Crustal Deformation of Kumamoto Earthquake –Surface Faults around Suizenji and Horizontal Displacements in Aso Valley

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Introduction

We constructed and analyzed the ground surface displacement associated with the 2016 Kumamoto earthquake sequence using satellite SAR images of the Advanced Land Observing Satellite 2. The deformation map derived from the SAR images generally shows elastic deformation caused by the main earthquakes but many other linear discontinuities showing displacement and large non-tectonic displacements are also found. In this presentation, we will introduce typical deformations occurred in a relatively flat terrain site and likely have influenced groundwater in Aso and Kumamoto area (Fujiwara et al. 2016, EPS; Fujiwara et al. 2017, EPSL).

Linear surface ruptures around Suizenji Park

Near Kumamoto city center, clear linear surface ruptures run from northwest to southeast (Fig 1) and we found minor surface breaks around Suizenji Park by field survey. In this area, dip-slip displacements are dominant and saw–tooth displacements are also found. This area is situated in an alluvial plain and the topography is rather flat. However, Fig 1 shows that one of the largest displacements coincides well with the topography (a height difference of only several meters). Therefore, some of these linear surface ruptures are likely to be hidden active faults that had moved in the past. The fact that their directions coincide with the conjugate faults of the Futagawa fault zone suggests that this group around Suizenji Park is closely related to activity of the Futagawa fault zone and that they have experienced simultaneous movement many times previously.

Large horizontal displacement in the Aso valley

Displacements reflect not only tectonic crustal deformation caused by main earthquake faults but also non-tectonic surface deformations. The largest deformations in the earthquake sequence were found in the Aso Valley, along the NW outer rim of the Mt. Aso caldera. Large, independent surface deformations occurred in three areas with diameters of 500 m–2 km in the Aso Valley, and each area was horizontally displaced more than 2m to the NNW (Fig 2). These areas are underlain by thick lake-bottom deposits of saturated silt with low penetration resistance. As the direction of the displacements was parallel to the ground slope in each area, the strong seismic motion of the earthquake most probably induced liquefaction in the lake-bottom deposits and the ground surface slid horizontally along the slope on the liquefied silt. Because the areas of the large displacements are closely related to the thickness and shape of the lake-bottom deposits, amplification of the seismic wave in these deposits likely contributed to the liquefaction. On the SSE side of the deformed areas, numerous graben-like ruptures developed. As these ruptures are caused by surface tension during the large horizontal displacement, they are not earthquake fault traces and the process of this deformation is non-tectonic.

Keywords: Kumamoto earthquake, Crustal deformation, Surface fault, Liquefaction, ALOS-2

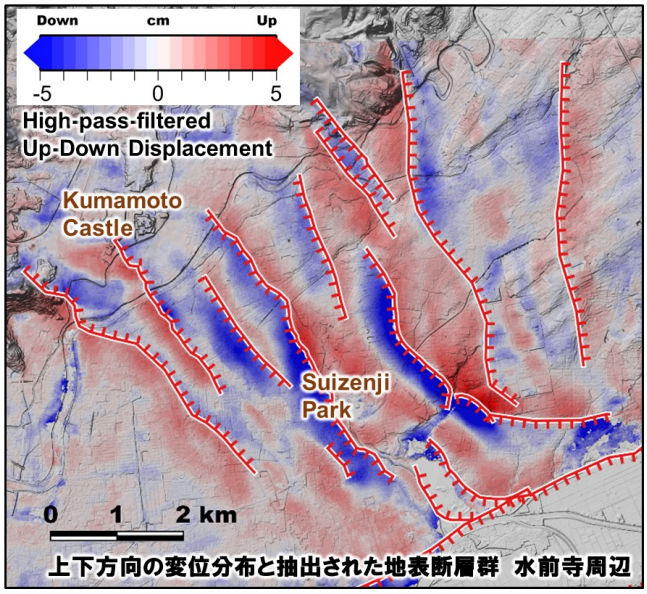

Fig 1. Up-Down displacement and detected surface faults around Suizenji

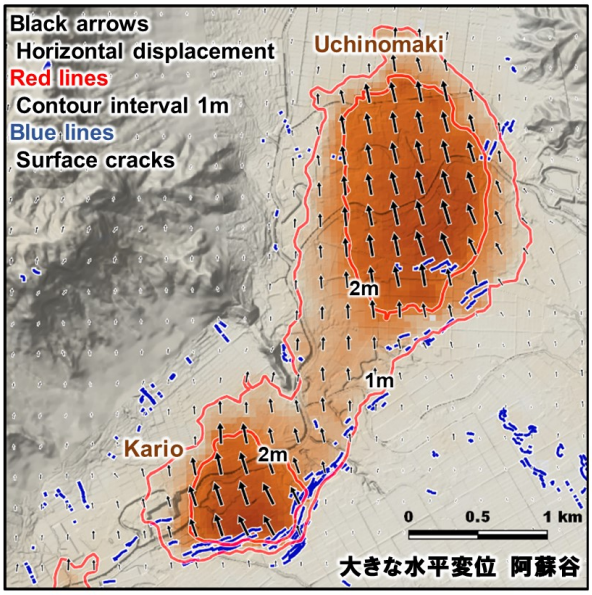

Fig 2. Horizontal Displacement in the Aso valley