Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

U002-05 Room:IC Time:May 25 10:06-10:30

Fluid-rich faults and updip slip propagation during great earthquakes in the Nankai and Sumatra subduction zones

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Seismic reflection data sets from two thickly-sedimented subduction zones, the Nankai Trough and the Sumatra subduction zones, reveal shallow fault systems that extend from the seismogenic zone updip close to the seafloor. Based on rupture models, some of these faults likely slipped during recent great earthquakes. Common to both data sets are high-amplitude fault-plane seismic reflections that have a reversed polarity relative to the seafloor and are inferred to be caused by relatively low-velocity, high-porosity within the fault zone. These are inferred to be weak faults conducive to slip during great earthquakes.

In the Nankai Trough, high-amplitude fault-plane reflections from the plate boundary megathrust can be traced downdip to ~ 10 km below seafloor in a 3D seismic reflection data volume acquired in 2006 across the Kumano Basin in the vicinity of the Integrated Ocean Drilling Program NanTroSEIZE drilling area. We attribute these anomalously high-amplitude fault-plane reflections to underthrusting of relatively high-porosity, fluid-rich sediment. The area where the fault has high-amplitude reflections corresponds to a region of anomalously shallow updip slip propagation during the 1944 Tonankai M8.0 earthquake. This fault may be weakened by the presence of fluids thus enabling unusually shallow updip slip propagation.

Two-dimensional seismic reflection data from Sumatra that were acquired in 2008 reveal the outermost accretionary wedge structure near the deformation front across the slip region of the 2004 M 9.2 earthquake. Here the outer wedge has multiple examples of high-amplitude, reversed-polarity reflections that are similar to Nankai examples. These thrusts extend upwards from the plate-boundary thrust through much of the upper plate and may have slipped during the 2004 event. In this presentation I will compare fault characteristics of both margins and their slip behaviors during great earthquakes.