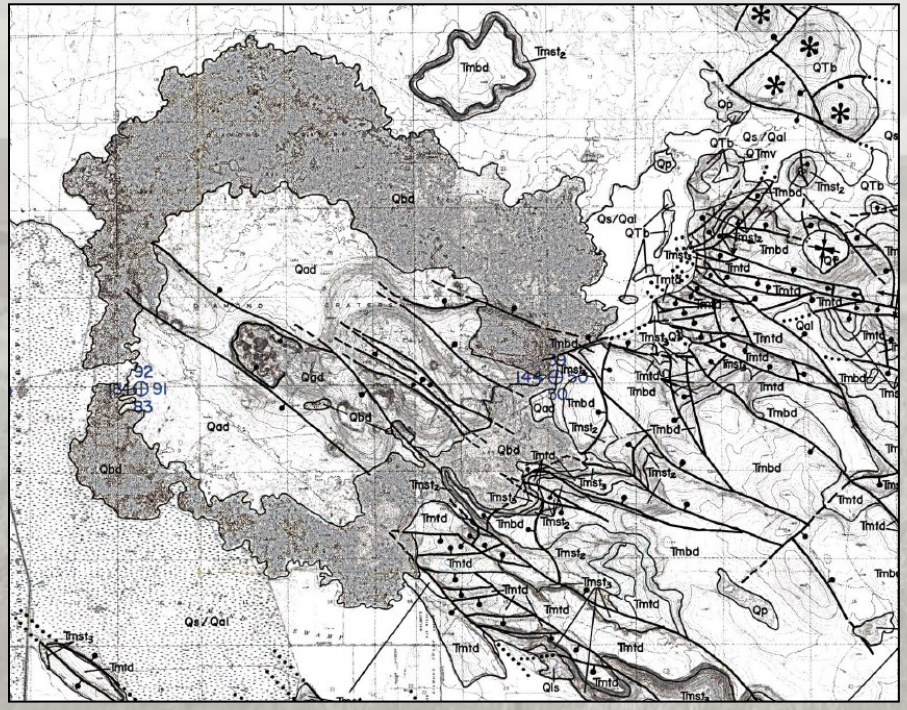


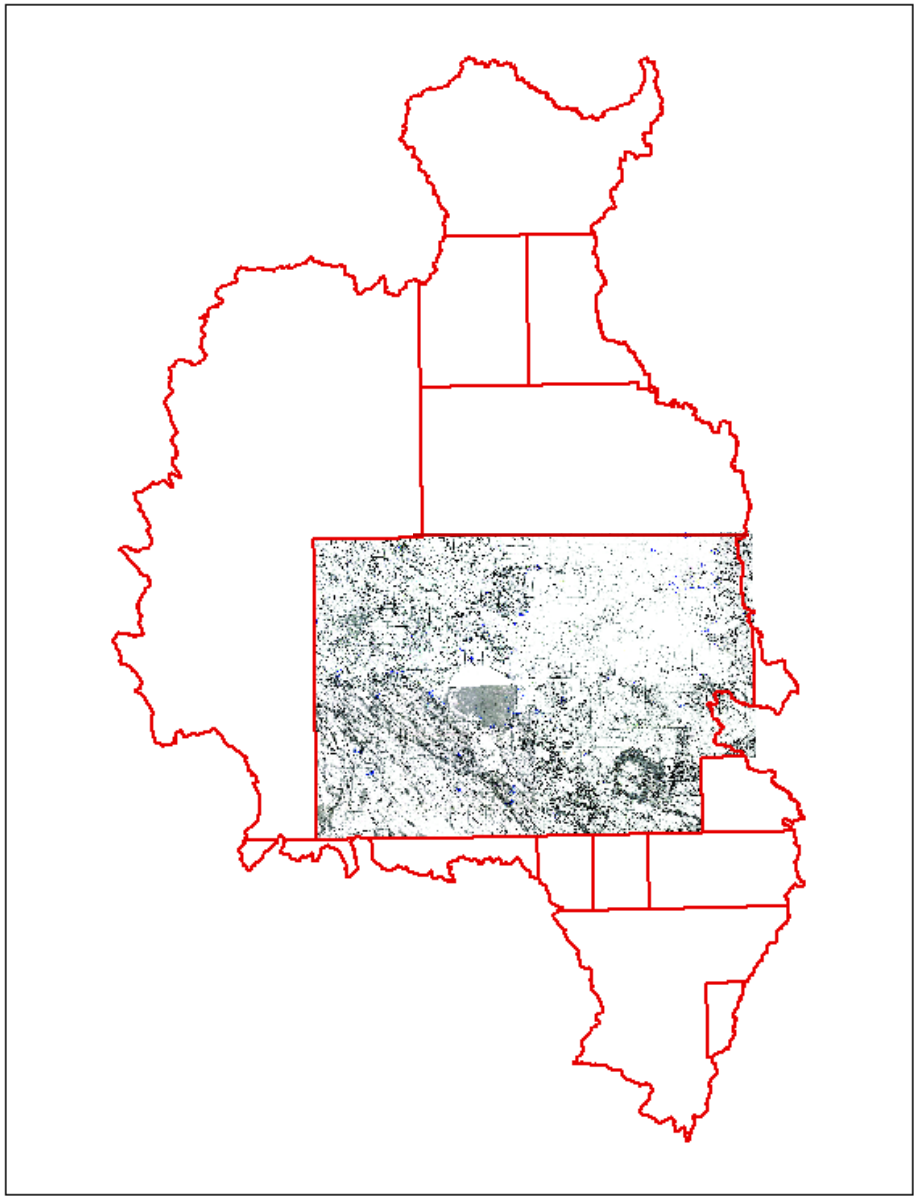


Source Data

Brown et al., 1980 (Southern Basin)

- Preliminary geology and geothermal resource potential of the southern Harney Basin, Oregon
- 1:62,500

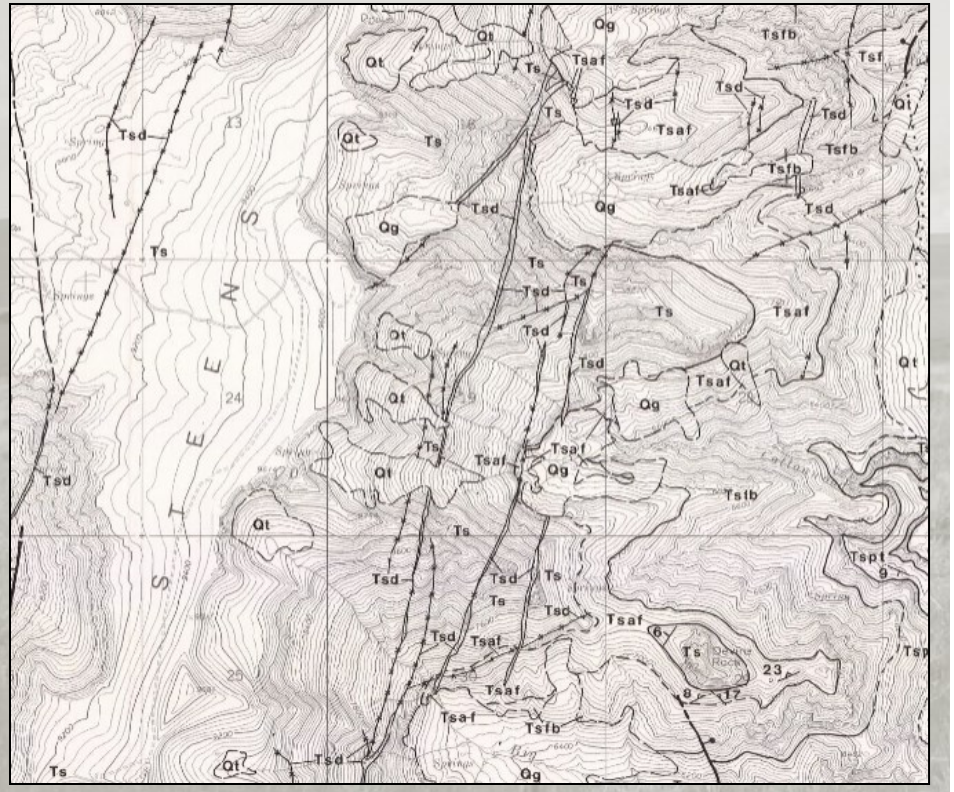


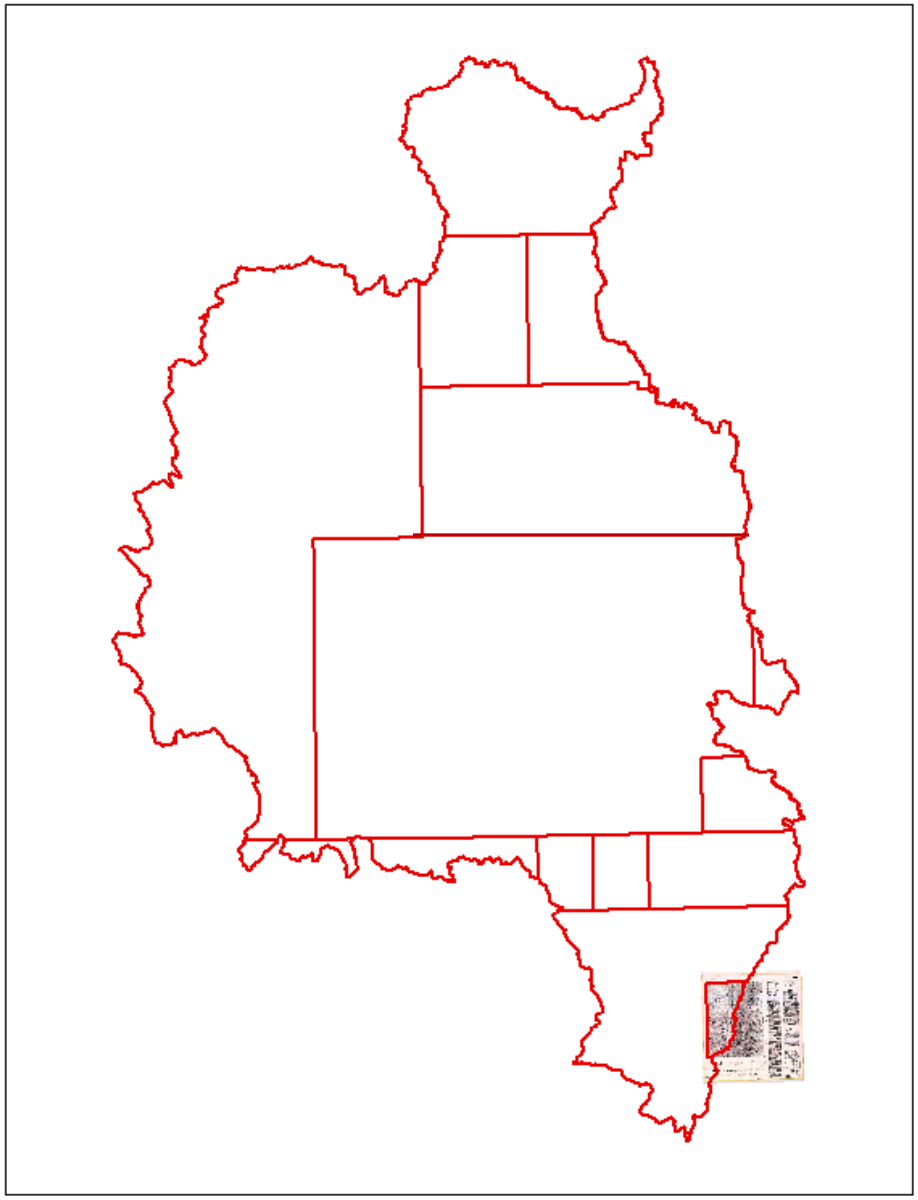


Source Data

Minor, 1987

- Geologic map of the Wildhorse Lake quadrangle, Harney County, Oregon
- 1:24,000

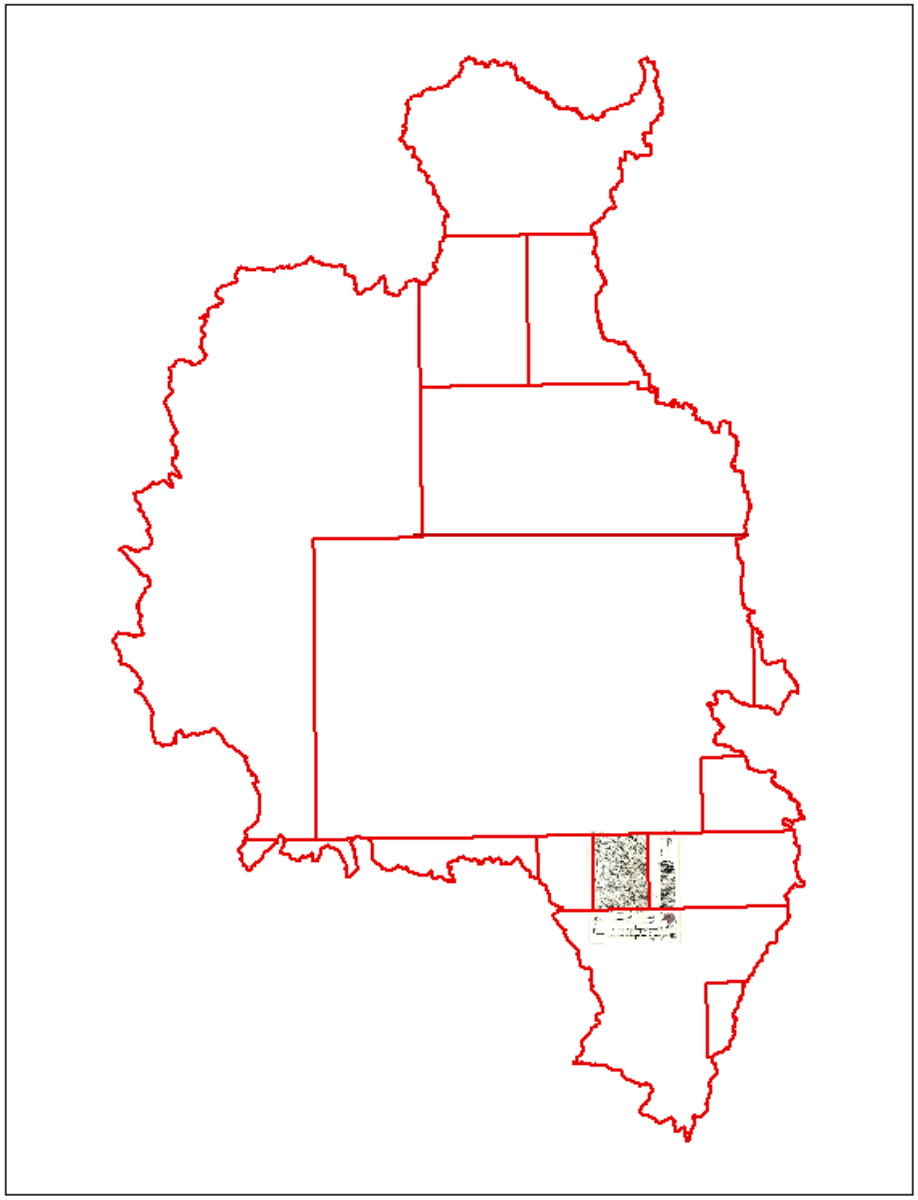




Source Data

Johnson, 1994

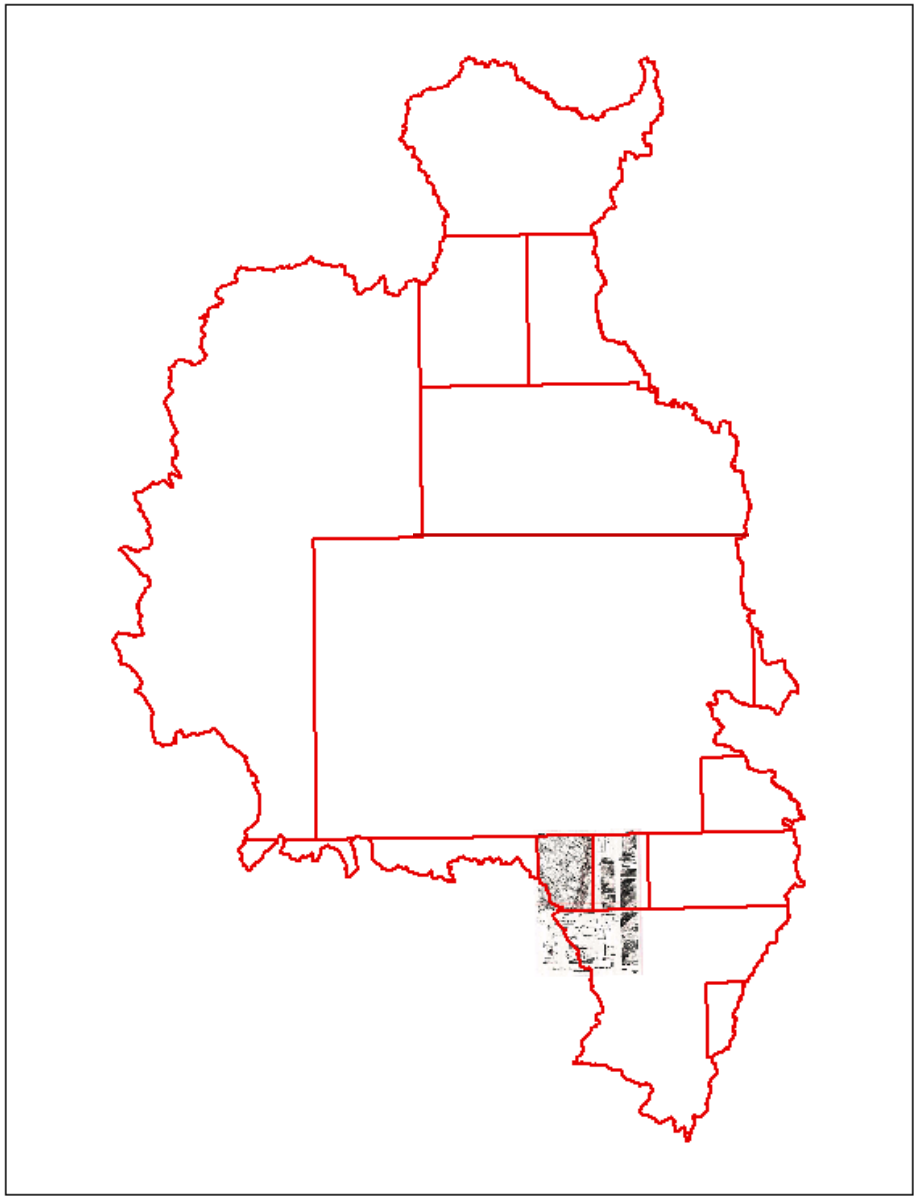
- Geologic map of the Krumbo Reservoir quadrangle, Harney County, southeastern Oregon
- 1:24,000



Source Data

Sherrod & Johnson, 1994

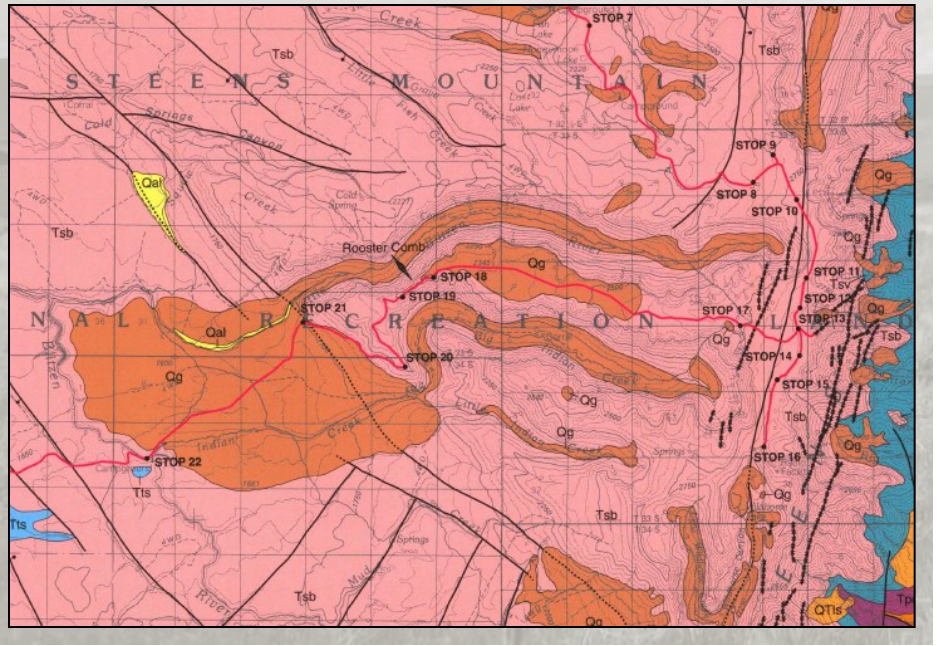
- Geologic map of the Irish Lake quadrangle, Harney County, south-central Oregon
- 1:24,000

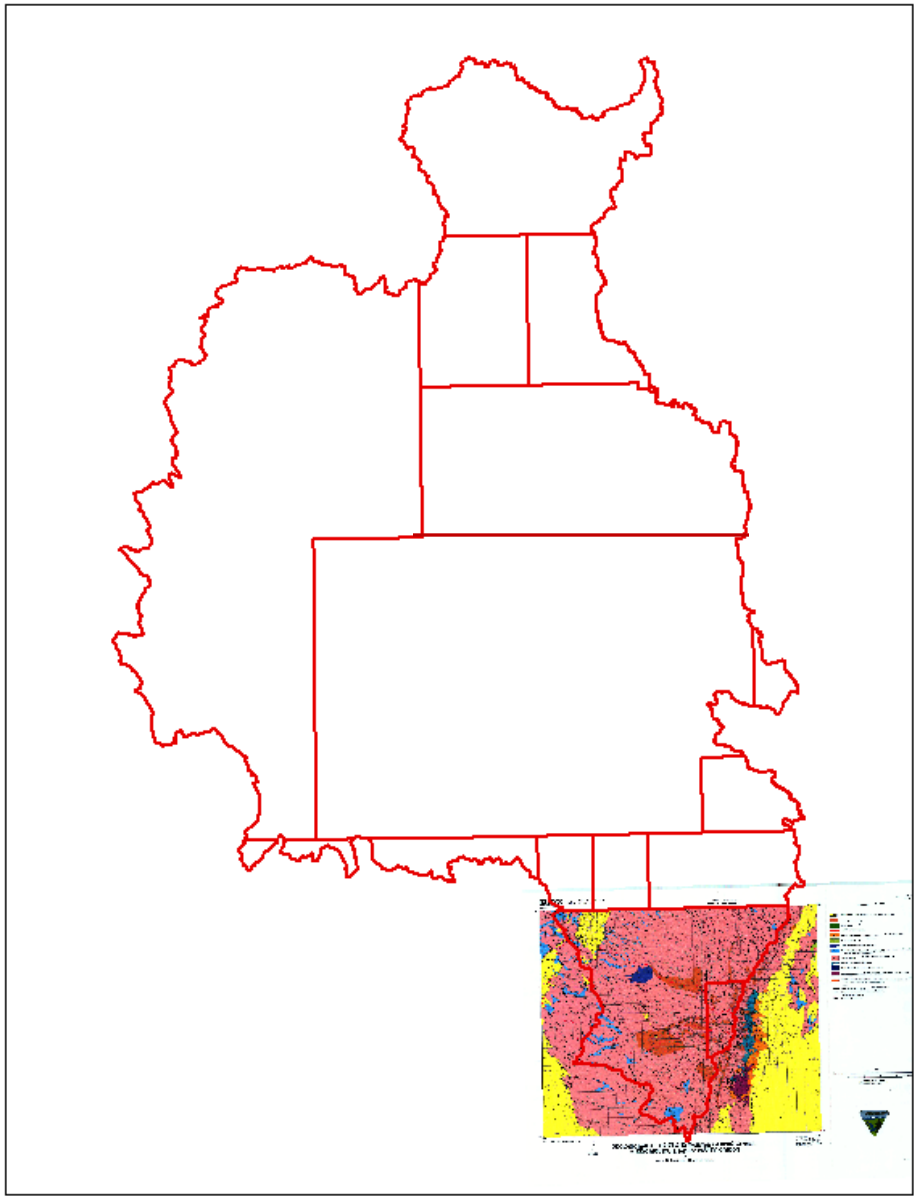


Source Data

Evans & Geisler, 2001

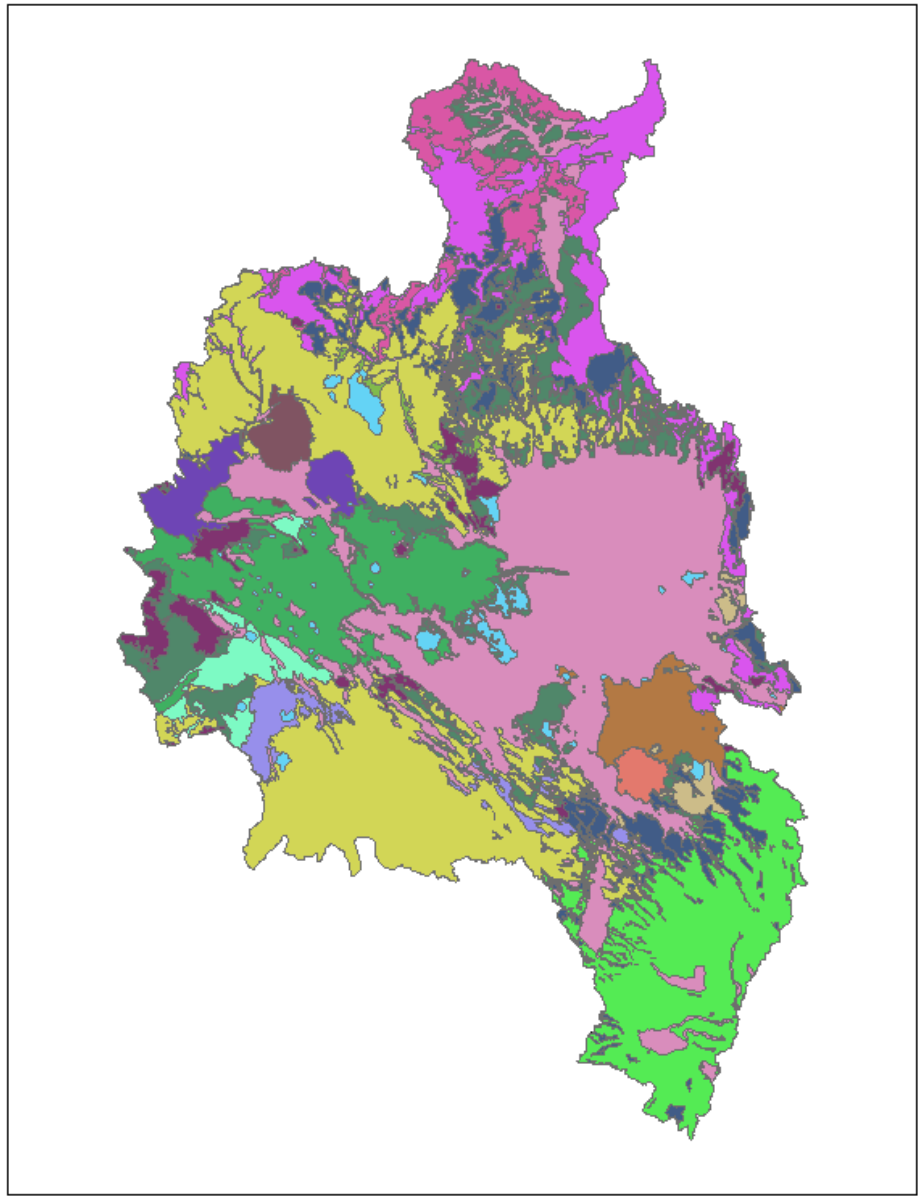
- Geologic field-trip guide to Steens Mountain Loop Road, Harney County, Oregon
- 1:100,000
- Cites field work of D. Sherrod (USGS) and J.A. Johnson, 1996





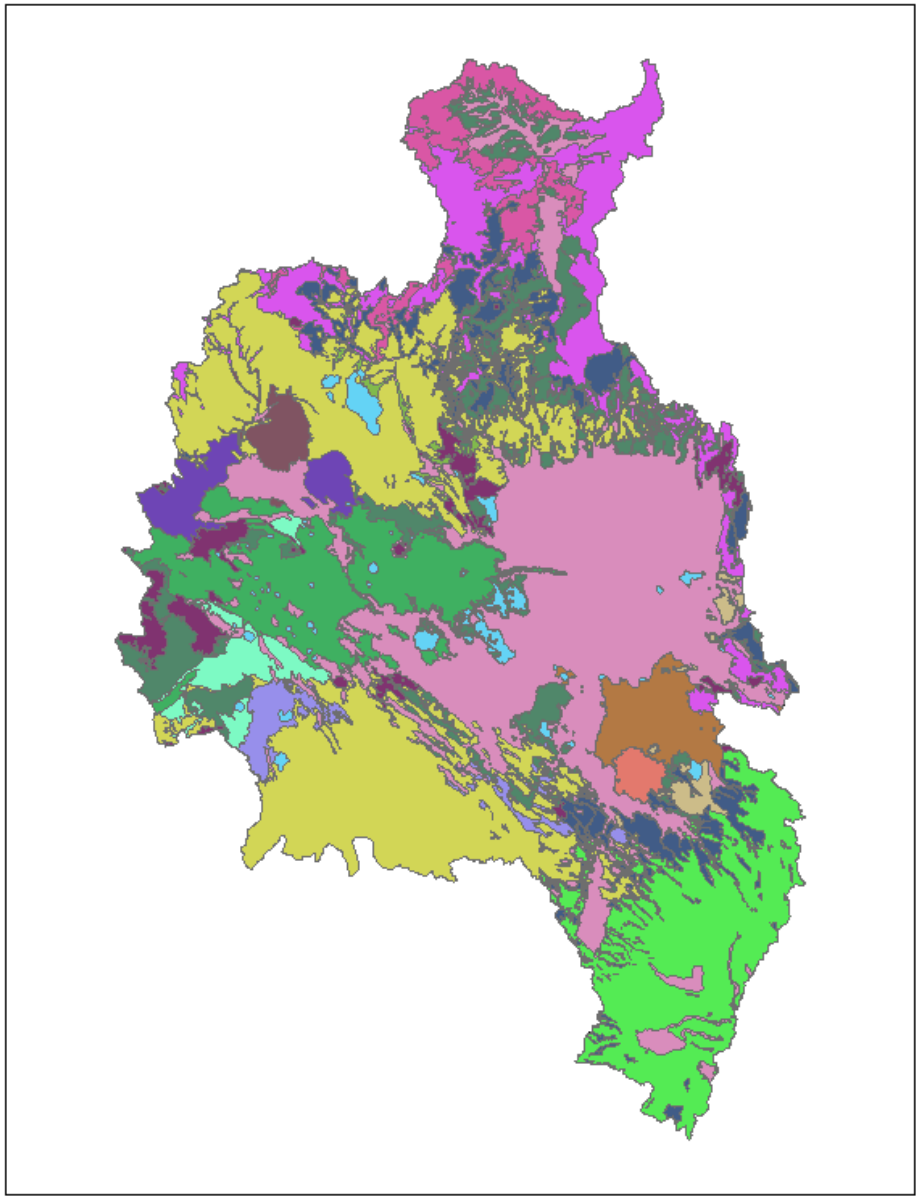
Modifications to OGDC

- **Digital compilation**
  - Polygon and fault data sourced largely from OGDC
  - OGDC modified where maps were excluded – underlying small scale maps generally used
  - Map boundary effects resolved using:
    - New 24k mapping (DOGAMI)
    - Radiometric ages
    - Whole-rock geochemistry
    - Elevation data
    - Satellite imagery
  - **Generalized into 18 regional geologic map units**



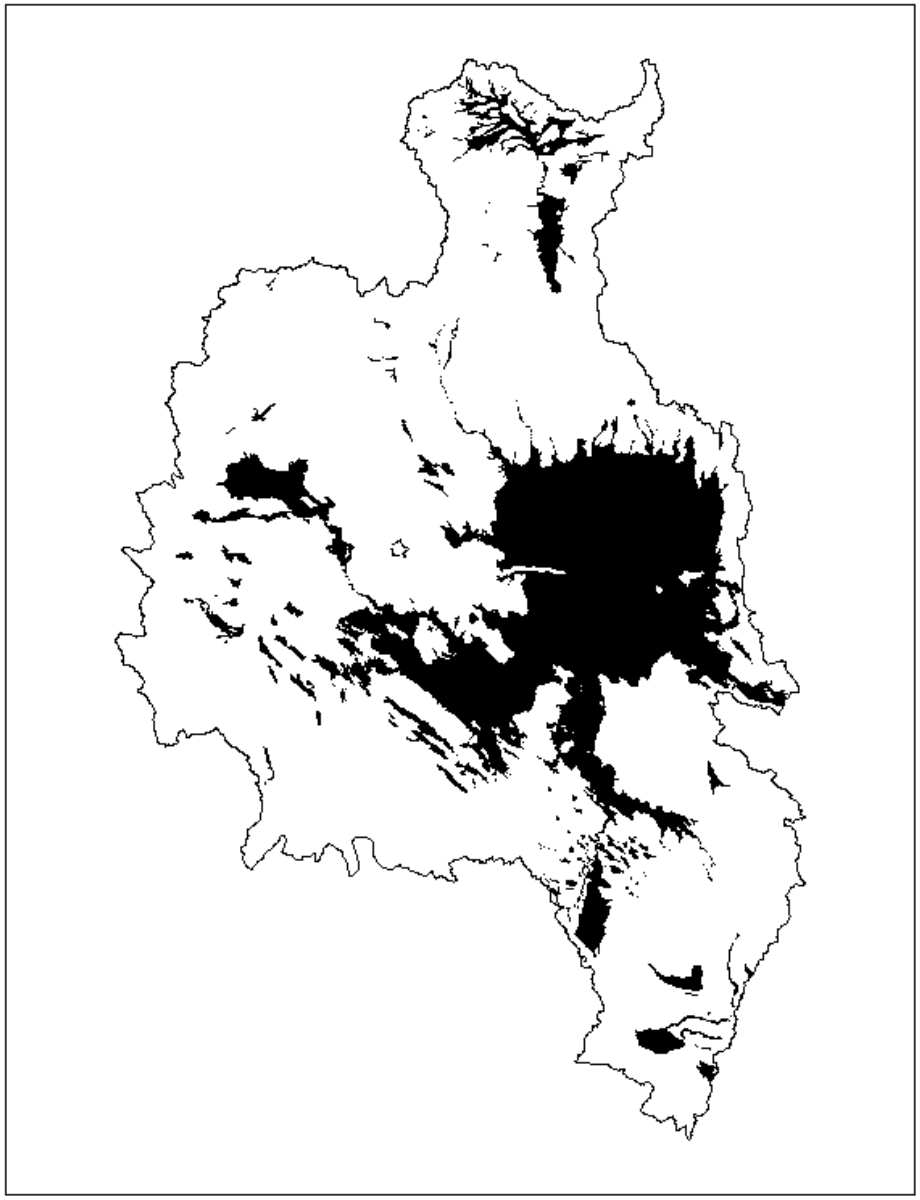
Harney Basin Geologic Units

1. Quaternary sedimentary deposits
2. Diamond Craters basalt and tephra
3. Volcanic vents
4. Voltage Basalt
5. Basalt (Pliocene-Pleistocene)
6. Tuffaceous sedimentary rocks & tuff
7. Silicic flows and domes
8. Olivine basalt
9. Basalt & andesite of Gum Boot Canyon
10. Rattlesnake Ash-flow Tuff
11. Drinkwater Basalt
12. Basalt of Harney Lake
13. Basalt & andesite of Dry Mountain
14. Andesite
15. Devine Canyon Ash-flow Tuff
16. Older volcanic rocks
17. Steens Basalt
18. Mesozoic rocks



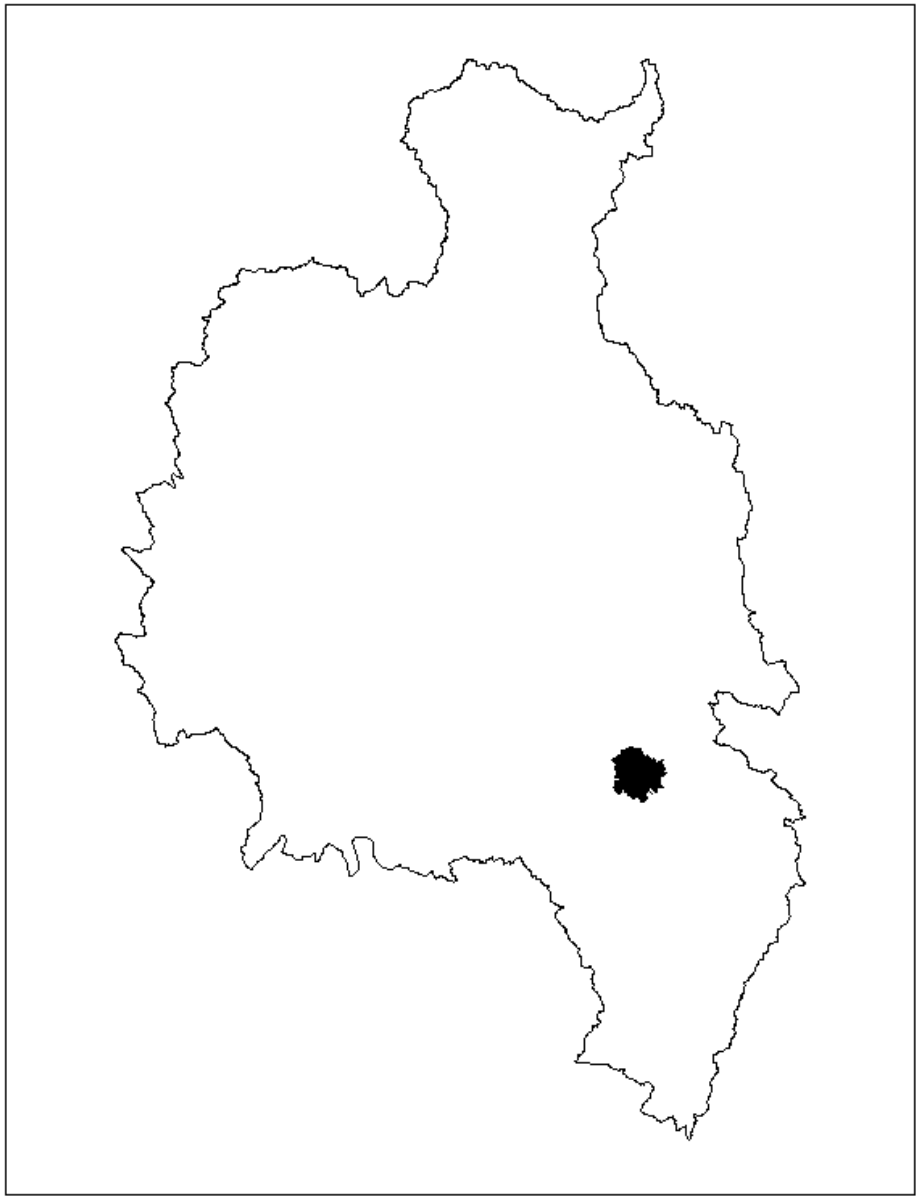
Sedimentary deposits

- **Sedimentary deposits (Holocene and Pleistocene) –** Unconsolidated to poorly consolidated clay, silt, sand, and gravel. Deposits originated as alluvium, alluvial fan deposits, colluvium, floodplain deposits, lacustrine deposits, talus, landslide, and other recent sedimentary deposits. Includes glacial deposits high on Steens Mountain.



Diamond Craters basalt and tephra

- **Diamond Craters basalt and tephra (Holocene) –** Olivine and plagioclase phyric olivine basalt lava flows and juvenile tephra including agglomerate, cinders and ash. Basalt is mostly vesicular, medium to dark gray, and ranges from glassy to holocrystalline forming thin flows with ropy pahoehoe surfaces. Emplaced sometime between about 7320 to 7790 years ago on the basis of radiocarbon ages and paleomagnetic constraints (Sherrod et al., 2012).



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  vesicular, mediun
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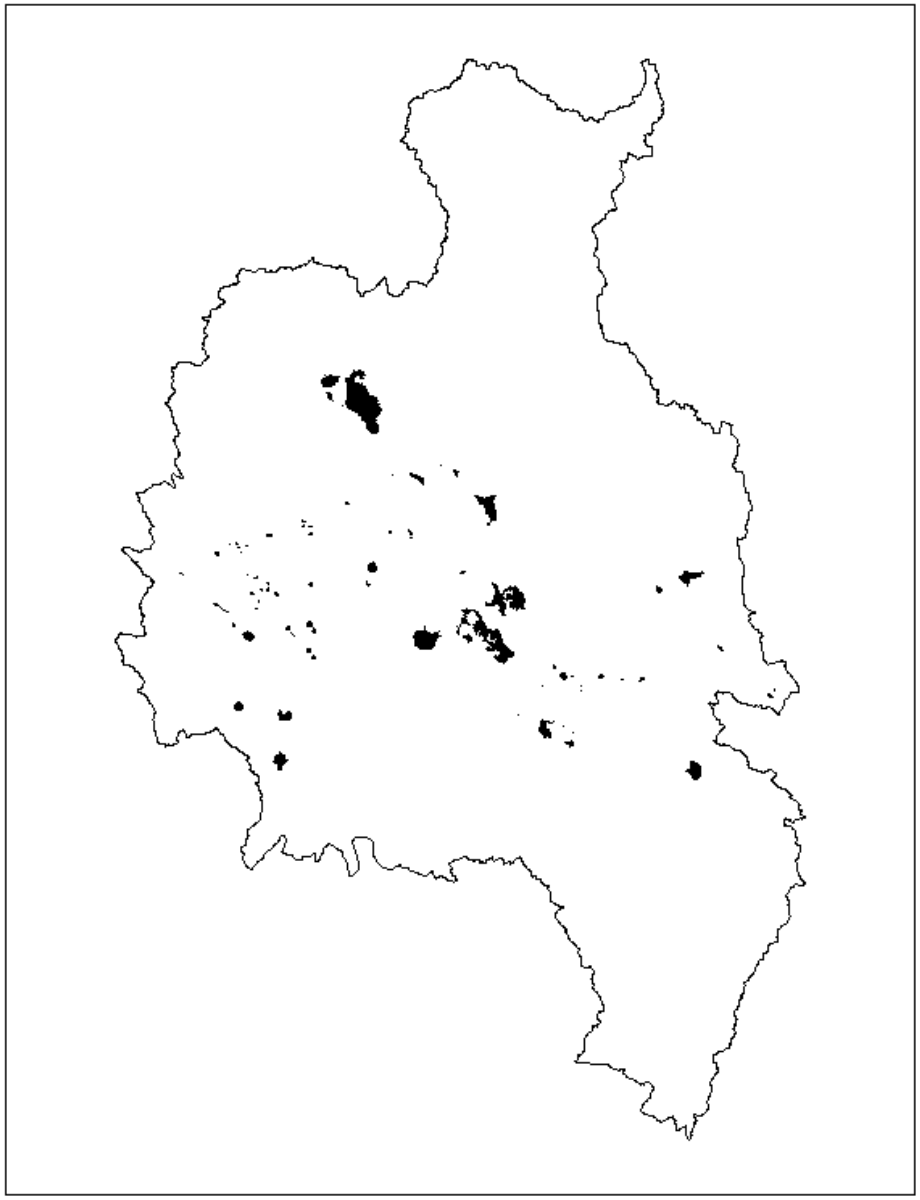
  surfaces. Emplac
  about 7320 to 77
  basis of radiocarb
  paleomagnetic co
  al., 2012).

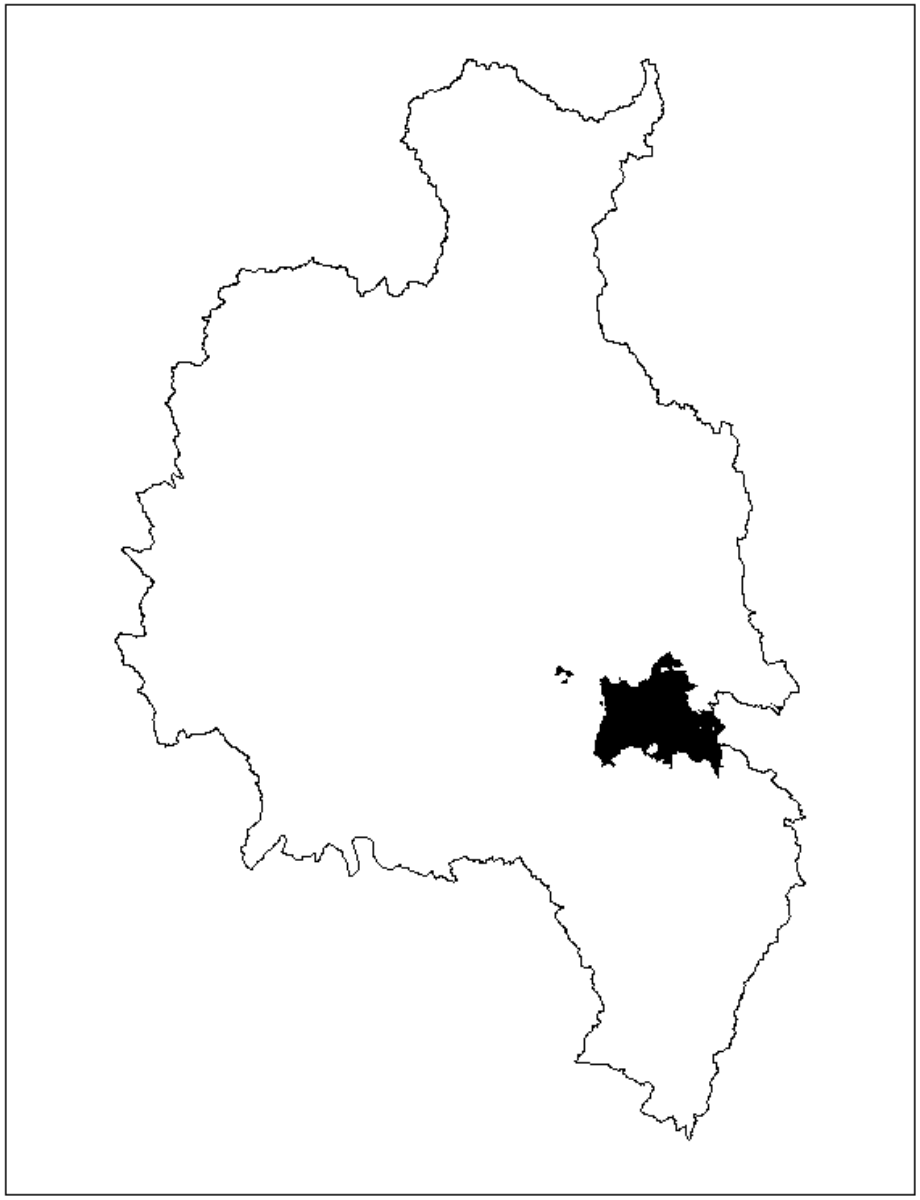
Volcanic vents

- **Volcanic vents (Pleistocene to late Miocene) –** Basaltic and andesitic scoria, cinders, agglomerate and thin flows associated with eruptive centers of mafic and intermediate volcanic units in the map area. Locally includes partly consolidated subaqueous deposits of palagonitized basaltic ejecta occurring as tuff and breccia cones and rings.



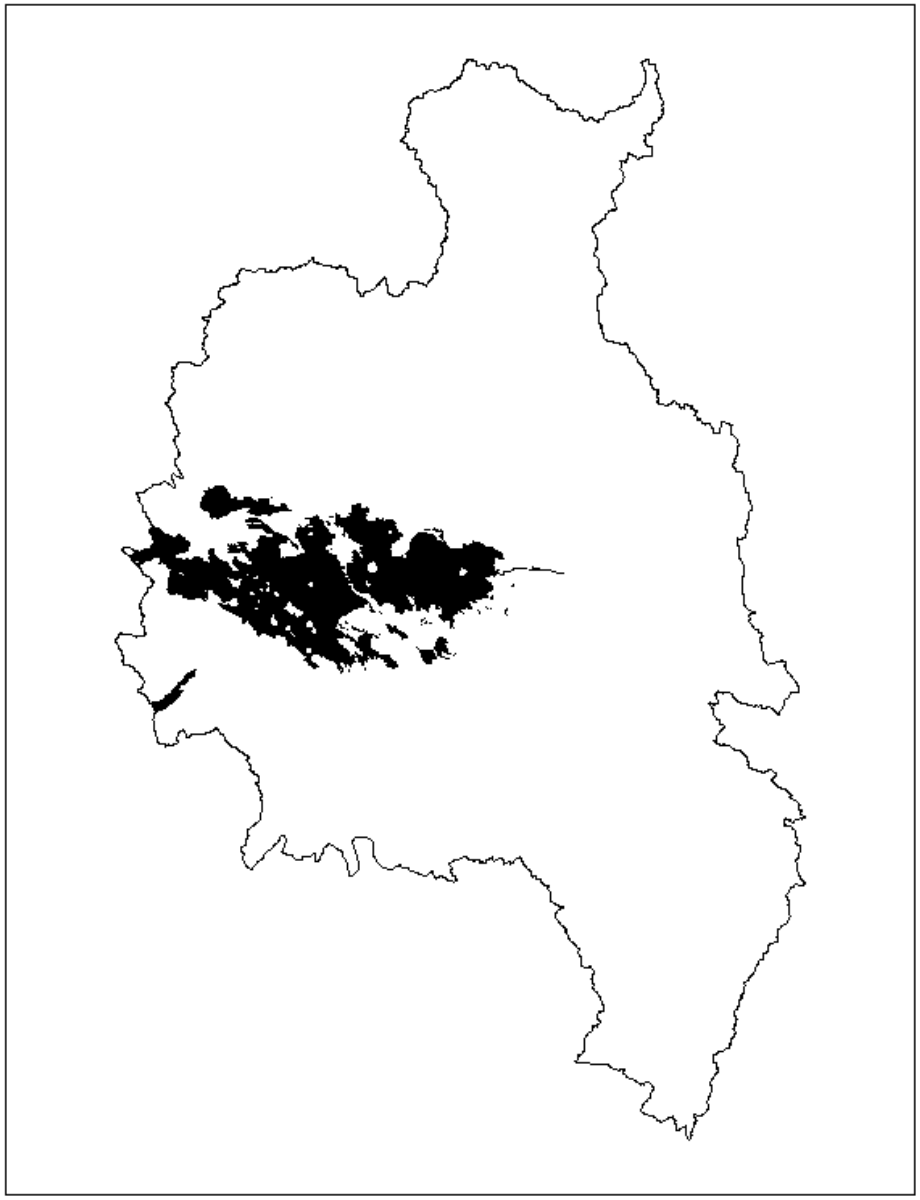
Voltage Basalt

- **Voltage Basalt (Pleistocene) –** Medium-gray, diktytaxitic, vesicular olivine basalt erupted as thin lava flows from several vents south of Malheur Lake. $^{40}Ar/^{39}Ar$ ages of 1.23±0.05 Ma and 1.47±0.08 Ma (Jordan et al., 2004).



Basalt

- **Basalt (early Pleistocene(?) and late Pliocene) –** Medium-gray, fine-grained diktytaxitic, commonly vesicular basalt. Predominantly high-alumina olivine tholeiite (HAOT) basalts of the High Lava Plains. Occurs as a series of thin flows locally separated by thin layers of sedimentary rock. Unit includes the Wright's Point member of the Harney Formation (Walker, 1979). Age assignment based on $^{40}Ar/^{39}Ar$ ages of 2.83±0.89 Ma (Streck and Grunder, 2012), 2.54±0.07 Ma at Wrights Point, and 2.2±0.04 Ma (Jordan et al., 2004).

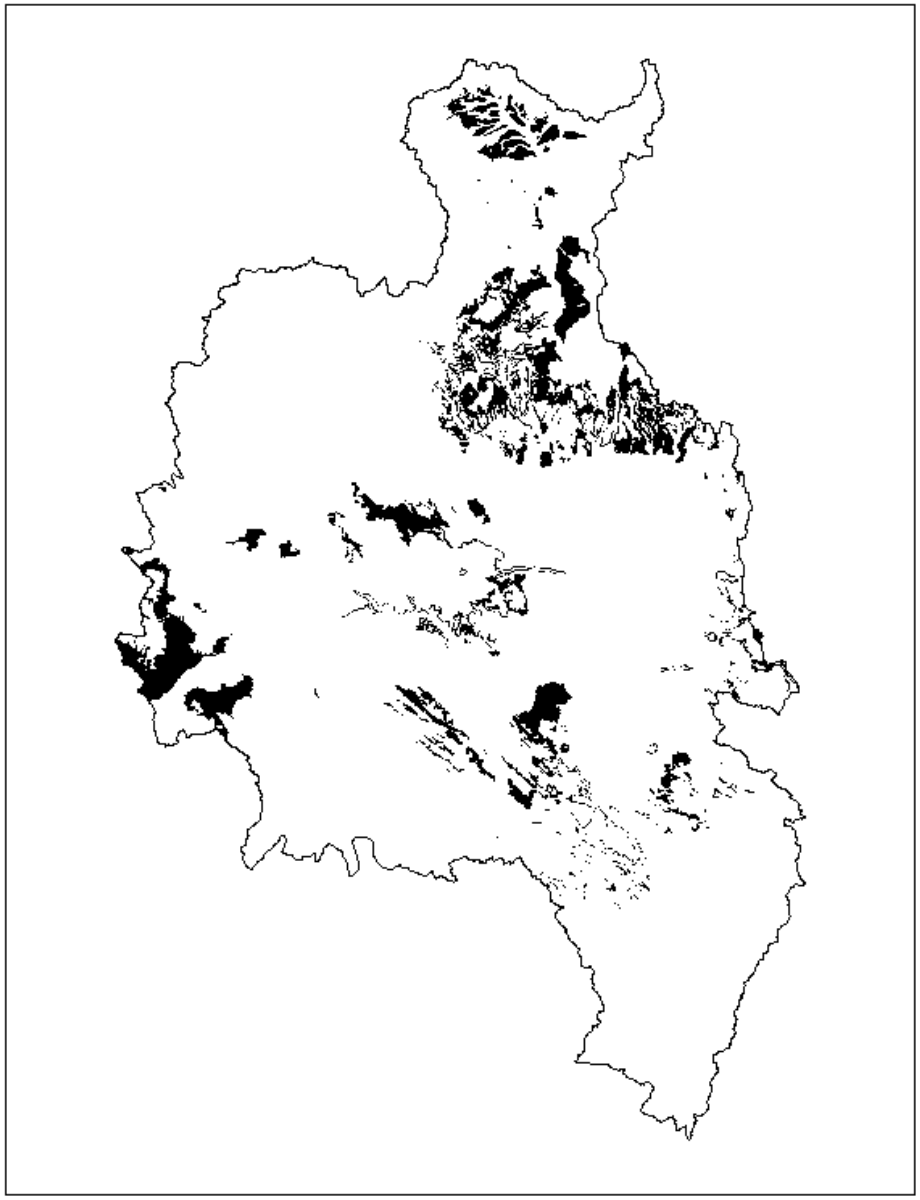


Basalt

- **Basalt (early Pleistocene(?) and late Pliocene) –** M
  diktytaxitic, cc
  Predominantly
  tholeiite (HAO
  Lava Plains. Oc
  flows locally se
  sedimentary r
  Wright's Point
  Formation (Wa
  assignment ba
  2.83±0.89 Ma
  2012), 2.54±0.
  and 2.2±0.04 M

Tuffaceous sedimentary rocks and tuff

- **Tuffaceous sedimentary rocks and tuff (Pliocene to Miocene) –** White to buff and pale brown to yellowish gray, semi- to well-consolidated, locally zeolitized lacustrine and fluviatile tuffaceous mudstone, siltstone, sandstone and conglomerate with numerous air-fall ash beds and tuffs, with 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. Includes all tuffaceous sediments and tuff underlying and overlying units Trt and Tdv, including the 8.41±0.16 Ma Prater Creek Ash-flow Tuff (Walker, 1979; Jordan et al., 2004).

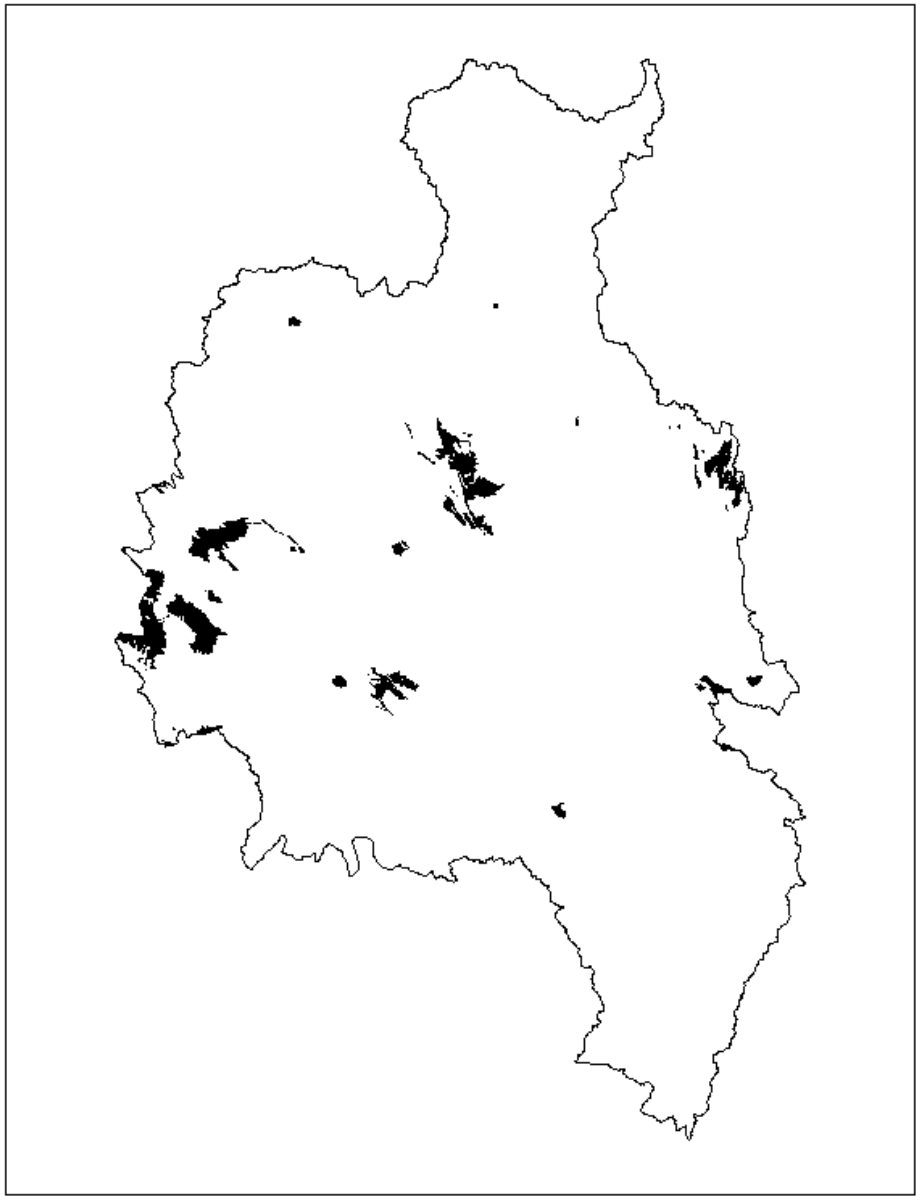


Tuffaceous sedimentary rocks and tuff

- **Tuffaceous sedimentary rocks and tuff (Pliocene to Miocene) –** White to buff and pale
to well-co
lacustrine
mudstone
conglome
ash beds
carbonate
consists o
pumice, s
plagioclas
clay matr
sediment
overlying
the 8.41±
flow Tuff
2004).

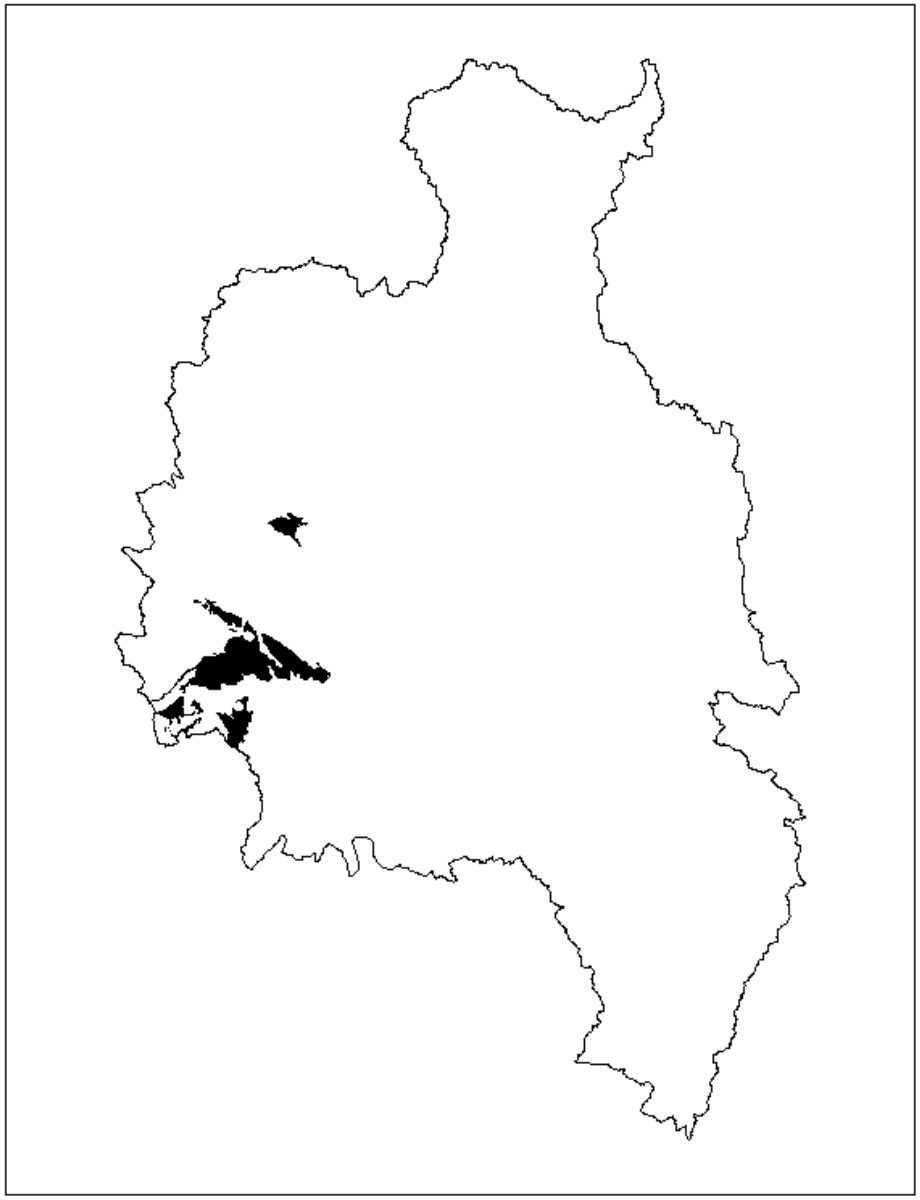
Rhyolite, dacite, and rhyodacite domes and lava flows

- **Rhyolite, dacite, and rhyodacite domes and lava flows (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. Occurs as exogenous domes and related flows and plugs.



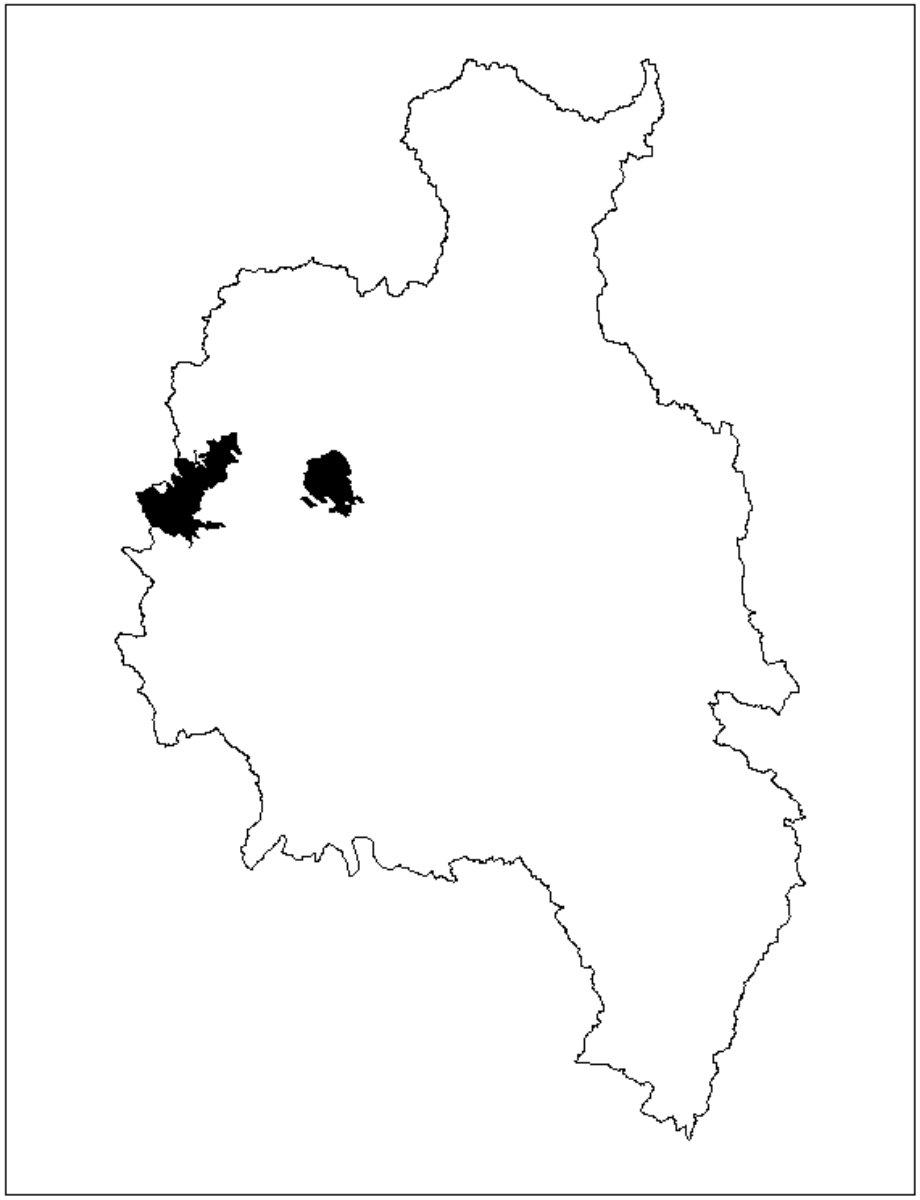
Olivine basalt

- **Olivine basalt (Pliocene to late Miocene) –** Dark-gray to black, fine-grained olivine basalt and some andesite. Locally includes thin interbeds of tuffaceous sedimentary rock. Overlies Rattlesnake Ash-flow Tuff in the southwest part of the map area. Age assignment based on stratigraphic position and a K-Ar age of 6.2±0.8 Ma (Fiebelkorn et al., 1982).



Olivine basalt and andesite of Gum Boot Canyon

- **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 200 feet. Overlies unit Trt southwest of Dry Mountain, but a $^{40}Ar/^{39}Ar$ age of 7.60±0.11 Ma from southeast of Dry Mountain (Jordan et al., 2004) suggests some part of this unit may be older.



Olivine basalt and andesite of Gum Boot Canyon

- **Olivine basalt and andesite of Gum Boot Canyon (late Miocene) –** Medium to dark gray, fine- to medium-grained, aphyric and diktytaxitic basalt with

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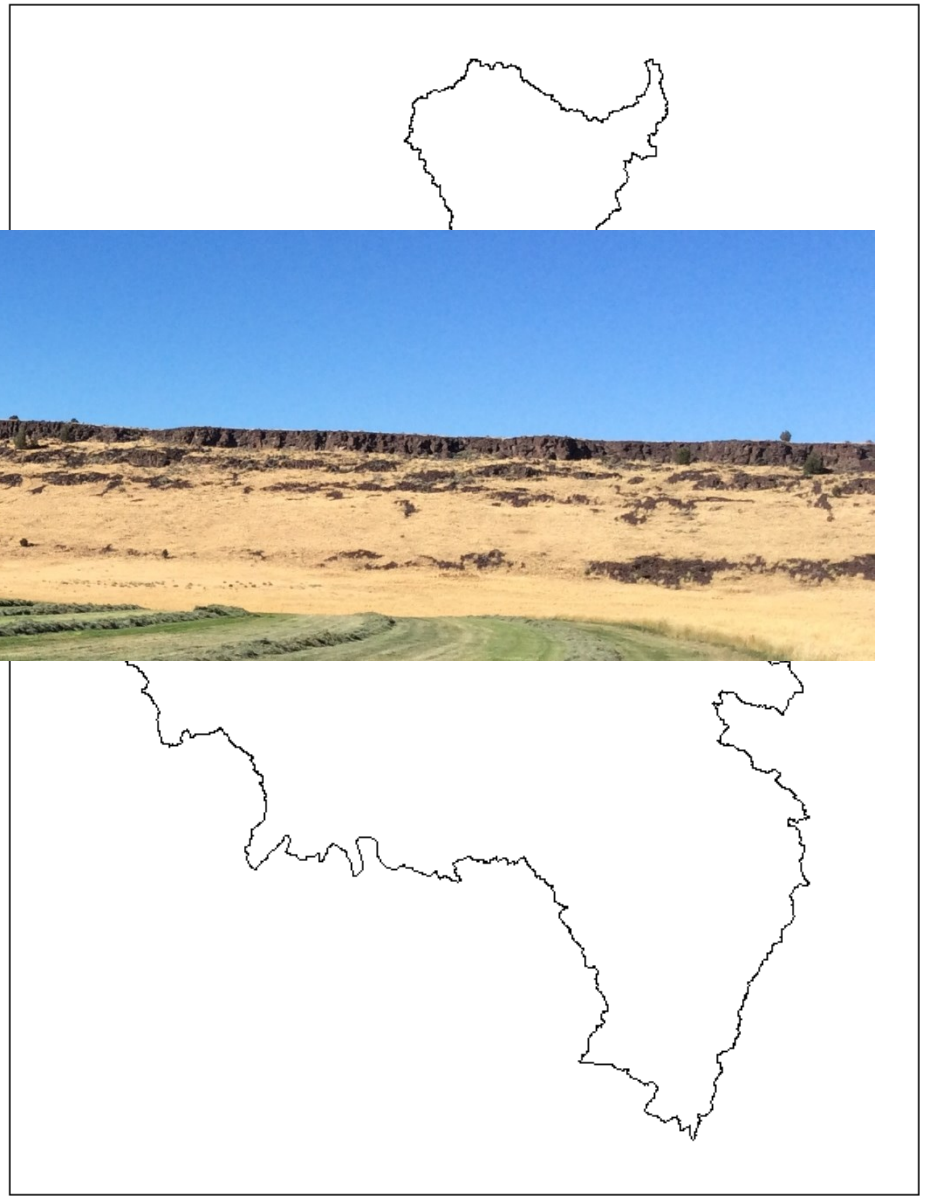
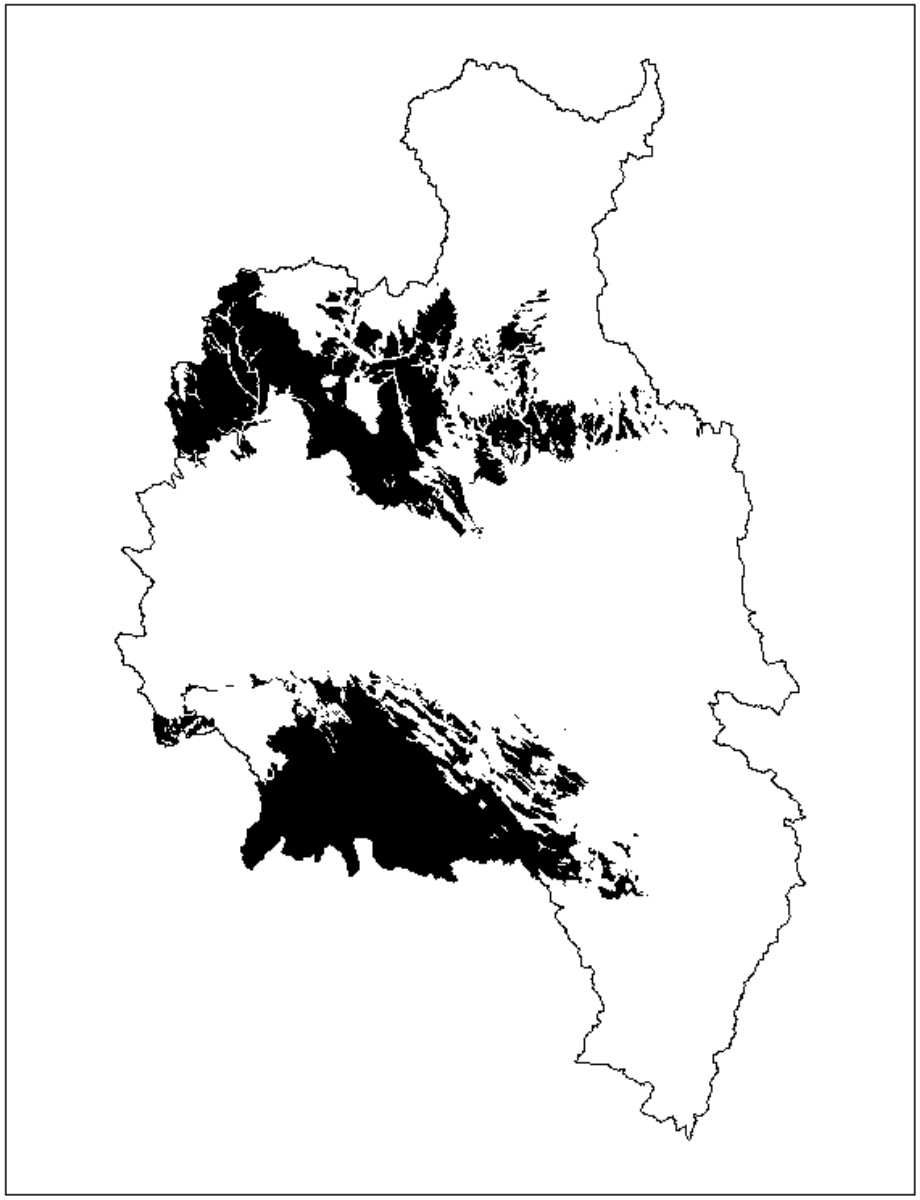


Rattlesnake Ash-Flow Tuff

- **Rattlesnake Ash-Flow Tuff (Late Miocene) –** Light-brown to red-brown to gray, nonwelded to densely welded, pumice-rich, crystal poor (<1 percent) rhyolite tuff; forms a single cooling unit throughout the map area typically ranging from 50 to 100 feet thick. Streck and Grunder (1995) proposed a source area located in the western Harney Basin, near Capehart Lake, on the basis of outcrop, pumice size, and facies distribution as well as flow direction indicators. $^{40}Ar/^{39}Ar$ ages of 7.05±0.01 Ma (Streck and Grunder, 1995) and 7.093±0.015 Ma (Jordan et al., 2004).

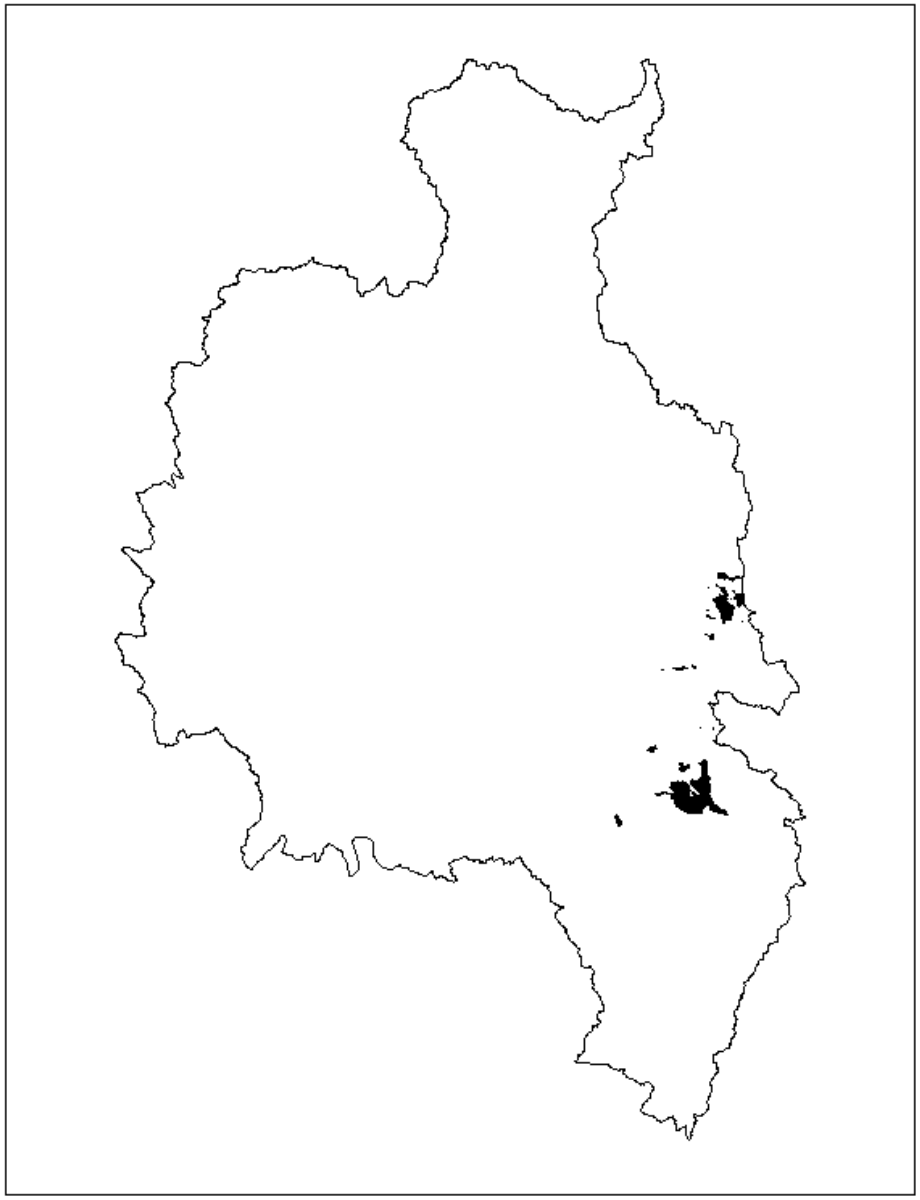


Rattlesnake Ash-Flow Tuff

- **Rattlesnake Ash-Flow Tuff (Late Miocene) –** Light-brown to red-brown to gray, nonwelded to densely welded, pumice-rich, rhyolite tuff; throughout t ranging from Streck and G source area Harney Basi the basis of facies distrib direction ind 7.05±0.01 M 1995) and 7. al., 2004).

Drinkwater Basalt

- **Drinkwater Basalt (late Miocene) –** Medium- to dark-gray, diktytaxitic basaltic rocks with locally abundant phenocrysts and glomerocrysts of plagioclase and olivine. Forms ridge-capping flows along the eastern margin of the basin near Crane and south and east of Diamond Craters. Commonly one, but locally several flows with a total thickness ranging from 20 to 200 feet. A $^{40}Ar/^{39}Ar$ age of 7.25±0.09Ma is reported for this unit (Millard, 2010).



Drinkwater Basalt

- **Drinkwater Basalt (late Miocene) –** Medium- to dark-gray, diktytaxitic basaltic r
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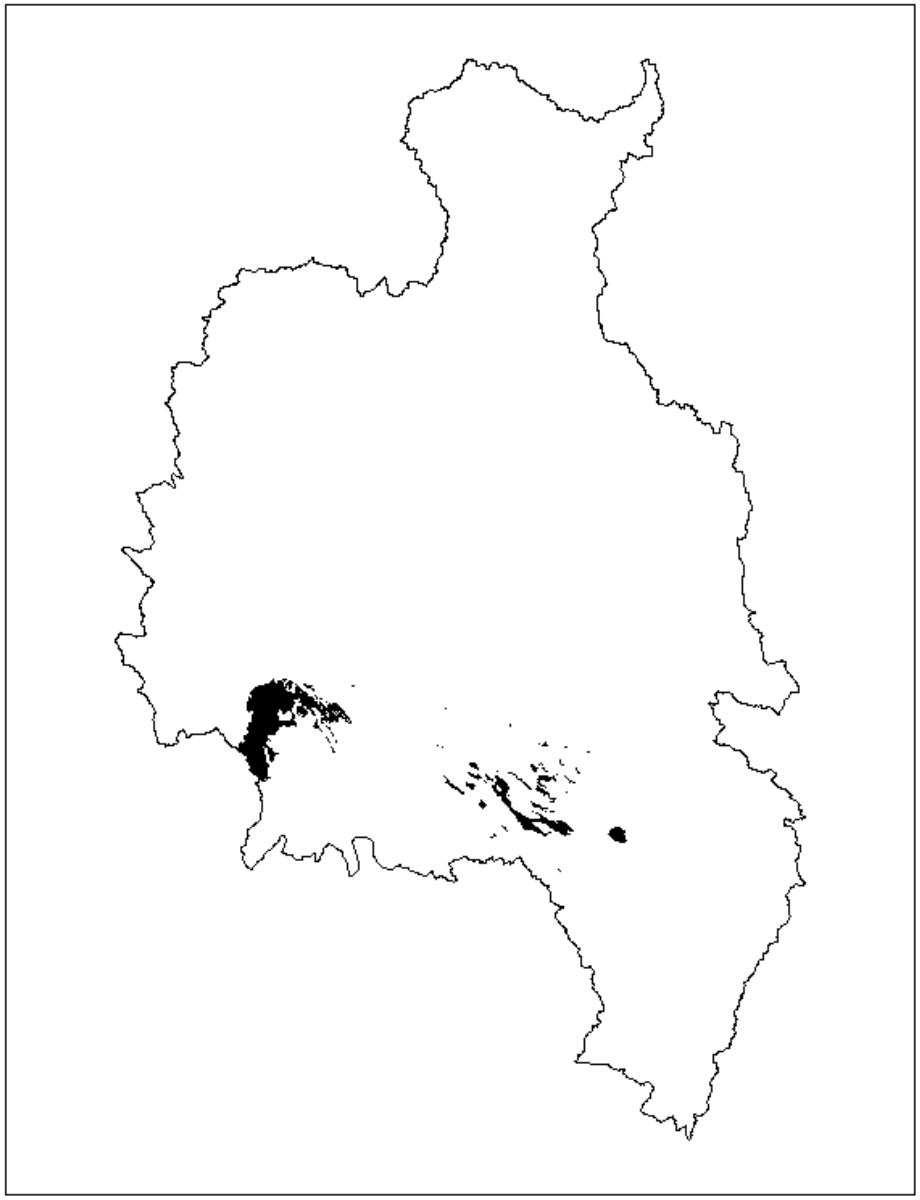
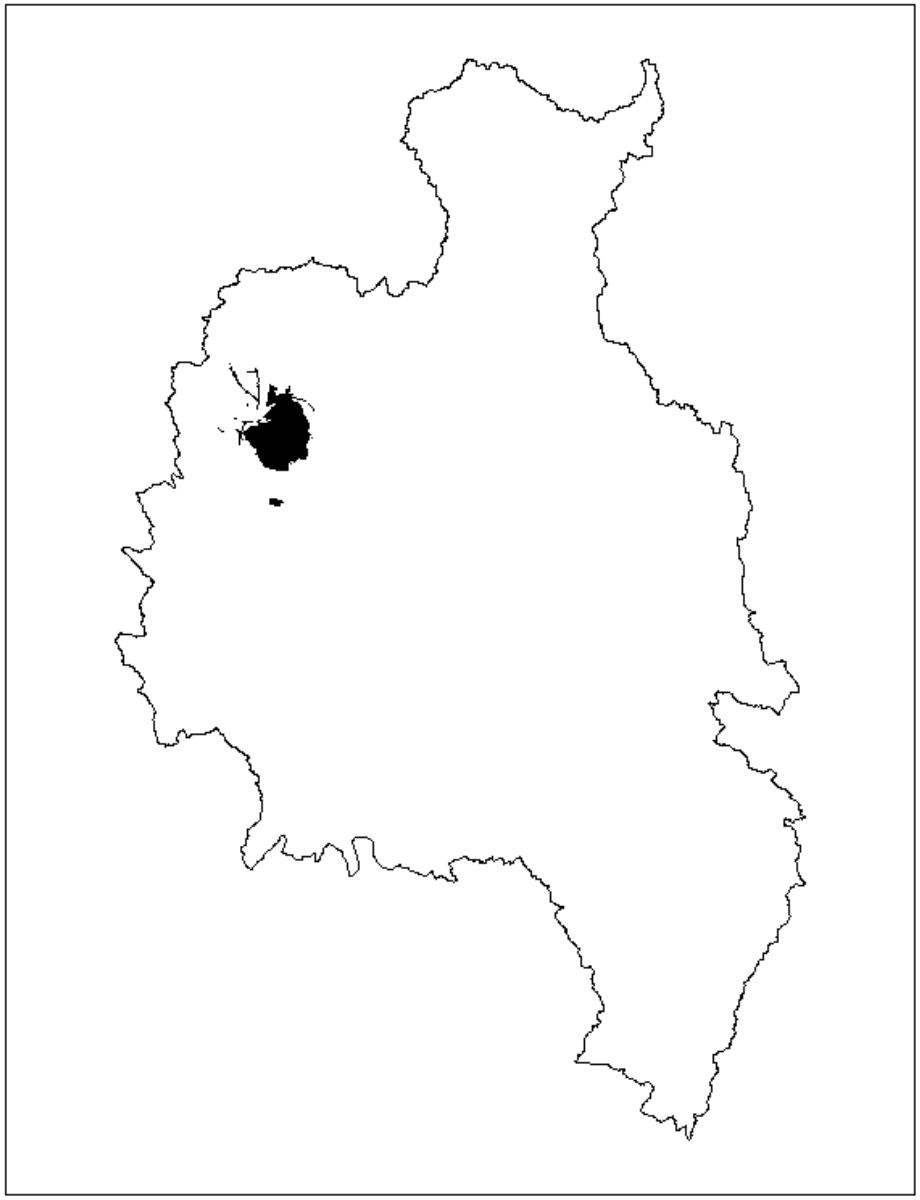
Basalt of Harney Lake

- **Basalt of Harney Lake (late Miocene) –** Black to dark-gray, olivine-bearing basaltic rocks with common yellowish devitrified glass and pillow structures. May intertongue locally with sedimentary rocks of unit Tts. Consists of several thin flows, each 10-20 feet thick and totaling about 150 feet. Underlies unit Trt and overlies unit Tdv south and west of Harney Lake. Included herein are Basalt of Hog Wallow (Johnson, 1994) and Basalt of Black Rim (Sherrod and Johnson, 1994) on the basis of stratigraphic position. Age assignment based on stratigraphic position and $^{40}Ar/^{39}Ar$ ages of 7.68±0.08 Ma and 7.54±0.13 Ma (Jordan et al., 2004).



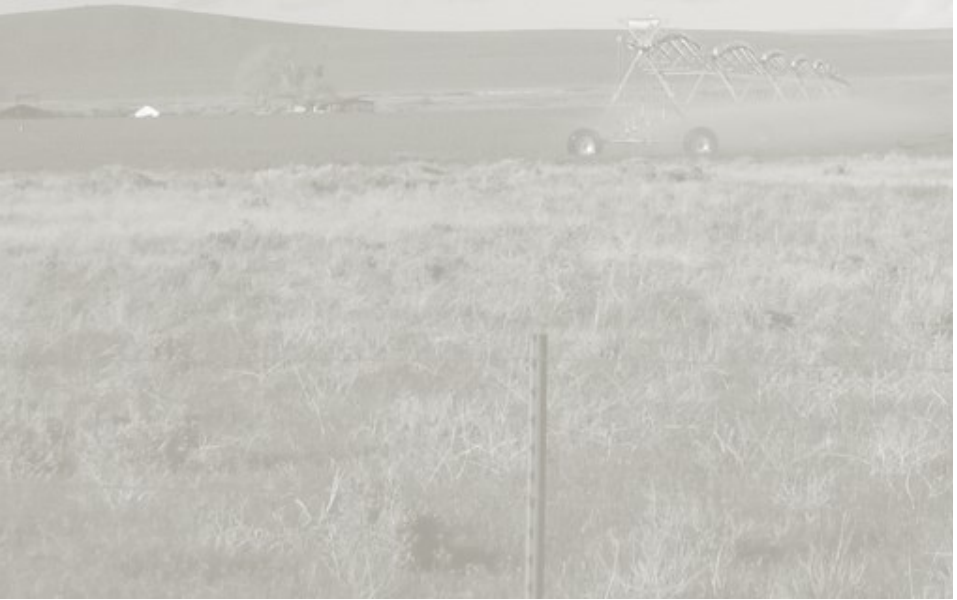
Basalt and andesite of Dry Mountain

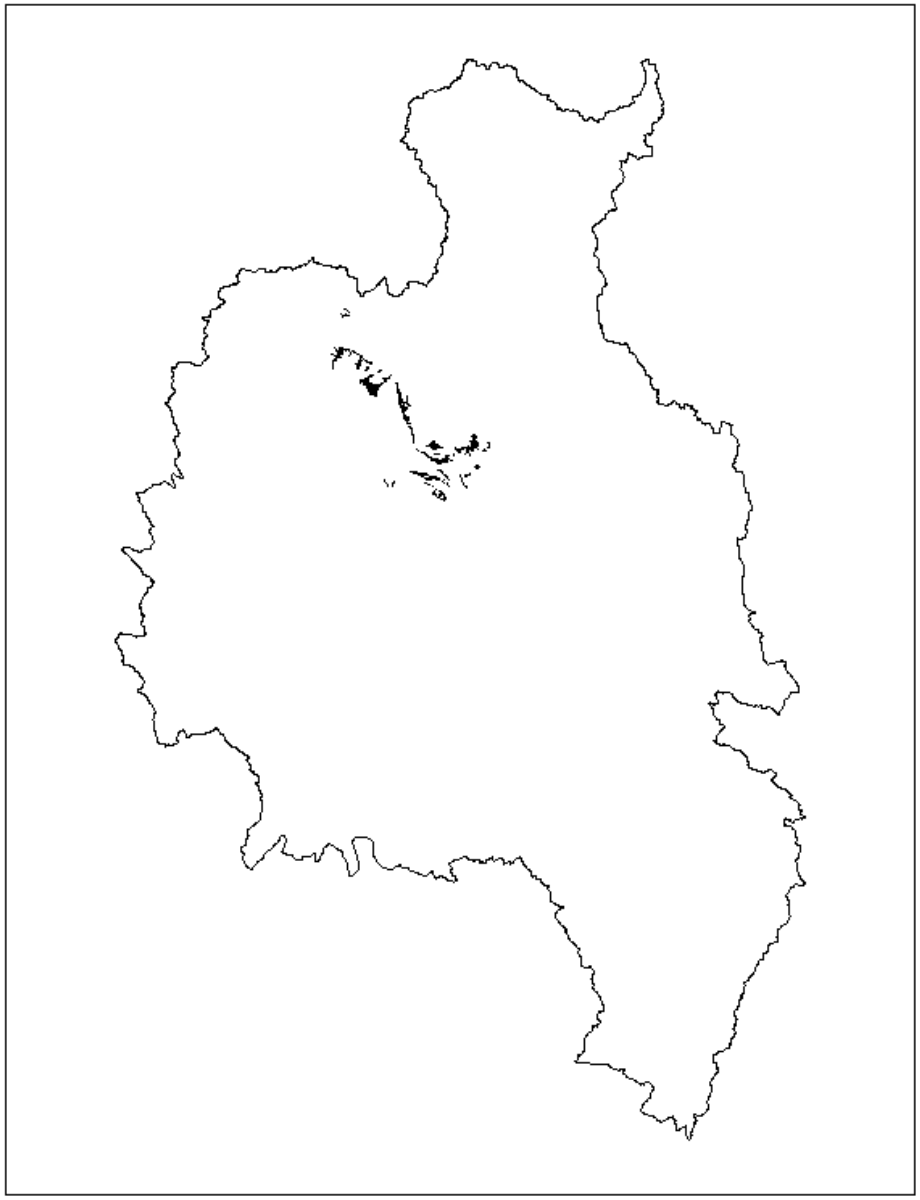
- **Basalt and andesite of Dry Mountain (late Miocene) –** Dark-gray, aphanitic to fine-grained andesite with rare olivine (Greene, 1972) and medium-gray, fine-grained high-alumina olivine tholeiite basalt with rare plagioclase and olivine, and sparse oval shaped vesicles (Iademarco, 2009). Numerous flows form a large shield volcano at Dry Mountain. A $^{40}Ar/^{39}Ar$ age of 7.91±0.12 Ma is reported by Iademarco (2009) and Streck and Grunder (2012).



Andesite

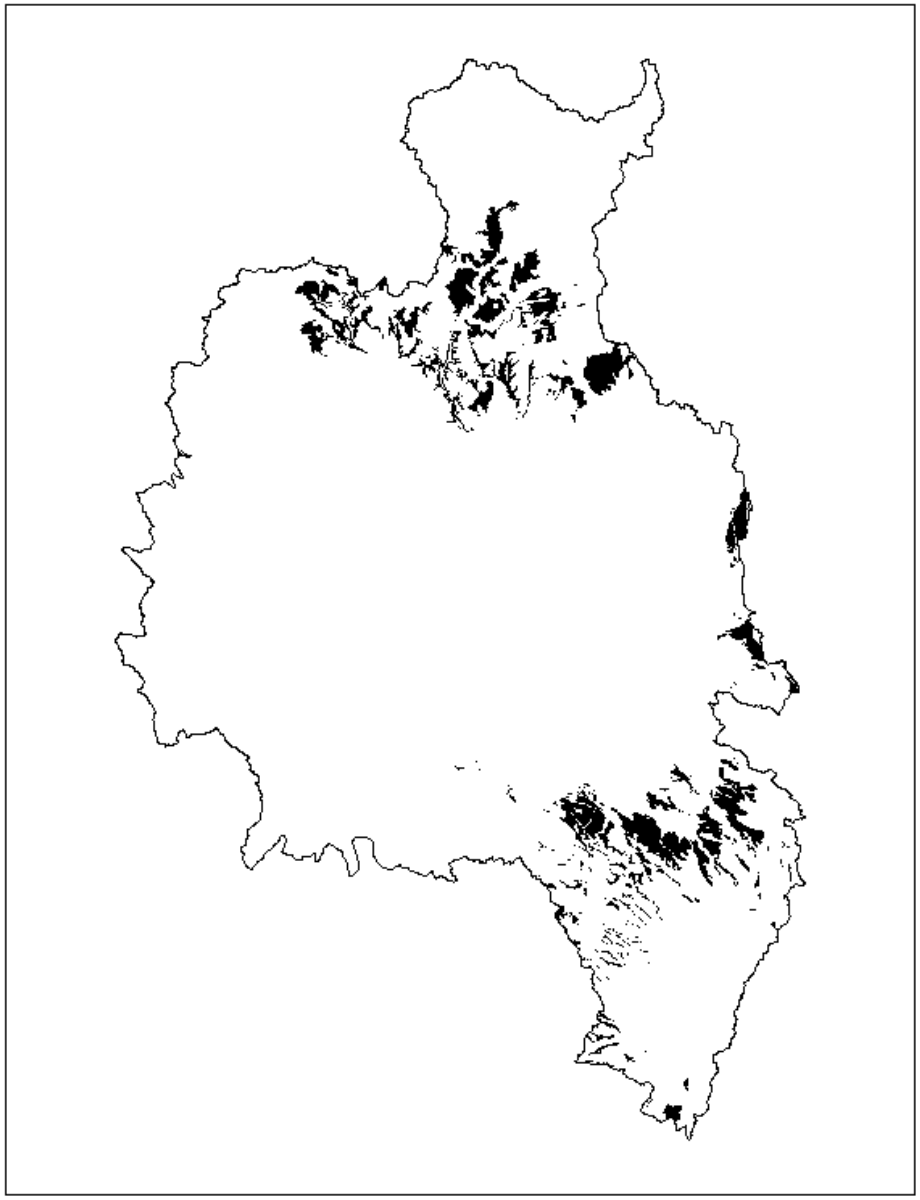
- **Andesite (late Miocene) –** Dark-gray brownish mottled aphyric andesite lava flows. Less than 1 percent phenocrysts of plagioclase and augite. Several thin flows with a total thickness of a few tens to 100 feet. Present between Little Emigrant Creek and Burns. Underlies unit Trt and locally overlies unit Tdv.





Devine Canyon Ash-flow Tuff

- **Devine Canyon Ash-flow Tuff (late Miocene) –** Light-gray to greenish-gray, nonwelded to densely welded, crystal-rich (up to 30%) rhyolite tuff; forms a single cooling unit throughout the map area ranging from a few feet to over 100 feet thick. Phenocrysts are mostly alkali feldspar and quartz with minor iron-rich pyroxene. Greene (1973) proposed a source area located in the Harney Valley southeast of Burns on the basis of thickness and crystal content. A $^{40}Ar/^{39}Ar$ age of 9.74±0.02 Ma (Jordan et al., 2004) is reported for the Devine Canyon Ash-flow Tuff.



Devine Canyon Ash-flow Tuff

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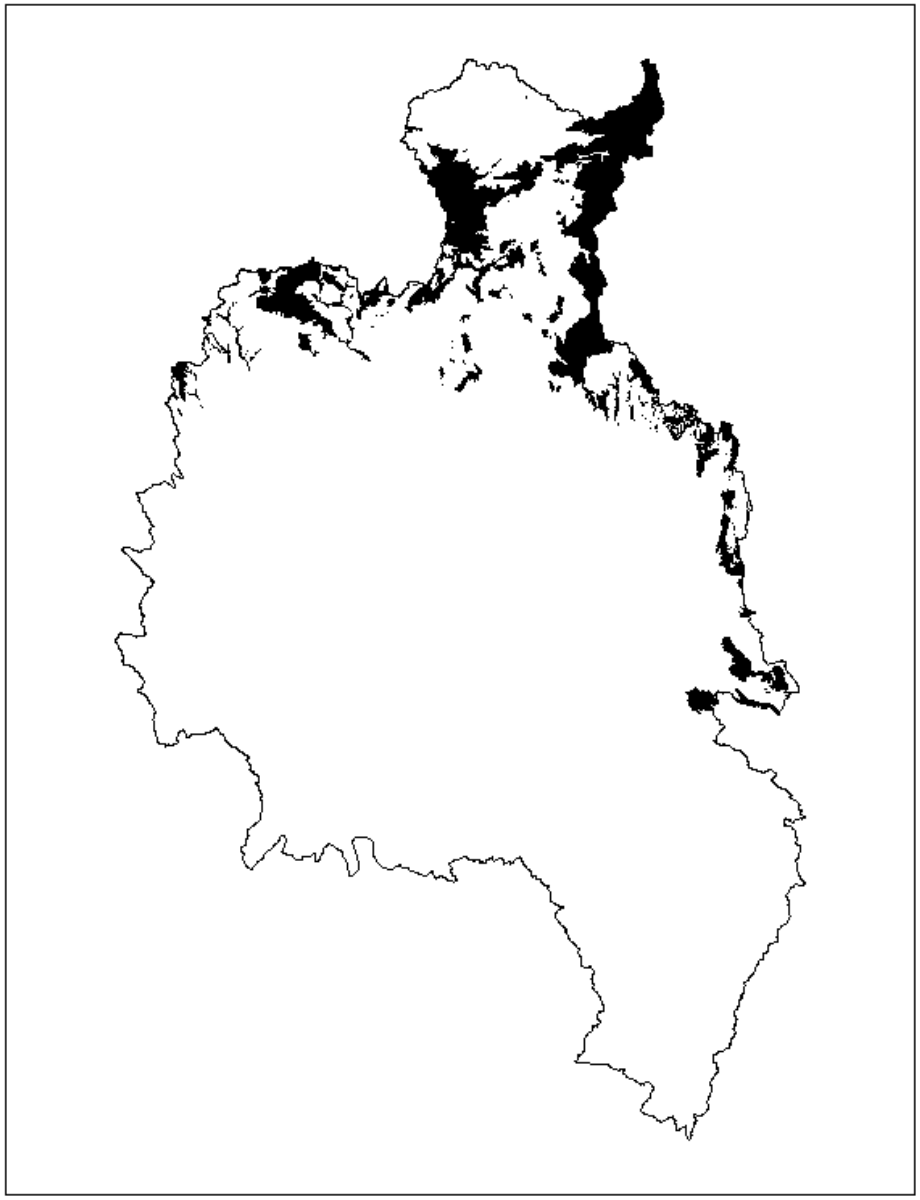
Older volcanic rocks

- **Older volcanic rocks (Miocene and late Oligocene) –** Volcanic rocks underlying unit Tdv in the northern and eastern parts of the basin. Predominantly basalt and andesite, this unit is lithologiclly diverse, including rhyolite lava flows and tuffs, rhyodacite and dacite lavas, and interbedded tuffaceous sedimentary deposits. In the northern uplands unit includes undifferentiated Columbia River Basalt Group lavas, Strawberry Volcanics, and Dinner Creek Tuff. Age assignment based on stratigraphic position and $^{40}Ar/^{39}Ar$ ages, including an andesite age of 24.75±0.15 Ma (Houston et al., 2018).

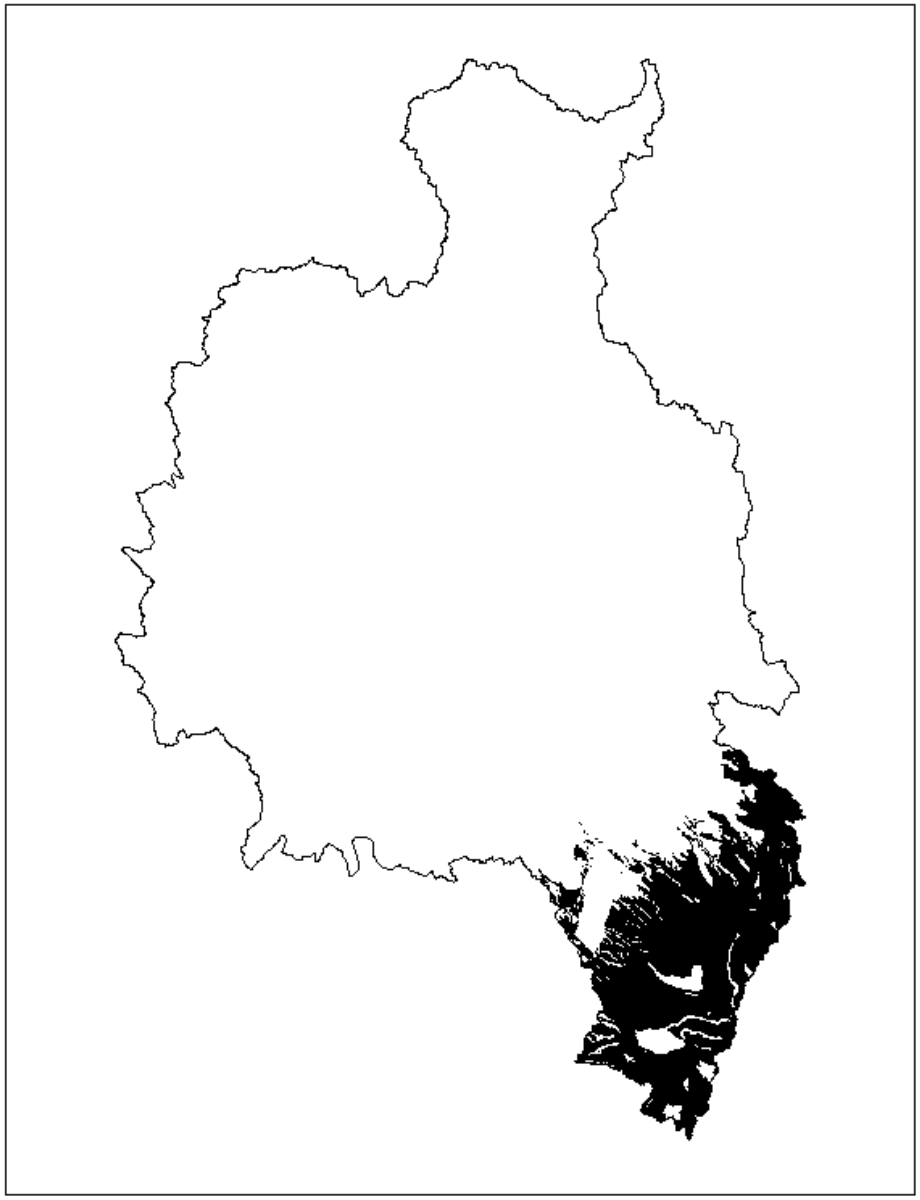


Older volcanic rocks

- **Older volcanic rocks (Miocene and late Oligocene) –** unit Tdv in th parts of the basalt and a lithologiclly lava flows ar dacite lavas, tuffaceous s northern up undifferentia Group lavas, Dinner Creel based on str $^{40}Ar/^{39}Ar$ age age of 24.75 2018).

Steens Basalt

- **Steens Basalt (Miocene) –** Dark- to medium-gray, vesicular to massive, aphanitic to coarsely plagioclase-phyric, intergranular to diktytaxitic olivine basalt. Commonly occurs as compound flows ranging in thickness from ~30 to 150 feet, although individual flow lobes rarely exceed 6 feet. A composite thickness of over 3,000 feet is exposed along the Steens Mountain escarpment. Unit was erupted from a low, elongate shield volcano centered near the Steens Mountain escarpment where numerous north- and northeast-striking dikes are exposed. Moore et al. (2018) reported a $^{40}Ar/^{39}Ar$ age of 16.97±0.06 Ma from the lowermost flow in a section on the Steens Mountain escarpment. The upper age limit of Steens Basalt volcanism was constrained at 16.6 Ma. by Camp et al. (2013).



Steens Basalt

- **Steens Basalt (Miocene) –** Dark- to medium-gray, vesicular to massive, aphanitic t
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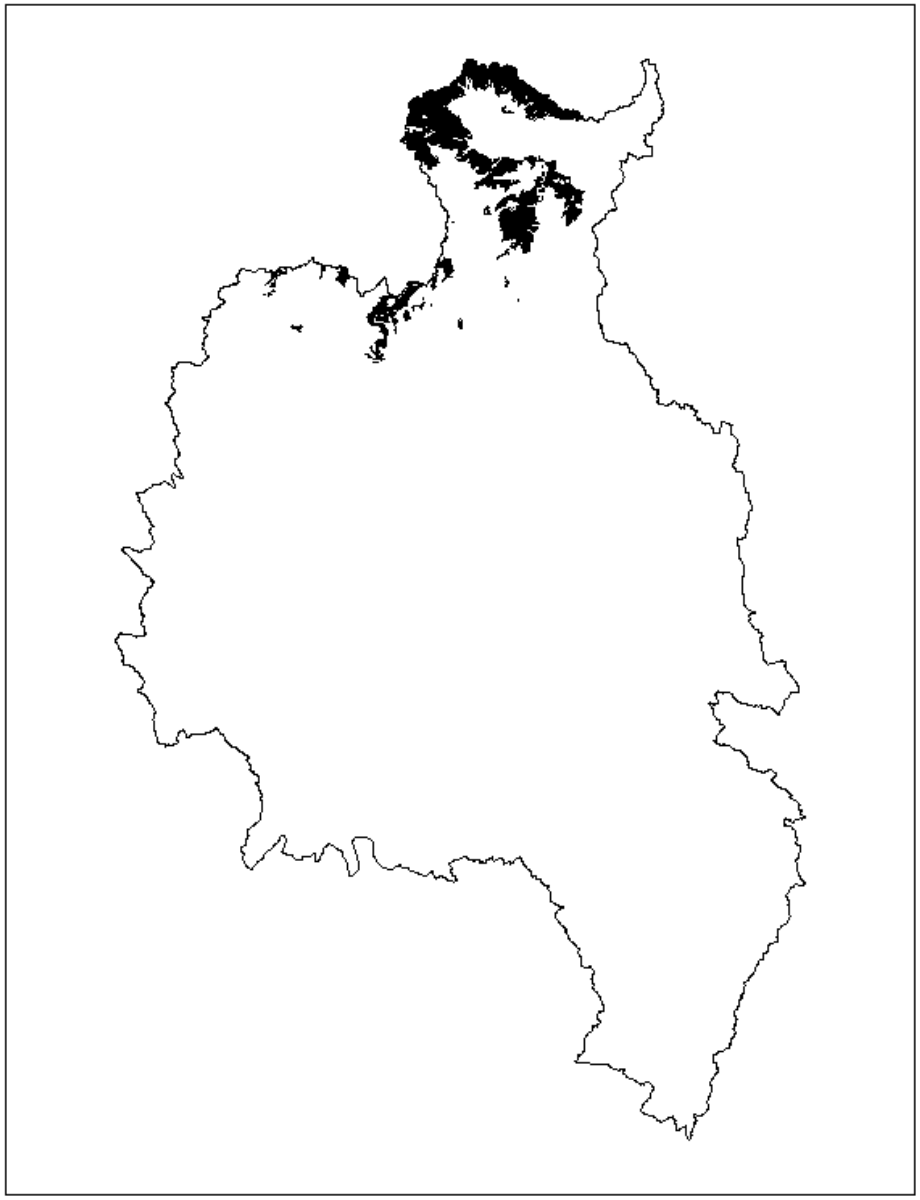
Mesozoic rocks

- **Mesozoic rocks (Late Jurassic to Late Triassic)** – Accreted Mesozoic rocks of the Izee Terrane. Includes interbedded volcanic and tuffaceous mudstone, siltstone, shale, graywacke, calcareous sandstone, conglomerate, limestone, tuff and minor andesite lavas of the Trowbridge and Lonesome Formations; Weberg, Warm Springs and Snowshoe Formations; Mowich Group; Keller Creek Shale; Murderers Creek Graywacke; and Laycock Graywacke. Also grouped with this unit are minor Eocene to Miocene intrusive rocks, and pre-Permian (?) serpentinite of limited extent associated with the Canyon Mountain Complex.



Mesozoic rocks

- **Mesozoic rocks (Late Jurassic to Late Trias**
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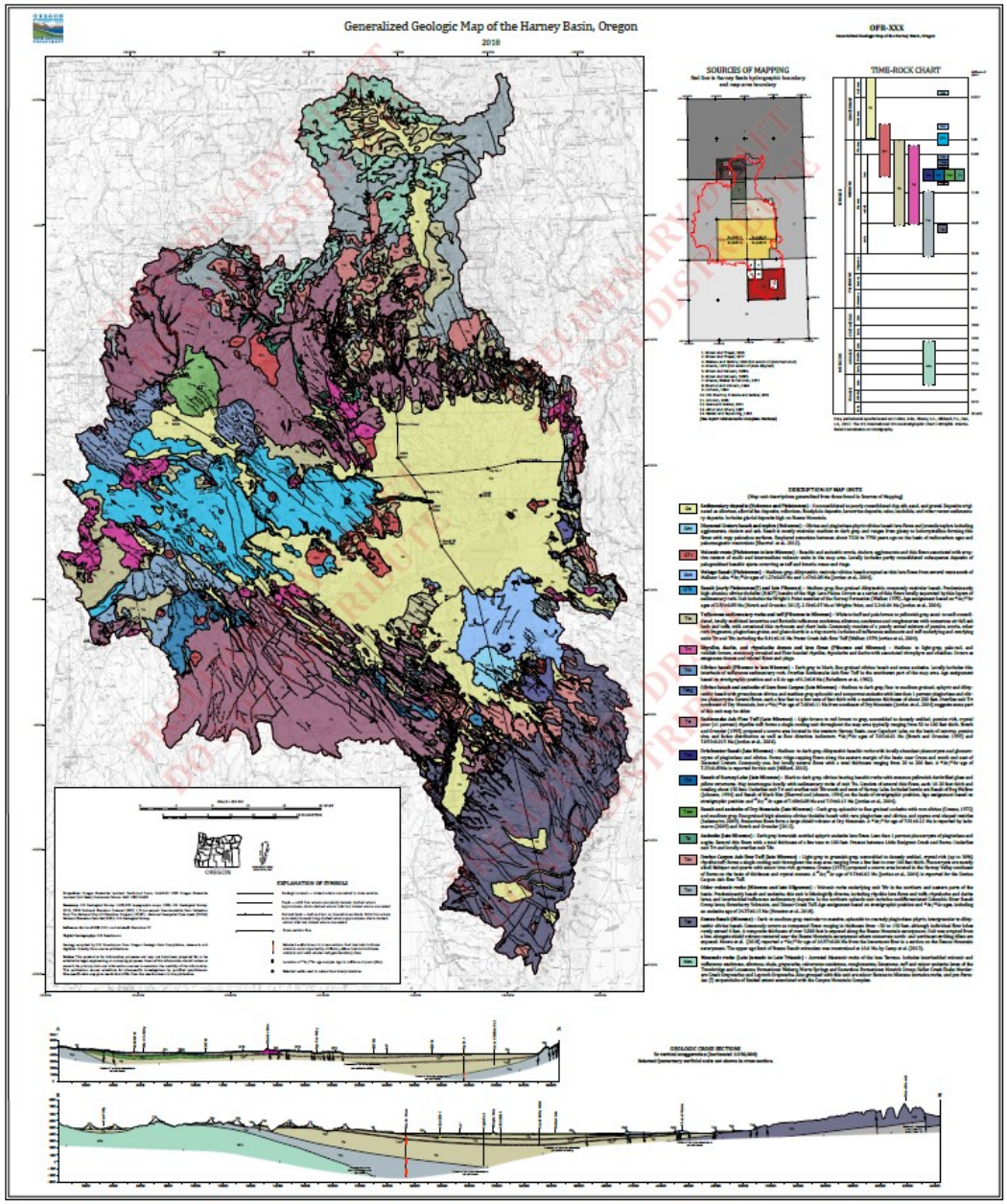
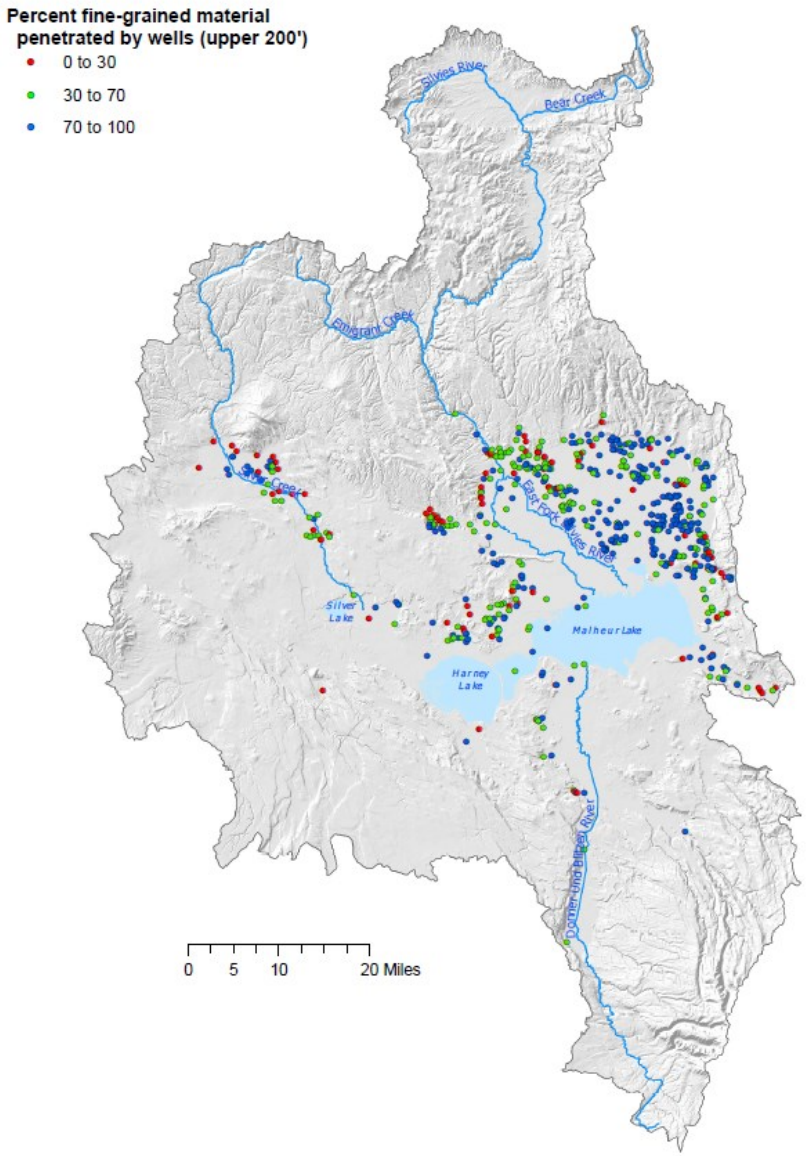
OWRD Open File Report

- Map plate and cross sections to be published as an OWRD Open File Report - 2019
- 1:250,000 scale
- Peer review ongoing (USGS; DOGAMI)
- Revisions ongoing
- Work to be presented at the 2019 GSA Cordilleran Section meeting May 2019
- Please take a look at the map and feel free to ask questions!

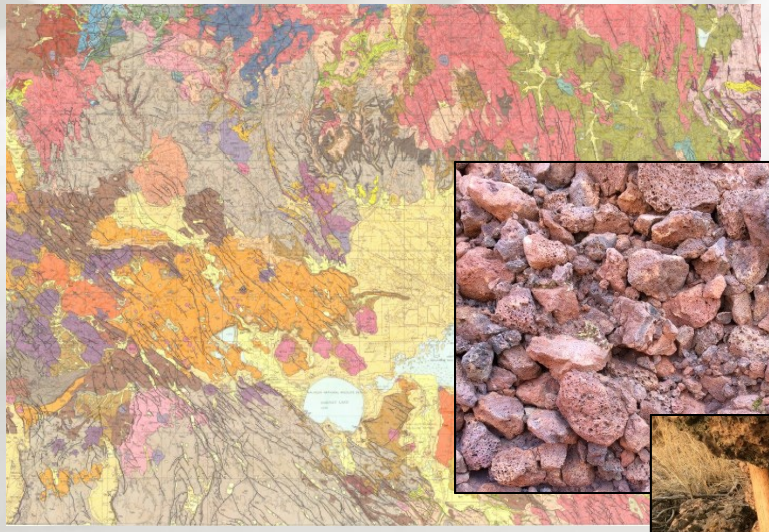


A note on the “Basin Fill”

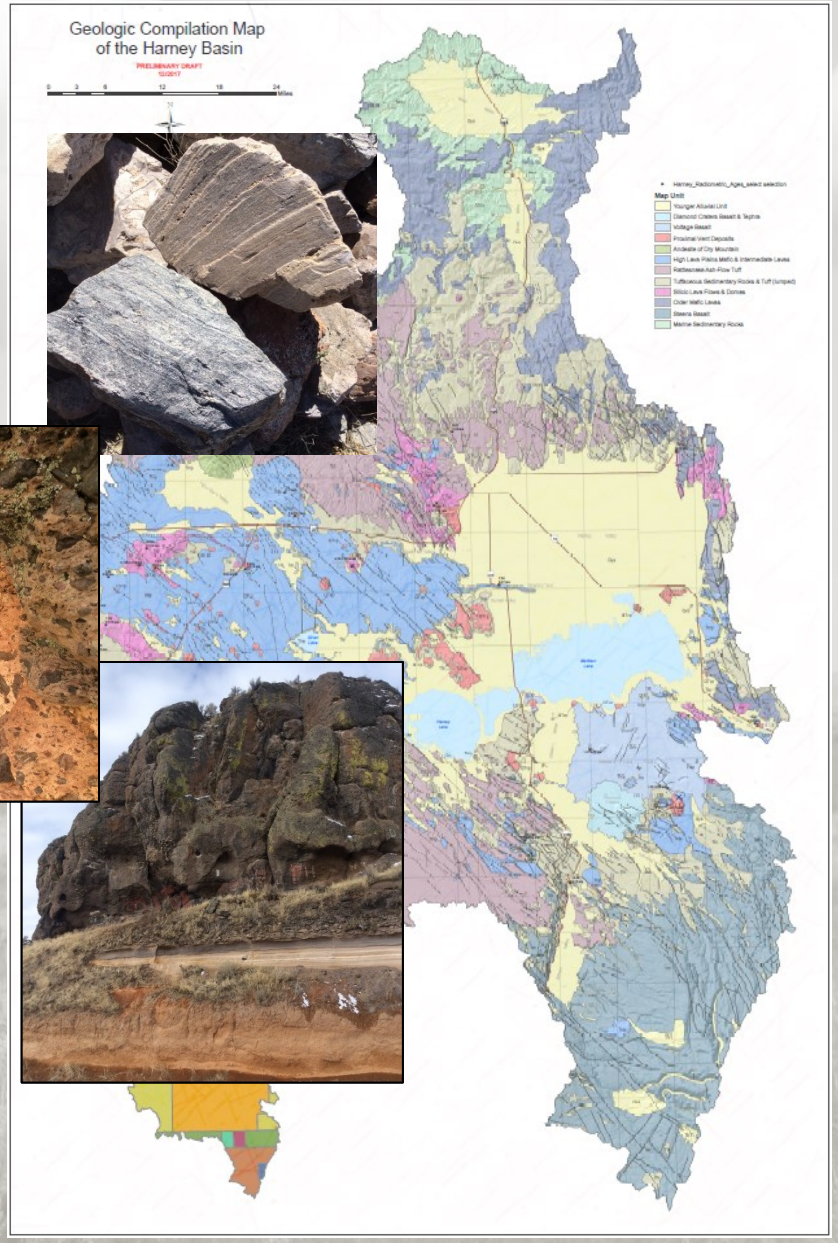
- Includes Quaternary and Tertiary basin fill deposits
- Basin fill deposits are highly heterogeneous laterally & vertically
  - Discontinuous lenses of gravel, sand, silt, clay
  - Locally includes tuffs, lavas & cinders
- Analyze ~2,500 well log formation descriptions. Upper 200 feet:
  - Coarser deposits near uplands
  - Finer towards the lakes
- Historic O&G well logs
  - Basin fill up to ~3,700+ feet deep



Thank You!



MAP SHOWING GEOLOGY AND GEOTHERMAL
RESOURCES OF THE SOUTHERN HALF OF THE
BURNS 15' QUADRANGLE, OREGON
1982


Geologic Compilation Map
of the Harney Basin
PRELIMINARY DRAFT