AOB Seminar

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講演題目: Subduction Thrust Earthquakes: Controls on the Maximum Size

The maximum size of subduction zone earthquakes, Mx, is an important scientific question and a critical earthquake hazard issue. The 2011, M9 NE Japan megathrust emphasized that this question needs more study. Historical Mx for different subduction zones range from greater than M9 (i.e., Japan, Chile, Sumatra, Alaska, etc.) to Mx less than M7.5-8.0 (i.e., Marianas and several other SW Pacific island arcs). An important problem I will not discuss is the short instrumental earthquake record of ~100 years (several 100 years historical data for a few subduction zones), compared to M9 return periods that may be more than 1000 years. We could be more confident of Mx if we had physical explanations for Mx. Many associations have been made between subduction zone characteristics and Mx but most have important exceptions. (I note the problem of tsunami earthquakes with "slow" slip, and ETS). Related to Mx is Seismic Coupling or Efficiency, i.e, the fraction of plate convergence accommodated by thrust earthquakes compared to aseismic motion. “Coupling” estimates involve down-dip width, commonly trench to 30 or 40 km, but much narrower downdip seismogenic widths exist.

Laboratory data indicate that faults are expected to be seismic for common crustal rocks, so special compositions or conditions are required for aseismic motion. There are two possible origins of low coupling (and small Mx): (1) Deep updip seismogenic limit and shallow downdip limit, (2) Areas on thrust that are seismic and other areas that are aseismic. There may be complete coupling with many moderate size megathrusts with stress concentrators from rough crustal topography (seamounts, fractures, etc.) stopping long ruptures, but usually low coupling is inferred for small Mx.

For the updip seismogenic limit, I will mainly discuss dehydration of stable-sliding clays, smectite (e.g., saponite) to illite/chlorite at 100-150C. Saponite is very weak (i.e., creeping part of San Andreas Fault). For the downdip seismogenic limit, there may be a temperature limit for hot subduction zones (SW Japan, Cascadia etc.), at ~350C; with a transition to ~450C, for velocity weakening to velocity strengthening (related to brittle-ductile transition), and for cold subduction zones, the limit may be the forearc mantle corner, downdip of which there is aseismic serpentintite and talc in forearc mantle due to rising dehydration fluids. For aseismic patches, I will discuss the importance of aseismic serpentinite/talc in the upper oceanic crust of the incoming plate.