Joint analysis of gravity and magnetism to detect a vertical density boundary of ground

Chika Takahashi[1]; Hitoshi Morikawa[1]

[1] Dep. of Built Environment, Tokyo Inst. of Tech.

Characteristics of strong motion are affected by 3-D subsurface structure. Thus, it is important to estimate the subsurface structure in order to consider the earthquake disaster and its mitigation. Many researchers have applied various geophysical survey techniques to estimate ground structures, such as seismic refraction and reflection, microtremor, gravity, magnetic surveys and so on. The gravity survey, especially, is useful to estimate large area with appropriate accuracy the bedrock structure of the analysis based on the gravity survey requires some assumptions to obtain a stable solutions of ground structure, because there are many unknown parameters and trade-offs among the parameters.Thus, usually, we assume a two-layered medium with homogeneous density. This type of structure can explain the many of observed gravity date and agree with different type of information such as borehole data.We, however, have a few cases where we cannot explain physical phenomena using such the simple model; for example, a medium which has a vertical boundary of density in a layered medium.

To solve the above problems, Chandler et al.(1981) have proposed a technique to detect vertical boundaries, which area called Moving Window Poisson (MWP) analysis method. They combined the first vertical derivative of the gravity anomaly with total field magnetic intensity anomaly reduced to the pole. They, furthermore, discussed quantitatively the relationships between the structural boundary and and the properties of the anomalies through some model studies. Since their analytical model has loss reality of the ground structure, we consider more realistic model and discuss the applicability of the MWP method to real structures. As a result, we can find to detect a vertical boundary using MWP method. However, if there are many anomalous sources in the sediment, it is very difficult to detect a vertical boundary. To avoid this difficulty, we consider the relationships between the pseudo gravity anomaly and the gravity anomaly , which is called method B hereafter, instead of the vertical derivative of the gravity anomaly and total field magnetic intensity anomaly reduced to the pole. As a result, although, method B can find roughly location of the vertical boundary, it is very difficult to point out its exact location, because of the less sensitivity to the anomaly of the medium. Then, we propose a method to use simultaneously the both Chandler's method and model B. Using this new method, which is called method C, we can detect a vertical boundary exactly without any ambiguitity.

Furthermore, we applied the method to gravity and magnetic data observed around Niigata-ken Chuetsu region and tried to find some possible boundaries in this area. As a result, the mountainous area in the south-western part of target area is picked out because of its complicated structure which consists of sediment and volcanic rock. Furthermore, the mountainous area in the central and eastern part of target area is also detected. This area agree well with the boundaries between the formation of the late Pliocene and of the early Plicene.

For the future development, we will establish a model of the ground structure using the information on the location of the vertical boundary of the density.