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PRELIMINARY GEOLOGIC MAP OF THE CABBAGE HILL 7.5′ QUADRANGLE, UMATILLA COUNTY, OREGON

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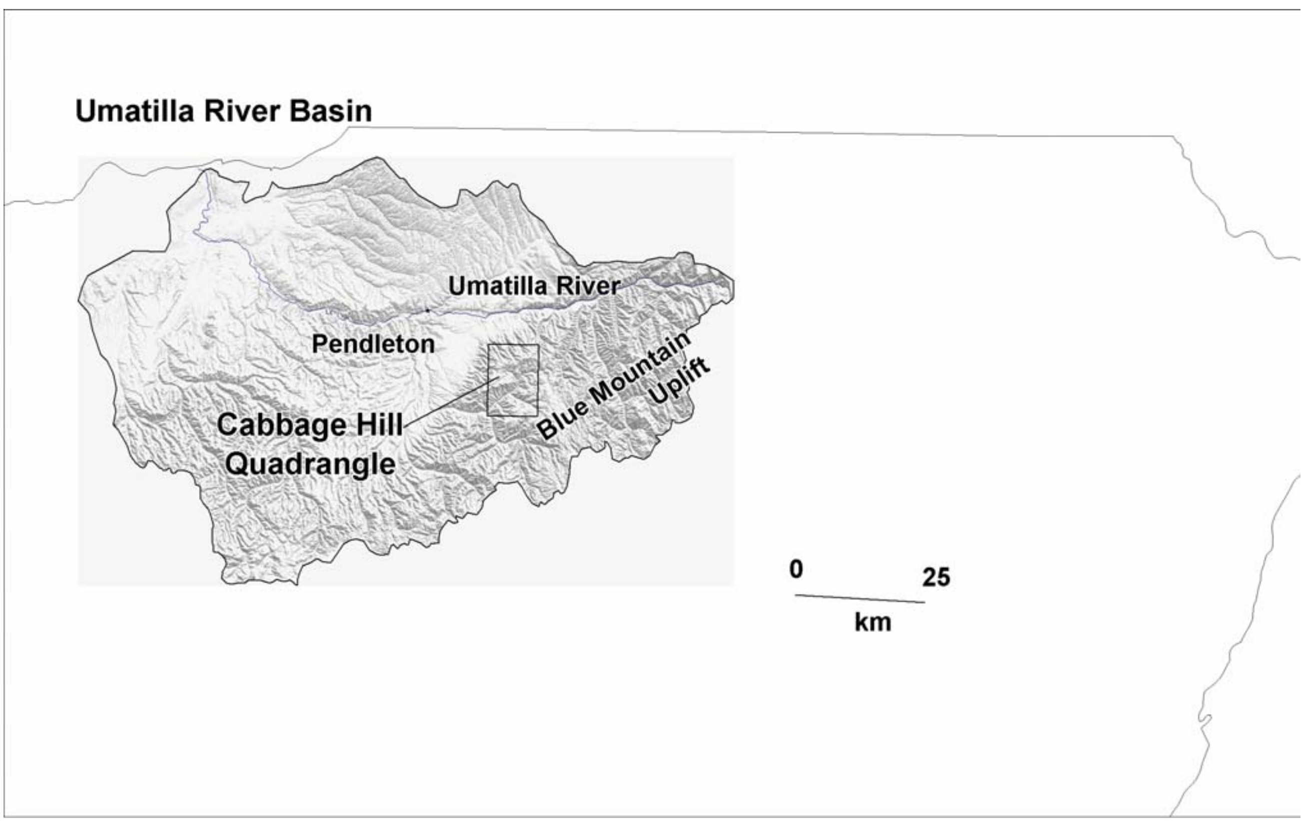
INTRODUCTION

The Cabbage Hill 7 ½' quadrangle is located along the northwest flank of the Blue Mountains Province of northeastern Oregon, and is centered on the headwaters to McKay Creek, one of the major tributaries to the Umatilla River. Western part of the quadrangle lies within the Confederated Tribes of the Umatilla Indian Reservation. Interstate 84 crosses the northern part of the quadrangle. Most of the quadrangle is timbered and timber and cattle are the main agricultural products. Primary geologic resource is groundwater, the long term sustainability of which is presently unknown.

The Cabbage Hill quadrangle is underlain by at least 350 m of Miocene flood basalts (Columbia River Basalt Group). Flow packages in the exposed, upper part of the Columbia River Basalt Group are well enough exposed and have different enough geochemical signatures to make mappable units. Flows in the lower part of the section are not distinctive enough to map with certainty.



Methodology and Previous Work

The 1:24,000 scale geologic map of the Cabbage Hill quadrangle was funded by in part by the USGS National Cooperative Geologic Mapping Program. The map is released as an interim map product as part of a larger mapping project covering the Umatilla River basin (Figure 1). Map and explanatory information is submitted with the understanding that the United States Government is authorized to reproduce and distribute reprints for government use. Geologic data were collected at the 1:24,000 scale combining new mapping with published and unpublished data from air photos, orthophotoquads, and digital shaded relief images derived from USGS 30 m DEM (Digital Elevation Model) grids.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 from Washington State University and Franklin and Marshall. Subsurface geology in cross sections is based on analyses of water-well drill records.

Subsurface geology in cross sections is based on analyses of water-well drill records.

Geologic studies in the Cabbage Hill 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). Additional work by Gonthier and Harris (1977), Gonthier and Bolke (1993) and Whiteman and others (1994) dealt primarily with Columbia River Basalt Group aquifers. Kienle and others (1979) mapped and described some of the major structures in the area.

PRELIMINARY DESCRIPTION OF GEOLOGIC UNITS – CABBAGE HILL 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.

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

COLUMBIA RIVER BASALT GROUP

Most of the lava flows exposed in the Cabbage Hill quadrangle are stratigraphically part of the Grande Ronde Basalt, the largest formation within the Columbia River Basalt Group. Top of the section is defined by two or more flows of the Frenchman Springs member, which here defines the base of the Wanapum Basalt. The two uppermost magnetostratigraphic members (N2 and R2) in the Grande Ronde Basalt underlie the Wanapum Basalt. Two chemically and petrographicaly distinctive flow packages have been separated out in the N2 magnetostratigraphic unit (Ferns and others, 2004a,b). The Sentinel Bluffs member, which everywhere in the Table Rock quadrangle is at the top of the Grande Ronde Basalt N2 magnetostratigraphic unit, overlies the Winter Water member, which overlies both N2, R2, and pre-Columbia River Basalt Group units.

WANAPUM BASALT

Tcwf **Frenchman Springs basalt (middle Miocene)** Flow-on-flow sequence of black to grayish-black, generally fine- to medium-grained, iron-rich basalt and basaltic andesite lava flows that weather to shades of brownish gray, brown, and bright orangish-brown. Individual flow packages display wide range of textural features, ranging from sparsely plagioclase phyric, glassy basalt to medium-grained, diktytaxitic flows. Fresh hand samples are generally dark grayish black to dark blue in color and are typically sparsely phyric, with small plagioclase feldspar phenocrysts. One porphyritic flow exposed near the base of the unit contains larger blocky plagioclase phenocrysts that are a translucent yellowish-brown color. Translucent phenocrysts are widely scattered and may be as much as 1 cm in width. Usually sparsely microporphyritic in thin section, with scattered microphenocrysts of plagioclase and crystal clots of plagioclase and clinopyroxene or set in variously textured groundmass intergrowths of plagioclase, clinopyroxene, opaques, and glass. Based on limited thin sections, scattered euhedral olivine microphenocrysts may be restricted to the Sand Hollow chemical type flows. Groundmass clinopyroxene can occur as minute interstertal grains or as optically continuous subophitic masses. Opaques occur as either needle-shaped lathes or blocky euhdral crystals. Opaques are highly magnetic. Over much of the quadrangle, poorly exposed, tending to erode to form rounded hills with the best exposures at road cuts and rock quarries or along to stream channels. Individual flows are generally no more than 30 m thick and, where exposed in road cuts, are made up of stacked flow lobes of massive lava that are separated by thin vesiculated flow tops and basal flow breccias. Cores to flow lobes form 1- 4 m thick, discontinuous, horizontal ledges that may extend for distances as great as 5 km. Flow cores are marked by widely spaced vertical joints and weather to form blocks. Coarser-grained flows commonly weather to form grussy slopes marked by spheroidal-weathering core stones. In quadrangle, unit appears to erode more readily than the underlying Grande Ronde Basalt. Displays normal remanent magnetic polarity. Separated on basis of geochemistry from other Columbia River Basalt Group units by high titanium (~3.00 wt percent TiO_2). Although separated elsewhere into 5 geochemical units on the basis of minute geochemical differences (e.g. Beeson and others, 1985), individual Frenchman Springs members could not be mapped separately in the Cabbage Hill quadrangle. Using the criteria established by Beeson and others (1985), the base of the Frenchman Springs is locally marked by a Sand Hollow flow, distinguished by low P2O5 and high Cr. Based on P2O5 and Cr abundances most of the flows in the Table Rock quadrangle are Sentinel Gap. Although nowhere more than 50 m thick in the Cabbage Hill quadrangle, the Frenchman Springs member thickens to more than 200 m in the Cayuse quadrangle to the north.

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.

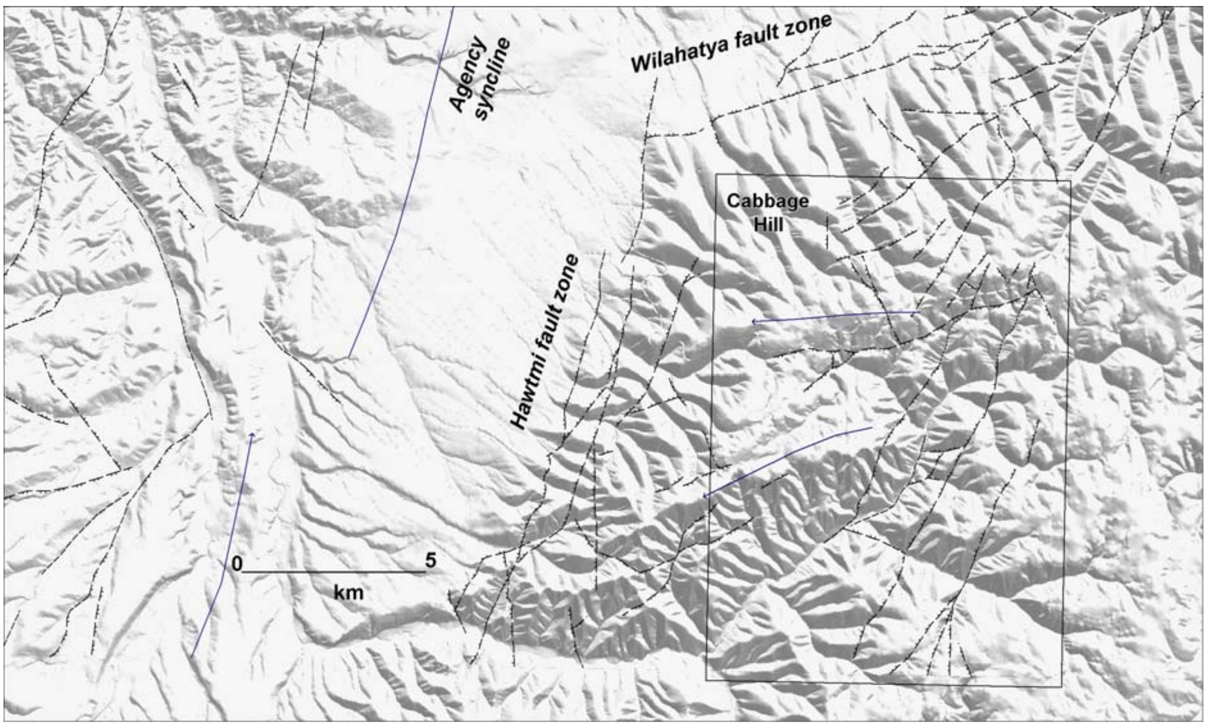
Tcgs Sentinel Bluffs unit (middle Miocene) Flow-on-flow sequence of dark grayish black, medium-grained, holocrystalline, iron-rich basalt and basaltic andesite lava flows. Unit is made up of thin flows and flow lobes, generally < 5m thick, that are marked by vesicular flow tops and basal flow breccias. Weathered surfaces are shades of brownish gray, reddish brown, and red. Thickest flows, which are as much as 20 m thick, are platy jointed. 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. Brownish gray, weathered surfaces to coarse grained flows sometimes display diktytaxitic textures defined by a groundmass of randomly oriented, lathe-shaped plagioclase crystals Generally medium to coarse grained and holocrystalline in hand sample. In thin section, commonly displays interstitial textures wherein scattered blocky microphenocrysts of plagioclase are set in a hollocrystalline groundmass of clinopyroxene and plagioclase with minor opaque minerals. May also contain minor amounts of olivine microphenocrysts. Base not exposed, but unit thickens to the north, where it is as much as 70 m thick in the Thorn Hollow quadrangle. In many places separated from the overlying Frenchman Springs flows by either a thin red soil zone or brown pebbly conglomerate (Vantage Horizon) that, in upland areas, is marked by springs. In quadrangle, generally more resistant to erosion than the overlying Frenchman Springs member, tending to erode to benches and tablelands. Separated from overlying Frenchman Springs flows on the basis of outcrop characteristics and geochemistry, most notably containing lesser amounts of titanium (<2.0 wt percent TiO_2) and phosphorous (<0.35 wt percent P_2O_5) than the Frenchman Springs. Equivalent to the Sentinel Bluffs unit of Reidel and others (1989) and the high MgO flows of Wright and others (1973) which mark the top of the Grande Ronde Basalt N2 magnetostratigraphic unit in the Pendleton area.

Tcgw Winter Water unit (middle Miocene) Hackly jointed, fine-grained, generally glassy, iron-rich basaltic andesite and iron-rich andesite lava flows. Unit is made up of as many as 4 flow packages each of which has 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, equidimensional blocks typically 10 cm in diameter. Flow cores, as exposed in road cuts and quarries, are marked by thin, undulating columnar joints that extend across horizontal, vesicle-rich bands. Flow top breccias typically chaotic, with orange-red breadcrust blocks and, in places, red spatter. In upland areas, wet draws and springs mark the top to the core of the uppermost Winter Water flow. Flow bases marked by dense, glassy, hackly jointed breccias containing thin selvages of yellow brown palagonitic glass. Aphyric to sparsely plagioclase phyric in hand samples. Basal zones typically glassy In thin section, generally hyalophitic with semi-aligned plagioclase microcrysts set in a black opaque groundmass. Cores display hyalophitic to intergranular ground mass textures, with granular clinopyroxene and black opaques. Scattered phenocrysts and glomerocrysts of plagioclase and clinopyroxene are not uncommon. In the Table Rock quadrangle, separated from the overlying Sentinel Bluffs unit on the basis of differing outcrop characteristics and geochemical analyses. The generally glassy and thicker Winter Water flows are markedly more silicic ($\geq$ 55.00 wt per cent SiO2) and contain lower amounts of magnesium (< 3.5 wt percent MgO) and higher amounts of potassium (> 1.7 wt percent K2O) than do the Sentinel Bluffs unit. . In the southern part of the quadrangle, thick hackly jointed, glassy flows are locally separated by thin holocrystalline flows with slightly higher magnesium (3.77 wt percent MgO) content. Unit is as much as 220 m thick in the southwest half of the quadrangle, where it rests directly on R2 magnetostratigraphic unit flows. Thins to a single flow that is 35 m thick in the east, where it rests on other N2 flows that are holocrystalline and contain larger amounts of MgO (> 4.0 wt per cent). and an older andesite dome complex. Considered to be correlative with the Winter Water unit of Reidel and others (1987) but ma, in the western part of the quadrangle, include flows of Reidel and others (1987) Umtanum and and Ortley units.

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 limited geochemistry, consists of two different chemical types, a high magnesium, moderate titanium flow with > 4.25 wt per cent MgO and ~ 2.1 wt per cent TiO2 and a high magnesium, low titanium flow with > 6.1 wt per cent MgO and ~ 1.6 wt per cent TiO2. The high magnesium flow is a medium grained, diktytaxitic flow that contains olivine. Unit is as much as 130 m thick in the southeast part of the quadrangle. Unit thins to the west where the Winter Water unit rests directly on the underlying R2 unit. 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 lava flows and flow breccias. Tops to individual flows commonly marked by red-weathering, blocky flow breccias. Individual cooling units appear to be discontinuous and cannot be traced laterally in outcrop with certainty. Top of the unit on Mckay Creek is marked by a 15 m thick, red-weathering flow that crops out to form cliffs.

Easternmost exposures are largely made up of chaotically broken flow breccias that appear to be aa flows. In thin section, typically hyalophitic to intergranular groundmass textures with phenocrysts and glomerocrysts of plagioclase and clinopyroxene. In the Cabbage Hill quadrangle, unit appears to be made up of solely of high titanium – low magnesium flows (> 2.3 wt percent TiO2 and < 3.7 wt percent MgO) that may be equivalent to the Wapshilla Ridge unit as defined by Reidel and others (1989). To the west, in the Table Rock quadrangle, unconformably overlies an older andesite dome complex along McKay Creek. 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 Cabbage Hill quadrangle are gently folded along west-plunging, east-west trending fold axis. Frenchman Springs Basalt flows capping Pumpkin Ridge, are down dropped to the south along a paralleling east-west trending, high-angle fault. Flows in the northern part of the quadrangle exhibit a pronounced, northwest tilt.

Apparent dips, as marked by contacts between flow pacakges, steepen to the northwest. Flow packages are truncated north of the quadrangle boundary, by high angle reverse faults of the Wilahatya fault zone (Ferns and McConnell, 2004).

The southeast corner of the Cabbage Hill quadrangle is cut by a prominent, northeast-trending topographic linear that is the southwest continuation the Thorn Hollow fault of Kienle and others (1979). The linear is defined by small displacement, generally down-to-the-west, high angle faults. Northward steepening of dips on the west side of the Thorn Hollow fault is consistent with Kienle and others (1979) classification of the Thorn Hollow as a right lateral fault.

Relative timing of structural development is conjectural. The pronounced northward thickening of the Frenchman Springs to the north of the Wilahatya fault zone may indicate that the Wilahatya fault zone was an active flexure at the time that the Frenchman Springs Basalt erupted during the middle Miocene. Hooper and Swanson (1990) consider northward thickening of late Grande Ronde Basalt flows to the east as evidence that the northeast trending Limekiln fault became active in the middle Miocene. Since there seems to be no thickening or thinning of lava flows across the Thorn Hollow fault, that structure appears to be younger in age and likely did not become active until all of the CRB flow packages had been erupted.

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