The Seattle Fault

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Introduction

The Seattle Fault Zone is a northwest striking shallow crustal reverse fault which runs just across downtown Seattle from Bremerton to Lake Sammamish. The Seattle Fault was last active in the year 900 AD when an estimated magnitude ~7.5 earthquake triggered tsunamis within Puget Sound. The human impact of another earthquake along this fault will be devastating. Over 4 million people live in Seattle Metro area and **estimates expect over 31,000 people to be displaced**, among other consequences.

Evidence for the Seattle Fault

Figure 1: Restoration Point at low tide

Exposed Bedrock at Restoration Point

Edge or tree line traces the pre-900 AD shoreline. Due to uplift, the underlying bedrock is exposed at the surface instead of covered by hundreds of feet of glacial till like the rest of Puget Sound. Restoration point uplifted ~21 feet during 900 AD earthquake.

Anomalous Sand Sheet in West Point, Seattle

In 1992 Brian Atwater discovered an anomalous sand sheet disconformably interbedded with tidal flat deposits in West Point, Seattle. The sand sheet contained trees and other debris which could only be transported under high energy tsunami conditions. **Roughly 6 feet of subsidence accompanied the tsunami.** Carbon dating of organic material yielded a date of ~1100 years ago.

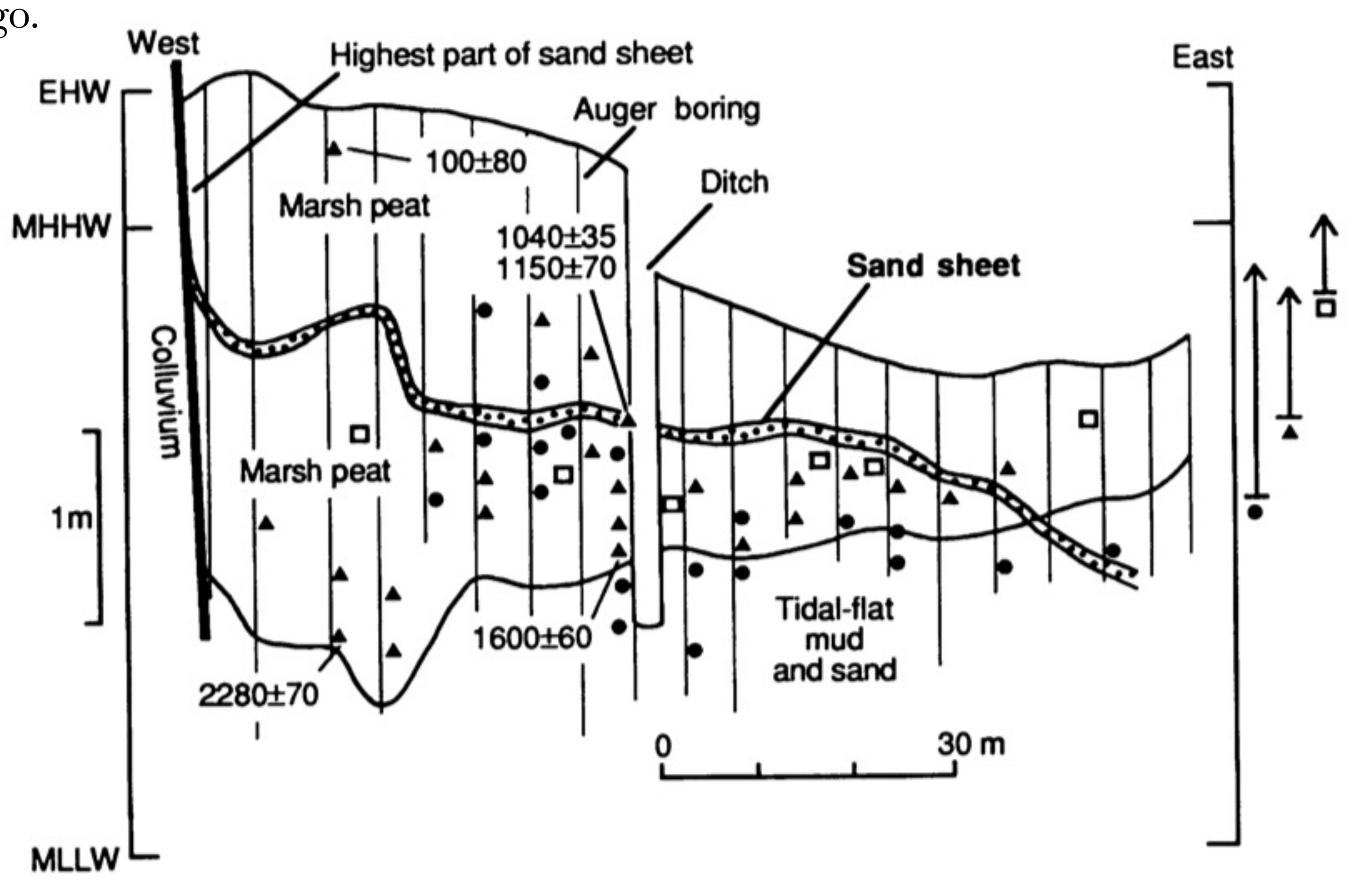

Figure 2: Anomalous sand sheet intermixed with tidal sediments. From Atwater & Moore (1992)

Where is the Strain?

Figure 3 displays active faults in the State of Washington. The Seattle fault zone runs across Downtown Seattle and is one of several southeast trending faults in the region. **The Seattle fault is a shallow crustal fault (5-10 km)** which is clearly defined both on outcrop and in seismic reflection profiles. Seismic work indicates it is a blind master ramp reverse fault thrust (Figure 4, Kelsey, 2008) which dips to the south ~50-60°. The fault may also exhibit north up 'roof fault' reverse faults which pose additional seismic risk to the Seattle area.

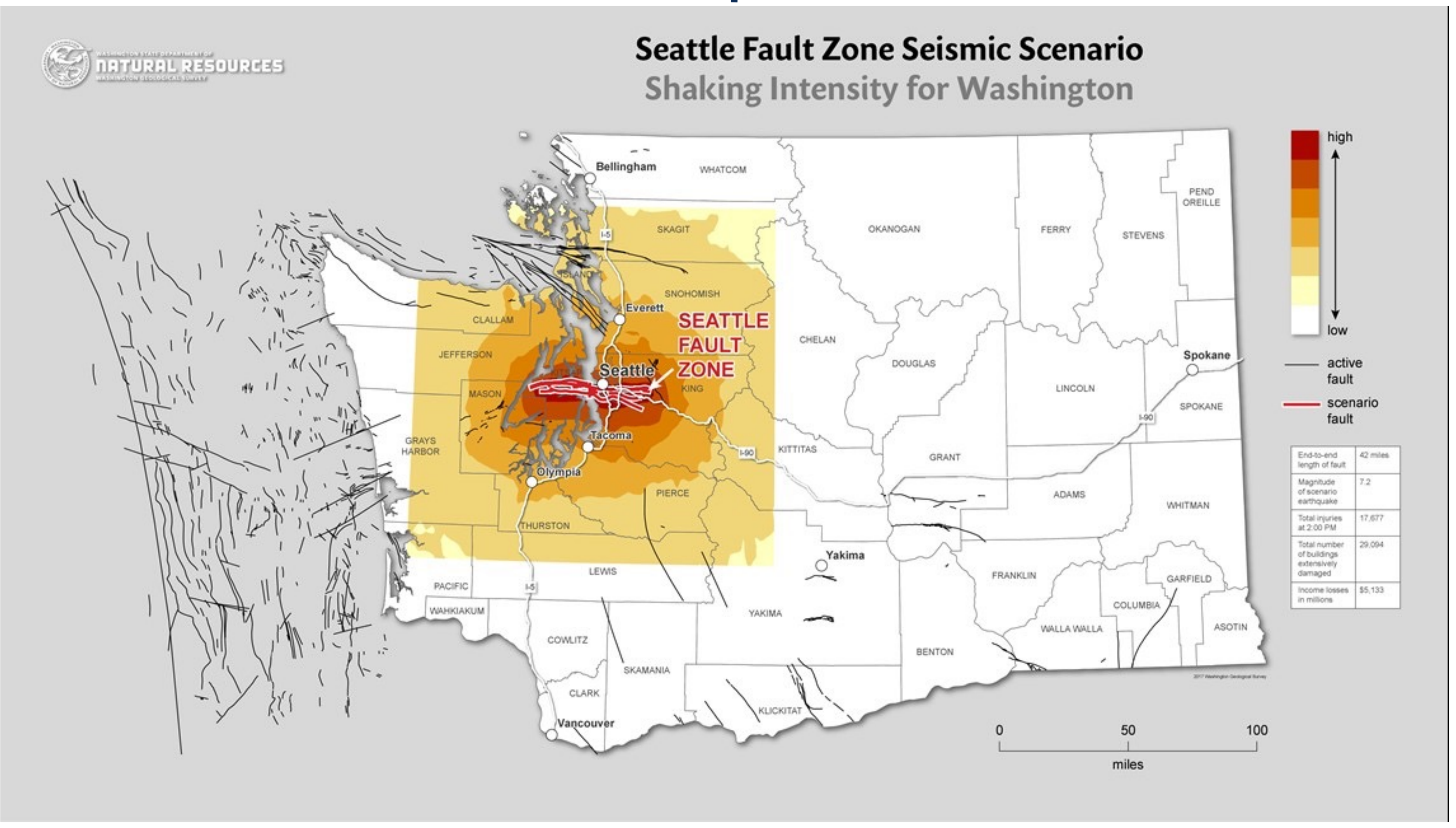

Figure 3: Location of active faults in the state of Washington, with emphasis on the Seattle fault and its shaking intensity throughout the region (Washington State Geologic Survey).

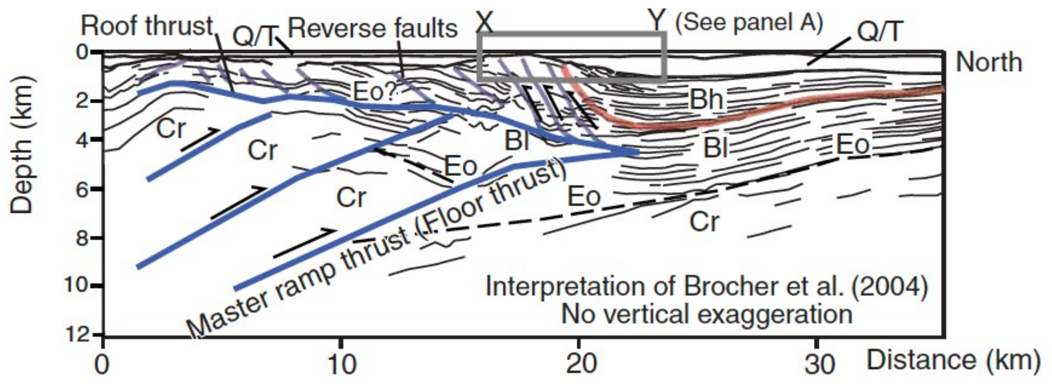

Figure 4: Cross section of the Seattle Fault Zone (Kelsey, 2008).

Where is the Stress?

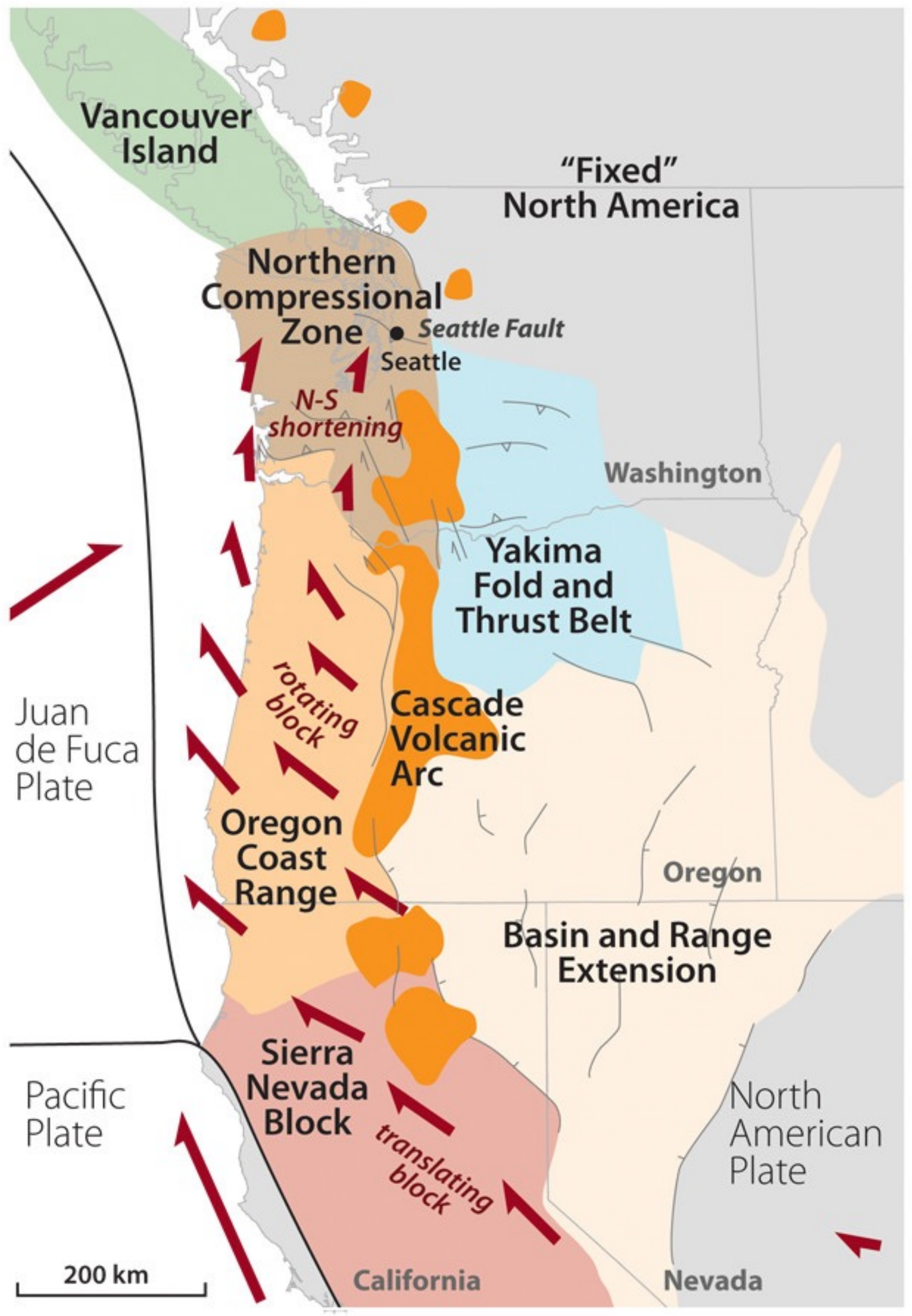

Figure 4: Schematic of the 'clockwise rotation' pheno-menon on the coast (From Wells, 1998)

The Seattle Fault is the earth's response to north/south compression which is created by several competing tectonic forces. The North American plate is moving to the southwest, the Pacific plate is moving to the northwest, while the Juan de Fuca plate is moving to the northeast. These relationships establish the phenomenon known as '**clockwise block rotation'** (Wells, 1998). In response to this plate tectonic motion, the Sierra Nevada block translates to the northwest forcing the Oregon Coast block to the north where intersects the southwest trending North American Plate. This results in a Northern Compressional Zone which accommodates and expresses stress through a series of reverse faults in the western half of Washington State and fold and thrust belts in the east. The Seattle Fault is one of these southeast trending features.

Human Impact

The Seattle Fault zone poses a significant seismic hazard to the Seattle region. The three most significant risks to residents of Seattle are the threats of **Tsunami**, shaking leading to **building collapse**, and **soil liquefaction** triggering landslides.

Seattle's geography is inherently susceptible to earthquake hazards. Downtown Seattle is at an especially significant risk. The fault directly intersects the neighborhood which is a low-lying area composed of reclaimed land especially prone to shaking and lique-faction. Additionally, Many of Seattle's most prominent neighborhoods sit atop steep glacial drumlins which are at a severe risk of landslides.

SEATTLE FAULT SCENARIO EARTHQUAKE	
End-to-end length of fault (kilometers)	68
Magnitude (M) of scenario earthquake	7.2
Number of counties impacted	15
Total injuries (*severity 1, 2, 3, 4) at 2:00 PM	17,677
Total number of buildings extensively damaged	29,094
Total number of buildings completely damaged	9,062
Income losses in millions	$5,133
Displaced households	31,278
People requiring shelter (individuals)	18,193
Capital stock losses in millions	$19,868
Debris total in millions of tons	7.42
Truckloads of debris (25 tons per truckload)	296,720
People without power (Day 1)	265,583
People without potable water (Day 1)	399,991

Figure 5: Seattle Fault scenario for a magnitude 7.2 earthquake (City of Seattle).

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