# Normal-fault components in the focal mechanisms of earthquakes in April 2016, Kyusyu region, Japan

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A swarm of earthquakes occurred in Kyushu region, Japan in April 2016. The activity includes two major earthquakes in Kumamoto prefecture with moment magnitudes of Mw6.1 on April 14th and Mw7.1 on April 16th. Many large aftershocks (Mw > 4) have been excited at least one month since the first Mw6.1 earthquake. The overall activity might be defined by a foreshocks-mainshock-aftershocks sequence. According to moment tensor catalog by F-net and Hi-net systems operated by National Research Institute for Earth Science and Disaster Prevention (NIED), the three major earthquakes seem to have occurred near the intersection point between the known Hinagu and Futagawa faults with mostly strike-slip focal mechanisms, whereas some potion of aftershocks seem to have occurred at the western extension of the Futagawa fault and northern/southwestern areas out of the Futagawa fault with focal mechanisms including normal-fault components. For revealing the contribution of normal-fault system during this swarm activity, I estimated the centroid moment tensor solutions of the major three earthquakes and large aftershocks (Mw > 4) by a grid-search algorithm (Takeo et al. 2010) and their uncertainties by the bootstrap method. The datasets are the records of F-net strong motion velocitymeters for two major earthquakes, and records of F-net broadband seismometers and three broadband seismometers in the southwestern Shikoku island installed by Earthquake Research Institute, the University of Tokyo in 2015. As a result, I obtained both strike-slip and normal-fault reliable solutions for aftershock sequence (4 < Mw < 6). The normal-fault solutions often appeared at off fault area of the Futagawa fault. The two major earthquakes had significant non-double couple components, which can be explained by the linear combination of the strike-slip double-couple solutions along the known fault systems and the normal-fault double-couple solutions along the fault systems. The contribution of Hinagu and Futagawa faults is hard to distinguish by the centroid moment tensor analysis because the difference in the strike angles of these fault system is not large enough. On the other hand, the total contribution of normal-fault solutions could be estimated to be about 15% for the Mw6.1 first earthquake and about 30% for the largest Mw7.1 earthquake. These values may be useful for the slip inversion of these earthquakes and for interpreting surface faulting. The total contribution of normal-fault solution will be estimated, which might have contribution for discussing the tectonics of the Beppu-Shimabara graben widely located off north of the Futagawa fault.

Keywords: Kumamoto earthquake, Centroid moment tensor analysis

 