Crustal deformation associated with the Sumatra-Andaman earthquake of 2004 and paleoseismological evidence for its repetition

Yasutaka Ikeda[1]; Hajime Kayanne[2]; Tomoo Echigo[3]; Masanobu Shishikura[4]

[1] Earth & Planet. Sci., Univ. Tokyo; [2] Earth & Planetary Sci., Univ. Tokyo; [3] Graduate School of Science, The University of Tokyo; [4] Active Fault Research Center, AIST, GSJ

The Sumatra-Andaman earthquake of 2004 (Mw 9.1˜9.3) is one of the biggest earthquakes that have occurred in the history of instrumental observations. Its rupture length is as long as 1200 km from off the northern tip of Sumatra to the Andaman Islands. Within this huge rupture area, four fairly large earthquakes of Mw 7.0-7.9 have occurred since the 19th century, but they seem to have nothing to do with strain release in the source area of 2004 Sumatra-Andaman earthquake. Similar phenomenon has been observed in the source region of the Chilean earthquake of 1960 (Mw 9.5) and in the southern Kuril subduction zone off Hokkaido, Japan.

We observed vertical displacements along the coasts of the Andaman Islands by using biological and geomorphologic indicators of sea level. Among these indicators, microatolls were most useful and precise. In general, the trench-ward (west and north) side of the Andaman Islands was uplifted and the back-arc side (southeast) was subsided, with the maximum amount of uplift 1.5 +- 0.1 m observed at Interview and North Reef Islands.

We obtained evidence for post-seismic movements at Mayabunder, northeast Middle Andaman. Here, a significant amount (˜1.3 m) of post-seismic subsidence has occurred during ˜1 month following coseismic uplift of ˜2.0 m. This phenomenon is likely to have been caused by aseismic, up-dip propagation of rupture front of the subduction thrust after the main shock.

The back-arc side of the Andaman Island has been subsided in the 19th century (evidence cited by Bilham et al., 2005), and was again subsided during the 2004 earthquake. However, marine terraces and emerged wave-cut benches exist widely over the area, indicating uplift on a geologic time scale. This suggests that there still is slip deficit on the deeper part of the plate interface (down-dip extension of the 2004 rupture), and that the slip deficit will be cancelled by slow postseismic slip.

In the northwestern part of the Islands are many fossil microatolls, which are likely to have emerged in association with similar gigantic earthquakes to the 2004 earthquake. In order to understand the mechanism and recurrence history of gigantic earthquakes in the northern Sunda arc, it is very important to reveal the history of relative sea levels recorded in fossil microatolls.