Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

SSS011-P08 Room: Convention Hall Time: May 27 17:15-18:45

Rupture characteristics of large earthquakes preceded by small slips in the mid part of the upper mantle

Keiko Kuge[1*]

[1]Dept. of Geophysics, Kyoto University

I show the rupture characteristics of large earthquakes at depths from 250 to 400 km that were preceded by small slips, based on analysis of teleseismic P waveforms recorded by the global and Japanese networks with use of regional data from Japan-Indonesia Seismic Network (JISNET).

Activity of intermediate-depth earthquakes (depth 60-400 km) generally decreases with depth, and becomes the minimum in the depth range of 300-400 km. The depth range corresponds to a boundary between different candidates for physical mechanisms of earthquakes, so characterizing ruptures of earthquakes there is important.

At depths from 250 to 400 km, only eight earthquakes with moment magnitude larger than seven occurred in the world since 1991. The P-wave displacement waveforms obtained from broadband-data archives of IRIS DMC show that among the eight earthquakes, two have clear precursors preceding the main slips. Whether or not precursors exist does not simply depend on either the size or depth of earthquakes. One earthquake with a precursor is the 2007 Java earthquake (Mw7.5), and the other earthquake is the 2006 Banda Sea earthquake (Mw7.6).

The Java earthquake occurred at a depth of about 300 km. The small seismic energy arrives about 3 to 11 seconds before the large P main pulse. The nature of the rupture propagation was well constrained by using regional waveforms from JISNET. The rupture initiated as the precursor and propagated to the western main slip horizontally with slightly up-dip. As decrease in slip was observed between the precursor and main slip, the rupture was not continuously accelerated. The rupture propagation is consistent with the results from teleseismic waveforms, including the images given by back-projecting the Hi-net array data. The studies of the Java earthquake demonstrate that precursors can provide good opportunities to examine rupture characteristics of intermediate-depth earthquakes through initiation, triggering, and scaling law.

The other Banda Sea earthquake occurred at a depth of about 400 km within the Australian plate subducting toward the west. Since few regional data are available, the rupture characteristics were estimated mostly by using teleseismic waveforms. The small seismic energy arrives about 5 to 12 seconds before the large P main pulse. The difference of arrival time between the precursor and main pulse tends to be shorter at the stations toward the south, which suggests that the main pulse source is located at a deeper portion to the southwest, relative to the precursor source. P waveform modeling with multiple time windows estimated a region of large slip to be in a southern portion on a finite fault using either nodal plane. The precursors look complicated at stations from the north to west, and the polarities of the very initial portions are opposite to those of the main P pulses. The polarities of the P-wave main pulses at most stations are in good agreement with the Global CMT solution that exhibits normal faulting with horizontal extension in the east-west. The point-source moment tensor solution determined from the P waveforms is also similar to the Global CMT solution. The different polarities of the very initial portions of P waves can be explained by change in the strike angle of the westward-dipping nodal plane if they are due to source complexity.

Acknowledgements: I am very grateful to the personnel of IRIS and JISNET. I especially thank Dr. Masaru Nakano for helping me to get the JISNET data.