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PRELIMINARY GEOLOGIC MAP OF THE CRESWELL 7.5′ QUADRANGLE, LANE COUNTY, OREGON

By

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Preliminary Geologic Map of the Creswell Quadrangle, Lane County, Oregon

Introduction

The Creswell quadrangle is in western Oregon at the southern end of the Willamette Valley (Figure 1.). It is entirely within Lane County, and includes part of the City of Eugene, all of the City of Creswell, and the community of Goshen. Rural areas within the quadrangle are dominated by home sites and small farms in the lowlands; the hilly areas south of Eugene and in the southwestern quarter of the quadrangle are predominantly timberland.

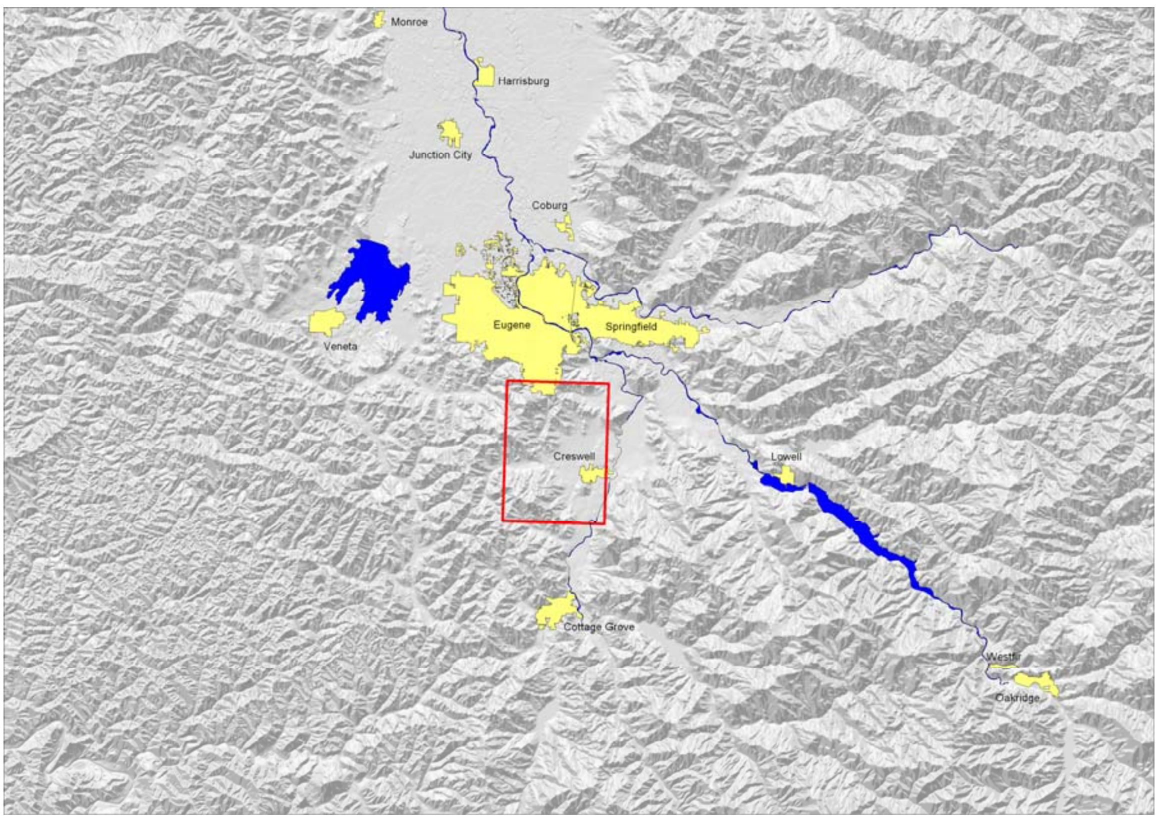

Figure 1. Location Map. The Creswell quadrangle is outlined by the red box.

Access to the quadrangle is provided by Interstate 5 and numerous paved or all-weather rural roads. The road network provides good access and exposure in most areas, however, nearly all property within the quadrangle is privately owned and vehicle access is limited locally. The quadrangle is primarily drained by Camas Swale Creek, which flows into the Coast Fork Willamette River less than one kilometer east of the quadrangle boundary. The Coast Fork Willamette River flows through the quadrangle for just under

3 km (2 mi) in the southeast corner. Wild Hog Creek, Hill Creek, and Spencer Creek drain smaller portions of the study area. Altitude in the quadrangle ranges from approximately 145m (478 ft) along Wild Hog Creek in the northeast corner , to 494m (1620 ft) on a basalt-capped hill in the southwest corner (T. 19 S., R.3 W., sec. 30).

Previous geologic mapping of the quadrangle includes Vokes and others, (1951), O'Connor and others (2001), and Retallack and others (2004). Retallack and others (2004) provide new radiometric ages for several tuffs. K/Ar dating of numerous volcanic rocks within the quadrangle are provided by Lux (1982).

The population of Lane County has grown by more than 50,000 people since 1990 (almost 18%); nearly two thirds of that growth has been in the City of Eugene. The City of Creswell has grown by more than 69% over the same time period. Existing geologic mapping in of the study area is small scale or reconnaissance in nature. The purpose of this mapping was to provide added detail on a large-scale map that could be used for improved ground water modeling, natural resource inventories, and geologic hazards assessment.

Methods

Field work for this study was conducted in the summer and fall of 2004. Most stations were located with a Trimble GeoXT GPS receiver and post-processed to reduced position error to less than 3m. Early in the study positions were located with a Garmin 12 GPS receiver. Those stations were adjusted slightly from the recorded position to better fit the Digital Raster Graphic (DRG) base map (UTM NAD27) or digital orthophoto quadrangle. Estimated position error is up to 10 m for these stations. Only rarely were Stations obscured by tree cover. Position for those stations was estimated based on nearby Stations and topography. In the relatively few areas that access was denied (see data map on plate) contacts are inferred based on topography or follow Vokes and others (1951), adjusted to fit the 1:2400 scale DRG base maps. The landslide deposit on the south side of Spencer Butte is mapped based in part on a description in Barton (1982).

Seventeen igneous rocks were selected for whole-rock and trace element geochemical analysis. Four additional samples, collected from silica-altered basalt, were analyzed for gold plus 34 trace elements. Sample locations are shown on the map. Major oxide and trace element analyses were performed by Dr. Stan Mertzman at Franklin and Marshall College; the Gold +34 package was performed by ActLabs-Skyline Assayers in Tucson, Arizona. Chemical analyses are provided in the appendices as a Microsoft Excel spreadsheet, along with text describing the analytical methods used by Dr. Mertzman and ActLabs-Skyline. Thin sections of all of the analyzed samples, plus 12 samples of tuff, were examined petrographically. Tuff samples were stained for both plagioclase and Potassium feldspar. Descriptions for sedimentary rocks are based hand lens or binocular microscope examination. One sample from a tuff unit within the quadrangle was submitted for $^{40}Ar/^{39}Ar$ dating at the Geochronology facility at Oregon State University. Results of that analysis are pending.

Contacts were refined by air photo, National Resources Conservation Service soils maps, and well log interpretation. Over 700 water wells were located using digital taxlot data. In most cases well locations were estimated by combining tax lot data with the digital orthophoto quadrangle. In some cases wells could be located with GPS and correlated with the Oregon Water Resources Department database. Unfortunately, the distinction between surficial deposits and underlying sedimentary rocks was often difficult for drillers to make, and few well logs provide useful stratigraphic data. Well locations, along with location method and estimated spatial accuracy are provided in the appendices. Logs for all the located wells are available online at the Oregon Water Resources Department website.

No new paleontological studies were conducted. Fossil localities shown on the map include stations located in this study, as well as localities listed by Vokes and others (1951). Only macrofossil and plant localities are shown. Data for fossil localities is given in the appendices.

Description of Map Units

Bedrock units within the quadrangle include marine sandstone of the Eugene Formation and terrestrial sedimentary rocks of the Fisher Formation. These formations are interbedded near their contact and are intercalated with numerous volcanic flows and tuff. Mafic and intermediate intrusions crosscut Eugene Formation at Creswell Butte, Spencer Butte, and two unnamed hills within the quad. Basaltic flows are in probable fault contact with Eugene Formation east of Coast Fork Willamette River in the southeastern corner of the quadrangle. The age of these units is well constrained by the ~41 Ma Tuff of Fox Hollow (Retallack and others, 2004) near the base of the section, and a ~32 Ma tuff that crops out at Short Mountain, at the top of the section. K/Ar ages for basaltic rocks within the quadrangle range from ~ 35 to ~40 Ma (Lux, 1982).

Surficial deposits in the study area consist of unconsolidated gravel, sand and silt in the active channel of Coast Fork Willamette River, fine-grained sand and mud deposited along the small streams, primarily Camas Swale Creek and Hill Creek, older alluvial deposits preserved in terraces north and south of Creswell Butte, and a few small alluvial fan deposits and landslide deposits. The age of unconsolidated deposits ranges from about 800 ka to Recent (O'Connor and others, 2001).

Volcanic rock names in the following descriptions follow the Total Alkalies-Silica ratio classification scheme of LeBas and others (1986), based on chemical analyses normalized to 100% without volatiles and all iron as Fe^{2+}. Mineralogic descriptions are based on petrographic analysis. Epoch designations are based on Palmer and Geissman (1999).

Rf Artificial fill (Recent)

Highway and construction fill and dams; small areas of cut and fill around residences and small dams containing farm ponds are not shown. Mapped primarily from topography and stereo air photo interpretation.

Qa Fine Grained Alluvium (Holocene)
Sandy mud and minor gravel deposited along Camas Swale Creek and its tributaries. Derived from hillsides adjacent to the deposits. The thickness of the unit is unknown, but probably less than 10 meters.

Qal Alluvium (Holocene)
Unconsolidated gravel, sand, and mud within the active stream channel and meander belt of the Coast Fork Willamette River. Distinguished from older alluvium (unit Qoa) by its meandering channel morphology, as opposed to the braided channels developed during the latest Pleistocene. The unit is typically incised into the underlying older alluvium. Mapped primarily after O'Connor and others (2001), modified to reflect topography on the1:24,000 scale base map.

Qls Landslide Deposits (Holocene and Pleistocene)
Unconsolidated mix of soil and rock emplaced by gravity sliding. Most landslide deposits shown on the map are inferred on the basis of geomorphology: a steep headwall scarp, hummocky surface, and a fan shaped run-out zone. However, several landslides have evidence of recent movement, typically bare soil at the headwall scarp.

Qf Alluvial Fan (Holocene and Pleistocene)
Fan shaped, unconsolidated deposits of gravel, sand, and mud along the margins of Camas Swale. Derived locally from streams draining the uplands in the southwest corner of the quadrangle. May include debris flow runout deposits.

Qoa Older Alluvium (late Pleistocene)
Unconsolidated gravel, sand, and mud deposited by South Fork Willamette River during the last Cascade glaciation. Equivalent to fan-delta alluvium (unit Qfd) mapped in the Eugene and Springfield quadrangles (Madin and Murray,2004; Hladky and McCaslin, 2005), but in the Creswell quadrangle the narrow valley of the Coast Fork Willamette River precludes the formation of the fan-morphology displayed in the Eugene and Springfield quadrangles. Mapped primarily after O'Connor and others (2001) who considered the unit to be latest Pleistocene.

Qtg Terrace gravel (Pleistocene)
Deeply weathered fluvial sediments, predominantly pebble conglomerate, deposited by the early Willamette River. Distinguished from younger fluvial sediments by the intense weathering- softened volcanic clasts are surrounded by matrix now nearly completely altered to clay. Distinguished from weathered Fisher Formation by its scarcity of angular clasts. This unit was observed in outcrop only in the northeastern corner of the quadrangle, along the Dillard Access Road southeast of Goshen, but it forms a distinct 3-5 m terrace-step west of Creswell and Creswell Butte. The unit was mapped elsewhere in the quadrangle after O'Connor and others (2001). Thickness is unknown, but probably is not great; underlying Eugene Formation sandstone is exposed at the base of the terrace along Gibson Lane, west of Creswell Butte. Age is estimated to be between about 800ka and 420 ka (O'Connor and others, 2001).

Tb Basalt and basaltic andesite (Eocene and Oligocene)

Typically porphyritic with seriate plagioclase, pyroxene, or both; locally with olivine, rarely aphyric. Black or gray when fresh, yellow, brown, or red-brown when weathered. Extreme weathering can produce a disaggregated mix of plagioclase in a brown earthy matrix resembling weathered Eugene Formation sandstone. Classification diagrams are shown in Figure 2. Flows range from a few to many meters thick, and individual flows are nearly always separated by layers of volcaniclastic conglomerate of the Fisher Formation, most of which are too thin to map separately. Most flows are concordant with the underlying sedimentary rocks, but some filled paleo-valleys. Good exposures north of Lynx Hollow show contacts with underlying volcaniclastic rocks are complicated by numerous dikes and sills and small faults. Lux (1982) reports whole rock K/Ar dates of 32.4 ± 0.8 Ma and 35.3 ± 0.9 Ma from basalt at 52nd Avenue and South Willamette Street, 38.7 ± 0.5 Ma for a basaltic andesite along Camas Swale Road, and 39.7±1.4 for basalt east of the Coast Fork Willamette River. The basaltic andesite flow capping Short Mountain overlies a tuff with an $^{40}Ar/^{39}Ar$ age of 31.8 ± 0.8 Ma (Retallack and others, 2004).

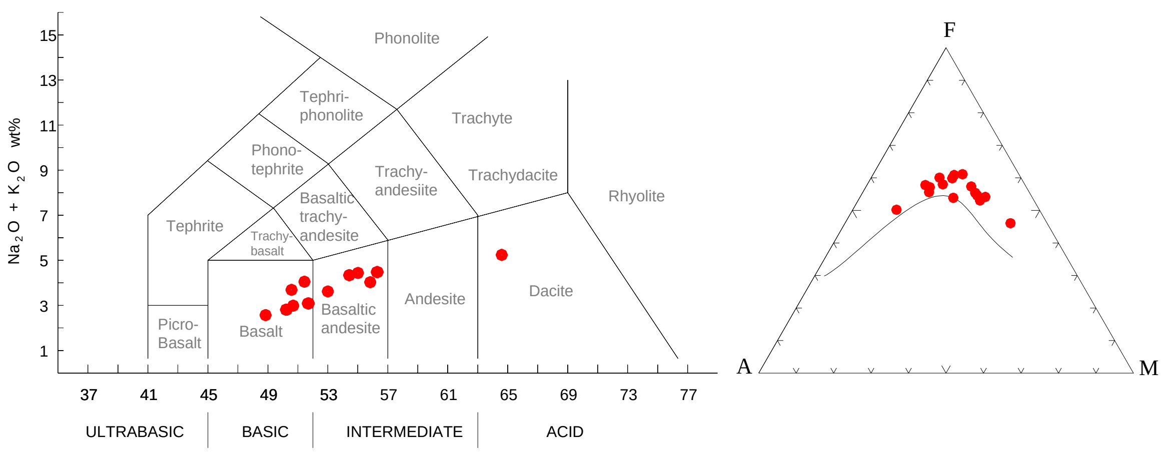

Figure 2. AFM diagram with Irvine and Baragar (1971) boundary between tholeiitic and calc-alkaline fields, and Total Alkali-Silica classification diagram. Dacite is vitrophyre from base of the Tuff of Fox Hollow. All other points are volcanic flows.

Tts Tuff at Short Mountain (early Oligocene)

Well-indurated crystal tuff. Fresh rock is gray with abundant glassy plagioclase and quartz crystals, weathered rock is brown. The tuff crops out between fluvial deposits of the Fisher Formation and basalt at Short Mountain, and as rubble overlying Eugene Formation on a ridge in the NW¼ of sec 27, T. 18 S., R. 3 W. Plagioclase crystals are abundant, rounded, and subhedral; single crystals are as large as 5 mm, and commonly form larger clots. Quartz is also abundant, rounded and embayed. Pyroxene is subhedral, up to 1 mm. Zircon is a rare accessory. The groundmass is completely recrystallised to Potassium feldspar and quartz. Lithics are variably abundant and include mafic volcanics and pumice. The tuff at Short Mountain has been correlated with the Tuff of Mosser Mountain by Retallack and others (2004); it is in the same stratigraphic position and petrographically similar to the Tuff of Daniels Creek of Madin and others (in prep.). Retallack and others (2004) obtained $^{40}Ar/^{39}Ar$ ages of 31.8 ± 0.8 Ma for the tuff at Short Mountain, and 32.3 ± 0.6 for the Tuff of Daniels Creek.

Tt Tuff undifferentiated (early Oligocene)
Deeply weathered crystal-lithic tuff that caps a hill at the south edge of the quadrangle, in the middle of the map. Consists of plagioclase crystals and very weathered volcanic clasts in white clay matrix. This tuff does not crop out extensively in the study area, and cannot be correlated with other tuffs in the quadrangle. Probable age is late Eocene based on stratigraphic position near the top of the volcanic section in the quadrangle.

Ttd Tuff at Dillard Road (late Eocene or early Oligocene)
Plagioclase-lithic tuff. The appearance of the tuff varies with position in flow. A typical outcrop is brown with abundant clear to frosty plagioclase. Where the flow is densely welded it is gray with a brown weathering rind. Anhedral to subhedral plagioclase crystals up to 3.5mm are prominent in all samples. Pumice-rich zones are mottled tan and brown. Magnetite up to 0.5 mm is a moderately abundant accessory, clinopyroxene, hornblende, and quartz are rare. Lithic clasts include a variety of mafic volcanic rocks and pumice. The ground mass is commonly recrystallised with patchy calcite alteration, but locally glass shards are well preserved. Welded tuff is ridge capping or crops out as a low bluff on the downthrown side of a fault north and east of Dillard Road. A non-welded horizon is preserved locally where the unit is still overlain by sandstone of the Eugene Formation. An $^{40}Ar/^{39}Ar$ age is pending.

Ttw Tuff at South Willamette Street (middle Eocene)
Deeply weathered crystal-lithic tuff that crops out near the south end of South Willamette Street. In an outcrop just southwest of Spencer Butte the tuff it is a well-indurated, porcelaneous, white rock with scattered magnetite crystals. Further south along South Willamette and Fox Hollow Roads it has mafic volcanic clasts and pumice up to 1cm, plagioclase up to 5 mm, sparse subhedral ghosts of pyroxene(?)up to 1mm and magnetite crystals in a waxy, tan groundmass. Exposures with recognizable relict clasts and crystals locally grade to amorphous red and white claystone. Thickness may be as great as 25 m. Age is estimated based on stratigraphic position.

Ttf Tuff of Fox Hollow (middle Eocene)
Massive pink and white, orange weathering, crystal-lithic dacite tuff. The tuff is well exposed between tuffaceous pebble conglomerate and basalt in the westernmost part of the quadrangle, north of Camas Swale Creek. A thin, black vitrophyre crops out at the

base of the tuff near the west edge of the quadrangle, approximately 0.75 km northwest of Moxley Cemetery. A deeply weathered lithic tuff that crops out south of Camas Swale Creek, near the head of Scott Creek, is tentatively correlated with the Tuff of Fox Hollow based on its stratigraphic position between tuffaceous conglomerate and olivine basalt flows. The tuff is commonly cliff-forming, producing good outcrop. North of Camas Swale Creek the tuff has variably abundant angular, polymict volcanic lithics, locally including pumice, up to 5cm. Pumice is commonly flattened, and where especially abundant it imparts a crude foliation. Abundant plagioclase crystals are clear, subhedral to euhedral, commonly broken, and include small magnetite crystals. Quartz is rare, occurring as rounded subhedral grains up to 1.2mm when present. No potassium feldspar was observed, despite staining of the thin sections. Magnetite is anhedral to euhedral, up to 0.5mm, with some skeletal or inclusion-filled grains. The groundmass varies from well-preserved deformed glass shards to completely recrystallised. In the tuff south of Camas Swale Creek lithic clasts include mafic volcanic pebbles and pumice. Crystals include magnetite and weathered mafic grains (pyroxene?). Plagioclase, which is typically abundant in the tuff of Fox Hollow, is missing or weathered beyond recognition. Quartz is absent. The tuff north of Camas Swale Creek is approximately 60 m thick at the quadrangle boundary, thinning to the southeast. South of Camas Swale Creek tuff is 15 to 25 m thick. A chemical analysis of a glass separate from the vitrophyre falls in the dacite field of a TAS diagram. Retallack and others (2004) obtained an $^{40}Ar/^{39}Ar$ age of 41.0 ± 0.6 Ma from plagioclase collected at an exposure of the tuff along Fox Hollow Road, approximately 6.5 km northwest of outcroppings of the tuff in the Creswell quadrangle.

Te Eugene Formation (middle Eocene to early Oligocene)

Predominantly thickly-bedded to massive arkosic sandstone with minor mudstone and scattered thin conglomerate. Eugene Formation crops out extensively in the north-central part of the quadrangle, on the western flanks of Spencer Butte, and at the head of South Fork Spencer Creek. Isolated exposures also crop out in the Coast Fork Willamette River and in a small stream due west of Creswell Butte. Eugene Formation typically forms thin soils, and outcroppings, although weathered, are relatively abundant. Fresh rock is olive green; in outcrop the sandstone is tan or orange brown with local dark-red iron-oxide staining. Plagioclase crystals and mafic volcanic grains make up the bulk of the sandstone, quartz is less abundant, mica is sparse but nearly always present. Grains are subrounded to subangular and moderately well sorted; sorting and rounding decrease near contacts with Fisher Formation. The matrix is tuffaceous, typically weathered to clay, locally cemented with carbonate or iron oxide. Although the Eugene formation is commonly fossiliferous (Vokes and others, 1951; Hickman, 1969) few fossil localities were found in the Creswell quadrangle. Fossil localities are noted on the map, but detailed examination of the fossils was not undertaken for this study. Near the head of South Fork Spencer Creek the Eugene Formation is a crumbly, white, massive sandstone consisting of abundant quartz, white clay, and sparse mica; plagioclase, normally abundant in the Eugene Formation, is apparently weathered or hydrothermally altered to clay. Similar poorly indurated sandstone crops in the lower Eugene Formation to the north , but it is not restricted to a single horizon (Madin and Murray, 2004). Thickness estimates for the Eugene Formation regionally range from approximately 1,500 m (5,000 ft)to 4,600 m (15,000 ft) (Vokes and others, 1951; Hickman, 1969). At least 90 m (300 ft) of Eugene Formation is exposed near the head of Christensen Creek, and nearly 100 m (320 ft) at the head of Wild Hog Creek. Assuming an easterly dip of 5° and no structural complications, the formation is approximately 415 m thick in the northern part of the quadrangle. The age of the Eugene formation within the Creswell quadrangle is constrained by $^{40}Ar/^{39}Ar$ ages of 41.0 ± 0.6 Ma for the Fox Hollow Tuff and 31.8 ± 0.8 Ma for the tuff at Short Mountain (Retallack and others, 2004).

Tf Fisher Formation (middle Eocene to early Oligocene)

Predominantly massive, volcaniclastic mudflow deposits and tuff, including conglomerate and breccia, pebble conglomerate, and rare sandstone and thin lacustrine mudstones. At Short Mountain interbedded conglomerate and sandstone have well developed fluvial structures. The unit is typically composed of well-rounded and angular mafic volcanic clasts as large as several centimeters with plagioclase ± pyroxene and magnetite crystals in a tuffaceous mud matrix. The unit locally includes many basalt and basaltic andesite flows, dikes, and sills, most too small to map separately; but in the southwest corner of the quadrangle conglomerate as thick as 200 m (700 ft) is apparently undivided by volcanic rocks. Plant fossils, primarily silicified wood and carbonized twigs and leaves, are abundant northwest of Goshen and along Mahr Road, southwest of Creswell. Two well know fossil floras are present in the quadrangle (Myers and others, 2002; Retallack and others, 2004); the Willamette Flora is exposed in the Interstate 5 road cut through the hill just north of Goshen, and boulders with remnants of the Goshen Flora are scattered near the overpass at the east end of Dillard Road. The Fisher Formation is approximately 430 m (1,410 ft) thick near Short Mountain, assuming 14° easterly dip as measured on the west slope of Short Mountain. More than 200 m of Fisher formation underlies the ~41 Ma tuff of Fox Hollow at the western edge of the quadrangle; at Short Mountain the unit is capped by the ~31 Ma Tuff of Short Mountain.

Tib Basaltic Intrusive Rocks (Late Eocene and Oligocene)

Black, fine-grained basalt at Spencer Butte and in an intrusive at the north-central quadrangle boundary (locally known as Mt. Baldy), and massive, green-black basalt with conspicuous large pyroxene phenocrysts in a large body and smaller outliers in the north-central part of the quadrangle, east and south of Dillard Road At Spencer Butte clinopyroxene is subhedral to anhedral, seriate, typically up to 1 mm, rarely up to 1.5 mm, and has abundant magnetite inclusions. Plagioclase is randomly oriented, intergrown, subhedral, and seriate up to 0.75mm. Orthopyroxene is sparse, and has pale-green to pink pleochroism. Rare float observed on the northwest flank of the butte was somewhat coarser grained, with subhedral to euhedral pyroxene and plagioclase up to 1.5mm in a finely crystalline groundmass. In the Dilllard Road intrusive clinopyroxene crystals up to 1.5 mm commonly form clots up to 4mm, and locally enclose plagioclase subophitically. Plagioclase crystals are subhedral, seriate up to 1.5 mm, have oscillatory extinction, albite and Carlsbad twinning, and have abundant melt inclusions. Magnetite is an abundant accessory, and grains up to 1.5 mm commonly enclose plagioclase microlites. The groundmass is predominantly plagioclase microlites and altered glass (?). The intrusive nature of the basalt at Spencer Butte is inferred from the prominent, steeply-dipping dikes(?) that crop out on the south end of the summit and much of the

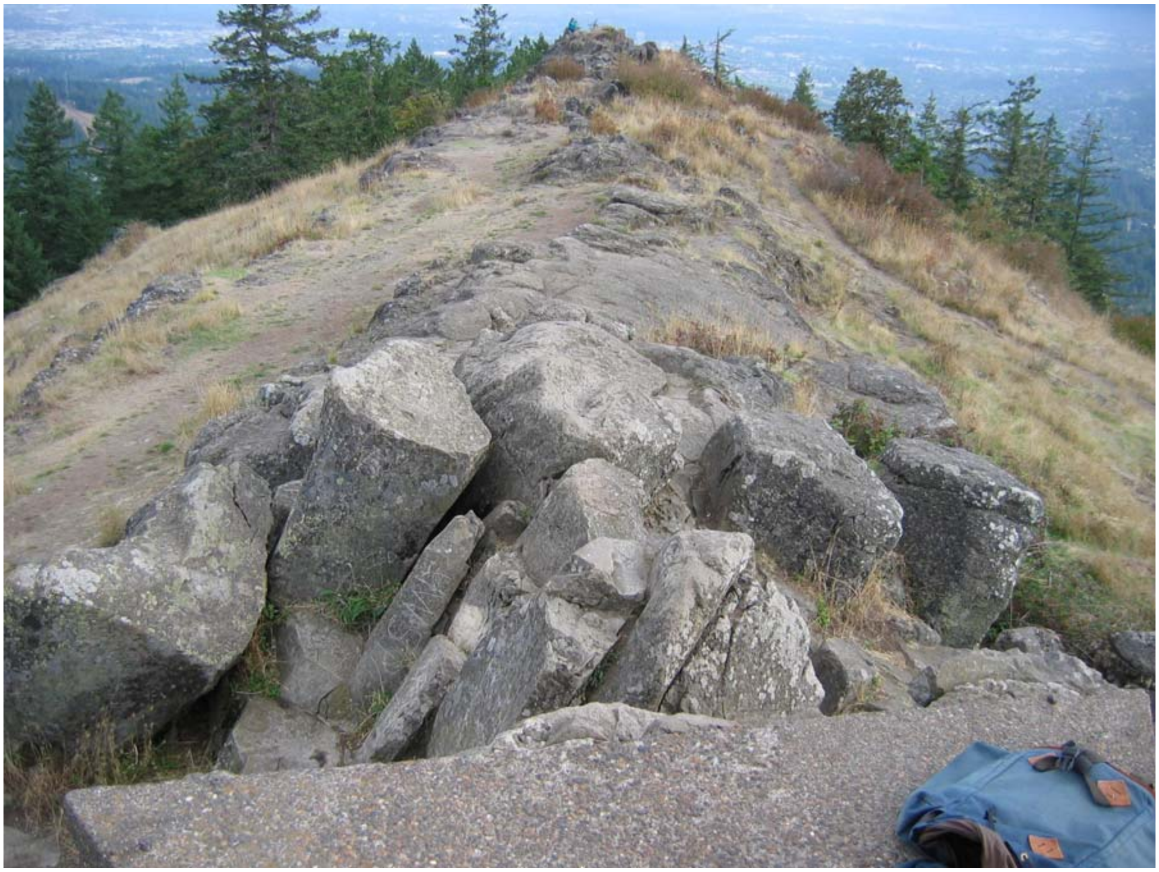

Figure 3. Intrusive basalt at the top of Spencer Butte, looking north.

southern slope (Figure 3). Along the southern edge of Mt. Baldy the contact with Eugene Formation is gradational, with numerous dikes intruding the sandstone parallel to the contact. Although the intrusive near Dillard Road is very similar to flows mapped nearby in the Eugene East and Springfield quadrangles (Madin and Murray, 2004; Hladky and McCaslin, 2005), driller's logs report nearly 200 m (650 ft) of basalt in wells drilled into the intrusive east of Dillard Road. At Spencer Butte the intrusive crosscuts Eugene Formation and basalt overlying Eugene Formation. Stratigraphically equivalent basalt approximately 1.2 km north of Spencer Butte was dated at 32.4 ± 0.8 and 35.3 ± 0.9 Ma (Lux, 1982; sample 43) so the intrusive is probably late Eocene or Oligocene. The other intrusive bodies crosscut Eugene Formation, so they are also probably late Eocene or Oligocene, as well.

Tiba Basaltic Andesite Intrusive Rocks (Late Eocene and Oligocene)
Gray, fine- to medium-grained basaltic andesite at Creswell Butte. Clinopyroxene grains as large as 1 mm locally form clots up to a few mm across giving the rock a speckled appearance in outcrop. Plagioclase is randomly oriented, seriate up to 1.5mm, and is variably altered to sericite(?). Magnetite, an abundant accessory, is anhedral, commonly skeletal, and as large as 0.5 mm. Intergranular pyroxene is mostly replaced by green

chlorite. The intrusive crosscuts Eugene Formation, so it must be younger than late Eocene.

Structural Geology

The general structure of the Creswell quadrangle is a sequence of interbedded terrestrial and marine sedimentary rocks dipping gently to the east. Measurements of bedding within the quadrangle are sparse because of the massive layering and generally small outcrop size typical in Eugene and Fisher Formations. A stereonet plot of poles to bedding planes for all measurements, including measurements taken from a 1.5 km buffer around the quadrangle and several measurements by Vokes and others (1951), has only 21 data points (Figure 4).

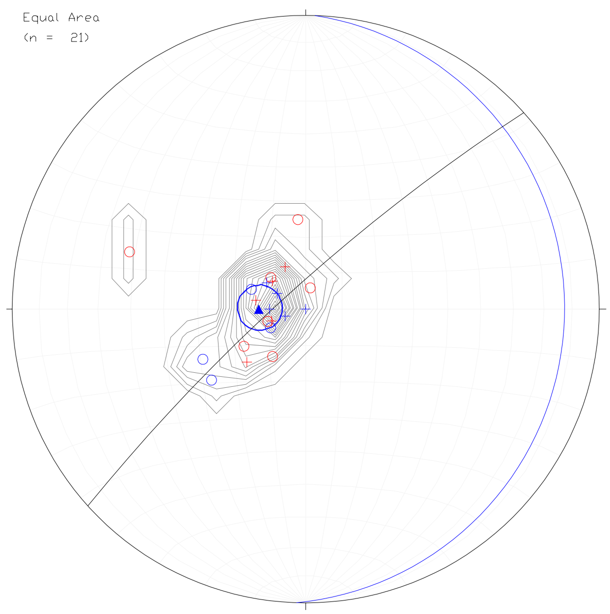

Figure 4. Equal area stereo plot of poles to bedding planes from the Creswell quadrangle. Circles - Eugene Formation, crosses- Fisher Formation; red symbols are measurements collected for this study, including some reading taken just outside of the quadrangle; blue symbols are measurements taken from a scanned image of Vokes and others (1951) map. Poles normal to the bedding plane are projected to the lower hemisphere, thus bedding dipping to the northeast would project a dot in the southwest quadrant of the stereonet. Poles to gently-dipping beds plot near the center of the stereonet, steeply dipping beds near the outer edge. The mean vector of all poles, shown by the blue triangle, trends ~272°, and plunges ~77°. A plane perpendicular to the mean vector, shown by the blue great circle, represents the “average” bedding orientation, striking ~358° and dipping ~11° east. The black great circle is the cylindrical best fit through all the data points. The outlier is a bedding measurement taken from Eugene Formation sandstone in the road cut at the entrance into Spencer Butte Park off South Willamette Street. Removing the outlier changes the mean vector only slightly, to 268°, plunging 79°.

The stereonet plot shows considerable scatter in the bedding measurements. A number of factors may contribute to the scatter. A small number of measurements was obtained over a large geographic area. Values for strike in the measurements of Vokes and others (1951) are only estimated from a scanned image of their map. Outcroppings in Eugene and Fisher Formation are typically small and bedding foresets or hummocky cross-stratification, observed elsewhere in the Eugene Formation (Murray unpublished data) may have gone unrecognized. Dip of bedding may be influence by drag folding or block rotation along unrecognized NW-trending faults. A cylindrical best-fit great circle through the data points describes an axis approximately parallel with the NW-trending faults mapped in the north half of the quadrangle. Despite the scatter, the stereoplot does show that bedding, on average, dips to the east.

The age progression of rocks within the quadrangle is consistent with the observed easterly dip in bedding. The oldest rocks, massive mudflow deposits of the Fisher Formation that underlie the ~41 Ma Tuff of Fox Hollow, crop out in the southwest corner of the quadrangle. The youngest rocks are basalt that overlies ~32 Ma tuff at Short Mountain in the northeastern corner of the quadrangle. The exception to this trend is the basalt that crops out just east of the Coast Fork Willamette River, which at ~40 Ma (Lux, 1982) is nearly as old as the Tuff of Fox Hollow. Water wells as deep as 185 ft drilled just west of the basalt penetrate only sedimentary rocks, so it is likely the basalt is uplifted along a fault approximately parallel with the river. If so, the fault is nearly perpendicular to faults that are mapped in the northern part of the quadrangle. Those faults, all trending NW or NNW, are approximately parallel with numerous faults mapped in the Eugene West (Madin and Murray, 2004), Veneta (Murray, in prep.), and Fox Hollow (Murray, unpublished data) quadrangles.

Offsets along the NW- and NNW-trending faults within the study area are between 20 and 30 m (60 to 100 ft) down to the west. Slickensides measured on small faults in basalt in the southern part of the quadrangle indicate dip-slip motion. Just outside the study area, in the northeast part of the Fox Hollow quadrangle, offsets in the Tuff of Fox Hollow indicate a down to the east movement of 40 to 50 m (140 to 165 ft) with a possible strike-slip component to the northwest (Murray, unpublished data). The outcrop pattern of the Tuff of Fox Hollow in that area is apparently dependent on both faulting and variations on the thickness of the tuff, which appears to be thickening to the northwest. The thickening is probably the result of deposition onto a variably eroded paleosurface.

Within the Creswell quadrangle volcanic flows and tuffs are generally concordant with the sedimentary rocks, but as is observed in the adjacent Fox Hollow quadrangle, they were locally deposited into erosional lows or against previously offset fault scarps, so that now they crosscut layering in the sedimentary rocks. An example may be the inferred fault along South Fork Spencer Creek. Although it trends northwesterly, parallel with a certain fault just to the southwest, it could in fact be younger basalt flows buttressed against the wall of a paleo-valley in Eugene Formation sandstone.

The age of faults in the Creswell quadrangle is not known. Faults cut rocks of Eocene and early Oligocene in age, but no scarps in the surficial deposits were observed. If, in fact, the volcanic rocks on the northeast side of South Fork Spencer Creek are buttressed against an earlier fault scarp, it would indicate faulting is as old as late Eocene.

Although recognition and radiometric dating of numerous tuff layers in the southern Willamette Valley has aided the interpretation of the structural geology (Retallack and others, 2004; Madin and Murray, 2004), deep weathering and petrographic characteristics that vary within the tuff layers, either due to gravity settling or through subaqueous deposition, leaves work to be done. Two tuff layers in the Creswell quadrangle, the tuff at South Willamette Street and the tuff at Dillard Road, might be correlated regionally with more study. A third tuff, the western outlier of the tuff at Short Mountain, is tentatively correlated based on petrographic similarity. A radiometric age or chemical analysis might prove or disprove that correlation, and perhaps correlate the tuff at Short Mountain with either the Mosser Mountain Tuff or the Tuff of Daniels Creek (Madin and others, in prep).

Geologic History

Bedrock units in the Creswell quadrangle were deposited within about a 10 million year period in the late Eocene and early Oligocene. The oldest rocks in the study area are tuffaceous mudflows of the Fisher Formation that crop out in the southwest corner of the quadrangle, where at least 210 m (700 ft) of massive conglomerate and breccia underlie a tuff tentatively correlated with the ~41 Ma Tuff of Fox Hollow. The youngest rocks in the quadrangle are a basalt flow at Short Mountain and fossiliferous, tuffaceous sandstone, mudstone and pebble conglomerate of the Fisher Formation north of Goshen. The basalt at Short Mountain overlies a ~32 Ma tuff (Retallack and others, 2004) and fluvial conglomerate and sandstone which are also mapped as Fisher Formation. A thin tuff interbedded with Fisher Formation in a roadcut along Interstate 5 immediately north of the quadrangle boundary has an $^{40}Ar/^{39}Ar$ age of 30.6 ± 0.5 Ma (Retallack and others, 2004).

The Tertiary deposits consist predominantly of terrestrial sedimentary rocks, lava flows and tuffs. However, in the north half of the quadrangle, and in isolated outcropping near Creswell Butte and in the Coast Fork Willamette River, the terrestrial rocks are interbedded with marine sandstone of the Eugene Formation. Fossil assemblages suggesting a shallow marine depositional environment for the Eugene formation (Hickman, 1969), and the inter-layering of marine and terrestrial sediments indicates that during the late Eocene and early Oligocene shoreline was within the study area.

Surficial deposits in the quadrangle consist of gravel deposited by the Willamette River and fine-grained sediments that were derived from local sources and deposited into the valleys of small tributaries to the Willamette River. The oldest gravels, preserved in a terrace deposit north and south of Creswell, are probably from 0.8 to 0.4 Ma (O'Connor and others, 2001). Incised into the terrace gravels are braided stream deposits derived from the Cascades during the late Pleistocene glaciation. The youngest deposits in the Creswell Quadrangle are active channel and flood plain deposits of the Willamette River and fine-grain alluvium within Camas Swale and its tributary streams

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List of Appendices

(Data Files on CD)

All coordinates in UTM Zone 10 NAD 27

Geochemistry

XRF_Methods.txt: Discussion of analytical methods used for whole rock and trace element analysis by Dr. Stanley Mertzman.

Au+34 INAA enhanced procedure.txt: Discussion of analytical procedures used for exploration geochemical analysis by ActLabs-Skyline assayers.

Creswell Geochemistry.xls: Geochemical data in Excel spreadsheet format, with coordinates.

Creswell Au+34 Package.xls: Geochemical data in Excel spreadsheet for INAA analyses.

Field Locations

Creswell Stations.xls: Field data, brief notes in Excel spreadsheet format with coordinates

Creswell Stations read me.txt: Explanation of data collection and abbreviations used in field notes.

Well Locations

Creswell Well Data.xls: Well locations with coordinates, OWRD Log ID number in Excel Spreadsheet Format. Location error estimated, xy in meters, z in feet. Located by TLl (taxlot), GPS (GPS reading in field), OWRD (USGS-OWRD data file).

Photographs

Outcrop and specimen photos in .jpg format, keyed to locations in Field_Data.

Petrography

Scanned thin sections and polished thin section billets as .jpg files keyed to Creswell Stations.xls

Paleontology

Creswell Fossil Locations.xls: Excel spreadsheet of fossil locations with coordinates, keyed to locations from this study and from Vokes and others (1951).

GIS Files

Creswell_Polygons.tab, .shp: Geology polygons labeled with unit ID, in Mapinfo Tab and Arcinfo Shape file format.

Creswell_Faults.tab, .shp: Geology polygons labeled with unit ID, in Mapinfo Tab and Arcinfo Shape file format.