The IAFI Puget Lobe Chapter monthly newsreel:

Introduction to the Milankovitch Theory, Ch 9, p. 1

This month, the Newsreel continues with a look at a Crescent Formation extrusion of Pillow basalt on Mt Tyler above the Dungeness River, and a walk along Royal Creek to look for evidence of the proglacial lake that formed in the Dungeness River valley resulting from the Fraser glaciation's Juan de Fuca / Puget Lobes blocking the river.

This extrusion is a vent and there are several other extrusions in the same area that will be added in the expanded version of this chapter after this presentation.

When we hear of pillow basalt flows, we never hear reference to interstitial spaces, or the space between pillows as they cool. We will look at some samples

And if time allows, look at the sheer cliffs on the west side of Mt Zion (northwest of Bon Jon Pass) that show the potential for glacial smoothing. Just a quick look, no rappelling gear involved.

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For the Upper Dungeness River Valley, we will consider the starting point of our journey to be at the intersection of Palo Alto road and FS 2830. However, how do we get there.

You'll be heading west from the Hood canal Bridge about 33 miles. Just past Blyn about 2 miles, you turn left off US101 onto Louella Road near Sequim Bay State Park. After going up Louella road about a mile, you will come to Palo Alto road, onto which you will make a left turn (south) and follow it for about six miles to FS 2830 where you will turn right.

Be aware that FS 2830 from the intersection of Palo Alto down to the Dungeness River bridge is steep, narrow, and rutty. RVs and trailers are prohibited.

About 2/3's of the way down you will start to see Crescent basalts. The road has been cut out of the cliff. When you get to the bottom you will see the bridge that crosses the Dungeness River. There is a small parking pad on the north side of the bridge, and across the river you will find the entrance to the Dungeness Forks campground. It is a primitive campground with water and outhouses and open during the summer-fall months (check with the US Forest Service and/or their on-line road updates).

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Below are some mileage and approximate driving time from the Intersection of Palo Alto/FS 2880 to points of interest.

Please note that times are dependent upon stops made and how fast you drive (which is slow). Also, the FS road numbers change from 2880 to 2870, then to 2860 on maps. It is best to look at a Forest Service map and decide where you're going and follow the lines on the map. Do not go fast – gravel road.

Mileage	Time	Elevation	Location	Comments
0	0		US101 / Louella Road	At top of hill turn left onto Palo Alto
6.8	11 min	1,379 ft	Palo Alto/FS2830 Dungeness River Road	
.8	4 min	857 ft	Dungeness Forks Campground	
5.2	17 min	3,111 ft	FS 2870 to FS Road 120	Mileage to Basalt Cliff
5.4	17 min	2,550 ft	FS 2870 to Upper Dungeness Parking Lot	
8.0			FS 2870 to Tubal Cain parking lot (mines and B-17 wreckage)	

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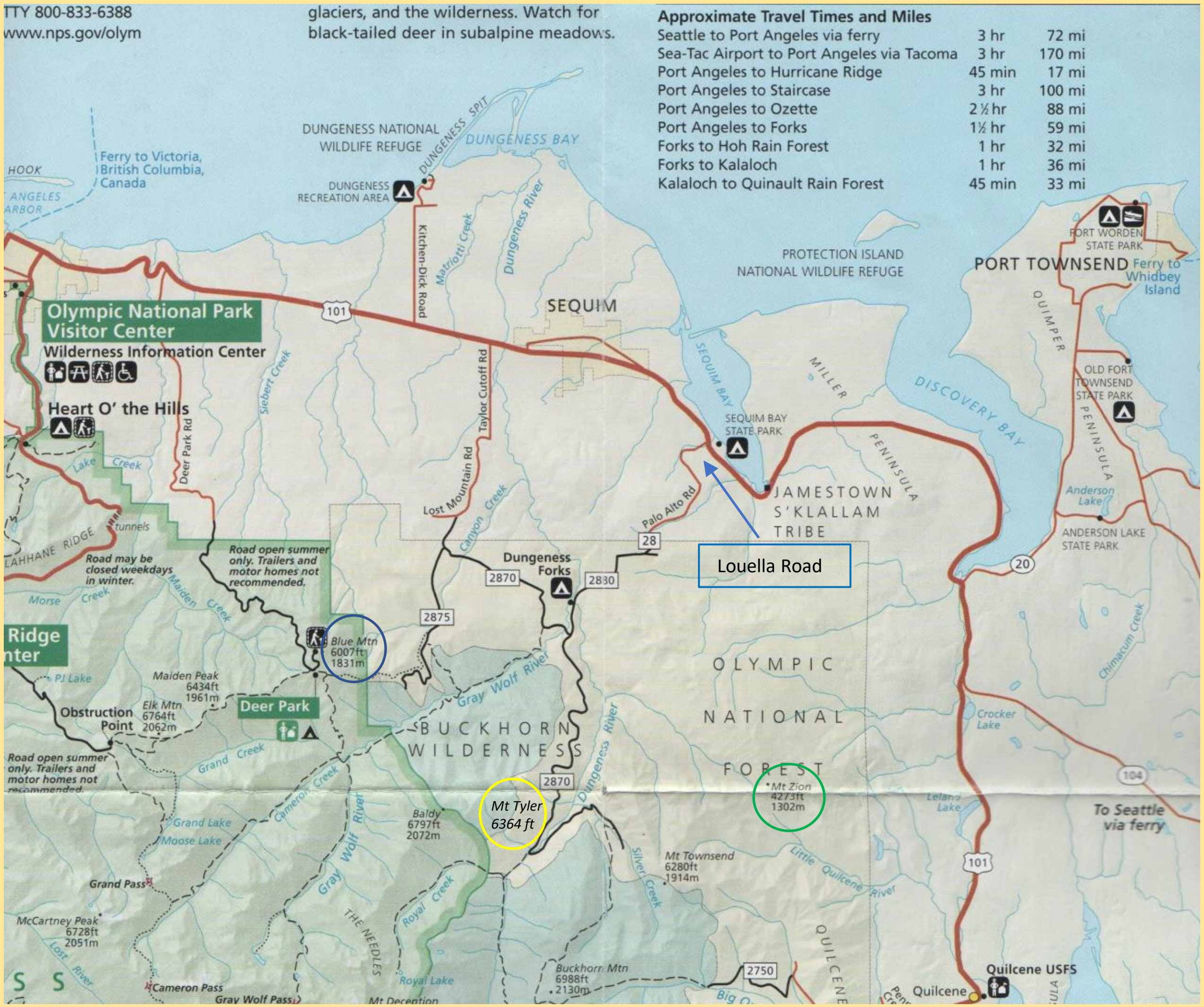

Note location of Blue Mountain (blue circle) which is the nominal location of the bifurcation between the Puget Lobe and the Juan de Fuca Lobe.

Mt. Zion (green circle) a nunatak during the Fraser Glaciation. See next page.

Mt Tyler (yellow circle) is our ultimate destination.

Olympic National Park
National Park Service
U.S. Department of the Interior
GPO 2003-496-196/40554

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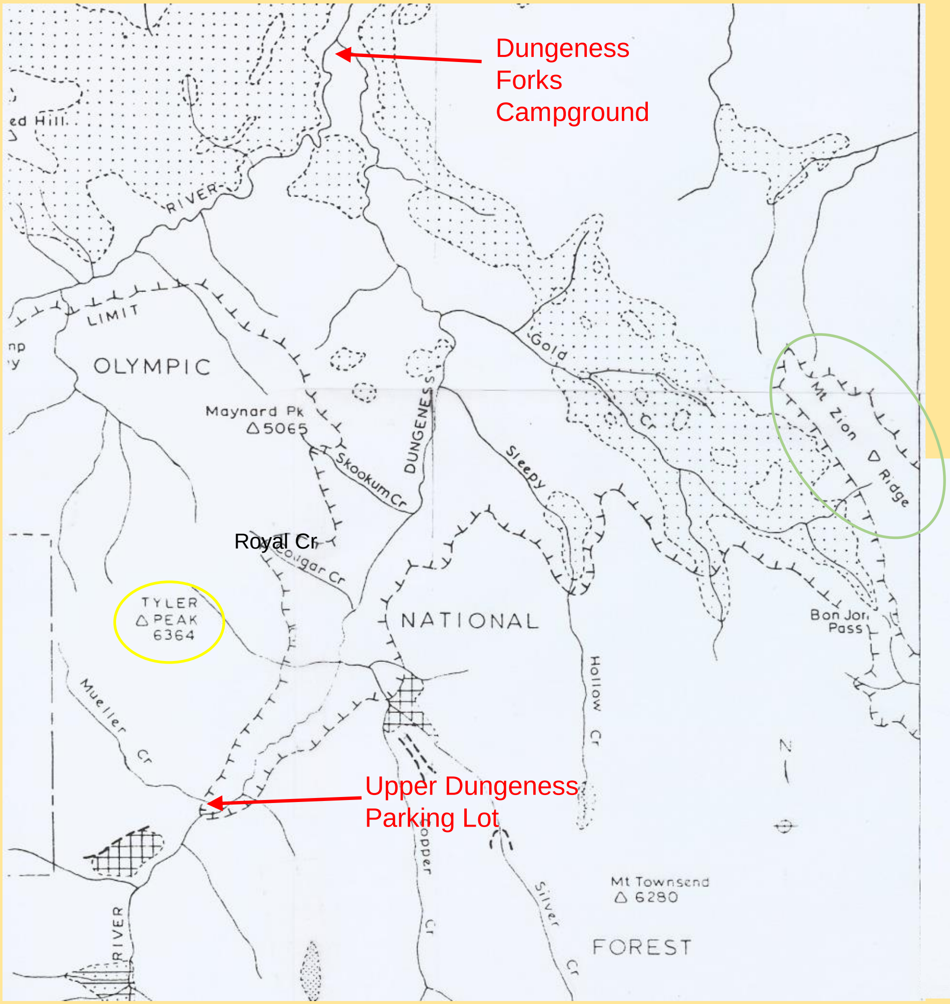
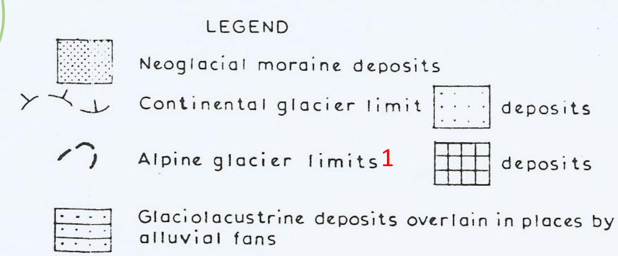


Note: The Dungeness Fork Campground is near the splitting point of the Puget and Juan De Fuca Lobes. Mt. Zion is a nunatak.
(Long, 1976)



Note 1: See Ch 9, p. 13 (not Slide)
for possible Alpine glacier feature

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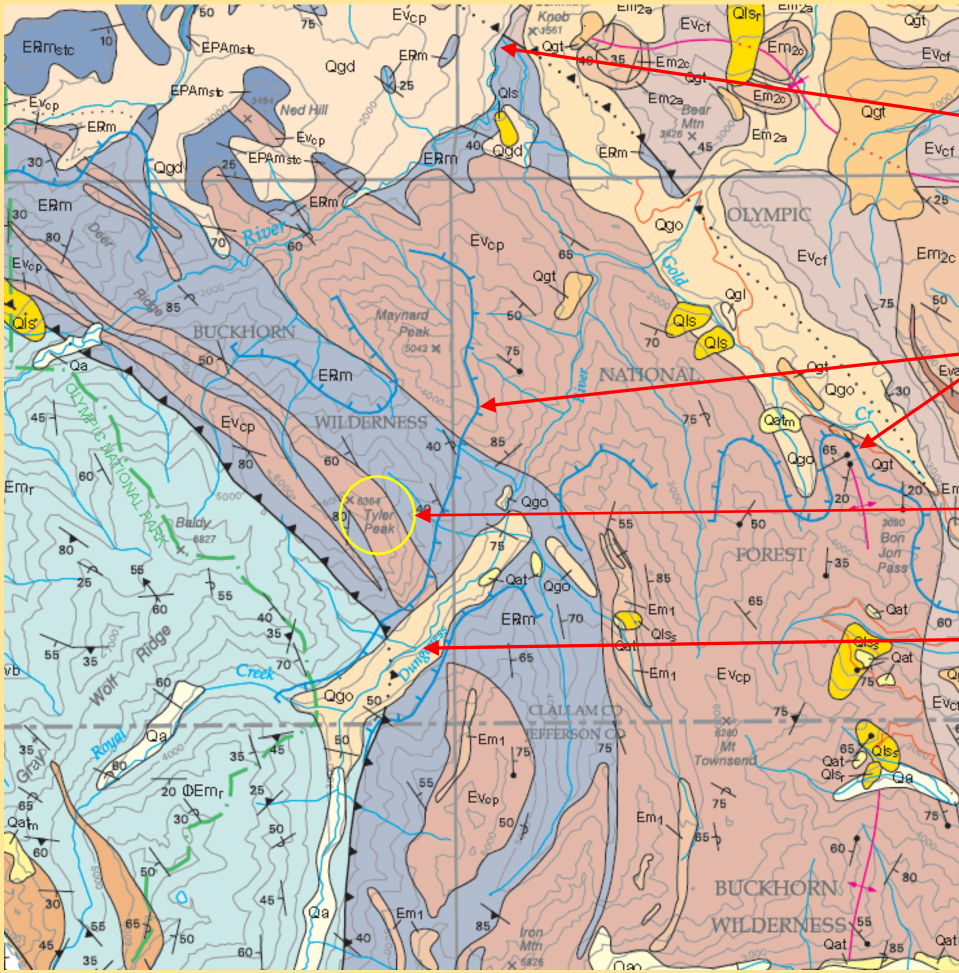

Dungeness Forks Campground

Limit of influence of the late Wisconsin Cordilleran ice sheet.
Or, area of Last Glacial Maximum of the Juan de Fuca Lobe

Mt Tyler

Upper Dungeness Parking lot
Elevation is about 2500 ft

DNR OFR 2003-4 Tyler Peak area showing current thinking on LGM

Long put LGM at 2,550 ft while DNR OFR 2003-4 shows limit at 3,200 ft. This may be a result of IRD (erratic) from the proglacial lake.

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Location and heights of important erratics (Ice Rafted Debris) in the Dungeness River Drainage[1]:

Location	Altitude (ft)	Map #
Bon Jon Pass	3,200	L1
South end of Mt Zion Ridge	3,450	L2
East Side Gold Creek on Mt Zion Trail	3,400	L3
North end of Mount Zion Ridge	3,550	L4
Mid-section Sleepy Hollow Creek on west wall	3,200	L5
Ridge of Maynard Peak between Skookum And Cougar creeks	3,550	L6
Dungeness River at Mueller Creek	2,500	L7
Camp Tony on Gray Wolf River	1,800	L8
Upper Slab Camp Creek near Deer Ridge	3,550	L9

Not shown in this presentation (L1–L9)

Note: The north end of Mount Zion the Fraser Ice Sheet bifurcated. Ice went down both sides of Mt Zion, making it a nunatak. Ice flowed along Dirty Harry Ridge and into the Dungeness River Valley. Further west at Blue Mountain is where the Juan de Fuca Lobe is considered as the official bifurcation point. It is the place on the northeastern Olympic peninsula where the ice sheet bifurcated into two lobes. (Long, p. 7)

[1] Long, W.A., Glacial Geology of the Olympic Peninsula, Washington. U.S. Forest Service Unpublished Report, 1976, p. 7

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Proglacial Lakes (Long, p. 8)

Gold Creek: This lake was overrun by the Juan de Fuca lobe and the lake spilled through 2,975-foot Bon Jon Pass into the Little Quilcene River drainage (Long, p. 7)

Dungeness River:

Terminal position of ice was about 2,500 (+- 50 ft)

Ice Rafted Debris (IRD) found inside Royal Creek valley to an altitude of 3,150 ft

A single granite boulder was found in the river valley above Royal Creek at 2,850 ft

Opposite Tyler Peak (east wall) granite found as float at 3,350 ft.

Indication that the surface of the proglacial lake was at the 3,400 ft level

This would make the depth of the lake approximately 900 ft

Lake would cover ice back to the 3,400 ft level (build Ice and Lake height graphic)

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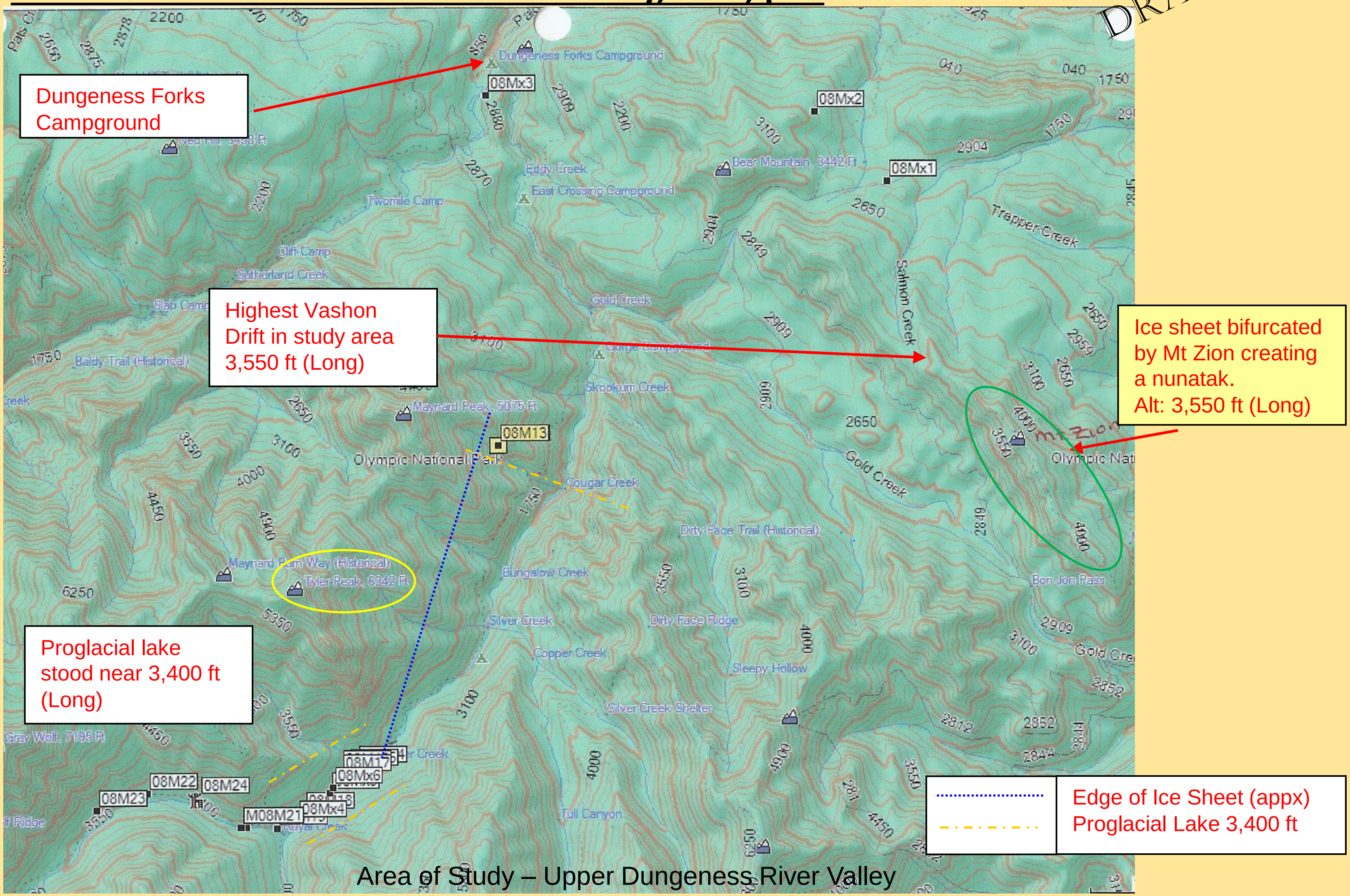
DRAFT



Area of Study – Upper Dungeness River Valley

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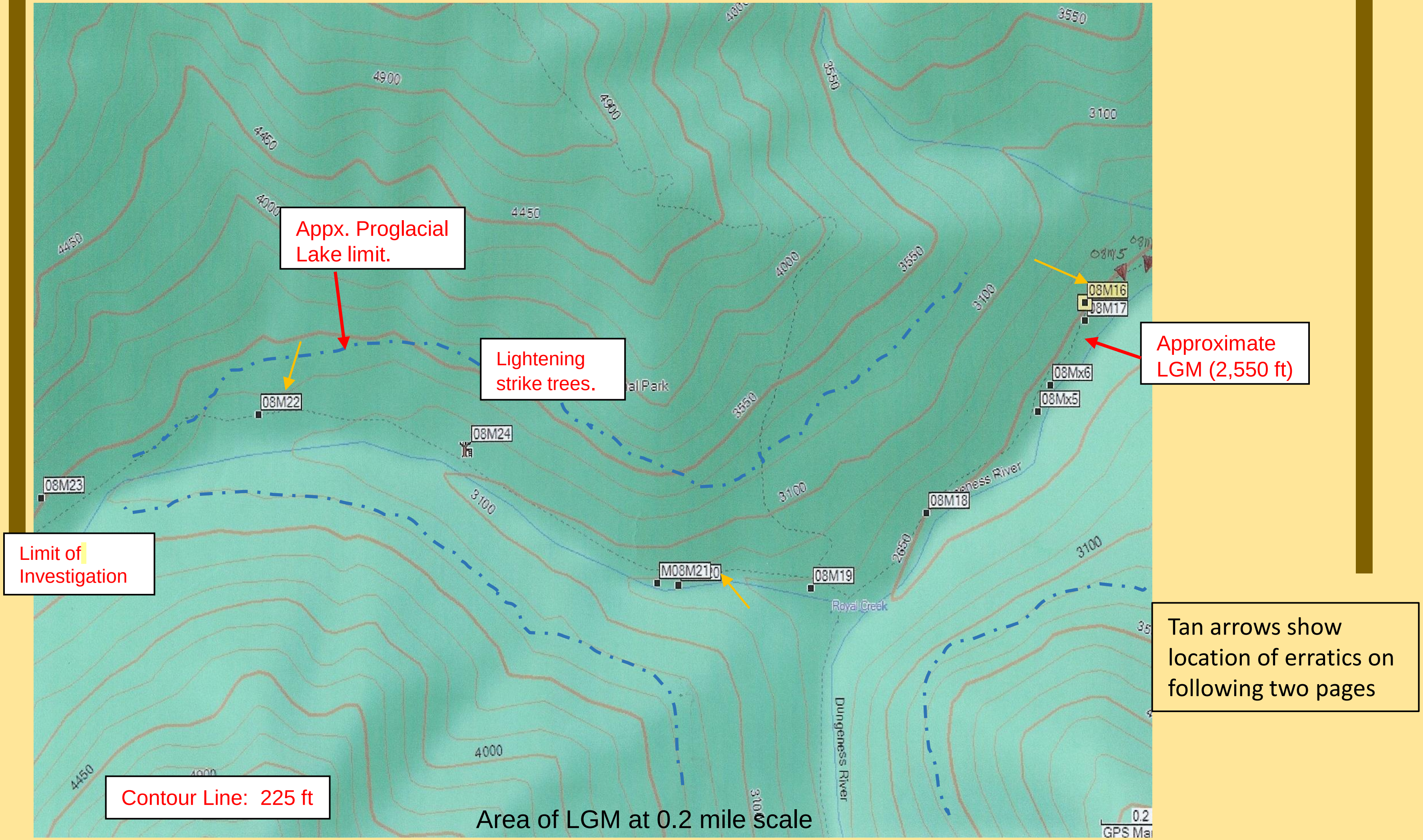

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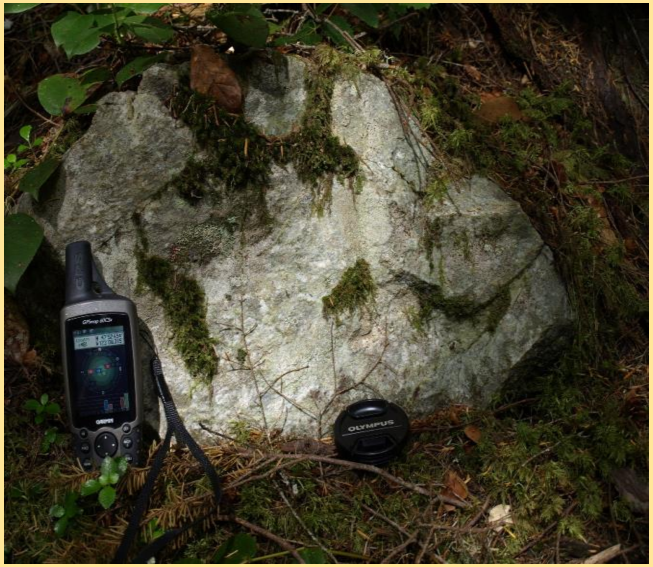
Some samples of erratic deposits of IRD (see note 1):



08M16
N47 52.647/123 08.313   2,513 ft

The three sample erratic's, on this page and the next, have not had their chemical composition identified at this time.

Note 1: IRD or Ice Rafted Debris: for our purposes the debris would be rafted into the lake by floating ice and released into the underlying water column as the ice melts. There are five sources, four processes, and four types of deposits. Our process is very simplified. (Benn, p. 296)

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08M20

N47 52.184/W123 09.504 2,893 ft

08M22 – Possible granite on right side

N47 52.466/W123 10.634 3,336 ft

This would be the maximum elevation we expect to find granite along the Royal Creek trail if the proglacial lake's elevation was at 3,400 ft elevation

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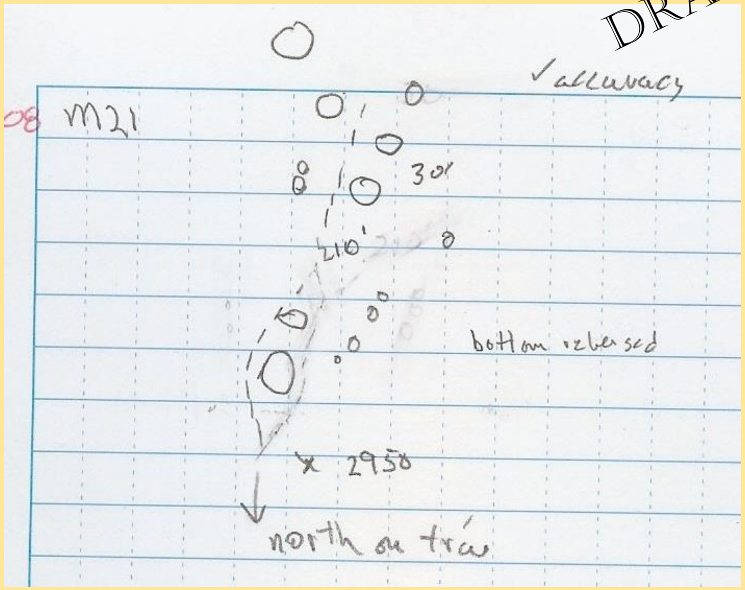
08M21



Configuration of 08M21 complex

N47 52.187/W123 09.561 2,931 ft
Further research needs to be done on this complex as we believe it to be alpine glacial deposit

(Long makes reference to a “a bouldery outwash valley train, which has been channeled by the river into long linear ridges up to 10 feet high, occurs below the alpine glacial deposit and can be traced to the mouth of Royal Creek.) (Long, p28, 1976)

There is a similar large boulder(s) train at the foot bridge at the confluence of the Dungeness River and Royal Creek about a mile up from the parking lot.

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Now on to our Pillow Basalt Cliff on Mt Tyler:

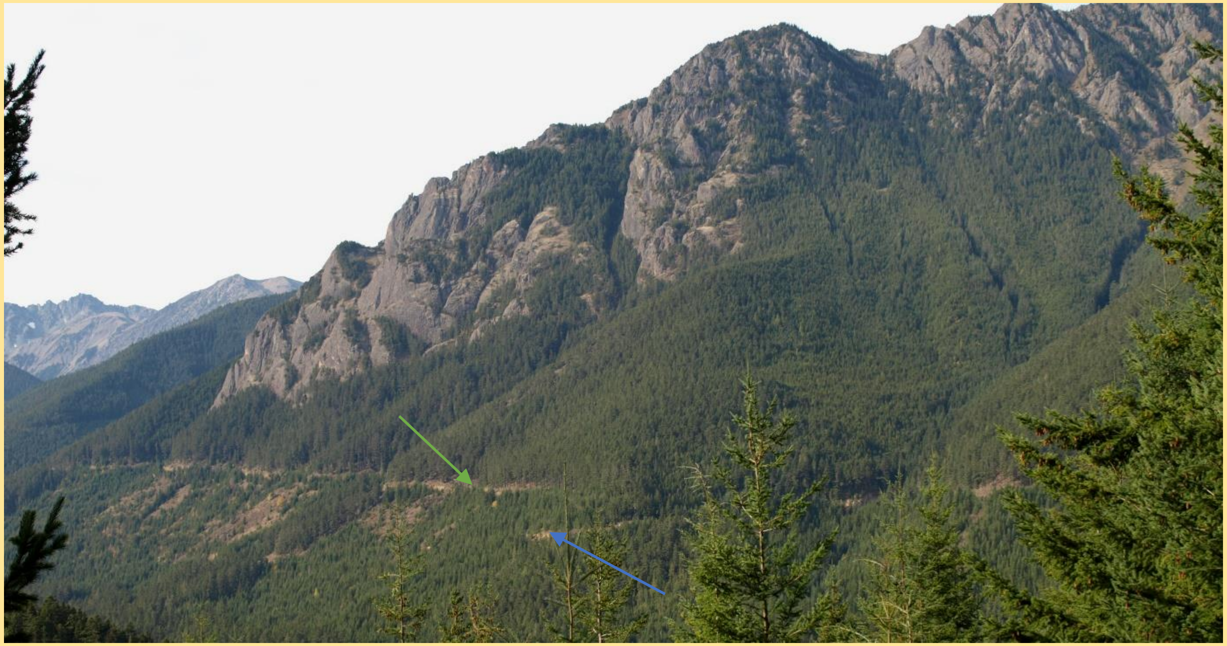

Figure 3: Tyler Peak from Tubal Cain road showing FS120 along lower slope below old growth with FS2860 angling down from the right-middle side towards the upper Dungeness parking lot.

While traveling FS120 you will pass by/through three formations as shown in Figure 4. **EP$_A$m** which are marine sedimentary rocks, then around Tyler Peak you will find yourself in **EVcp** or marine basaltic rock which are pillow dominated. As you drive along FS120 stop and look closely at (keep your eyes on the road and **stop to look**) Tyler Peak which is composed of pillow basalt. Its cliffs appear nearly vertical. Towards the SW side of Tyler Peak you get back into **EP$_A$m** for a short while. Then just past the Massive Pillow Basal Cliff (MPBC) you go around a corner and pass over the fault separating the **EP$_A$m** formation and **ΦEm$_r$** formation or the marine rhythmites (or thin bedded sedimentary rocks). The precise location of can be seen at the culvert about 500 feet north of MPBC.

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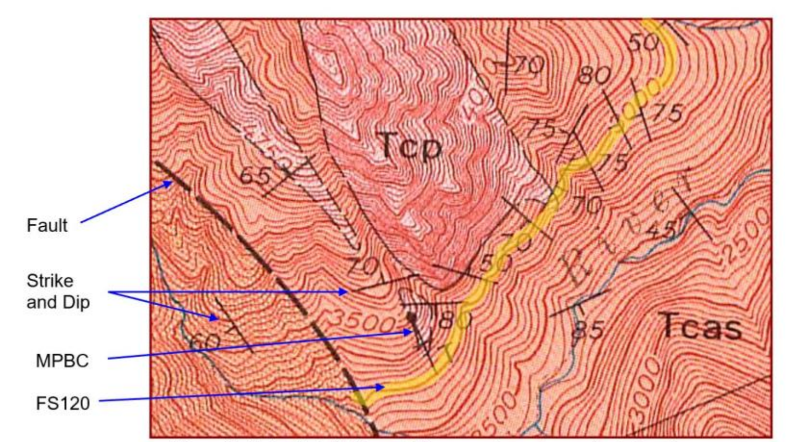
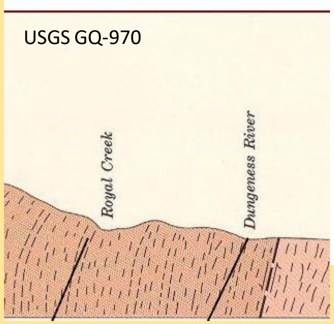


Figure 8: Tyler Peak Strike and Dip examples. Approximate location of FS120 shown in transparent yellow. (USGS GQ-970)

Figure 8. From USGS GQ-970. It is very busy and complicated. For all intents and purposes, it shows the effect of the Peripheral Rocks pushing the Crescent formation to near vertical. Please note that the contour lines are at 50 ft and quite close. Looking at the previous page Mt Tyler is near vertical, so the contour lines are accurate. Rope and body harness are recommended.

Figure 9. A revised version of Figure 8 that allows the viewer to get a better perspective Strike and Dip. The small graphic below is from the cross section of the area between Royal Creek and the Dungeness River. It shows the Dip.



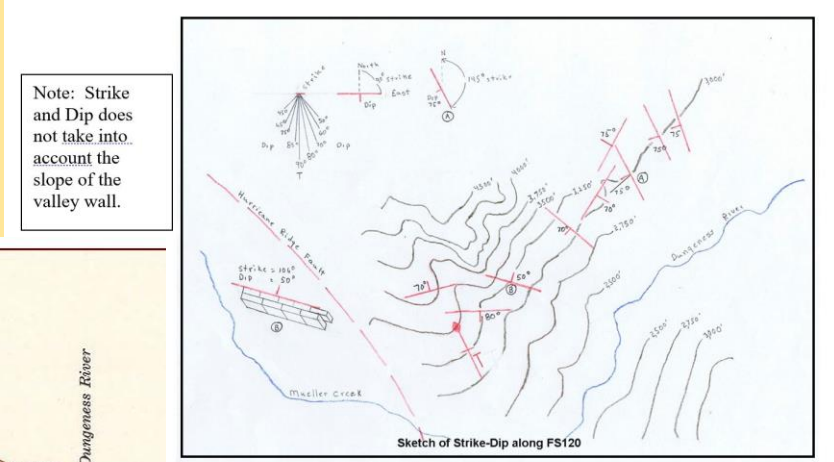


Figure 9: Sample of Strike and Dip at Tyler Peak (redrawn from Fig. 8)

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How do you tell the proper orientation (up) or dip of pillow basalt? Pillow basalt is unlike normal sedimentary bedding of a formation. Bedding as shown in Figure 9, example Ⓑ is straight forward. The bedding is arranged in easily identifiable layers. See Figure xx, "Intrusion of Basalt into Blue Mountain (EPA$_m$ Formation)" where you will see the individual layers. However, if you look at Figure xx, Massive Pillow Basalt Cliff (South and North Lobes) you will notice layering is absent. For pillow basalt you need to look for the "bottom" of the pillow where it flowed over pre-existing or hardened pillows. Where you can see the "bottom" of the pillow, it will have flowed (pulled by gravity) into the interstitial space, much like the pointed end of a heart; or, the pillow below it will have "pushed up" and rounded the bottom of the pillow flowing over it.

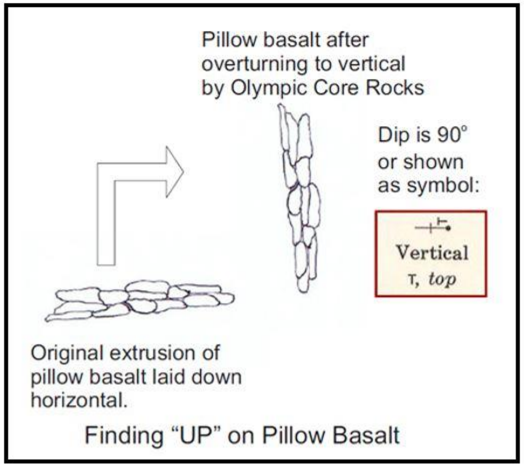

Figure 10: How you identify "up" on Pillow Basalt.[3]

Need face on view showing triangular appearance of pillow

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The table below shows the five types that Gregg and Fink (1987) studied, their cooling rates, and the effect of flow rate and slope increase.

Type of flow	Cooling rate that produces type of flow on 6° slope	As the flow rate and slope increase the Ψ values decrease	
Pillows	Ψ < 3		
Lobate Sheets	not studied		Formed in a manner similar to pillows
Lineated sheets	3 < Ψ <13	X	W/increasing effusion rate the surface folds become regularly spaced
Ropy sheets	13 < Ψ < 25	X	
Jumbled sheets	Ψ >25	X	High flow velocities prevent crustal formation except at the margins of the sheets

These are classified by cooling rate, the slope upon which the type is extruded, and the extrusion rate of the lava. The parameter or equation is: " Ψ = the ratio of time (in minutes) required for solid crust to form on the surface of the surface of the flow to a characteristic time scale for horizontal advection" or the time (in minutes) it takes for a crust to form on extruded lava.

A transition can occur from one type to another type. A transition was been observed on the CoAxial eruptive center on the Juan de Fuca Ridge in 1993. In this flow the pillows transitioned to lineated sheets. Slopes were 10° to 30°.

CoAxial comments: Interestingly, in this eruptive event, while the initial eruptive center was a fissure about 2,500 m long and between 1 - 3 m wide, within an hour the fissure was reduced to a single vent. While the lava flowed for ~10 days, the majority (½ of the volume) occurred in the first 2 hours.

The progression can be from a lineated sheet flow (highest effusion rate) to a downstream lobate flow then to a pillow as the rates of effusion decline. And the reverse is true, increasing flow rates or slopes and decrease cooling rate leads from pillows, to lobate, to lineated, to ropy, and then to jumbled.

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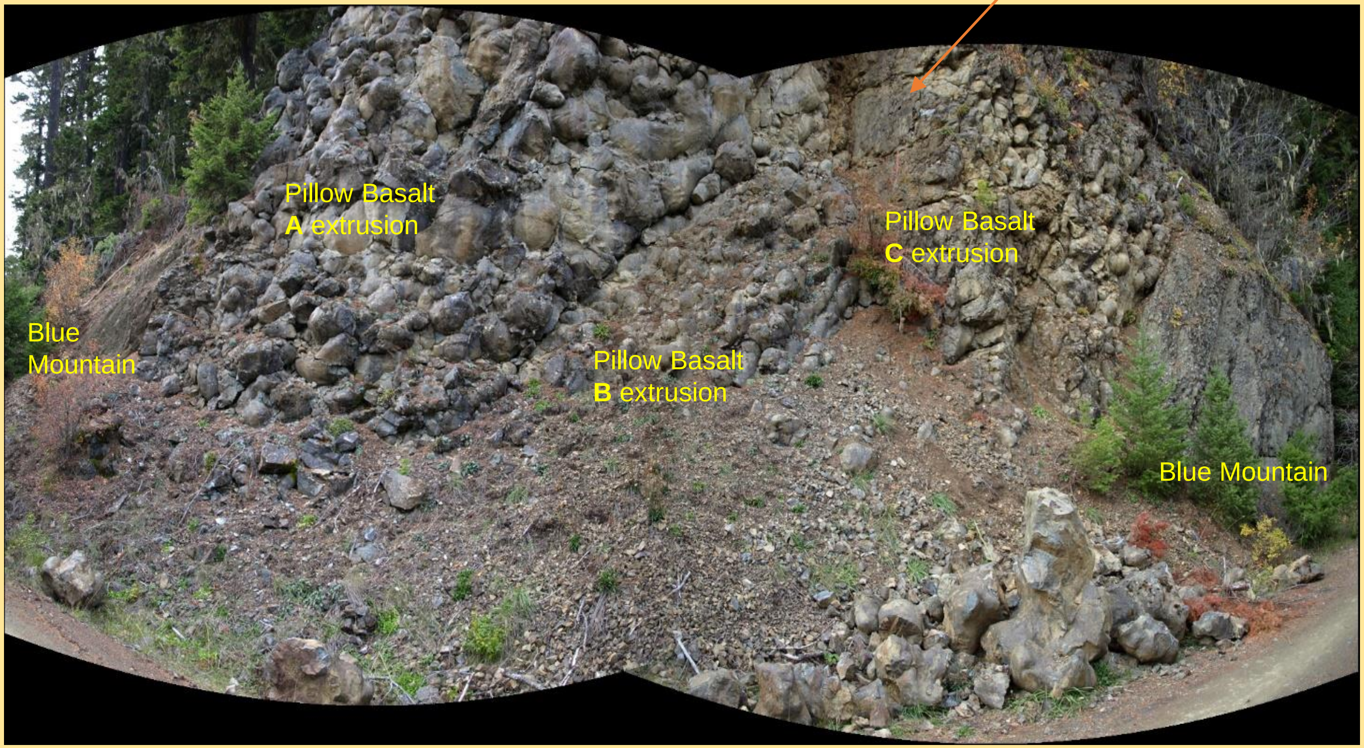
Massive Pillow Basalt Cliff (MPBC):

Notice the flat smooth appearance of this face



The A, B, C extrusions represent a simplified chronology of assumed extrusion events. “A” extrusion may be the youngest based on its appearance that overrides “B” and “C”. “C” may be the oldest based on the apparent smooth surface split or vent, or be part of B. See next page.

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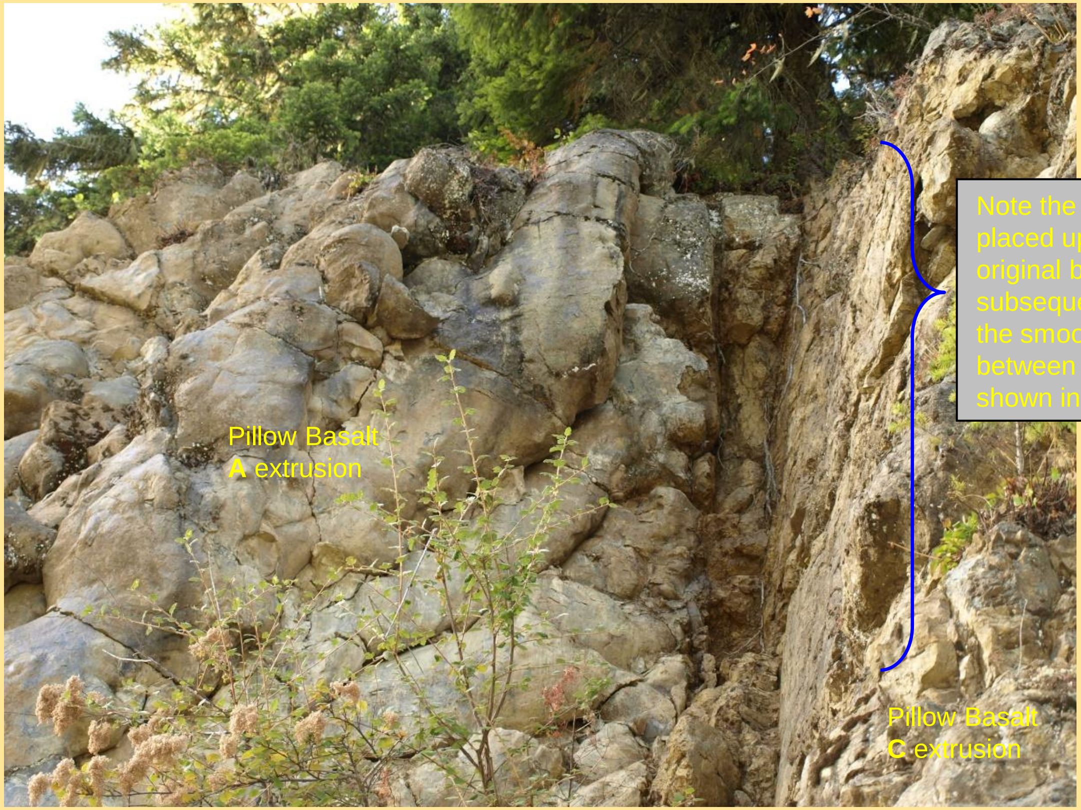

Note the apparent stress that was placed upon the basalt of the original basalt extrusion (C) by subsequent extrusions (A, B) and the smoothness of the (strain) split between extrusions A and C as shown in this photo.

Weathering of rock is a peculiar phenomena. For instance, in the Revett Formation, Belt Series of NW Montana, the base rock , argillite, breaks clean with a grey appearance, it then weathers to a rust color in a few years. Over time it weathers to show the characteristics of its original sedimentary “appearance” at the time it was laid down 1.5 Bya: turbidity currents, drop stones, desiccation features, and other assorted sedimentary features.

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Striations appear on many pillows on the MPBC as they passed between cooler pillows during extrusion.

It is not readily apparent in this picture, but there may be "interstitial" spaces between these pillows. On the next page are examples of interstitial spaces. Two types have been located: (1) Apparent gas/heat vents, and (2) spaces that were filled over time with seepages mostly composed of carbonate (limestone).

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Gas / heat vent?

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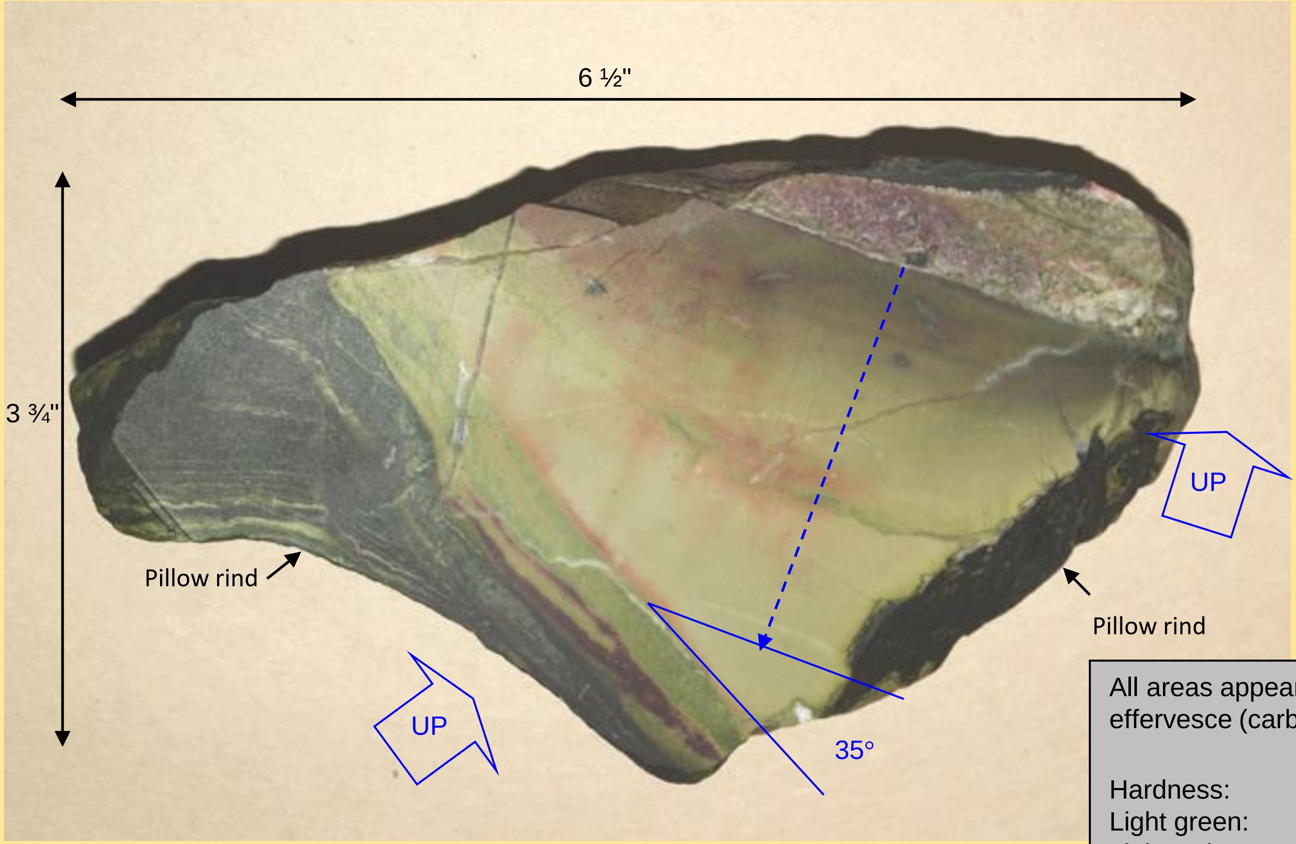

All areas appear to effervesce (carbonate)

Hardness:
Light green:
Light red:
Dark brown:
Dark green:
White:

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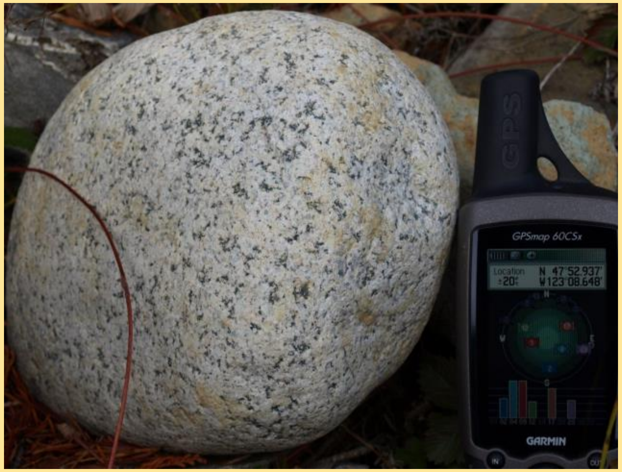
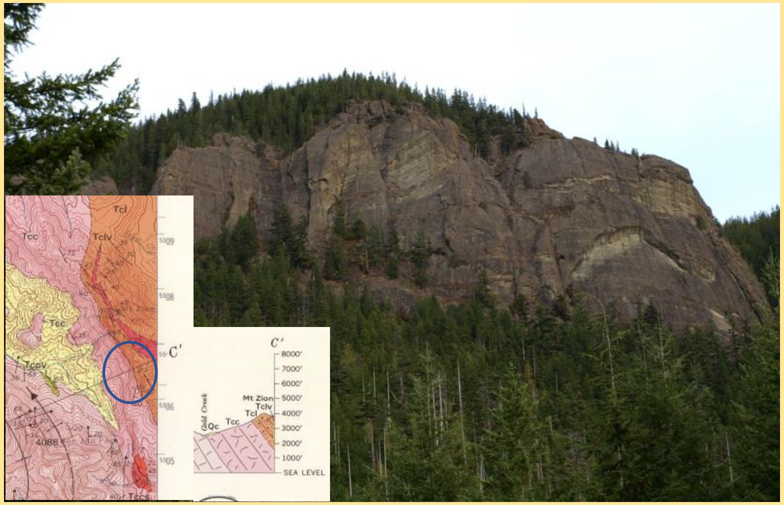
This is a quick look at some features found in the Dungeness River and Mt Zion area.

At the end of FS120 are several pieces of granite above the right side of the road. They are located along the slope at N47 52.938 W123 08.647 at elev. 3,221 ft. See Figure xx below. This is the highest an IRD/erratic we've found along FS120.



These cliffs are found on the southwestern side of Mt Zion near Bon Jon Pass. USGS GQ-970-1 shows TCL - Lyre Formation pebble to boulder conglomerate, and TCC – upper basalt member of the Crescent Formation in this area. Another photo shows "cave structures" or "lava tubes". More investigation is required.



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In Sep 2021 (Ch10), the Newsreel will continue with a look at the Kame terrace on FS23 above Vance Creek, and then go beyond the High Steel Bridge over the S. Fork of the Skokomish River to look at the eskers* below Denny Ahl Hill (and one esker located on the side of Denny Ahl). And yes, we'll straddle the Frigid Creek Fault for some excitement.

* The esker shown on our web page is from that area and is used by the FS/landowners as a "borrow pit". That's why the vertical end.

The Chapter Newsreel has a time limit of approximately 15 minutes prior to the start of the meeting to be shown. Consequently, its condensed. However, newsreels will be expanded before being placed on the website after the meeting. It will show the date it was put on the website or in most cases a "revision date" indicating new or corrected data.