DEPARTMENT OF THE INTERIOR
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Base from U.S. Geological Survey, 1982

Geology mapped by J.J. Rytuba and J.H. Smit, 1979; J.T. Bateson, 1979 and 1985; S.A. Minor, 1983 and 1985–87; D.B. Vander Meulen, 1983; David Roth, 1985; and T.L. Vercoutere, 1986

SCALE 1:24 000

1 ½ 0 1 MILE

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 40 FEET
DATUM IS MEAN SEA LEVEL

APPROXIMATE MEAN DECLINATION, 1989

OREGON
QUADRANGLE LOCATION

GEOLOGIC MAP OF THE V QUADRANGLE, HARNEY COUNTY, OREGON

BY
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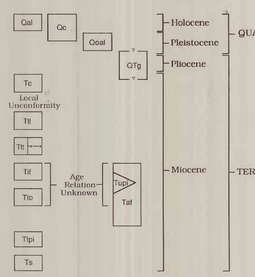
1989

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

Qal **Younger alluvium (Holocene)**–Unconsolidated to weakly consolidated, generally well-bedded and well-sorted, fluviatile gravel, sand, and silt deposited in major stream channels and flood plains. Locally includes minor slope wash and eolian deposits. Maximum thickness less than 5 m

Qc **Colluvium (Holocene and Pleistocene)**–Unconsolidated, generally unsorted and poorly bedded gravel, sand, and silt deposited chiefly as slope wash and talus. Locally includes eolian and landslide deposits and alluvium. Maximum thickness about 25 m in southwest part of map area

Qoal **Older alluvium (Pleistocene)**–Weakly to moderately consolidated, generally well-sorted and well-bedded, fluviatile gravel, sand, and silt. Forms terrace lying a few meters above the modern channel of Cottonwood Creek near the southwest corner of quadrangle. Thickness less than 10 m

QTg **Gravel deposits (Pleistocene?, Pliocene, and Miocene?)**–Moderately consolidated, weakly bedded to well-bedded, poorly sorted gravel and subordinate cobbles, sand, and silt. Located only near northwest corner of quadrangle. Gravel inferred to be ancient basin fill deposited mainly as a colluvial apron or pediment. Maximum thickness may exceed 10 m

Tc **Conglomerate (Miocene)**–Conglomerate, with minor lenticular interbeds of sandstone, siltstone, and tuff, and basal tuffaceous sedimentary rocks. Conglomerate generally weakly stratified, clast-supported, and very poorly sorted with a matrix of sand, silt, and clay. Clasts consist mainly of subangular to subrounded boulders, cobbles, and pebbles locally derived from Steens Basalt (Ts) and welded ash-flow tuff (Tto, Ttt, and Ttl). Typically thin interbeds of gray to white air-fall tuff and reworked tuff present in finer grained parts of unit. Lower part of conglomerate grades downsection into basal tuffaceous sedimentary rocks by an increase in number and thickness of tuffaceous interbeds. Basal part consists of white, tan, or pale grayish yellow, punky, fine-grained tuffaceous sedimentary rocks and intercalated, 3-6-cm-thick, gray vitric tuff; sedimentary rocks are well bedded, well sorted, and chiefly composed of reworked vitric ash and grains of quartz and feldspar. Basal tuffaceous part less than 100 m thick. Unit commonly concealed by thin surficial colluvial deposits (unmapped) containing abundant big boulders and cobbles from the conglomerate. Conglomerate probably deposited syntectonically mainly as colluvial and alluvial wedges at the base of large paleoscarps along major faults, and thus likely contains numerous local, intraformational angular unconformities. Thickness locally may exceed 1 km. Lower tuffaceous rocks may be at least partly correlative with the Trout Creek Formation, which was deposited about 15.3-13.4 Ma, on basis of K-Ar dates of associated volcanic rocks at type section about 10 km north of map area (Evernden and James, 1964; Rytuba and others, 1981)

Ttl **Tuff of Long Ridge (Miocene)**–Nonwelded to densely welded ash-flow tuff forming simple cooling unit underlain by basal nonwelded air-fall tuff. Ash-flow tuff compositionally zoned into a lower aphyric comenditic zone and thicker upper crystal-rich rhyolitic zone. Lower zone consists of white nonwelded tuff grading upwards into a 3-m-thick, purplish- to greenish-gray vitrophyre and overlying light bluish gray to light greenish gray, platy, devitrified welded tuff. Gradational tuff separating lower and upper zones characterized by either transitional purplish-green crystal-bearing tuff or thin interstratified greenish-gray aphyric and brown crystal-rich tuff. Upper zone is dark-purplish-brown, flaggy, devitrified, densely to partly welded tuff containing distinctive lenticular to whimpy, dark-brown blebs of oxidized tuff. Crystal fragments increase in abundance upwards from less than 1 percent near base to 10 percent near top and consist, in order of decreasing abundance, of alkali feldspar, clinopyroxene, fayalite, and Fe-Ti oxide. Devitrification products include arfvedsonite and aegerine; crystals coarsen upwards. Compaction foliations well defined by beige, coarsely crystalline, flattened pumice; vapor-phase cavities concentrated along compacted pumice. Welded parts of tuff locally flow folded; stretched and lineated pumice visible on platy cleavage surfaces where welded. Cooling unit commonly capped by several meters of light-pinkish-orange, finely vesicular tuff. Welded part of tuff forms columnar-jointed cliffs and weathers dark bluish brown (lower zone) to dark brown (upper zone). Basal air-fall tuff (10-20 m thick) consists of white, gray, and conspicuous brick-red, well-sorted, bedded, pumice-lapilli tuff. Maximum thickness of unit about 200 m near southeast corner of map area. Ash-flow tuff equivalent to member 5 of the tuff of Long Ridge of Rytuba and McKee (1984), which together with two lower members of the tuff present elsewhere in region, form a composite sheet. Member 5, whose eruption resulted in the Long Ridge caldera 5 km east of map area, has yielded K-Ar dates of 15.8±0.5 Ma and 16.0±0.4 Ma (Rytuba and McKee, 1984). Also equivalent to part of the alkali rhyolite of Jordan Meadow of Greene (1976) and to ash-flow unit 3 of Carlton (1969)

Ttt **Tuff of Trout Creek Mountains (Miocene)**–Nonwelded to densely welded comendistic ash-flow tuff forming simple cooling unit underlain by basal nonwelded air-fall tuff. Basal part of cooling unit consists of gray nonwelded tuff grading upwards into beige partly welded tuff and overlying dark-gray to black, crystal-rich (20-30 percent) vitrophyre 1-2 m thick. Densely welded upper part of tuff greenish- to bluish-gray and markedly crystal rich; contains 20-25 percent crystal fragments of blocky sanidine (10-20 percent), equant quartz, clinopyroxene (including aegirene), Fe-Ti oxide, and locally fayalite and semigmatite; includes as much as 2 percent andesitic lithic fragments. Densely welded tuff devitrified to aegirine, arfvedsonite, and felsic minerals. Beige, lenticular, vapor-phase cavities are common within compacted pumice toward top of ash-flow tuff. Welded part of cooling unit typically forms rubbly ledge or cliff and is columnar jointed where thick; weathers dark gray. Basal air-fall tuff is white to gray, generally well bedded and well sorted, and has maximum exposed thickness of about 20 m. Unit has maximum thickness of about 80 m in northwestern part of map area; shown on map as single dash-x line where less than 10 m thick. Unit informally named by Rytuba and McKee (1984), who report K-Ar dates of 15.9±0.3 and 15.8±0.3 Ma for tuff; also equivalent to part of the alkali rhyolite of Jordan Meadow of Greene (1976) and to ash-flow unit 2 of Carlton (1969). Eruption of ash-flow tuff resulted in Pueblo caldera (Rytuba and McKee, 1984) 10 km northwest of map area

Tf **Intermediate flows (Miocene)**–Intertonguing lava flows consisting of primarily black to gray, aphyric, platy, flow-folded, and locally vesicular and autobrecciated andesite and latite. Andesite flows closely resemble those of the andesitic flows unit (Taf). Quartz-bearing felsic lava flows locally present. Flows weather to various shades of brown. Unit has a maximum thickness of about 40 m at Mahogany Ridge; unit there, however, locally includes as much as 15 m of poorly exposed tuff of Oregon Canyon (Tto)

Tto **Tuff of Oregon Canyon (Miocene)**–Nonwelded to densely welded ash-flow tuff forming simple cooling unit underlain by basal nonwelded air-fall tuff. Ash-flow tuff compositionally zoned from a comendiitic lower zone to a trachytic upper zone. Lower zone consists, from base upwards, of white nonwelded to partly welded tuff, purplish- to bluish-gray, 1-m-thick vitrophyre, and light-blue-gray, platy to flaggy, devitrified densely welded tuff. Crystal fragments in lower zone, which constitute about 10 percent of rock, consist of large (as much as 1 cm) blocky sanidine, quartz, arfvedsonite, and clinopyroxene. Andesitic lithic fragments common (several percent) in lower zone. Products of pervasive devitrification in densely welded part of tuff include arfvedsonite; conspicuous beige, compacted pumice fragments are coarsely crystalline and contain axial vapor-phase cavities lined with quartz, arfvedsonite, and K-feldspar. Gradational tuff separating lower and upper zones similar to lower zone except for presence of dark-bluish-gray, lenticular to whispy blebs charged with Fe-Ti oxide that become more numerous and larger up section and weather rusty brown. Upper zone of cooling unit consists of tannish- to reddish-brown, incipiently welded, locally highly oxidized, punky to frothy ash-flow tuff; contains numerous dark-red, brown, and gray scoriaceous lapilli. Crystal fragments in upper zone (about 5 percent) include sanidine, quartz, and aegirine-augite; minor vapor-phase minerals line vesicles. Densely welded parts of tuff locally flow folded and weather dark bluish brown (lower zone) to orangish brown (gradational zone). Lower zone exhibits columnar jointing and commonly forms cliffs, whereas gradational tuff is only weakly jointed and forms less prominent outcrops; upper zone typically forms a ledge less than 5 m thick. Basal air-fall tuff white to tan, bedded, well sorted, and of variable thickness. Maximum thickness of unit approximately 125 m in southwestern part of map area. Unit informally named and described by Rytuba and McKee (1984), who reported a K-Ar date of 16.1±0.2 Ma for the ash-flow tuff. Equivalent to ash-flow tuff unit one of Carlton (1969) and to part of the alkali rhyolite of Jordan Meadow of Greene (1976). Ash-flow tuff forms compound cooling unit near its source, the Washburn caldera, 20 km east of map area (Rytuba and McKee, 1984)

Taf **Andesitic flows (Miocene)**–Medium- to purplish-gray, aphyric andesite and basaltic andesite lava flows and rare, intercalated andesitic tuff breccia and rhyolitic, partly welded ash-flow tuff. Lava flows average about 15 m in thickness but locally exceed 30 m. Except for thinner flows, flow interiors conspicuously platy and flow-folded; flow tops and bottoms vesicular and locally autobrecciated; textures range from pilotaxitic and intergranular (flow interiors) to intersertal and hyalo-ophitic (flow margins); composed of plagioclase (An_{50-65}) microlites, clinopyroxene, olivine, Fe-Ti oxide, and apatite. Contact with underlying Steens Basalt (Ts) locally gradational through thin zone containing some basalt and andesite flows or several slightly porphyritic (plagioclase) and platy basaltic flows. Flows weather chocolate brown to reddish brown and mainly form slopes. Maximum exposed thickness of unit is about 250 m, but may be thicker in northeastern part of map area where base is not exposed

Tupi **Upper porphyritic intermediate flows (Miocene)**–One or more brownish-gray, conspicuously porphyritic lava flows of intermediate (latitic?) composition; lath-shaped plagioclase (calcic andesine) phenocrysts as long as 6 mm compose 5-10 percent of rock. Plagioclase also forms glomerocrysts with augite and Fe-Ti oxide. Trachytic groundmass composed of plagioclase, pyroxene, Fe-Ti oxide, apatite, and interstitial felsite. Platy to flaggy, flow banded, and flow folded. Weathers dark orangish brown and commonly forms cliffs. Maximum exposed thickness of about 100 m in easternmost part of map area where unit is intercalated with andesitic flows unit (Taf); present only in eastern part of map area

Tupi **Lower porphyritic intermediate flows (Miocene)**–One or more lava flows very similar in appearance and composition to upper porphyritic intermediate flows (Tupi); separated from overlying andesitic flows unit (Taf) on basis of pronounced porphyritic nature and thickness of flow(s). Maximum exposed thickness of about 75 m in north-central part of map area where unit forms very prominent cliffs

Ts **Steens Basalt (Miocene)**–Light- to dark-gray porphyritic to aphyric lava flows of olivine basalt and basaltic andesite. Flows average about 5 m thick and commonly form resistant, laterally continuous cliffs; less competent flow tops and bottoms typically very vesicular and locally autobrecciated. Composed of 40-70 percent plagioclase, 20-30 percent clinopyroxene, 7-10 percent olivine, 5-15 percent Fe-Ti oxide, and as much as 15 percent glass. Conspicuous platy, zoned plagioclase phenocrysts (An_{60-70}) as long as 4 cm that constitute as much as 50 percent of some flows; distribution and abundance of plagioclase phenocrysts variable within individual flows, between adjacent flows, and (or) between groups of flows; phenocrysts conspicuously white on weathered surfaces. Less-abundant olivine phenocrysts generally associated with plagioclase as glomerocrysts. Sequences of aphyric, platy to blocky, commonly coarse-grained flows present throughout unit. Other textures include diktytaxitic, ophitic, subophitic, intergranular, and intersertal. Vesicles locally filled with calcite, zeolites, and (or) clays. Unit includes very rare interbeds less than 2 m thick of tuff and tuffaceous sedimentary rocks. Unit has maximum exposed thickness of about 450 m. Unit correlated on basis of similar lithology and magnetostratigraphy (Minor, 1986; Mankinen and others, 1987) with the Steens Basalt. Type section of Steens Basalt, about 60 km to the north, has a recalculated age (Dalrymple, 1979) of 15.5 Ma, based on an original mean age of 15.1 Ma determined by Baksi and others (1967), but unit is now considered to have age of about 15.9 Ma because of ages of overlying dated tuffs (Tto, Ttt, and Ttl)

- Contact–Dashed where approximately located; queried where uncertain; dotted where concealed
- Fault–Dashed where approximately located; queried where uncertain; dotted where concealed. Bar and ball on apparent downthrown side. Opposing arrows (cross sections only) show apparent relative sense of vertical movement. Single arrow shows dip direction and amount as inferred from geometry of fault trace
- Syncline–Trace of hinge surface, showing plunge direction. Long-dashed where approximately located; short-dashed where inferred; dotted where concealed
- Formline–Trace of arbitrary flow surface or bedding plane in Steens Basalt (Ts) and conglomerate unit (Tc). Shown in cross sections only
- Strike and dip of bed and flow surface
- Directly measured
- Approximately determined
- Strike and dip of compaction foliation in welded tuff

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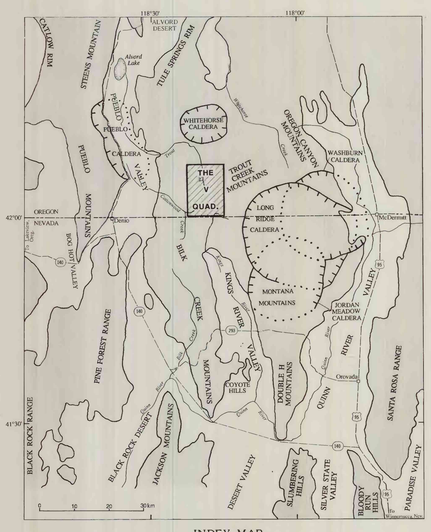

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