The IAFI Puget Lobe Chapter monthly newsreel:

Introduction to the Milankovitch Theory, Ch 7, (p. 1)

Last time we talked about: The Fraser, Possession, and Double Bluff glaciations and where we find the last exposed sediments.

In Chapter 7 we will review:

The brief, but not complete, geological history of Hood Canal. Has it been there "in perpetuity" or just since the Fraser glaciation? What does the bottom look like, and where did all that sediment come from – the bottom topography isn't exactly flat. And where is the Crescent formation going if the North American plate is pushing west and the Juan de Fuca plate pushing east.

As shown herein, the Hood Canal fault zone extends northward from directly east of Potlatch, Washington, near the southern end of Hood Canal, through Hood Canal and Dabob Bay and is inferred to extend farther northward on land to about 5 km east of the southern end of Discovery Bay. Other northerly striking faults have been mapped and inferred a few to several kilometers east of the northern part of the Hood Canal fault zone, where they are mapped as largely inferred faults in and along Discovery Bay.

(Gower and others, 1985 #4725; Johnson and others, 2000 #4755; Dragovich and others, 2002 #5715).

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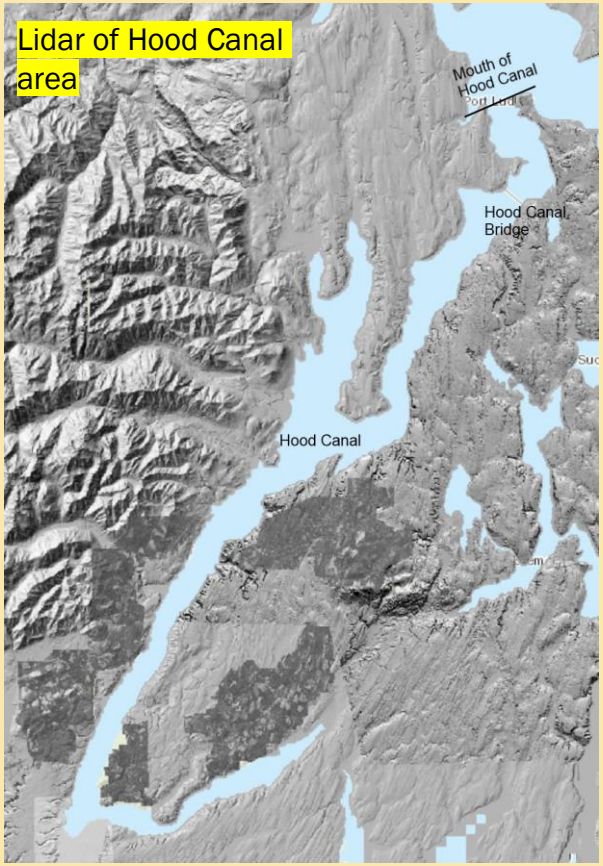
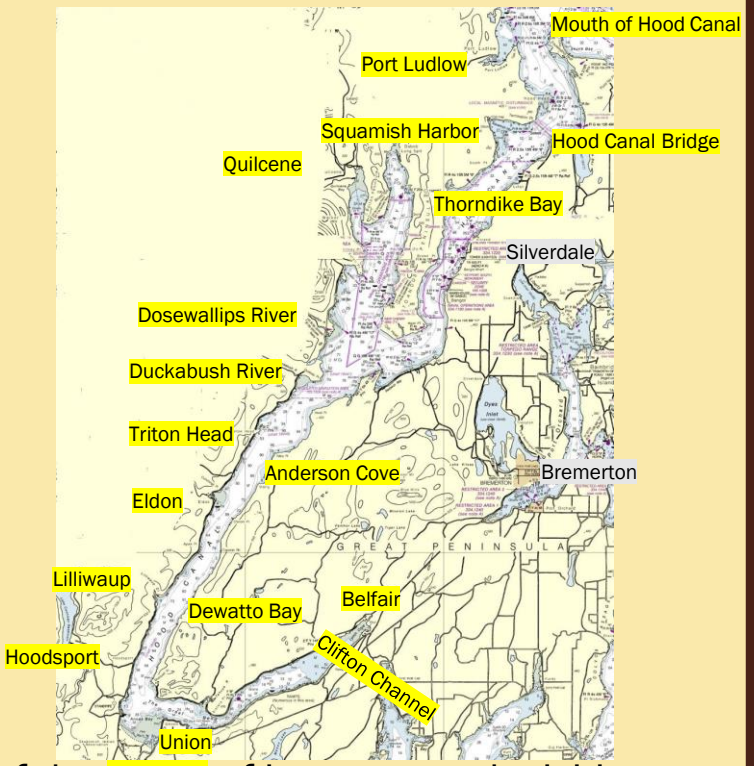
What is and where is Hood Canal.

Hood Canal runs Southwest-Northeast against the Olympic Peninsula with the Crescent Formation bordering the west side of the canal and the Kitsap Peninsula providing the eastern shoreline.





Some of the areas of interest worth visiting

Introduction to the Milankovitch Theory, Ch 7, (p. 3)

Now that we know where and the extent of Hood Canal, we want to put together some facts as best we can. One of the facts is "is there a fault down the middle of Hood Canal". Well, yes, we'll talk about it. And how long has Hood Canal been there?

It is said that Hood Canal, in its present physical condition, may not have existed prior to Frasier Glaciation. Part of this is that between the Whidbey Interglaciation and the beginning of the Frasier Glaciation (a 70k year span), the area of Puget Sound was filled in and level, and only had rivers draining the Puget Sound lowlands of which Hood Canal is part of. Sediments flowing out of the Cascades and Olympics is the cause. However, as seen in the Notes below:

Note: 1. "We suspect that Hood Canal was filled with sediment prior to the Vashon Stade because older units appear continuous across the canal." (Lilliwaup 7.5-Minute Quadrangle (pamphlet) Open file Report 2010-4, page 4)
Note: 2. "...and the interpretation by Crandell and others (1965) that the troughs predated and were re-excavated by the Vashon-age glacier." (Thorson, R.M., Glacio-isostatic Response, Puget Sound, Washington, GSA Bulletin, Vol9 Sep1989

Note 3: The period prior to the Whidbey Interglacial (Termination 2 ~130kya) could reasonably have created a "paleocanal" Hood Canal, as the length of time of the $\delta^{18}O$ isotope line (see next slide) on the graph suggests the possibility. The time for the Double Bluff Glaciation $\delta^{18}O$ curve was below –0.4 was 60K years. Possession $\delta^{18}O$ was ~ 8k years, and Fraser Glaciation was below -0.4 from ~35Kya to 12Kya or about 23K years. And, we saw in the Newsreel #6, the last identified Possession sediments weren't found further south than Anderson Cove on the Holly Geological 7.5 Quadrangle OFR 2011-5. With the last Double Bluff sediments (Qgp) near Maytown, south of Olympia, shown on Maytown Geologic 7.5-Minute Quadrangle)

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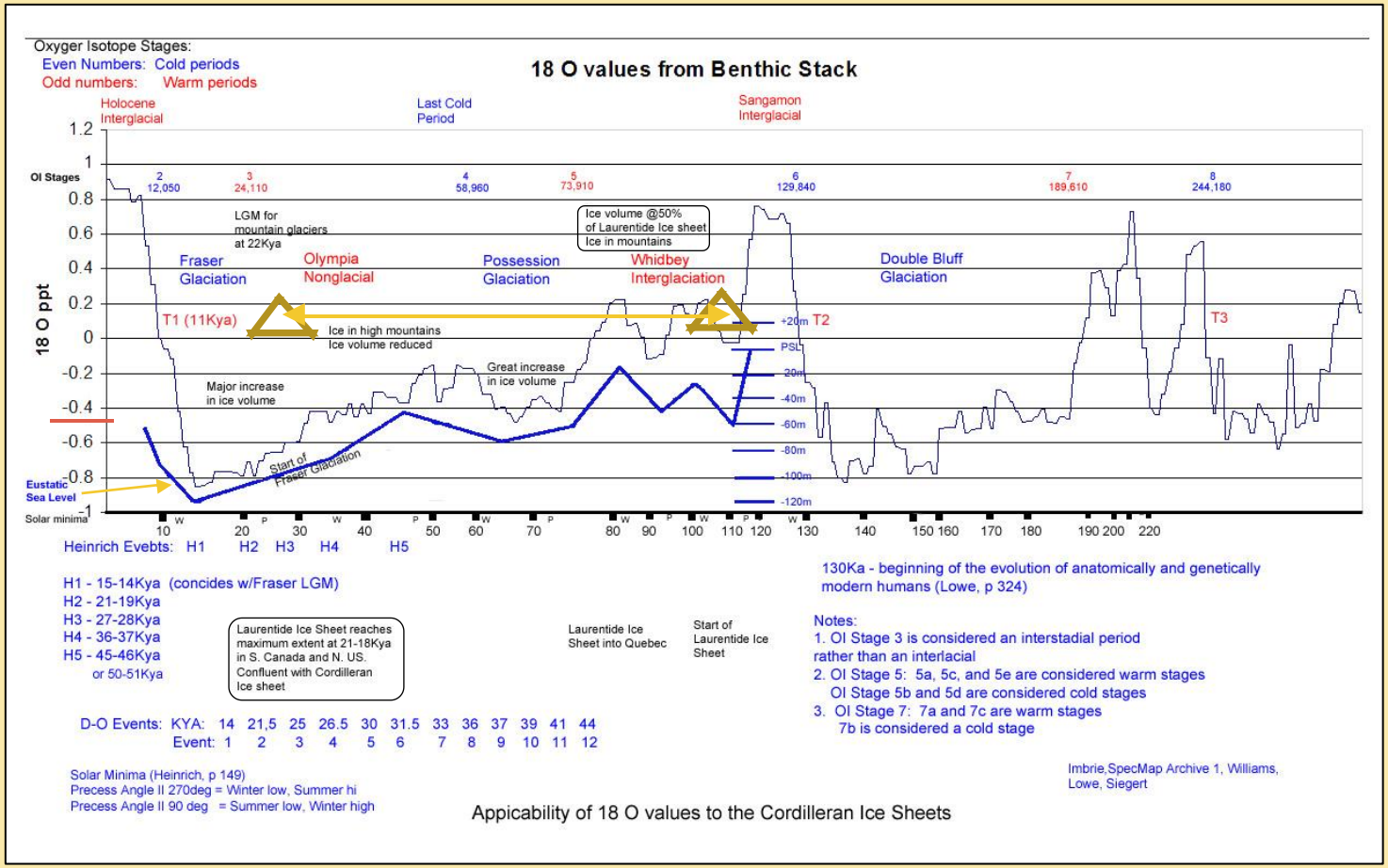

The tan arrow between the tan triangle's intimates that there was no ice front gouging a trough-like feature wherein Hood Canal now exists. See Newsreel Chapter 6, p. 4, or Holly Quadrangle OFR-2011-5. The current Canal would be gouged out during the Fraser Glaciation. Also see Note at bottom of previous slide.

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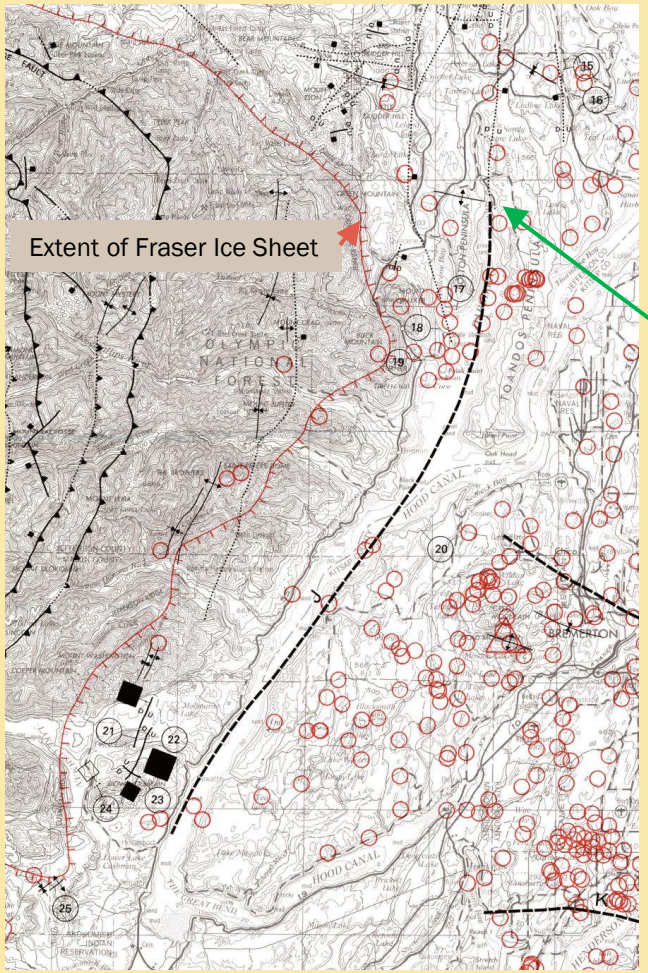
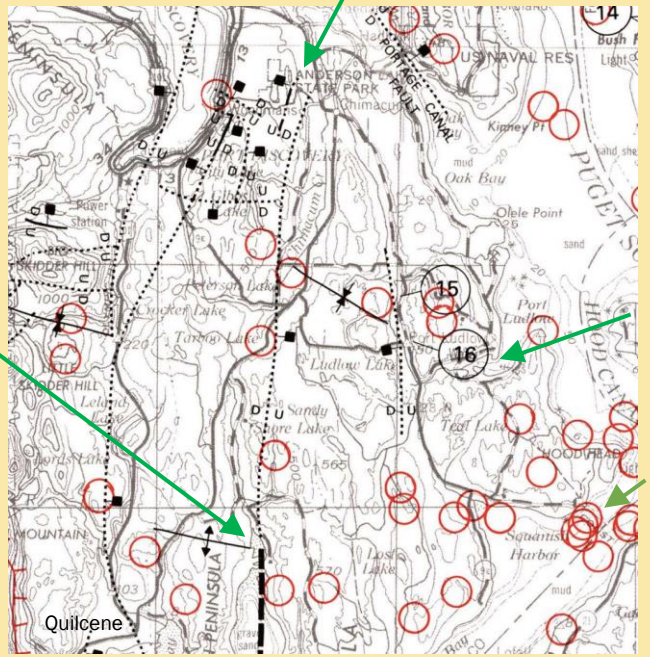
The Hood Canal Fault: Is it or is it not? We show it!





Note the preponderance of earthquakes east of Hood Canal on Kitsap Peninsula as shown by the Red circles.

Note: "We suspect that Hood Canal was filled with sediment prior to the Vashon Stade because older units appear continuous across the canal." (Lilliwaup 7.5-Minute Quadrangle (pamphlet) Open file Report 2010-4, page 4)

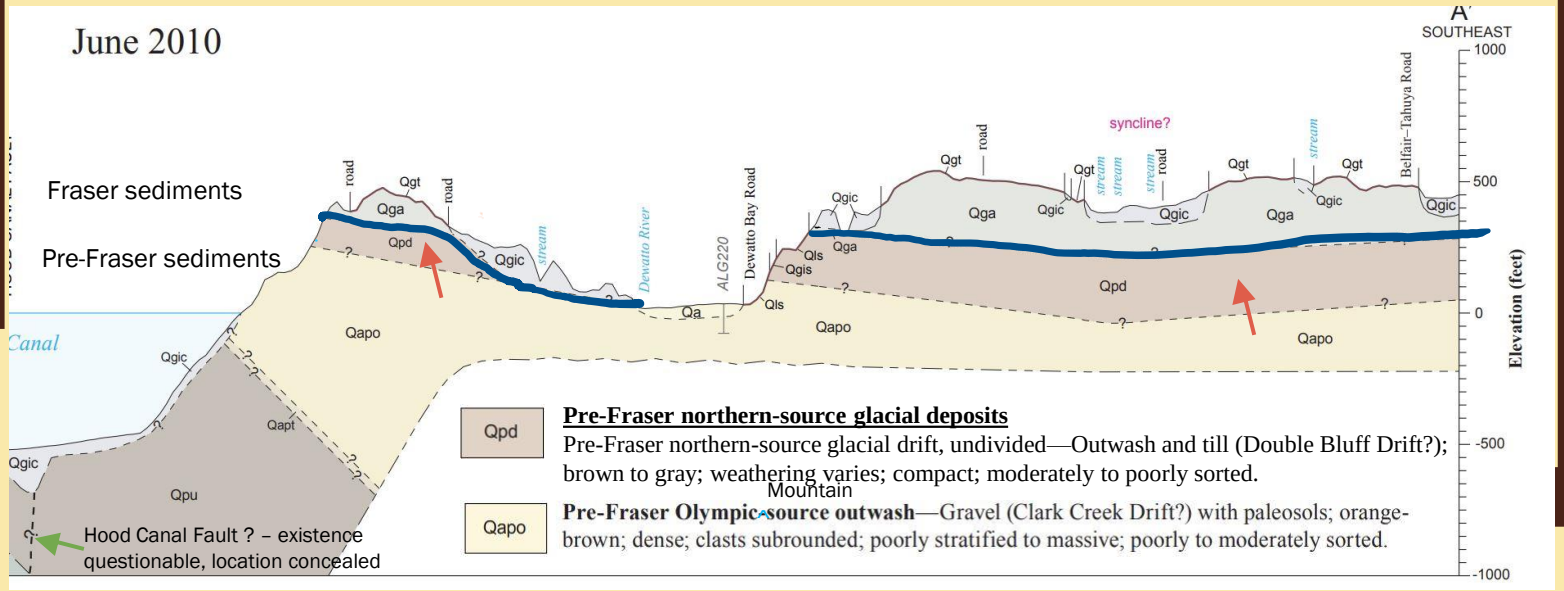
Note: SR 104 was built after USGS Map I-1613 (dtd 1985) was prepared.

Introduction to the Milankovitch Theory, Ch 7, (p. 6)

On our geological map of Lilliwaup shown in Newsreel #6, the Fraser sediments are in excess of 200 ft; whereas the pre-Fraser sediments (Double Bluff glacial, Whidbey interglacial, Possession glacial, and Olympic interglacial) are in excess of 1,000 feet thick as shown on this map. (This cross section continued next slide)

Lilliwaup 7.5 Quadrangle OFR-2010-4

Also, see Thornson, 1989, page 1165, Column 3, para 2.



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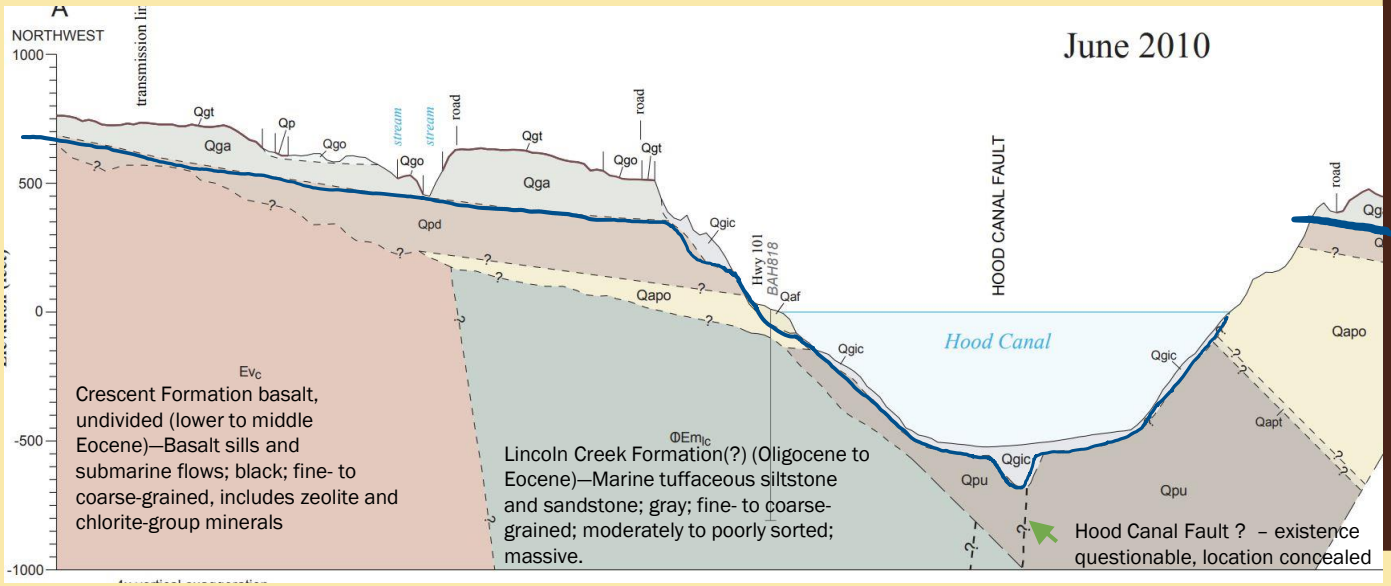
On our geological map of Lilliwaup the west side of the cross section shows the Fraser sediments are in excess of 200 ft; whereas the pre-Fraser sediments (Double Bluff glacial, Whidbey interglacial, Possession glacial, and Olympic interglacial, and Tertiary Crescent Formation and sediments) were well in excess of 1,700 feet thick as shown on this cross section as shown on this map. In addition, the Hood Canal Fault's existence is shown as "questionable and concealed".

Fraser sediments

Pre-Fraser sediments



Lilliwaup 7.5 Quadrangle OFR-2010-4

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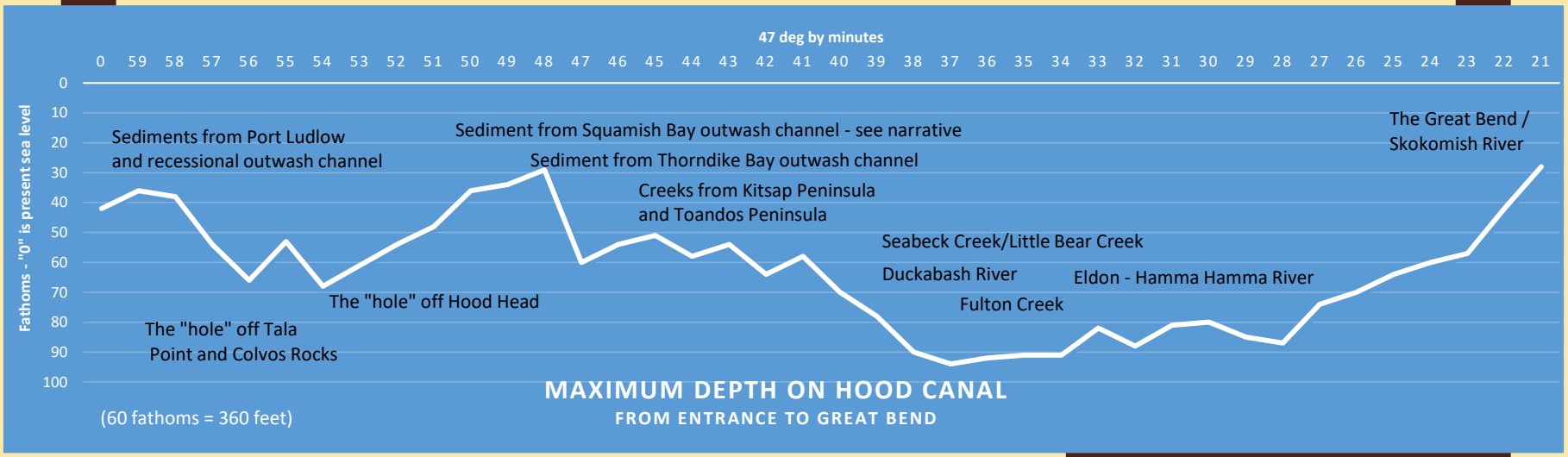
We now want to return to the northern part of Hood Canal and look at it's bottom profiles and work our way south. This bottom profile is taken from NOAA Navigation charts of Hood Canal at the deepest locations from 47° 21.000N through 48° 00.000N. See the Geomap graphs starting on page 12. And notice the creeks draining out of Jefferson Cty and the direction of the sediment high points, especially Thorndike creek and Ludlow Bay.



Depth data from:
Hood Canal to Dabob Bay NOAA Chart 18476
Hood Canal Entrance NOAA Chart 18477
Data represents deepest sounding on above charts -

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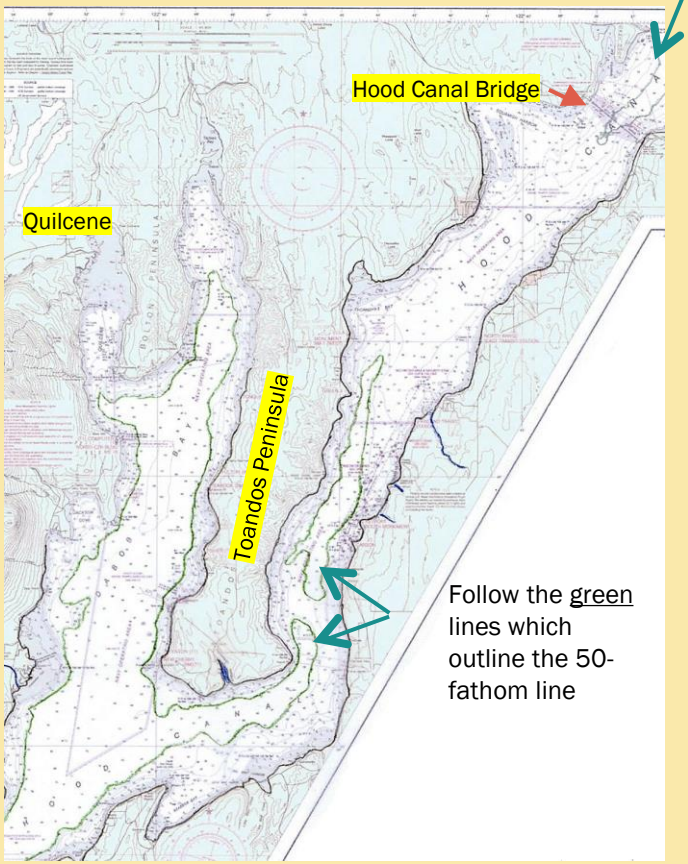
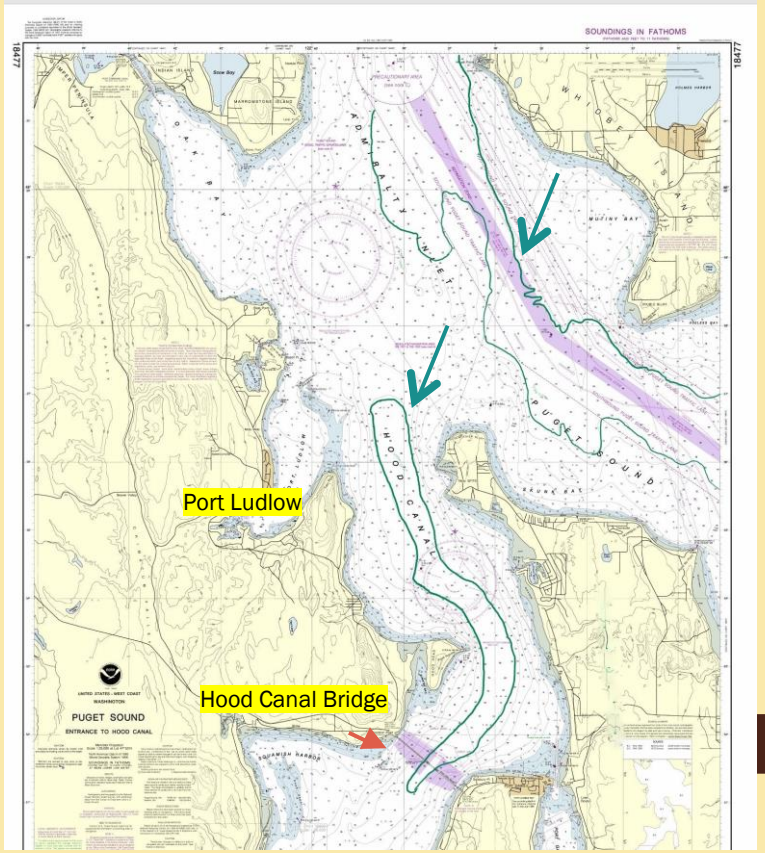
Interestingly, when the 50-fanthom line is outlined you see the same “waves” from the entrance of Admiralty Inlet to the Hood Canal Bridge and below to Toandos Peninsula. The areas below 50-fathom outline are “troughs”; whereas the “crests” lay between them, and possibly resulted from sediment deposited by glacial outwash. See the previous chart

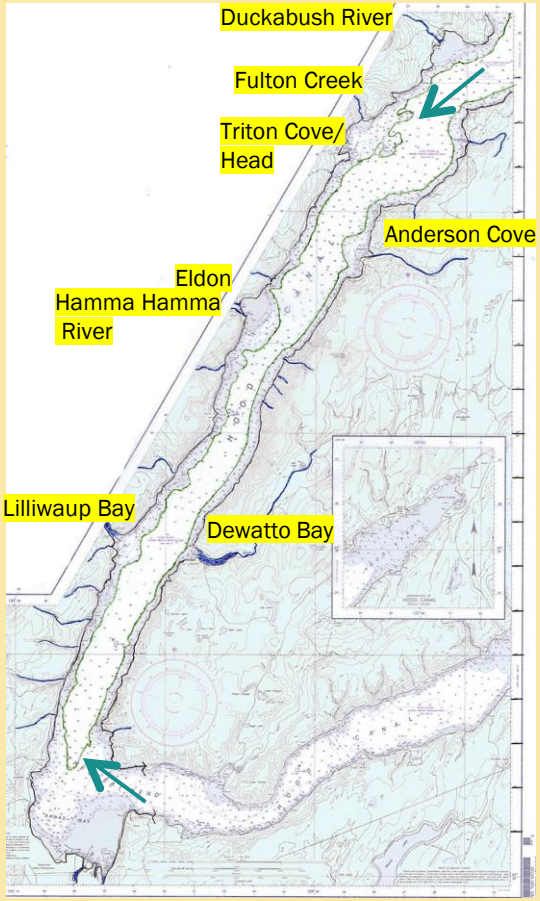




Introduction to the Milankovitch Theory, Ch 7, (p. 10)

Interestingly, when the 50-fanthom line is outlined you see the same "waves" from the entrance of Admiralty Inlet to below Toandos Peninsula

We see that the 50-fathom line in below Toandos Peninsula is fairly steep and near-shore, except where rivers and/or creeks enter Hood Canal. It is also continuous. There are several places where "spires" are near the surface, such as, Triton Head, the Sisters, and Covlos Rocks.



Follow the green lines which outline the 50-fathom line

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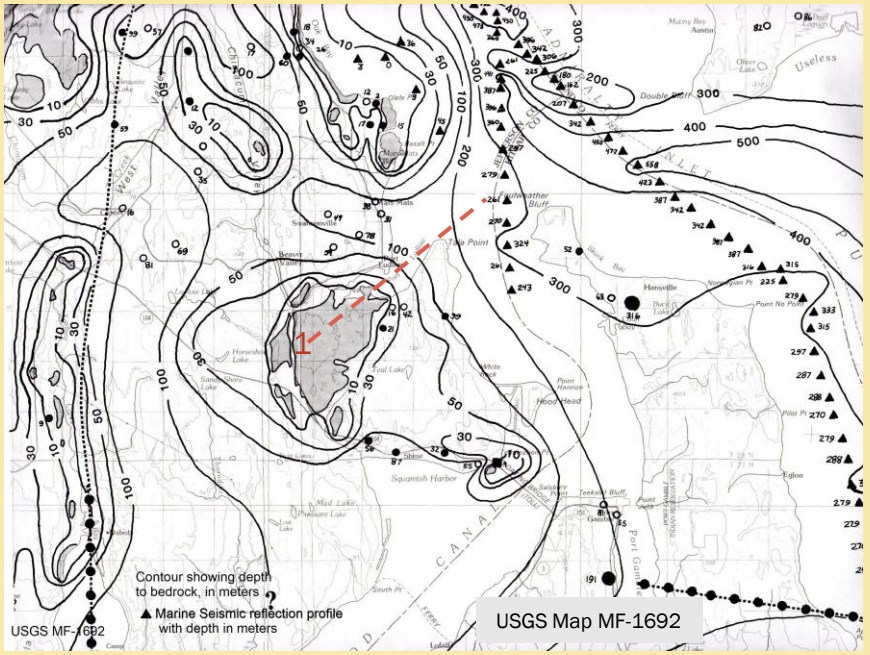
This chart shows the estimated bedrock depth in northern Hood Canal. For example, at Port Ludlow the Crescent formation's highest point (1) is 495 ft on the ridge overlooking SR19 on Timberton Ridge. And 4 ½ miles from that point to a point in Hood Canal at the 65 fathoms mark off Tala Point the depth is ~390 ft. From the sea surface to bedrock is 848 ft., for a total of 1,343 ft. elevation change.

Timberton Ridge (USGS topo map actual above sea level)	495 ft
Hood Canal sediments (Mean Sea Level to 65 fathoms mark on Nav Chart 18477)	(390 ft)
From MSL to bedrock (Sea level to 261 m mark at ▲)	848 ft
From Timberton Ridge to Bedrock	1,343 ft

Note: see slide/page 21 for view of bottom profile. As there may be spires at bottom.

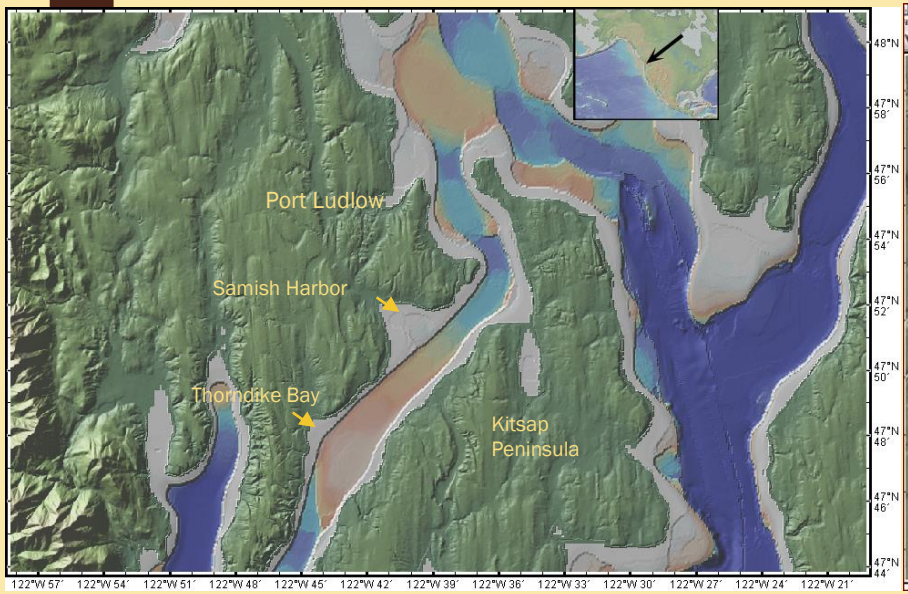


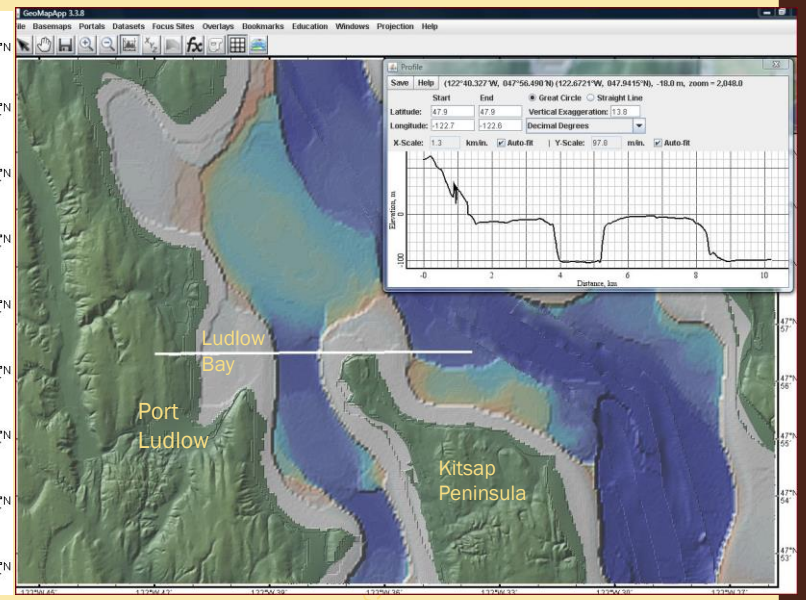
Note: Bedrock surface converted to feet to allow for ease of calculations. I.e., 100 meters = 325 feet, likewise 200 meters = 630 feet.

Introduction to the Milankovitch Theory, Ch 7, (p. 12)

This profile shows the surface, both terrestrial and underwater surface:

- Green is terrestrial
- Grey is shallow water or mud flats
- Brown to tan to lite blue to dark blue is decreasing water depth (as shown in the graph on right side)





GeoMap images provided by Lamont-Doherty Earth Observatory, Columbia University.

For both Samish Harbor and Thorndike Bay outwash channels are visible which deposited substantial sediments into and filling Hood Canal. See Slide 13

Note: the similarity between the above (left) graphic and the Excel graph on p. 8. There is the same "wave" as suggested by color changes:

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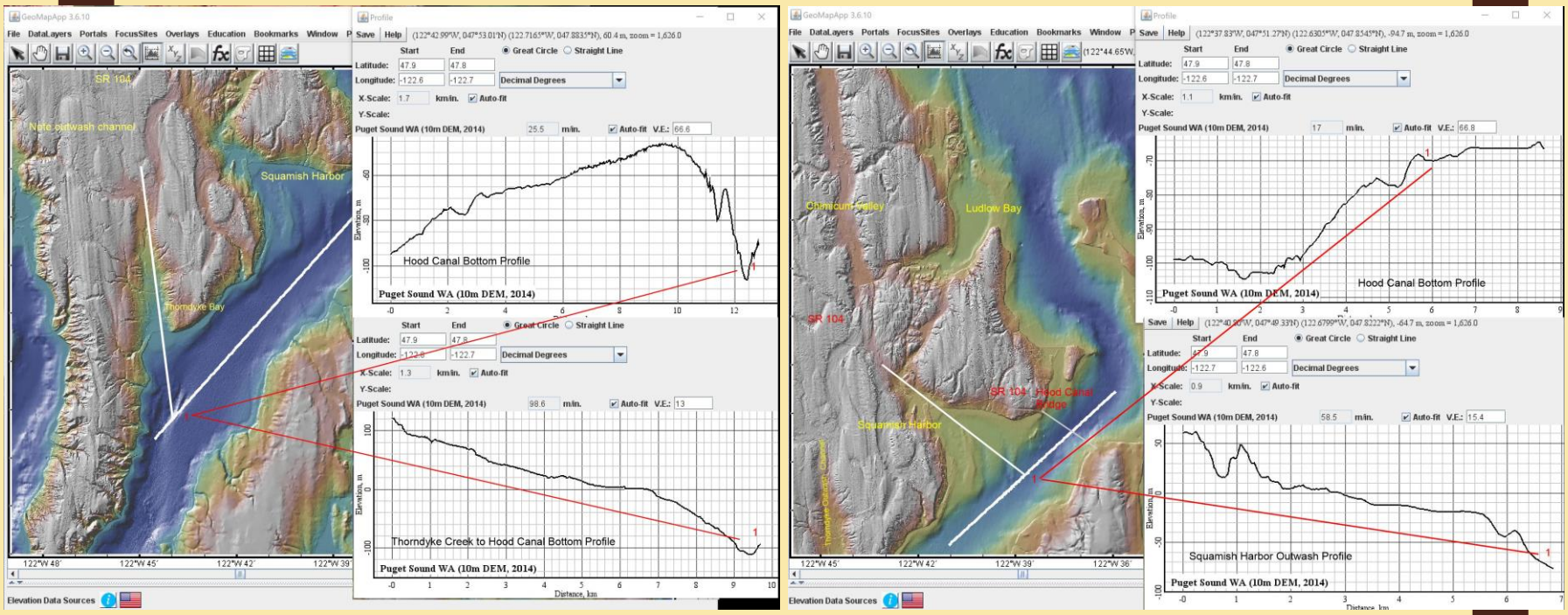
The following Geomaps show the bottom topology of selected places. Below we see Squamish Harbor and Thorndyke Bay. Notice the appearance the “waves” as shown by the change in colors denoting depth. Also, the appearance of outwash channels in both graphics.



Note: The Hood Canal bottom profiles are drawn from the north, i.e., the left side of the graph starts from the north indicated by the “start” and “end” boxes at the top of the graph. And the “elevation” and “depth” only apply the that graphic profile, so each graph needs to be reviewed to see depth or elevation.

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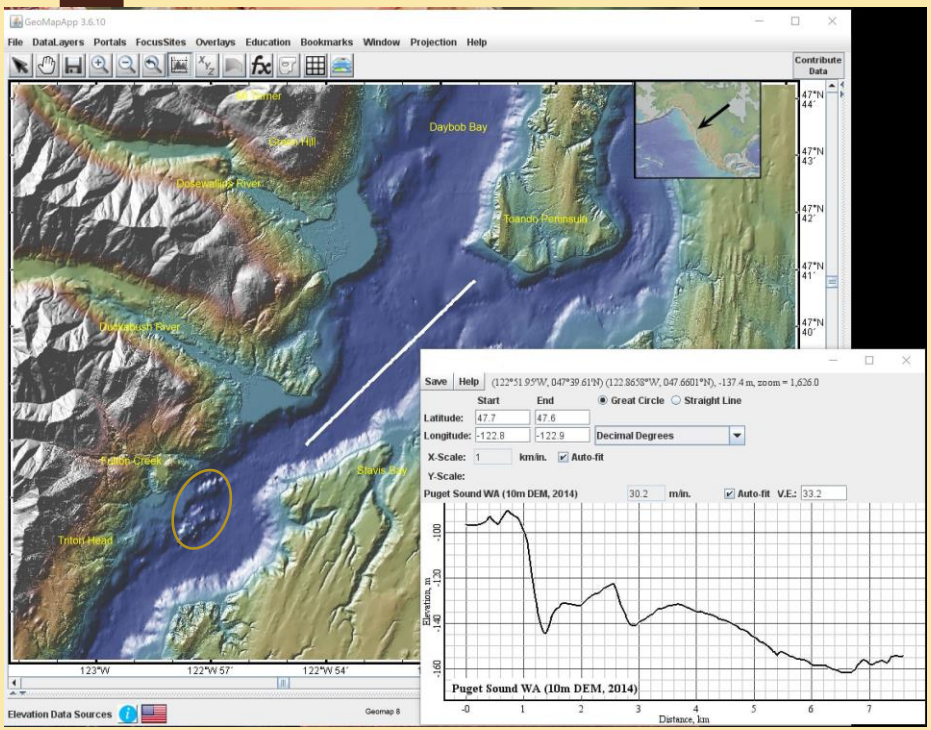
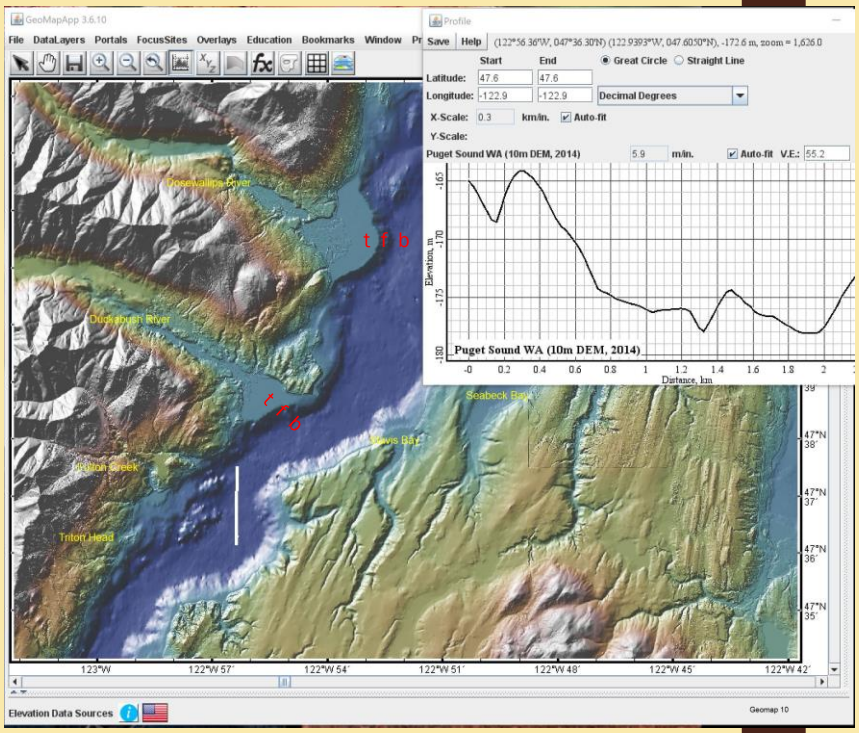
Next, we'll look at the Dosewallips River delta, the Duckabush River area, then Fulton Creek and the Triton Cove area for interesting bottom features.





Note: The appearance of Crescent Formation basalt(?) at the location of the tan circle, which appears to force the canal to bend around that "exposed" basalt.

In addition, the Dosewallips and Duckabush river fans have topsets (t), foresets (f), and bottomsets (b) shown above. However, these foresets do not have the appearance of berms as found at Hamm Hamma (slide 15 or Lilliwaup (slide 16).

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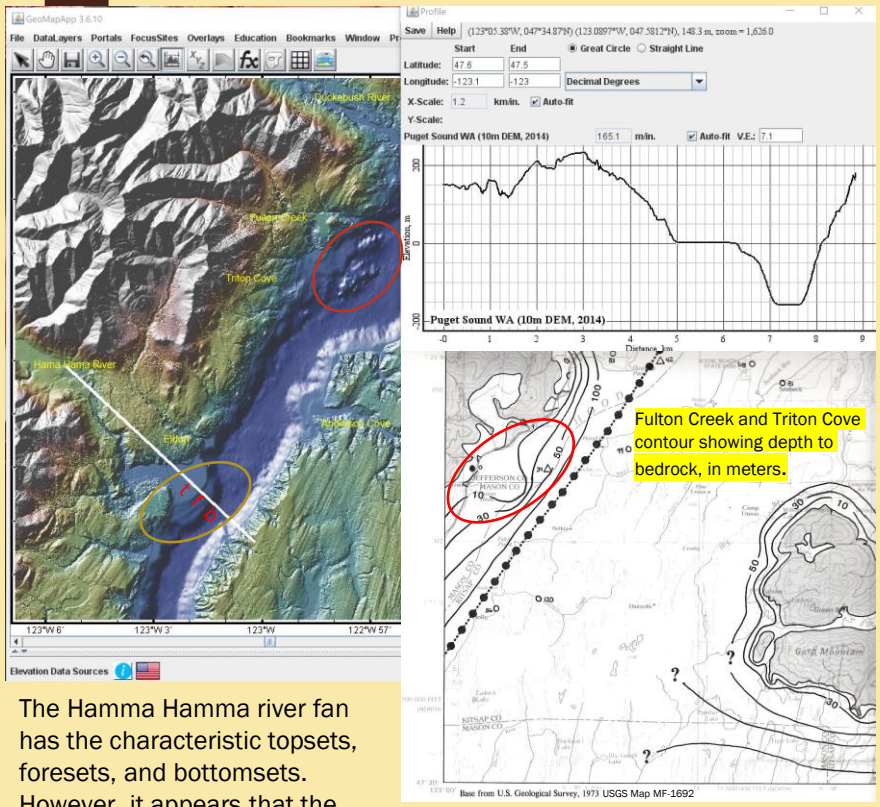
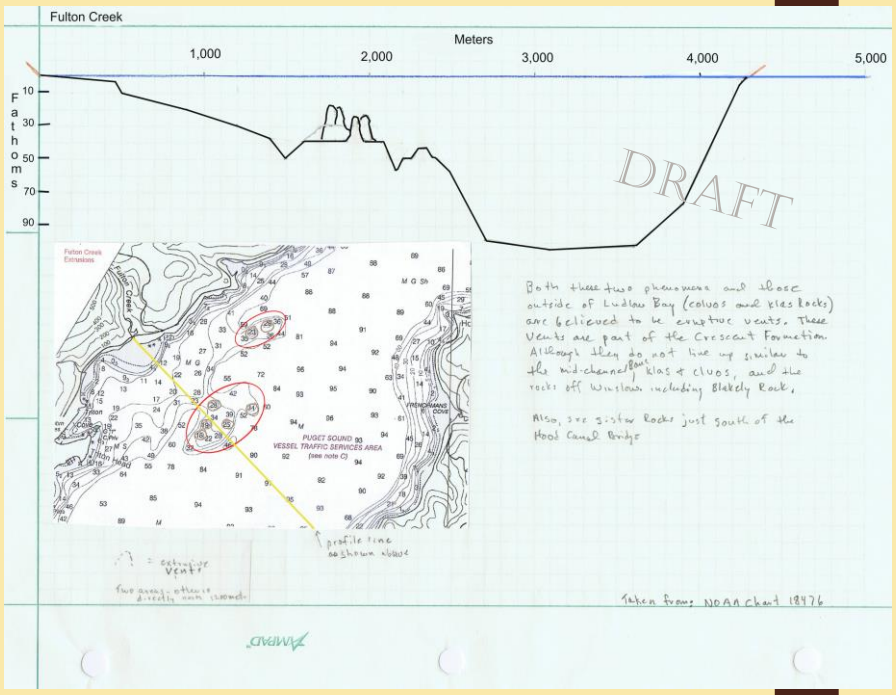
Next, we'll look at the Triton Cove/Fulton Creek area, along with the Hamma Hamma River area for interesting spires and a foreset feature.



The Hamma Hamma river fan has the characteristic topsets, foresets, and bottomsets. However, it appears that the foreset may characterize isostatic rebound as seen in the tan circle.



Note: The appearance of Triton Cove area (left graphic) at the location of the red circle, appears to force the canal to bend around that "exposed" basalt. See previous slide (14) for better perspective.

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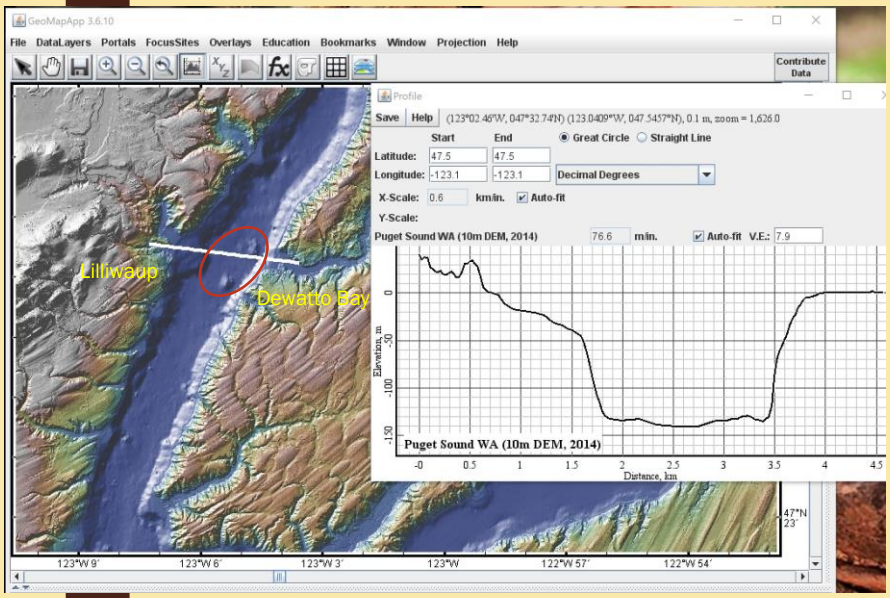
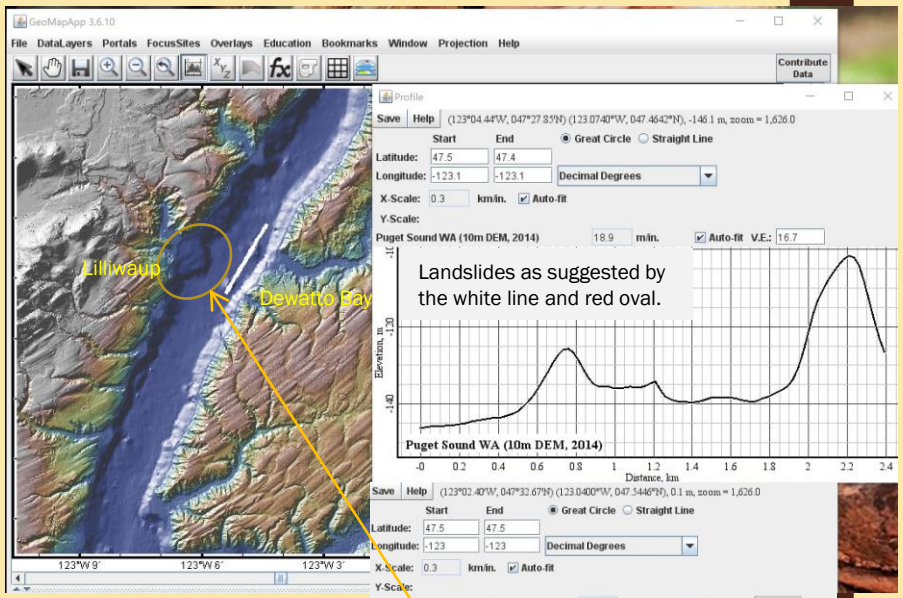
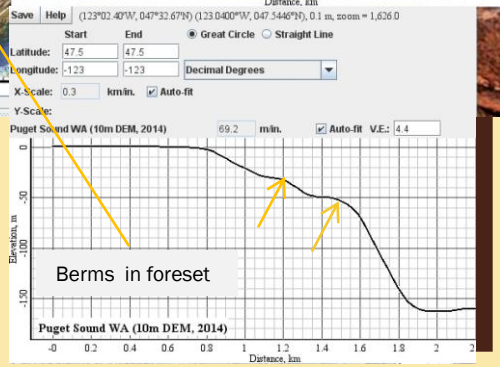
For our last look, we'll Visit the Lilliwaup area another foreset feature similar to the Hamma Hamma River delta and Dewatto Bay to see an underwater landslide.







Note: The upper two features in the red oval "appear to be erosional remnants of large landslide blocks of semi-consolidated glacial outwash and (or) glacial deltaic sediments…pre-Fraser alpine glacial outwash…." DNR OFP 2012-01, Nov2012, page 3, Figure 1b.

The Lilliwaup Creek fan has the characteristic topsets, foresets, and bottomsets. However, it appears that foreset berms may characterize isostatic rebound as seen in the tan circle. Similar to "strand lines" at Missoula, MT that resulted from different lake levels in Lake Missoula during the Fraser Glaciation. More study w/b done.

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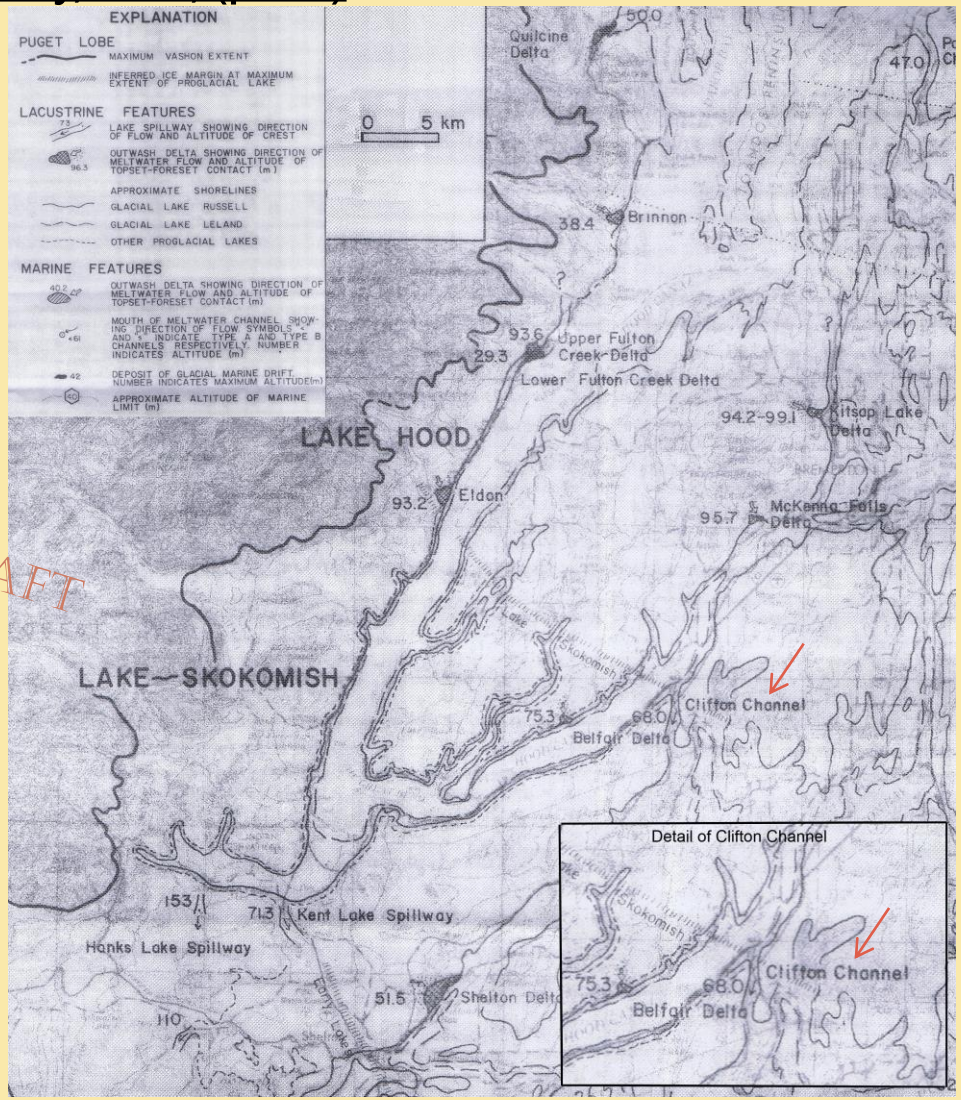
We are familiar with Lake Russel that "preceded" the Puget Lobe ice front down from Canada. However, a preliminary version of USGS OFR 81-370 "showing selected lacustrine and marine features formed during deglaciation". It shows a Lake Hood, along with a channel, Clifton Channel, just south of Belfair that drained Lake Hood until rebound and further deglaciation opened the Lake Leland spillway and the subsequent marine opening at Port Townsend. This channel was like the Black Lake Spillway – with a relatively flat, slow moving current that did not create a gorge or "v" shaped channel as swift water would.

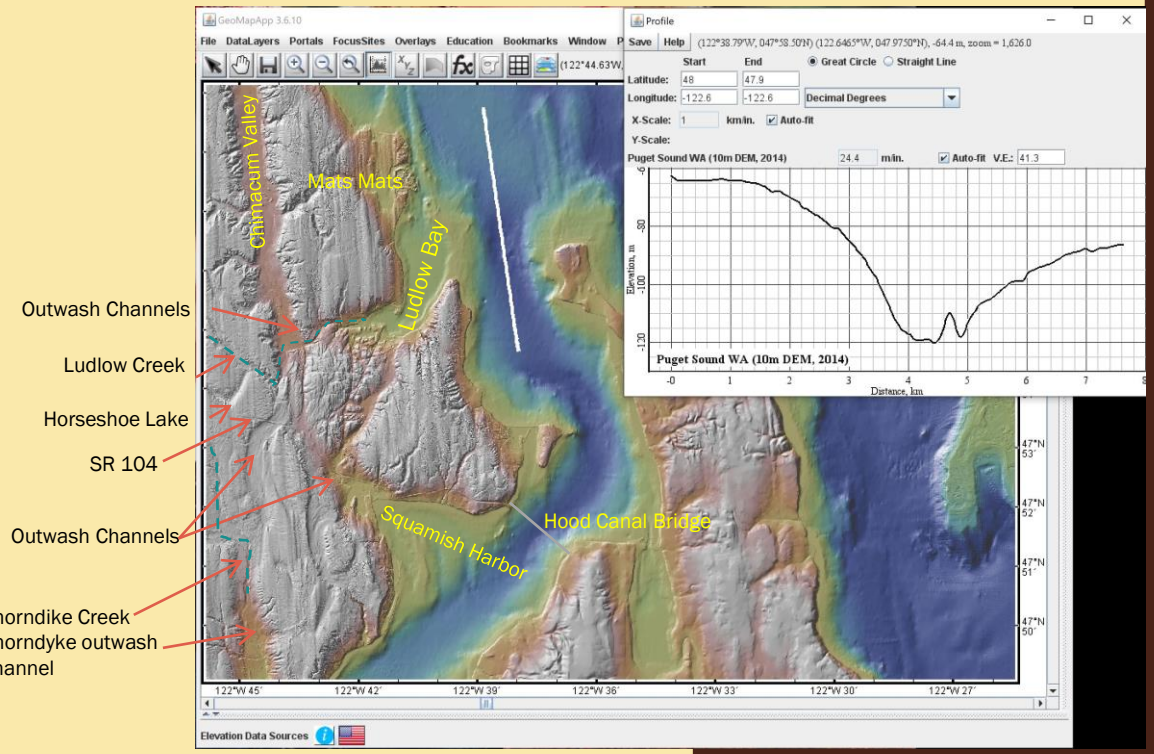


Introduction to the Milankovitch Theory, Ch 7, (p. 18)

Now we will go back up to Port Ludlow and look at the entrance to Admiralty Inlet and Hood Canal. See Slide 8 for the graphic showing the bottom profile of Hood Canal – crests and troughs are prevalent in northern Hood Canal due to outwash.

We will return to Port Ludlow in a future Newsreel and discuss the geological/glacial features found in the area. There is glacial smoothing, erratics, *indicator trains* (erratics pointed back to where they originated or *provenance*).

SR104 was built along a col. Ludlow Creek flows north from its origin in Ludlow Lake out to Ludlow Bay. Thorndike Creek flows south down to Hood Canal (See Slide 13)



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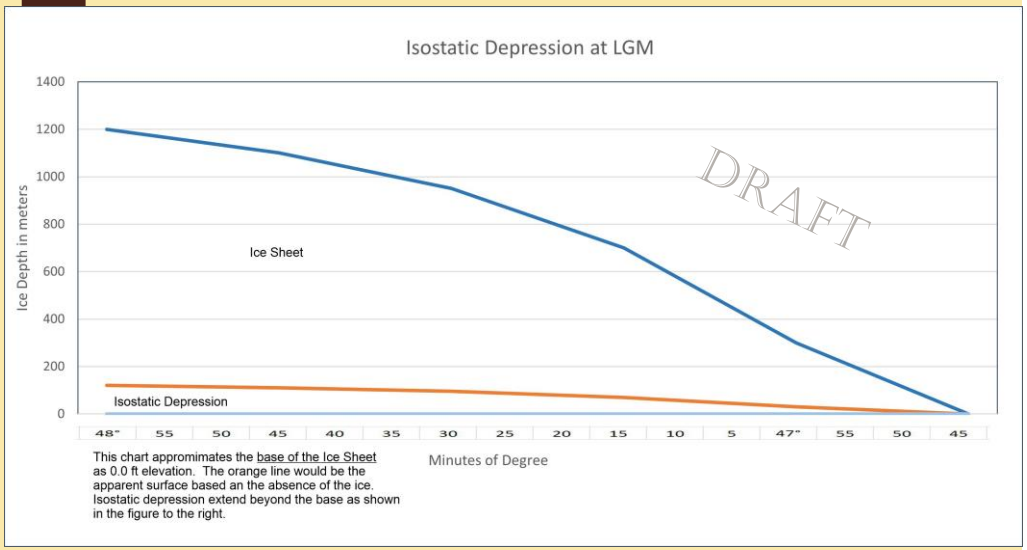
When we talk about isostatic depression – we are talking about the weight of the Fraser Ice Sheet depressing the land down under it – as ice has weight. The ice dam near Sandpoint was broken when the Lake Missoula floated it at 90% of it's height (~2K ft). As the Puget Lobe advanced into the Puget lowlands, it generated a "bow wave" ahead of it (not shown). Depression of the mantle by the weight of ice would generate a bowl effect to the sides or a lesser depressed area.



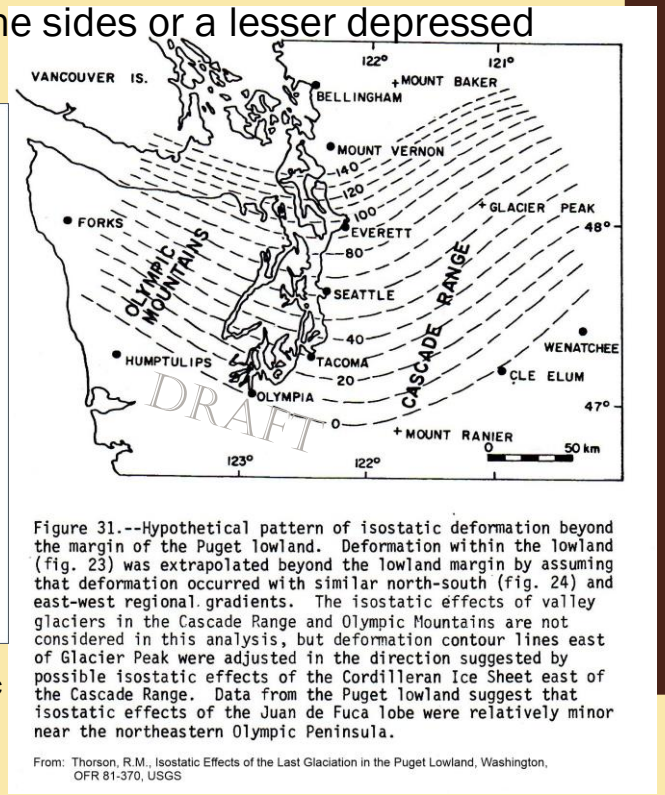


Figure 31.--Hypothetical pattern of isostatic deformation beyond the margin of the Puget lowland. Deformation within the lowland (fig. 23) was extrapolated beyond the lowland margin by assuming that deformation occurred with similar north-south (fig. 24) and east-west regional gradients. The isostatic effects of valley glaciers in the Cascade Range and Olympic Mountains are not considered in this analysis, but deformation contour lines east of Glacier Peak were adjusted in the direction suggested by possible isostatic effects of the Cordilleran Ice Sheet east of the Cascade Range. Data from the Puget lowland suggest that isostatic effects of the Juan de Fuca lobe were relatively minor near the northeastern Olympic Peninsula.

From: Thorson, R.M., Isostatic Effects of the Last Glaciation in the Puget Lowland, Washington, OFR 81-370, USGS

There is a more current isostatic chart that does no take the deformation to as great an extent as this one. Still looking.

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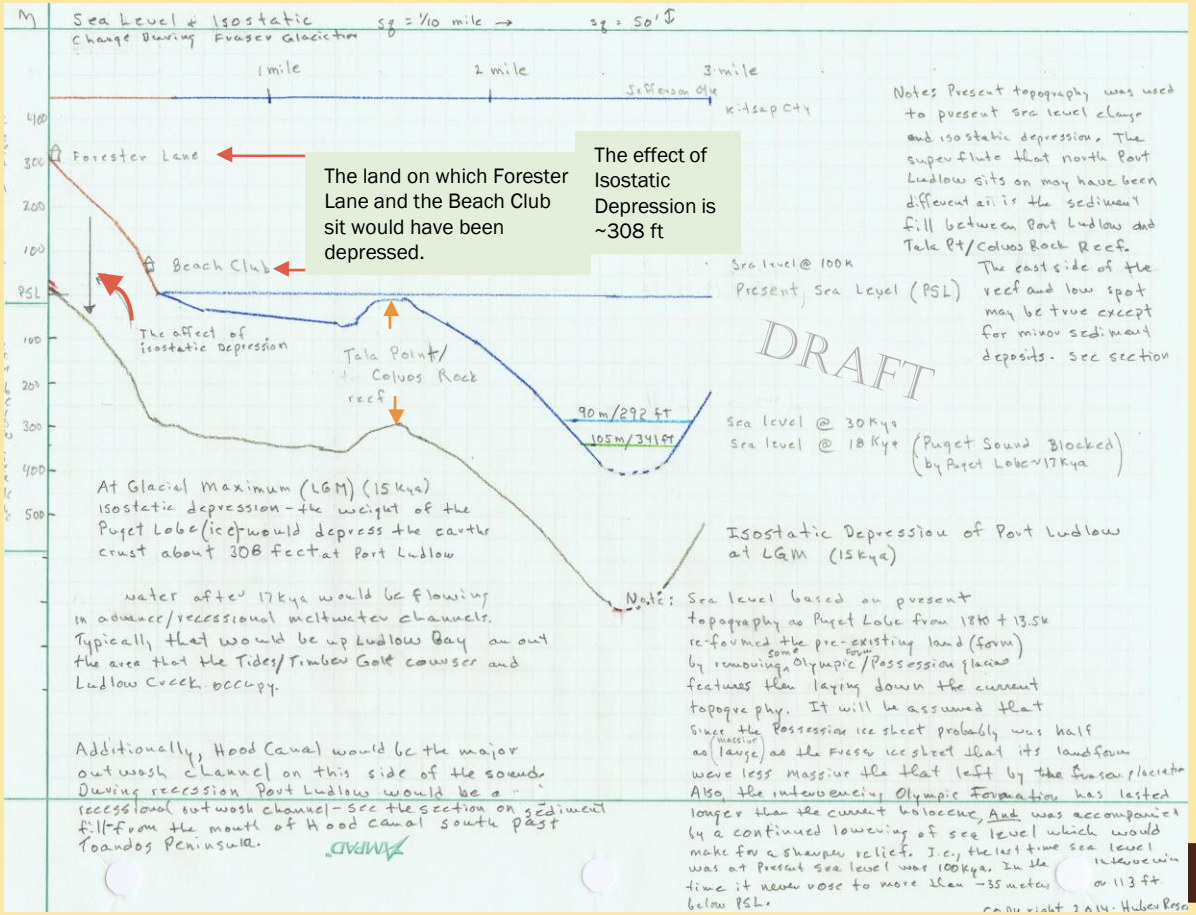
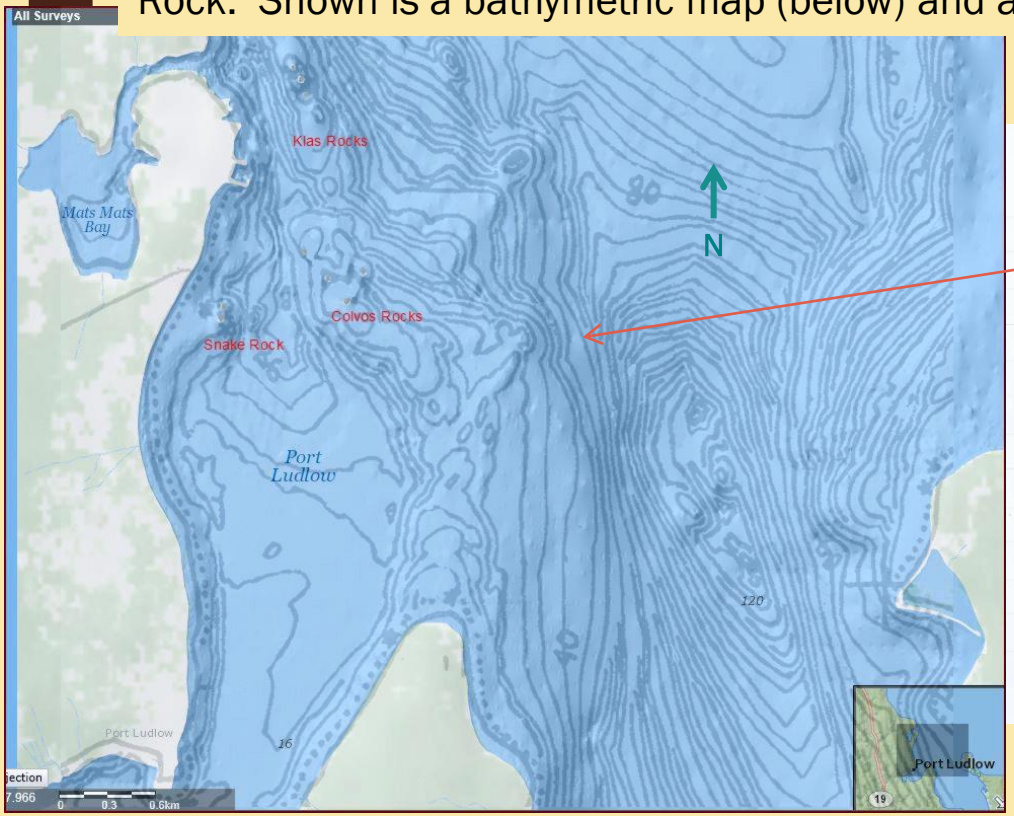
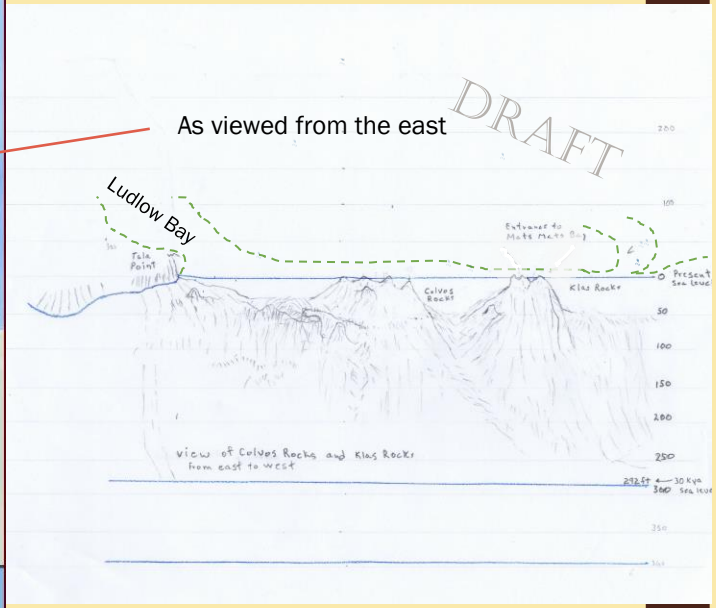
How would isostatic depression have impacted Port Ludlow?



Introduction to the Milankovitch Theory, Ch 7, (p. 21)

There are several spires or rocks in Hood Canal: Colvos, Sisters, and off Titan Head. North of Port Ludlow are found Klass Rocks, Colvos Rocks and Snake Rock. Shown is a bathymetric map (below) and a rough drawing of Colvos Rocks.





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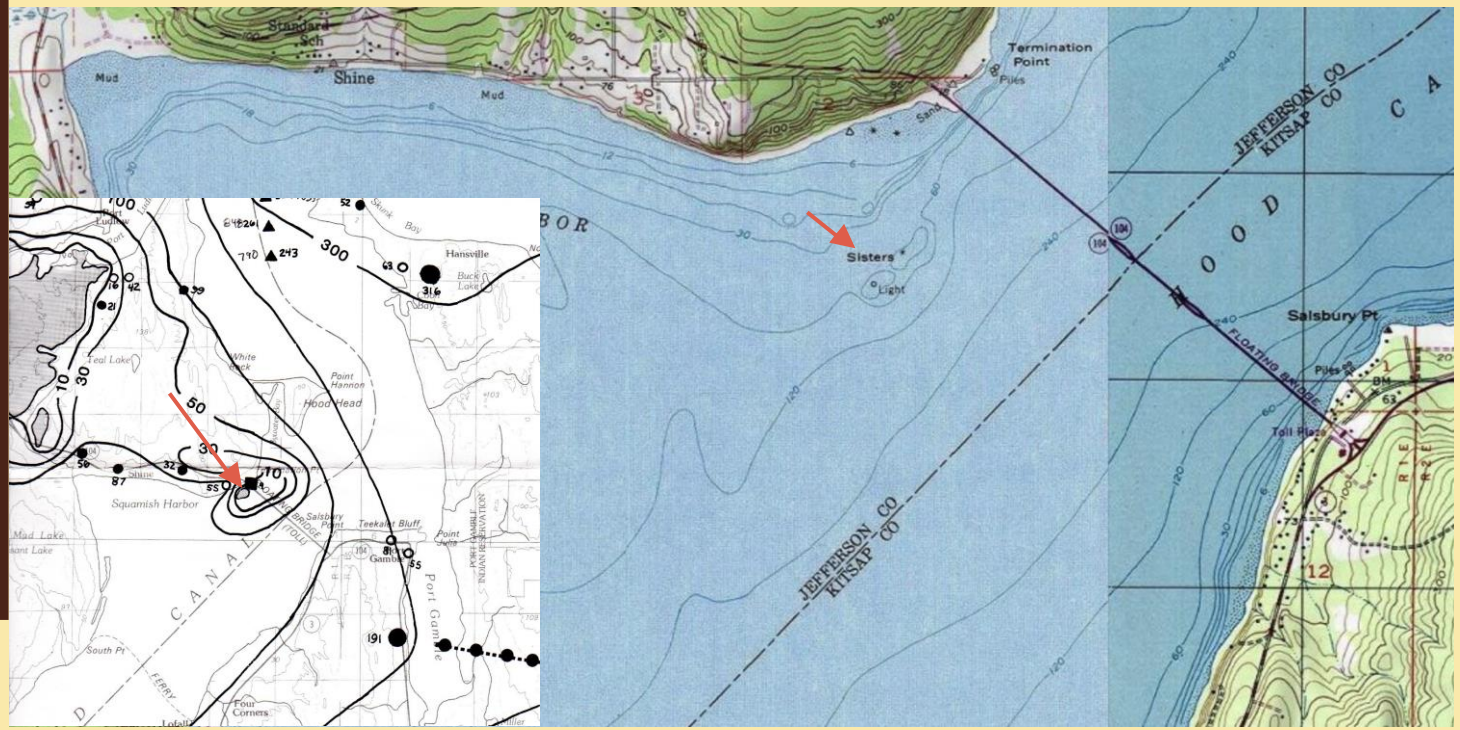
Sisters: Are south of the Hood Canal Bridge and are seen towards the west end.



Introduction to the Milankovitch Theory, Ch 7, (p. 23)

In conclusion, there are many open questions about Hood Canal.

a. Since the Crescent Formation was formed as a product of subsurface and surface extrusion; hence, the abundant pillow basalt. And part was extruded as surface basalt. What we see as "spires" may be extrusive features which appear common in Hood Canal as evidenced, for example, on Slide 15 (Triton Cove), Slide 21, (Ludlow Bay), and Slide 22 (Sisters). More research will be done on these phenomena. However, presently the exposed basalt appears to have been extruded out of water. Any pillows appear to be formed in a surface water environment. And the problem is the exposed basalt along SR19 west of Port Ludlow is glacially smoothed. More when we get to the discussion on Port Ludlow.
b. As an exercise in futility, a measurement of the volume of sediment in Hood Canal and the adjacent land area, such as, Thorndyke Bay, will be measured.
c. And, once upon a time, a colonnade was found in the area of Thorndyke Creek. Where did it come from and is it still there. This brings up the question as to how much "earth" has been (re)moved by glacial activity.

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Introduction to the Milankovitch Theory, Ch 7, (p. 24)

In March 2021, the Newsreel will continue with Chapter 8:

a. A catchall of pertinent facts about Continental Ice Sheets including was the last Puget Lobe (Fraser) a true Continental Ice Sheet (CIS) or a piedmont glacier. And a look at Alpine moraines on the west side of the Olympics.

b. And a look at surging glaciers and…was /could there have been a surge of the Fraser Glaciation Puget Lobe?

In May 2021, the Newsreel continues with a look at an extrusion of Pillow basalt (Crescent Formation) on Mt Tyler above the Dungeness River, and a walk along Royal Creek to look for evidence of the proglacial lake that formed during the Puget Lobe. And if time allows, look at sheer basalt cliffs on the west side of Mt Zion (northwest of Bon Jon Pass) that show the potential for glacial smoothing.

In Sep 2021, 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. (The esker shown on our web page is from that area and is used as by the FS/landowners as a “borrow pit”.)

An IAFI Puget Lobe Chapter monthly newsreel:

Introduction to the Milankovitch Theory, Ch 7, (p. 25)

This is a “Map Showing Seafloor Geology in the Strait of Juan De Fuca Area…” (OFR 87-1). A lot went on during the Fraser Glaciation. We will keep looking at Hood Canal.

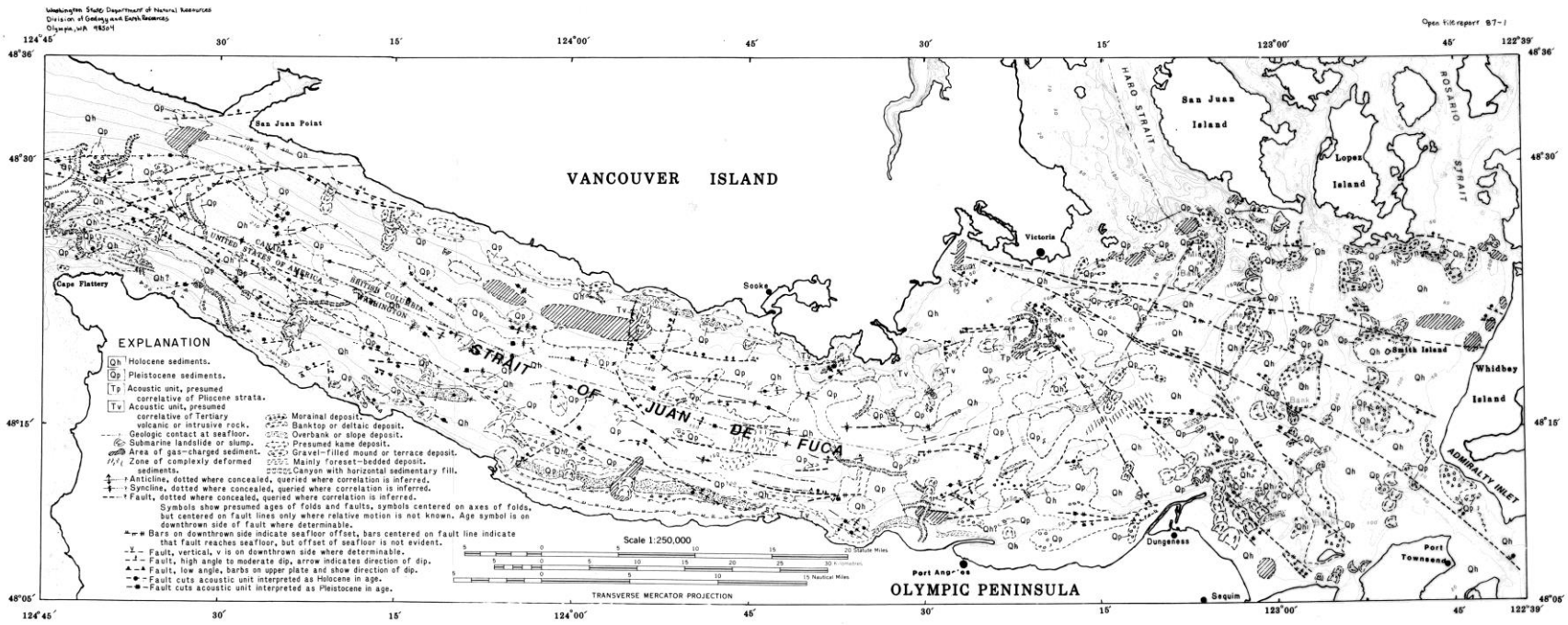

PLATE 3. MAP SHOWING SEAFLOOR GEOLOGY IN THE STRAIT OF JUAN DE FUCA AREA, WASHINGTON, U.S.A. AND BRITISH COLUMBIA, CANADA.
Screened bathymetry from Canadian Hydrographic Service Map 15783-A.