Crustal deformation associated with the 2016 Kumamoto Earthquake and its effect on the magma chamber of Aso volcano

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The Mj6.5 earthquake (foreshock) struck the Kumamoto Prefecture on 14 Apr. 2016, and the Mj7.3 earthquake (mainshock) followed it on 16 Apr. 2016. Aso volcano which is recently active is located to east of their epicenters, and then it is concerned that the earthquake affects its volcanic activity. In this study, we derived fault models from crustal deformations obtained by InSAR analysis and estimated the effect of crustal deformation on the magma chamber of Aso volcano based on their models.

To detect crustal deformation, we used InSAR analysis with ALOS-2/PALSAR-2 data. In the period between the foreshock and the mainshock, a left-looking observation from descending orbit (observation from west sky) was carried out. We analyzed it with data observed before the earthquake and detected slant-range shortening and extension area to the west of the Hinagu Fault. This slant-range change distribution could be explained by 1m right-lateral slip in the fault with the strike which is the same to that of the Hinagu Fault. After the mainshock occurrence, several PALSAR-2 observations were carried out from various directions, and we analyzed PALSAR-2 data observed from six orbit tracks for the mainshock investigation. In all results, discontinuity of slant-range change along the Futagawa Fault was identified, indicating the main fault for this earthquake. Furthermore, steep gradient of slant-range change was also identified along the Hinagu Fault and east extension of the Futagawa Fault. Especially, it seems that the strike of east extension of the Futagawa Fault changes to northeast direction. Analysis of observed SAR data from east sky derived slant-range shortening in north of the Futagawa Fault and slant-range extension in south. On the other hand, results of SAR data from west sky showed opposite results. Such deformation can be roughly explained by right-lateral slip of the fault. However, slant-range change distribution is more complex; for example, slant-range extension was obtained in both sides of the fault around Nishihara village. We found that their slant-range changes could be reasonably explained by a model with four faults (F1-F4). F1 and F2 are along the Hinagu and the Futagawa Faults, and F3 corresponds to extension from the east end of the Futagawa Fault. Their faults have almost right-lateral slip. F4 was estimated under the Nishihara village and its rake angle was about 250 deg., including normal dip-slip component. From analysis of InSAR pair which didn't include mainshock occurrence time, local deformation along the fault was obtained, but obvious deformation associated with volcanic activity was not identified. At the time of this paper submission, the observation data of the volcano observation network (V-net) of NIED do not show significant change in volcanic activity of Aso Volcano.

Based on the revealed seismic fault models, we calculated the displacement and stress field around Aso volcano by FEM method to evaluate the effects on Aso magma plumbing system. Disturbances due to seismic faults are categorized into three types, i.e., static, quasi-static and dynamic effects, here we consider only static ones as a preliminary analysis. Suto (2006) suggested a magmatic reservoir at the 6km depth beneath Kusasenri region, in addition, Abe et al. (2010) implicated the sill source at 15km depth. In this evaluation, the estimated fault depths are about 0~10km, therefore, we only assume the shallower magma reservoir. The result shows complex distributions of displacements and stresses, but we can notice the following significant points: 1) the western part of magma reservoir experiences tensional stress about 10MPa toward southwest, 2) the magma reservoir deforms to an ellipsoid elongated to west-east. Displacement around the western part is

about 60cm westward, and the top of reservoir and Aso surface is downward about 10cm.

Keywords: Kumamoto Earthquake, Aso volcano, crustal deformation, Magma chamber

