

Vertical displacement in Naruko Volcano area following the 2011 Tohoku earthquake deduced from precise leveling survey

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Large subsidence accompanied the 11 March 2011 Great East Japan Earthquake along the Pacific coast. GEONET data have indicated that the subsidence goes down westward (<http://www.gsi.go.jp/common/000059956.pdf>). In a summer field seminar by the Division of Earth and Planetary Material Science, Tohoku University, we made precise leveling survey for 10km on the second-order leveling route along the National Route 47 (from benchmark number 047-064 to 047-074; hereafter indicated as BM64, BM74 etc.) which locates along the east to west in Naruko area, Miyagi prefecture, to detect the vertical crustal deformation of this area. We performed the leveling twice (23-28 August, 2011 and 19-25 August, 2013) using bar-code leveling rods (Leica CPCL3) and an electronic digital level (Leica DNA03). By comparison with the data by Geospatial Information Authority of Japan in 2009, we acquired the change of difference in elevation at each benchmark against the westernmost BM64. We conducted round-trip survey between each benchmark and re-measured when the residual error did not meet the first-order leveling, except the segments between BM66 and BM68 in 2011 and between BM72 and BM74 in 2013 due to the fixed seminar schedule.

Contrary to our expectation before the leveling, we found all benchmarks subsided against BM64 and the degree of subsidence increases westward. At the 2011 leveling 5 months after the earthquake, benchmarks BM66, 68, 70, 72, and 74 subsided 13.0mm, 21.4mm, 81.7mm, 91.1mm and 113.9mm, respectively. This subsidence continued further with decreasing the amount, 8.5mm, 16.2mm, 23.7mm, 41.9mm and 46.2mm between 2011 and 2013, respectively. Obtained displacement pattern along the leveling survey between 2011 and 2013 is almost similar pattern with the 2009 and 2011 one.

Ozawa and Fujita (2013) and Takeda and Fukushima (2013) showed local depressions on some major volcanic areas in Tohoku region by In-SAR analysis. They explained the depressions by the east-west extension of hot and soft medium under the volcanoes. Our research route locates on one of that volcanic area and our leveling result is consistent with their previous studies. In contrast, their analysis just focused on the coseismic displacement. In our analysis, we found not only subsidence during the coseismic stage but also the subsidence in the postseismic stage. Particularly, it is worth noting that the subsidence increases remarkably between BM68 and BM70, which is inferred to cross the rim of Naruko caldera.

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