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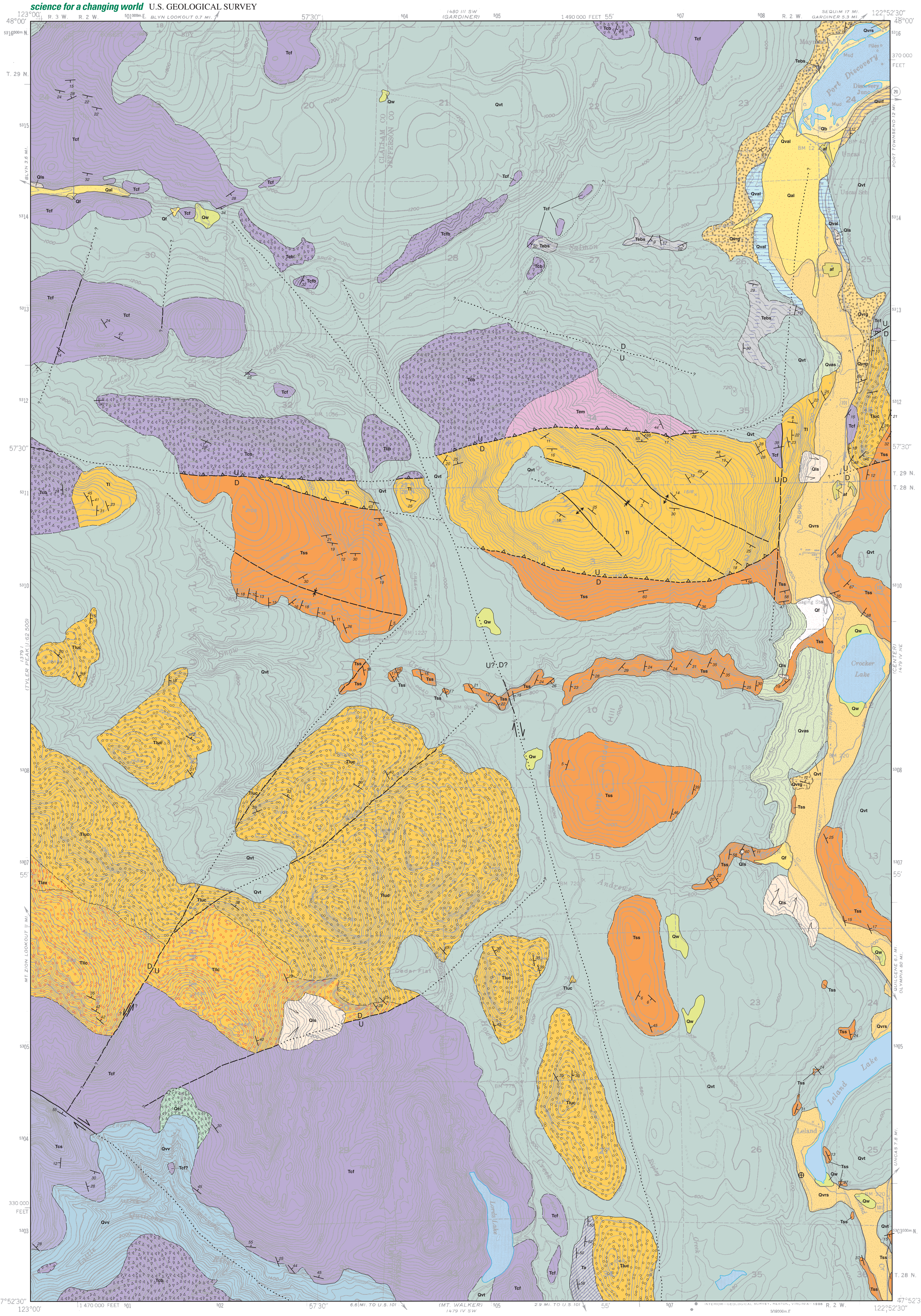
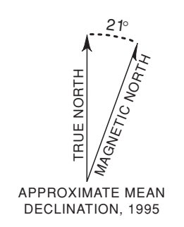
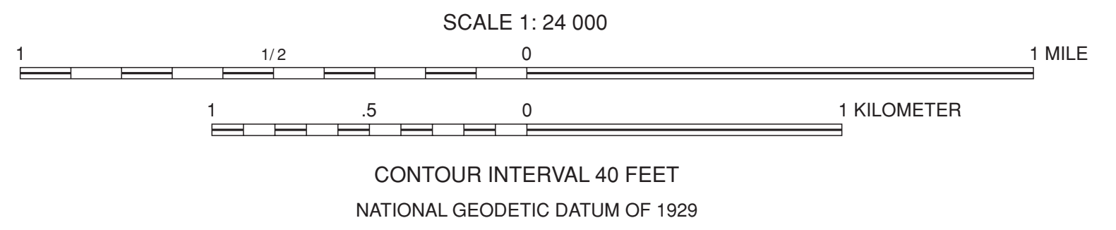
Preliminary geologic map of the Uncas 7.5' quadrangle
Clallam and Jefferson counties, Washington



Base from U.S. Geological Survey, 1953 (rev. 1973)
Universal Transverse Mercator projection, zone 10





PRELIMINARY GEOLOGIC MAP OF THE UNCAS 7.5' QUADRANGLE CLALLAM AND JEFFERSON COUNTIES, WASHINGTON

By

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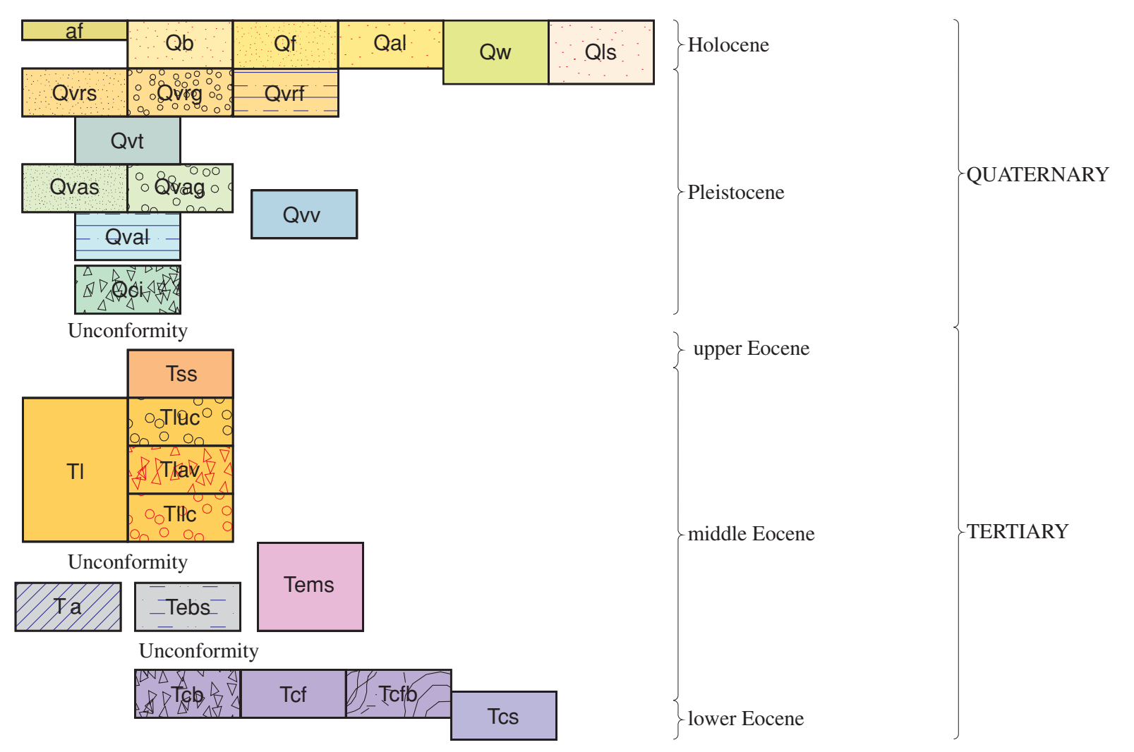
1999

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

Nonglacial deposits

af	**Artificial fill (Holocene)**—Mud, sand, and gravel of varying proportions, possibly including foreign debris such as concrete, logs, timbers, or brick. Used for highway roadbeds and other construction. Thickness generally greater than 2 m. Mapped where fill substantially obscures or has altered original geologic deposit.
Qb	**Beach deposits (Holocene)**—Soft sand, silt, and mud deposited or reworked by wave or tidal action at head of Port Discovery. Contains logs and timbers at or above high tide. Deposits lie within 2 m of high tide.
Qf	**Alluvial fan deposits (Holocene)**—Boulders, cobbles, and soft sand deposited in lobate form where streams emerge from confining valleys and reduced gradients cause sediment loads to be deposited.
Qal	**Alluvium (Holocene)**—Moderately sorted soft deposits of cobble gravel, pebbly sand, and sandy silt along the floodplain of Snow and Salmon Creeks south of Port Discovery, and along Snow Creek in the northwest corner of the map. Gradational with and including sediment equivalent to unit Qb
Qw	**Wetland deposits (Holocene and late Pleistocene)**—Peat, marsh, and bog deposits, with some intermixed sand, silt, and clay. Unit is very soft, water saturated, and occupies shallow depressions in till (Qvt) or low-lying areas of recessional outwash sands (Qvrs).
Qls	**Landslide deposits (Holocene and late Pleistocene)**—Diamicton of angular clasts of bedrock and surficial deposits derived from upslope and commonly includes trees. Includes areas of irregular, hummocky topography. Poorly consolidated. Landslide four kilometers south of Port Discovery consists of house-sized blocks of Lyre Formation conglomerate.

Glacial deposits

DEPOSITS OF VASHON STADE OF FRASER GLACIATION OF ARMSTRONG AND OTHERS (1965) (PLEISTOCENE)—Consists of:

Qvrs	**Sand-dominated recessional outwash deposits (late Pleistocene)**—Stratified unconsolidated sand-dominated sand and gravel deposits. Occupies lower parts of lower Snow Creek-Crocker Lake-Leland Lake valley. May include interbeds of gravel-dominated recessional outwash deposits (Qvrg)
Qvrg	**Gravel-dominated recessional outwash deposits (late Pleistocene)**—Stratified unconsolidated gravel-dominated sand and gravel deposits. Occupies lower margins of lower Snow Creek-Crocker Lake-Leland Lake valley, but lies higher than sand-dominated recessional outwash deposits (Qvrs). May include interbeds of sand-dominated recessional outwash deposits (Qvrs)
Qvrf	**Fine-grained recessional glaciomarine or glaciolacustrine deposits (late Pleistocene)**—Stratified firm fine silt with rounded dropstones of pebbles and cobbles along Highway 20, southeast of Port Discovery. Coarse silt and sand are interbedded. Beds are greater than 3-10 cm thick. Some contacts between beds are convoluted, and sand dikes and blobs are present and cross bedding. Overlies probable till
Qvt	**Till (late Pleistocene)**—Compact and firm light to dark gray non-stratified diamict containing subangular to well-rounded clasts, glacially transported and deposited. Clasts are commonly granitic and were derived from the Cascade Range or Canada. Often overlies advance outwash deposits (units Qval, Qvas, Qvag) in the eastern part of the quadrangle and bedrock in the western part of the quadrangle. Generally forms an undulating surface a few meters to a few tens of meters thick. However, west of Crocker Lake more than 75 m of till is exposed
Qvv	**Valley-fill glacial and glaciofluvial deposits (late Pleistocene)**—Bedded sandy-matrix clast-rich compact diamict with angular clasts and a few large boulders, interbedded with firm fine to coarse sand and silt, and clast-poor clayey matrix diamict, which we consider as till. Clasts are commonly basaltic with probable local provenance. Occupies the headwaters of the Little Quilcene River drainage in the southwestern part of the map area
Qvas	**Sand-dominated advance outwash deposits (late Pleistocene)**—Well-bedded, sand-dominated compact sand and gravel deposits. May have interbeds of silt or clay. Deposited by streams and rivers issuing from front of advancing ice sheet
Qvag	**Gravel-dominated advance outwash deposits (late Pleistocene)**—Well-bedded gravel-dominated compact sand and gravel deposits. Almost devoid of silt or clay, except near base as discontinuous beds. Deposited by streams and rivers issuing from front of advancing ice sheet
Qval	**Advance outwash lake deposits (late Pleistocene)**—Laminated to massive silt, clayey silt, and silty clay deposited in a lowland lake south of Port Discovery. Sediment is firm. Inferred to be proglacial because it is overlain by sand-dominated advance outwash sediments
Qci	**Indurated colluvium (Pleistocene?)**—Indurated unsorted iron-stained angular colluvium on flanks of the Olympic Mountains in the southwestern part of map area. Inferred to predate Vashon stade, because sediment is indurated and lying on bedrock

Bedrock

Tems	**Micaceous sediments (Eocene?)**—Massive buff brown micaceous siltstone and fine sandstone on the north side of Big Skidder Hill. Bedding commonly indistinct or not present. May be correlative to Scow Bay sandstone or the upper Eocene and lower Oligocene Makah Formation, the upper Oligocene Pysht Formation, and the Miocene Clallam Formations at northwestern tip of Olympic Peninsula, where these formations are described as micaceous by Snavely and others (1993) and Garver and Brandon (1994)
Tss	**Sandstone of Snow Creek**—Sandstone and silty sandstone turbidites. Beds 5 cm to 1 m thick. Contains channelized interbeds of pebble and granule conglomerate and siltstone up to 1 m thick. Clasts are dominantly quartz and chert. Foraminifera indicate an upper Narizian age (Spencer, 1984)

LYRE FORMATION (MIDDLE EOCENE) divided into:

Tluc	**Upper conglomerate member**—Pebble and cobble conglomerate in a matrix of medium to coarse granule sand. Contains some sandstone interbeds. Dominantly chert, basalt, and conglomerate clasts in decreasing order of abundance (Spencer, 1984). Clasts to 1 m
Tlav	**Andesite tuff and breccia**—Andesite and hornblende andesite tuff and breccia, white to light gray. Locally contains rare leaves and coalified wood. Commonly massive, but some tuffs are thin bedded
Tllc	**Lower conglomerate member**—West of Cedar Flat unit is predominantly thick bedded to massive conglomerate; to the south thin to thick bedded sandstone with minor conglomerate is most common. Conglomerates are composed of well rounded pebbles and cobbles of chert with lesser amounts of metasedimentary and igneous rocks, quartz, and graywacke. Lower part of unit south of Snow Creek locally includes some angular to rounded basalt clasts. Sandstones are fine to coarse- grained and commonly contain scattered pebbles. Siltstone is sandy and thinly to faintly bedded. Hornblende separates from an andesite boulder in this unit collected just west of the quadrangle boundary, near Mount Zion, yield K-Ar ages of 35.5 and 41.0 Ma (Yount and Gower, 1991). However, Spencer's (1984) biostratigraphic work indicates member is middle Eocene in age, and therefore it is likely there was some argon loss in the samples analyzed
Tl	**Lyre Formation, undifferentiated**—Pebble and cobble conglomerate in a matrix of medium to coarse granule sand. Contains some sandstone interbeds. Dominantly chert, basalt, and conglomerate clasts in decreasing order of abundance. Clasts to 1 m. (data from Spencer, 1984). No direct fossil control on age, but because it lies between the Narizian Aldwell Fm. and the upper Narizian sandstone of Snow Creek, it is probably lower Narizian (Spencer, 1984)
Ta	**Aldwell Formation (middle Eocene)**—Massive to bedded slope mudstone and turbidite sandstone, basaltic conglomerate, lithic sandstone, and siltstone. No fossils have been dated from within the quadrangle, but along strike on the east side of Quilcene Bay foraminifera indicate an early Narizian age (Spencer, 1984), where the section is almost 300-m thick. Coeval with Eocene basaltic sediments (Tebs)
Tebs	**Basaltic sediments (middle Eocene)**—Basaltic conglomerate and breccia, fine- to medium-grained, dark gray to black massive sandstone, with thin local interbeds of dark siltstone. Lowermost few meters is gray-green argillaceous limestone pods and basaltic sedimentary breccia. Total thickness is approximately 230 m along Salmon Creek; benthic foraminifera and molluscs indicate age of section ranges from upper Ulatisian to lower Narizian (Spencer, 1984)

CRESCENT FORMATION (LOWER AND MIDDLE EOCENE) divided into:

Tcf	**Basalt flows**—Massive basaltic lava flows. May contain calcite or zeolite-filled amygdules. Lava may contain pyroxene phenocrysts. Tops of flows may have red oxidized zones indicating subaerial eruption. May contain minor basaltic breccia (Tcb)
Tcb	**Basalt breccia**—Rubbly, reddish weathering angular basaltic breccia. No silty or sandy matrix, indicating subaerial eruption of lava. May contain minor basalt flows (Tcf)
Tcfb	**Basalt flows and breccia**—Rubbly, reddish weathering angular basaltic breccia, and massive basaltic lava flows in roughly equal proportions. Breccia contains no silty or sandy matrix and lava flows may have red oxidized zones
Tcs	**Basaltic submarine deposits**—Pillow lava and pillow and lapilli breccia, amygdular lava flows, dark gray calcareous mudstone, basaltic siltstone and sandstone. Intruded by basaltic sills. At head of Quilcene River sandstone makes up approximately half of section. East of quadrangle at Olele Point, Crescent Formation contains marine siltstone and sandstone with Ulatsian foraminifera (Yount and Gower, 1991). At Bon Jon Pass, 1 km west of the southwest corner of the quadrangle, calcareous nannoplankton from the top of this unit are referred to the CP 11 zone, or early Eocene (D. Bukry, written communciation, 1998)

EXPLANATION

Contact — Dashed where approximately located; dotted where concealed

Fault — Sense of offset uncertain; dashed where approximately located; dotted where concealed

Fault — U, upthrown side; D, downthrown side

Reverse fault —Dashed where approximately located; dotted where concealed

Fault — Showing relative horizontal movement; dashed where approximately located; dotted where concealed

Syncline — Dashed where approximately located, dotted where covered

Anticline — Dashed where approximately located

Strike and dip of beds

15 Inclined

⊕ Horizontal

22f Dip of foreset beds

GEOLOGIC SUMMARY

INTRODUCTION

The Uncas quadrangle in the northeastern Olympic Peninsula covers the transition from the accreted terranes of the Olympic Mountains on the west to the Tertiary and Quaternary basin fills of the Puget Lowland to the east. The relief of the map area ranges from sea level at Port Discovery to 4116 feet on the flank of the Olympic Mountains to the southwest. Previous geologic mapping within and marginal to the Uncas quadrangle includes Cady and others (1972), Brown and others (1960), Tabor and Cady (1978), Yount and Gower (1991) and Yount and others (1993). Paleontologic and stratigraphic investigations by University of Washington graduate students (Allison, 1959; Thoms, 1959; Sherman, 1960; Hamlin, 1962; Spencer, 1984) also encompass parts of the Uncas quadrangle. Geologic mapping for this report was conducted in February 1998 by Haeussler and Wells following preliminary mapping by Yount in 1976 and 1979. The description of surficial map units follows Yount and others (1993) and Booth and Waldron (in press, 1998). Bedrock map units are modified from Yount and Gower (1991) and Spencer (1984). Geologic time scale is that of Berggeren and others (1995).

The Uncas quadrangle lies in the forearc of the Cascadia subduction zone, 10 km east of the Cascadia accretionary complex exposed in the core of the Olympic Mountains (Tabor and Cady, 1978). Underthrusting of the accretionary complex beneath the forearc has uplifted and tilted to the east the Coast Range basalt basement and overlying marginal basin strata, which comprise most of the Uncas quadrangle. The Eocene submarine and subaerial tholeiitic basalt of the Crescent Formation on the Olympic Peninsula is thought to be the exposed mafic basement of the Coast Range, an oceanic terrane accreted to the margin in Eocene time (Snavely and others, 1968). The Coast Range basalt terrane may have originated as an oceanic plateau or by oblique marginal rifting, but its subsequent emplacement history is complex (Wells and others, 1984). In southern Oregon, onlapping strata constrain the suturing to have occurred by 50 Ma; but on southern Vancouver Island where the terrane-bounding Leech River fault is exposed, Brandon and Vance (1992) concluded suturing to North America occurred in the broad interval between 42 and 24 Ma. After emplacement of the Coast Range basalt terrane, the Cascadia accretionary wedge developed by frontal accretion and underplating (Clowes and others, 1987). Domal uplift of the part of the accretionary complex beneath the Olympic Mountains occurred after ~18 million years ago (Brandon and others, 1998). Continental and alpine glaciation during Quaternary time has reshaped the growing topography of the Olympic Mountains.

STRATIGRAPHY

The oldest rocks in the quadrangle belong to the lower and middle Eocene Crescent Formation, which consists of submarine and subaerial basalt flows, breccia, and interbedded sedimentary rocks. Pillow lavas, pillow and lapilli breccia, amygdaloidal lava flows, dark gray calcareous mudstone, basaltic siltstone, and sandstone make up the lower submarine unit (unit Tcs) exposed in the southwestern corner of the quadrangle. Calcareous nannoplankton from interbedded turbidite siltstone and sandstone at the top of the submarine unit at Bon Jon Pass, 1 km west of the quadrangle, are referred to the CP 11 zone, or early Eocene (about 50 Ma), by D. Bukry (written communication, 1998). Most of the upper part of the Crescent Formation consists of amygdaloidal basaltic flows and breccia (units Tcf, Tcb, Tcfb). The breccia are monolithologic, and the flows sometimes have rubbly reddish weathering surfaces indicative of subaerial eruption. However, Spencer (1984) noted that south of the study area, on the west shore of Quilcene Bay, there are massive basaltic flows interbedded with pillow lavas, indicating complex interfingering of environments typical of oceanic islands. No ages have been determined from the subaerial part of the Crescent Formation within the quadrangle. In the Bremerton area, 40 km to the south, Duncan (1982) reported an $^{40}Ar/^{39}Ar$ age of 55 Ma, and Babcock and others (1992) report an $^{40}Ar/^{39}Ar$ age of 50.3 ± 1.5 Ma. East of the quadrangle, Yount and Gower (1991) report foraminifera referable to the Ulatisian stage (early middle Eocene) within marine siltstones and sandstones of the Crescent Formation.

Marine basaltic conglomerate, sandstone, and mudstone (unit Tebs) overlie the basaltic flows and breccia of the Crescent Formation. These basaltic sediments are found in the northeastern part of the quadrangle along the Salmon Creek drainage and along Highway 101 on the west side of Port Discovery. Spencer (1984) measured the section in Salmon Creek as more than 232-m thick and argued that they are sourced from the Crescent Formation. Spencer (1984) found the contact between the underlying basalts and the upper sediments was irregular and undulatory, with limestone and basaltic breccia at the base of the section, suggesting a period of erosion between deposition of the two units. Subaerial basalt flows and breccia stratigraphically beneath the marine basaltic sandstones indicates subsidence following the end of basaltic volcanism. The basaltic sediments contain upper Ulatisian to lower Narizian benthic foraminifera and molluscs indicative of middle Eocene age. Macro-, micro-, and trace fossils are indicative of subtropical to warm temperate water conditions in a neritic depositional environment with water depths <200 m (Spencer, 1984).

The middle Eocene Aldwell Formation is found in one small exposure in the southeastern corner of the quadrangle along Highway 101. Better exposures can be found just south of the quadrangle along the highway. Regionally, the Aldwell Formation consists of thin-bedded slope mudstone and thin-bedded turbidite sandstone (Tabor and Cady, 1978). Massive to well-bedded basaltic conglomerate and lithic sandstone occur locally. Along Quilcene Bay, basal Aldwell Formation interfingers with basaltic sediments, and the contact is placed where coarse, massive to thick-bedded volcaniclastic sediments give way to the more thinly bedded sandstone and siltstone of the Aldwell (Spencer, 1984, p. 24-25). The upper contact of the Aldwell Formation is not exposed, but it may be unconformable based on relations with the overlying Lyre Formation elsewhere on the Olympic Peninsula. Foraminifera from the Aldwell Formation are referable to the lower Narizian or upper Ulatisian stages. Calcareous nannoplankton from the Aldwell are referable to the CP 14a zone (upper middle Eocene, about 44-41 Ma) at Quilcene Bay (Bukry, written communication). This fossil data indicates the Aldwell Formation is coeval with the middle Eocene basaltic sediments described above. The paleoecology of faunas collected from the Aldwell Formation are indicative of cool to cold water in the bathayal zone (Spencer, 1984), which is quite different from the neritic water depths and warm temperatures during deposition of the upper Crescent Formation sediments.

The late middle Eocene Lyre Formation is about 300-m thick in the study area (Spencer, 1984) and consists mostly of conglomerate, with some interbedded andesite tuff and breccia. There is no direct fossil control on the age of this Formation in the study area, but to the west, it contains foraminifera referable to the upper Narizian stage (Snavely and others, 1993). The conglomerates are both clast and matrix supported. Commonly there is no preferred orientation for the clasts, which indicates deposition by debris flows in a submarine fan environment. The interbedded andesitic volcanic rocks on Mount Zion (unit Tlav) may represent post-Crescent rejuvenation of Coast Range volcanism or may represent distal Cascade-derived lavas. Silicic volcanic rocks presumably part of the Crescent Formation have been described in the Sequim quadrangle to the north (H. Schasse, personal communication, 1998). In the southern part of the Uncas quadrangle, the Lyre Formation lies on the Aldwell Formation. Along the western edge of the quadrangle, and northeast of the quadrangle, the Lyre Formation lies directly on the Crescent Formation. Spencer (1984) observed the contact in the upper part of the Snow Creek drainage, and described it as irregular and undulatory. The contact northeast of the quadrangle contains basaltic cobble and boulder conglomerate. From these observations, Spencer (1984) inferred there was considerable relief on the surface beneath the Lyre Formation. Spencer (1984) measured 418 paleocurrent indicators in the Lyre Formation and found a consistent south-southwest direction of transport. The base of the section has a higher percentage of basaltic clasts indicating erosion of the underlying Crescent Formation. Chert and phyllite clasts are also common in the conglomerates, and Snavely and others (1993) and Garver and Brandon (1994) concluded similar clasts in the Lyre Formation at the northwestern tip of the Olympic Peninsula were derived from Mesozoic sediments on southern Vancouver Island.

We informally refer to silty sandstone and sandstone turbidites in the Snow Creek drainage as the sandstone of Snow Creek. The section in the upper Snow Creek drainage is 567-m thick; foraminifera are referable to the upper Narizian stage and are, "... indicative of cool to cold water temperatures and water depths in the lower bathayal zone" (Spencer, 1984, p. 135). Petrography of the sandstones indicates chert and quartz predominate, with chert being a significant proportion of the clasts (Spencer, 1984). Spencer (1984) notes the Snow Creek unit and the rest of the Lyre Formation are related because of a conformable contact and because there is an abundance of chert and metamorphic clasts in both units, which indicates a similar source area. Deposition of the sandstone of Snow Creek appears to be localized because it is not found northeast of the quadrangle, where the Townsend Shale, a unit found outside of the study area, lies unconformably on the Lyre Formation (Thoms, 1959), and the Snow Creek member is missing.

Yount and Gower (1991) and Tabor and Cady (1978) map the Snow Creek unit as the Twin River Formation, and Spencer (1984) considers it to be a member of the Lyre Formation. We prefer to map it as a separate unit similar to the Hoko River Formation of the western Olympic Peninsula (Snavely and others, 1993). We thus avoid expanding the Lyre Formation, and we avoid using the term "Twin River," which has been used as a Group name to refer to several formations that range in age from upper Narizian (uppermost middle Eocene) to Miocene time (e.g. Garver and Brandon, 1994). The lowermost of the formations in the Twin River Group is the Hoko River Formation, which is similar in composition and age to the sandstone of Snow Creek, as used in this study.

Eocene(?) micaceous sediments on the north side of Big Skidder Hill (unit Tems) are problematic. There are no ages from this unit, and contacts with the adjacent Lyre and Crescent Formations are not clear. Massive micaceous siltstone and fine sandstone predominate. They could represent one of three micaceous sequences in the forearc: early middle Eocene Tyee Formation equivalents (Scow Bay sandstone?), Armentrout and Berti, 1977; late middle Eocene Puget Group; or upper Oligocene Pysht Formation and the Miocene Clallam Formation (Garver and Brandon, 1994). Because the micaceous sediments apparently rest on Crescent Formation and are in an upthrown block against Lyre Formation on Big Skidder Hill, it appears likely it may be one of the pre-Lyre units.

Overlying all of the Tertiary units are surficial deposits related to the Vashon stade of the Fraser glaciation of Armstrong and others (1965). The only surficial deposits we found that may predate this stade are indurated colluvial deposits on the flank of the Olympic Mountains in the southwestern part of the study area (unit Qci). Sediments predating the Vashon advance are usually indurated, due in part to the great weight of the ice that overlay the region. The colluvial deposits are also indurated and lie directly on bedrock. They contain locally derived clasts and thus may be correlative with the Evans Creek stade of the Fraser glaciation (e.g. Booth, 1990), a time of widespread alpine ice advance in the Cascade Range and Olympic Mountains that predated the culmination of the Vashon-age ice sheet by about 5,000 years.

During the Vashon advance, the Vashon ice sheet bifurcated northeast of the study area into the Puget lobe, which occupied the Puget Lowland, and the Juan de Fuca lobe, which occupied the Strait of Juan de Fuca (i.e. Waitt and Thorson, 1983). The Puget lobe blocked northward drainage from the Puget Sound region and formed proglacial lakes that drained southward along the Chehalis River valley to the Pacific Ocean at the southwestern extent of Puget Sound. The Juan de Fuca lobe presumably blocked drainage of Port Discovery before occupying it. Pebbly and stoney silts (unit Qval) near Discovery Bay are interpreted as these proglacial lake deposits. These sediments are overlain by both sand- and gravel-dominated advance outwash deposits (units Qvas and Qvag) that were deposited by streams and rivers issuing from the front of the advancing ice sheet. The ice sheet first covered the study area around 18,000-17,500 cal yr B.P., reached its maximum extent in southern Puget Sound around 16,950 cal yr B.P. (Porter and Swanson, 1998), and covered the region with up to 1500 m of ice (Booth, 1987). Till (unit Qvt) marks the presence of the ice sheet in the study area, and mantles most surfaces. Granitic clasts within the till attest to a source at least 100-km away in the Coast Mountains of British Columbia.

The Puget lobe rapidly retreated from its maximum extent and a series of proglacial lakes formed. Retreat of the Juan de Fuca lobe is not as well documented, but it probably also retreated rapidly. When the ice front retreated to the latitude of the study area around 16,500 cal yr B.P. (Porter and Swanson, 1998), the lakes no longer drained to the south through the Chehalis River valley, but began to drain northward through the Leland Creek spillway (Thorson 1979, 1980; Waitt and Thorson, 1983), located along the Port Discovery-Crocker Lake-Leland Lake valley on the east side of the study area. This northward-draining lake is named Lake Bretz (Waitt and Thorson, 1983), although it was initially named 'Lake Leland' by Thorson (1979, 1980). The Leland Creek spillway is 10-15 km long, has a fairly constant width of 200-400 m, and is constrained by the Tertiary sediments on the valley walls. The current high point of the Leland Creek spillway lies at an elevation of 68.6 m, between Crocker Lake and Leland Lake (Thorson, 1979). Thorson (1989) reports silty lake sediments extending to an elevation 60-m to the south of the spillway crest, but these are generally absent to the north. There are some stratified fine silts with rounded dropstones of pebbles and cobbles along Highway 20, southeast of Port Discovery. Higher energy recessional outwash deposits (units Qvrs and Qvrg) overlie, or are incised into, till and were probably deposited while the spillway was active. Recessional gravels lie on point bars exclusively north of the high point of the Leland Creek spillway, possibly due to the higher velocity of streamflow. Following deglaciation there was isostatic rebound as well as a rise in sea level. Details of this history are elusive within the study area, but isostatic rebound explains the presence of glaciomarine or glaciolacustrine deposits at elevations above sea level. Thorson (1989) estimated the magnitude of rebound at Gardiner as 140 m, a few kilometers north of the study area on the west shore of Discovery Bay.

Following the Vashon glaciation, landslides developed on some steep hillsides (unit Qls). Perhaps the most interesting of these is a landslide about 4 kilometers south of the head of Port Discovery, where a massive jumble of Lyre Formation conglomerate, with blocks as large as houses, slumped off the east-facing hillside. As a result, the landslide deflected Snow Creek eastward. The modern depositional environment includes alluvium (unit Qal) and alluvial fan deposits (unit Qf) along modern streams, and beach deposits (unit Qb) along the shores of Port Discovery. Human modification of the geomorphology is mostly seen as artificial fill (unit af) along Highway 101.

STRUCTURAL HISTORY

The structure of the Uncas quadrangle appears difficult to interpret, with faults striking north, east, northeast and northwest. Overall, the area has been tilted eastward on the flank of the growing Olympic uplift, which was accompanied by folding and faulting of the bedrock strata into an eastward plunging synclinal structure. Although attitudes in the Crescent Formation are similar to those in the Lyre Formation, an unconformable contact is inferred by the absence of the Aldwell Formation and the deposition of Lyre conglomerate directly on the Crescent Formation. This suggests deformation began in late middle Eocene time. In the Cape Flattery area, at the northwestern tip of the Olympic Peninsula, the Lyre overlies the main thrust at the base of the Crescent Formation and suggests that it postdates the beginning of accretionary wedge formation (Snavely and others, 1993). On Big Skidder Hill, the attitudes in the Lyre are variable. The attitudes of the overlying Snow Creek member of the Lyre generally strike north or north-northeasterly, which suggests the younger member saw a different structural history than the rest of the Lyre Formation. However, Spencer (1984) argues for a conformable contact at the base of the Snow Creek member, and outcrops of the Snow Creek member along Snow Creek can be interpreted as being positioned near the nose of an eastward-plunging syncline. The eastward plunge of the fold along upper Snow Creek, the eastward dips of most units, and the northwest-striking depositional contacts between the Lyre and the Crescent Formations in the southwestern part of the quadrangle are caused by eastward tilting of the entire area during uplift of the Olympic Mountains, since about 18 Ma (Brandon and others, 1998).

There are three major fault zones in the map area: east-west faults flanking Big Skidder Hill, a major northwest-striking dextral fault zone along Deadfall Creek, and north-striking faults along the Discovery Bay-Crocker Lake zone.

The east-west striking faults on the north and south flanks of Big Skidder Hill may be reverse(?) faults in which Crescent Formation is faulted southward over the Lyre Formation and the Lyre is likewise faulted over sandstone of Snow Creek. Fault scarp breccias indicative of topography and faulting during deposition were not observed and suggest the faults formed later, due to north-south compression of the Olympic Peninsula. Another east-west striking fault with south-side up motion may exist about a mile north of Big Skidder Hill. A fault is needed to explain the presence of the Eocene(?) micaceous sediments on the north side of Big Skidder Hill topographically above the Aldwell-age basaltic sediments in the Salmon Creek drainage.

In the southwestern corner of the quadrangle, the right-lateral Bon Jon Pass fault heads northwest along Deadfall Creek and the little Quilcene River. This fault is exposed in a quarry near the summit of the pass where a 10-m wide shear zone with strong horizontal slickensides juxtaposes Crescent Formation submarine deposits on the southwest with Crescent Formation basaltic flows on the northeast. Locally, these slickensides indicate right-lateral offset. Northeast-trending faults cutting through Cedar Flat juxtapose Lyre Formation with the Crescent Formation and may be normal or left-lateral faults kinematically related to the Bon Jon Pass fault.

A north-northwest trending linear trough in the center of the quadrangle extends along Ripley Creek, the north fork of Andrews Creek, and through the valley west of Big Skidder Hill. West of Little Skidder Hill it corresponds with the contact between the sandstone of Snow Creek and the Lyre Formation. Outcrops along the walls of the Snow Creek drainage reveal several near vertical fractures, some of which indicate right-lateral offset. No major fault was observed, but areas of no exposure in the creek could obscure a fault of moderate displacement.

Along the Discovery Bay-Crocker Lake trend the Lyre Formation and sandstone of Snow Creek on the east side of the valley is folded with northeast strikes, suggesting sinistral drag along the north-northeast fault zone. Total displacement across this fault zone seems limited, given that the stratigraphy is similar on both sides and that a number of structural elements (east-west striking faults, small Crescent uplifts) also appear to correlate across the Leland Creek Valley if small sinistral slip is allowed.

Overall, the deformation and fault pattern generally suggests north-south compression in post-Snow Creek time, a conclusion consistent with underthrusting of the Crescent beneath Vancouver Island and continued northward migration of the Coast Range in response to oblique subduction (Clowes and others, 1987; Wells and others, 1998).

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