A Model of 3-D Bedrock Structure Obtained from Gravity Survey around the Damaged Area by 2004 Niigata-ken Chuetsu Earthquake

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1. Introduction The Niigata-ken Chuetsu Earthquake of $M_J 6.8$ occurred on October 23, 2004 and brought serious damage to the Chuetsu region of mid-Japan. In this area, many active foldings are found and it is known that the subsurface structure is complex. In a case where we simulate the earthquake ground motions during the main shock, we need detailed information with respect to the subsurface structure including the 3-D shape of the boundary for the seismic bedrock. This kind of information, however, has not been provided enough in this time.

Thus, we carry out the gravity survey around Chuetsu region and estimate a 3-D shape of the upper boundary for the gravity basement.

2. Method of the Observation The observation area is located in 37°12'N to 37°33'N and 138°42'E to 139°00'E: 39km × 26km of NS – EW. Thus, the area includes Nagaoka, Ojiya, and a part of Uonuma. The observation sites with 2km intervals were set and some part was filled by 1km intervals. We spent 42 days for the observation during June to November, 2005 and obtained values of gravity at 397 sites.

We used Automated Burris Gravity Meter made from ZLS Corp. and LaCoste & Romberg Gravimeter, Model G made from Micro-g LaCoste Inc. for the survey. Locations of the observation sites were determined by the differential survey of GPS. The error of the position is less than 1m in the horizontal and vertical.

3. Results To ensure the stability of the analysis, we introduce the gravity data published as a CD-ROM[1], and calculate the Bouguer anomaly using the gravity data of 436 sites in the considering area. Using some well-known techniques, the assumed density is

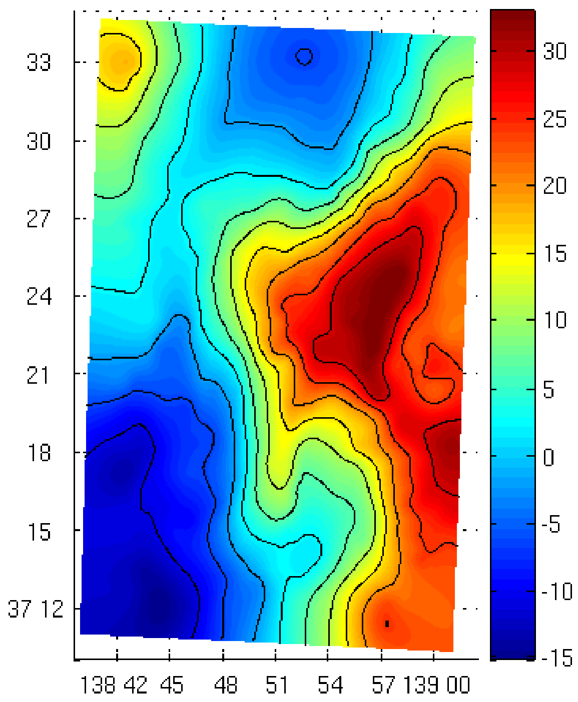

Figure 1: Bouguer anomaly (ρ= 2.40 [t/m^3]).

determined as 2.40 [t/m^3]. After some corrections of the data such as the terrain correction, the Bouguer anomaly map is calculated as shown in Figure 1.

Then, we estimate the 3-D gravity basement under the assumption that the ground consists of two layers: bedrock and sediment. The sediment is assumed as homogeneous medium with density of 1.90 [t/m^3].

To obtain a realistic model of gravity basement, we consider the follows: (1) to remove the contribution for the Bouguer anomaly from the deep structure such as upper mantle etc. and (2) to constrain the depth to the bedrock. For the former, a band-pass filter is applied to the Bouguer anomaly. For the latter, we give some control points: that is, 3 sites from array observations of microtremors[2], 5 sites from deep boreholes which reach

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to the bedrock[3], 2 sites from P- and S-wave reflection experiment[4], and 5 sites in mountainous area where the bedrock appears on the surface[3, 5]. The 3-D shape of the gravity basement, which is calculated by using a method proposed by Komazawa[6], is shown in Figure 2.

As a result, depth of the gravity basement reaches to more than 3000m at the northern part of Nagaoka. Furthermore, steep slopes of the gravity basement are observed around the marginal area of eastern mountains and a hollow is observed in the south-eastern area of the fault plane of the main shock.

4. Discussion Comparing the predominated directions of the slopes of the gravity basement with the strikes of the active faults, the directions correspond to the geological propereies. The obtained model of subsurface structure agrees with the results from some previous survey and researches such as deep borehole data etc.

Using the proposed model, we carried out a simple numerical simulation of the earthquake ground motion by an aftershock. The distribution of the maximum velocities (NS) is shown in Fig.3. From the simulation, it seems to be observed that the area with large amplitude of the ground motion corresponds to the severly damaged area. However, the synthetic motions do not strictly coincide with the observed ones at some sites. For the future de-

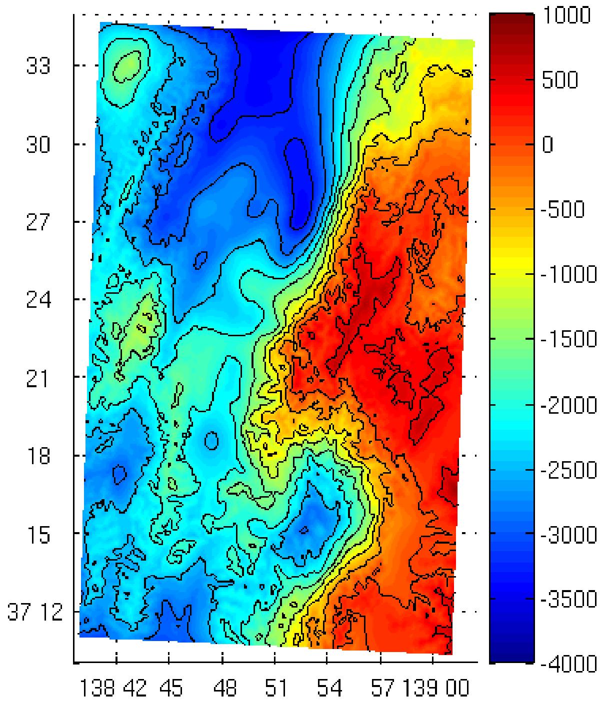

Figure 2: Altitude of gravity basement (density of the sediment: 1.9 [t/m^3]).

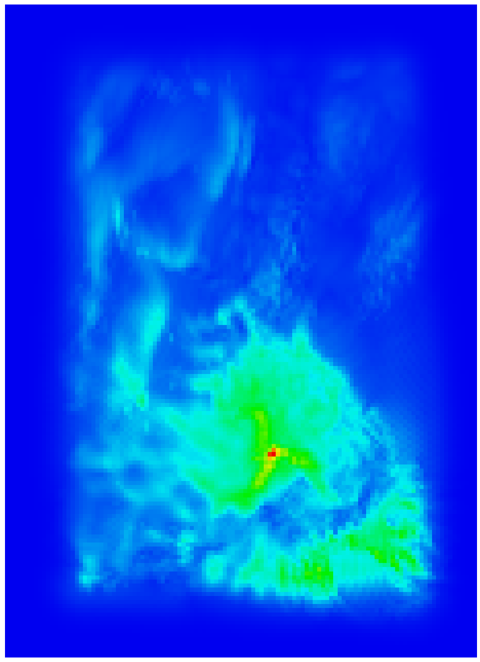

Figure 3: Maximum velocities (NS component) obtained by the numerical simulation of an aftershock.

velopments, thus, it is necessary to revise the model on the basis of the discussion of the differences between the synthetic and observed motions.

5. Conclusions We carried out the gravity survey around Chuetsu region and proposed a 3-D model of the subsurface structure which consists of two layers. Through the comparison with the results of some previous researches and numerical simulation of an afrershock, it is concluded that the proposed model of the subsurface structure can be used to explain the phenomena during the earthquake qualitatively. We would like to ackowledge NIED (K-NET and KiK-net), and Japan Oil, Gas and Metals National Corp. for their valuable data.

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