A seismicity-compatible new model of subducting plate downbend, basal subduction tectonic erosion (STE), and the large-scale tectonic and seismogenic evolution of convergent margins.

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Large earthquakes at the downbends of subducting plates demonstrate major ruptures extending through the plate to >50km depth. Below the Japan Trench microseismicity extends to nearly 100km depth. These features are inconsistent with elastic flexure models of plate downbend. Such models also fail to provide effective basal STE.

A new model of plate downbend has been developed (in conformity with observations in trenches and with the occurrence of outer rises) in which downbend results from the progressive evolution of a succession of steps wherein, consistent with first-motion data, each step rotates about a virtual fulcrum beneath the oceanward side. Graben in trenches result where the step-faults gape as the throw increases. Most of the downbend, and therefore most of the increments in step-fault throw, occur well beneath the forearc. Each such increment offsets the subduction interface, creating a downward asperity composed of forearc material, which may lock subduction until it is sheared off.

This model can not only explain close-coupling in subduction zones, but also yields a highly efficient mechanism for STE of the hanging wall. The downbend faulting concentrates STE at the downbend, whose location is thereby progressively advanced beneath the margin. Therefore the segmentation of circum-Pacific subduction zones, involving landward displacement of the downbend by 200-650km in some segments, is attributed to differences in STE of the hanging wall, and not the properties of the slab.

Results of these studies include:-

(1) Both seismic close-coupling and major STE undercutting of margins are limited to where the subducting plate is/was less than about 70Ma old.

(2) Interplate mechanical coupling at the downbend, associated with active STE, transmits horizontal force from the subducting plate to the hanging wall, causing foreland-directed thrusting which migrates as the downbend does.

(3) The aseismic front, well noted in Japan, corresponds to the completion of downbend faulting at the subduction interface.

The talk will be illustrated with examples from Japan, New Zealand and the Americas.