A review of observational studies on the hypocenter and crustal structure of the 2016 Kumamoto earthquake

*Hiroshi Shimizu[1]

1. Institute of Seismology and Volcanology, Faculty of Sciences, Kyushu University

Since an occurrence of M5.0 earthquake at the northern end of the Hinagu fault zone in 2000, an intensive seismic observation has been carried out deploying temporary seismic stations in the middle Kyushu. Thus the dense seismic network recorded the largest foreshock (M6.5) and main shock (M7.3) of the 2016 Kumamoto earthquake. Furthermore an urgent joint seismic observation by several universities and institutes in Japan was conducted immediately after the large shocks in order to investigate the detailed feature of the seismic activity and the crustal structure around the source region of the Kumamoto earthquake.

The hypocenter of the M6.5 earthquake of April 14 locates beneath the Hinagu fault zone. While the hypocenter of the M7.3 earthquake of April 16 locates about 5km WNW of the M6.5, and beneath the Futagawa fault zone. The seismic activity was distributed along both the Futagawa and Hinagu fault zones, and the induced earthquakes were activated along the Beppu-Shimabara graben. However, detailed hypocenter distribution and the focal mechanism solutions indicate that the strike and dip angle of the M6.5 fault do not coincide with those of Hinagu fault, and that the initial rupture of the M7.3 started at off-fault of the Futagawa fault. In addition, the aftershocks were not active at the fault plane on which the main rupture of M7.3 took place.

In the middle Kyushu, the high background seismicity had been observed, and the M5.0 earthquake in 2000 also took place in the source region of the 2016 Kumamoto earthquake. Inelastic strain distribution estimated by seismic moment tensor data implies that the source region corresponds to the relatively large strain area, which suggests the large inelastic strain created stress concentration. Although the N-S minimum principal stress is dominated in this region, the maximum and moderate principal stresses are spatially alternated. The complex fault system and seismicity could be attributed to such a uniaxial extension of deviatoric stress field.

Seismic tomography and magnetotelluric analysis show that the aftershocks mainly occur moderate to high seismic velocity and low conductivity area of fault zone. On the other hand, the high Vp/Vs ratio and conductive region exists below the large earthquakes. In addition to the stress concentration, the fluid supply from the lower crust probably triggered the large earthquakes and high-level seismicity.

Keywords: Kumamoto earthquake, hypocenter distribution, crustal structure

