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GEOLOGIC MAP OF VASHON AND MAURY ISLANDS, KING COUNTY, WASHINGTON

By

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INTRODUCTION

Vashon and Maury Islands display a wide variety of geologic deposits, which reflect many geologic environments and processes. Multiple ice-sheet glaciations and intervening nonglacial intervals have constructed a complexly layered sequence of deposits that underlie both islands to a depth of more than 300 m below sea level. These deposits not only record glacial and nonglacial history but also control the flow and availability of groundwater, determine the susceptibility of the slopes to landslides, and provide economic reserves of sand and gravel.

Vashon and Maury Islands occupy about 95 km^2 in the south-central Puget Lowland about 20 km south-southwest of downtown Seattle (fig. 1). The islands are surrounded by channels of Puget Sound, some as deep as the islands are high (greater than 200 m). Shorelines provide over 80 km of generally well-exposed coastal outcrops. They reveal a high degree of lithologic and stratigraphic detail not ordinarily displayed in the heavily vegetated Puget Lowland. Generalized geologic cross sections depict stratigraphic relations exposed in coastal outcrops along the shoreline of Vashon and Maury Islands (map sheet).

The geology of the islands was first mapped by Willis (1898), who named the most recent glaciation after deposits he observed on Vashon Island. Subsequent work included the regional mapping of Garling and others (1965) and the near-shore study by the Washington Department of Ecology (1979). My fieldwork took place during the winter of 1987 and the successive springs of 1987, 1988, and 1989 as part of a King County-supported groundwater study. In the course of mapping, I inspected road cuts, foundation excavations, most stream channels, and the entire coastline of both islands. Landslide identification was facilitated by aerial photographs and data compiled directly from the Coastal Zone Atlas (Washington Department of Ecology, 1979). Paul Haase of the U.S. Geological Survey provided valuable well-log data for interpretation of subsurface structures.

GEOLOGIC SETTING

During the Pleistocene, the Puget Lowland was glaciated at least several times by ice originating in the mountains of British Columbia (Crandell and others, 1958; Easterbrook and others, 1967). By analogy to the most recent glaciation, a lobe of the Cordilleran ice sheet (named the "Puget lobe" by Bretz, 1913) advanced down the trough now occupied by Puget Sound, filling the lowland from the Cascade Range to the Olympic Mountains (map sheet). During these glacial times, clasts of distinctive rock types were carried southward by the ice and its meltwater and were subsequently deposited in the Puget Lowland. These "exotic" lithologies, particularly high-grade metamorphic rock types, are found in both tills, typically impermeable and laid down beneath the ice sheet itself, and in glacial outwash, permeable sand and gravel deposits laid down by water originating from the ice sheet.

During intervening nonglacial times, drainage from the adjacent mountains surrounding the Puget Lowland moved a more limited suite of rock types, particularly unmetamorphosed sandstones and lavas, over parts of the region (although reworking of lowland glacial deposits may incorporate exotic lithologies as well). The existing channels of Puget Sound currently isolate the islands from the mainland sediment supply, so lithically equivalent sediments are not being deposited here today. Yet the widespread presence of older such material on both Vashon and Maury Islands suggests that the present channel and inlet configuration did not necessarily persist much before the most recent glaciation. Nonglacial deposits in the map area therefore record a discontinuous, incomplete record of periods when lowland drainage courses traversed the area, interbedded with the (also discontinuous) record of regional glacial advances.

The naming and regional correlation of the individual glacial advances in the Puget Lowland has a long and still-evolving history. Willis (1898) first presented evidence for multiple episodes of glaciation in the Puget Lowland. Crandell and others (1958) proposed a sequence of four glaciations separated by nonglacial intervals based on stratigraphic sequences in the southern Puget Lowland (see map sheet), east of Vashon and Maury Islands. Easterbrook and others (1967) named and described deposits farther north of three glaciations and their intervening interglacial periods. Efforts at dating these separated stratigraphic sequences (Easterbrook and others, 1981; Easterbrook, 1982) have not yet provided any demonstrable correlation beyond the most recent ice-sheet advance. Recent work by Westgate and others

(1987) suggests little or no correlation between the "northern" and "southern" sequences (fig. 2).

Regional correlations of isolated island exposures highlight these difficulties. Garling and others (1965)

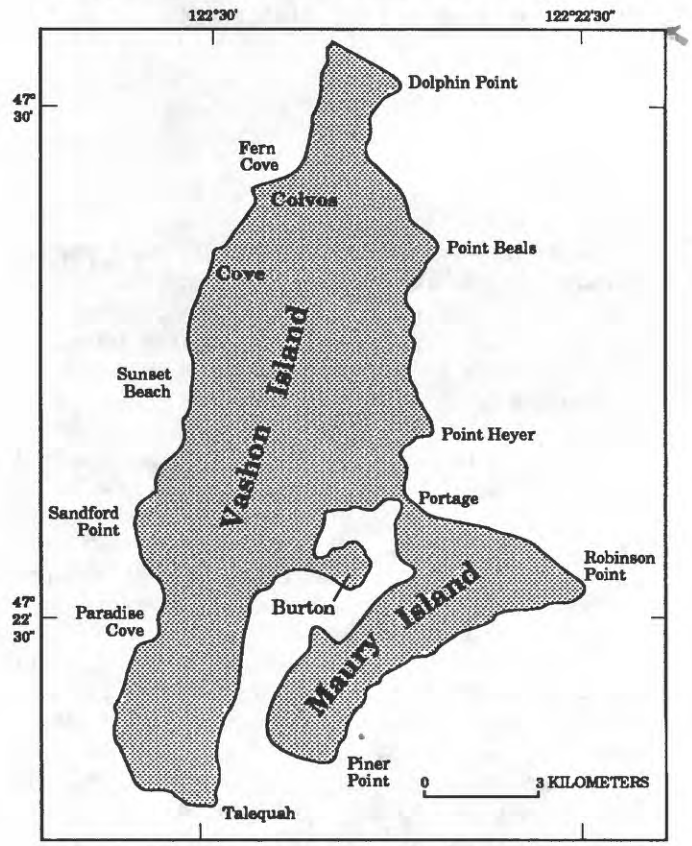

Figure 1. Map showing Vashon Island and Maury Island and principal place names.

presumed that what they called the Salmon Springs(?) Drift could be traced sufficiently close to Vashon and Maury Islands from its type locality that a correlation with the island deposits was warranted. Following Crandell and others (1958), they also presumed that this Salmon Springs(?) Drift originated from the glaciation immediately preceding the most recent ice-sheet advance (the Fraser glaciation of Armstrong and others, 1965). The type-Salmon Springs Drift, however, has been recently dated at older than 750,000 B.P. (Easterbrook and others, 1981; Westgate and others, 1987), leaving an interval in which one and almost certainly more than one additional glaciations reached into the Puget Lowland (Lea, 1984; Booth, 1990). Thus either the penultimate drift exposed on Vashon and Maury Islands is younger than the type Salmon Springs, or a long depositional record is absent in at least the surface exposures here (as appears to be the case in the type section farther east).

In this study, pre-Fraser glacial deposits are not assigned regional names. Deposits of the Vashon stade (for example, the regional ice-sheet advance and retreat) of the Fraser glaciation, culminating about 15,000 B.P., are widely distributed and dated throughout the lowland region (see review by Booth, 1987). These deposits are well exposed and so named on the islands here. The Colvos Sand Member (Walters and Kimmel, 1968) of the Vashon Drift (equivalent to the Colvos Sand of Garling and others, 1965), described as the lowermost member of the Vashon advance outwash, is here abandoned as a mapping unit because it distinguishes a deposit of no particular time-stratigraphic significance and ambiguous lithologic or textual distinction. This follows recent convention in geologic mapping throughout the central Puget Lowland (for example, Minard, 1983; Pessl and others, 1989; Booth, 1990). These strata are here reassigned to the Vashon advance outwash (Qva).

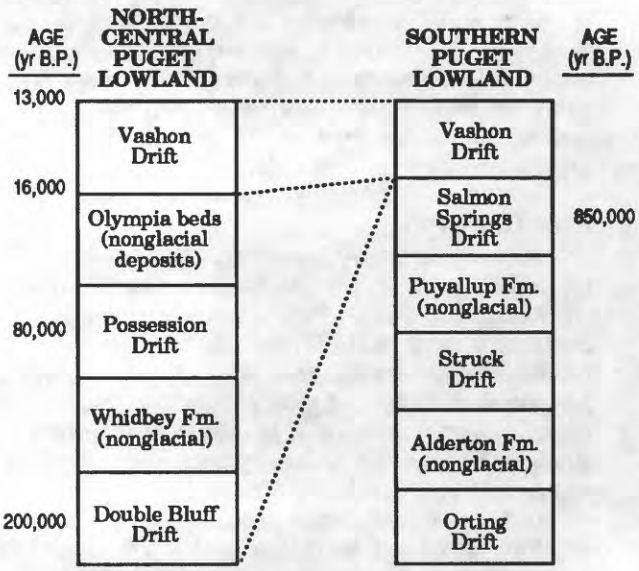

Figure 2. Regional correlations in Puget Lowland. All dates from Easterbrook (1986). Informally named Olympia beds from Minard and Booth (1988).

Pre-Vashon nonglacial deposits, variously assigned by Garling and others (1965) to either their Colvos Sand or Kitsap Formation, are here mapped largely as either the transitional beds (Qtb) or the (informal) Olympia beds of Minard and Booth, 1988 (Qob). They are inferred to mark deposition during or at the close of the Olympia interglaciation of Armstrong and others (1965) on the basis of stratigraphic position, locally gradational upper contacts, Vashon-age sediment, nonglacial textures and lithologies, and widespread occurrence.

Beneath the Olympia beds, a widely exposed lacustrine deposit commonly crops out near sea level. Although mapped as a separate unit because of its continuity and distinctive fine-grained lithology, it may well represent only a distinguishable facies of Olympia-age deposition. Interbeds of texturally equivalent sediment within the herein-mapped Olympia beds, particularly along the north shore of Maury Island, support such an interpretation.

The Kitsap Formation (Armstrong and others, 1965; see also Garling and others, 1965) is also here abandoned. Its utility as a stratigraphic marker is hampered in part by the formation's definition as fine-grained sediments lying between two other units of uncertain value, the Salmon Springs Drift and herein-abandoned Colvos Sand member. The formation as defined may also be substantially time-transgressive, possibly spanning more than one glaciation. For example, Garling and others (1965, p. 31) suggest its correlation with the 15,000-year-old Lawton Clay Member of the Vashon Drift (Mullineaux and others, 1965); with the Quadra Sand of Clague (1976), identified as advance outwash of the Vashon ice-advance; with interglacial deposits of finite radiocarbon (for example, Olympia) age in the Seattle area (Stark and Mullineaux, 1950); and with deposits of the Whidbey Formation, predating even the Possession glaciation of Easterbrook and others (1967) farther north. Deeter (1979) mapped the Kitsap Formation farther north but also noted ambiguities in its definition and usage. The abandonment of this unit follows recent regional stratigraphic convention (for example, Blunt and others, 1987). Its strata are here reassigned to either the transitional beds (Qtb) or older pre-Fraser units (Qpf, Qcs, Qpof, or Qcso).

Beneath the Olympia beds as mapped in this study, various glacial and nonglacial sediments are exposed, particularly along the west shores of Vashon Island. In the north and central parts of the map area, at least two tills underlying the Vashon-age deposits are locally exposed, with intervening fluvial and lacustrine deposits. South of about Paradise Cove, however, coarse oxidized outwash is common but two distinct tills are absent. These various layers are subdivided on the basis of stratigraphic position and texture, but I have not mapped them as correlative with other named formations in the Puget Lowland. Such correlation will require reliable dating of these deposits, probably in conjunction with a better understanding of regional glacial history. Speculative correlations, however, are suggested by stratigraphic sequence, relative weathering, and one infinite radiocarbon age at the south end of Vashon Island (sample number USGS 2693; >53,000 B.P.); speculative correlations are shown in fig. 3.

MAPS AND SECTIONS

Three diagrammatic cross sections (on map sheet), a structure contour map (fig. 4), and a 1:24,000 geologic map accompany this report. The cross sections represent an idealized view of the deposits as exposed in the sea cliffs. These particular areas were chosen because of their complexity and general degree of exposure, which enable most (but not all) of the stratigraphic relations to be directly observed or readily inferred.

The structure contour map (fig. 4) displays the altitude of the base of the Vashon-age advance outwash. Control was provided by the mapped surface exposures of this unit and eighteen water-well logs on file at the U.S. Geological Survey in Tacoma, Wash.. Because the base of this unit is defined by the uppermost appearance of silt, assigned to either the transitional beds (Qtb) or older lacustrine units (Qpf, Qcs, Qpom, or Qcso), this contour map delineates a horizon of particular hydrogeologic importance, namely the aquitard underlying the uppermost extensive aquifer beneath the islands' surface. Where this surface descends below sea level, it marks the likely location of a pre-Fraser arm of Puget Sound.

NORTH-CENTRAL PUGET LOWLAND (Easterbrook and others, 1967)	VASHON and MAURY ISLANDS (this study)
Vashon Drift	Qvr Qvi Qvt Qva
Olympia beds (nonglacial deposits)	Qtb Qcs Qob Qpf
Possession Drift	Qdi Qti
Whidbey Fm. (nonglacial)	Qcso Qpff, Qpfm Qpof, Qpom Qsgo
Double Bluff Drift	Qdo Qto Qsgo

Figure 3. Speculative correlations for Vashon and Maury Islands, Washington. See Description of Map Units for explanation of map unit symbols used in this figure.

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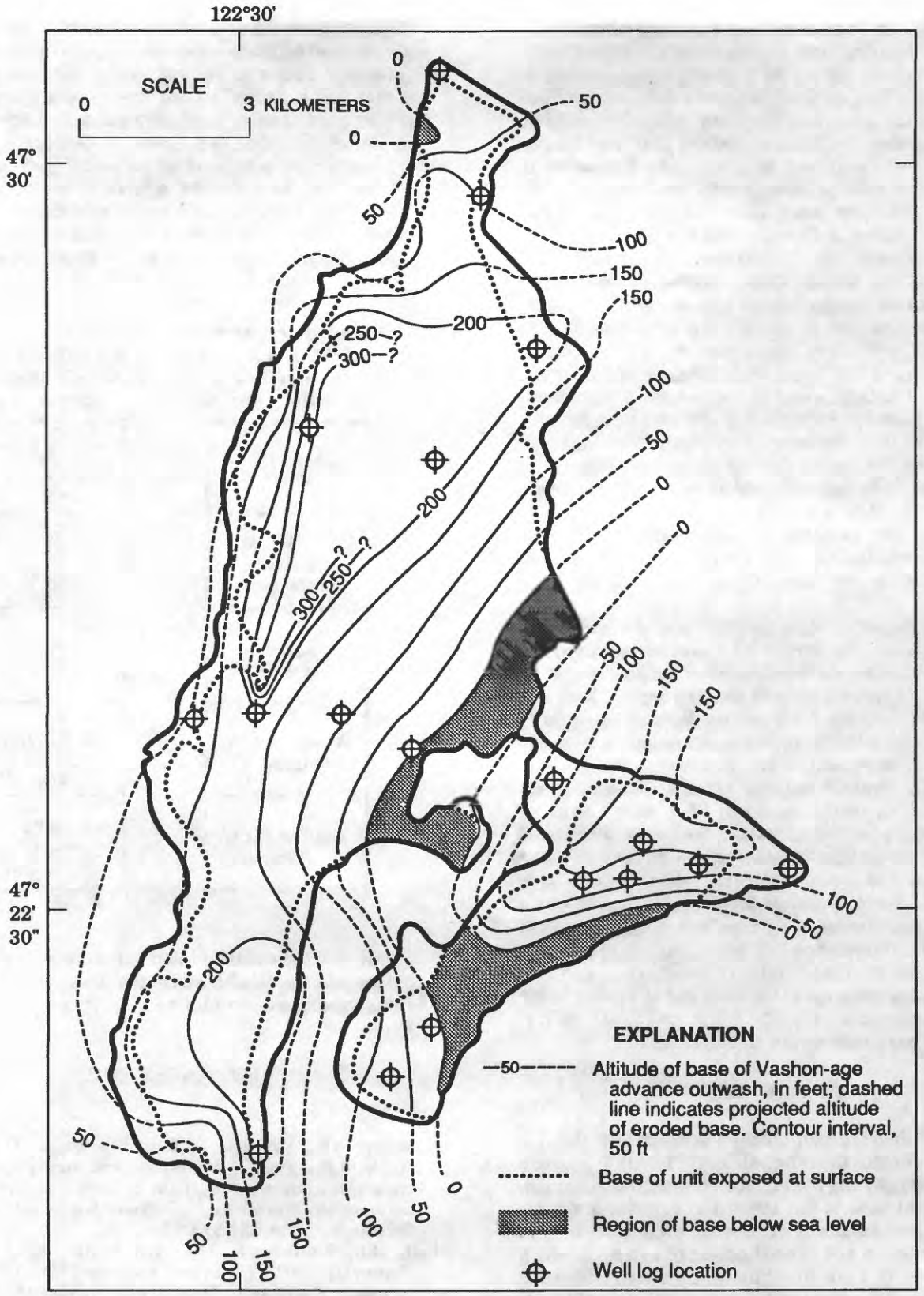

Figure 4. Structure contour map showing altitude of base of Vashon age advance outwash, in feet.

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7.5-minute quadrangles

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