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## MAJOR FINDINGS

- The Catfish Lake scarp of the Tacoma fault extends from the Vaughn quadrangle through the Mason Lake quadrangle into the Lake Wooten quadrangle.
- All glacial till in the quadrangle was initially thought to be only Vashon in age. An interbedded sediment sequence yielded an infinite radiocarbon date, meaning that the till beneath it is pre-Vashon in age.
- Most landslides in the area are rooted in pre-Vashon fluvial or glaciofluvial deposits.
- Established a local glacial stratigraphy.

## INTRODUCTION

Most of the land surface of the Mason Lake quadrangle, located near the center of the Puget Lowland, is covered by a thin veneer of glacial drift of the Vashon Stage of the Fraser Glaciation (Armstrong and others, 1965) overlying a sequence of pre-Vashon glacial and nonglacial sediments. The southwest-trending elongate hills that characterize much of the terrain are drumlins sculpted by the Puget lobe of the Vashon continental glacier. Outcrops of pre-Vashon glacial and nonglacial deposits are rarely well exposed in the quadrangle, as they are less resistant to erosion and do not form prominent outcrops. Poorly consolidated pre-Vashon fluvial and glaciofluvial deposits are more permeable than Vashon deposits and have low cohesion. They are the source of numerous landslides in the quadrangle.

The sediments brought by glaciers into the Puget Lowland may be from any of three different source regions. If the predominant rock fragments and grains are from granitic and metamorphic rocks, the probable source is the Coast Range of British Columbia (northern provenance); if the sediments contain andesitic volcanic rock fragments and glass in addition to granitic and metamorphic rock fragments, the probable source is the Cascade Range of Washington (Cascades provenance); and if the predominant rock fragments and grains are from basalt and mafic rocks, the probable source is the Olympic Mountains (Olympic provenance). This section of glacial deposits from the Mason and the quadrangle cross-cut granitic and metamorphic rock fragments and lack andesitic rock fragments and glass, indicating that the deposits are of northern provenance. This differs from deposits in the eastern part of the Puget Lowland, which contain andesitic volcanic rock fragments and glass indicative of Cascades provenance (Walsh and others, 2003).

## GEOLOGIC HISTORY

Bedrock is not exposed in the quadrangle; depth to bedrock is more than 500 ft in the eastern part of the quadrangle (Buchanan-Banks and Collins, 1994). Bedrock is believed to be basal and related rocks of the Crescent Formation, exposed in the Olympic Mountains (Tabor and Cady, 1978) and on Green and Gold Mountains 15 mi north of the quadrangle (Haesseler and Clark, 2000). Our mapping deal with only the uppermost 200 to 300 ft of the more than 500 ft of glacial and nonglacial deposits exposed or intercepted by water wells in the Mason Lake quadrangle. This 200- to 300-ft-thick sequence is divided into Vashon and pre-Vashon sediments.

### Pre-Vashon Deposits

Sediments deposited prior to the Vashon Stage of the Fraser Glaciation are subdivided into three units: pre-Vashon deposits, undifferentiated (unit Qpu); pre-Vashon deposits, fine grained (unit Qptf); and pre-Vashon till (unit Qpt). Most exposures of pre-Vashon till are too small to be shown at map scale. Only one small exposure (Hiawatha Creek, sec. 22, T21N R2W) of pre-Vashon glacial till (unit Qpt) is large enough to be shown as a polygon. Unit Qpt (symbol) is also exposed at low tide in parts of the wave-cut platform at Pickering Passage—on the shores of Harstine Island and the Kitsap Peninsula. An exposure adjacent to the dock in Jarrell Cove State Park is easily accessed.

A second pre-Vashon glacial till was intercepted in water wells in the north-adjacent Lake Wooten quadrangle, as shown in the cross sections of Derkey and others (2009). Water well drillers often designate the compacted layers of till as "hardpan" in their logs. Well logs indicate that this second pre-Vashon till, which is also present in the Lake Wooten and Mazon Lake quadrangles, is composed of sand, silt, and clay (silt) (unit QP2) exposed in either the Mazon Lake or Lake Wooten quadrangles. However, the second till is of northern provenance or Olympia provenance is unknown. Till exposed immediately west of the Lake Wooten quadrangle on the north shore of Hood Canal (Lake Wooten provenance) in Logan, Wash. Duvall and others (2007) suggest that the second till is composed of glacial till from the Mazon Lake area of the Lake Wooten and Mazon Lake quadrangles. We suggest that the second till unit could be Olympia provenance. Both till units are older than a radiocarbon infinite age from an overlying unit in the Lake Wooten quadrangle (Derkey and others, 2009) and could explain the "young glacial tillage" (Logan and Duvall, 2007), which is related to the two older tills and correlation with any possible till unit of the Paget Lowland area were not established.

Interglacial and noninterglacial deposits intersected in drilling water wells are usually logged as loess (based on gravel, sand, and clay). Inconsistencies between water wells logs and rapid lateral facies changes preclude correlation of well logs. The only stratigraphic control available is from the dated radiocarbon interval at the base of the Mason Lake quadrangle; drillers have logged a unit they refer to as ‘clay’, which probably includes abundant silt. In the cross sections, we have separated this clay unit from pre-Vashon deposits, undifferentiated (unit QP0) and designated it pre-Vashon deposits, fine grained (unit QP1). The relative thickness of the clay unit varies considerably among the wells. The clay unit is present in all wells except unit QP2 corer where it was exposed large enough to be included as a map unit in the vicinity of Jarvis Cove. State Park area on Harstine Island. Carbonaceous material believed to be from the same silt and clay bed in the Lake Wooten quadrangle (Derkey and others, 2009) was found to be radiocarbon infinite, substantiating our belief that it occurred beneath the pre-Vashon. This clay unit, from this interval on the east shore of Harstine Island, has been dated by AMS yielding a radiocarbon infinite age (Legan and Wells, 2007), again substantiating that the underlying silt is pre-Vashon.

### Vashon Glacial Deposits

Unit mapping of the Masouke quadrangle identified Vashon-age deposits consisting of advance outwash (unit Qgq), till (unit Qgt), and outwash and ice contact deposits (units Qgo, Qgos, Qgic, and Qgoe). Stratigraphic relationships are illustrated in Figure 1 and Cross Sections A and B. Vashon till (unit Qgt), which may be as much as 50 ft thick, is typically poorly sorted with angular sand-size grains. It was compacted by the weight of the overlying glacier and is resistant to erosion relative to the other Quaternary units—only a few streams have cut down through it. Tree roots rarely penetrate it, and water does not easily move down through it, resulting in overland flow during periods of high precipitation. Numerous small, circular depressions are scattered throughout the till surface. Vegetation flourishes in these depressions with *acomplanatus* accumulation of peat (unit Orh).

Sediments underlying Vashon till (unit Qg) consist of Vashon advance outwash (unit Qga) and a diverse sequence of glacial outwash and interglacial deposits. Vashon advance outwash is often difficult to distinguish and map separately from the non-till deposits older than Vashon till. Consequently, the only deposits mapped as Vashon advance outwash (unit Qga) occur near and adjacent to Mason Lake. The subsurface between Hood Canal and Mason Lake consists of a thick sequence of pre-Vashon, non-till deposits, which we map as pre-Vashon deposits, undifferentiated (unit Qpu). Cross Section B is a schematic representation of this sequence based upon data from only one water well log.

## LANDSLIDES

Numerous landslides have been identified in the Mason Lake quadrangle. Landslide polygons (Isabelle Sarikhan, Wash. Divn. of Geology and Earth Resources, unpub. data, 2009) were modified using lidar to establish approximate boundaries. Virtually all landslides that have been identified are associated with pre-Vashon deposits, undifferentiated (unit Qpu). The larger landslide scarps encroach upward into overlying Vashon till (unit Qgt). We suggest that the more permeable outwash and nonglacial deposits in the Mason Lake quadrangle, when combined with steep slopes, are subject to development of landslides.

## STRUCTURE

The lake-identified trace of the Catfish Lake scarp of the Tacoma fault (Sherrod and others, 2003, 2004; Nelson and others, 2009) is in the northeast corner of the quadrangle. The fault is a high-angle reverse fault that dips northward at 55 to 60 degrees, with 'up' on the north side of the fault (Logan and Walsh, 2007). We have extended the trace of the fault northward into the Lake Wooten quadrangle based on lidar and on exposures in a borrow pit (Derkey and others, 2009). Although the strong lake-identified trace of the fault appears to end where we have discontinued the solid fault trace on the map, which is also where Nelson and others (2009) have ended it, we suggest there is evidence of its extension into the Lake Wooten quadrangle (Derkey and others, 2009).

### DESCRIPTION OF MAP UNITS

### Holocene and Pleistocene Nonglacial Deposits

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| ni  | <b>Modified land (Holocene)</b> – Soil, sediment, or other geologic material that has been locally reworked to modify the topography by excavation and/or redistribution.  |
| Qa  | <b>Alluvium (Holocene)</b> – Silt, sand, and gravel deposited by streams; may include some lacustrine deposits and organic materials, such as peat.  |
| Qb  | <b>Beach deposits (Holocene)</b> – Mud, sand, and gravel deposited in the intertidal zone, or residual pebble-cobble gravel and isolated boulders on a wave-cut platform.  |
| Qp  | <b>Peat (Holocene)</b> – Organic-matter-rich sediments deposited in closed depressions; in addition to peat, may contain silt and clay; commonly clogged with aquatic plants, abundant tree snags, stumps, and other woody debris in and adjacent to shallow or seasonal swamps and ponds.   |
| Qal | <b>Alluvial fan (Holocene)</b> – Silt, sand, and gravel deposited where upward streams meet valley floors; generally overlies till (unit Qg), recessional outwash (unit Qgo), and alluvium (unit Qa).  |
| Qc  | <b>Landslide deposits (Holocene and Pleistocene)</b> – Generally loose, jumbled, tan to gray, silty sandy gravel with few to no discernible sedimentary structures; surfaces of landslides are often highly irregular; may contain clasts of older units; often associated with surface failures or block falls. Almost all occur in pre-Vashon sediments, undifferentiated (unit Qp). |

### Deposits of the Vashon Stade of the Fraser Glaciation

- Qgo** **Vashon recessional outwash (Pleistocene)**—Recessional and proglacial outwash sand and gravel of northern provenance, locally containing silt and clay; stratified; gray, tan, or brown; moderately to well rounded, poorly to moderately sorted; may include ice-contact, stratified drift, and lacustrine deposits. Divided into:

- Cross Sections.** Cross sections were constructed based on sparse reliable water well data. Wells were used to establish the stratigraphy and do not depict a precise depth to unit contacts. The cross sections schematically represent stratigraphy and should not be used to determine depth to a particular stratigraphic unit at any point along their path.

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