Segmentation of the Western Taiwan active fault zone inferred from its structural analogy to the Nankai trough region, southwest Japan

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1. Structural outline of the forearc region along the Nankai trough

The forearc region along the Nankai trough possesses the trough-parallel structure comprising landward trough slope, outer ridge zone, forearc basin zone and forearc rise from the offshore side. Landward-dipping large thrust faults, which are thought to be causative faults of great plate-boundary earthquakes along the Nankai trough, occur along the trough-side foot of the outer ridge zone.

2. Segmentation of the forearc basin zone by transverse structures and its relationship to the great plate-boundary earthquakes

The forearc basin zone along the Nankai trough is segmented into five regions 120 to 150 km long by N-S-trending transverse structural highs and associated thrust faults extending from five coastal promontories on the Pacific coast to the offshore outer ridge zone. Many inversion studies of seismic waveforms, tsunamis and crustal movements data have proved that these structural segments coincide, in both location and dimension, with the source areas of great earthquakes such as the 1944 Tonankai and 1946 Nankai earthquakes. These segments are characterized by the common structure composed of a forearc basin fringed, on both east and south sides, by a structural high and associated thrust faults delineating an inverted-L-shaped trace.

3. Imbricate structure of western Taiwan, especially in the Taichung area

Western Taiwan is characterized by the west-facing, N-S-trending imbricate structure. In the Taichung area, the westernmost thrust sheet, soled by the Changhua fault, contains a frontal structural high (Tatuchi upland) and an inner basin (Taichung basin) parallel to the sole fault. An overlapping thrust sheet soled by the Chelungpu fault also has nearly the same tectonic components: a frontal mountainous region (deformed older structural high) and an inner syncline (older basin) extending in the N-S direction.

4. Transverse structures in the Taichung area

These N-S-trending structural highs and basins are cut by E-W- to ENE-striking transverse structures. The Tatuchi upland and Taichung basin are truncated by the ENE-trending Tuntzuchiao fault, which branches from the Changhua fault and ruptured during the 1935 Hshinchu-Taichung earthquake. The northern tip of the Chelungpu fault, a causative fault of the 1999 Chi-Chi earthquake, bends eastwards on the immediate east of the Tuntzuchiao fault and cuts an N-S-trending syncline (Plio-Pleistocene basin).

The northern tip of the older Shuangtung fault also curves eastwards at nearly the same latitude.

5. Mirror-image relationship between the Nankai trough region and western Taiwan, and its implication for plate tectonic regime of the two regions

The geologic structure of the Taichung area is a mirror image of the structure characterizing the source areas of plate-boundary earthquakes along the Nankai trough. This fact indicates that the two areas are under analogous tectonic regime, i.e., oblique convergence. Their mirror-image relationship reflects a left-oblique convergence in the Taichung area and a right-oblique convergence along the Nankai trough.

6. Segmentation of the western Taiwan active fault zone by transverse structures

E-W- to ENE-striking transverse structures analogous to those in the northern Taichung area develop at three other areas in the western Taiwan active fault zone: near Hshinchu, near Minhsiung, and near Tainan. The western Taiwan active fault zone is divided into five regions or segments 60 to 80 km long by the four transverse structures.

Structural analogy of west Taiwan to the Nankai trough region strongly indicates that the five segments are correlative to the source areas of large earthquakes in this fault zone. This model leads to the idea that an entire rupture of the segment in the Taichung area produced the 1999 Chi-Chi earthquake. A rupturing of the segment between Hshinchu and Taichung probably caused the 1935 Hshinchu-Taichung earthquake.

7. Perspective and problem on future large earthquakes in western Taiwan

The 60- to 80-km-long segment size of western Taiwan is nearly a half of the Nankai trough region (120 to 150 km long) and may regulate the size of future earthquakes resulting from individual rupturing of the five segments.

Along the Nankai trough, Segment A and B off Shikoku have ruptured successively with a very short time lag within one seismic event. Segment C and D off the Tokai region and adjoining segment E along the Suruga trough also have caused multiple segment earthquakes.

The possibility of multi-segment earthquakes in the western Taiwan active fault zone remains unknown.

In the Nankai Trough region, transverse faults at the segment boundaries have never been known to rupture independently of reactivation of the E-W-trending main faults, the upper tips of which reach the trough-side foot of the outer ridges.

In western Taiwan, on the other hand, transverse faults at the segment boundaries may have ruptured independently of faulting of main thrusts during the 1906 Minhsiung, 1935 Hsinchu-Taichung and 1946 Hsinhua earthquakes. If this idea is correct, it may be

necessary to take precautions against E-W-trending active faults near Hsinchu, which have no record of recent rupturing.