State of Oregon
Department of Geology and Mineral Industries
Vicki S. McConnell, State Geologist

OPEN-FILE REPORT
O-06-10

PRELIMINARY GEOLOGIC MAP OF THE THORN HOLLOW 7.5′ QUADRANGLE, UMATILLA COUNTY, OREGON

By

Mark L. Ferns
Oregon Department of Geology and Mineral Industries

2006

This publication is a U.S. Geological Survey STATEMAP 2003 deliverable.

Oregon Department of Geology and Mineral Industries Open File Report
Published in conformance with ORS 516.030

For copies of this publication or other information about Oregon’s geology and natural resources, contact:

Nature of the Northwest Information Center
800 NE Oregon Street #5
Portland, Oregon 97232
(503) 872-2750
http://www.naturenw.org

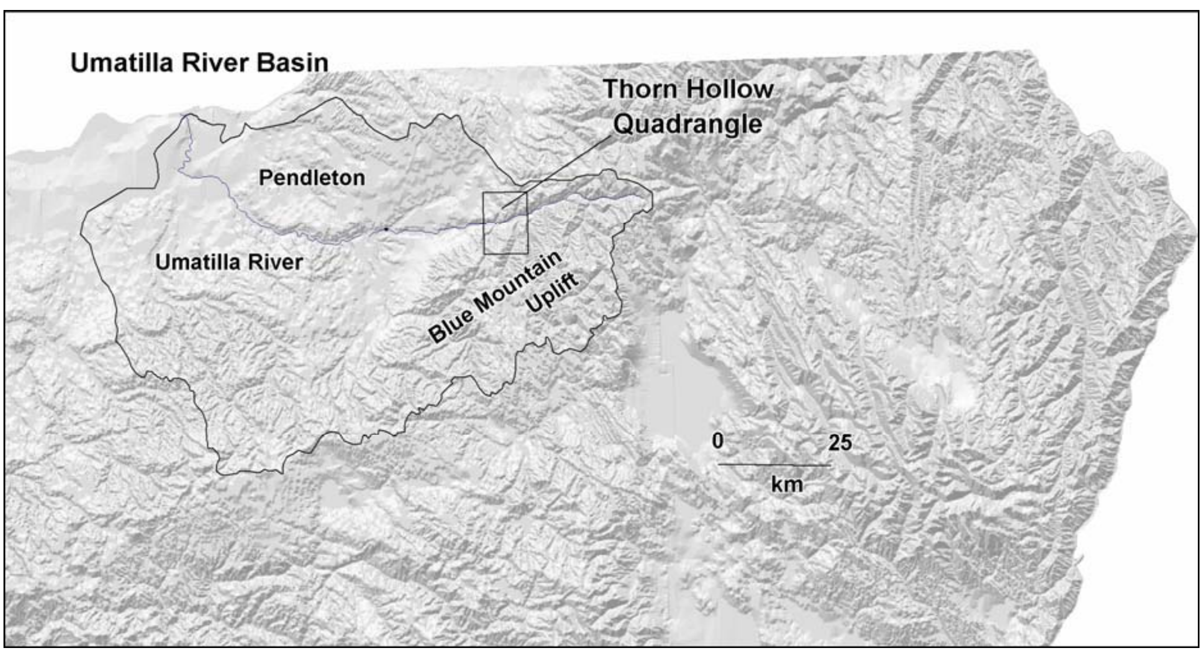
PRELIMINARY GEOLOGIC MAP OF THE THORN HOLLOW QUADRANGLE

By Mark L. Ferns, Oregon Department of Geology and Mineral Industries.

INTRODUCTION

The Thorn Hollow 7 ½' quadrangle is located along the northwest flank of the Blue Mountains Province of northeastern Oregon, and is centered on the Umatilla River, some 15 miles east of Pendleton, Oregon. Most of the Thorn Hollow quadrangle lies within the Confederated Tribes of the Umatilla Indian Reservation. Dry land wheat and cattle are the main agricultural products. Timbered lands occur in the highlands to the south. Primary geologic resource is groundwater, the long term sustainability of which is presently unknown.

The Thorn Hollow quadrangle is underlain by an unknown thickness of Miocene flood basalts (Columbia River Basalt Group). Some individual flow packages in the exposed, upper part of the Columbia River Basalt Group have enough exposure and sufficiently distinctive geochemical signatures to constitute mappable units. Lower units exposed in deep tributary canyons to the Umatilla River do not appear to be distinctive enough to map with certainty.



Methodology and Previous Work

The 1:24,000 scale geologic map of the Thorn Hollow quadrangle was partially funded by the U.S. Geological Survey's National Cooperative Geologic Mapping Program under assistance award #03HQAG0070. The map is released as an interim map product as part of a larger mapping project covering the Umatilla River basin (Figure 1). Geologic data were collected at the 1:24,000 scale combining new mapping with published and unpublished data from air photos, orthophotoquads, and digital shaded relief images derived from USGS 30 m DEM (Digital Elevation Model) grids. Mapping was supplemented with x-ray fluourescence (XRF) geochemical analyses. Subsurface geology in cross sections is based on analyses of water-well drill records.

Geologic studies in the Thorn Hollow quadrangle first began in the1960's when Hogenson (1964) released a report on the geology and groundwater of the Umatilla River basin. Reconnaissance mapping in the late 1970's by the U.S. Geological Survey, resulting in the 1:250,000 scale map of the Pendleton quadrangle (Walker, 1973). Columbia River Basalt Group units were later mapped in detail by Swanson and others, 1980; who also collected a considerable amount of geochemical data (Wright and others, 1979; 1980; 1982). Long strike length, small displacement faults at Saddle Hollow and Thorn Hollow were first described by Kienle and others (1979).

PRELIMINARY DESCRIPTION OF GEOLOGIC UNITS – THORN HOLLOW QUADRANGLE

Surficial Deposits

Qa Stream alluvium (Holocene and late Pleistocene) Gravel, sand, and silt deposited in active stream channels and on adjoining flood plains. Includes gravel and channel sand deposited in active or recently channels and overbank silt and mud deposited along the modern flood plain. North of the Umatilla River, includes loess and ash deposited along Spring Creek and its tributaries.

Qts Terrace deposits. (Pleistocene) Unconsolidated to weakly consolidated, brown to orangish brown deposits of coarse boulder gravel and pebbly sand. Unit forms benches along the Umatilla River and is comprised of rounded clasts of volcanic rocks. Generally no more than 10 m thick.

TERTIARY VOLCANIC AND SEDIMENTARY UNITS

Tms **Sedimentary rocks (late Miocene)** Unconsolidated to poorly consolidated deposits of clay, silt, and sand. Includes volcanic-clast pebble gravels that are exposed only in road cuts and bar ditches. Unit is mapped largely on the basis of rounded land forms. Mostly fine-grained silt and clay, weathering to form deep silty soils. Although previously interpreted as loess deposits (), herein interpreted as wind-reworked, fine grained alluvial plain and lacustrine deposits. On basis of stratigraphic position, correlative to the McKay Formation.

COLUMBIA RIVER BASALT GROUP

Three major Columbia River Basalt Group units are exposed in the Thorn Hollow quadrangle. Flows in the quadrangle include the basal Umatilla member of the Saddle Mountain Basalt; the Frenchman Springs member of the Wanapum Basalt, and four mappable units in the upper part of the Grande Ronde Basalt.

SADDLE MOUNTAIN BASALT

Tcsu Umatilla member (middle Miocene) Fine-grained, dark bluish gray aphyric lava flow exposed only in the northeast part of the quadrangle where it forms poor subcrops. Deeply weathered to shades of gray and brownish gray. Elsewhere, where the Umatilla flow typically overlies tuffaceous sediments, generally weathers to form 0.5 m orange-stained blocks. On fresh surfaces, grayish to bluish black and fine grained. In thin section, holocrystalline with scattered microphenocrysts of plagioclase, clinopyroxene, and olivine set in a fine-grained intergranular groundmass. Displays normal remanent magnetic polarity. The Umatilla member has a distinctive chemical composition that makes it an easily recognized and important stratigraphic marker. The basalt of Umatilla ranges in composition from an iron-rich trachyandesite to an iron-rich basaltic trachyandesite marked by high potassium (>2.5 wt percent K_2O) phosphorous (> 1 wt percent P_2O_5) and exceptionally high barium (>3,000 ppm Ba). Ferns and others (2004) report a $^{36}Ar/^{40}Ar$ – $^{39}Ar/^{40}$ Ar isochron age of 13.64 $\pm$ 0.17 ma for the Umatilla member

WANAPUM BASALT Multiple flow-on-flow lava flows. The Frenchman Springs basalt(Swanson and others, 1981; Hooper and Swanson,1990) is the only member of the Wanapum Basalt that has been identified in the Thorn Hollow quadrangle.

The Dodge and Lookingglass members, which crop out below the Frenchman Springs member in areas to the east, have been identified from water well drill cuttings from adjoining quadrangles to the west.

Tcwf **Frenchman Springs basalt (middle Miocene)** Flow-on-flow sequence of black to grayish-black, generally medium- to coarse-grained, iron-rich basalt and basaltic andesite flows. Flows weather to shades of brownish gray, brown, and bright orangish-brown. Fresh samples are generally dark grayish black in color and marked by distinct crystal faces. Generally microphorphyritic or porphyritic, with distinct plagioclase phenocrysts. Porphyritic flows contain sparse, pale yellow, blocky plagioclase phenocrysts as much as 1 cm in length. Individual eruptions apparently produced chemically discrete flows that form packages as much as 40 m thick wherein stacked flow lobes are separated by thin vesiculated flow tops and basal flow breccias. Cores to individual lobes pinch and swell laterally, forming discontinuous outcrops. Coarser-grained flows commonly weather to form grussy slopes marked by spheroidal-weathering core stones. Distinguished on basis of geochemistry from other Columbia River Basalt Group units by high titanium (~3.00 wt percent TiO_2). Based on slight differences in TiO_2, MgO, P_2O_5, unit includes at least 3 separate flows. Includes flows correlative to the Sand Hollow and Sentinel Gap units of McConnell (in prep). Where exposed on Kanine Ridge and near Rattlesnake Canyon, on the north side of the Umatilla River west of Saddle Hollow, unit is marked by thin basal flows that belong to the Sand Hollow unit, with 0.51 - 0.65 wt percent P_2O_5 and 3.057 - 3.113 wt percent TiO_2. Overlying flows in both localities are comparatively richer in phosphorus (0.69 – 0.72 wt percent P2O5) and poorer in titanium (2.937 – 2.965 wt percent TiO2). High titanium (3.13 wt percent TiO_2) low phosphorus (0.60 wt percent P_2O_5) flows belonging to the Sentinel Gap unit overlie the high phosphorus flows west of Thorn Hollow where the Frenchman Springs member is over 200 m thick. Unit thins to the south and east.

GRANDE RONDE BASALT

Flow-on-flow sequence of bluish-black aphyric to sparsely plagioclase phyric lava flows. Includes both medium grained crystalline and fine-grained glassy lava flows. Two uppermost flow packages mapped separately on basis of geochemistry and petrology. Underlying flows separated into 2 magnetostratigraphic units on basis of magnetic polarity as measured in the field by a fluxgate magnetometer.

Tcgs Sentinel Bluffs unit (middle Miocene) Flow-on-flow sequence of dark grayish black, iron-rich basaltic andesite lava flows. Unit is made up of thin flows and flow lobes, generally < 5m thick, that are marked by vesicular flow tops and basal flow breccias. Weathered surfaces are shades of brownish gray and reddish brown. Central parts of individual flows form laterally discontinuous outcrops. Thickest flows, which are as much as 20 m thick, are platy jointed. Coarser grained flows commonly form reddish- and yellowish-brown punky subcrop from which spheroidal-weathering corestones erode. Based on strong geochemical similarities, unit is made up of chemically discrete lava flows that form individual flow packages as much as 30 m thick wherein overlapping flow lobes are separated by vesiculated flow tops and basal flow breccias. Generally holocrystalline. Brownish gray, weathered surfaces to coarse grained flows sometimes display diktytaxitic textures defined by a groundmass of randomly oriented, lathe-shaped plagioclase crystals. Flows generally contain olivine microphenocrysts. Unit thickens to the northeast, where as much as 140 m of Sentinel Bluff flows are exposed along the Umatilla River. In places, separated from overlying Frenchman Springs flows by a thin red soil zone. Readily distinguished from overlying Frenchman Springs flows on the basis of geochemistry, notably low titanium (<2.0 wt percent TiO2) and phosphorous (<0.35 wt percent P2O5). Distinguished from underlying Winter Water unit by high magnesium contents (> 4.35 wt % MgO). Equivalent to the Sentinel Bluffs unit of Reidel and others (1989) and the high MgO flows Wright and others (1973) at the top of the Grande Ronde Basalt N2 magnetostratigraphic unit.

Tcgw Winter Water unit (middle Miocene) Hackly jointed, fine-grained iron-rich basaltic andesite and andesite lava flows. Unit is made up of one or more flows that have coalesced to form thick, hackly jointed cooling units as much as 50 m thick. Typically forms ridge crests marked by gray and grayish-brown, angular blocks 10 cm in diameter. The angular, equidimensional blocks weather from a thick entabulature that forms a marker horizon that can be traced laterally across canyons. Aphyric to sparsely plagioclase phyric and often glassy. In the Thorn Hollow quadrangle, easily distinguished from overlying Sentinel Bluffs unit by lower magnesium (< 3.5 wt percent MgO) and higher potassium (> 1.7 wt percent K2O). In the southern part of the quadrangle, thick hackly jointed, glassy flows are locally separated by thin holocrystalline flows with markedly higher magnesium (3.77 wt percent MgO) content. Unit is between 70 and 80 m thick throughout the quadrangle. Correlative with the Winter Water unit of Reidel and others (1987).

$Tcgn_2$ N_2 magnetostratigraphic unit (middle Miocene) Flow-on-flow sequence of fine-grained, generally holocrystalline lava flows. In the Thorn Hollow quadrangle, includes all normally polarized lava flows below the Winter Water unit. Includes iron-rich basaltic andesite and andesite lava flows and flow breccias. Individual flows are sometimes marked by red weathering basal flow breccias. Outcrops are discontinuous and individual flow lobes or cooling units cannot be traced laterally across canyons with any certainty. Based on geochemistry, includes at least 3 different chemical types, including high magnesium flows (> 4.25 wt percent MgO); high titanium – low magnesium flows (> 2.25 wt percent TiO2 and < 3.5 wt percent MgO); and low titanium – low magnesium flows (< 2.0 wt percent TiO2 and < 3.7 wt percent MgO). The flows that crop out below the Winter Water unit are typically high magnesium flows and locally include a medium grained diktytaxitic flow which has a very high magnesium content (> 5.5 wt percent MgO). Considerable variation in thickness is apparent. Unit is as much as 130 m thick in the southeast part of the quadrangle where the base is marked by high titanium – low magnesium flows and thins to the west and north, to about 90 m, where the base is marked by low titanium – low magnesium flows. Age of the N_2 unit lies between 15.5 and 15.7 +/- 0.3 Ma (Baksi, 1989).

$Tcgr_2$ R_2 magnetostratigraphic unit (middle Miocene) Flow-on-flow sequence of aphyric to sparsely plagioclase-phyric lava flows. Includes iron-rich basaltic andesite and andesite lava flows and flow breccias. Red weathering basal flow breccias are common. Individual cooling units appear to be discontinuous and cannot be traced laterally in outcrop with certainty. Top of the unit on Buckaroo Creek is marked by a 15 m thick, red-weathering flow that crops out to form cliffs. Includes at least 3 geochemically distinctive flow types; high titanium – low magnesium flows (> 2.3 wt percent TiO2 and < 3.7 wt percent MgO); low titanium – high magnesium flows (<2.0 wt percent TiO2 and > 4.2 wt percent MgO, and low titanium – low magnesium flows

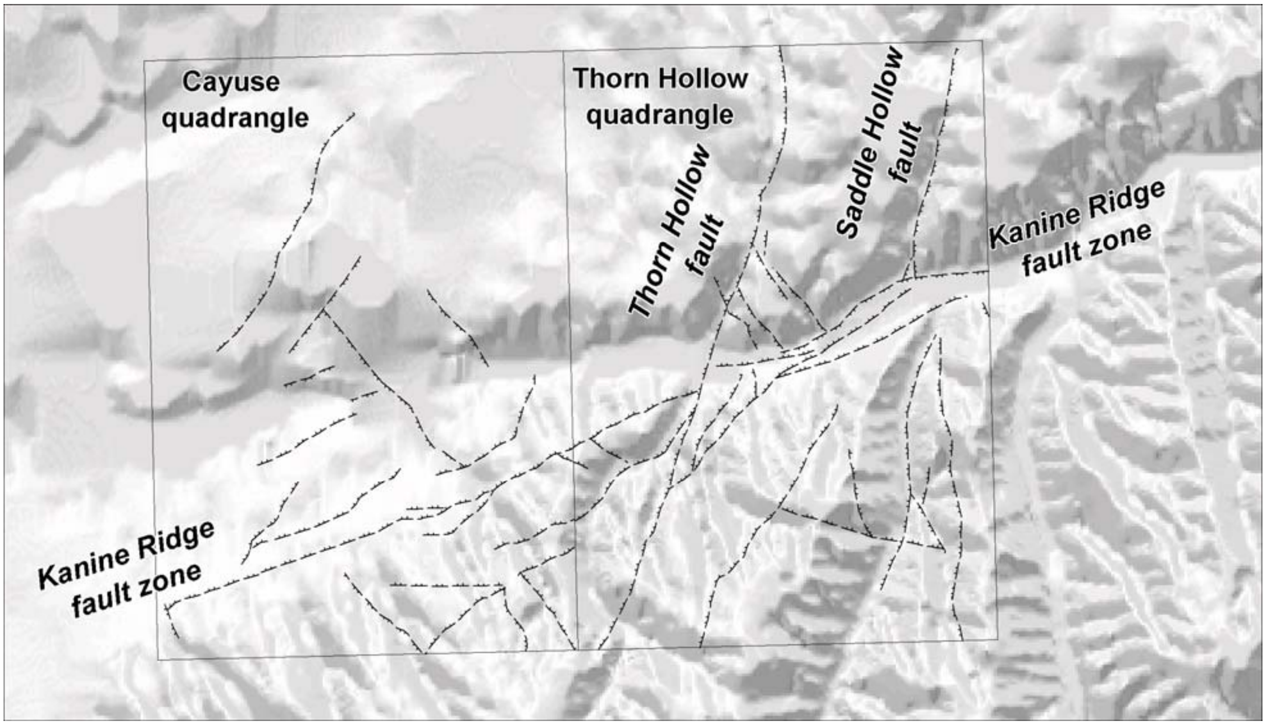
(< 2.2 wt percent TiO2 and < 3.8 wt percent MgO). Stratigraphy is complex, with low titanium – high magnesium flows cropping out between high titanium – low magnesium flows. The high titanium flows appear to be equivalent to the Wapshilla Ridge chemical type flows as defined by Reidel and others (1989). Base of the unit is not exposed in the Thorn Hollow quadrangle. In adjoining quadrangles to the south and east, the R2 magnetostratigraphic unit ranges between 150 and 250 m thick. Thickens to the north, where Kuehn (1995) reports a thickness of at least 530 m. Age of the R_2 unit lies between 15.7 +/- 0.3 and 15.9 +/- 0.2 Ma (Baksi, 1989).

STRUCTURE

Flow packages in the Thorn Hollow quadrangle show a pronounced, northwest tilt Apparent dips, marked by interflow contacts, steepen to the northwest, into a compex flexure zone, referred to as the Kanine Ridge fault zone, which is defined by northeast-trending, high angle normal and reverse faults. Flow package dips to the south of the Kanine Ridge fault zone are steeper than tributary stream gradients. The Kanine Ridge fault zone parallels to the Umatilla River and can be traced westward into the adjacent Cayuse quadrangle, where it is coalesces into a moderate displacement, high angle reverse fault.

Two prominent, northeast-trending topographic linears, the Saddle Hollow and Thorn Hollow faults of Kienle and others (1979), appear to cut across the Kanine Ridge fault zone. Although both linears coincide with small displacement vertical faults, major sense of displacement along both in the Thorn Hollow quadrangle appears to be right lateral, as first noted by Kienle and others (1979). Sense of vertical displacement along the westernmost, more persistent Thorn Hollow fault appears to be down to the west while the apparent sense of vertical displacement along the Saddle Hollow fault is down-to-the-east. A north verging drag fold along the west side of the Saddle Hollow supports Kienle and others (1979) interpretation of a right lateral fault.

Relative timing of structural development is conjectural. Northward thickening of younging flow packages away from the Kanine Ridge fault zone may indicate that the Kanine Ridge fault zone was an active flexure during the middle Miocene. Similar active northeast trending flexures have been described along the Limekiln fault further to the east (Hooper and Swanson, 1990). The Saddle Hollow and Thorn Hollow faults do not appear to have been active until all of the CRB flow packages had been erupted.


Cayuse
quadrangle
Thorn Hollow
quadrangle
Thorn Hollow
fault
Saddle Hollow
fault
Kanine Ridge
fault zone
Kanine Ridge
fault zone

REFERENCES

Baksi, A.K., 1989, Reevaluation of the timing and duration of extrusion of the Imnaha, Picture gorge, and Grande Ronde Basalts, Columbia River Basalt Group, *in* Reidel, S.P. and Hooper, P. R., Volcanism and tectonism in the Columbia River Flood-Basalt Province: Geological Society of America Special Paper 239, p. 105-111

Fiebelkorn, R.B., Walker, G.W., MacLeod, N.S., McKee, E.H., and Smith, J.G., 1983, Index to K-Ar determinations for the State of Oregon: Isochron/West, no. 37, p. 3-60.

Gonthier, J.B., and Bolke, E.L., 1993, Summary appraisal of water resources of the Umatilla Indian Reservation: U.S. Geological Survey Water Resources Investigation Report WRI 91-4087, 54 p.

Gonthier, J.B., and Harris, D.D., 1977, Water resources of the Umatilla Indian Reservation, Oregon: U.S. Geological Survey Water Resources Investigation Report WRI 77-3, 111 p.

Hogenson, G.M., 1964, Geology and ground water of the Umatilla River basin, Oregon: U.S. Geological Survey Water Supply Paper 1620, 162 p.

Hooper., P.R., and Swanson, D.A., 1990, The Columbia River Basalt Group of the Blue Mountains Province, *in* Walker, G.W., ed., Geology of the Blue Mountains region of Oregon, Idaho, and Washington: Cenozoic Geology: U.S. Geological Survey Professional Paper 1437, p. 63-99.

Hooper, P.R., Johnson, D.M., and Conrey, R.M., 1993, Major- and trace-element analyses of rocks and minerals by automated X-ray spectrometry: Washington State University Geology Department Open-File Report, 36 p.

Kienle, C.F..Jr., Hamill, M.L., and Clayton, D.N., 1979, Geological Reconnaissance of the Wallula Gap Washington - Blue Mountains - La Grande, Oregon region: Unpublished report prepared for the Washington Public Power Supply System by Shannon and Wilson Inc., contract o. 44013, C.O. No 38, 58 p.

Reidel, S.P., Tolan, T.L, Hooper, P.R., Beeson, M.H., Fecht, K.R., Bentley, R.D., and Anderson, J.L., 1989, The Grande Ronde Basalt, Columbia River Basalt Group; Stratigraphic descriptions and correlations in Washington, Oregon, and Idaho, *in* Reidel, S.P. and Hooper, P. R., Volcanism and tectonism in the Columbia River Flood-Basalt Province: Geological Society of America Special Paper 239, p. 21-53.

Swanson, D.A., Anderson, J.L., Camp, V.E., Hooper, P.R., Taubeneck, W.H., and Wright, T.L., 1981, Reconnaissance geologic map of the Columbia River Basalt Group, northern Oregon and western Idaho: U.S. Geological Survey Open-File Report 81-797, 33 p, 5 map sheets, scale 1:250,000.

Whiteman, K.J., Vaccaro, J.J., Gonthier, J.B., and Bauer, 1994, the hydrogeologic framework and geochemistry of the Columbia Plateau aquifer system, Washington, Oregon, and Idaho: U.S. Geological Survey Professional Paper 1413-b, 73 p.

Wright, T.L., Black, K.N., Swanson, D.A. and O'Hearn, T., 1980, Columbia River Basalt: 1978-1979 sample data and chemical analyses: U.S. Geological Survey Open-file Report 80-921