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Estimation of the stress field and the pore-pressure from focal mechanisms in the focal area of the 2008 IMNE

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1. Introduction

The 2008 Iwate Miyagi Nairiku earthquake with a magnitude of 7.2 occurred in the southwest part of Iwate Prefecture and northwest part of Miyagi Prefecture on June 14, 2008. Previous studies have revealed the aftershock distribution, coseismic and afterslip distribution, and seismic wave velocity structure. These studies suggest that crustal fluid may had influence of the occurrence of the mainshock.

In this study, we estimated the stress field before and after the mainshock, and pore-pressure distribution after the mainshock using the data recorded by the routine stations of Tohoku University, JMA, Hi-net-NIED, and temporal stations by the Japan Nuclear Energy Safety Organization and the Group for the aftershock observations of the Iwate-Miyagi Nairiku Earthquake in 2008.

2. Estimation of the stress field

First, we divided the data set into into 2 subsets before (1998-2008/6/14) and after the mainshock (2008/6/14-9/30), and we estimated the stress field by the stress tensor inversion (Abers and Gephart, 2001) using first motions of the earthquakes. Before the mainshock, the maximum principal stress (sigma-1) direction seems to orient ESE-WNW or E-W. sigma-direction seems to orient E-W especially in the south of the focal area. These directions are consisted with the average directions of the P-axis of the focal mechanisms of the earthquakes in each area before the mainshock. The minimum principal stress (sigma-3) axes are horizontal in the east areas, but perpendicular in the west areas. These directions are consisted with the directions of the principal strain rate in each area. (Miura et al., 2004)

After the mainshock, stress field have some varieties in the local scale (5-10km) in the focal areas. sigma-1 direction are NW - SE in the east areas, but NE - SW in the shallow part (0-2 km) of west areas, and E-W in the south areas. These directions are consisted with the average directions of the P-axis of the focal mechanisms of the earthquakes in each area after the mainshock. Other areas have WNW-ESE directions of sigma-1 axis. These change of the sigma-1 directions before and after the mainshock can be explained by the stress change caused by the mainshock slip if we assume the low values of the deviatoric stress (sigma-1 / sigma-3 ~1.025).

3. Estimation of the spatial distribution of the pore pressure

By assuming that the weakening of the frictional strength is caused by the pore-pressure, we estimated the frictional strength (Rivera and Kanamori, 2004) and the pore-pressure distribution by using the aftershock data. High pore-pressure is estimated in the western and northern parts of the focal area. S wave velocity is low beneath these high pore-pressure areas (Okada et al., 2009, 2011). The region of the high pore-pressure zone is also consisted with the spatial extent of the large coseismic and after slip (Iinuma et al., 2009). These consistencies may suggest that the overpressurized fluid from the deeper part is redistributed due to the fault slip and weaken the frictional strength of the fault plane in the west area of the focal areas.

Keywords: focal mechanism, stress, pore pressure