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Significance of Tectonic Geomorphology in the Prediction of Plate Boundary Earthquakes around Japan

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Active faults observed on sea floor are resultants of repeated large earthquakes. However, fundamental information for prediction of large earthquakes such as the detailed distribution of active faults was not well known mainly due to lack of data regarding seafloor topography. To make a more precise submarine active fault map along the trench, we have made detailed seafloor topographic images based on 90m and 150m DEM processed from the original data obtained by Japan Coast Guard and JAMSTEC. Then we have produced anaglyph images of seafloor for interpretation of active faults, similar in manner we use air-photo stereo sets for inland active fault interpretation. In anaglyph images, we can easily observe seafloor relief throughout wide area, and it is no so difficult for most of us to identify active faults that dislocate seafloor. Escarpments or flexure slopes were formed by reverse faulting, whether a fault reaches seafloor or terminates in depth. Slopes tectonically formed are convex in their profiles, and are associated with tectonic bulge to their west. Active fault distribution along and around the Japan Trench is rather simple compared with that of the Nankai Trough.

Active faults along the Japan Trench area are grouped into the following three fault zones; from east (1) normal faults on Outer Rise, (2) extensive thrust faults on the trench slop, and (3) lineaments on the shelf slope. One of the continuous thrusts extends from off-Sanriku to off-Ibaraki for over 400km, and is probably related to the source fault of ”The 2011 off the Pacific coast of Tohoku Earthquake”. We compare location of hypocentral regions of historical earthquakes (Earthquake Research Committee, 1999) and distribution of tectonic landform such as submarine active faults and tectonic bulges. Some of the hypocentral regions are located on tectonic bulges, suggesting that extent of seismic source faults in depth will be detected from distribution of tectonic bulges. Source fault for Meiji Sanriku earthquake (M8.2 - 8.5) may be related to a 200km-long active fault along the trench off Sanriku. Numerous lineaments of normal faulting are distributed on the outer-rise slope and they are generally short, and may cause M7 class earthquakes. The 1933 Sanriku earthquake (M8.1-Mw8.4) is believed as one of the Outer Rise earthquakes, but we do not find any long normal fault that matches to the extent of a M8 class earthquake. One of the aftershocks of the 311 Earthquake probably took place along a long NNE-SSW normal fault on the Outer Rise off Fukushima. Normal faults are also densely distributed on the uplifted zone by extensive thrusting along the west of the trench, and they may suggest location of asperities on the earthquake source fault.

The Nankai Trough is a candidate site for the occurrence of large earthquakes of M8 class in near future. The trough has been well studied by many marine geologists, and they have revealed characteristic structure of the plate boundary. As mapped by previous works (Research Group for Active Submarine Faults off Tokai; 1999, Tokuyama and others; 2001, Kimura and Kinoshita eds., 2009), there are several trough-parallel north-dipping thrusts. We defined location and geometry of active faults much more accurately than those previously known. We depicted two candidate active faults for two large historical earthquakes; 1944 Tonankai and 1946 Tokai. The former one extends eastward from off southeast coast of Kii peninsula across Kumano Trough for over 100km, and the latter extends eastward from off southeast coast of Kii peninsula across Shionomisaki submarine canyon and along southern foot of Tosabae, and outer ridge south of Tosa Basin until it reaches far off Ashizuri peninsula. Several extensive strike-slip faults are also found in Tosa Basin, suggesting that these faults will generate earthquakes with strong ground motion with smaller tsunami in future.

Keywords: submarine active fault, plate boundary, large earthquake, Japan Trench, Nankai trough