

Vertical movement during recent half year and gravity anomaly in the Murono mud volcano, Niigata, Japan

Shigekazu Kusumoto^{1*}, Keiya Sudo², Mika Kawabata², Yoichi Fukuda³

¹Graduate School of Science and Technology for Research, University of Toyama, ²Department of Earth Sciences, the Faculty of Science, University of Toyama, ³Department of Geophysics, Graduate School of Science, Kyoto University

It is known that the surface in and around mud volcano located in Murono area, Matudai, Tokamachi City, Niigata, Japan, (we call this mud volcano simply the Murono mud volcano in the following) has been deformed extremely in vertical direction by large earthquake in the neighborhood. However, its inter-seismic vertical movement has not been known. In this study, we performed precise leveling periodically and attempted to obtain the inter-seismic vertical movement in the Murono mud volcano. We also performed precise gravity survey on the bench marks we set in the area and obtained Bouguer gravity anomaly, in order to estimate subsurface density structure in mud volcano and compare vertical movement with gravity anomalies.

The Murono mud volcano is the little mud volcano of the scale of length 100m and width 70m, and spouts gas and muddy water actively at present. We set up the bench marks of 61 in this mud volcanic area by the interval from several m to 20 m, and carried out the leveling of 5 times in June, July, October, November and December, 2012. We employed digital level for leveling, and obtained the elevation on each bench mark by the net adjustment. Accuracy of each observation was about 1.96mm/km. From observations during recent half year, we found that there are uplift reaching about 26 mm and subsidence of 14 mm in the Murono mud volcano. The uplift area obtained in this observation corresponds roughly to the uplift area obtained in the previous observations.

Bouguer gravity anomaly observed in the Murono mud volcano is negative gravity anomaly around -8.5 mGal, if Bouguer density is assumed to be 2400 kg/m³. The area where conspicuous vertical movement was observed has lower gravity in the Murono mud volcano area, and it indicates that there would be low density layer in shallow depth. Here, we expect that this low density layer consists of muddy water, from geological and geophysical surveys around this area.

We have guessed that overpressure change of the low density layer caused the vertical movement observed at the surface. However, the observation by leveling should be continued for a while, in order to show a cause of the vertical movements. And, as additional observation, it will be better that we will carry out precise gravity observation on the bench mark periodically in order to trace mass movement due to overpressure change.

[Acknowledgment]

This study was carried out by the discretionary budget of the President of University of Toyama. In addition, Waseda University permitted us to carry out gravity survey and leveling on the premises in the Murono area and helped us for some observations. We are most grateful to University of Toyama and Waseda University.

Keywords: Mud volcano, Leveling, Gravity anomaly, Vertical movement