The significance of seismicity after The 2016 Kumamoto Earthquake sequence

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We applied the double-difference method (hypoDD; Waldhauser and Ellsworth, 2000) using cross-correlation of waveform data as well as the ordinal differential picking time data for the 2016 Kumamoto Earthquake sequence including the largest earthquake with magnitude (M) of 7.3 occurred on April 16, 2016 following the second largest earthquake with M6.5 on April 14, 2016. A total 5,272 events are consisted of three different subgroups; 1) events (M > 0) between the M6.5 event and the M7.3 event, 2) events (M > 0) after the M7.3 event to April 19, 3) otherwise event (M > 3) from April 19 to April 27, 2016. Waveforms obtained by the multi-institute networks such as NIED Hi-net, JMA, Kyushu university, and Kagoshima university are adopted for preparing both cross-correlation of their waveform data and ordinal differential picking time data for differential travel times used by hypoDD. Therefore, the final relocated earthquake distribution made sharper lines and confined clusters. Particularly for this study area, the final hypocenter distributions are easily traceable following the known active fault traces such as the Hinagu fault range and its surroundings while the Futagawa fault range shows more complicated shapes than the Hinagu fault. Particularly, along the vertical planes or planes with high angle dips become apparent shape of seismicity during this earthquake sequence. Orientations of these planes agree the strike direction of the focal mechanisms estimated by the first motion phase arrivals, which routinely or manually determined by the NIED Hi-net.

Immediately after the first M6.5 event, the seismicity extremely increases along the Hinagu fault range. After the largest M7.3 event, the seismicity increases along the Futagawa fault as well as the Hinagu fault and spread to the northeastern of the Futagawa fault such as the Mt. Aso area, and Ohita region. These two main events are occurred at the complicated region where the Hinagu and the Futagawa faults marge each other. Although the nucleation of these two main events are not clear whether on the Futagawa or Hinagu fault, our relocation results show that the clear location of very high seismicity on the Hinagu fault range immediately after the M6.5 event but not on the Futagawa fault range at this moment. The active seismicity on the Futagawa fault range started after the M7.3 event.

The seismicity between the northeastern tip of Futagawa fault and southwest of the caldera of the Mt. Aso has isolated by extremely fewer than its surroundings whereas seismicity dramatically increases after the M7.3 event. In this region and surroundings had been a moderate seismicity area and not been observed any significant difference from surroundings in terms of seismicity according to the background seismicity over 10 years due to JUICE catalog (Yano et al., 2015) in which all inland shallow hypocenters were determined by NIED Hi-net are re-determined by hypoDD. This region coincides with the area where coseismic slip amplitude during the M7.3 event becomes the maximum about 5 m in the depth down to 10 km, according to source inversion result by Kubo et al. (2016). This zone also coincides with thick low P-wave velocity zone (Matsubara and Obara, 2011) underneath.
The area around the Mt. Aso and Ohita prefecture have been seismic region from the past, according the JUICE catalog. The seismicity in this area has been observed along the lines, which run in both vertical and north dipping direction. After the M7.3 event, the seismicity in this area increased significantly. Majorities of the events can be traced where background seismicity had occurred

particularly in vertical direction. However, there are some aftershocks occurred where seismicity is not apparent from JUICE catalog. Their new activity has shaped a linear pattern running from northwest to southeast.

Keywords: Kumamoto earthquake, Seismicity, Earthquake relocation

