Northwest Geological Society

Society Field Trips in Pacific Northwest Geology

Whidbey Island Quaternary Sediments

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Gerald W. Thorsen
927 56th St.
Port Townsend, WA

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Introduction

This field trip guide and our three stops should provide an overview of almost all of the mappable Quaternary units on Whidbey Island in Island County and the central Puget Lowland. (See Plate la, b for locations.) Stop 1 probably offers better exposures of a greater number of units than does any other locality in the entire Puget Lowland. Stop 2 will introduce, close up, some characteristics of the Whidbey Formation, as well as the Esperance/pseudo-Esperance problem. Stop 3 emphasizes the Holocene and modern processes, problems, and some potential hazards.

Time limitations (and tide) confine us to the three planned stops, where we will sample less than 3 miles of Island County's 200 miles of shoreline. If there is time and interest, we could make a brief stop at the southernmost bedrock on Whidbey. (Its only contribution? to the Quaternary is that striations indicate ice movement to the west!)

Table 1, a generalized stratigraphic column presented on the next page, sets the stage for the trip. There, as well as in the text and figures, I have taken some liberties that could be confusing, primarily through the use of informal names. For example, I differentiate Double Bluff and Possession Drifts into till and glaciomarine facies, where possible, to emphasize that all three glaciations (including the Fraser) had late glaciomarine deposition. I also emphasize the importance of the West Beach Silt (both loess and lake-bed facies) in differentiating advance outwash sands of the Fraser (Esperance Sand) and the Possession (Possession sand) glaciations.

Some operational notes for this part of the trip:

Mileages on the map (Plate la, b) are from the end of our first trek at the lighthouse at Fort Casey, not from Ebey's Landing, our first stop and the start of the trek. Capital letters followed by an asterisk (e.g., B*) indicate "drive-bys", not stops. These drive-bys are points of interest between stops and are briefly discussed in the text.

Banks and upper beaches, at least those at Stops 1 and 2, are largely private property, so please use discretion as we walk along and during any "trenching operations". Owners are well aware of the importance of vegetation to bank stability. Also, if you want a closer look at the paleosol at the base of the loess at Stop 1, you can get it.with little climbing. The local easterly dip of the unit here brings it much lower when we round the corner ("Point Ebey") to the southeast.

Stop 1. Ebey's Landing

From Ebey's Landing we have an overview to the northwest. The bank of Partridge Gravel in the distance is separated from the Strait by a barrier bar that protects the bank here from erosion. The bank is made up of the Partridge gravel. Note the lumpy upper surface of the otherwise flat gravel terrace. These are dormant sand dunes, now cut off from their supply by vegetation on the bank. Such linear dunes, parallel to the bank, rim much of the bluff area to the north of here. Note also that the dunes are covered by mature conifer, indicating that they have been stable (not accreting or eroding) for centuries, possibly millennia.

The island in the middle distance to the west is Protection Island. A valley fill of basaltic gravel underlying Vashon advance outwash of mixed lithology indicates that the island was part of the Olympic Peninsula during the Olympia nonglacial interval but cut off from the mainland during the following glaciation. Wood from the base of that fill at high-tide elevation, has been dated at about 34,000 yr BP. A now buried loess from the adjacent highland drapes into and interfingers with that fill but does not seem to extend below it, suggesting that the paleosol at the base of the loess may correlate with the buried forest at the base of the fill.

We will walk south from the parking area to the lighthouse at Fort Casey, a distance of about 2.6 miles, where we will (I hope) meet the vans. Our first point of interest is about 750 yards south of where the road climbs away from the beach. There are sections (one sheet, in the pocket) for this stop. A dike-like remnant (perpendicular to the shoreline) can be seen in the upper grassy slope. The following discussion refers to a section about 50 yards south of this landmark.

Note the rust-colored paleosol at the base of the massive silt mid-bluff. This paleosol is the most obvious horizon for examining the vertical offset along the thrust faults that cut this section and others to the south. These faults seem to split into multiple splays and die out near the top of the loess, but they extend as far as you can see into the underlying sands. Are these faults (we will see at least two more)

Period	Age, in Thousands of years BP	Unit	Unit description (most common appearance or lithology)	Stop where seen
Holocene	5 – 0	Slide deposits	Uneven, hummocky topography, fronting near-vertical scarps	1
	5 – 0	Beaches	Sand and gravel	1, 2, 3
		Peat [1]	Brown and black organic muck with isolated large wood debris	2, 3
	5 – 0	Dunes [2]	Low hills of fine, uniform sand rimming shoreline bluffs	1(distant) betw. 2, 3
Fraser Glaciation	13 – 11	Everson glacial marine drift Partridge Gravel [3]	Tan blocky clay, nonstratified, with isolated dropstones Gray sandy gravel in angle-of- repose slopes	1, 2, 3 1 (distant)
	20 + – 13	Vashon Till	Till overlain by gmd (Everson)	1, 2
		Esperance Sand	Gray pebbly sand, angle-of-repose banks	1
Olympia nonglacial interval	28* – 20	West Beach silt (informal name)	Yellow-tan silt in vertical banks, little or no stratification except where deposited in a local lake	1, 2
Possession Glaciation	90 – 28*	Possession drift	Till and ? overlain by gmd	1
		Possession sand [4] (informal name)	Gray pebbly sand, angle-of-repose banks	1, 2
Whidbey interglacial interval	100 – 90	Whidbey Formation	Gray stratified silt, ice-compacted peat, local sand, pebbly sand, oxidized in places	2, 3
Double Bluff Glaciation	250 – 100	Double Bluff drift	Till overlain by gmd	1

I/ Three forms, including that within the Whidbey, visibility dependent on elevation of beach and stage of tide 21 Removed for development in places
3/ Cynthia Carlstad (oral commun., 1996(?)) concludes that the gmd and gravel interfinger (are contemporaneous) in
this area 4/ Also known as "pseudo-Esperance"; indistinguishable from Esperance where the West Beach silt is absent
* Dates on wood from Protection Island suggest that the Possession/Olympia boundary may be at least 34,000 yr BP

Table 1. Generalized geologic column for the Quaternary of Whidbey Island as seen on the NWGS field trip. Gmd, glaciomarine drift. Ages (except for Holocene) from table 1 of Blunt et al. (1987)

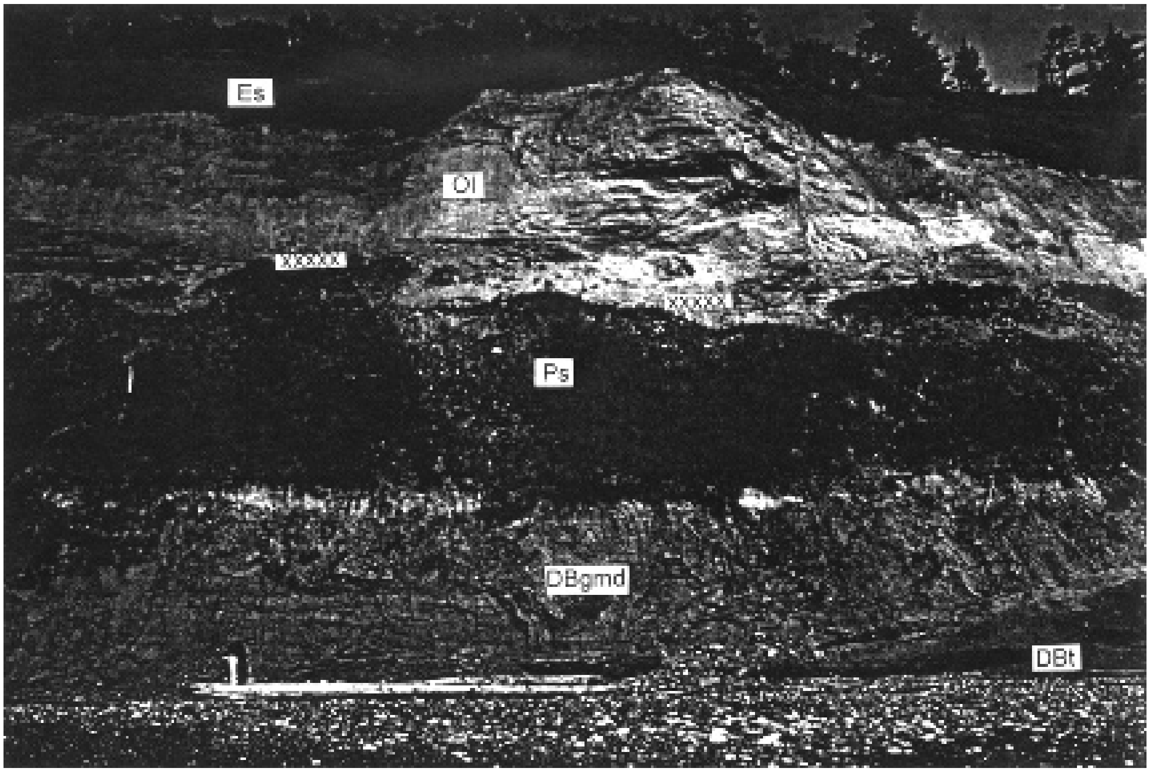


Figure 1. Fault 2. Note how it splays upward as it cuts the loess. Es, Esperance Sand; Ol, Olympia loess (West Beach silt); Ps, Possession outwash sand; DBgmd. Double Bluff glaciomarine drift; DBt, Double Bluff till. The paleosol at the base of the loess is marked by xxx

the result of Olympia-age tectonic activity when the loess was at the surface and still soft? If tectonic, why are there no traces cutting the drift below the sands? If the faults are of glaciotectonic origin, how could the ice sheet get "traction" this deep, and why don't the faults cut the loess as a single plane rather than splitting near the top? Also, the faults here are straight and cut the underlying sands, whereas a clearly glaciotectonic fault cutting the loess near Oak Harbor curves downward and dies out along the contact at the base of the loess.

Fault two can be seen in mid-bluff just north of where the Double Bluff till emerges from beach level and just south of the "private beach" sign. (See Fig. 1.) Characteristics are similar to the first fault (fault angle, amount of offset, does not fully cut the loess, cuts the underlying sand). I could find no fault plane cutting the glaciomarine facies of the Double Bluff drift. Can you? Is this because the glaciomarine drift (or gmd) was unconsolidated at the time? (Flighly unlikely, as it must have been overridden by the Possession ice.) The upper one-third of the bluff here is Esperance Sand.

Approaching Point Ebey, the till along the toe of the bluff rises in elevation. The overlying glaciomarine facies of the Double Bluff here is a gray clayey silt with isolated dropstones. It contains the planispiral foraminferan Elphidium, a genus found today in the cold shallow marine waters of Alaska. Today we will see this association of till overlain by glaciomarine drift for each of the three glaciations.

The partly grassed angle-of-repose slope above the gmd is sand that I have interpreted as advance outwash of the Possession glaciation. This association may be tenuous, as I am basing it on two ages from Protection Island; these, I believe, are correlative with the paleosol overlying this Possession outwash. Possession till apparently was not deposited or was eroded away here, as at Point Wilson. Instead, the Possession sand is capped by the paleosol we have followed since the first exposure. I am not a soils man, but confirmation of this unit as a paleosol was blessed by Leon Folmer, a paleosol specialist with the Illinois State Survey when he was here on an AMQUA field trip. During a visit to the well-studied paleosols of Farm Creek near Peoria I saw striking similarities. You can get closer looks at this paleosol soon without climbing because the unit and its associated loess dip eastward and are lower in elevation beyond Point Ebey.

The vertical massive silt above the paleosol is, I believe, a loess of the Olympia nonglacial and here separates Possession from Vashon outwash sands. I informally call it the West Beach silt (WBs) rather than loess as there are a few places (one we will soon see) where it appears to have been deposited in water. The WBs, like most loess, oxidizes to a characteristic yellowish color (hence the Yellow River in China). With patience, luck in choosing a good site, and a good pick, it is possible in places to breach the oxidized "casing" and find a dark-gray silt with flecks of black (carbon?).

"Point Ebey" exists in part because the toe of the bluff here is protected from erosion by the hard, tough till. Not so obvious is the fact that the beach here is only a thin veneer on a platform of till. Thus, vertical lowering of the beach during a storm event is severely limited, further protecting the bluff. (Elsewhere, in areas of thicker beach sediments and similar wave exposure, the beach profile may drop a meter or so during a single storm and expose the bank toe to severe pounding by waves at high tide.) While we are on the subject of beach processes, take a look at the tall granitic boulder on the lower beach to the south. In 1976 its flared “skirt” was largely buried in gravelly sand and the then-vertical column was as smooth as a tombstone. Now it rests on a platform of cobbles, and the column is encrusted with barnacles. My interpretation is that there is no longer enough finer beach material to keep the column “sand-blasted” by sediment suspended in storm waves. Was the fine material here removed during the screaming southerly of February 1977 that blew apart the Hood Canal Bridge?

As we continue south, you will note that there is very little source of gravel in this entire shoreline sector. Although the area is subject to severe winter southerly wind storms, the net longshore drift is from the north (Keuler, 1988) and the nearest significant source of gravel is from beyond the barrier bar we saw earlier, a distance of about 2.5 miles. Thus, it may be decades before this beach is restored to its 1970s condition.

The point is also a good place for an overview to the south. The best bank location reference visible from here is probably the large wooded area (a deep-seated landslide) hi the distance represented in Figure 2 by Is. Bracketing the slide, the bare, vertical upper bluff south of the landslide is classic Vashon till, quite unlike the messy drift above us here. The grassy angle-of-repose slope below the till is Vashon advance outwash (Esperance sand). The horizon at the bottom of the Esperance is the contact between it and the underlying dark and steeper bank of lakebed silts. This contact marks the end of the Olympia nonglacial interval in this area.

Returning our attention to the bank here (Point Ebey), there have been a few changes from sections to the north. First, the Double Bluff till disappears near here, but the gmd continues along the toe of the bank. Second the West Beach silt is cut by another thrust fault, this one at a noticeably lower angle. Third, the upper third of the loess we have been following is now well stratified. Why? How? Fourth, the Esperance Sand has pinched out and the entire upper one-third of the bluff is drift, the uppermost part possibly Everson gmd. Note the chaotic nature of the Vashon drift here for comparison with the more typical till we will see soon.

As we walk south, the glaciomarine facies (gmd) of the Double Bluff drift continues and we can sometimes see it forming the wave-cut platform under the beach. Continuing, the top of the impermeable gmd begins to perch ground water, no doubt a factor in recent slope failures in overlying sediments here. These toppling or block fall failures provide the best and closest look at the WBs we will see today.

In this recent slide area, note the extensive fractures parallel to the bluff face. (These are also common in other glacially compacted, cohesive sediments such as till.) Here, I believe they are responsible for the deep weathering at this site. Elsewhere I have found the oxidized weathering rind as thin as 0.5 m. Note the greenish caste of the paleosol in places. Why

Figure 2. View to the southeast from Point Ebey. Vt, Vashon till; Es, Esperance Sand; Os, Olympia silt (lake beds); Ol, Olympia loess (west Beach silt); Pd, Possession(?) drift; Ws, Whidbey(?) oxidized sand; Is, landslide.

greenish? Those with experience or training in pedology may be able to see subtle soil structures such as peds. Leon Folmer could at this site. Why no apparent carbon here, such as would cause brownish hues that are common in the unit elsewhere on Whidbey (and in Illinois)? Leon explained that under some conditions soil microbes eat all of the disseminated carbon. Discrete fragments of carbon are extremely rare anywhere hi this soil. The largest I have found was about 3 mm long. Near-vertical streaks of vivianite, which I assume to be a replacement of rootlets, can be seen in this unit elsewhere.

Continuing south, 1,300 feet of largely covered bank is represented by the gap C-C. Section C'-D (the wooded landslide) shows the Vashon till thinning to the south and the Esperance Sand reappearing. The lower half of the section is largely made up of silt both stratified and unstratified (Fig. 2). The relation between the silts and the WBs isn't clear, but I think the lakehed silt and the loess are contemporaneous. Please ignore the oxidized pebbly sand near beach level unless you can explain it.

Near the wooded landslide (Fig. 2) a massive silt close to the beach level contains at least two species of gastropods and rare pelecypods. These are tiny (<5 mm) and quite fragile. Stanley Mallory of UW has identified these as fresh-water dwellers. I interpret the massive silt that encloses them as a water-laid facies of the loess to the north and south. The massive nature of the silt suggests continuous deposition. How could the snails live in such an environment? Higher in the bank here can be seen the stratified silts more characteristic of lake-bed deposition overlain by Vashon outwash sand.

South of the forested slide (D1) we see the continuation of the lakebed silts with the overlying Esperance. This horizon is obvious even where covered because of the change in slope as well as vegetation. Note the contrast between the massive and uniformly textured Vashon Till here as compared to the chaotic drift at Point Ebey.

Continuing south we soon encounter till at the toe of the bluff. One might assume that this was the same Double Bluff till that we saw at Point Ebey. However, if we project this to the next exposure nearby (Appendix), we will see a drift (?) totally unlike the one at Point Ebey. This, the last significant exposure of Stop 1, could use some detailed lab and microscope work. A good student paper. Any volunteers?

First problem: What is this weird mixture making up the lower bank? Why the faint lavender cast in places (possibly magnetite-rich hypersthene)? What is that white stuff Appendix, Fig. C)? Why the chaotic structure? To me, this unit looks more volcanic than glacial, but Bob Forbes' microscope exam found no glass shards. He suggests (oral, commun. May 2001) that the white pigmentation may be a clay and would warrant some x-ray work.

If this lower unit is Whidbey, then the overlying slightly greenish gmd is Possession. This gmd resembles a gmd at Point Wilson that is clearly Possession. Also, it bears little resemblance to the Double Bluff gmd we saw at Point Ebey. Overlying this gmd is the loess facies of the West Beach silt. Note the relief in its upper surface where it was eroded away by the streams depositing Esperance sand.
The oxidized sands nearby to the south are probably Whidbey. Oxidized sand and pebbly sand are common in better exposed sections of the Whidbey Formation elsewhere. As we walk south to the van pickup point, we will see oxidized sand in contact with the overlying Vashon Till.

Drive-Bys

(See Plates la, b, where these letters have asterisks to make them more visible.)

A, at mile 5.7. Small borrow pit in the Partridge Gravel on the side of a kettle in what I call "Coupeville Prairie". The same(?) black soil that we see here is uniformly less than a meter thick here and drapes preexisting topography in Port Townsend and on Protection Island. Here the substrate is well-drained gravel. In Port Townsend it is generally till. This apparent lack of relationship to underlying geologic "parent material" suggests that it is not a product of on-site weathering processes but has been transported (a loess?).

B, at mile 6.7. Kettle country. Note the forested kettles to the west. Equally large kettles can be seen on Smith Prairie, east of Coupeville. The upland surface of both prairies ("Coupeville" and Smith) is about 200 feet elevation (disregarding the kettles and dunes). The floor of a kettle west of here, Lake Pondilla, is below sea level.

C, Libby Road roughly follows the margin of glacially smoothed terrain (to the north) and the rugged recessional deposits, mainly Partridge Gravel with kettles, to the south.

Stop 2.- Launch Ramp at the end of Hastie Lake Road

Construction of waterfront homes to the north required the removal of drift logs from building sites. I do not know whether the boulder wall was planned or an afterthought. Would it handle a small (e.g., 5 feet above high tide) tsunami?

Peat deposits make up the platform under the beach at the launch ramp and to the north. At a minus-2-foot tide they can be seen extending at least 200 feet seaward of high tide. In contrast to peat at our next stop, this is woody peat and includes logs with roots in places. A similar peat in Port Townsend near Point Wilson has been studied by Bob Forbes. That deposit, exposed only at minus-1-foot and lower tides, also encloses considerable wood, some logs with limb stubs, as well as conifer cones. According to Forbes (written and oral commun., 2001), borings recovered ostracodes; these were identified by Claire Carter (USGS) as *Cyprideies beaconensis* (LeRoy), a species that lived in lowsalinity (brackish) water, thereby suggesting that the trees may have been killed by a change from fresh-water bog conditions to an estuary environment. Three radiocarbon dates on the wood range from about 2,600 yr BP in a 4-foot core to 2,300 yr BP at the surface (if we throw out a couple of “flyers”). It would be interesting to compare the ring patterns of logs here with those in the one collected at Point Wilson.

As we walk south from the parking area we can see typical Whidbey Formation in both the bank and the wave-cut platform. Glacially compacted peat and silty peat are abundant in both, but the gray silt and silty sand along with oxidized sand are better exposed in the bank. Elsewhere, coarser facies of the Whidbey contain oxidized pebbly gravel. Note the erosional amphitheater in the upper half of the bank with the strong spring flow from ground water perched on the Whidbey Formation.

The Whidbey is considered to have been deposited in an environment similar to that of the modem Skagit Flats (the Burlington-Mount Vernon-La Conner area). The flats have a surface gradient of about 1 foot/1,000 feet. Assuming a similar gradient for Whidbey deposits and assuming that the top is close to “natural” (has not been substantially eroded), it would appear that the shoreline was then at least several miles seaward of today’s.

Farther south, at the deep notch in the bank (Fig. 3), the Vashon till thickens abruptly, the base dropping to beach level. Here, the erosion-resistant till in the bank is probably the reason there is a slight seaward bulge in the shoreline. (Were the till also in the beach platform, as at Stop 1, we might have a noticeable point here.) Above the till can be seen typical oxidized Everson glacial marine drift. Note the closely spaced random jointing. Where Everson is at sea level (wet all the time), it is not jointed and may be gray.

Looking south, in the distance we can see the base of the bluff made up of Whidbey Formation. Overlying that is a thick angle-of-repose section of advance outwash. The permeability contrast between these two units commonly results in perched ground water at that horizon. Such a setting is a primary reason for many large deep-seated landslides along Puget Sound shorelines.

Above the outwash is the vertical face of the oxidized loess we saw close up at Stop 1. The paleosol at its base is not visible from here. If the date (34,000 yr BP) from Protection Island can be extrapolated to here, it means that the outwash sands below are “pseudo-Esperance”, that is, they are from the Possession glaciation. Again, Possession till is missing. (See Fig. 4) Why does an ice sheet capable of depositing such a thick and extensive advance outwash have such an elusive till? (About the only “good” Possession till is at Possession Point, at the south tip of Whidbey Island.)

Above the loess is a thin Vashon drift composed largely of discontinuous sands and gravels. Vashon till reappears near the south end of this section (out of sight from here), but more commonly it is absent in this section. Nowhere in these sections is Vashon advance outwash more than about 10 feet thick, and the Esperance Sand is essentially missing.

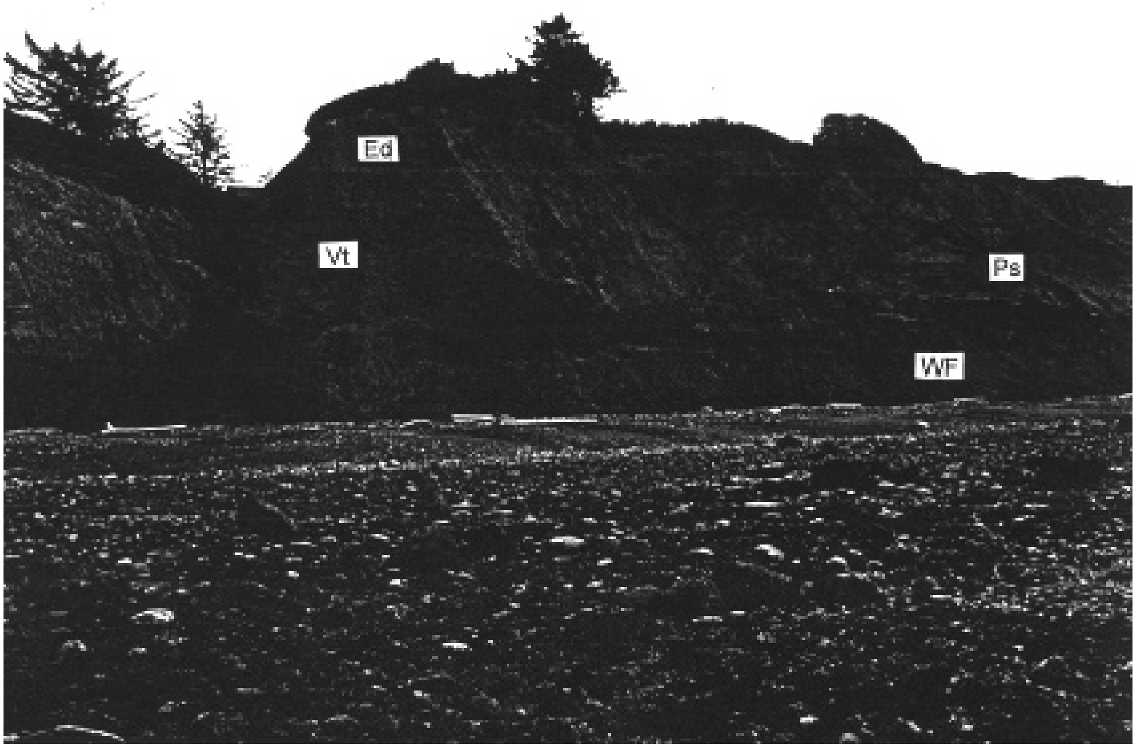


Figure 3. The “notch” south of Stop 2. Ed, Everson glaciomarine drift; Vt, Vashon till; Ps, Possession outwash sand; WF, Whidbey Formation.

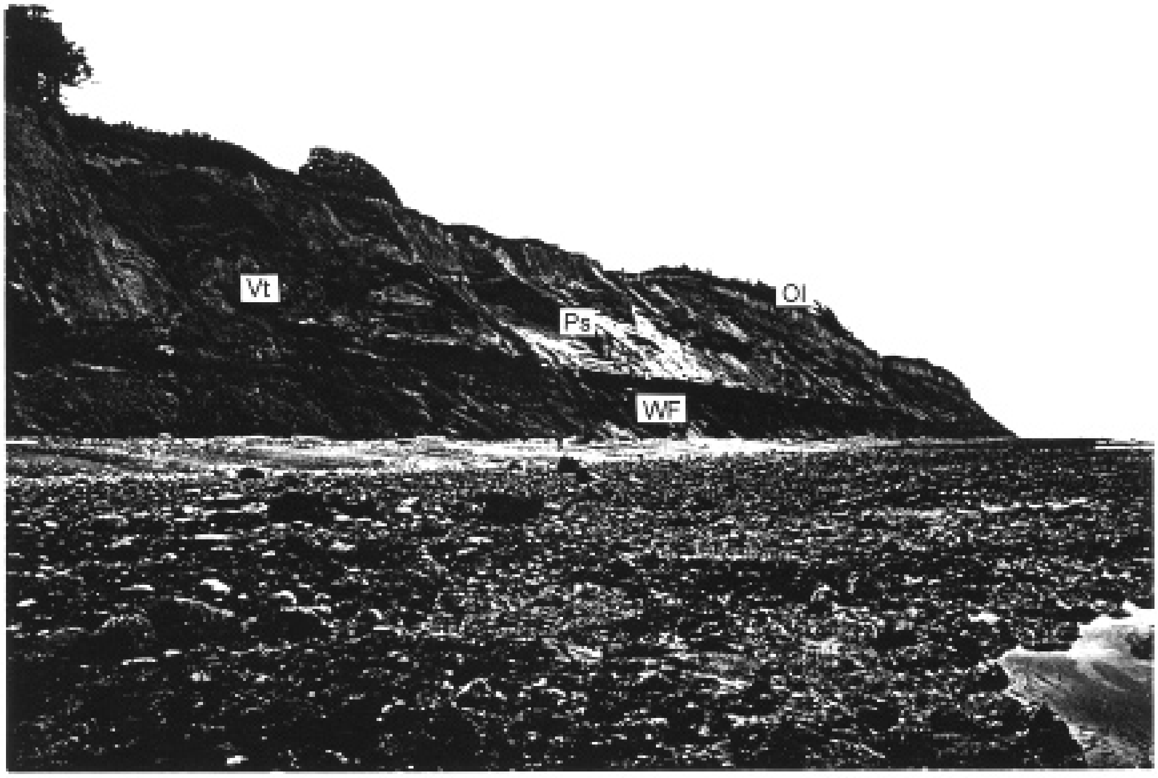


Figure 4. The lower bank silt and peat of the Whidbey Formation (WF) as well as the Possession sand (Ps) are cut by the Vashon till (Vt) (left). The uppermost (vertical) bluff on the distant right is the loess facies of the West Beach silt (Ol).

Returning our attention to the beach here, can anyone find the vandalized bench mark on a low granite beach boulder just north of "the notch"? Coast and Geodetic Survey surveyors mentioned in their 1960s notes that they didn't trust this station ("LOW") because it appeared to have moved. Until last winter I questioned their questioning. That was before a boulder nearly twice this size at North Beach (Port Townsend) moved shoreward more than 5 feet. I wrote this off as a mistake in my measurements.. When I visited the area after a severe storm a month later, the boulder had moved almost 20 feet seaward(I), rotated 40 degrees, and the beach was gone. Now, I too don't trust boulders as reference points.

Drive-By

D, at mile 12.5. Figure 5 shows the stump of a fir(?) tree that was apparently killed by sand dunes. The stump and most of the dunes along this stretch of West Beach Road have been removed during residential development. If you look carefully between the houses as we drive north, you may be able to see the change in topography between the places where the dunes remain and where they have been removed. The thick section of outwash sands making up the bank at this intersection has been exposed by erosion, and there are now localized sandstorms during severe westerly winds.

Stop 3. Swantown

Park at the destroyed bulkhead/seawall and walk south (uphill) to a small parking area. The view to the north is shown hi Figure 6 (next page). Rigg (1958) bored the Swantown peat bog (inland of the bar) and showed his findings in the cross section (bottom of Fig. 6). Note that he assumed that the bar on which the road and homes are built was the seaward side of the bog. He interpreted the bar as a "ridge of gravel and boulders... developed by the action of waves and current" upon a substrate of till. Rigg had no way of knowing that the bar actually developed on top of the bog peat because the beach deposits generally cover the seaward extension. My photo (upper photo, Fig. 6) shows a portion of this area during the rare times when it is devoid of sand and gravel.

The peat underlying the beach here is soft, confirming that it is Holocene. For example, one can embed a tennis-ball size rock into its surface with mere body weight. (Compare that to the glacially compacted peat of the Whidbey Formation at Stop 2.) The peat that is occasionally exposed in the surf zone here is medium brown and uniform in texture, unlike the much darker "woody peat" under the beach at Stop 2. Rigg found the peat hi the Swantown bog to be about 10 feet thick, whereas he found the deposit hi a similar coastal bog at Cranberry Lake to the north to be about 50 feet thick. Possibly the Swantown bog is thicker "offshore"?

How can such material exist under the pounding of storm waves along the Strait of Juan de Fuca? Some factors may be the very low gradient of the beach, the fibrous nature of the peat, and its usual cover of beach sediments. It is soft but tough and appears to be withstanding wave action better than some steep banks of bedrock along the shores of the Straits of Georgia and San Juan Islands.

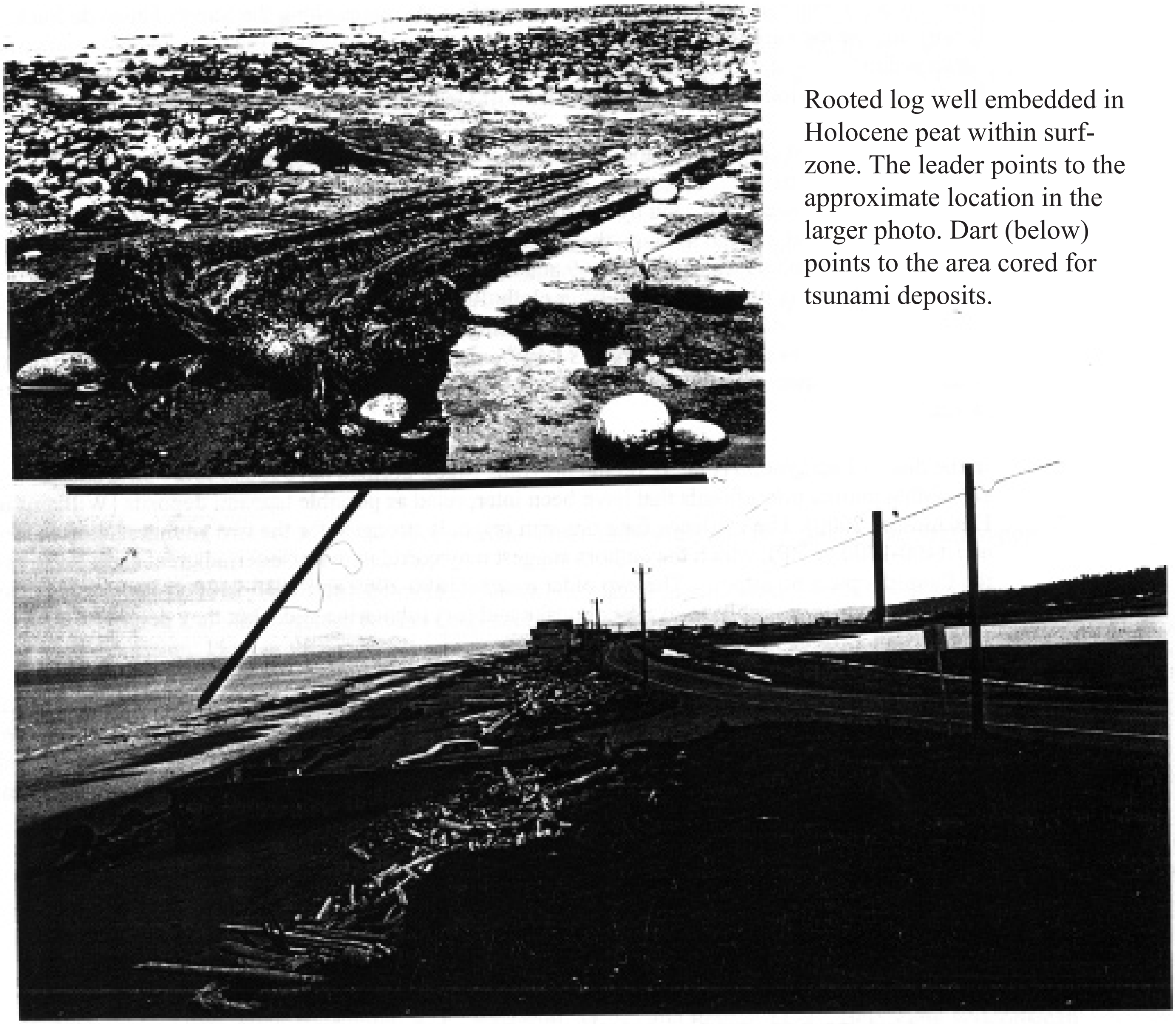
Figure 5. Bluff-top dunes. One of several large conifer stumps rooted in a late Holo-cene paleosol. In the background, note the vegetated dune that probably killed this forest.

Did the existence of such "foundation material" contribute to the early demise of this bulkhead/seawall? The seawall was rather massive, as you can see from the wreckage. It was apparently built in the early 1970's but was severely damaged by the time of my first visit in January 1975. Its sheer weight may have compressed the peat enough to crack the concrete. (A vertical log ['piling'] bulkhead just seaward of these standing remnants was built in 1969 and severely damaged by March 1970. Construction details are not available, but my photos show no filter cloth. Remnant "stumps" lasted for years, possibly because they were founded within the peat instead of resting upon it also would have been somewhat resilient.) This site is a good example of "Thorsen's Law" on shore protection structures - Bulkheads function well where they are unnecessary — and its corollary - Where needed, they commonly fail during the first storm.

hi the distant background (Fig. 6, on the previous page), borings have found four "sand sheets" containing marine microfossils that have been interpreted as possible tsunami deposits (Williams and Hutchinson, 2000). The evidence for a tsunami origin is strongest for the two youngest sheets (1160-1350 and 1400-1700 yr BP), which the authors suggest may correlate with "inferred great earthquake events at the Cascadia plate boundary". The two older events (1800-2060 and 1830-2120 yr BP) are also thought to be tsunami events, possibly from a local quake and (or) submarine slide, but they do not rule out a storm surge origin.

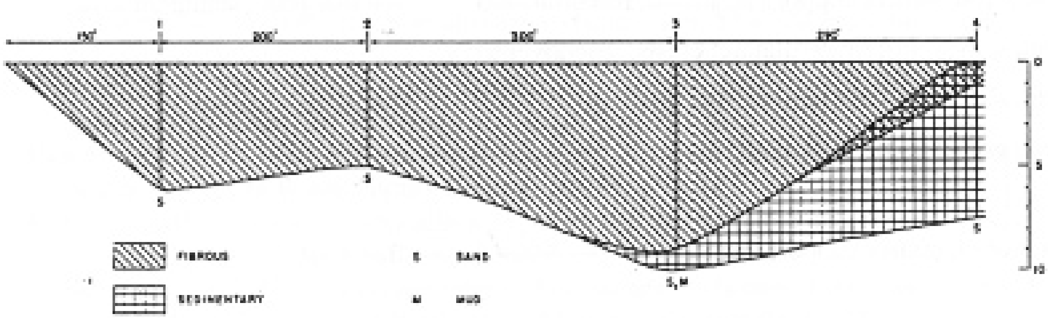
Here most of us are standing on Everson glaciomarine drift (gmd). (Those near the edge may be standing on sod overlying air.) Scramble down to the beach. Note that the gmd here bears little resemblance to that at the last stop. A glaciomarine researcher with extensive experience studying seafloor cores in Antarctica (Domack, 1983) has identified ten lithologies here, overlying a basement of Whidbey Formation and representing the following facies of gmd and the bracketing sediments:

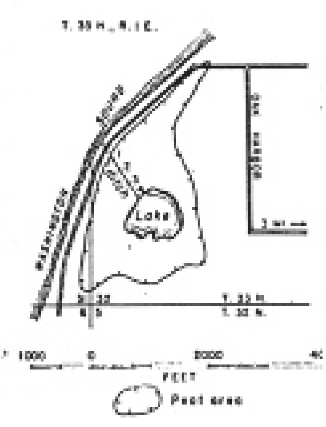
Everson glaciomarine drift lithologic sequence	Facies
Gravely sand, gravel lag----------------------------------	Emergence
Diamicton, matrix support, massive	Ice rafted and mass flow
Mud, massive, dropstones	Dispersed meltwater and ice rafted
Mud, laminated, dropstones	
Diamicton, matrix support, stratified, resedimented	Ice marginal, sediment flow
Sand, gravel, imbricate diamict clasts, resedimented	
Sand, silt, horizontal laminations, grading	Turbidite channel
Sand, gravel, graded, rippled	
Gravel	
Diamicton, matrix support, massive -----------------	Basal till



Rooted log well embedded in Holocene peat within surf-zone. The leader points to the approximate location in the larger photo. Dart (below) points to the area cored for tsunami deposits.

Figure 6. Overview to the north at Stop 3, Swantown. Note that the lake is now much larger than that shown by Rigg (below). The road and houses are built on a barrier bar that spans the Swantown bog (i.e., does not bound it on the seaward side as shown below).





I don't reproduce his section here because 20 years of erosion has changed it. When you have identified his units, let's walk south far enough to see a distant headland of till.

Looking south, in the distance we can see the base of the bluff made up of Whidbey Formation. Overlying that is a thick angle-of-repose section of advance outwash. The permeability contrast between these two units commonly results in perched ground water at that horizon. Such a setting is a primary reason for many large deep-seated landslides along Puget Sound shorelines. This headland, where the rapidly thickening till reaches the shoreline, is more than 200 feet seaward of the more easily eroded Whidbey Formation to the north. This overview also emphasizes one of the quandaries in deciphering the Quaternary of the Puget Lowland. We have Whidbey Formation at the toe of the bluff and a thin skin of Vashon drift along the top. Without the Olympia-age loess here as a marker horizon such as at Stop 2, there is no way of determining if the thick section of outwash sand we see is Vashon advance outwash (Esperance Sand) or Possession advance outwash (pseudo-Esperance Sand).

End of Trip

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Note: All of these reports are in the collection of the Washington Division of Geology and Earth Resources library in Olympia. See also the “Bibliography and index of the geology of Island County, Washington” compiled by C. J. Manson and available free on paper, on disk, or by email by calling the Division at 360-902-1450. The most recent version is February 2000.

Appendix

Darts on Figure A point to positions of close-ups B and C. Units are as follows:

Vt - Vashon till
Es - Esperance Sand
Ol - Olympia loess (West Beach silt)
Pd - Possession glaciomarine drift

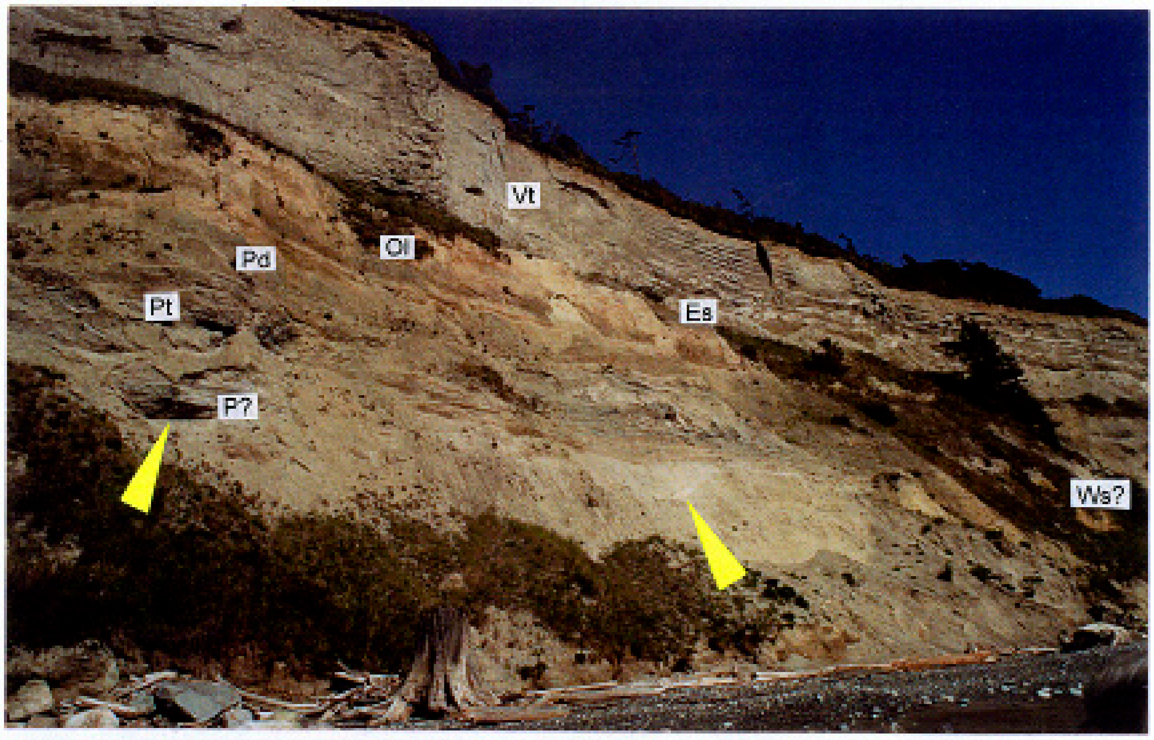
Pt - Possession till P? - Possession(?) Ws? - oxidized sand, possibly Whidbey

Note that the angle-of-repose slope of Esperance Sand is visible only as the edge of a grassy surface; it is much thicker than it appears from the beach. Also note the relief at the top of the Olympia-age loess as it was eroded by Esperance-depositing streams (Fig. C).

These photos show the characteristic orangish-yellowish tan of the loess facies of the West Bay silt. Figure B shows the subtle greenish gray of the Possession glaciomarine drift. The fine white material in Figure C may be a clay (see Text).

Appendix

Figure A



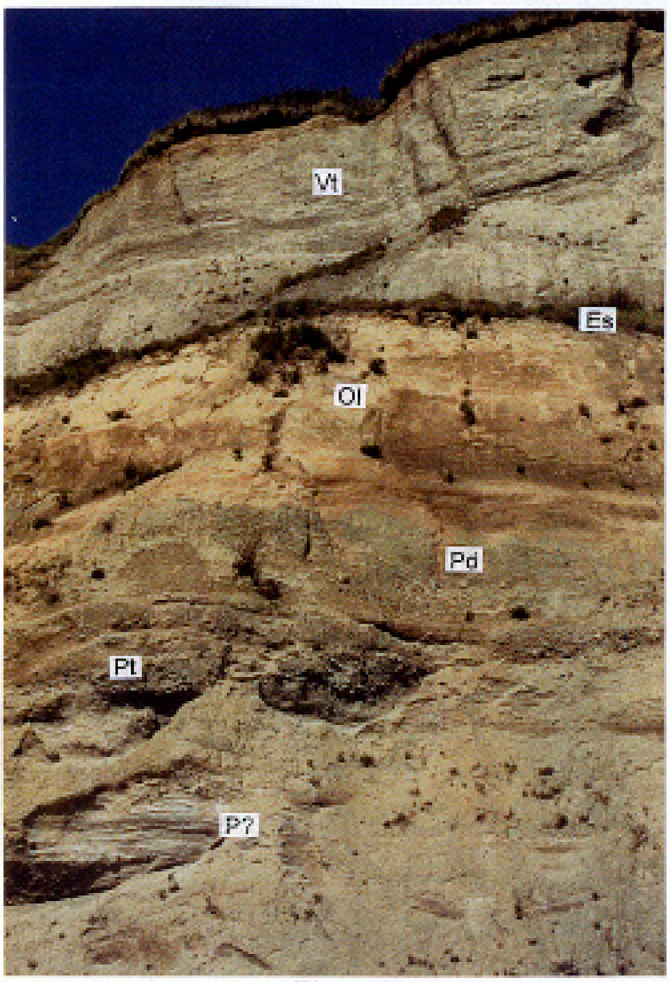


Figure B

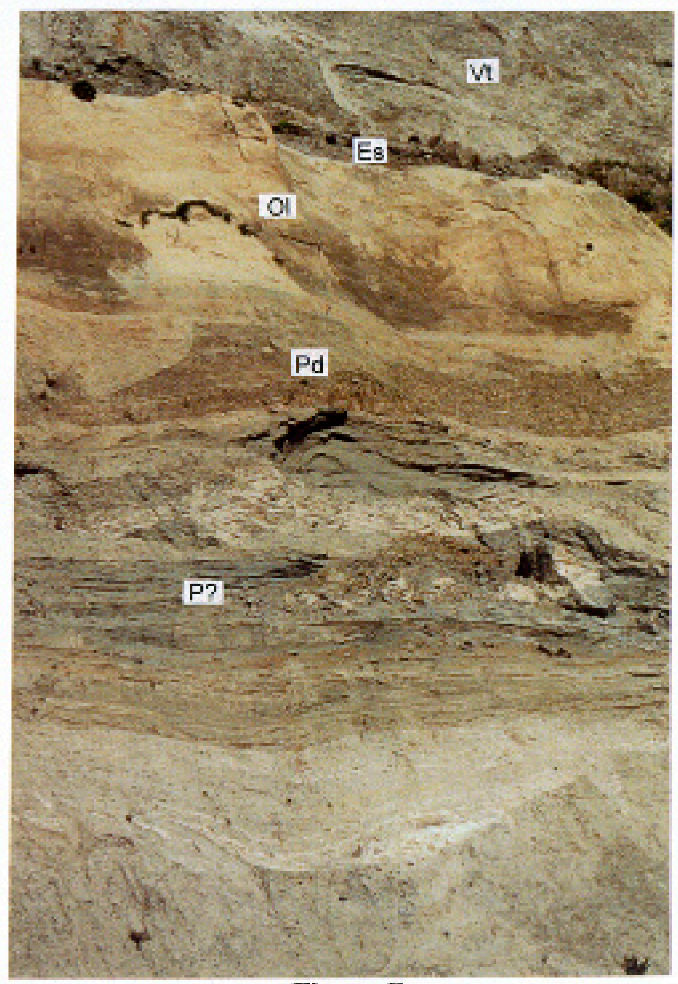


Figure C

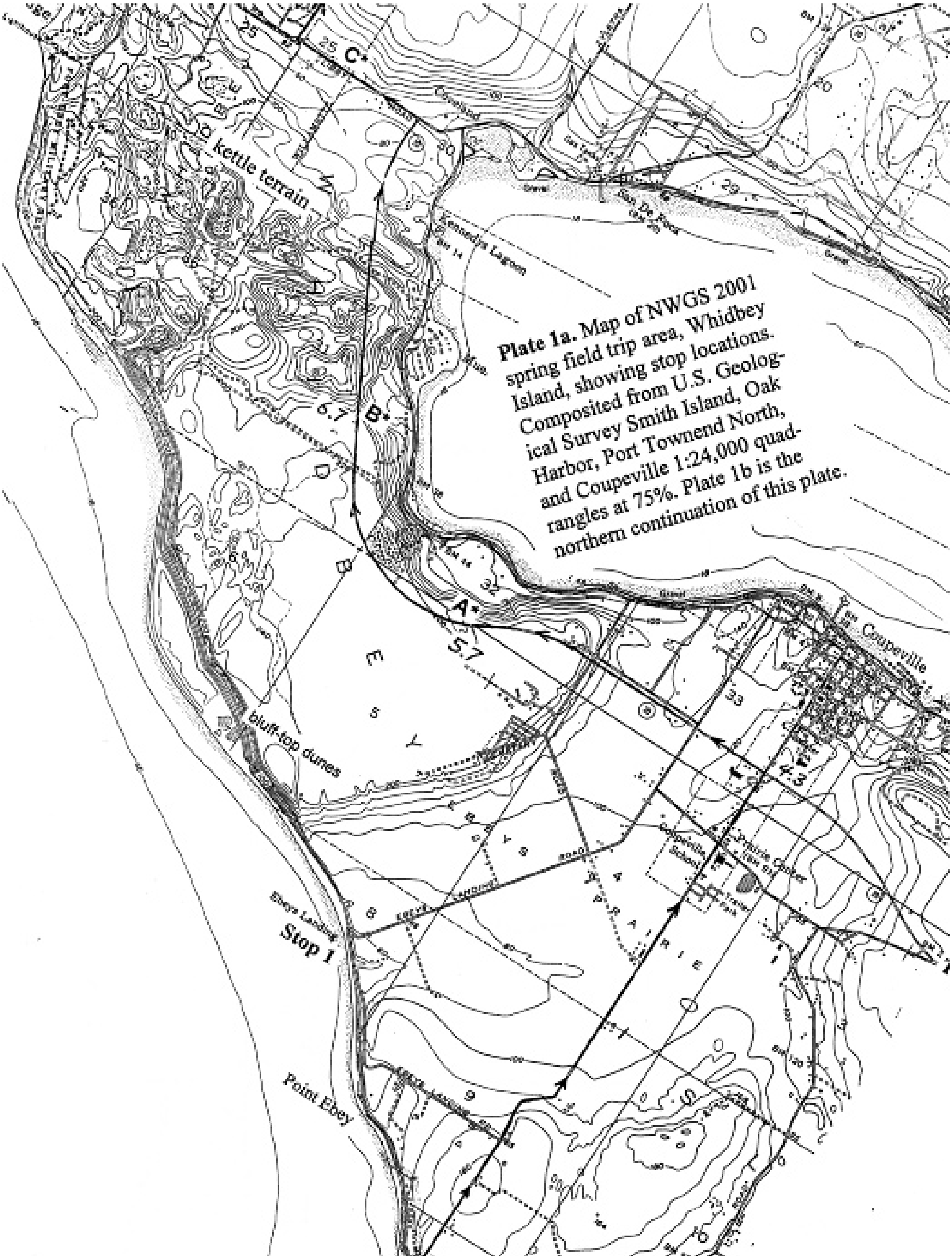


Plate 1a. Map of NWGS 2001 spring field trip area, Whidbey Island, showing stop locations. Composited from U.S. Geological Survey Smith Island, Oak Harbor, Port Townend North, and Coupeville 1:24,000 quadrangles at 75%. Plate 1b is the northern continuation of this plate.

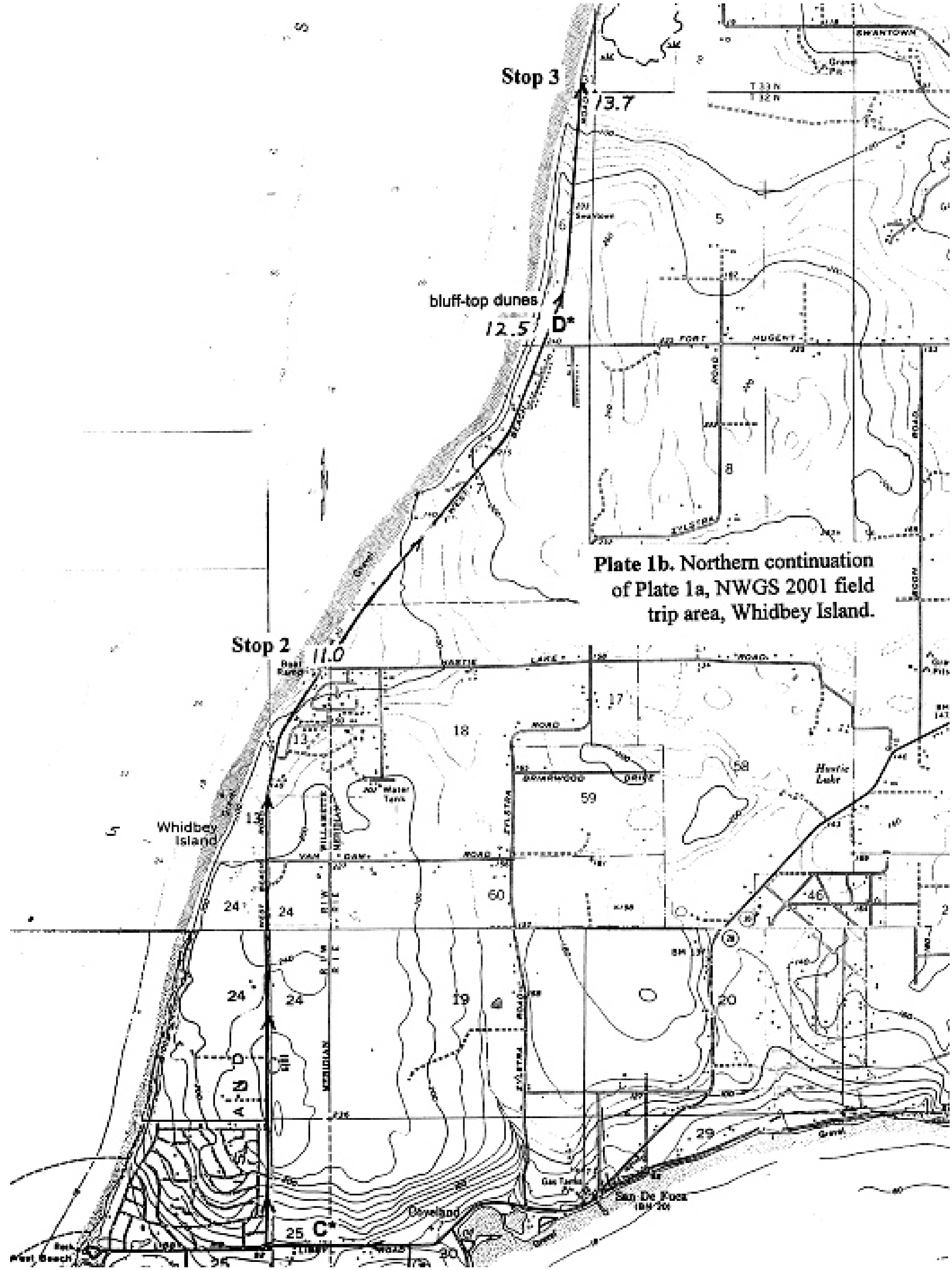


Plate 1b. Northern continuation of Plate 1a, NWGS 2001 field trip area, Whidbey Island.

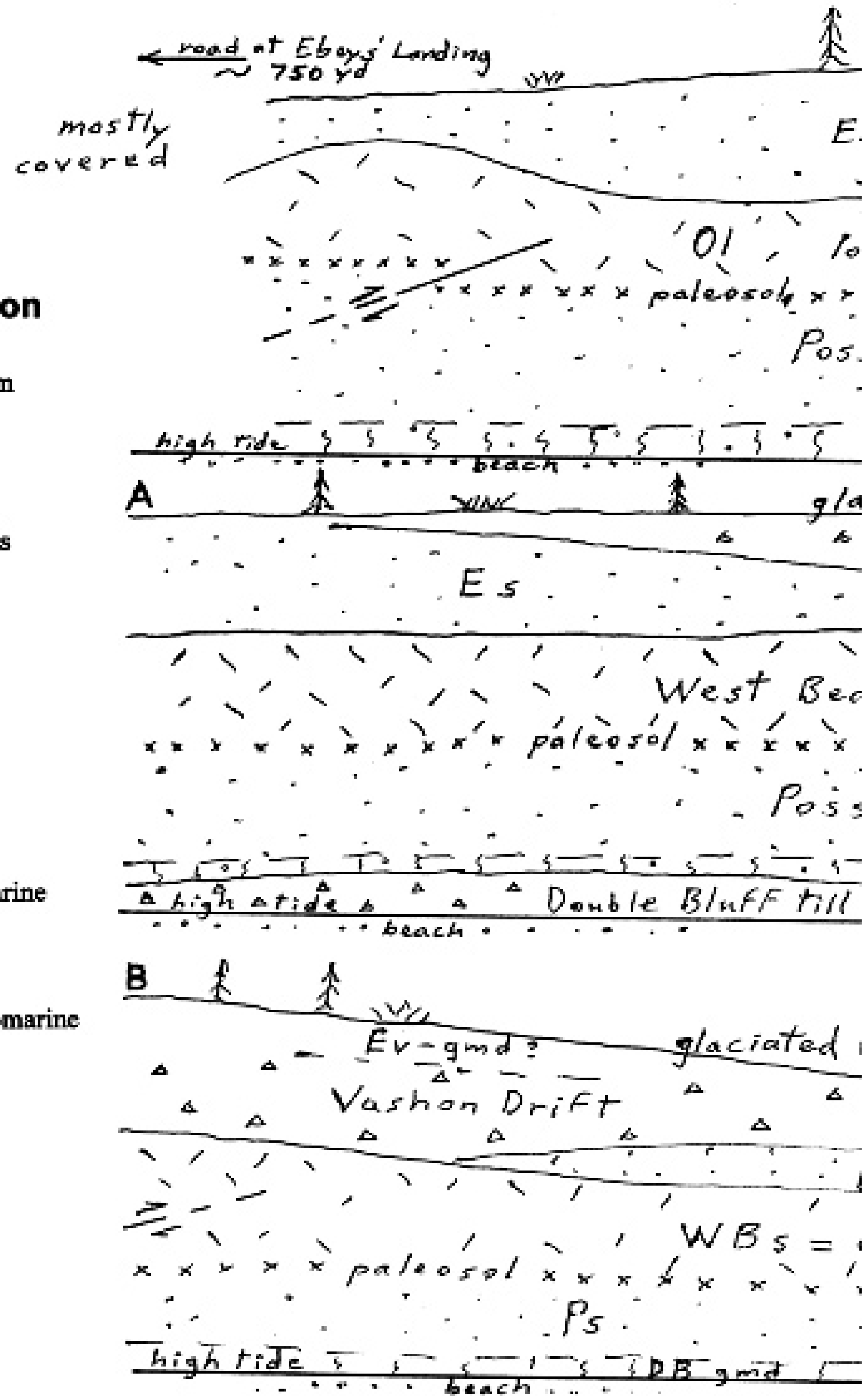
Stop 1. Vertical section

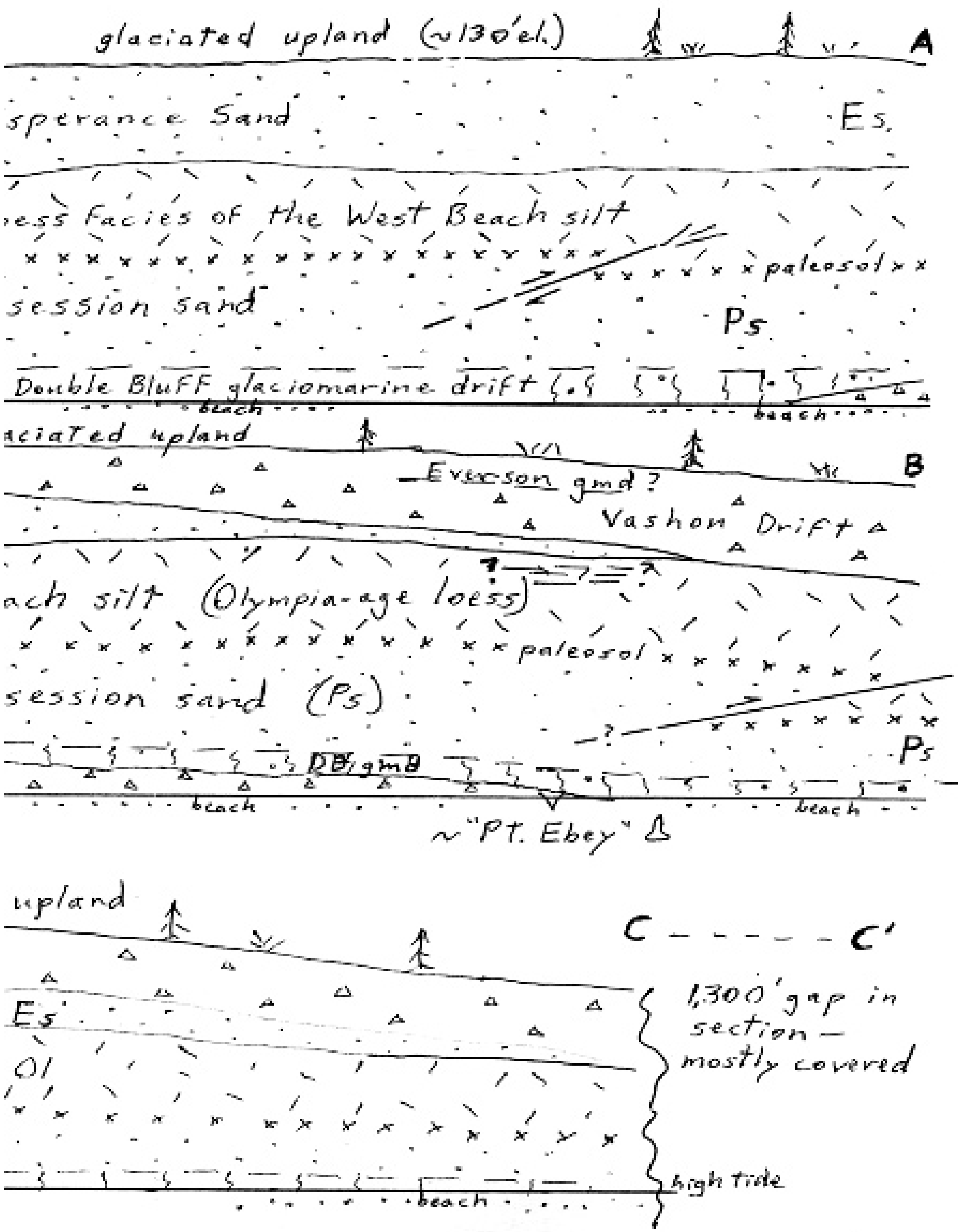
These sections were drawn from a panorama of projected aerial oblique slides. Thus, the scale may vary by ±10%.

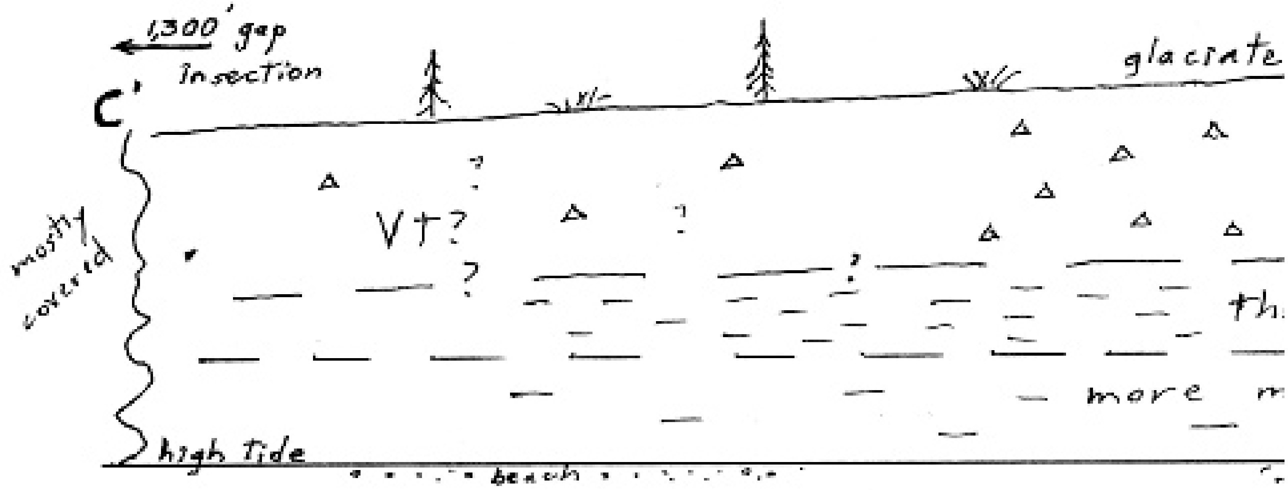
Scale, vertical and horizontal, is roughly 1 inch = 60 feet.

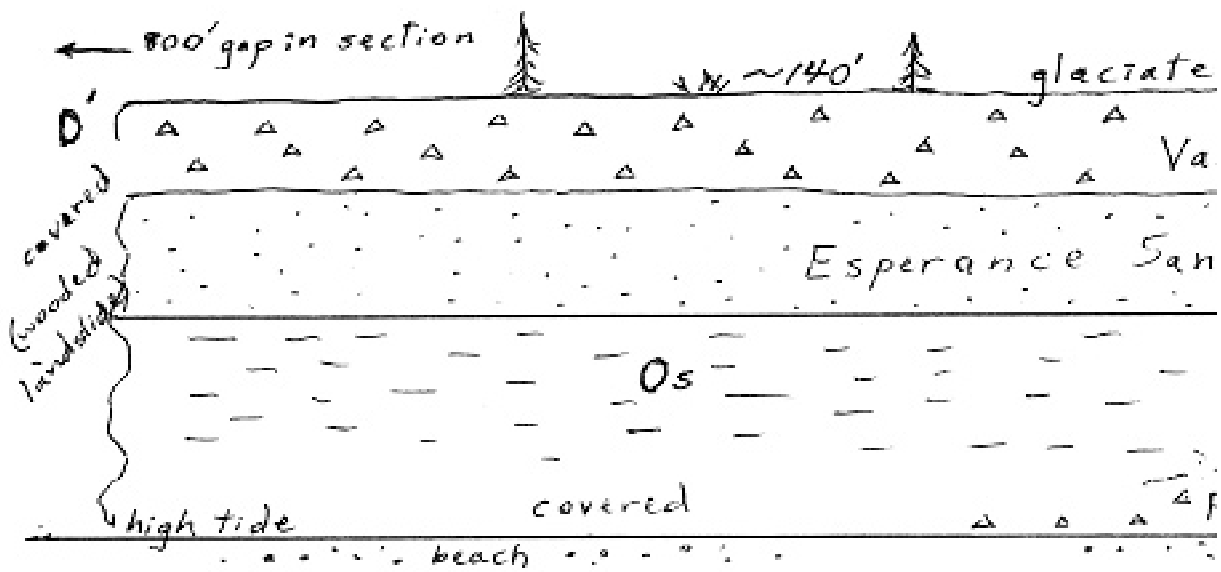
Explanation

Ev, Everson glaciomarine
Vt, Vashon till
Vd, Vashon drift
Es, Esperance Sand
Os, Olympia silt
Ol, Olympia loess
Pd-gmd, Possession glaciomarine
Pt, Possession till
Ps, Possession sand
WF, Whidbey Formation
DB-gmd, Double Bluff glaciomarine
DBt, Double Bluff till



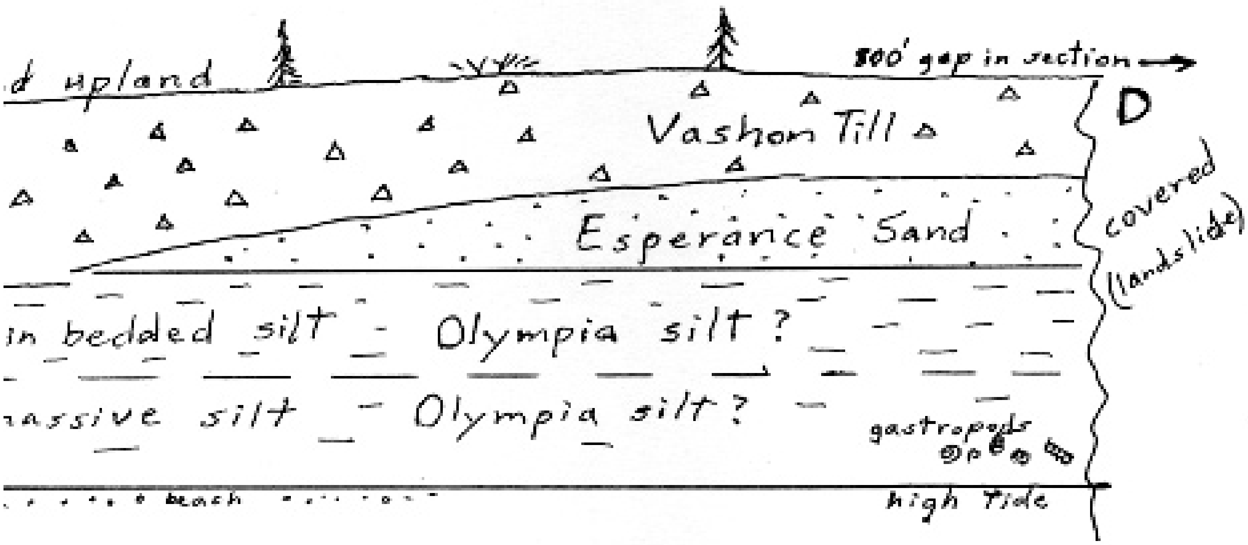

glaciated upland (~130' el.)
A
sperance Sand
Es
ess Facies of the West Beach silt
paleosol
session sand
Ps
Double Bluff glaciomarine drift
beach
beach
aciated upland
B
Everson gmd ?
Vashon Drift
ach silt (Olympia-age loess)
paleosol
session sand (Ps)
Ps
DBgmd
beach
beach
~"Pt. Ebey"
upland
C - - - - - C'
Es
Ol
1,300' gap in section — mostly covered
high tide
beach

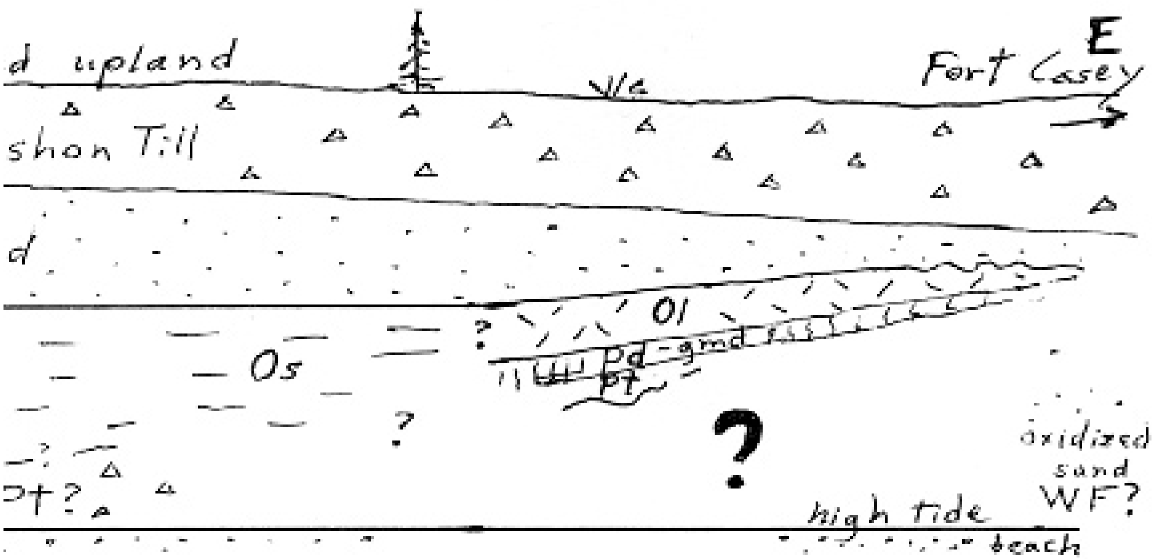




Stop 1. Vertical sections (continued)

These sections were drawn from a panorama of projected aerial oblique slides. Thus, the scale may vary by ±10%. The scale, vertical and horizontal, is roughly 1 inch = 60 feet.





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