UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PRELIMINARY GEOLOGIC MAP OF THE CLEAR LAKE SW QUADRANGLE

SKAGIT AND SNOHOMISH COUNTIES, WASHINGTON

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U.S. Geological Survey

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INTRODUCTION

> "The mountainous sections[1] are very rugged and stand out in great contrast with the flat valley country. The lower lands and hills are covered with a mantle of unconsolidated gravel, sand, and clay, left largely through the action of the great ice sheet of the past. These covering materials, together with intensely thick vegetation and forests, make geologic work quite unsatisfactory in the majority of districts. The cleared lands are usually the alluvial flats. The logged-off hillsides may contain a few rock outcrops, but these must be reached by following old grown-over logging roads and by struggling over wind-falls, through underbrush, etc. Nearly every bit of geological data that is not acquired on a beaten path must be obtained through great physical effort and with a sacrifice of very much time." O. P. Jenkins (1924)

We used an orthophoto base for this geologic map because large-scale base maps of suitable accuracy are lacking. We include a part of the Clear Lake 15-minute topographic quadrangle (scale 1:62,500) in this report, but that map, derived from a 1941 plane-table survey, was not sufficiently accurate for our mapping objectives. We mapped on aerial photographs (photography in 1976; scale approximately 1:24,000) and compiled on the Clear Lake SW orthophotoquad, the southwest one-fourth of the Clear Lake 15-minute topographic map. We supplemented our field mapping on the 1976 photographs with aerial photographs taken in 1941 (scale approximately 1:40,000); interpretation of these photographs aided us in mapping geologic structures and deposits now obscured by dense vegetation. This map is the fourth geologic map produced at a 1:24,000 scale from Clear Lake orthophotoquad maps (see Whetten, Dethier, and Carroll, 1979; 1980, and Dethier, Whetten, and Carroll, 1980).

In addition to the geologic map on an orthophoto base, three other maps are included in this report: (a) an index map, (b) a geologic map showing only geologic units and structures, and (c) a copy of the southwest quarter of the Clear Lake 15-minute topographic map showing generalized bedrock units and structures, for the convenience of the reader in locating map features that are not apparent on the orthophoto base.

ACKNOWLEDGEMENT

Sally Safioles assisted in the field and drafted the map.

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1. (of western Skagit and Snohomish counties)

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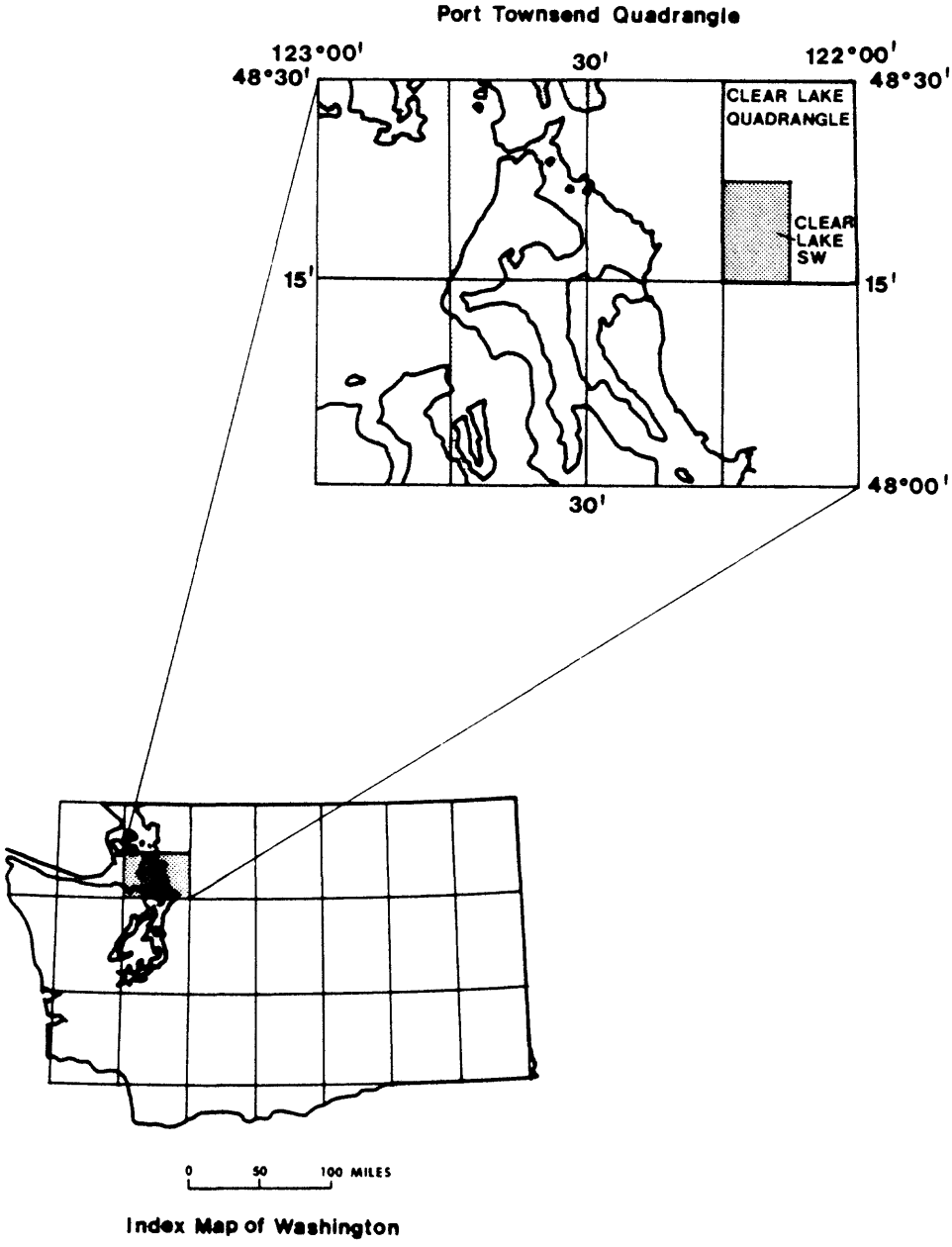
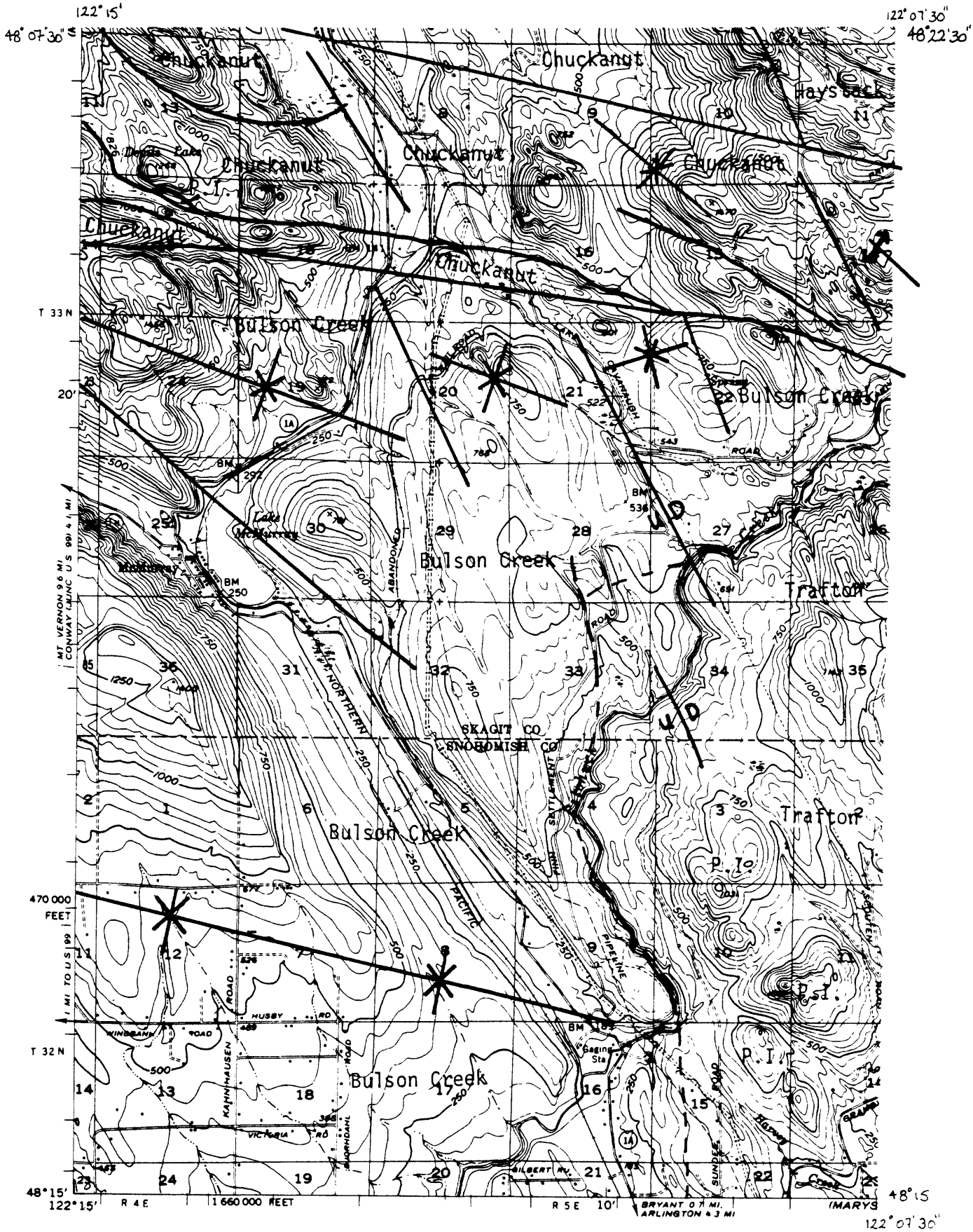
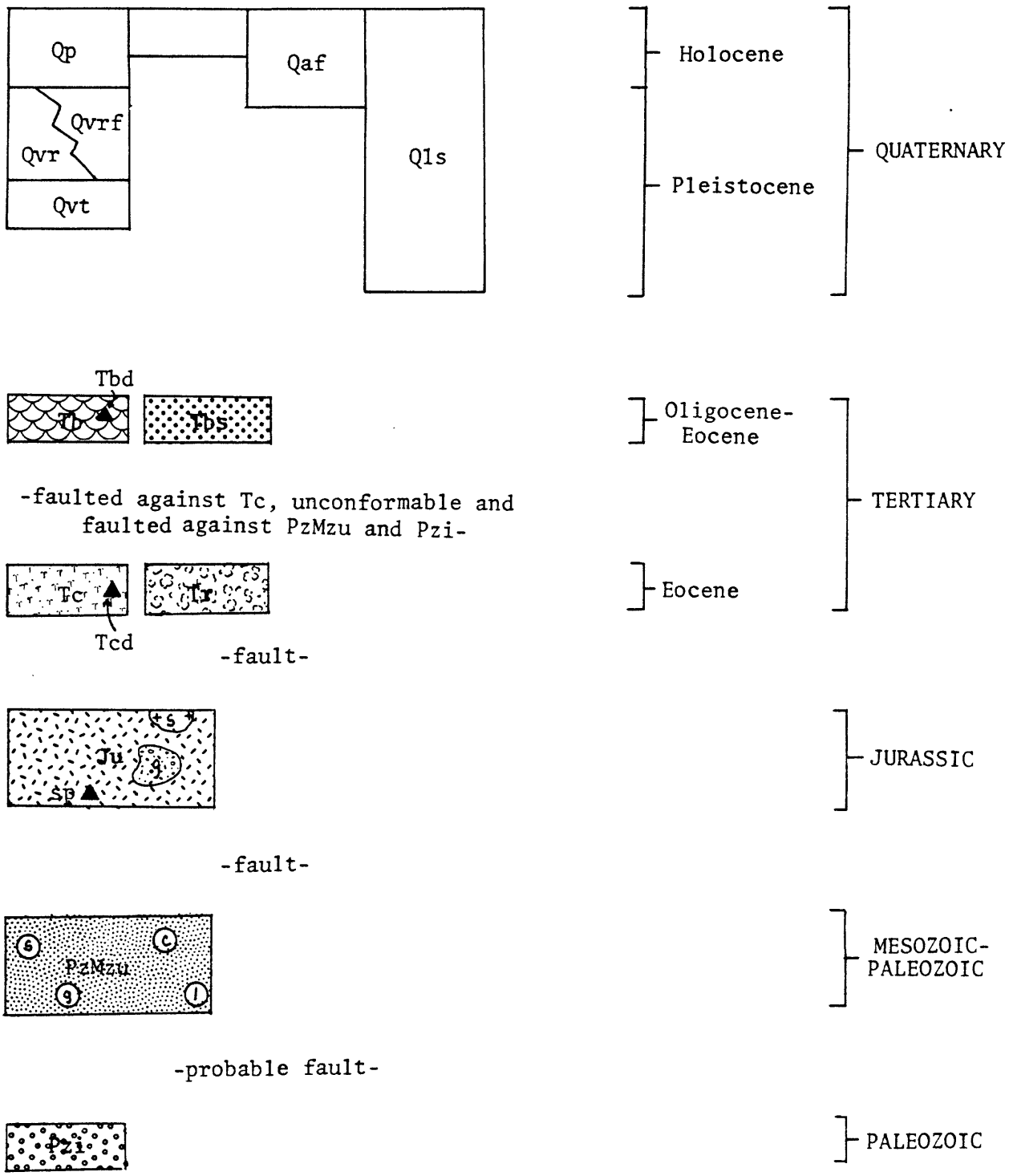


Index map showing locations of Port Townsend (1:100,000), Clear Lake (1:62,500) and Clear Lake SW Orthophoto (1:24,000) quadrangles.



Southwest quarter of the Clear Lake 15 minute topographic quadrangle (1:62,500) showing geographic names, faults, folds, contacts, and principal bedrock units. (Bulson Creek=Bulson Creek unit, Chuckanut=Chuckanut Formation and Tertiary rhyolite, Haystack=Haystack unit, Trafton=Traftion unit, P.I.=Paleozoic Intrusive unit). Bulson Creek depositional contact indicated by dashed line.

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

af ARTIFICIAL FILL

Qal ALLUVIUM - Holocene gravel and sand, and isolated silt deposits occurring along Pilchuck Creek and near Lake McMurray. Sediment is well-sorted and stratified, with subrounded to rounded clasts. Unit includes low terraces 2-6 meters above the modern flood plain.

Qp PEAT - Latest Pleistocene and Holocene fibrous to woody peat and muck deposits. Includes extensive deposits in many shallow elongate ponds and bogs near the Devils Mountain Fault, and north and south of Pilchuck Creek. Tephra from Mount Mazama ($\sim$ 6900 yrs BP) is present as a layer, 20 to 50 mm thick, in some deposits.

Qaf ALLUVIAL FAN - Latest Pleistocene and Holocene cobbles, sand, and boulders deposited southwest of Big Lake, west of Lake McMurray and in other areas where upland streams spill onto valley floors. Deposits consist of poorly to moderately sorted, moderately stratified alluvium, and sediment deposited by debris flows. Clasts are angular to subangular. Overlies recessional deposits.

Qls LANDSLIDE - Pleistocene and Holocene landslide deposits. Deposits are compact, poorly sorted, nonstratified, consist of angular boulders and cobbles in a matrix of finer material, and generally occur downslope from source-area scars which resemble small glacial cirques. The boundaries of the landslides with bedrock and other surficial units are drawn principally from interpretation of aerial photographs. Most landslides include transported glacial material and blocks of locally derived bedrock. Unit may include isolated areas of bedrock, recessional fan deposits, and undisturbed glacial till too small to be shown at a scale of 1:24,000.

RECESSIONAL DEPOSITS

Qvr RECESSIONAL OUTWASH - Late Pleistocene sand and gravel, including fine sand and silt deposits in some areas. Deposits are poorly to well-sorted, stratified, and consist of subangular to rounded clasts. Forms terraces as much as 30 m above modern streams along and south of Pilchuck Creek, and north of Lake McMurray. Collapse structures in the trough north of Lake McMurray and at the south end of the lake suggest deposition on or against ice. Extensive areas of silt which flank the south and southeast shores of Big Lake contain marine molluscs and gastropods dated at 13,040 $\pm$ 65 yrs BP (S. Robinson, personal communication, 1980) by the radiocarbon method. Unit may include small areas of alluvium (Qal).

Qvrf ALLUVIAL FAN - Late Pleistocene poorly to moderately sorted and stratified alluvium and sediment deposited by debris flows. Clasts are angular to subangular. An extensive alluvial fan is exposed on the west slope of Mt. Washington on the east border of the map area. The fan deposit overlies till and is

associated with areas of recessional outwash too small to be shown at a scale of 1:24,000.

Qvt TILL - Late Pleistocene nonsorted, nonstratified, compact deposits consisting of angular to subrounded pebbles, cobbles, and boulders in a matrix of sand, silt, and clay. Till mantles much of the upland area. The prominent northwest-trending bedrock troughs and ridges north and south of Pilchuck Creek are mantled in most places with till; unit includes discontinuous patches of recessional outwash in the troughs, and isolated bedrock outcrops.

Tbd BASALT DIKE INTRUDING BULSON CREEK UNIT - Porphyritic basalt, with phenocrysts of pyroxene in a fine-grained pyroxene-plagioclase groundmass.

Tb/Tbs BULSON CREEK UNIT OF LOVSETH (1975) - Conglomerate, lithic sandstone, and siltstone; outcrops are generally poorly cemented and weathered. Tb is predominantly conglomerate and conglomerate and sandstone, occurs in the western part of the map area, and probably was deposited largely in fluvial and alluvial fan environments. Tbs is sandstone, sandstone and siltstone, and coal (Jenkins, 1924); occurs in the eastern part of the map area, and was deposited at least partly in a shallow-water marine environment as determined by Late Eocene to Early Oligocene shallow water marine megafossils reported by Danner (1957), Lovseth (1975), and Marcus (1980). Tb and Tbs are locally faulted together and may also interfinger, and both units unconformably overlie and are locally faulted against older units (Pzi and PzMzu). Basal beds of Tbs in Pilchuck Creek are very coarse conglomerate (see Danner, 1957, p. 502-503) derived from underlying Pzi. Most clasts in conglomerate appear to have been derived from local sources. Sandstone is generally lithic, but some beds to the east contain abundant K-feldspar, suggesting a source from outside the map area.

Tcd BASALT DIKE INTRUDING THE CHUCKANUT FORMATION - Dark, homogeneous fine-grained rock occurring as thick, well-jointed bodies. K-Ar whole rock ages obtained by Bechtel (1979) are 41.2 $\pm$ 1.8 m.y., 49.9 $\pm$ 2.2 m.y., and 46.4 $\pm$ 2.2 m.y.

Tr RHYOLITE - Ash-flow tuff, flow rock, and probable intrusive rhyolite, locally brecciated, with minor andesite flows, apparently intruding and locally interbedded with Tc. C. W. Naeser (written communication, 1979) obtained a fission-track age on zircon of 52.7 $\pm$ 2.5 m.y. (early Eocene) from rhyolite tuff interbedded with sandstone from a quarry south of Table Mountain (SE¼sec. 14, T. 33N., R. 5E.), and Lovseth (1975) dated zircon from rhyolite from the Hendricks quarry near Big Lake at 41.5 $\pm$ 3.4 m.y. by the same method. The significance of this age difference is not known.

Tc CHUCKANUT FORMATION - Fine- to coarse-grained feldspathic sandstone, siltstone, and coal, massively bedded to finely laminated, with abundant plant debris suggestive of quiet-water to fluvial deposition. Chuckanut-type rocks in map area are probably early Eocene on the basis of early Eocene fission-track ages of detrital zircon from Chuckanut-type sandstone from outside the map area (C. W.

Naeser, oral communication, 1979), early Eocene (Bechtel, 1979) dikes (unit Tcd), and early Eocene rhyolite (unit Tr) that are associated with the Chuckanut. The Chuckanut is faulted against Ju and Tb.

Ju UNDIFFERENTIATED ROCKS OF THE HAYSTACK UNIT - A tectonic mixture without discernible stratigraphic order including greenstone and metaplutonic rock, sedimentary rock, and serpentinite assigned by Lovseth (1975) to the "Rocks of Table Mountain". Nearly concordant Jurassic U-Pb ages (160-170 m.y.) were obtained from two quartz diorite bodies outside the map area (Whetten, Zartman, Blakely, and Jones, 1980). Whetten and others (1980) correlated rocks in Haystack unit with the Fidalgo ophiolite (Brown, Bradshaw, and Mustoe, 1979) in the San Juan Islands on the basis of aeromagnetic properties, age, and lithology. Rocks of the Haystack unit are more strongly metamorphosed in the map area than in the San Juan Islands; aragonite, epidote, and actinolite are present in greenstone, and most sedimentary rocks are moderately to strongly foliated. Rocks of the Haystack unit are in fault contact with the Chuckanut Formation. Unit Ju designates bedrock areas of the Haystack unit that are (a) composed of several lithologies, or (b) poorly exposed. The Haystack unit is divided into:

g GREENSTONE - Generally massive and non-foliated but locally weakly to moderately foliated. Pillow and pillow breccia structures commonly preserved.

s METASEDIMENTARY ROCK - Slate, argillite, and metagraywacke, moderately to strongly foliated, with relict bedding locally preserved.

sp SERPENTINITE - Serpentinite commonly separates blocks of different lithologies. Green to black outcrops vary from strongly foliated to massive.

PzMzu UNDIFFERENTIATED ROCKS OF THE TRAFTON UNIT OF DANNER (1957, 1966) - A chaotically deformed tectonic mixture of chert, argillite, greenstone, and limestone. Within the unit to the southeast, Danner (1957, 1966) has identified Permian Tethyan fusulinids in limestone pods, and D. L. Jones (oral communication, 1977-79) has identified radiolaria in chert ranging from mid-Paleozoic to Jurassic. No fossils have been identified from within the map area. The lithologies listed below are indicated for each outcrop in order of decreasing abundance of each lithology:

ⓒ CHERT - Black to gray ribbon chert commonly associated with ⓢ, intensely crumpled and broken by folding and faulting.

ⓢ ARGILLITE AND SILTSTONE - Black, non-foliated to incipiently foliated, occurs in association with ⓒ and ⓖ. Unit includes minor fine-grained graywacke.

ⓖ GREENSTONE - Predominantly green tuff associated with ⓒ and ⓢ, but also including pillow lava, and massive flows.

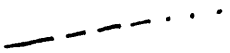
ⓛ LIMESTONE - Fault-bounded blocks of gray limestone.

Pzi MEDIUM- TO COARSE-GRAINED INTRUSIVE ROCK - Ranges from pyroxene gabbro to hornblende-biotite quartz diorite, generally weakly to moderately foliated. Similar quartz diorite associated with PzMzu outside of map area was dated as mid-Paleozoic (R. E. Zartman, written communication, 1978).

MAP SYMBOLS

Outcrop visited by us but consisting of non-foliated or non-bedded rock. Symbol used for other rocks where foliation or bedding was not measured. Symbol denotes outcrops with large areas mapped as bedrock, and isolated outcrops in areas of Quaternary sediments.

Contact



Fault - dashed where inferred, dotted where concealed, ball and bar on downthrown side.

Strike and dip of beds.

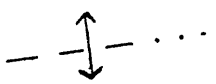
Strike and dip of overturned beds.

Horizontal beds.

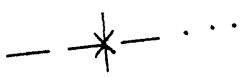
Stike of vertical beds.

Strike and dip of foliation.

Vertical foliation.



Inferred axis of anticline, dotted where concealed.



Inferred axis of syncline, dotted where concealed.

Sample locality for fission-track date on zircon from rhyolite.