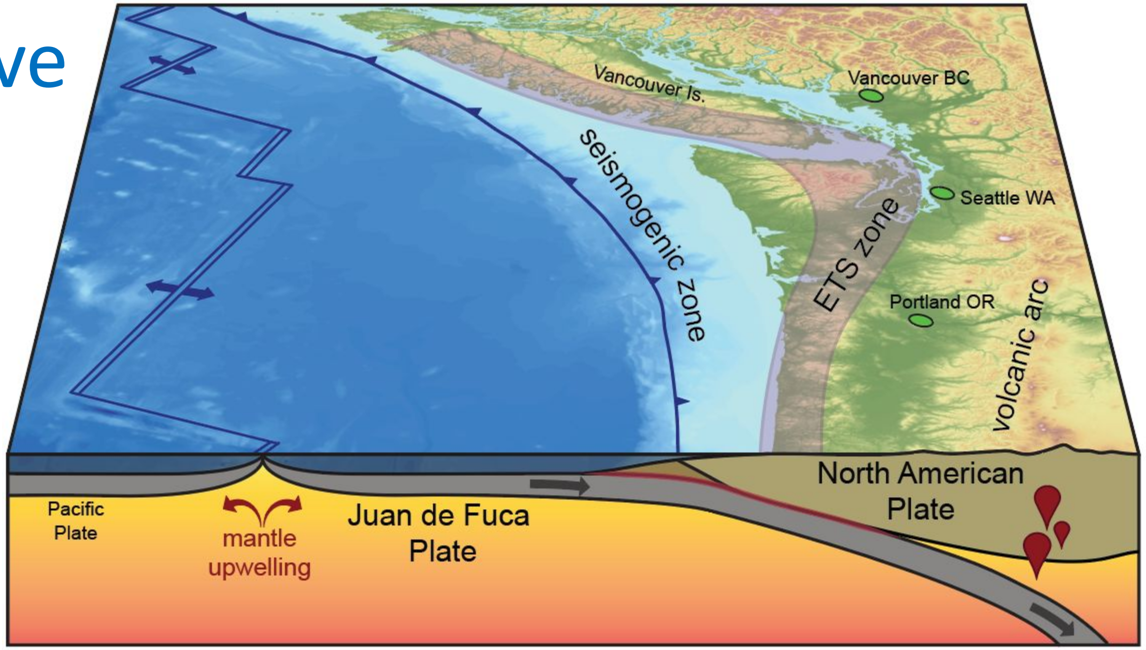
Welcome to Cascadia!

34 major volcanoes,
11 Holocene active

young, warm

thick sedimentary prism



internally deforming incoming plates

temperate wet forearc, arid backarc

last great plate-interface earthquake 1700 AD

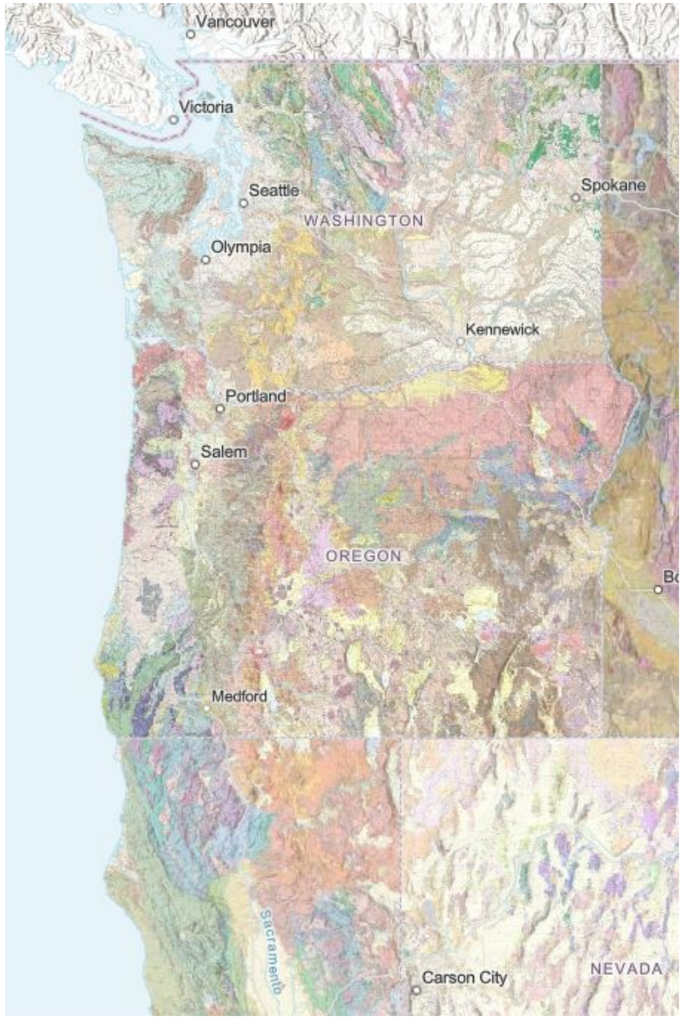
dispersed 'monogenetic' fields & mafic volcanism

oblique, low-angle, 3-4 cm/yr subduction

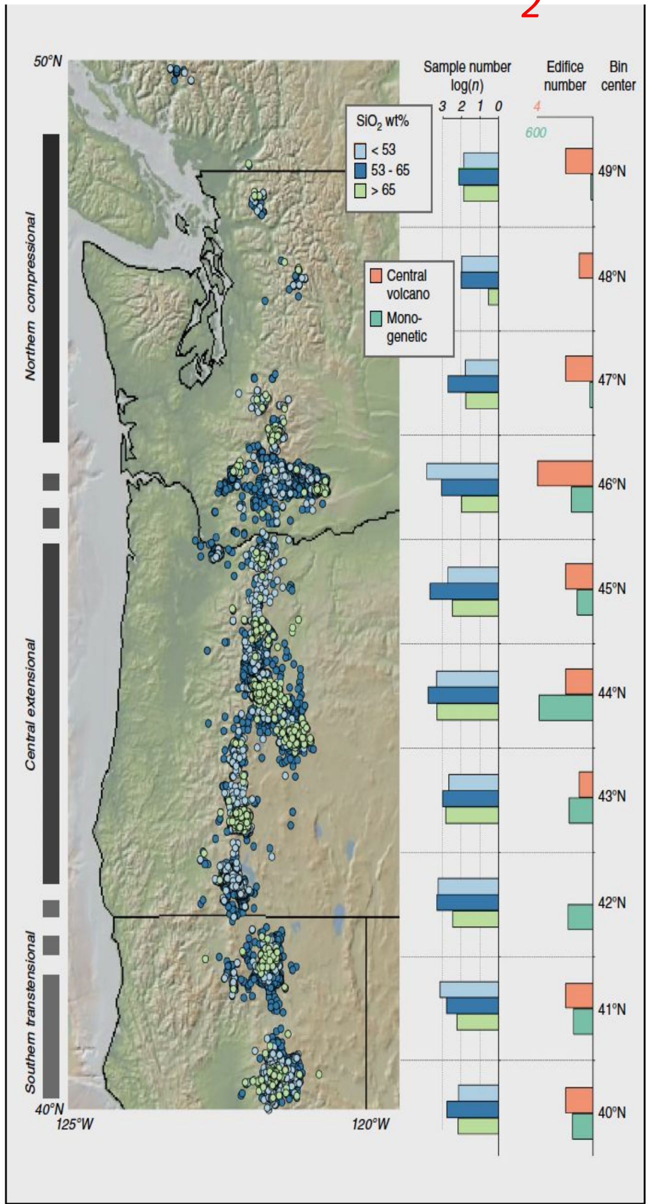
LOTS of Contextual Data Exist (just a few examples)

COSMOGENIC NUCLIDE

GEOLOGY



VOLCANIC $SI0_2$



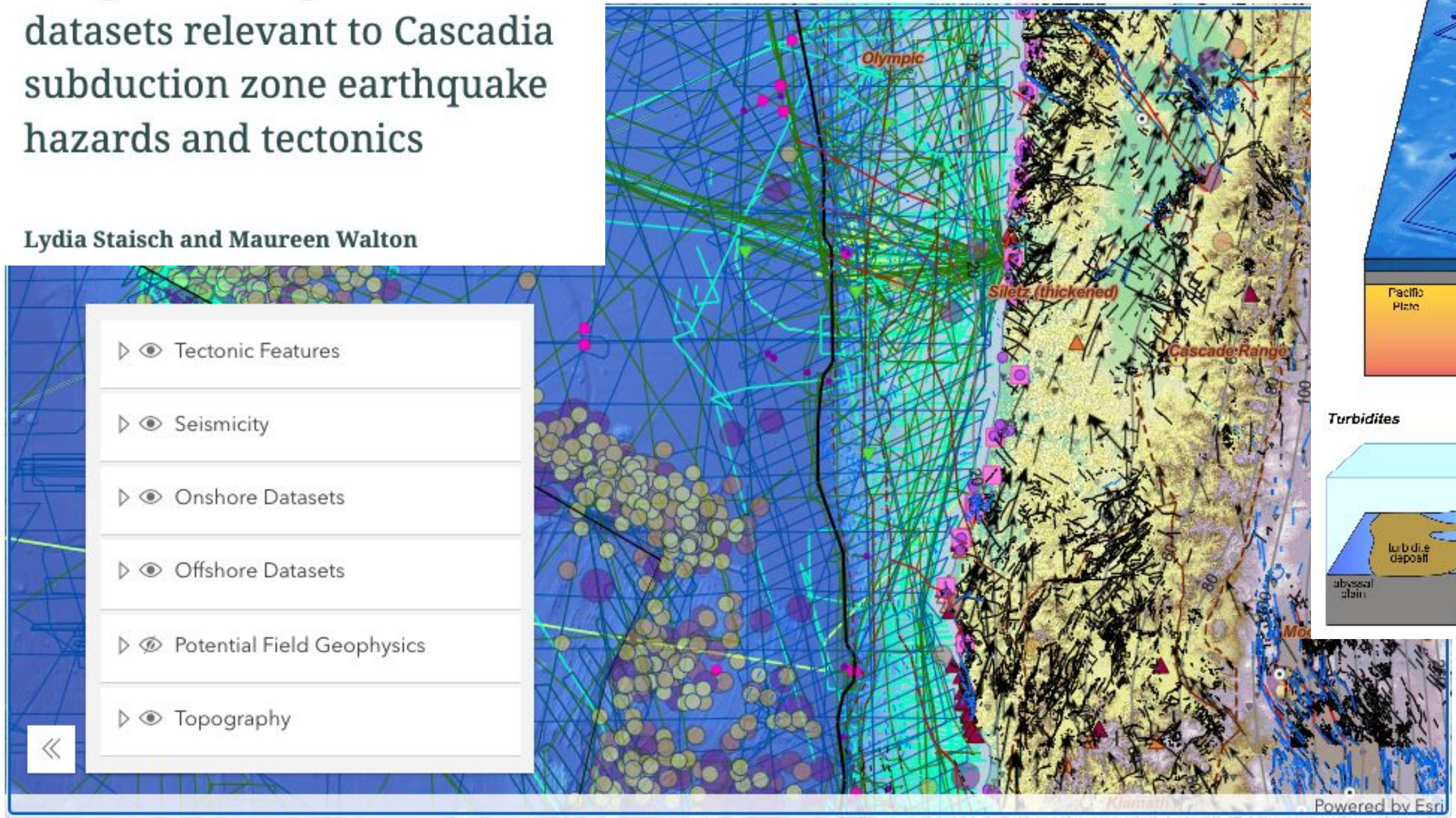
30-m BATHYMETRY

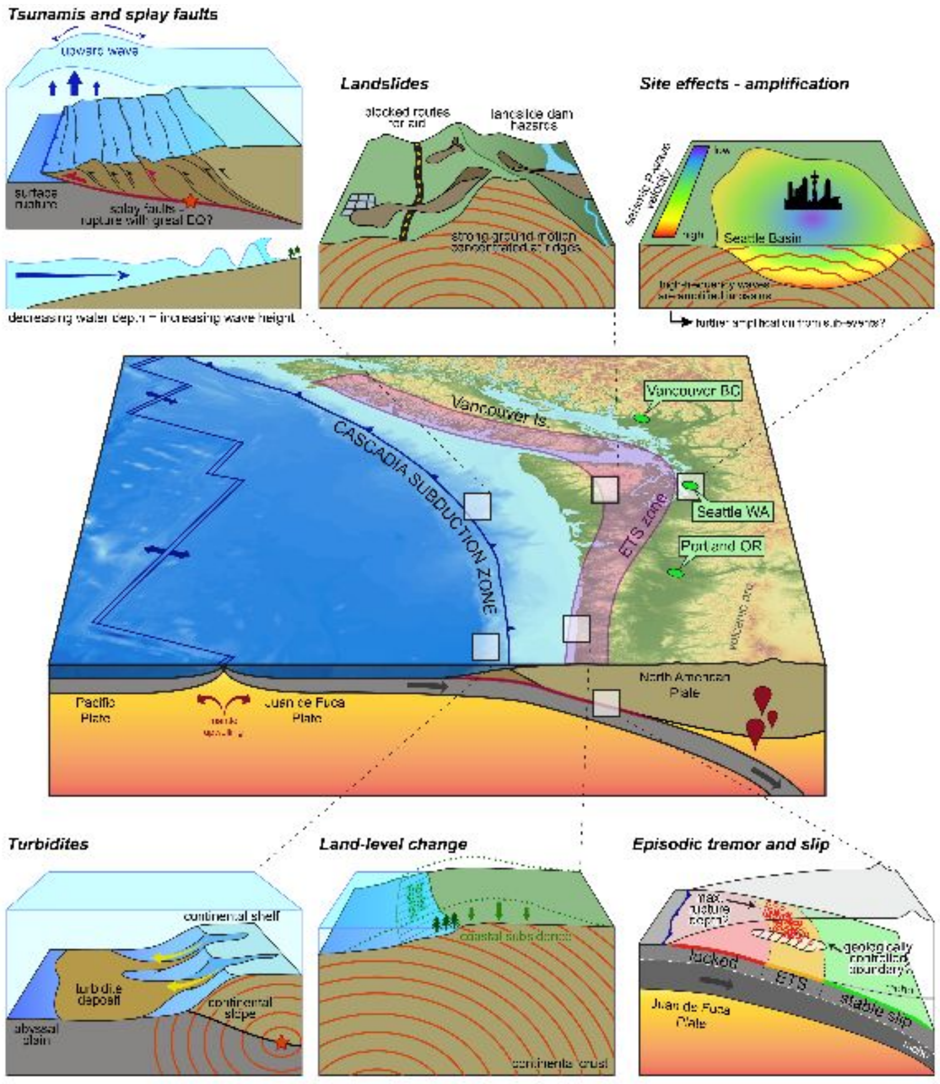
LOTS of Contextual Data Exist (just a few examples)

Cascadia subduction zone database

compilation of published datasets relevant to Cascadia subduction zone earthquake hazards and tectonics

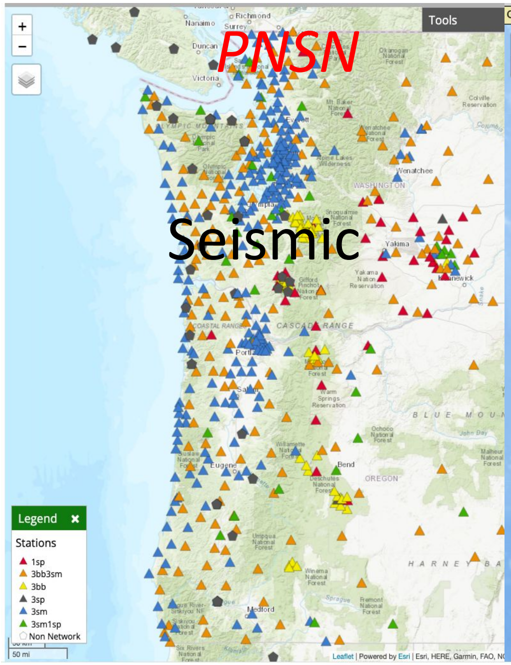
Lydia Staisch and Maureen Walton

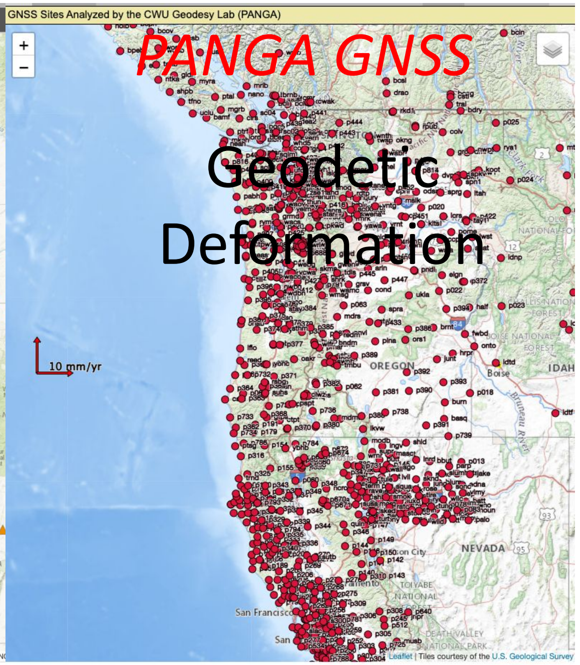


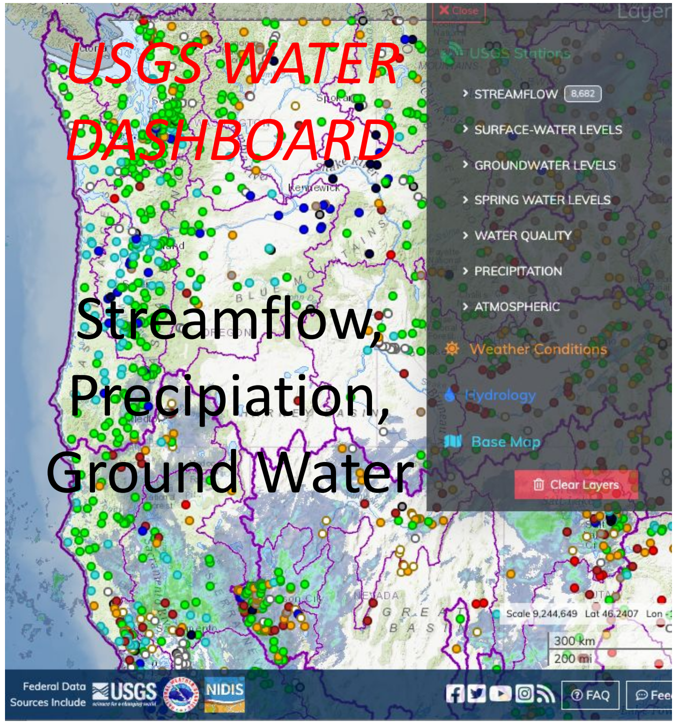


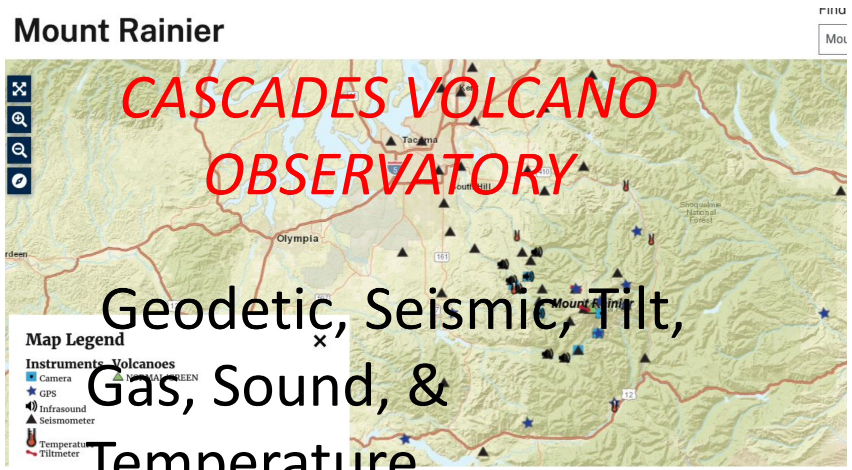
https://geonarrative.usgs.gov/cascadia_database_storymap/

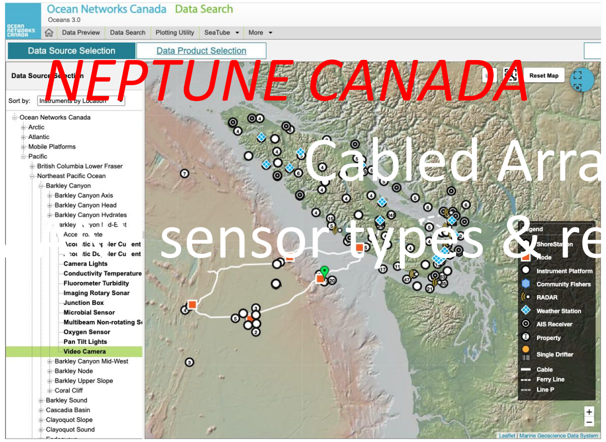
Continuous Monitoring of Many Processes

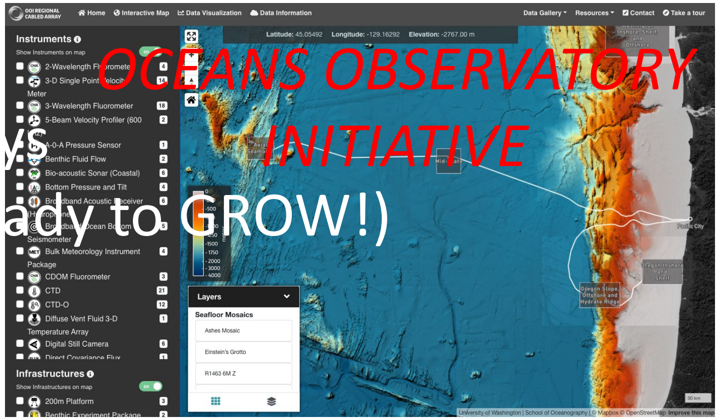












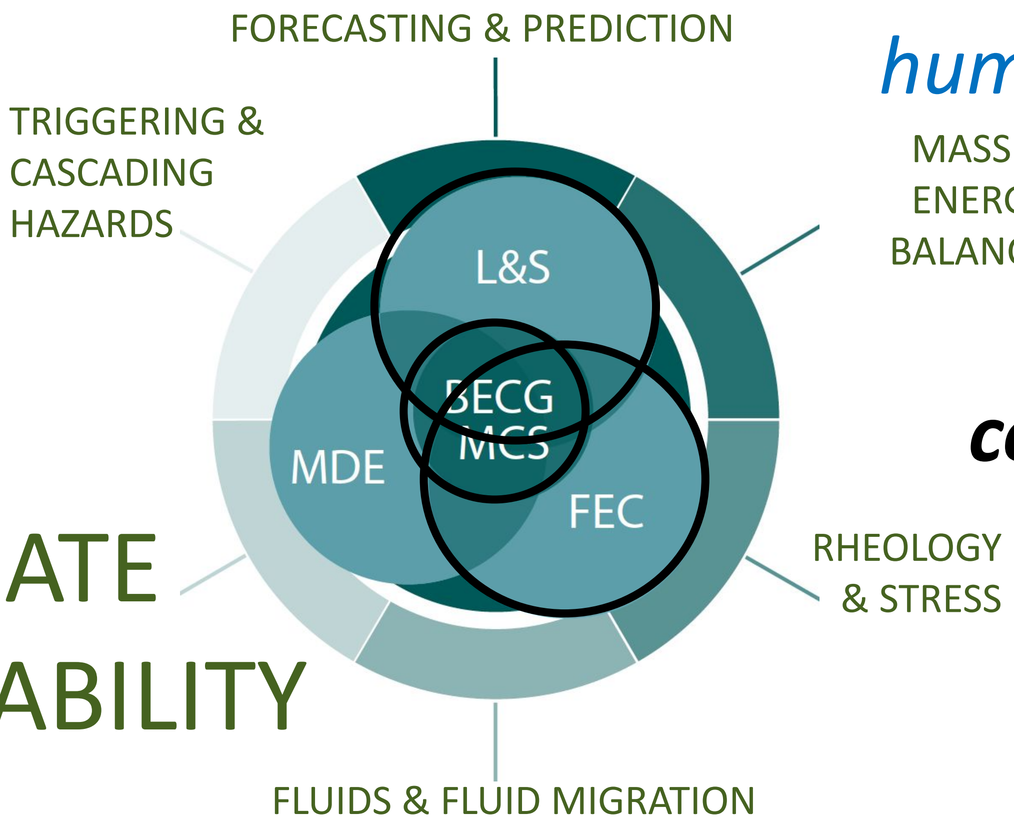
Integrated subduction zone science rules!

partnerships

human deployments

onshore arrays

collective impacts



CLIMATE VARIABILITY

modelling collaboratory

lab & sample consortia

MANY Complementary Projects Underway

COPE COASTLINES AND PEOPLE

Cascadia CoPes Hub

The Cascadia Coastlines and Peoples Hazards Research Hub

Home Research Engagement Resources People Calendar News Contact

Informing and enabling integrated hazard assessment, mitigation, and adaptation —including comprehensive planning, policy making, and engineering— through targeted scientific advances in collaboration with coastal communities

Team 1 - Geohazard Sources & Integrated Probabilistic Modeling

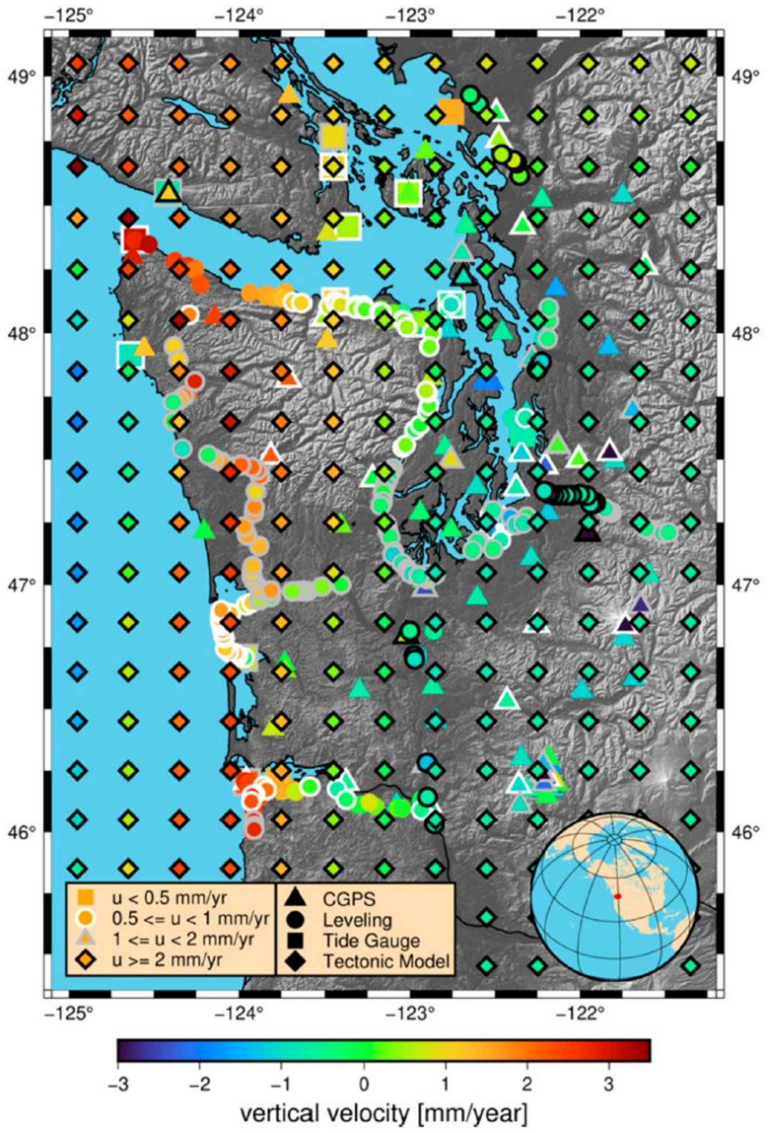
Team 2 - Inundation and Coastal Change Hazards

Team 3 - Community Adaptive Capacity

Team 4 - Broadened and Inclusive STEAM Education

Team 5 - Community Co-Production of Hazards Knowledge

Measured & Interseismic Coupling Model Vertical Velocities

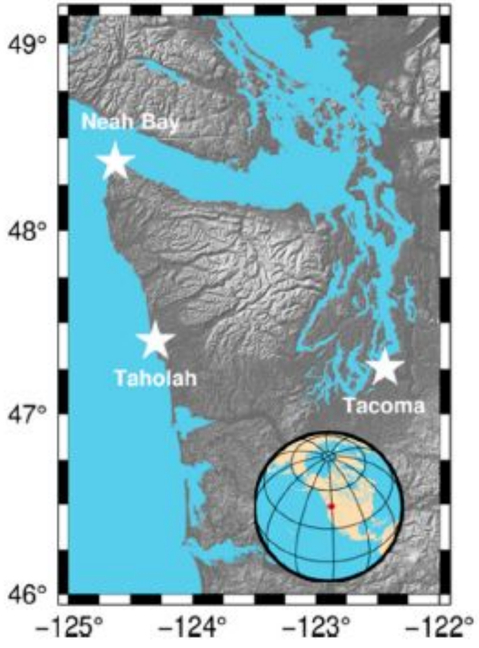


water

Article

An Assessment of Vertical Land Movement to Support Coastal Hazards Planning in Washington State

Tyler J. Newton [1,*], Ray Weldon [1], Ian M. Miller [2], David Schmidt [3], Guillaume Mauger [4], Harriet Morgan [4] and Eric Grossman [5]

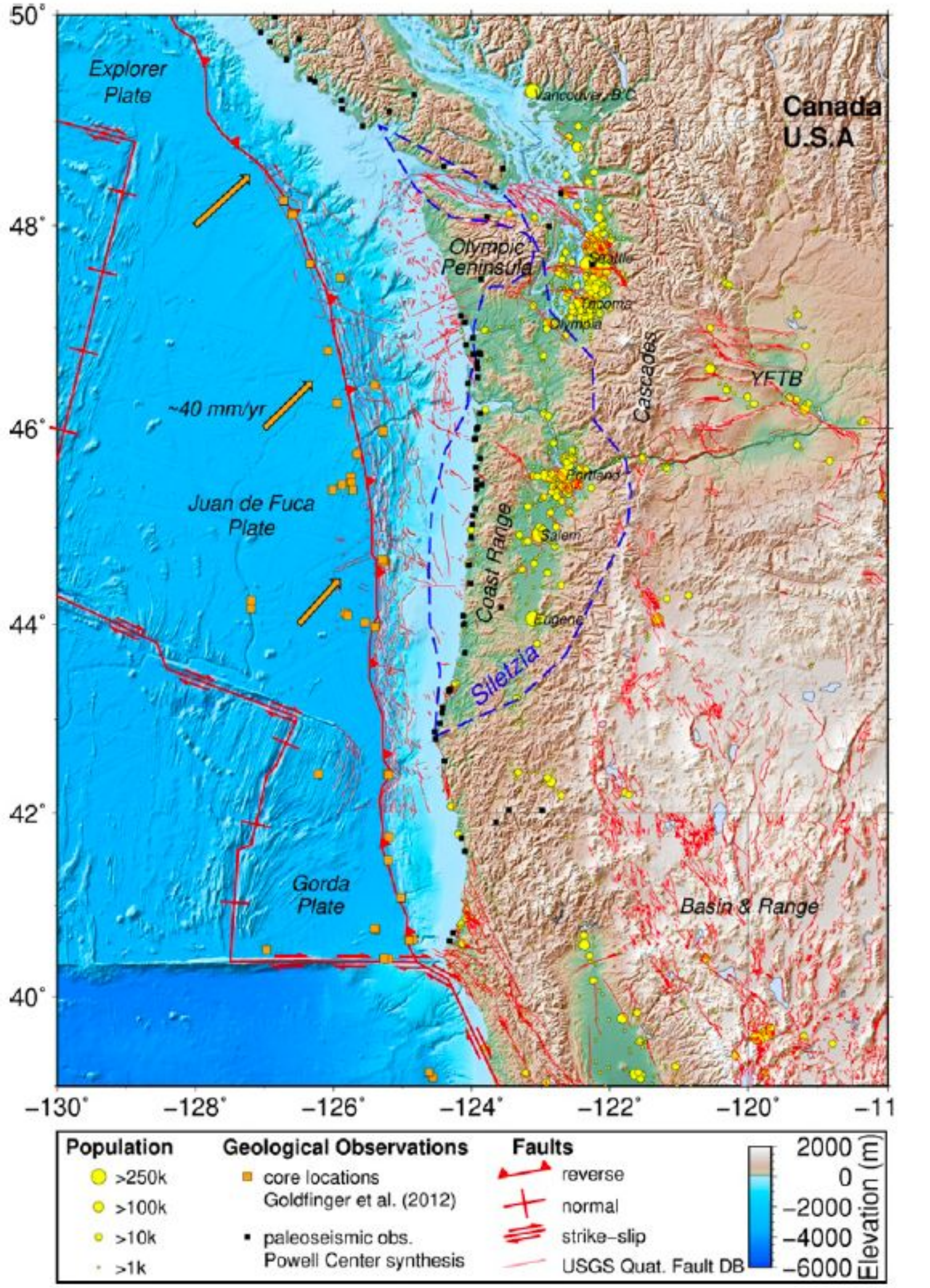


PROJECTED RELATIVE SEA LEVEL CHANGE FOR 2100
(cm, averaged over a 19-year time period)

Location	Vertical Land Movement Estimate	Greenhouse Gas Scenario	Central Estimate (50%)	Likely Range (83-17%)	Higher magnitude, but lower likelihood possibilities: 10% probability of exceedance	1% probability of exceedance	0.1% probability of exceedance
Tacoma (47.3N, 122.4W)	-15.24±6.1	Low	64.0	45.7-82.3	91.4	140.2	240.8
		High	76.2	57.9-100.6	109.7	161.5	268.2
Neah Bay (48.4N, 124.6W)	27.5±9.1	Low	15.2	-3.0-36.6	45.7	94.5	192.0
		High	30.5	9.1-51.8	60.9	115.8	225.6
Taholah (47.4N, 124.3W)	9.1±15.24	Low	39.6	18.3-64.0	73.2	118.9	216.4
		High	51.8	30.5-79.2	88.4	140.2	246.9

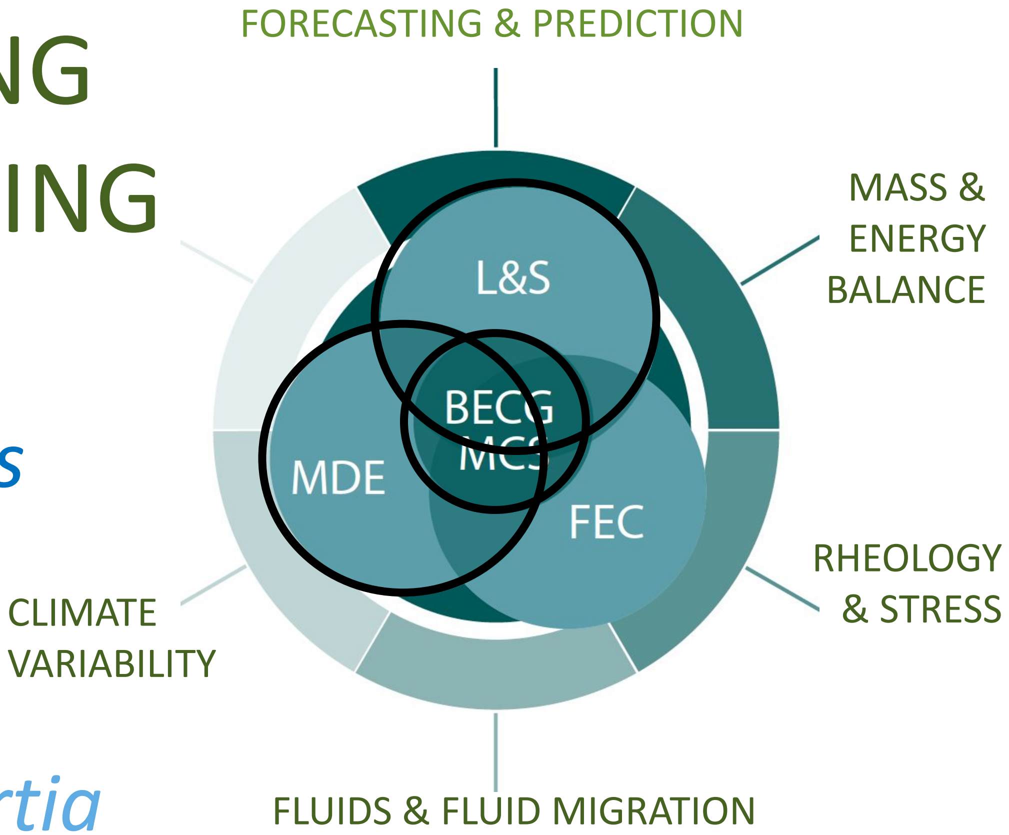
Another Potential Complementary Project

(no data collection!)



TRIGGERING & CASCADING HAZARDS

human deployments



collective impacts

partnerships

lab & sample consortia

modelling collaboratory

onshore arrays

Mount Rainier Lahar Hazards

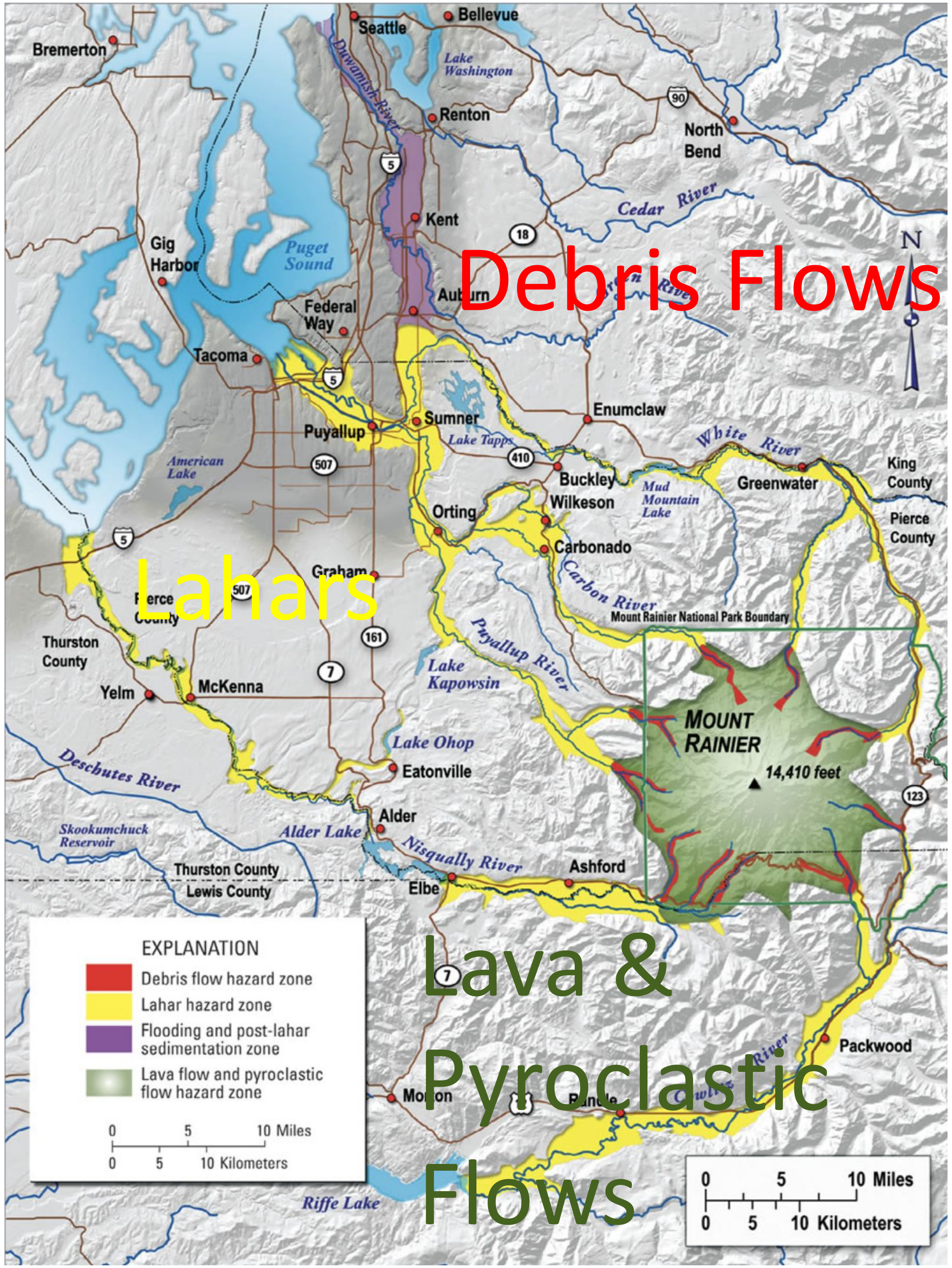
- ~40 eruptions in last 10,000 years
- 8 lahars associated with eruptions, most recent one was not (landslide)
- 9 large lahars in last 5,600 years have reached now-densely populated areas (most recent ~1500 AD)
- >90,000 people live in Rainier lahar hazard zones

A collective response by Pierce County, Affiliated Tribes, Federal Agencies (USGS, NPS, NOAA, USFWS), WA State: DNR, EMD, Historic Preservation Office, Univ. of WA

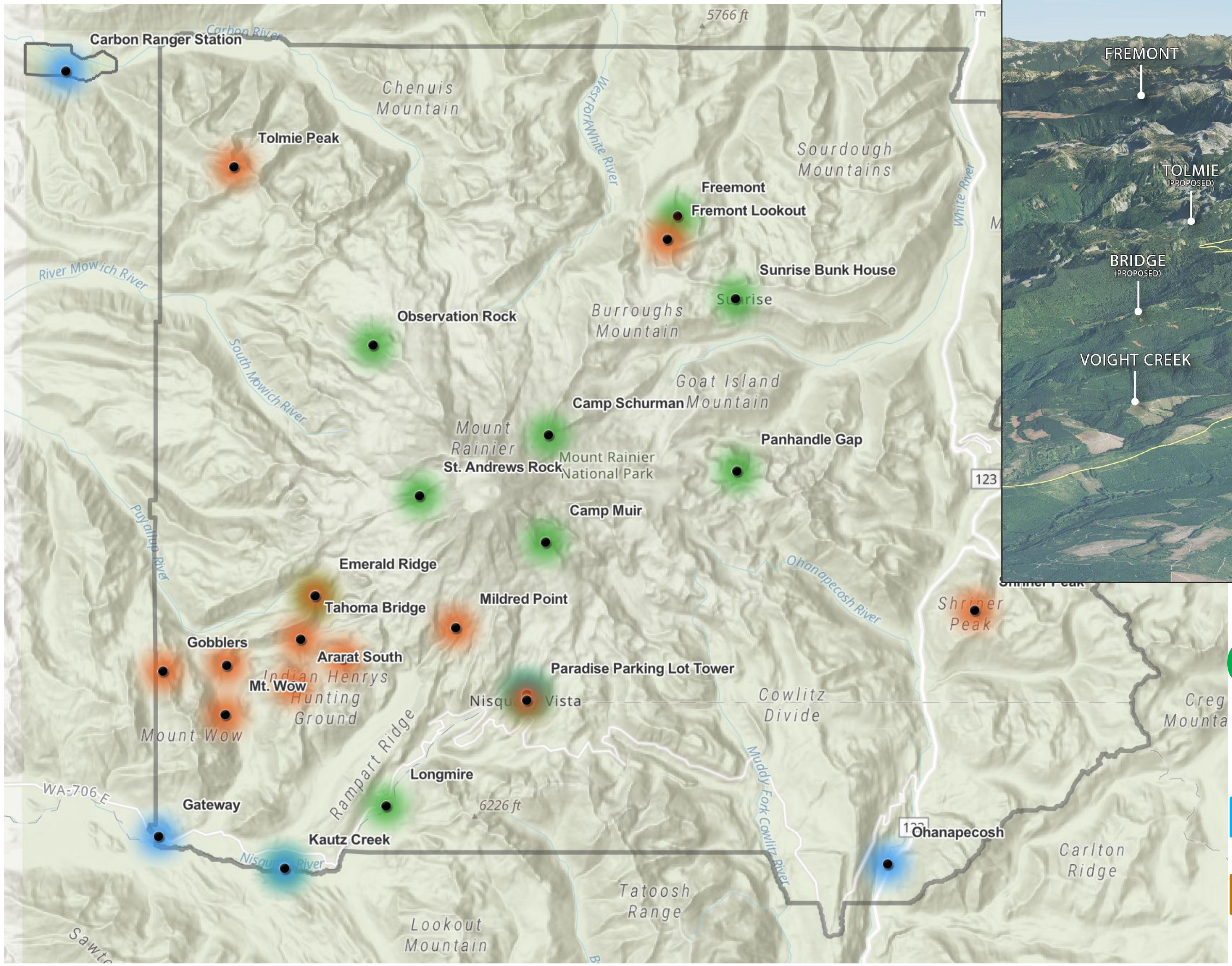
Photo by Seth Moran, USGS

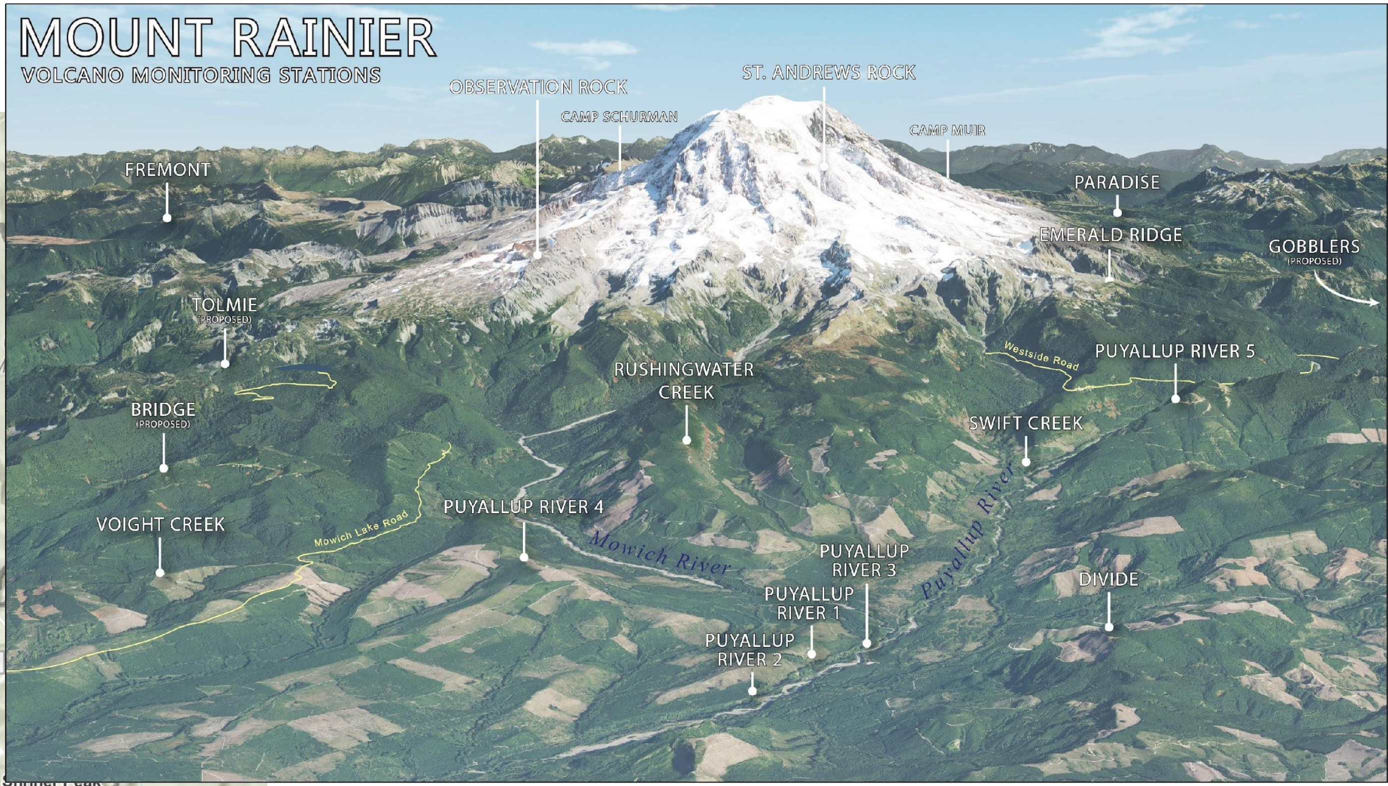
Modeling the Dynamics of Lahars that Originate as Landslides on the West Side of Mount Rainier, Washington

Open-File Report 2021–1118



Mount Rainier – Lahar Detection System



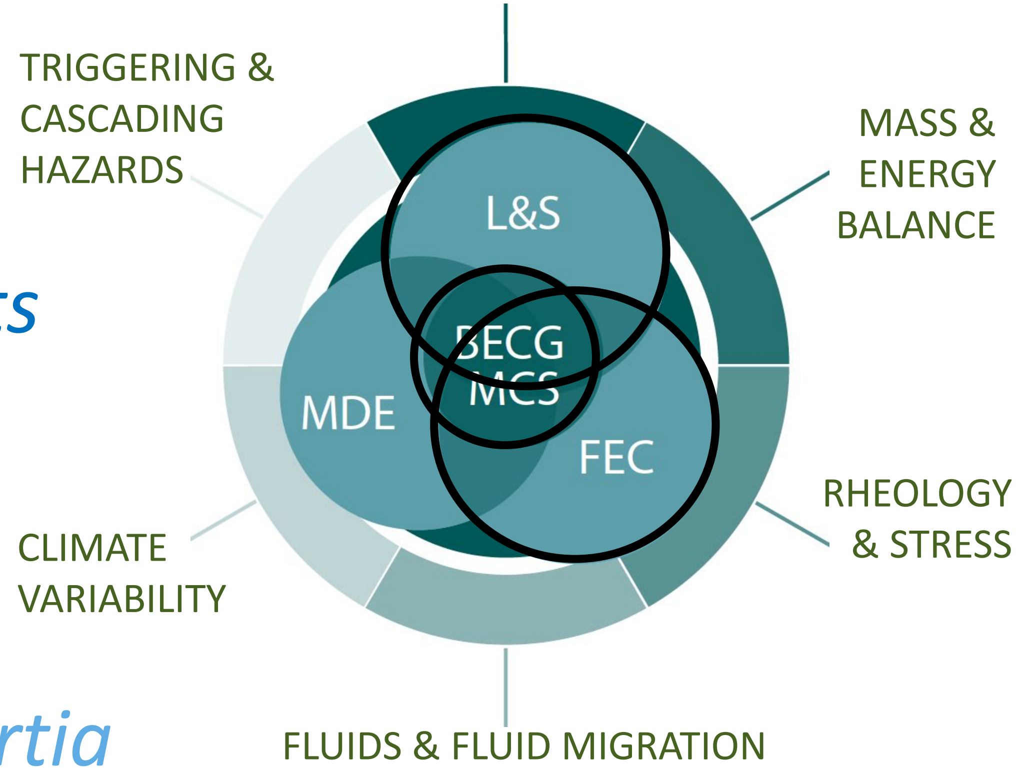


Current: 23 seismometers, 7 GPS, 1 tilt, 14 infrasound, 2 webcams

Planned

Proposed

FORECASTING & PREDICTION



human deployments

collective impacts

partnerships

lab & sample consortia

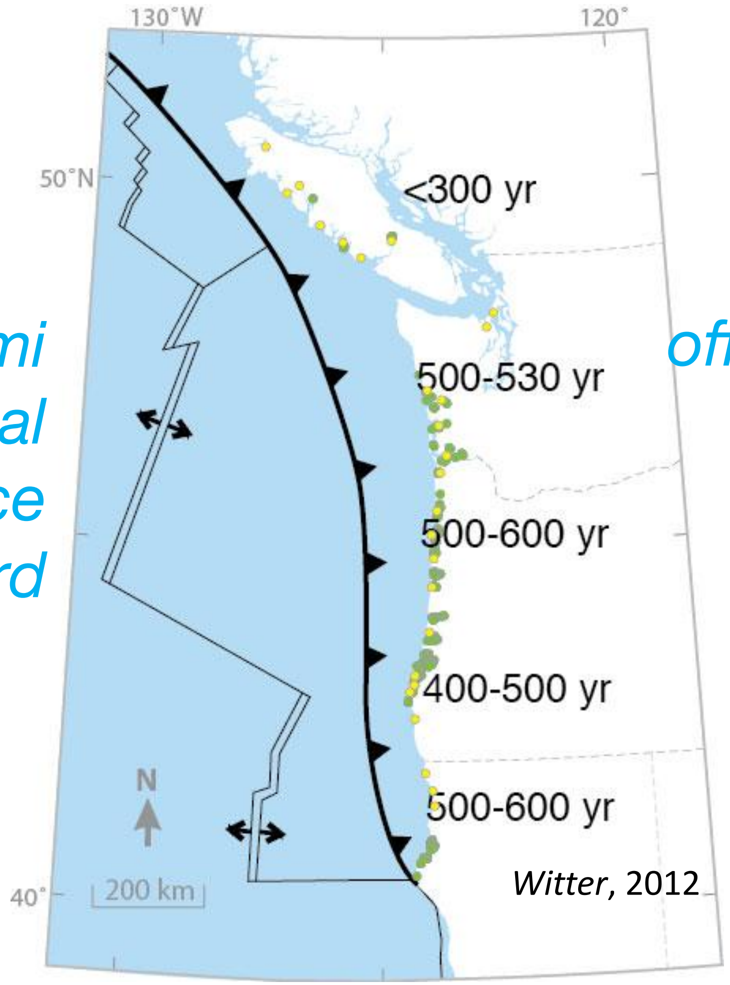
modelling collaboratory

onshore arrays

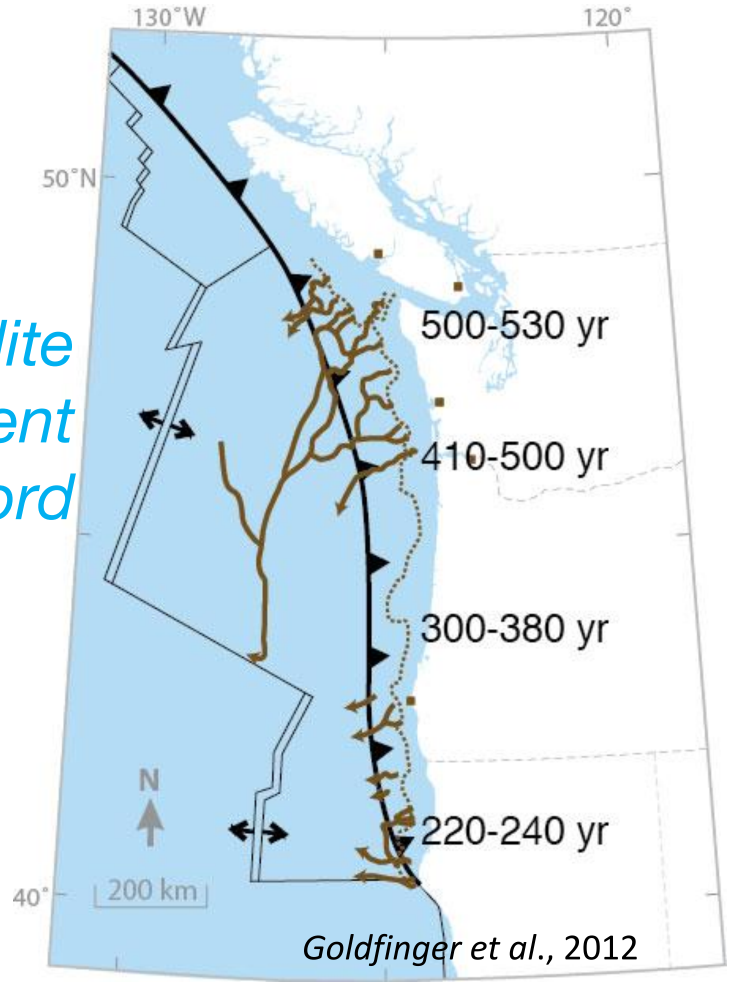
Earthquake Forecasts Rely on Recurrence Estimates

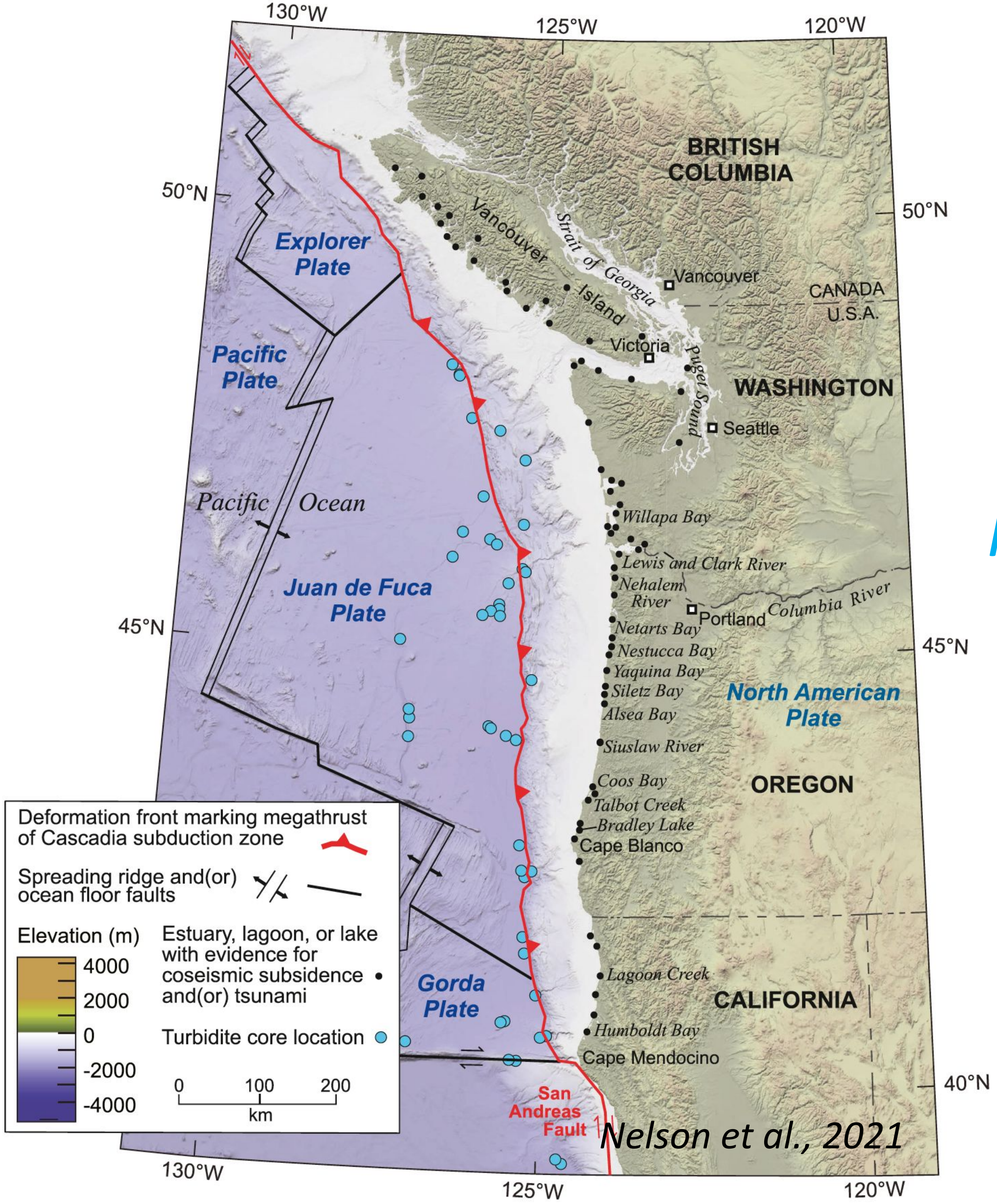
Paleoseismic onshore and offshore records differ significantly (i.e., more frequent earthquakes in the south increases hazard there by ~40%)!

onshore tsunami & coastal uplift/subsidence record



offshore turbidite & sediment record

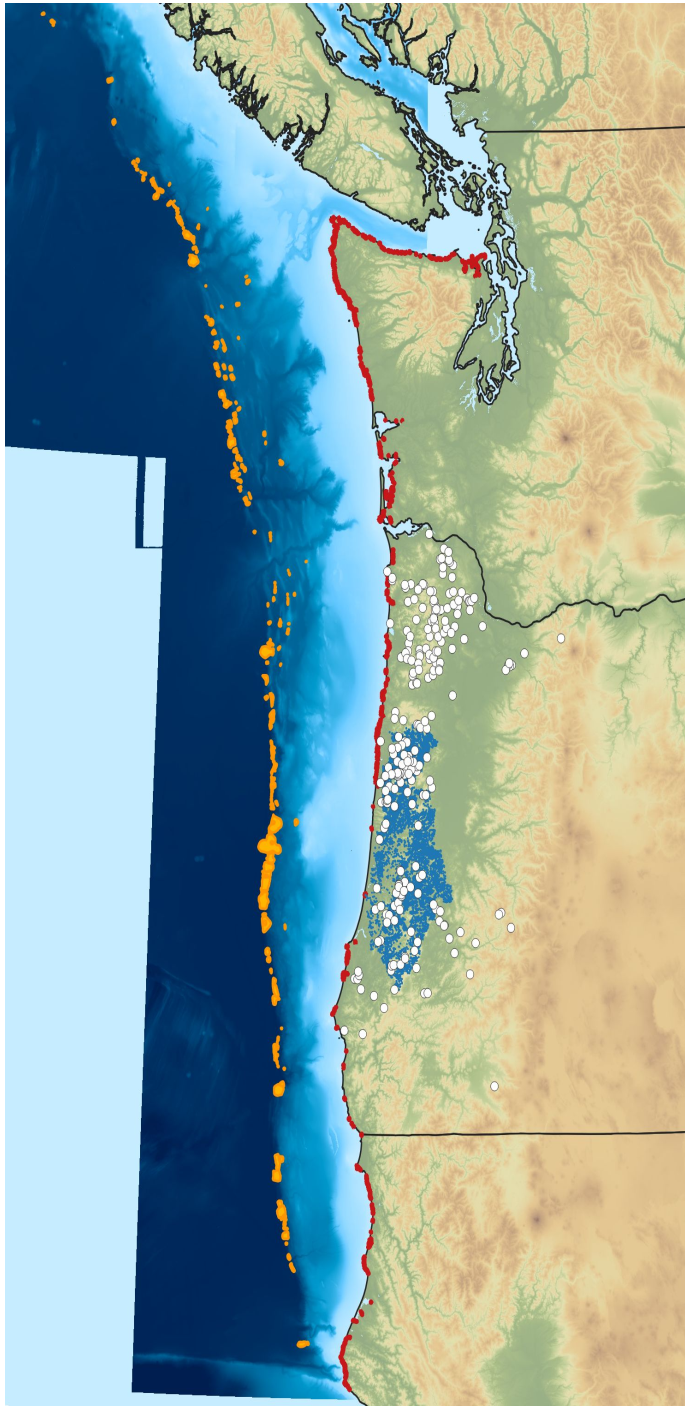




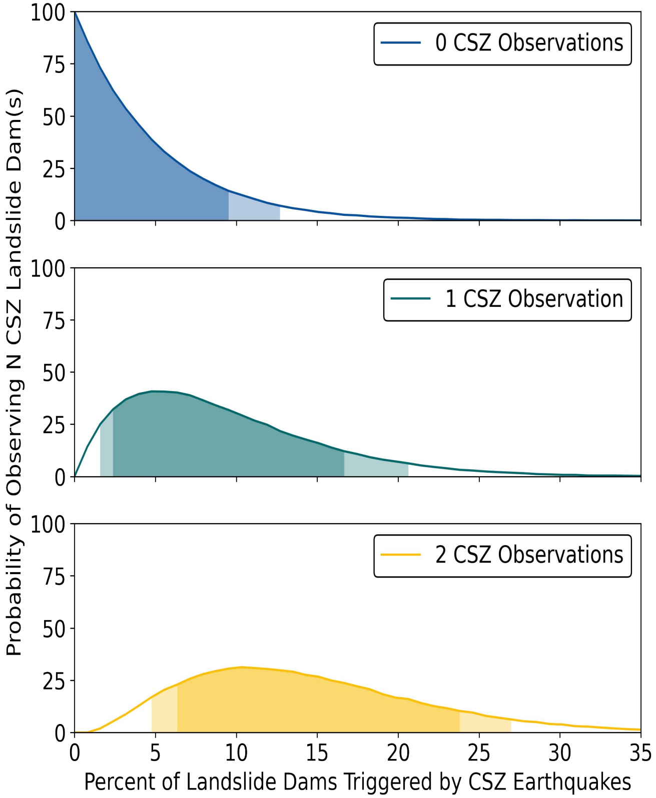
Nelson et al., 2021

‘State-of-the-art’ paleoseismic observations have uncertainties that cannot distinguish single full- to multiple partial-margin ruptures.

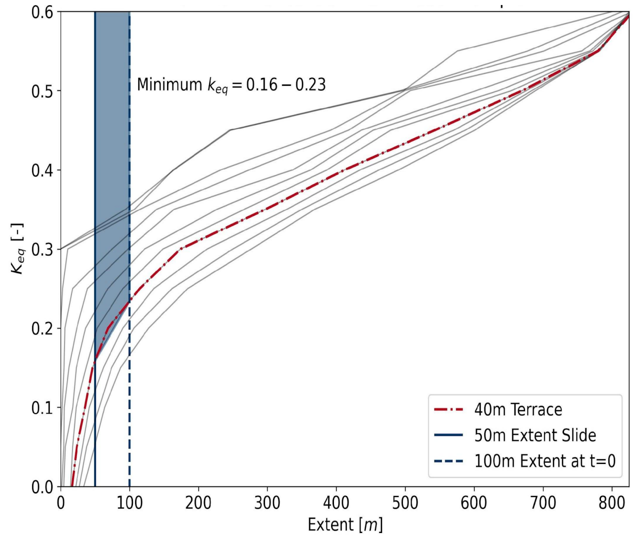
Microfossil derived land-level change, tsunami inundation, and turbidite evidence suggest ~17 M>8 earthquakes in the last 6700 yrs, at highly variable intervals – but LARGE uncertainties remain!



New lidar-derived landslide inventories, failure modeling, high-res age dating (dendrochronology) address balance of climatic & tectonic drivers.



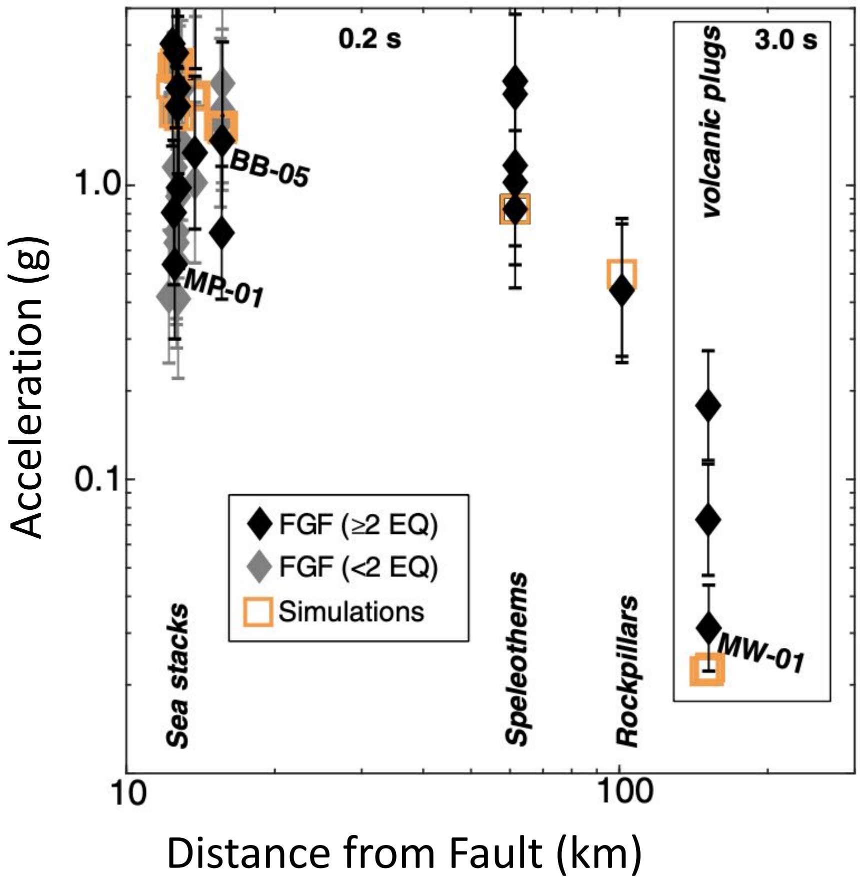
Failure modeling of 'strong' coastal marine terrace landslides constrain ***minimum*** *shaking intensities*

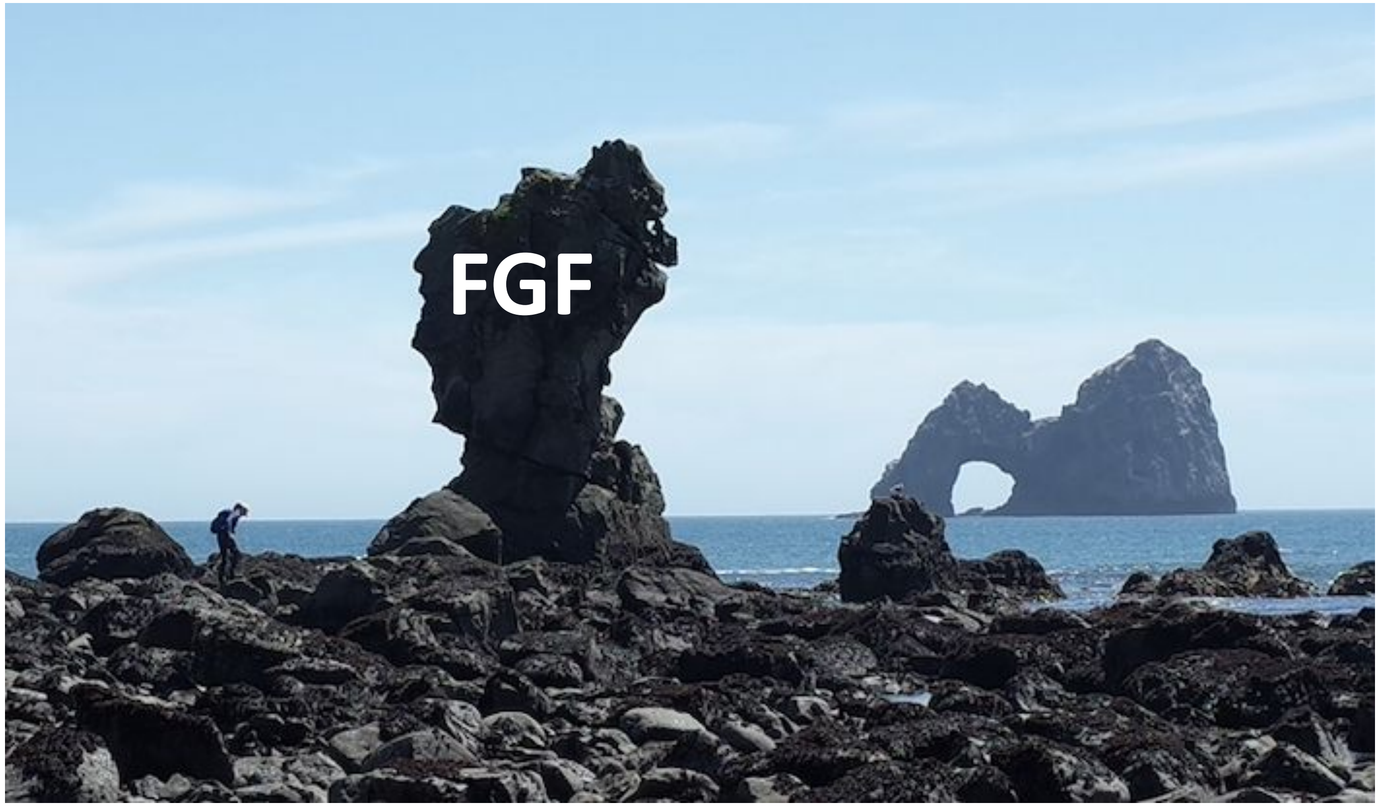


Dendrochronology ages of 10s of landslide-dammed lakes; <u>none are 1700</u>, most during extraordinarily wet period in late

Grant, Lahusen, 2022

Fragile geologic features (FGF) provide new constraints on maximum shaking, on 1-10,000 yr timescales.

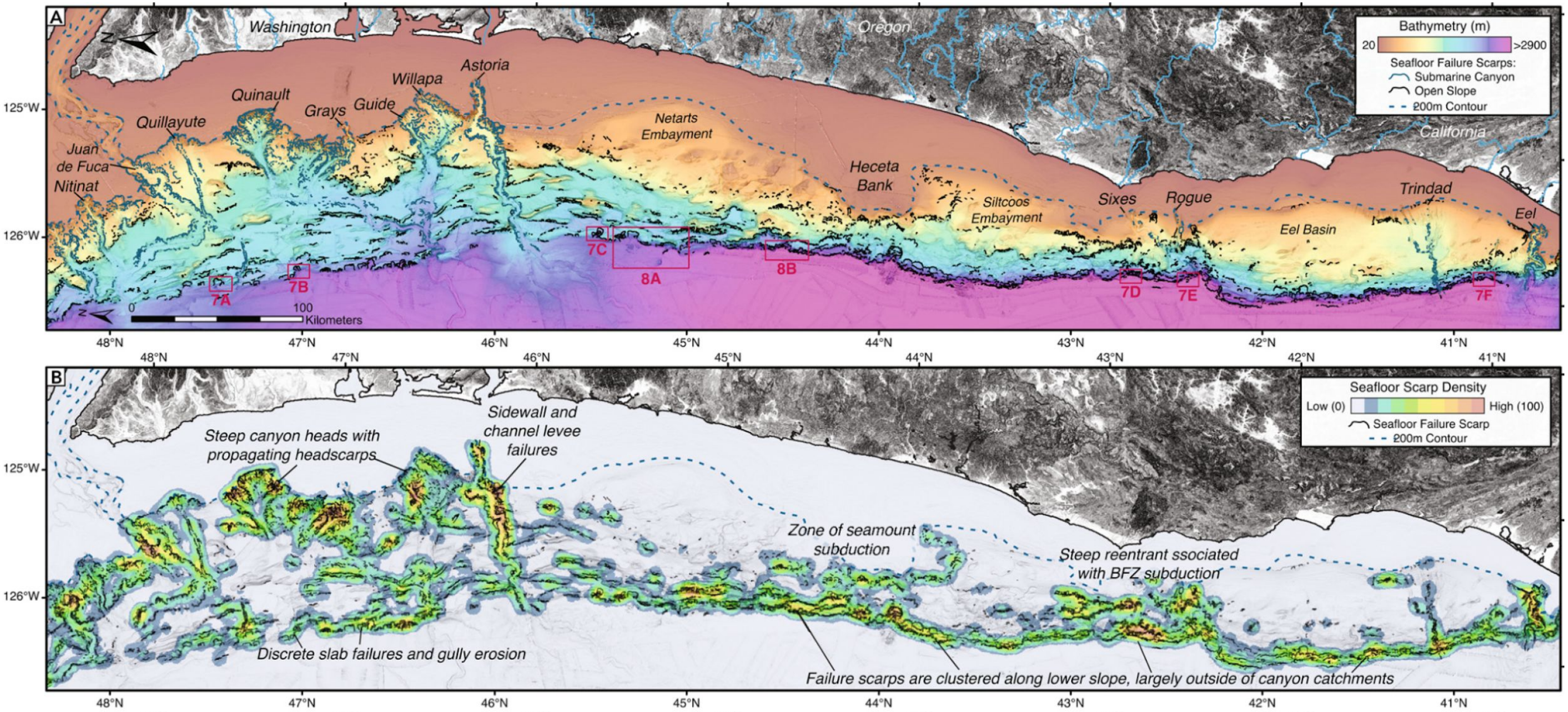




Observed and modeled FGF breaking motions at shaking periods of 0.2 and 3.0 s.

McPhillips and Scharer (2021) & Frankel et al. (2018)

New bathymetric-derived landslide inventories & ground motion modeling address sediment transport initiation and flow paths.

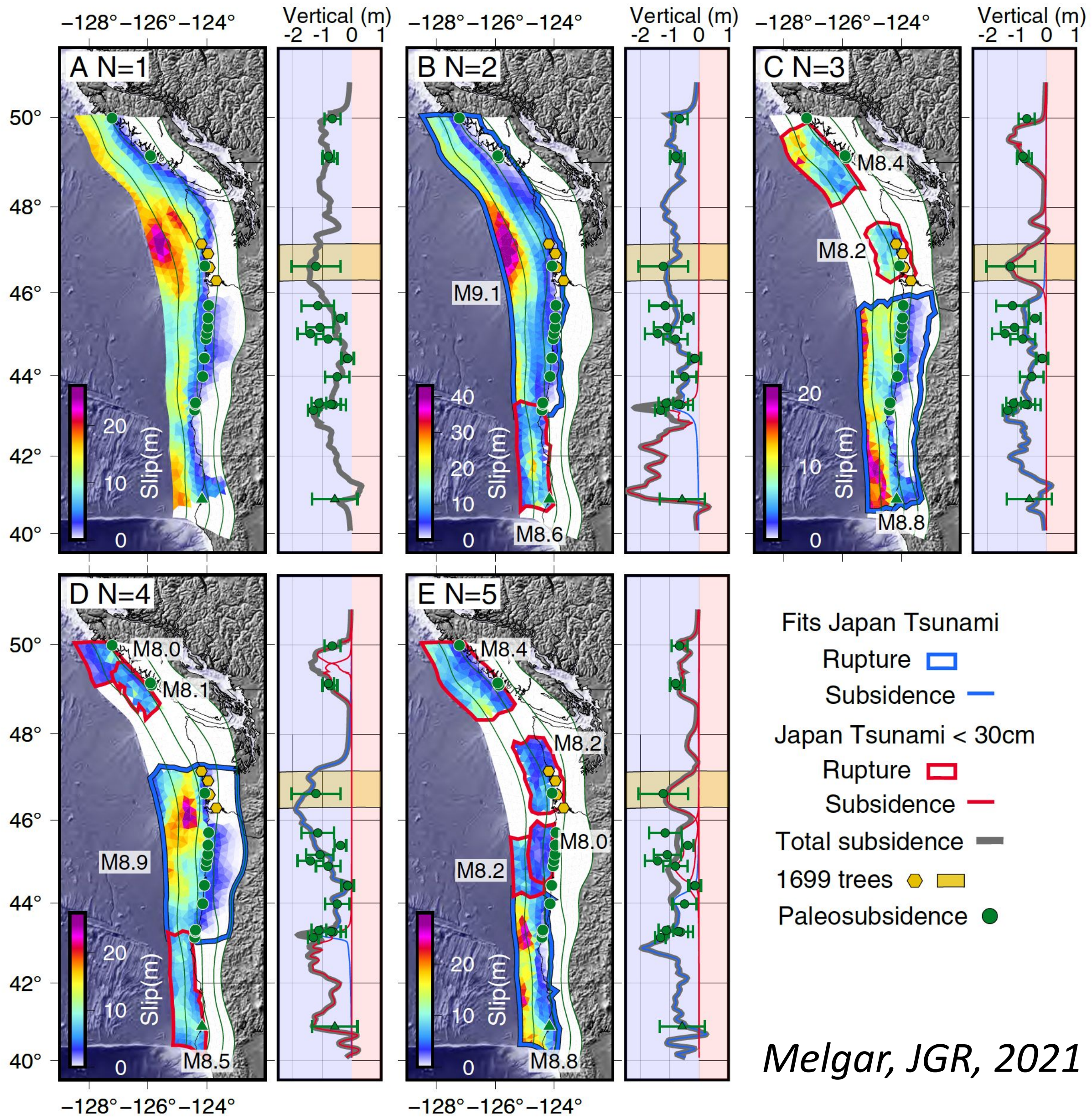


Hill et al., 2022

Extensive mass wasting occurs along steep lower slopes, over 800 km, and likely source of abyssal plain turbidites, suggesting rethinking of the role of channel sediment transport & earthquake recurrence models.

Observation-informed models constrain forecasted rupture scenarios.

Wir



Melgar, JGR, 2021

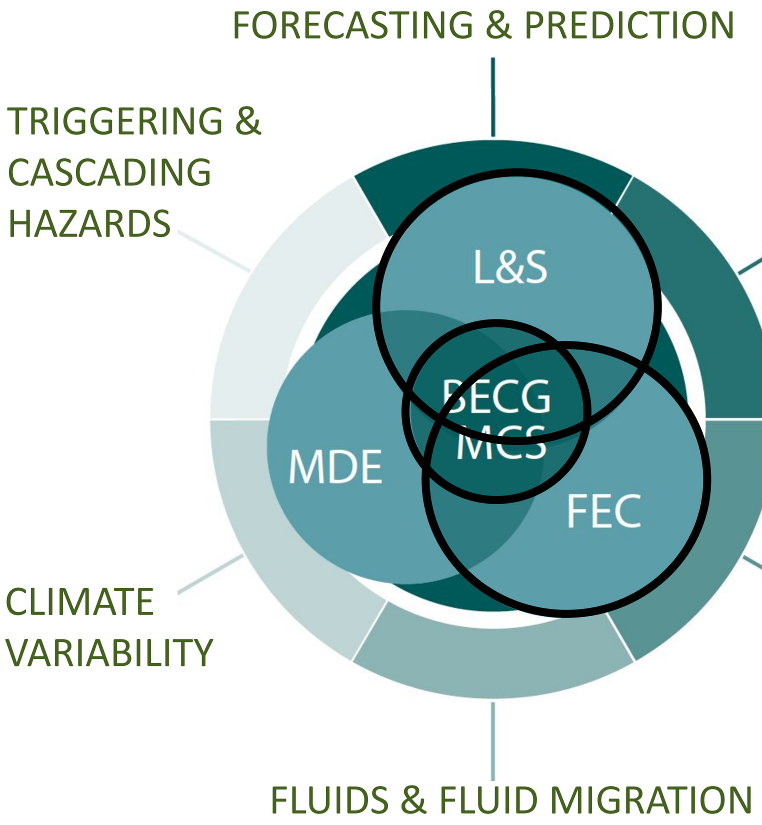
1700 earthquake Japanese tsunami inundation,

Cascadia paleoseismic subsidence estimates,

and geodetically constrained locking models

limit consistent modeled rupture scenarios, but sequences remain plausible.

partnerships



MASS & ENERGY BALANCE

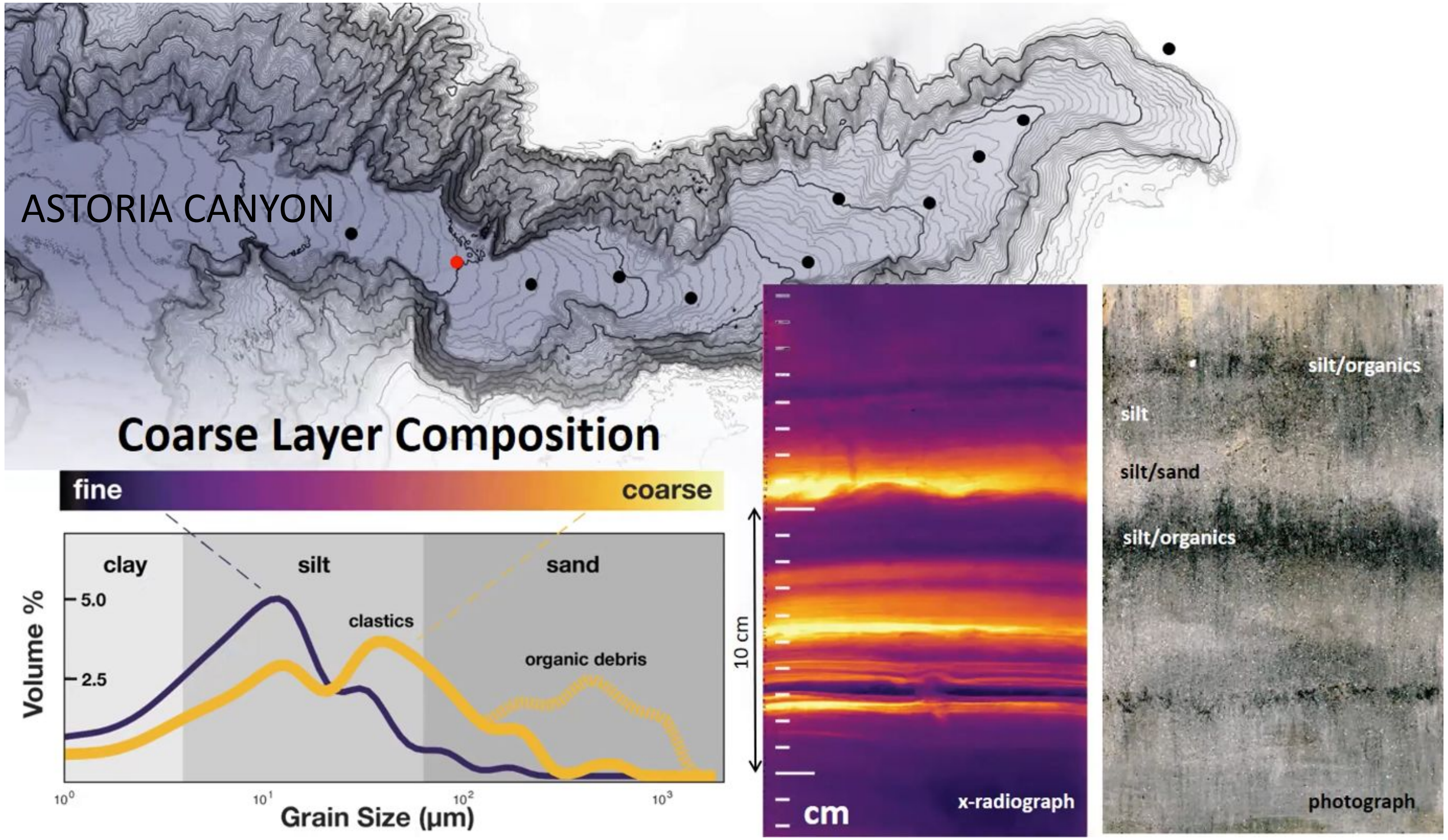
human deployments

modelling collaboratory

offshore instrumentation (new)

lab & sample consortia

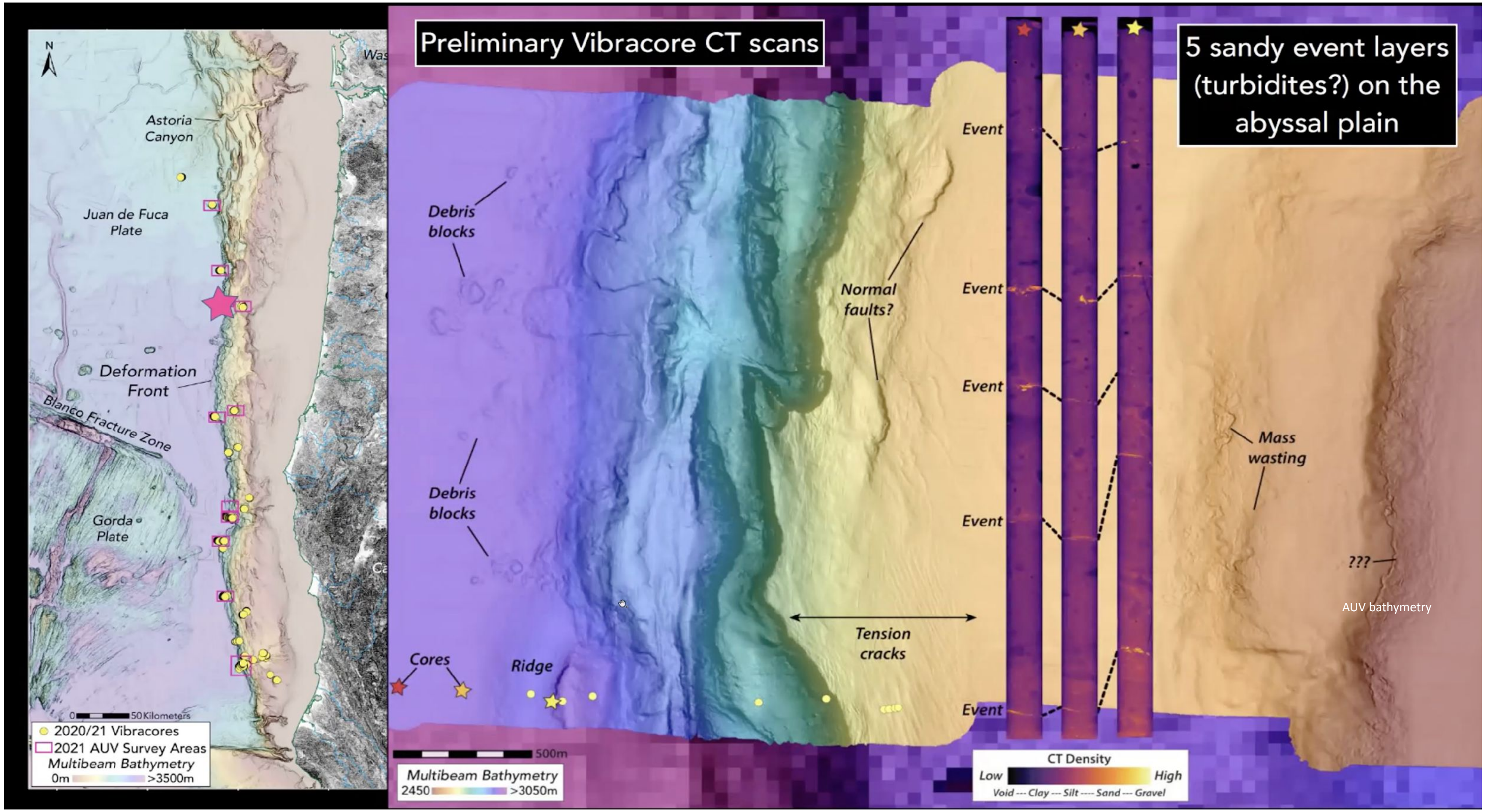
Sediment transport monitoring from the coast to deep sea measures fluxes to constrain storm and seismic drivers.



Ogston et al., 2019, 2022

Storms cause small sediment flows (NOT earthquakes), even in mild spring/summer times. New expanded deployments are underway, with coring.

Offshore resolution approaches that onshore, pinpointing potentially tsunami-generating faults, submarine landslides, and testing source inferences based of turbidite correlations.

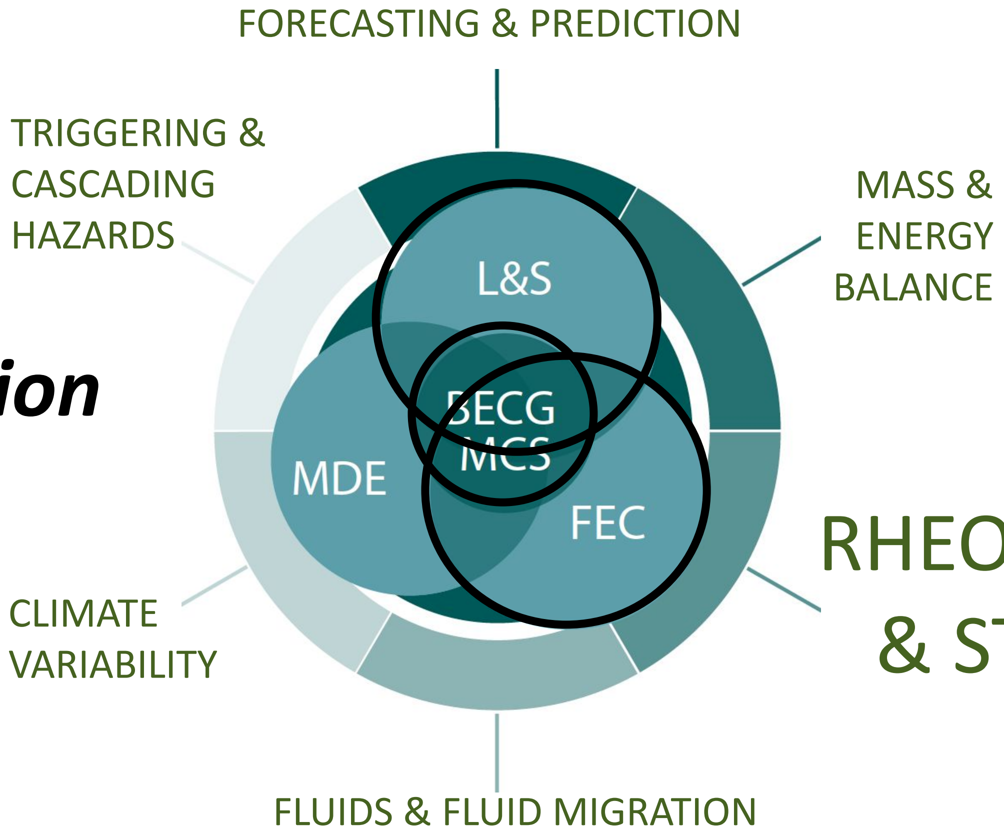


Offshore high-res bathymetry, subsurface CHIRP imagery, and ROV-coring

Hill et al., 2021, 2022

on-land arrays

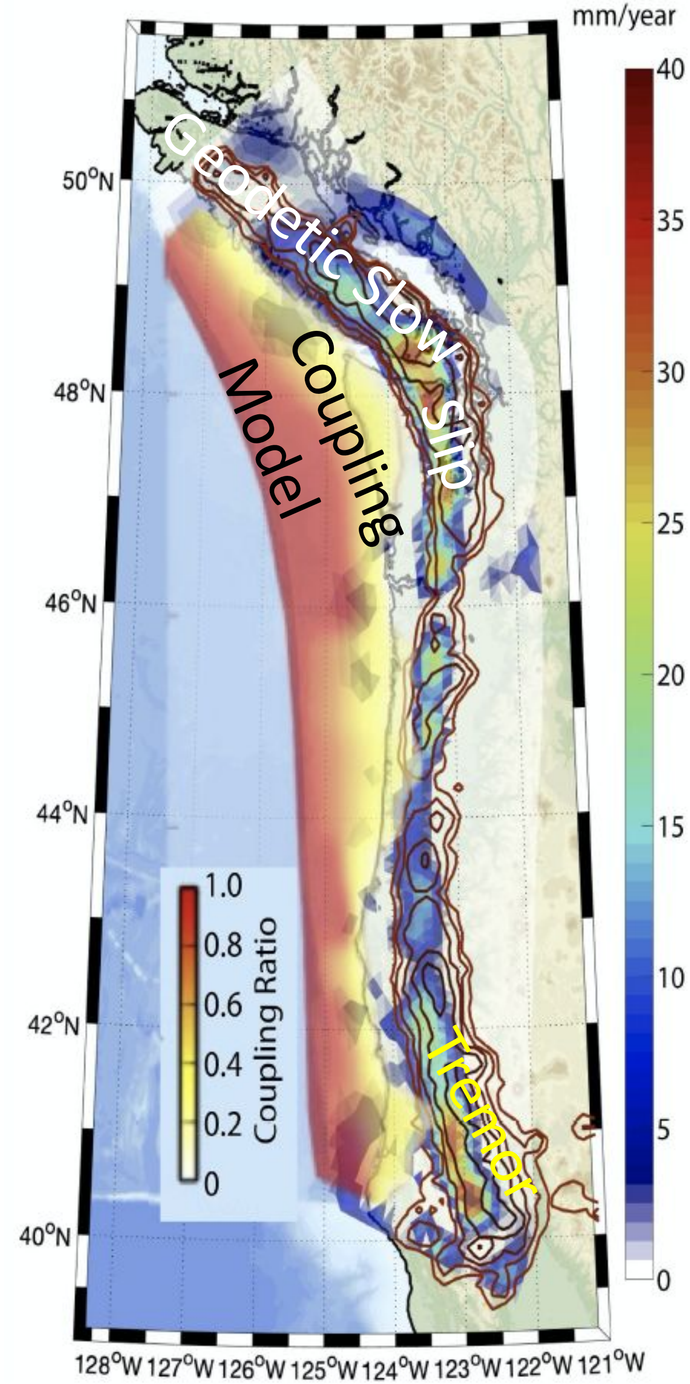
offshore instrumentation

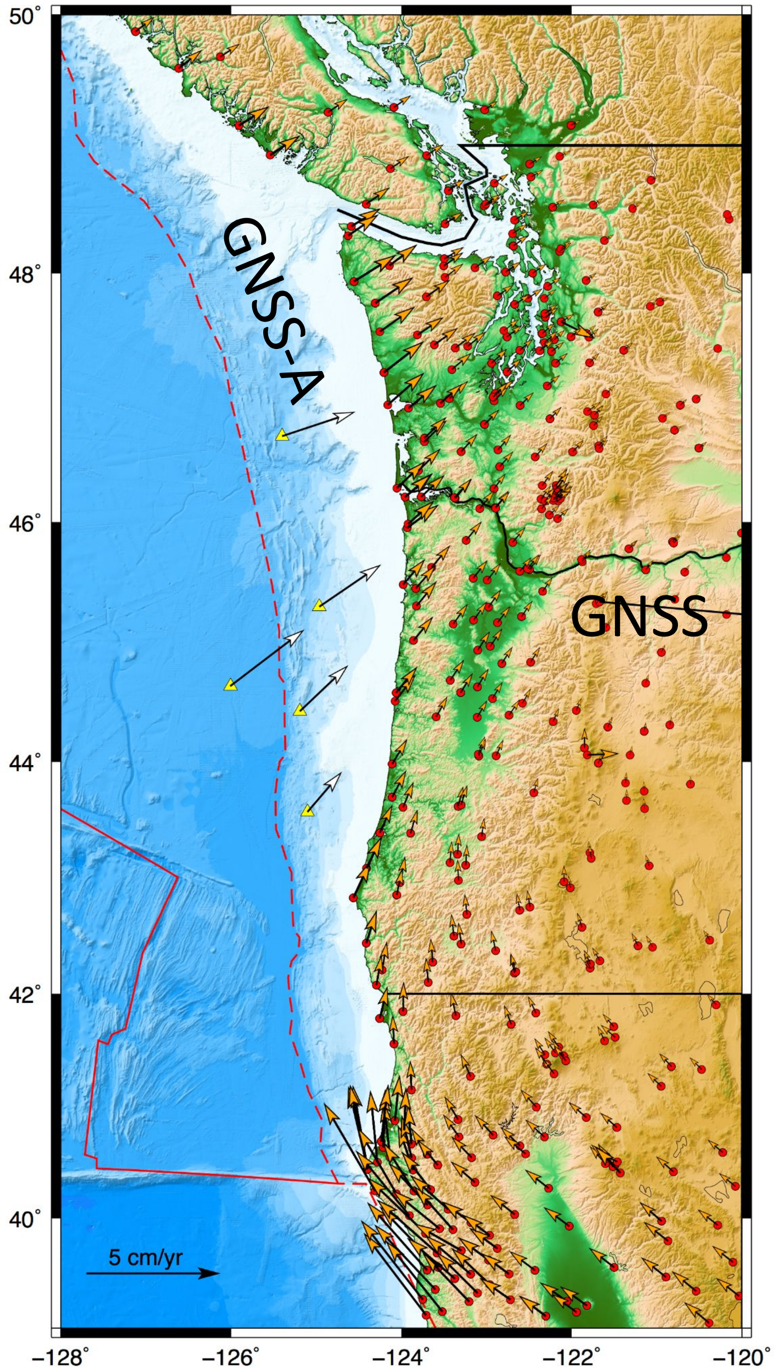


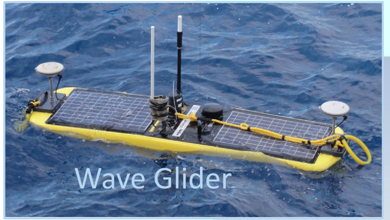
RHEOLOGY & STRESS

modelling collaboratory

partnerships








Future Directions for Seafloor Geodesy

Home | Community Experiment | Meetings | Instrument Pool | Communicate

Near-Trench Community Geodetic Experiment

A five year NSF-funded project that will establish open and accessible seafloor deformation data offshore Alaska and Cascadia, in regions responsible for some of the largest earthquakes and tsunamis ever recorded.

New software, data, and training will prepare next-generation Earth scientists!

Click here for project updates

Alaska

Six new sites are planned here near the rupture area of the 1946 'tsunami earthquake', the southern extent of the 1964 Magnitude 9.2 Good Friday earthquake (2nd largest ever recorded), and complimenting existing sites in between.

Installation is planned for summer 2023.

Cascadia

Six new sites are planned along the rupture area of the 1700 (expected magnitude about 9) earthquakes responsible for large tsunami waves as far away as Japan. These sites represent a range of expected coupling behaviors using on-land data, and compliment existing and planned US and Canadian sites.

Installation of new sites started in 2022 as a part of commissioning of the SGIP, and will continue through 2023.

Software Development

Project oversees the development of open-source code for the processing of GNSS-Acoustic data for seafloor horizontal positioning.

- Software is a redevelopment of existing FORTRAN codes and shell scripts developed by C. David Chadwell for processing data including measurements made with Wave Gliders.
- Existing code, which includes proprietary routines, is developed and maintained by J. DeSanto, whom should be contacted for availability, and requirements.
- First public release of the new open-source code via GitHub is planned for 2024.
- Following initial release, community training courses are planned.

Short-Courses

- Two short-courses for "Data Processing" are planned that will utilize the newly developed software for working with available community data. Courses will prioritize graduate students and postdocs.
- Two short-courses are planned for "Future PIs" that will develop understanding of opportunities and limitations of current tools, ship-time requests, network design, and cooperation with local and international partners.

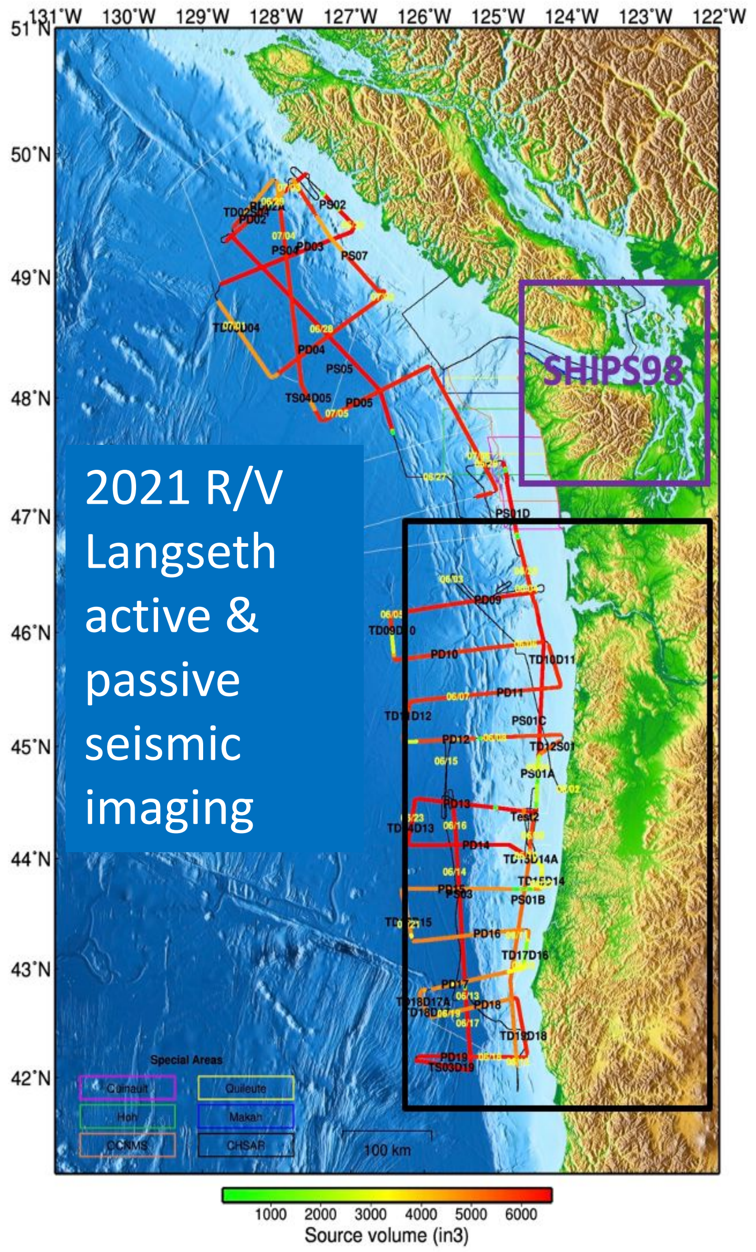
Apply-to-Sail

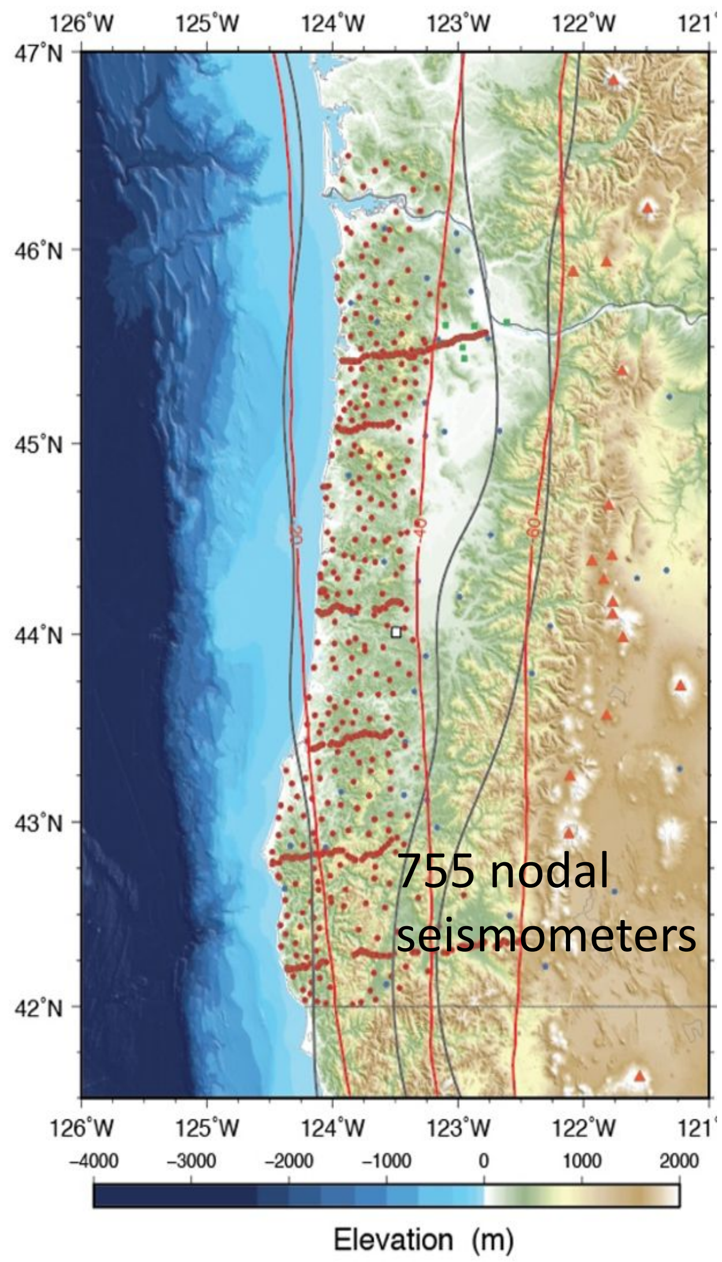
Seagoing opportunities are planned for students, post-docs, and early-career scientists along each of the deployment, recovery and any repair legs where instruments are going to the seafloor. Announcements will appear shortly after determination of follow-year ship schedules.

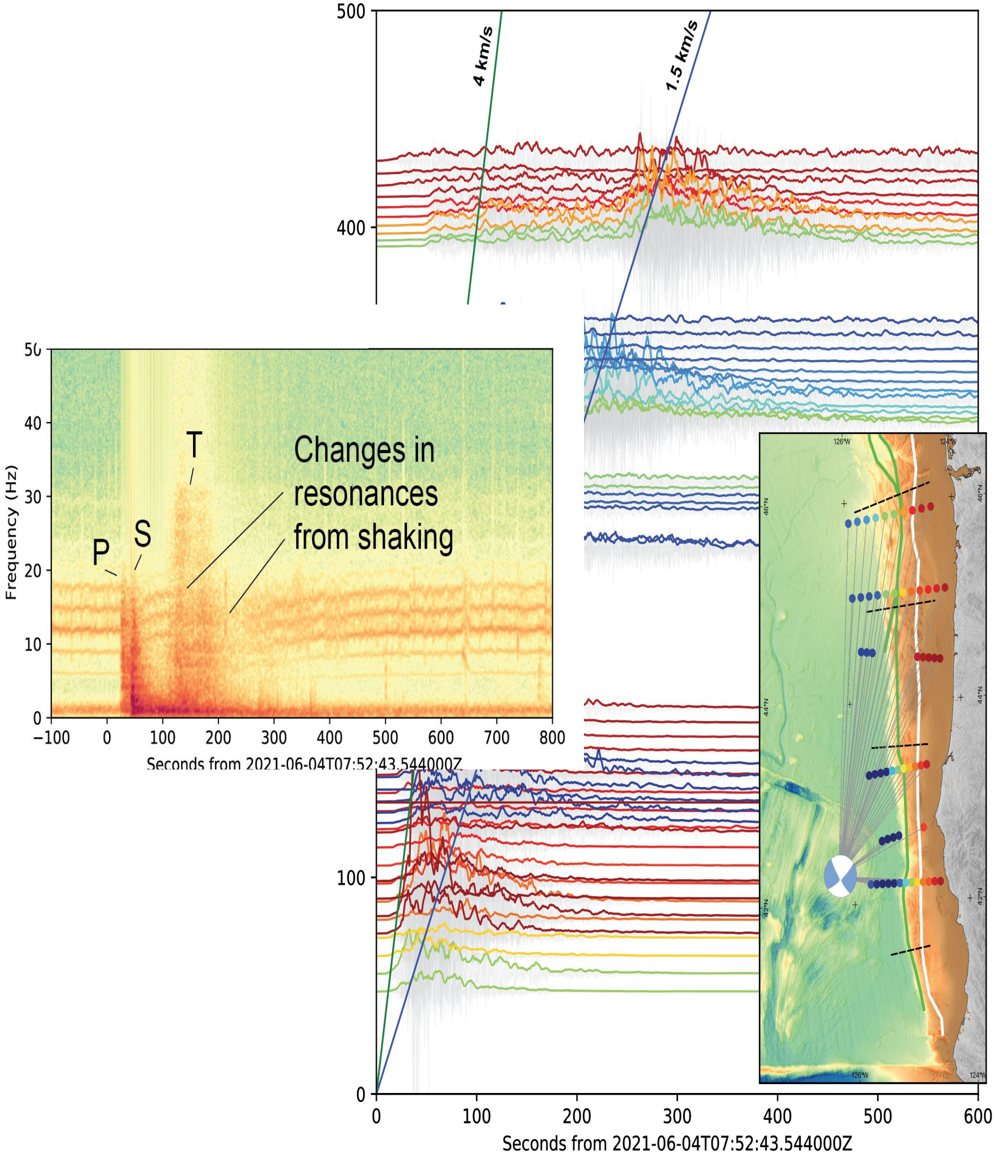
Community Archive

All community experiment data will be openly available and following FAIR standards through the GAGE facility currently operated by UNAVCO.

Schmalzle, 2014; Bartlow, 2020;Wech, 2021; DeSanto, 2022

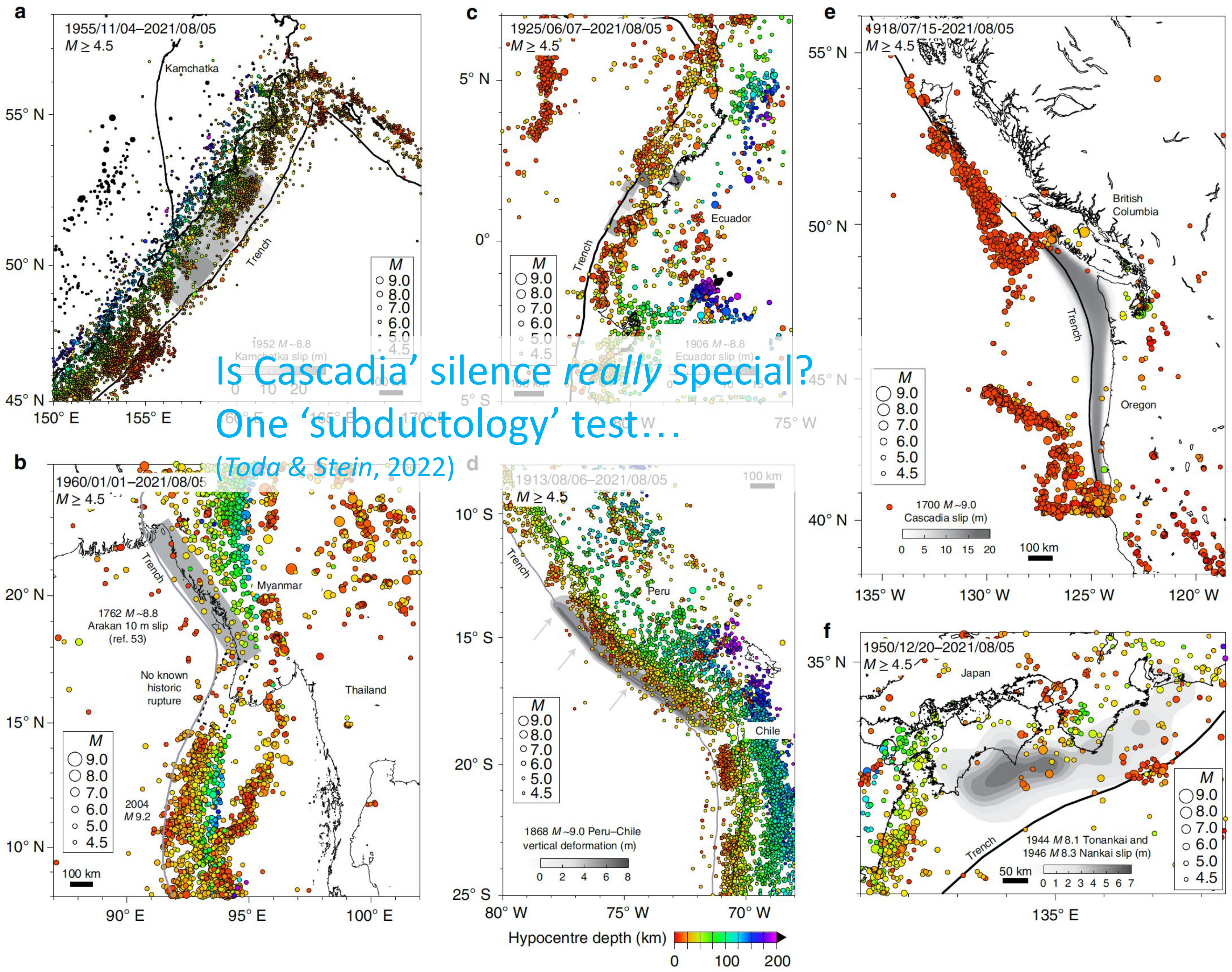

2021 R/V Langseth active & passive seismic imaging
SHIPS98
Special Areas
Quileute
Hoh
Makah
CCNMS
CHSAR
100 km
Source volume (in3)
1000 2000 3000 4000 5000 6000


755 nodal seismometers
Elevation (m)
-4000 -3000 -2000 -1000 0 1000 2000


4 km/s
1.5 km/s
Frequency (Hz)
P
S
T
Changes in resonances from shaking
Seconds from 2021-06-04T07:52:43.544000Z
Seconds from 2021-06-04T07:52:43.544000Z

”THE VALUE OF COMPLEMENTARY SITES

…The most effective strategy is to form a set of comparison sites that differ in only a few, scientifically interesting ways… This subductology approach has yielded insights into past reviews of extant data but has not been utilized extensively as a deployment strategy.”



Is Cascadia’ silence *really* special?

One ‘subductology’ test…

(*Toda & Stein*, 2022)

2022

SZ4D

COMMUNITY MEETING

YOUR TASK NOW: Answer "How can we design the observational, experimental, numerical components to enable translation of results, resources, and training from one site and one community to another (e.g., lessons learned from Chile to Cascadia) and to subduction zones globally?"