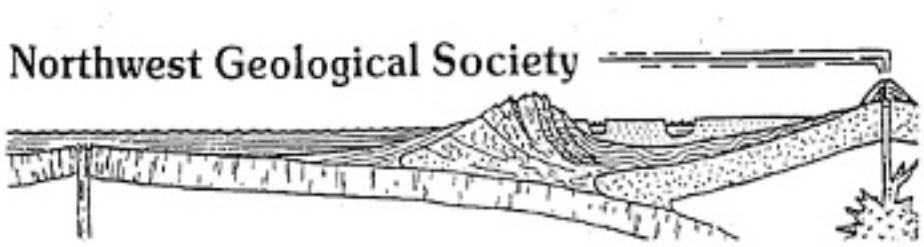

Northwest Geological Society

Society Field Trips in Pacific Northwest Geology

Pleistocene Deposits and Subglacial Landforms of the Southeastern Puget Sound Lowland

1990

Derek Booth
King County

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NORTHWEST GEOLOGIC SOCIETY
FIELD TRIP

Pleistocene Deposits and Subglaclal Landforms of the Southeastern Puget Lowland

Derek B. Booth King County

INTRODUCTION

Although the occurrence of multiple gldelations In the Puget Lowland has been recognized since Willis (1898), the actual number of those glaciations and the correlation of individual deposits to specific glacial episodes remain unresolved to the present day. This field trip will review a portion of the strati graphic sequence in the southeastern part of the Lowland, evaluate the conclusiveness of nearby deposits correlated to that sequence, and consider some of the landforms of subglacial and ice-marginal activity formed by successive ice-sheet advances. Crandell and others (1958) defined a four-fold sequence of ice-sheet glaciations and interglaciations in the southern Lowland. From youngest to oldest their intervals are:

GLACIATIONS	INTERGLACIATIONS
Vashon	
	Olympia
Salmon Springs	
	Puyallup
Stuck	
	Alderton
Orting	

Their terminology has demonstrated remarkable persistence over the years, particularly in widespread naming of the first pre-Vashon glacial or fluvial deposit as Salmon Springs. An enriched 14C date by Striver and others (1978) of ca. 70 ka appeared to confirm the plausibility of such correlations.

In the north-central Puget Lowland, Easterbrook and others (1967) defined a three-fold glacial sequence based on sea-cliff exposures on Whidby Island. No dates were obtained and no correlation was attempted with the southern sequence.

Complications in the southern sequence have become apparent. Most awkward is the determination that even the penultimate glacial deposits are reversely magnetized (Easterbrook and others, 1981), placing their age beyond 745 ka. In addition to leaving over a half-mi 11 ion-year gap in the stratigraphic record, no usable stratigraphic framework is available to interpret the fresh-looking drifts of the north-central Lowland or deposits of a large pre-Vashon advance in the southern and eastern Lowland (Lea, 1984; Booth, 1990) that Lea Inferred to be probably no more than 140 ka on the basis of weathering characteristics, particularly rinds. Such a regional correlation also Implies that deposits of multiple recent gladatlons, as suggested by the global oxygen-isotopic record, are entirely absent over thousands of square kilometers; yet three much older deposits are preserved and exposed in many locations. There are several purposes to this field trip:

1) To review a portion of Crandell and others' (1958) stratigraphic framework (stops 1, 2, and 3).

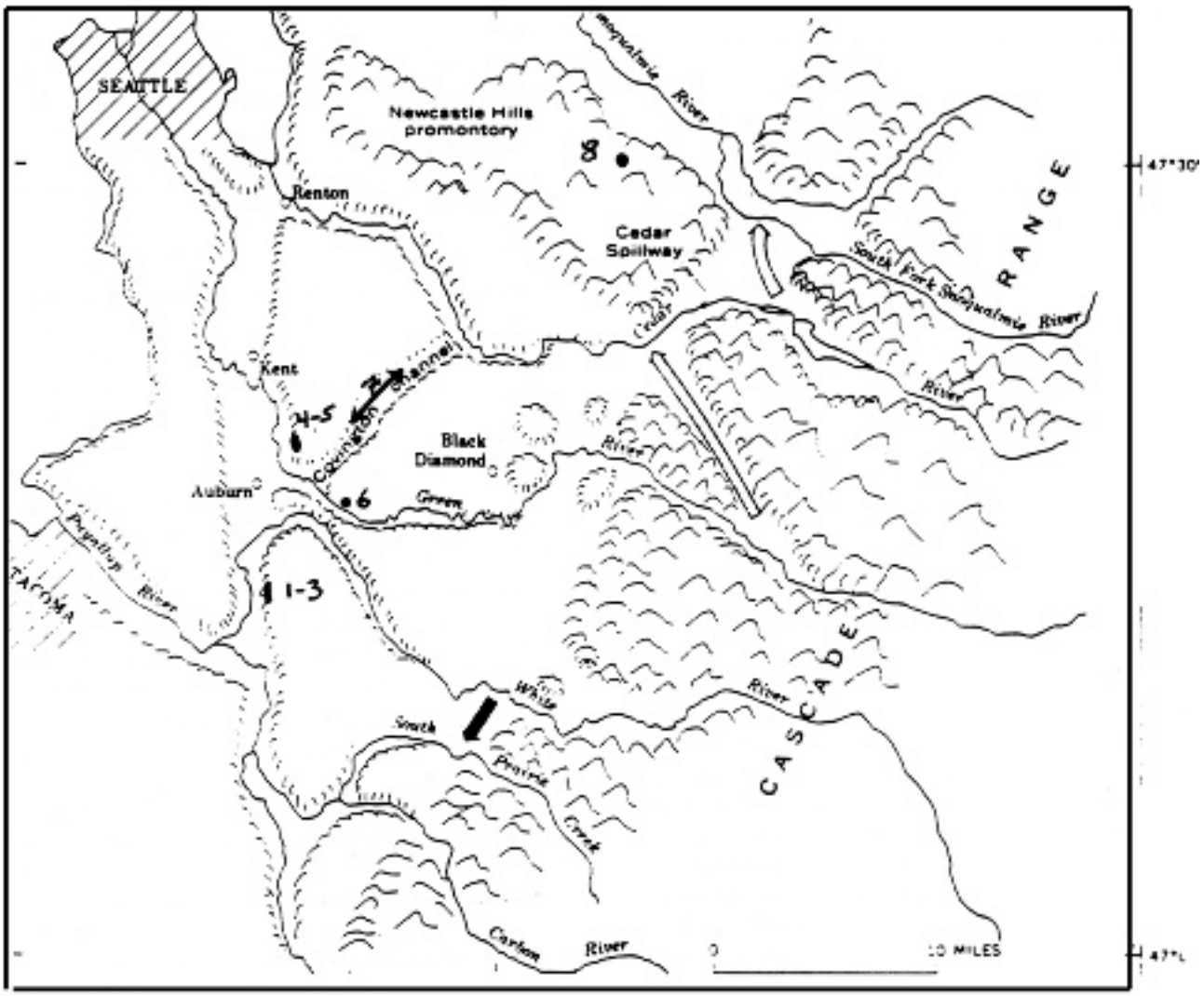
2) To review Mullineaux's (1970) imperfectly correlated sequence a few miles north, 'and to assess whether field observations support the proposed correlations (stops 4, 5, and 6).

3) To observe some of the deposits and landforms associated with water near the ice-sheet's edge, including recessional outwash (non-stop 7), subglacial water channels, and ice-marginal embankments (stop 8).

Stop 1 - "Salmon Springs Drift" (Crandell, 1963; 1-1/2 miles north of type section): east side Stuck/Puyallup River Valley, along State Route 5, 2.0 miles south of White River bridge. Exposures along this area of road are rather plentiful and consist primarily of gravel and sand of mainly Cascade provenance (see following description).

SALMON SPRINGS DRIFT

At many localities in ihe Puyallup and Duwamish Valleys the Puyallup formation is overlain by till of pre-Vashon age and pebble to boulder gravel of northern and central Cascade provenance. In most places these sediments appear to represent a single drift unit. In exposures near Sumner, however, the presence of nonglacial sediments between two deposits of drift in this stratigraphic interval indicates that two glaciations or two advances of a single major glaciation are represented. The Salmon Springs drift includes both of these post-Puyallup, pre-Vashon glacial deposits, and. in addition, nonglacial deposits in the same stratigraphic interval (Crandell. Mullineaux. and Waldron. 1958).



From Mullineaux 1970
Figure 22

EXPLANATION

Abandoned preglacial courses of Cedar and Green Rivers near mountain front

Abandoned postglacial pre-Osceola course of White River

DESCRIPTION

Northeast of Sumner (measured section 13) the Salmon Springs drift includes two gravel and till units separated by about 4 feet of volcanic ash. silt, and peat. The sediments below the volcanic ash consist of 10 to at least 27 feet of oxidized pebble to boulder gravel of central Cascade and northern provenance. At one exposure in the vicinity of Salmon Springs, the basal pan of this unit contains a layer of till at least 5 feet thick.

The volcanic ash bed that is exposed in the vicinity of Salmon Springs in the middle of the drift is 6 to 12 inches thick. Heavy minerals in the ash are principally hornblende and hypersthene. in a ratio of about 3 to 1. and small amounts of biotite and magnetite. The light fraction consists chiefly of plagioclase and glass.

The part of the formation above the peat and ash consists of 37 to 55 feet or more of gravel, sand, and till. There is a wide range of provenance in these deposits: although they are predominantly of central Cascade derivation, the base of the gravel in the vicinity of Salmon Springs contains as much as 15 percent pebbles of Mount Rainier derivation, in contrast to only 6 percent of northern derivation. The upper part of this gravel contains 1 percent pebbles of Mount Rainier provenance and 26 percent pebbles of northern provenance. The heavy minerals of the sand fraction of this deposit show a similar vertical change: the basal beds are predominantly hypersthene and small amounts of hornblende, magnetite, and ilmenite, but contain no garnet.

Measured section I5

[Location: eait wall of White (Stuck) River ralley. In (fully 150 :eet east and another gully 400 feet north of lontheut corner of the SWV4 sec. 18. T. 20 N., R. 5 B.. In Vlclnlty of Salmon Spring*, about 1 mile nortbeut of Sumner. W«‹h. (composite)

	Feet
Vashon Drift	
11. Sand and pebble to cobble gravel; unoxidized	>30
Salmon Springs drift (upper parti :	
10. Sand, very fine, and silt. light-olive-gray--	2. 0
9. Sand and pebble to cobble gravel: oxidized; northern provenance in part..	37. 0
Nonglacial sediments:	
8. Silt and clay, pale-yellowisb-brown	. 5
7. Peat, very compact, black, and silty peat—	. 3- 1. 5
6. Silt, brownish-gray; rich in vegetative debris	1. 5
5. Volcanic ash	. 5- 1. 0
Salmon Springs drift (lower part) :	
4. Sand and pebble to cobble gravel; oxidized; northern provenance	20 -27
Puyallnp formation:	
3. Sand, medium to coarse, and lenses of granule to pebble gravel; poorly defined cut-and-flll stratification; Mount Rainier provenance	30. 0
Stuck drift:	
2. Till, very compact: unoxidized	2-5
1. Sand and pebble to cobble ‘gravel; oxidized: northern provenance	>20

whereas the upper beds contain as much as 15 percent garnet and only about 10 percent hypersthene.

At the bluff exposure (fig. 10) in the northwestern part of Sumner (measured section 8), the Salmon Springs consists of basal sand of northern derivation about 28 feet thick. This is overlain by 75 feet of pebble and cobble gravel. The lower pan of this gravel is of northern and Cascade provenance, but upward the gravel becomes increasingly rich in rocks and minerals of Mount Rainier derivation and poor in northern rock rypes. Although this sand and gravel unit rests directly on the Puyallup formation, its relation to the peat and ash beds of the Salmon Springs area is not known. About 0.3 mile north of the bluff at Sumner. on the west wall of the Duwamish Valley a discontinuous layer of gray till. 10 feet thick, lies immediately above the Puyallup formation. There is a mixed zone, 4 feet thick, along the base of this till, and wedpe-slmped masses of till extend 3 to 6 feet down into the Puyallup formation. This till is overlain by more than •25 feet of sand and pebble and cobble gravel in which there is another lens of till as much as 1 foot thick.

In addition to the 2 drift units and the intervening peat and volcanic nsh. 2 other sedimentary units occur in the stratipraphic interval between the Puyallup forma¬tion and the Vashon drift. These deposits make up much of the Duwamish Vallev wall north of Stunner.

One unit consists of sand and pebble to cobble gravel predominantly of central Cascade provenance; the other consists chiefly of sand and pebble gravel, mostly of Mount Rainier derivation. The strntigraphic relation of these deposits to the two drift units and to the non-glacial sediments in the vicinity of Salmon Springs is uncertain. The gravel of central Cascade provenance is exposed along the east valley wall in the vicinity and north of Dieringer, and the sediments of Mount Rainier provenance crop out along the west valley wall north of Sumner, northwest of the Lake Tapps quadrangle.

Stop_2 - Puyallup Formation” (Crandell, 1963; 1/2 mile northwest of Measured section 13): 0.9 miles south of Stop 1. Pumaceous sand 1s well exposed at this roadcut, on the east side of State Route 5, and 1s apparently directly overlain by the gravel of Stop 1.

Stop_3 - “Stuck Drift” (Crandell, 1963): 0.3 mile south of Stop 2 on the east side of the highway. Walking from Stop 2 is recommended, as parking here is poor. The Stuck Drift here is a very compact, remarkably unweathered till, clearly underlying the deposits of Stops 1 and 2.

Stop 4 “Salmon Springs Drift” (Mullineaux, 1970; 1/3 mile northwest of Measured section E): 5 miles north of Stop 1 on east sidewall of Green River valley, just past the end of 104th Place S.E. south of Lea H111 Road. Park at the cul-de-sac of 104th and walk upriver about 50 yards on dirt track; then turn left up obvious gully. The gravel here 1s very compact and cemented, moderately weathered, and has quite similar clast lithology to that seen at Stop 1. Exposures are not truly continous with the type Salmon Springs, as implied by Mullineaux (1970), but mapped extent suggests their overall continuity.

SALMON SPRINGS DRIFT

-Stony till and outvrash .sand and gravel assigned to the Salmon Springs Drift overlie Purallupl?) de¬posits and underlie Vashon Drift along the Green Hiver. White River, and Duwamish Valleys. Along the Duwamish Valley walls, tliese deposits can be traced into the type Salmon Springs Drift in the Lake Tapps quadrangle. The Salmon Springs Drift is named for -prinjrs on the east wail of the Duwamish Valley about ‘! miles south of Auburn i Crandell and others. 1958). Fluvial sand and gravel of Cascade provenance locally underlies and overlies Salmon Springs outwash irravel and locally is mterl)edded with northern out-wash alone rhe Duwamish Valley wall near Auburn. These Cascade-derived sediments are closely associated \rith and are similar in irrain size to the Salmon Springs stratified drift, and they are mapped and described as part of the Salmon Springs deposits.

LITHOLOGY

The Salmon Springs Drift consists chiefly of fluvial ~and and gravel. The formation locally includes one or two till layers, and in places its lowermost and upper¬most beds are fluvial sand and gravel mainly of Cas-’•ade provenance. The formation is well exposed in northeast Auburn in the Duwamish and Green River valley walls. There, the formation consists of thick -and and gravel of Cascade or mixed Cascade and

northern provenance at the base: this sand and gravel is overlain by northern sand and gravel that includes two layers of till, which in turn is overlain by sand and gravel of Cascade provenance (section £", fig. 18).

STRATIGRAPHIC RELATIONS

The Salmon Springs Drift lies unconformably on the Puyallup(?) Formation or the intermediate drift ;md is unconformably overlain by Vashon Drift. The base of the Salmon Springs is exposed at sections C and E. where the formation lies in channels cut into the underlying Puyallup ?) and intermediate drift formations. The base of the Salmon Springs is more than a hundred feet lower along Duwamish Valley than it is along the Green and White River valleys a few miles to the east. A north-trending valley, whose east wall was a short distance east of Auburn, may have been filled by Salmon Springs Drift. Along the Green River valley east of Auburn, brown Salmon Springs Drift locally is overlain by gray gravel and stony till that underlie Vashon till. This gray drift has been mapped as part of the Salmon Springs, though it may be younger.

Section E. Composite section in center sec. 17, T. 21 N., R. 5 E., in Green River and Duwamish Valley waiit

	Thickness
Vashon Drift:	<}£)
Sand and pebble gravel, gray to light-brown, friable -	>40
Till, stony, gray (sample 845-16-6)..	30
Gravel, pebble and sand, gray	15
Salmon Springs Drift:	
.Sand and pebble gravel, reddish-gray to gray; Mount Rainier provenance.	>20
Sand and gravel, olive-gray to brown; northern provenance	5-10
Till, stony, olive- to brownish-gray (sample 845-16-5)	15
Sand and pebble gravel, brown; northern provenance.	40
Till, stony, olive-to brownish-gray	5-10
Sand and gravel, brown; northern provenance	5-10
Gravel. pebble-and-cobble, and pale-yellowish-brown to brown sand; Cascade or mixed Cascade and northern provenance: grades into overlying northern sand and gravel	20
Silt and clay, peaty; contains scattered stones	3
Gravel, pebble-and-cobble, and pale-yellowish-brown, light-brown, and brownish-gray sand: Cascade or mixed Cascade and northern provenance	50
Sand and silt, blusish-gray to reddi.-h-brown: contains wood and peat	5
Sand and pebble gravel, reddish-brown —	5
Puyallup(?) Formation:	
Silt and sand, peaty, reddish-gray to brown; Mount Rainier provenance.	5-10
Mudflow, hard, compact stony silt and sand	>5

Stop 5 "Puyallup(?) Formation" (Mullineaux, 1970): 100 yards northwest of Stop 4. Enter the brush just north and east of the cul-de-sac and look about 20 yards upslope for exposed shelves of thin laminated silt and clay, often with seepage dripping off them.

PUYALLUP (?) FORMATION

Thin beds of sand of central Cascade and Mount Rainier provenance, and silt, clay, and peat lie above rhe intermediate drift and below Salmon Springs Drift. These sediments contain climatic evidence of in-rerelacial conditions, but they could not be traced into cither the Alderton or the Puyallup interglacial deposits of the Puyallup Valley. They are tentatively correlated with the Puyallup Formation because they directly underlie Salmon Springs Drift.

The name Puyallup Sand was established by Willis i !<<98c), who applied it to the compact gray sand of -Mount Rainier provenance that is exposed along the Puyallup Valley, and to the interglacial episode represented by the sand. The name has since been changed ro Puyallup Formation because the sand at the type locality is a facies of an assemblage of sand, gravel. and mudflow deposits of Mount Rainier provenance (Crandell and others, 1958).

Stop_6 - "Intermediate Drift" (MulUneaux, 1970; Measured section D): Green River valley sldewall just upstream of Soos Creek on Lake Holm Road, 1-1/2 miles east-southeast of Stop 5. Parking 1s almost nonexlstant on Lake Holm Road, so park above the upper switchback just west of 130th Avenue S.E. and walk down. The "Salmon Springs Drift" is particularly easy to miss, being only suggested, by poor exposures of sand on the upper south-trending leg of the switchback. Unequlvocable "Intermediate Drift," looking remarkably similar to the "Puyallup(?) Formation" of Stop 5, Is well exposed shortly after road turns north. More granular deposits are Intermittently exposed down-road to the valley bottom. At the lowermost bend to the north, across the street from a house and at closest approach to the Green River, a very pebble-poor dlamlct with a silt-clay matrix Invites debate as to Its origin and deposltlonal environment.

INTERMEDIATE DRIFT

The formation next younger than the Orting(?) in the mapped area is an unnamed drift here informally termed "intermediate." This stratigraphic unit, which consists mostly of two fine-grained clay-rich till mem¬bers separated by 50-175 feet of stratified sediments, crops out along the Green and White River valley walls. The intermediate drift lies between formations that are tentatively correlated with the Orting Drift and Puyallup Formation of the Puyallup Valley. Its position thus suggests equivalence with drift of the Stuck Glaciarion i table 1). but it cannot be traced to that formation. The intermediate drift, furthermore, is strikingly dissimilar to the type Stuck Drift that is only about > miles to the southwest. The type Stuck is thin and contains only a single till member that is coarse grained and stony. Because of the lithologic difference, it does not seem likely that the intermediate drift is an extension of the Stuck Drift exposed in the Puyallup Valley. It does seem likely that

the intermediate drift was deposited at some time during the Stuck Glaciation. yet it is possible that it resulted instead from a glaciation not represented in the Puyallup Valley sequence. For that reason, and because of the lithologic difference, the term "Stuck" is not applied to the intermediate drift of this report.

The upper part of the intermediate drift of this report is correlative with the lower of two drift sheets first described as intermediate in the Buckley quadrangle (Crandell and Gard, 1959). The lower drift sheet there was later assigned to the Stuck Drift by Crandell (1963).

Section D. North wall of Green River valley

Section measured in SW1/4SE1/4 sect 15 and NW 1/4NE1/4 sect. 21 T21 N.,R .5E in cutbank of Green River and along Lake Holm Road

	Thickness
Yashon Drift:	
Gravel, pebble-and-cobble, sandy, yellowish-brown..	25
Salmon Springs Drift:	
Gravel, pebble, sandy, brown; lenticular, locally contains blocks of clay and glacial till...	10
Sand, medium to coarse, brown (not continuously exposed) •.	35
Intermediate drift:	
Silt and clay, thinly laminated, bluish-gray	20-25
Till, mostly silt and ciay, olive-gray (sample 867-.>-!)	20-25
Sand, fine to medium, gray to brown: crossbedded in part, contains interbeds of silt.	40
Silt and clay, thinly laminated, yellowish-gray to brown.	10
Till, chiefly silt and clay, olive-gray (sample 867-6-1)	65

Non-Stop 7 - Jenkins outwash channel; State Route 18 from the Auburn-Black Diamond Road northeast 10 miles to the Cedar River. Ice-marginal and submarginal drainage along the eastern edge of the retreating Vashon-age ice sheet sought ice-free paths west into the low-elevation axis of the central Lowland. The Cedar Spillway, a low gap in the hills separating the Snoqualmie River valley to the north from the Covington Drift Plain to the south, funnelled vast amounts of water and sediment into a series of outwash channels now traversed by this section of Highway 18. Correlative deposits can be traced across the Auburn Valley into Federal Way and northeast Tacoma, covering in total over 200 km2.

From the Cedar River, the highway then follows a far less favorable route than that traversed by late-glacial meltwater. The road ascends the southern flanks of the ridge known as the "Newcastle Hills Promentory" or, more locally, the "Issaquah Alps." This upland reflects late-Tertiary folding of Eocene volcanic and sedimentary rocks, severed from the main Cascade Range by the subglacially carved and subaerially exploited Cedar Spillway, about 12 km east.

Stop 8 - Views of the east-central margin of the Vashon ice-sheet, the ice-marginal embankments of Lakes Hancock and Calligan and the South and Middle Forks Snoqualmie River, and the Snoqualmie Embayment.

To reach this stop, continue on State Route 18 to Interstate 90, about 10 miles beyond the Cedar River. Turn east on 1-90 1-1/2 miles to Exit 27, turn right at the base of the ramp, and bear left in 0.1 miles. The views to the north that constitute the last stop may be accessed in one of three ways. Easiest is to continue straight about 0.3 miles to the Snoqualmie Winery parking lot; however, rapid growth of downslope conifers threatens to obscure the view by about 1990. Slightly more difficult is to park at the gated logging road on the right 0.25 miles from the exit ramp, walk up it 300 yards, and turn right up a spur road another 200 yards to less obstructed views. Most ambitious, and most rewarding, is to continue up the main logging road to the next right-hand branch, about 3/4 miles, and ascend it several hundred yards to a large borrow pit. The resulting panorama displays the entire east-central glaciated lowland, particularly the eastern ice margin and submarginal drainage channels west of Mount Si.

(see illustration on following page)

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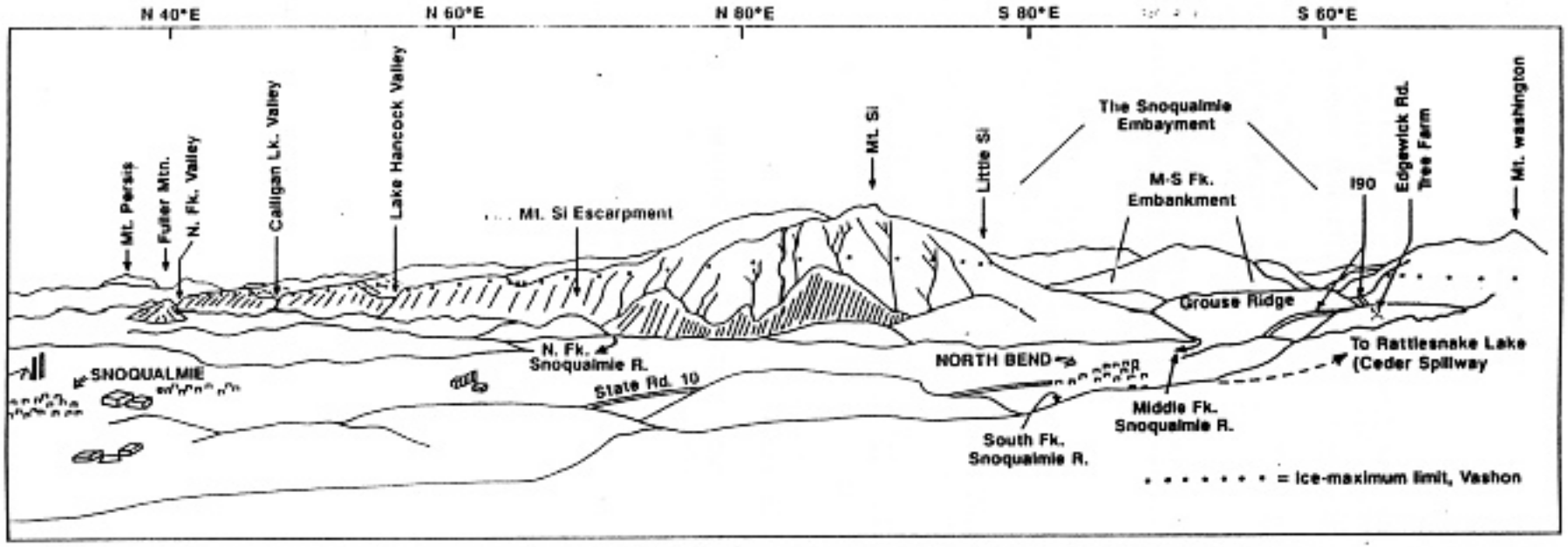

VIEW FROM RATTLESNAKE MOUNTAIN (last stop)