Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SSS39-17 Room:IC Time:May 25 16:15-16:30

A mechanical scenario for the occurrence of the Tohoku earthquake: stress concentration and thermal fluid pressurization

MITSUI, Yuta[1*], IIO, Yoshihisa[2], FUKAHATA, Yukitoshi[2]

[1]Sci. Hokkaido Univ., [2]DPRI, Kyoto Univ.

As a preliminary result, Mitsui and Iio (2011, EPS) proposed a scenario of the generation mechanism of the 2011 Tohoku earthquake on March 11, referring to geophysical observation data; the M7-class earthquake, which had occurred on March 9 after the active period of M7-class earthquakes and afterslip, might trigger the M9 Tohoku Earthquake through its afterslip. Similar scenarios had been also presented by several researches. Mitsui and Iio also implied that some mechanisms, such as thermal pressurization of pore fluid (TP) on the fault plane, caused extremely large slip in the northern part of the M9 fault to propagate the seismic rupture over the whole fault. On the basis of this way of thinking, Mitsui et al. (accepted, EPSL) modeled an M9 earthquake cycle, including M7-class earthquakes, with the TP mechanism near the trench. Although several different models for the generation process of the Tohoku earthquake had been proposed, our concept provides a good explanation for the occurrence of the Tohoku earthquake.

Moreover, here, we perform dynamic rupture simulations for better understanding the generation process of the 2011 Tohoku earthquake. We construct a fault model to assimilate the moment release in the seismic slip inversions. It also reflects the estimation of shear stress changes before the Tohoku earthquake, due to the four M7-class earthquakes during 2003-2011 (Iio and Matsuzawa, submitted). We assume a dynamic weakening mechanism of TP to represent nonlinear weakening friction. The simulation result implies the following things about the 2011 Tohoku earthquake. (1) The rupture around the hypocenter was enhanced by the stress accumulation due to the preceding M7-class earthquakes. (2) The enhanced rupture triggered the TP mechanism in the near-trench area to cause nearly total stress release, which promoted the rupture throughout a wide region including the source areas of the M7-class earthquakes and a surrounding conditionally stable area. (3) Without sufficient stress accumulation, the moment release of the Tohoku earthquake ended as an M8-class earthquake. (4) TP in the near-trench area should be effective but moderate (depending on the size of the TP area).

Keywords: The 2011 Tohoku earthquake, thermal fluid pressurization, stress concentration, dynamic rupture simulation