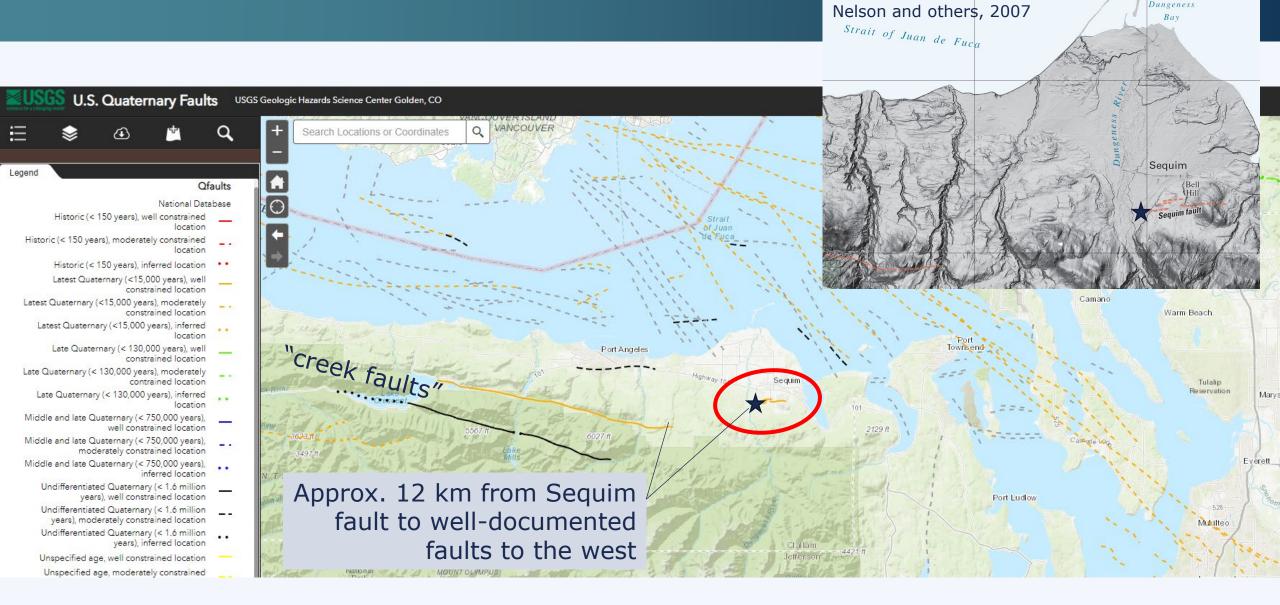
Preliminary Observations of the Sequim Fault for the Dungeness Off-Channel Reservoir Project

May 24, 2023

Sequim Fault

- Included as Class A fault in the U.S. Geological Survey Quaternary Fault and Fold Database
- Poorly studied and understood
- Database mapping consists of four strands ranging from approx. 1 to 2 km each, zone with a total length of approx. 4.5 km (7 km in text entry)
- Basis of inclusion in database from one map (Nelson and others, 2007) that covered lidar-based mapping of generally east-west-striking faults along the northern Olympic Peninsula.
- Not included in 1:24,000-scale geologic mapping of the Sequim (Schasse and Logan, 1998) or Carlsborg (Schasse and others, 2000) quadrangles



A.R., Sherrod, B.L., Wells, R.E., Lidke, D.J., Ha

citation for this record:, compiler, 2017, Fault number 549, Sequim fault, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 04/20/2023 11:04 AM.

		-1	The Seattle Guilt aine is a 4-10 7 km wide east freeding Guilt zone that extends from the Cascade Kange foothits on the east across the Puget Lowland to Mood Canac.	terriperious sediments in cores, Results of these studies provide detailed information on the distrib
Synopsis			crossing Lake Sammanish, Lake Washington, Puget Sound, Bainbridge Island, and the Kitsop Peninsula. Various strands of the fault zone in largely concealed beneath the major population centers of Seattle, Bellevue, and Bremerton. It forms the northern boundary of a belt of bedrock exposures that cross much of the Puget Lowland.	Washington, and identify numerous large blockslides, sediment slumps, and debris flows. They a their care surroles. They noted that massive submarine block slides and retransmise submarine
39100513			The depth to bedrock north of the fault zone is as much as 1 km (nount and others, 1985 #4746; Johnson and others, 1999 #4729). The fault zone has been imaged on selection and/others, 2009 #4729. The fault zone has been imaged on selection and/others. 2001 #4720. Prot and others, 2001	Southle fault zone and (or) large to great temblors obsewhere in Cascadia. They further noted that
			41137, Johnson and others, 1292 44729, correlates with large gravity and magnetic anomalies (Danes and nine others, 1295 44723, Blakely and others, 2002 44710), and	seismites imply seven sedimentary disturbances in the lake in the last 3500 years. They correlated earthquake, and correlated another with the A.D. 900–930 earthquake along the Seattle fault zone
			In represented by a prominent velocity anomaly on tomographic models (Brocher and others, 2001 44718; Calvest and others, 2001 44722). These data indicate the zone consists of three or more south-disping thrust faults that form the structural boundary between the South's up in the south and the South's board to be a south of the south and the South's board to be a south and the South and to be a south and the South and the South and the Southe's board to be a south and the South and the South	seismites caused by landslides during earthquakes; and they concluded that, collectively these do
			Blakely and others (2002 H4716) have named three of these structures the frontial fault, the Blakely Harbor fault, and the Orchard Point fault. Nelson and others (2003	region that has occurred about every 300-500 yr during the past 3500 yr.
Name comments			#5868) termed the "frontal lauk" the "Seattle fault." The Seattle fault zone also includes north-dipping reverse or thrust faults, such as the Toe Jam Hill fault (Helton and others, 2000 HFT33; 2002 HFT36; 2003 HSB68), which forms a complex scarp in densely forested terrain on Bainbridge Island. Slip on both south- and north-dipping faults	Toe Jam Hill site, trenches 570-6 to 570-30. Nelson and others (2000 #1732, 2002 #1736; 2003 #580 trench sites along the scarp of the Toe Jam Hill fault, a north dipping backthrust in the Seattle fau
			within the zone probably is associated with offset on a south-dipping master fault (e.g., Pratt and others, 1997 #4737) at depth. Surface-deforming earthquakes have	(Nelson and others, 2000 #4733; 2002 #4136; 2003 #5868) and the corresponding site numbers as
County(s) and State(s)	CLALLAM COUNTY, WASHINGTON		occurred on the Seattle fault zone in the latest Holocene, most recently about 1040-910 cal yr BP, (A.D. 900-933) as summarized by Nelson and others (2014 #7625).	(370-8), Saddle (570-9), and Bear's Lair (570-30). Four of these sites are located within about 200 indicate three or possibly four surface custuring earthquakes between about 2500 and 1000 vr B
	CEALEAM COUNTY, WASHINGTON	Name commen	Danes and others (1965 MT23) first suggested the presence of a major east-trending fault in the Puget Lowland near Seattle on the basis of gravity and magnetic	Sectomish River delta sites (570-11). The Sectomorphi River delta is located directly north of Ex
		-	anomalies and drill-hole data. Rogers (1970 #4730) also noted the large geophysical anomalies in the same location and suggested the name "Seattle-Dremeton fault."	channel-bank stratigraphy at numerous sites along the delta and radiocarbon ages, Bourgeois as
Physiographic			Gover and others (1985 M125) briefly outlined geologic and geophysical relationships across this feature, which they designated "inferred structure I." Yourst and Holmes (1992 M176) introduced the name "Seattle fault" for this feature, which they considered a south dipping thrust or reverse fault. Recognition that the structure	liquefaction, at least one event of abrupt subsidence, and at least one tsunami since about A.D. I relations, indicate that a prominent event of strong shaking produced liquefaction, abrupt subsi
province(s)	PACIFIC BORDER		includes multiple parallel faults and other structures led to the use of the name "Seattle fault zone" (Johnson and others, 1999 #4729; Brocher and others, 2001 #4718; Netson and others, 2001 #5668).	(2001 #4720) concluded that these features probably resulted from the earthquake on the Seatth
province(s)		County(s) ar		Two sites at Vasa Park, RigiRap (570-12) and Blackberry (570-13) were located along an eastern s about 16 km east of Seattle. The trenches exposed a west to north northwest-striking fault zone
Reliability of location		State	d king county, washington N kitsup county, washington	across subvertical dip-slip faults that appear to accommodate bedding plane slip in the steeply
Reliability of location		Physiograph	R PROFIL ROBOR	strand of the fault zone at this locality. Sherred and others (2001 #1735) and Sherred (2002 #177 weathered Miccene valcaniclastic sediments on the southwest over Pleistocene stacial deposits
	Compiled at 1:unspecified scale.	province) Reliability	51	Pleistocene or younger faulting, but also noted that any ilolocene history is unknown, because y this site. Radiocarton ages suggest that the last event occurred between 11.550.49 vr BP and 4.
	complied at Lunspecified scale.	Resublity - locatio	Good Compled at 1,24,000 and 1,300,000 scale.	this site. Radiocarbon ages suggest that the last event occurred between 11,550x49 yr BP and 4, also reported that a ravine, about 4 km east of this site at factoria, exposes proglacial lake sedin
				Waterman Point trenches 570-14 to 570-26. Nelson and others (2003 IR6250) presented data from
	Comments: WA attributed to Nelson and others (2007) mapped at unspecified scale.		Comments: Strands of the Seattle fault zone are generally concealed beneath a cover of water, dense vegetation and thick Pleistocene glacial and interglacial deposits. Inferred locations of south-diaging faults in the Seattle fault zone are based on high-resolution seismic-reflection crofiles (Jahnson and others, 1999 4472). Brocher and	scarp of the Waterman Point fault; the trenches exposed north-dipping backthrust faults that just west, the names assigned to the trenches and the corresponding trench-site numbers assigned
	comments, we attributed to version and others (2007) mapped at unspectied scate.		others, 2001 #1711; Liberty and Pspe, 2007 #1756; Liberty and Prats, 2008 #1703; Liberty 2009 #1720; Lamb and others, 2012 #17513; high-resolution aeromagnetic surveys (Blakely and others, 2002 #1716; geologic mapping (e.g., Haecustier and Clark, 2000 #1720; Dragovich and others, 2007 #17504; and interpretation of UDAR	(570-16); the latter two about 200 m apart. All three trenches showed evidence of a large earther
			Bucknam and others, 1999 MI211 Harding and Berghoff, 2003 MI228 Harding and others, 2002 #1721 Hautenud and others, 2003 MI215 2003 MI211 Visio and others.	suggests a second, younger undated surface rupturing earthquake producing vertical displacemy others, 2004 #7075, in addition, later analysis of radiocarbon ages may provide evidence for a se
			2006 #7680; Muller and Handing; 2007 #7674); Lecation of fault from GER, Selamogenic, MGSM (http://www.dncwa.gov/publications/ger, partal_selamogenic_features.zip, downloaded 05/23/2016) attributed to Haugenud 12005 #7605); Disposich and others (2007	and others, 2004 #7675).
Geologic setting			#15(H), Liberty and Post (2008 #7620), and Liberty (2009 #7620).	Kelsey and others (2008 #7672) surveyed the Seattle fault zone uplifted shore platforms initially d determine whether uplift was uniform throughout the Seattle fault zone. Indicating a single region
		Geologic settin	The cast trending thread faults of the Seattle fault zone accommodate north south compression due to the northward migrating forearc of the Cascadia convergent	and others, 2000 H1742), or if shoreline split elevations locally vary where the platforms intersec
Length (km)			margin (Wells and others, 1200 H1742; NoCaffrey and others, 2000 H1731; Miller and others, 2001 H1732). Geodetic studies (e.g., Khazaradze and others, 1292 H1734)	#5068) that possibly independently ruptured the Seattle fault zone at least three times in the past north of the Point Glover (site 570-17) fault where only one platform extends along the shoreline:
Lengen (kin)	7 km.		indicate about 4-5 mm/yr of north/south crustal shortening in western likelyington, some of which is accommodated by slip on the Seattle fault zone (Wells and Johnson, 2000 HFH3). The fault zone forms the boundary between uplitted Tertiary rocks of the Seattle uplitt on the south and thick Tertiary to Quaternary strata of the	Point Glover fault locally uplithed the upper platform once and then regional uplith during the Sec lower platform. Cumulative offset of the upper platform is about 12.7 m with approximately 3.5-
			Seattle basin on the north. Gravity and seismic studies (e.g., Brocher and others, 2001 #1718, 2001 #7631) indicate that Ecoene volcanic rocks exposed at the surface in	attributed to the regional uplift associated with the A.D. 900-930 earthquake on the Seattle fault.
Average strike	Sum of all		the Seattle uplift are buried by as much as 9-30 km of younger sediments in the Seattle basin. Long term contraction rates across the Seattle uplift determined through analysis of fold geometry suggest between 0.25 and 1.0 mm/yr for the past few hundreds of thousands of yeas, which accounts for about 10 percent of the total	Jam Hill fault (mapped in trenches by Nelson and others (2003 #5868) intersects the shoreline (si earthquakes deformed the shoreline: the regional Seattle fault zone A.D. 900-930 event and an ex
Average strike	Sum of all		shortening of the western Washington crust (Booth and others, 2004 #7970).	3-3.5 m (Kelsey and others, 2008 #3672).
Sense of movement		Length (kr	N (24m)	Gonst Creek (site 570-15). Arcos (2012 #7665) mapped tsunami and overlying debris flow deposits
	Unspecified	Average stri	ter Latra	Creek where it empties in the wetlands surrounding Sinclair Inlet. Deposits beneath the modern v and then inundated by a sandy tounami deposit from offshore, which in turn was covered by a san
	knowledge of the	Sense	100 11	deformation within the top of the tsunami deposit and lack of vegetation on its surface. Arcos (20 This suggests that the earthquake triggered not only the tsunami but also might have caused slop
Dip	KIIOWIEUUE OI IIIE	requerte	et Thrust	maximum age of radiocarbon dated leaves beneath the debris flow deposit and a minimum age fl correlates the uplift to the A.D. 500–510 Seattle fault rupture. Because this site is located between
	Knomedge of the		Comments: The Seattle Jault zone is a complex zone that accommodates north-south shortening (Yount and Holmes, 1972 44745; Johnson and others, 1994 44739; Pattl and others, 1997 447739; Johnson and others, 2094 44739; Pattl and others, 2001 447319; Bakely and others, 2002 44736; Biocher and others, 2004 47313; Dominant	simultaneously. Arcos (2022 #7969) modeled tsunamis generated by each fault and determined th
Paleoseismology studies			stip is south-side up on south-dipping faults, producing the Seattle uplift. The zone also includes north-dipping reverse faults, such as the Toe Jam Hill fault and	deposits. Following the debris flow, the uplifted, forested area began to subside back to intertidal of an in-situ hemiock snag new consumed by the salt marsh, first mapped in 1880. Study location
	Sequim fault		Waterman Point fault (Nelson and others, 2000 #4733; Haugerud and others, 2001 #4735; Nelson and others, 2002 #4736; Nelson and others, 2003 #5868; Haugerud and others, 2001 #4736; Nelson and others, 2003 #5868; Haugerud and others, 2001 #4736; Nelson and others, 2003 #5868; Haugerud and others, 2001 #4736; Nelson and others, 2003 #5868; Haugerud and others, 2001 #4736; Nelson and others, 2003 #5868; Haugerud and others, 2001 #4736; Nelson and others, 2003 #5868; Haugerud and others, 2001 #4736; Nelson and others, 2003 #5868; Haugerud and others, 2001 #4736; Nelson and others, 2003 #5868; Haugerud and others, 2001 #4736; Nelson and others, 2003 #5868; Haugerud and others, 2001 #4736; Nelson and others, 2003 #5868; Haugerud and Others, 2001 #4736; Nelson and others, 2003 #5868; Haugerud and Others, 2001 #4736; Nelson and others, 2003 #5868; Haugerud and Others, 2001 #4736; Nelson and others, 2003 #5868; Haugerud and Others, 2001 #4736; Nelson and Others, 2003 #5868; Haugerud and Others, 2001 #4736; Nelson and Others, 2003 #5868; Haugerud and Others, 2001 #4736; Nelson and Others, 2003 #5868; Haugerud and Others, 2001 #4736; Nelson and Others, 2003 #5868; Haugerud and Others, 2001 #4736; Nelson and Others, 2003 #5868; Haugerud and Others, 2001 #4736; Nelson and Others, 2003 #5868; Haugerud and Others, 2001 #4736; Nelson and Others, 2003 #5868; Haugerud and Others, 2001 #4736; Nelson and Others, 2003 #5868; Haugerud and Others, 2001 #4736; Nelson and Others, 2003 #5868; Haugerud and Others, 2001 #4736; Nelson and Others, 2001 #	3A-01 Avcos (2012 #7669)
Geomorphic expression				Spotted Fing trench (vite 535-28) across the Island Wood scarp, southwestern Bainbridge Island, (Nelson and others, 2024 FTIC5). The trench exposed evidence of two surface deforming events:
	Seguini idule		¹⁹ 25'-87'5.	 Rediocarbon ages suggest deformation occurred during the same time frame as other studies
Age of faulted surficial			Convents: Dip proposed by various investigators spans a broad range. Using industry seismic reflection data, Johnson and others (1994 ##130) inferred a mean dip of	Geomembic
0			45-60° 5. to a depth-of ~ 6 km for the northern fault in the Seattle fault zone (Prontal fault of Blakely and others, 2002 H716), and suggest the dip-of the zone shallows with depth. Using a different industry seismic-reflection database, Pratt and others (2007 H7131) inferred a dip-of about 45° 5. for the Frontal fault in the upper G km and	expression upbit extends 5-10 km southward from the Frontal fault and 30 km eastward from Oyes inlet to t
deposits			presented a model showing a dip of about 28-25".5. at depths of 6-16 km, Johnson and others (1999 M172)) used high-resolution seismic reflection data to infer that the dip of the Frenzil fault in the union? I km varies along strike from du/dV 5. Haussaler and others (2000 M1727) used network mythed data in central kituan Country to	others, 2001 #4739) show that late Quatemary faulting continues eastward across Lake Washingt short (3: to 2 km long). 3: to 7 m high scarosalione the Toe Jam Hill Built (Bucknam and others.)
			infer that the Frontal fault dips 65-70° S. near the serface but shallows to roughly 30° at depths of 5-6 km beneath Cold Mountain, west of Bremerton. Bused on	and Waterman Point fault (Haugerud and others, 2001 #4735; Haugerud and others, 2003 #6211; P
Historic earthquake			microsolomicity, Brocher and others (2001 M1718) favor a model in which the Seattle fault zone dips steeply from the surface to a depth of about 25 km. Nelson and others (2014 #7615) summarize the on going debate regarding the subsurface geometry of the Seattle fault zone and presents the various models in figure 3.	undoubtedly been buried or ended during Pleiotocene glaciation. The Puget Lowland was occup continental ice sheet, with the most recent ice retreat occurring about 16 ka (Porter and Swansor
		Participant in a state of the s		(Booth, 1994 #4713). The tops of bedrock hills on the Seattle uplift stand as much as 300-400 m h
Most recent prehistoric	latest Quaternary (<15 ka)	studi	Paleoseismologic investigations of shoreline deposits and twenching studies have been conducted along and near fault strands of the Seattle fault zone. Detailed investigations of shoreline deposits of Puget Sound and sediments and submerged forets of Lake Washington are described in some of the sites listed below. These off-	Age of faulted The Seattle fault (hontal fault of Blakely and others, 2002 44716) is largely concealed beneath yo data suggest it justaposes Tertiary bedrock and Quatemary glacial and interglacial deposits at sh
deformation			Fault investigations document evidence for late Holocene land-level changes, bunamis, and (or) landbildes that are interpreted to be effects of large earthquakes and faulting in this region. The evidence from many of these off fault sites can be confidently correlated with a Holocene earthquake on the Seattle fault zone. Nelson and	#41317; Johnson and others, 2999 #4729). Sherrod and others (2001 #4139) describe a possible en
			others (2014 #7675) compile calibrated radiocarbon ages that closely limit the times of surface deformation near the Seattle, Tacoma (561), and Saddie Mountain (575)	juntaposing Miocene bedrock and undated Quaternary glacial deposits. Recent UDAR topograph deglaciation (about 15,000 yr BP) along much of its trace. In this scenario, upper Quaternary dep
	Comments:		Faults. Evidence from some other off-fault sites, however, cannot be confidently related to a specific fault or zone of faults. The off-fault sites discussed below are included herein with the Seattle fault zone based on existing reports and interpretations as well as in part based on their previously to the Seattle fault zone. Some other	surface. The Blakely Harber fault is also concealed, but geologic and geophysical data suggest it deposits at shallow depth across much of the central Puget Lowland. The Port Orchard fault is si
			coastal study sites nearby in the Puget Lowland, such as the Shine, Winslow, and Hansulle sites (e.g., Bucknam and others, 1992 H602; Sherrod, 2001 H140), have been reported to show little or no evidence of late Holocene land level changes, tsunami deposite, and other possible earthquake-related features. In addition to the	at shallow depth it forms a contact between Eocene-Oligocene marine deposits and Eocene volo
			paleoseismology sites listed below, Schuster and others (1992 #600) reported rock availanches and limiting radiocarbon ages from the southeastern Olympic Mountains.	others, 2002 MITIG: Trenches across the scarps of north dipping faults show displacement of Pin bedrock, Pleistocene glacial deposits, and postglacial latest Pleistocene to Holocene) deposits.
December 1. Internet			They concluded that these avalanches probably were triggered by seismic shaking related to earthquakes in the last few thousand years, and suggested that the Seattle fault gone was one of a few obvious candidates for the earthquakes that might have triggered these avalanches. These rock avalanche study sites are discussed in more	2000 #41733, 2002 #4736; 2003 #5868). The fault along the Nateman Point scarp cuts Eccene Olig Holocrea deposits (Nelson and others, 2003 #5258).
Recurrence interval			detail in the paleoseismology studies of the Saddle Mountain faults (STS), which are located along the southeastern flank of the Olympic Mountains directly southeast of	However deposits (Nersen and others, 2003 Ph250).
Clin vata satagany			the rock avalanches studied by Schuster and others (2002 #600).	earthquake
Slip-rate category	Unspecified		Restoration Finite (370-2) and Aki Point (370-2). Bucknam and others (2002 AG22) documented several meters of abrupt late Holocene uplift at these two coastal sites in the Seattle Isult zone. Based on isotopic age dating and other information, they concluded that this uplift probably reflected land level changes related to a major	Most recent latest Quaternary (<15 ka)
			earthquake along the Seattle Built zone about 1000-1100 years ago. Other studies and more precise age during (e.g., Atwater and Noore, 1992 #597, Atwater, 1999 #47155, suggest that up/IPL at these sites probably is related to subsidence at the West Point site (STO 3) and imply that the earthquake responsible for these land level	deformation Comments: Nelson and others (2014 #7(-75) summarize an OuCal analysis of ten of the most close
Date and Compiler(s)			changes can be more tightly constrained to about 3050-1000 cal yr BP (A.D. 900-931). Sherrod and others (2000 #1741) expanded on this earlier study with a core	that restrict the age a large earthquake on the central Seattle fault zone to 1540-510 cal yr BP (20 (1050-3020 cal yr BP) in eastern Puget Sound. In addition, the central Seattle fault zone may slip
Date and compiter(s)	2017		transect across a nearby marsh. The stratigraphy beneath the marsh concurs that the area experienced abrupt 7 m uplift that shifted the tide flat to a freshwater environment around 3000 cal yr BP.	hundred years for periods of 1000-2000 yr, and then not slip for periods of at least several thousa
			West Point (531-3) and Culture Bay (533-4). The West Point site is located in tidal Bat sediments at West Point along west edge of Seattle and east coast of Puget Sound.	
References			Based on tidal marsh stratigraphy and radiocarbon ages from this site, Atwater and Moore (1992 #597) documented evidence for subsidence and a townami generated in	Recurrence 0.2 to 12 k.y. (<16 ka)Toe Jam Hill fault interval
References	#6916 Nelson, A.R., Personius, S.F., Buck, J., Bradley, L-A., Wells, R.E., Schermer, E.R., 2007, Field and laboratory data from an earthquake history		the Puget Sound about 1200-2000 years ago. The evidence suggests that a large earthquake on the Seattle fault zone generated the trumami by causing abrupt uplit south of the fault (e.g., at Restoration Point, 570-1, and Alki Point, 570-2) and complimentary subsidence to the north at West Point. Atwater and Moore (1992 #557) also	Comments: Detailed paleoseismologic investigations within the Seattle fault zone have been con
	study of scarps of the Lake Creek-Boundary Creek fault between the Elwha River and Siebert Creek, Clallam County, Washington: U.S. Geological		correlated tsusami deposits of similar age at Culturs Bay on southern Whidbey Island with this event, but reported that there is no evidence of related land-level changes at Culturs Bay, Atwater (1999 #115) later reported high precision radiocarbon ages from a Douglas Fir log at the West Point site, which constrain the age of this	Sherrod and others, 2001 #4739; Nelson and others, 2002 #4736; 2003 #5868; One large (M2 7) la the basis of an uplifted terrace (Sherrod, 1965 #4171; Buckinam and others, 1992 #602; Atwater, 2
			at clinics buy, interaction (2009 HV L2) when reported improvement autocarbon ages from a pologies for ing at the vest room site, which consistent one age or one earthquake to between 1056–1030 cally EP (A.D. 900–503, Atwater, 2009 HVTLS).	the 1550-5020 yr BP Seattle fault zone earthquake (Atwater and Moore, 1992 #507; Karlin and Abe #600; Bucknam and others, 1992 #602; Bourgeois and Johnson, 2001 #4720; Sherred, 2001 #4740)
	Survey Scientific Investigations Map 2961, 2 sheets.		Lake Mashington sites (370-5). The eastern part of the Seattle fault zone crosses Lake Mashington. At several sites in and along the lake, submarine landslides, tarbidites,	backthrust) on southern Dainbridge Island reveal evidence of 3 or 4 ground-ruptaring earthquakes
			and submerged forests on submarine landhildes provide evidence of prehistoric earthquakes along the Seattle fault zone and (or) along faults elsewhere in Cascadia (e.g., Karlin and Abelia, 1992 #500, Jacoby and others, 1992 #500, Prunier and others, 1907 #6712; Karlin and others, 2004 #67133. Jacoby and others (1992 #500) dated	earthquakes overlaps in age with and is inferred to correlate with the 1050–1020 yr BP event. Bas report radiocarbon measured recurrence internals of ~0.2 to 12 k.y. for post-glacial (since 16 ka) of
			submerged trees on landslide deposits in the lake and reported that the most recent landslides in three separate localities may have occurred simultaneously, about	intervals range from 12,000 yr between late Pleistocene and late Holocene earthquakes to as litt
			1000 years ago. Based on tree-ring pattern matching with a dated log from the West Point site (575-3), they concluded that bark-year trees from the Lake Washington sites 31 died to the concentre on did the same from the West Point site (576-3), they concluded that bark-year trees from the Lake Washington	2003 #5668). Nelson and others (2003 #5868) note that the earthquake history of the Toe Jam Hill

 Database entry for the Sequim fault (left) is sparce compared with the database entry for the Seattle fault (right)

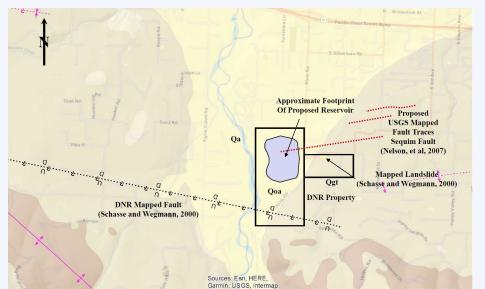
4

...plus 60 references covering pages

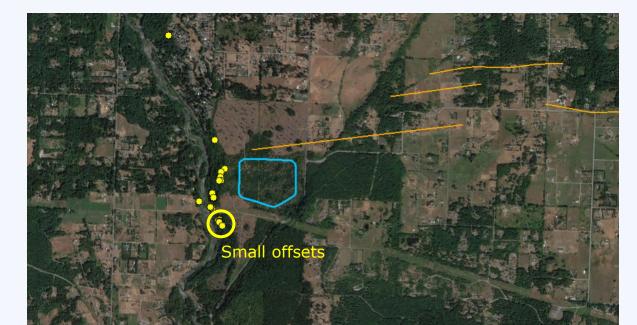
- Prior communication between S&W and the USGS suggests the survey was in favor of reclassifying the Sequim fault from a Class A to Class B fault:
 - Class A: "Geologic evidence demonstrates the existence of a Quaternary fault of tectonic origin, whether the fault is exposed for mapping or inferred from liquefaction or other deformational features."
 - Class B: "Geologic evidence demonstrates the existence of a fault or suggests Quaternary deformation, but either (1) the fault might not extend deeply enough to be a potential source of significant earthquakes, or (2) the currently available geologic evidence is too strong to confidently assign the feature to Class C but not strong enough to assign it to Class A.

Investigation of the Sequim Fault for the DOCR

- PanGEO Report (2020)
 - Nelson (2007) is basis for fault
 - Faults in previous geologic maps are questionable
 - B. Sherrod and S. Angster of USGS performed field recon with PanGEO
 - Recon revealed 'No certain evidence of past faulting/Holocene movement'



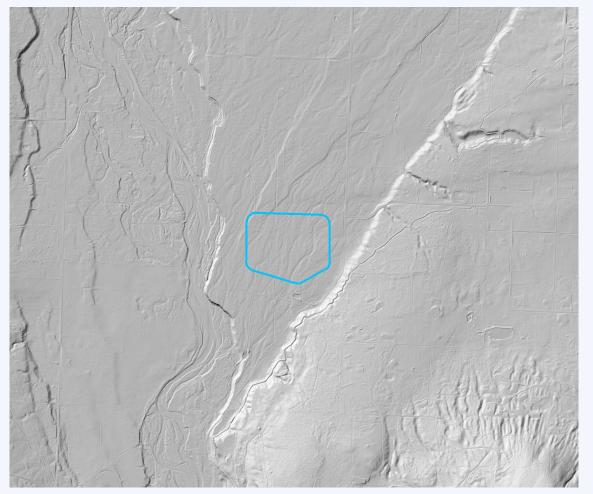
- Shannon & Wilson recon (2021)
 - D. O'Malley and W. Pollock
 - Observed several small-offset fractures in bluff southeast of the site



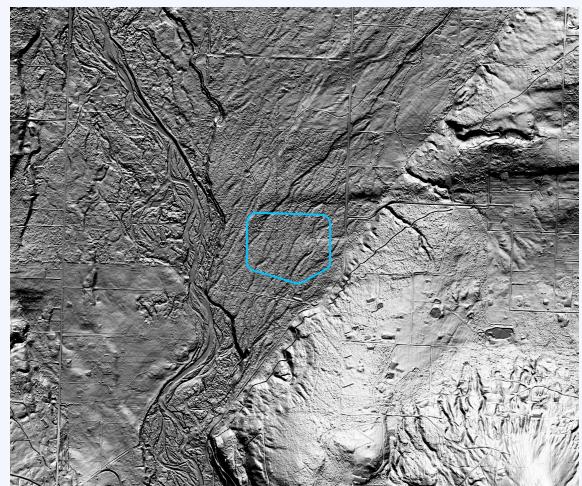
S&W Reevaluation of the Sequim Fault

- Downloaded digital terrain model (DTM) for the 2019 Olympic Peninsula Washington 3DEP Project administered by the USGS
- 3 ft x 3 ft grid resolution with average ground classification (non-vegetation, -structure, -vehicle, etc.) of 1.84 points/m²; vertical accuracy on the order of 10 to 20 cm.
- The DTM was used to develop several derivative topographic products:
 - Hillshades with various sun azimuth, angle and vertical exaggeration
 - **Slope** (visually manipulated to highlight shallow slope angles)
 - Local relief (moving window to calculate high and low elevation within window)
 - Low pass filter (nine-pixel moving window, assigns average value removes speckling and sharpness, typically not related to natural topography)

HILLSHADE

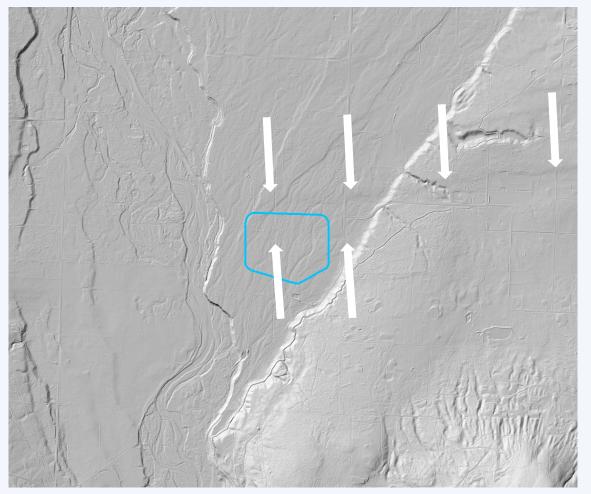


Sun azimuth: 315° Sun angle: 45° Vertical exaggeration: 1x

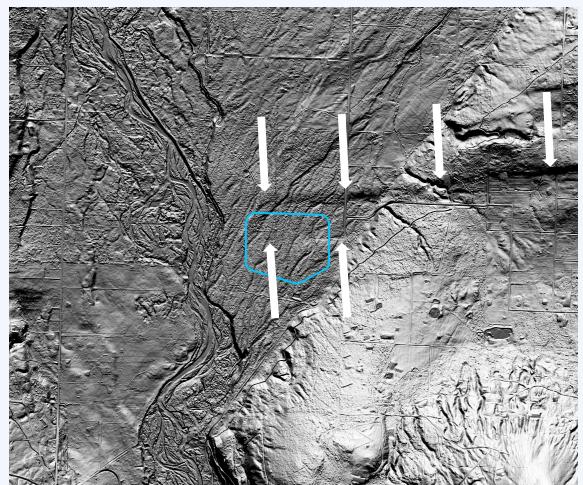


Sun azimuth: 0° Sun angle: 20° Vertical exaggeration: 10x

HILLSHADE

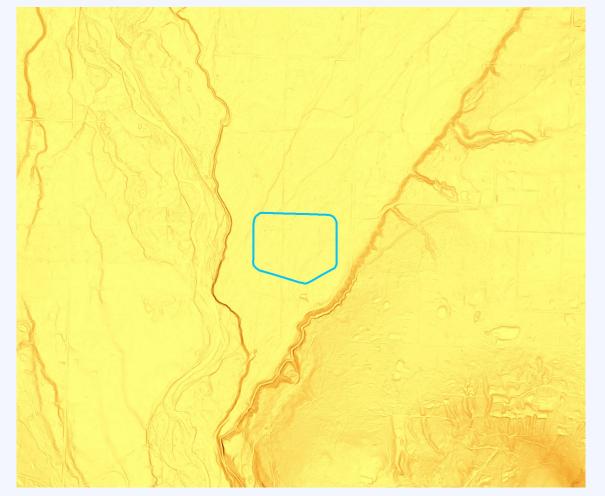


Sun azimuth: 315° Sun angle: 45° Vertical exaggeration: 1x

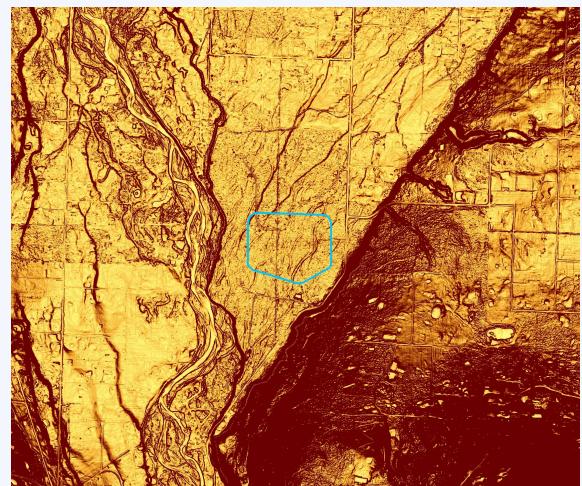


Sun azimuth: 0° Sun angle: 20° Vertical exaggeration: 10x

SLOPE

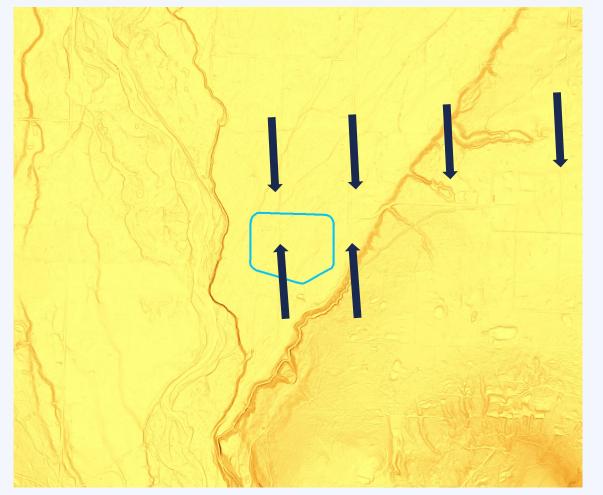


Ramped 0° to 80° (max)

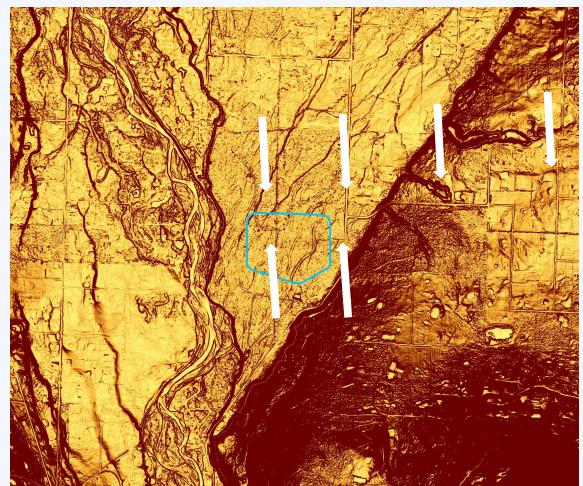


Ramped 0° to 6°

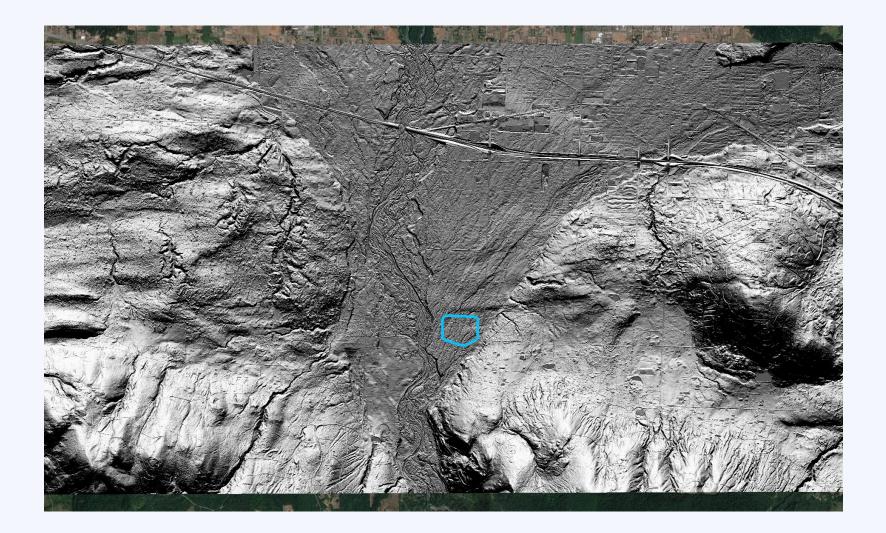
SLOPE

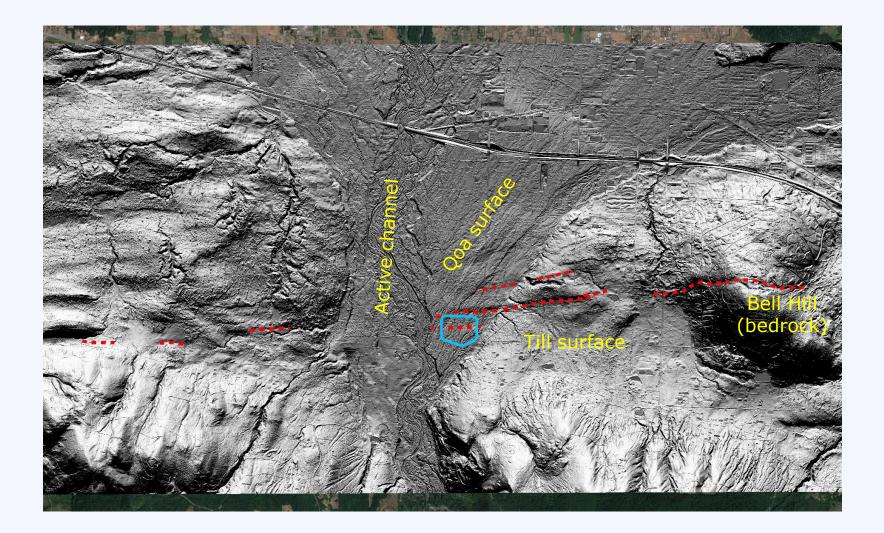


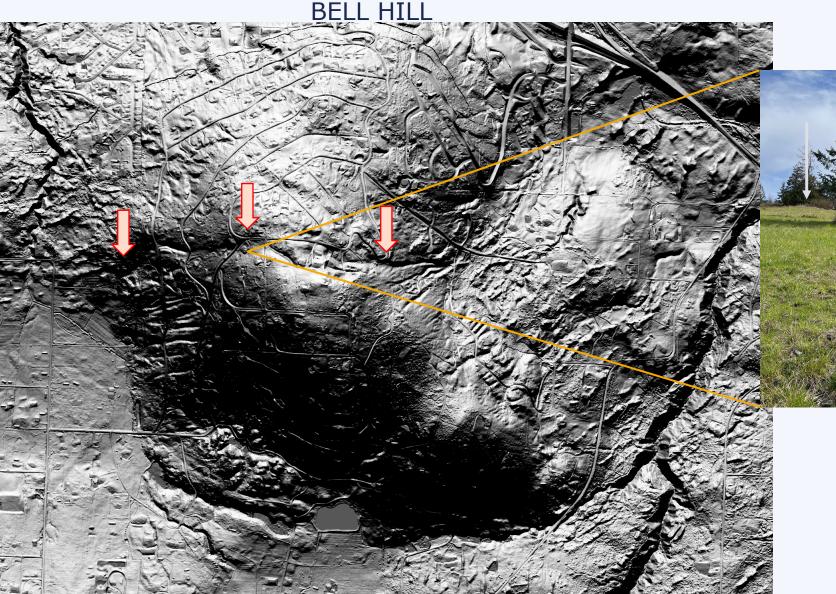
Ramped 0° to 80° (max)



Ramped 0° to 6°

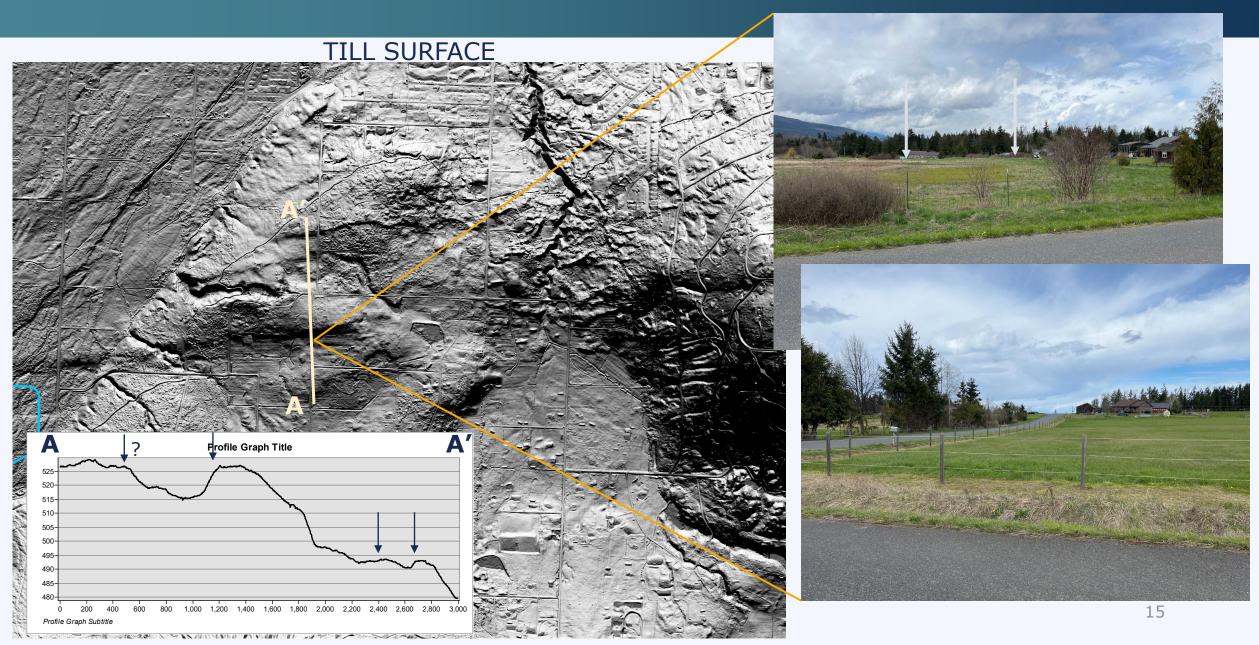


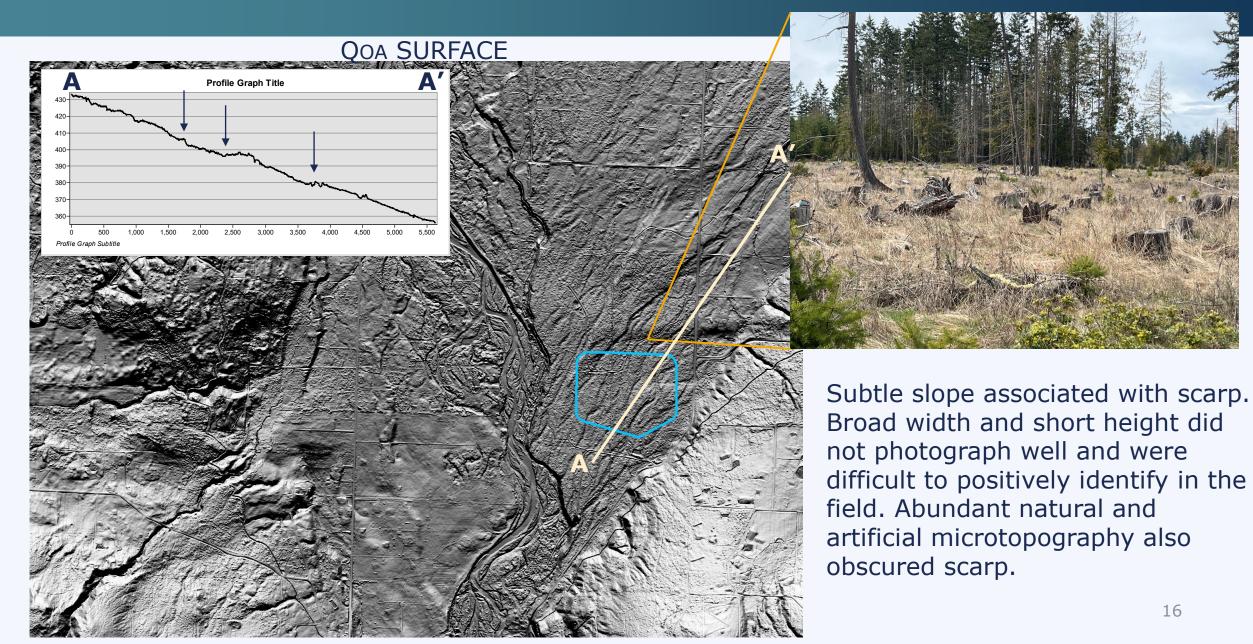






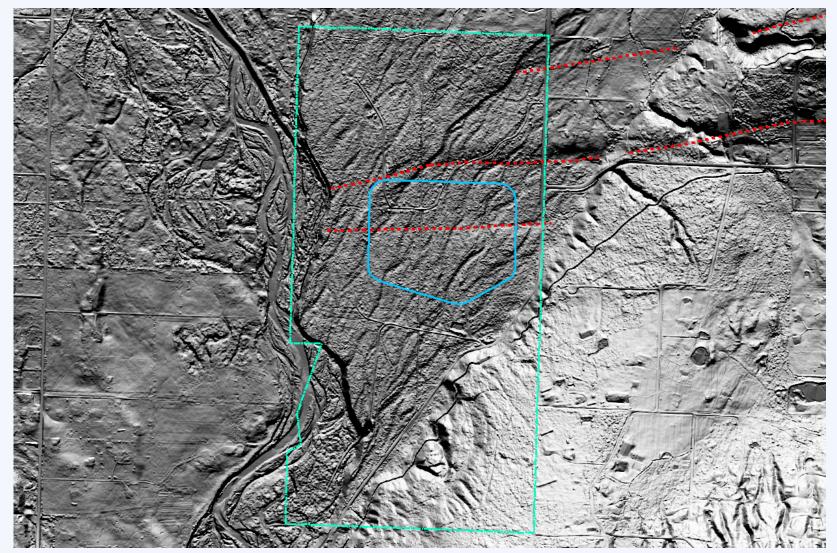
Subtle geomorphic features commonly associated with surface rupture noted along interpreted fault trace such as drainage capture and swales







Property Boundary

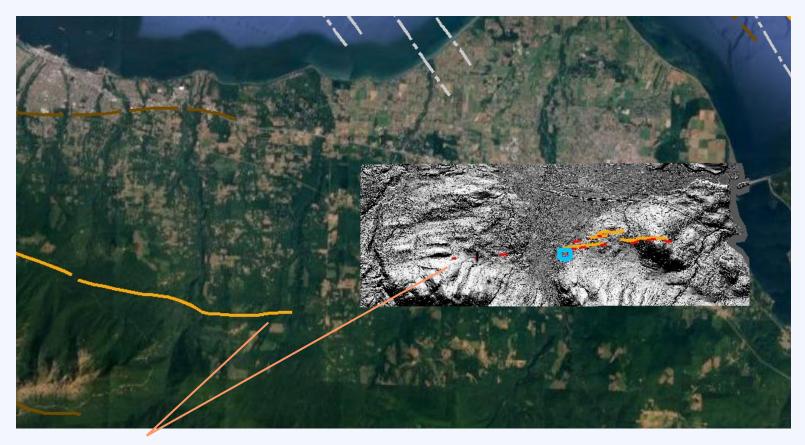




Qoa extends to near base of bluff north/downstream of scarps



Qoa over glacial (advance?) outwash in the vicinity of the project of the scarps. This is also approx. the most downstream exposure of glacial deposits, which have been covered by colluvium and/or vegetation. Note tilted bedding transitioning to horizontal bedding (many potential causes).



- Approx. 7 km to well documented faults to the west
- Little confidence in what has been mapped of the Sequim fault west of the Dungeness River valley

Alternative Hypotheses of Origin

Supporting

- Tectonic fault
 - Linearity
 - Corresponding differences in scarp height in different age material (number of recorded events)
 - Uphill-facing
 - Generally similar orientation to known faults to the west
- Cracking/settlement/liquefaction
 - Diffuse scarps
 - Graben
- Bedrock high
 - Scarps align with bedrock fabric to west
 - Differential settlement (low and high)
- Anthropogenic
 - Active logging area
 - Noticed evidence of ground disturbance

Opposing

- Very subtle, inconclusive in Qoa in field
- Short, no obvious structural link to faults to the west
- Inconsistent relationship with MASW till depth

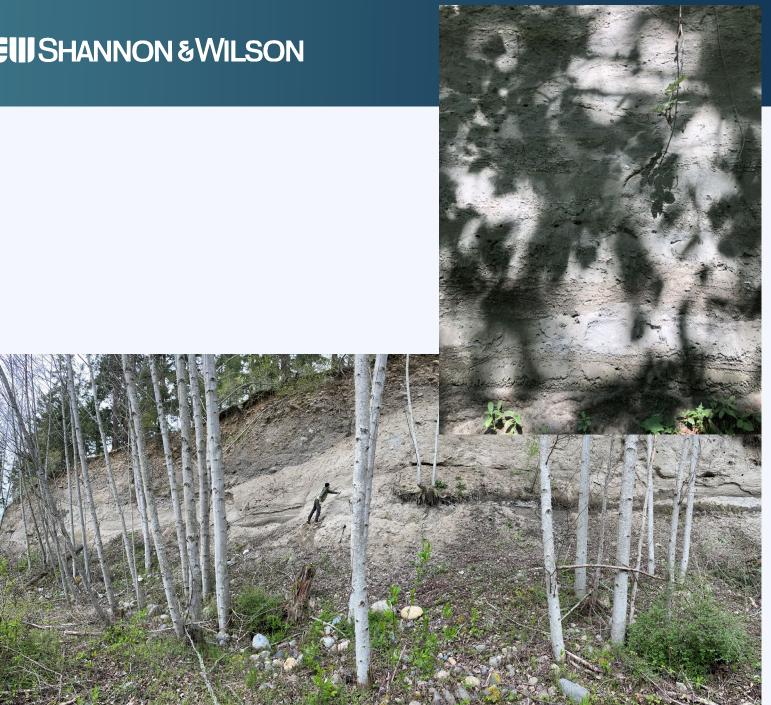
- Linearity (weak evidence)
- Corresponding differences in scarp height in different age material would be unlikely
- Corresponding differences in scarp height in different age material would be unlikely
- Longer than would be expected

Additional Study

- Given the uncertainty in the origin of the observed topographic scarps, additional study may be warranted to understand whether they are faultrelated, and if so, their age.
- Possible additional study methods / activities
 - Geomorphic mapping
 - Enhance lidar, additional assessments, profiles, etc.
 - Log Dungeness River east bluff
 - Clean selected areas with excavator or backhoe to facilitate observation
 - Trench excavation
 - Dozer or excavator trench across north and south scarps
 - Log exposures
 - Will likely require deep excavation
- Phased approach may be recommended



• Large exposure in river bluff south/upstream of site. Glacial stratigraphy ideal for identification of deformation. Observed several small offsets, interpreted as glaciotectonic.



Questions

- 1. Is there a fault? If there is a fault, is it active?
- 2. What level of confidence can be gained about the presence or absence of an active fault?
 - a. Desktop work
 - b. Field Work
- 3. If there is an active fault, what are the implications for the use of the site?
- 4. How can the presence of a fault be addressed in the reservoir design?

Questions from the County...