S051-P003 Time: May 27 17:00-18:30

Characteristics of the rupture propagation direction of subduction zone earthquakes

Yumi Matsuda[1], Kazuo Yoshimoto[2], Masakazu Ohtake[3], Haruo Sato[4]

[1] Department of Geophys, Tohoku Univ, [2] Geophys.,Tohoku Univ., [3] Dept. of Geophysics,Tohoku Univ, [4] Geophysics, Science, Tohoku University

It is important to know the common characteristics of rupture process of subduction zone earthquakes to understand the generation of earthquakes and the stress field of plate convergence boundaries. In our research, we focus our interest on the rupture propagation direction on a fault. To find out characteristics of the rupture propagation direction, it is necessary to analyze not only large earthquakes but also moderate ones.

In order to estimate the rupture propagation direction of moderate to large earthquakes, we propose a simple method based on the relative hypocenter determination. In this method, we assume that there exists a small portion with large moment release on the fault plane that is characterized by the peak amplitude of P-wave displacement. We call this portion the maximum slip region, and locate it relative to the initial rupture point using the peak delay time with respect to the arrival of initial P wave. The direction of a vector that connects the initial rupture point and the maximum slip region can be taken as a good measure of the rupture propagation direction.

By using this method we estimate rupture propagation directions of 65 events with magnitude of 6.0 or larger in subduction zones. Broadband seismograms collected by IRIS for the period 1994-2000 are analyzed. Comparing the rupture propagation direction with the direction of the subducting oceanic plate motion relative to the overriding continental plate, we find following characteristics of the rupture propagation direction:

(1)For many earthquakes, rupture propagates in the opposite direction to the subducting plate motion; 27% of the rupture propagation directions fall within 45 degrees including the direction opposite to the plate motion. This frequency is twice as large as that of uniform distribution (in uniform distribution, the frequency is 12.5%). This may indicate that rupture tends to initiate at a deep part of fault and propagates in the up-dip direction along the plate boundary.

(2)Rupture propagation in the same direction as subducting plate motion appears only for shallow earthquakes shallower than 60km. On the other hand, 70% of events that has rupture propagation direction orthogonal to the subducting plate motion occur at depths of 60 to 350 km.

We further compare our result with the results of previous studies on rupture process of great earthquakes including the estimate of fault zone from aftershock distribution. From those past results, we find that events whose rupture initiated at a deep part of the fault are dominant, 21 out of 32 events. This supports our result that rupture tends to propagate opposite to the subducting plate motion.

Kato and Hirasawa (1997, 1999) performed a numerical simulation study of the sliding process on a plate boundary in a subduction zone by assuming rate- and state-dependent friction law. Their results indicate that the rupture propagation direction varies with friction parameters on the boundary, and that rupture mainly propagates in the up-dip direction when the characteristics slip distance is large. This implies that the rupture propagation direction from observation may give new information for estimating friction parameters of plate boundaries.