GPR survey in mud volcanoes at Goshougake hot spring in Akita prefecture

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Mud volcano is defined as a mud diapr rising with high pressured pore water (Wakita, 1996). In this study, we investigated mud volcanoes in the area of Goshougake hot spring using GPR (Ground Penetrating Radar) in consideration of the target depth of 10 m.

In previous research, the study of isotopic geochemistry (Matsubaya et al., 1974), mapping of geothermal anomaly (Yuhara et al., 1985), and micro-tremors observation (Ehara and Kitamura, 1985) were carried out in mud volcano areas. But the study for detecting the symptom of the eruption of mud volcanoes in the near future has't carried out.

Mud volcanoes sometimes damage human life. The mud volcano in Sidoarjo, Indonesia was erupted in 2006 and the large amount of the erupted mud buried a residential area, factories, and a main highway (Tanigawa and Shimamoto, 2008). The study focusing on mud volanoes is important for disaster prevention. If we predict the eruption of mud volcanoes, we would be able to contribute to disaster prevention and/or mitigation. We carried out this GPR survey on the purpose of predicting the location of eruption of the mud volcanoes.

In this study, we used 4 kinds of anntena of 100 MHz, 270 MHz, 400 MHz, and 900 MHz with the GPR equipment SIR-3000 made by GSSI (Geophysical Survey System, Inc). We employed the profie measurement in the method of survey. We set the measurement lines covering all of sidewalk for sight seeing except for closed section to the public. There are steps in the parts of sidewalk at the slope. In the case of 100 MHz, 270 MHz, and 400 MHz, we put wooden boards on he steps and moved antennas on the boards. In the case of 900 MHz, invesitigation on the steps was avoided. We obtained the reflection sections in data analysis after time-zero correction, FIR filter processing, and background removal processing using the software RADAN exclusive to the GPR analysis. Depth scale in the reflection section is calculated with the relative dielectric constant $\varepsilon_r = 10$ considering the clay layer distributed on the surface of the survey area.

The results by 100 MHz, 270 MHz, and 400 MHz anntenas showed clear reflections appeared in the white alteration zone. Especially, the result of 270 MHz showed reflections most clearly. The result of 900 MHz didn't show anomalies on the alteration zone, but the reflection with hyperboric wave pattern was appeared at the location passing on a pipe under the sidewalk. The section of 900 MHz also showed continuous reflection series. The cntinuous series of reflections appeared at 0.4 - 0.5 m in depth suggests the interface of the bottom of the concrete roadbed on the soil layer. Consequently, the investigation using 900 MHz antena would be useful for maintenance of the sidewalk.

So far, on the obtained GPR sections, we are not so sure about the predicting the location of eruption of the mud volcanoes in the near future. We want to improve the accuracy of structure interpretation by the application of the deconvolution filter and the migration processing and so on using the seismic exploration analysis software Sesimic Un*x. In addition, we want to make the theoretical wave sections revealing the anomalies from mud volcanoes by forward modeling. We think the information of the distribution of electrical conductivity is useful, because it is thought that high conductive mud with water rises in the vent of mud volcano. So, we feel necessary to investigate the distribution of conductivity using the broadband frequency domain sensor GEM-2.

Keywords: Mud volcano, Ground Penetrating Radar, Dielectric constant