Tsunami Generation from Earthquakes: The Role of the Shallow Trench

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Plate Interface Seismicity in Subduction Zones

Because they are the primary source of numerous small and large tsunamis and ~90% of all seismic moment release occurs along the subduction interface, it is important to understand how it works.

Our current arguments for processes that allow subduction zone seismicity are as follows:

When the oceanic plate subducts, the interface heats through contact with the overriding plate by conduction & frictional heating. Such that at between 10-20 km depth, when the plate interface heats beyond ~100-150°C, brittle failure can occur because of dehydration reactions that transform abundant smectite and opal (both with low coefficients of friction) to lillite and quartz (with more friction). Thus allowing stick-slip behavior. A later transition back to stable-sliding occurs down-dip, about 40-50 km depth, due to further increased temperatures or contact with the mantle wedge, but is not important for tsunamigenesis.

Though this description works well for most subduction interface events, it is clear that at times earthquakes occur well above this 100° isotherm. In fact, when these earthquakes do not obey this “ updip limit”, they become much more likely to generate tsunamis because of geometry and reduced rupture velocity. Determining where these events may next occur is a challenge that will require a global evaluation of strain accumulation in the shallow trench.

Near-trench rupture and tsunami excitation

Gagnon et al., 2005

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