Subduction Zone Marine Geohazards Project Plans

Subduction zone earthquakes, tsunamis, volcanoes, and landslides are some of the most dangerous and powerful natural hazards on Earth. The largest earthquakes on Earth occur within subduction zones at the interface between the downgoing and overriding plate. While locking and strain accumulation occurs in deeper regions, much of slip in megathrust earthquakes occurs at shallow depths along the plate interface, which has great potential to initiate large tsunamis associated with seafloor displacement. With an initial focus along the Cascadia margin, ongoing and planned work will provide key onshore/offshore constraints that feed directly into earthquake, tsunami, and landslide hazard assessments and situational awareness products.

Preliminary morpho-tectonic analyses highlight distinct along-strike variations in morphology along the Cascadia margin that may reflect spatial variations in megathrust behavior. Identification and regional mapping of active fault structures will provide insight to this segmentation pattern, earthquake recurrence intervals, stress/strain accommodation and variations in coastal uplift or subsidence. We plan to investigate the linkages between fluvial systems, dispersal pathways, tectonic basins, fault interactions, seafloor morphology, and offshore storage locations, which will help to identify basins prone to strong shaking, areas of the slope susceptible to landslides, and/or optimal environment(s) for marine paleoseismology studies.

Key scientific questions:
To what extent and how frequently do potentially tsunamigenic upper plate structures rupture with the megathrust?
How do along strike variations in the morphology and structure of the overriding plate relate to possible segmentation of the megathrust?
How is sediment delivered and redistributed across the continental shelf and slope?
How does earthquake shaking translate to slope failure?
What is the role of fluids in subduction zone processes?
Where are the most active upper plate faults located?
Integrating high resolution geophysical surveys and geological sampling to investigate subduction zone hazards

High resolution imaging of the seafloor and shallow subsurface is necessary to characterize the margin morphology, identify submarine landslides and better delineate the structure of the upper plate and connections to the megathrust. These data will provide insight into shallow deformation features that are difficult to discern with existing (mostly crustal scale) seismic data and will help us investigate recent fault activity and distinguish between different types of slip behavior.

Example: Identification of faults in high-resolution Chirp data improves fault maps and informs seismic hazard assessments.

Targeted Products:

- Earthquake Recurrence History
- 3D Fault/Geologic Model
- Quaternary sediment distribution & properties
- Bathymetry / Backscatter & Seep Distribution
- Hazard Maps (earthquake, landslide, tsunami)
- Event Response (e.g., rapid OBS deployments)

Field Work Plans/Goals

<table>
<thead>
<tr>
<th>Year</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>Comprehensive multibeam bathymetry &amp; backscatter between 200-1600m water depth</td>
<td>Systematic characterization of the upper plate structure</td>
<td>High-resolution 3-D (P-cable) MCS in targeted regions (e.g., Northern &amp; Southern Cascadia comparison sites)</td>
<td>Seabed sampling: Ship based piston and gravity cores</td>
<td>Follow up work in Cascadia, Alaska or other U.S. subduction zones</td>
</tr>
<tr>
<td>2019</td>
<td>High-resolution 2-D geophysical surveys (Chirp subbottom, Sparker MCS, Magnetometer) Southern Cascadia</td>
<td></td>
<td></td>
<td>Targeted ROV surveys and sampling Cascadia sites TBD</td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2022</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ideally, these high-resolution 2D & 3D surveys will be paired with deeper crustal scale studies conducted in conjunction with research partners. Additional multibeam surveys also will be conducted as opportunities arise.

Potential Partners

NOAA, BOEM, Ocean Exploration Trust, Humboldt State University, University of Washington, Oregon State University, MBARI, GEOMAR, NSF, Canadian Geological Survey and others working in Cascadia or on related subduction zone hazards.

Janet Watt (PCMSC Lead PI), jwatt@usgs.gov
Nathan Miller (WHMSC Lead PI), ncmiller@usgs.gov
Danny Brothers, dbrothers@usgs.gov
Jason Chaytor, jchaytor@usgs.gov
Peter Haeussler, pheusl@usgs.gov
Jenna Hill, jhill@usgs.gov
Jared Kluesner, jkluesner@usgs.gov
Uri ten Brink, utenbrink@usgs.gov

The USGS plan, entitled Reducing Risk Where Tectonic Plates Collide—A Plan to Advance Subduction Zone Science, is available online: https://doi.org/10.3133/cr1428