Thermal structure and intraslab earthquakes in the Nankai Trough

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The Nankai Trough is generally described as a subduction zone where the young (15–30 Ma) Philippine Sea Plate (PSP) subducts beneath SW Japan at a shallow angle with a convergence rate of about 4.5 cm/yr. There are, however, considerable along-strike variations in plate age and dip — in fact, the contortions of the PSP subducting at the Nankai Trough are greater than those of any other young subducting plate that we know of.

These sharp contortions of the PSP are tracked via intermediate-depth seismicity beneath SW Japan which extends to depths of over 100 km beneath Kyushu in the western Nankai Trough, while seismicity farther to theThis trend is abruptly reversed, however, beneath the western coast of the Kii Peninsula, at the boundary between the eastern and western Nankai Trough. We show that here the slab undergoes an abrupt change in geometry, and that even thought the slab to the east is as young as that subducting beneath Shikoku, it dips at a considerably larger angle and the seismicity extends to greater depths. Furthermore, the total downdip length of the seismically active part of the slab is significantly shorter than that of the slab of similar age to the west. We suggest that this can be explained if the slab extends into the asthenosphere, because this will be much more effective at heating up the slab, causing the mineral phase assemblages of the subducting oceanic crust to undergo dehydration reactions at shallower depth. If this is so, then the greater dip may be consistent with pressure on the slab exerted by asthenospheric flow associated with the rapid rotation of SW Japan between 16 and 14 Ma. east beneath Shikoku and Honshu rarely exceeds 70 km depth. These earthquakes are largely confined to a very thin zone which marine seismic surveys show corresponds to the oceanic crust of the subducting PSP. Numerical modeling of the subducting plate's thermal evolution suggets that these earthquakes are associated with dehydration reactions occurring in the mineral phase assemblages of the subducting oceanic crust. This is consistent with seismicity extending to greater depths beneath Kyushu, where the slab is older (30 Ma) and therefore cooler than it is beneath Shikoku, where the slab is as young as 15 Ma and seismicity is more shallow.