

= Seattle Fault =

The Seattle Fault is a zone of multiple shallow east @-@ west thrust faults that cross the Puget Sound Lowland and through Seattle ( in the U.S. state of Washington ) in the vicinity of Interstate Highway 90 . The Seattle Fault was first recognized as a significant seismic hazard in 1992 , when a set of reports showed that about 1 @, @ 100 years ago it was the scene of a major earthquake of about magnitude 7 ? an event that entered Native American oral legend . Extensive research has since shown the Seattle Fault to be part of a regional system of faults .

= = Notable earthquake = =

First suspected from mapping of gravitational anomalies in 1965 and an uplifted marine terrace at Restoration Point ( foreground in picture above ) , the Seattle Fault 's existence and likely hazard were definitely established by a set of five reports published in Science in 1992 . These reports looked at the timing of abrupt uplift and subsidence around Restoration Point and Alki Point ( distant right side of picture ) , tsunami deposits on Puget Sound , turbidity in lake paleosediments , rock avalanches , and multiple landslides around Lake Washington , and determined that all these happened about 1100 years ago ( between A.D. 900 ? 930 ) , and most likely due to an earthquake of magnitude 7 or greater on the Seattle Fault .

Although the A.D. 900 ? 930 earthquake was over a thousand years ago , local native legends have preserved an association of a powerful supernatural spirit ? a 'yahos , noted for shaking , rushes of water , and landsliding ? with five locales along the trace of the Seattle Fault , including a " spirit boulder " called Psai @-@ Yah @-@ hus near the Fauntleroy ferry dock in West Seattle .

= = Geology = =

The Seattle Fault is the structural boundary where 50 ? 60 millions of years old ( early Tertiary ) basalt of the Crescent Formation on the south has been uplifted ? the Seattle Uplift ? and is tipping into the Seattle Basin , where the Tertiary bedrock is buried under at least 7 km ( 4 @.@ 3 miles ) of relatively softer , lighter sedimentary strata of the younger Blakeley and Blakely Harbor formations . This has resulted in a 4 to 7 km ( 2 @.@ 5 to 4 @.@ 3 miles ) wide zone of complex faulting , with three or more main south @-@ dipping thrust faults . Most of the faulting is " blind " ( not reaching the surface ) , and generally difficult to locate because of the generally heavy vegetation or development . Three principal strands have been identified , their location determined by high @-@ resolution seismic reflection and aeromagnetic surveys . The northernmost strand lies nearly along Interstate 90 and then under Lake Sammamish . The central section of the fault zone ? where it crosses the apparent location of the Olympic @-@ Wallowa Lineament ? shows marked variation in the location of the strands and of the underlying structure , but the nature and significance of this is not understood .

The fault extends for approximately 70 km ( 43 miles ) from near Fall City on the east , where it appears to be terminated by the South Whidbey Island Fault , to Hood Canal on the west ( not shown on the map ) . where matters are as yet unclear ( see discussion at Puget Sound faults # Question of western termination ) . It is the northern edge of the Seattle Uplift , of which the Tacoma Fault is the southern edge . One model has the Seattle and Tacoma faults converging at depth to form a wedge , which is being popped up by approximately north ? south oriented compression that ultimately derives from plate tectonics . Another model ( see diagram ) interprets the Seattle Uplift as a sheet of rock that is being forced up a ramp . Subsequent work suggests that the structure of the Seattle Fault may vary from east to west , with both models being applicable in different sections . A later model has part of the north @-@ thrusting sheet forming a wedge between the sedimentary formations of the Seattle Basin and the underlying bedrock .

The Seattle Fault is believed to date from about 40 million years ago ( late Eocene ) . This is about the time that the strike @-@ slip movement on the north @-@ striking Straight Creek Fault to the east ceased , due to the intrusions of plutons . It appears that when the Straight Creek Fault

became stuck the north ? south compressive force that it had accommodated by strike @-@ slip motion was transferred to the crust of the Puget Lowland , which subsequently folded and faulted , and the various blocks jammed over one another .

Other scarps associated with the Seattle fault have been identified by LIDAR @-@ based mapping ; trenching has generally shown the faulting to be more complex than was first realized . Many of the details of the Seattle Fault , including recurrence rate , remain to be resolved . A study of sediments in Lake Washington found evidence of seven large (  $M > 7$  ) earthquakes in the last 3500 years .

Surface scarps due to faulting are rarely observed in this area ( due to topography , vegetation , and urbanization ) ; a rare exception can be seen at Mee Kwa Mooks Park south of Alki Point . This is the site of the West Seattle Fault ; the prominent rise there is due to uplift on the north side of the fault .

= = Hazard = =

The Seattle Fault ( and the related Tacoma Fault ) is not the only source of earthquake hazard in the Puget Lowland . Other faults in the near surface continental crust , such as the South Whidbey Island Fault ( near Everett ) , and the yet to be studied Olympia Fault ( near Olympia ) , though historically quiescent , are suspected of generating earthquakes of around magnitude 7 . Others , such as the 2001 Nisqually earthquake , originate about 50 to 60 km ( 31 to 37 miles ) below Puget Sound in the Benioff zone of the subducting Juan de Fuca Plate ; being so deep their energy is dissipated . And there are the infrequent but very powerful great subduction events , such as the magnitude 9 1700 Cascadia earthquake , where the entire Cascadia subduction zone , from Cape Mendocino to Vancouver Island , slips .

But the Seattle and Tacoma faults are probably the most serious earthquake threat to the populous Seattle ? Tacoma area . A 2002 study of bridge vulnerability estimated that a magnitude 7 earthquake on the Seattle Fault would damage approximately 80 bridges in the Seattle ? Tacoma area , whereas a magnitude 9 subduction event would damage only around 87 bridges in all of Western Washington . The same study also found that with failure of just six bridges ( the minimum damage for a Benioff  $M 6 @. @ 5$  event ) there could be at least \$ 3 billion lost in business revenue alone . Subsequent retrofitting by the Washington Department of Transportation and the City of Seattle would likely reduce damage to key bridges . But there is concern that such an earthquake on the Seattle Fault would devastate unreinforced masonry ( URM ) buildings , of which the City of Seattle is estimated to have around a thousand , concentrated in Capitol Hill , Pioneer Square , and the International District .

Other recent work indicates that the Seattle Fault can generate two types of earthquakes ; both pose " considerable hazard " to the Seattle metropolitan region . The A.D. 900 ? 930 earthquake is believed to be the only instance in the past 7 @, @ 000 years of the type that causes a regional uplift . The other type is more localized and shallower ( and therefore more damaging ) ; at least four such events are believed to have occurred in the past 3 @, @ 000 years on the west end of the fault . ( The history of the central and eastern segments is not known . )

Calculations based on fault length and paleoseismological studies show that the Seattle Fault can generate a very damaging magnitude 7 @. @ 0 earthquake . In addition to extensive damage to unreinforced structures and structures built on fill ( such as much of Seattle 's Pioneer Square area , the industrial area , and the waterfront ) , computer modeling has shown that such earthquakes could cause a tsunami of about 2 m ( 6 feet 7 inches ) high on Elliott Bay . The modeling shows that such a tsunami would also inundate the industrial areas on Commencement Bay 30 miles south ( Tacoma ) and low @-@ lying areas on the Puyallup River delta . There is also concern that a severe or prolonged event could cause failure of the Duwamish or Puyallup River deltas , where the main port facilities for Seattle and Tacoma are located ( Harbor Island and Commencement Bay ) .