Analysis of Crustal Defomations of Kumamoto Earthquake Obtained by JISLaD System Using GEONET Observation Data

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Introduction

We have developed the every-day automated analyzing system of all GEONET network sites, and have been analyzing GEONET observation data (RINEX data) since 2008 in Nippo Co. Ltd., and obtained daily and weekly coordinate solutions of all GEONET sites (Shimada et al., 2008, 2009, 2013, 2015). Moreover we have developed the Japanese Information System of Land Deformations (JISLaD) applying the GEONET coordinate solutions above obtained, and monitoring time variations of baseline lengths and crustal strains of the nationwide GEONET observation network (Itoh et al., 2015; Ukei et al. 2015a, 2015b).

Applying JISLad System, we deduced crustal deformations of the largest foreshock (M6.5) occurred at 21:26, April 14, 2016 (JST) by the fault movement in the northern part of Hinagu fault system, and the main shock (M7.3) occurred at 1:25, April 16, 2016 (JST) by the fault movement in Futagawa fault system.

In our system, we analyze routinely 24-hourly GEONET RINEX data from 0:00 to 23:59 UTC and obtain daily and weekly coordinate solutions. In the Kumamoto Earthquake, the main shock occurred 28 hour after the largest foreshock, but it is not possible to obtain daily solution routinely that do not include both the largest foreshock and the main shock, thus we manually analyze 24-hourly RINEX data from 13:00, April 14 UT (22:00, April 14 JST) to 12:59, April 15 UT (21:59, April 15 JST), and obtained the daily coordinate solutions which do not include the largest foreshock nor the main shock co-seismic deformations.

Co-seismic deformation

Using the weekly coordinate solution during April 7 and 13 before the largest foreshock, the daily coordinate solution between the largest foreshock and the main shock mentioned above, and the weekly coordinate solution during April 16 and 22 after the main shock, we obtained the co-seismic horizontal and vertical movements around the epicenters of the largest foreshock and the main shock.

In the co-seismic movement of the largest foreshock, the GEONET Johnan site (021071 site) west of the Hinagu fault moves 27 cm NNE and 5mm subsidence. The Kumamoto site (950465 site) north of the fault moves 12cm NNW and 3cm uplift. Those co-seismic movements are consistent with the theoretical movements when the northern part of the Hinagu fault moves right-lateral strike-slip.

Next in the co-seismic movement of the main shock, the Choyo site (960701 site) near northeast end of the Futagawa fault moves 99 cm SW and 25cm uplift. The Kumamoto site (950465 site) north of the southwest end of the fault moves 76 cm ENE and 19cm subsidence. The Johnan site (021071 site) south of the southwest end of the fault moves 28 cm ENE and 19cm subsidence. Three sites east of the fault move 21cm –13cm WNW to SW and maximum 9cm subsidence. The other sites north of the fault move almost north, and the sites south of the faults south in general. Those movements are generally coincided with the preliminary result of the co-seismic movement of the main shock released by Geospatial Information Authority of Japan (GSI).

Dilatational strain

We reduce triangulation network of the GEONET sites that does not contain the triangle across the seism generic fault both in the largest foreshock and the main shock, and calculate the distribution of the dilatational strain.
Both for the largest foreshock and the main shock, the distribution of the dilatational strain is consistent with those expected from the right-lateral strike slip, but the pattern does not show the representative one calculated from the theoretical dislocation theory.

Discussion and conclusion
The main shock of the Kumamoto earthquake (M7.3) is one of the largest earthquakes occurred by the active faults inland Japanese Islands in the recent 100 years. Moreover the Futagawa and Hinaku fault system locates the central part of Kyushu Island and the GEONET network sites are located surrounding the seism generic faults. However the observed co-seismic motions and the dilatational strain distribution do not show the expected clean pattern of the right lateral strike slip. This is caused by the fewer in number of the network site, spacing 10km-20km interval between the sites in this region. For the advanced study of inland earthquakes applying GEONET network, densification of the network sites (at least spacing of equal or less than 10km interval between sites) is thought to be necessary.

Keywords: GEONET network, co-seismic motion, dilatational strain, JISLaD

