Estimating reservoir sedimentation by gravimetry technique: A case study in Tseng-Wen reservoir

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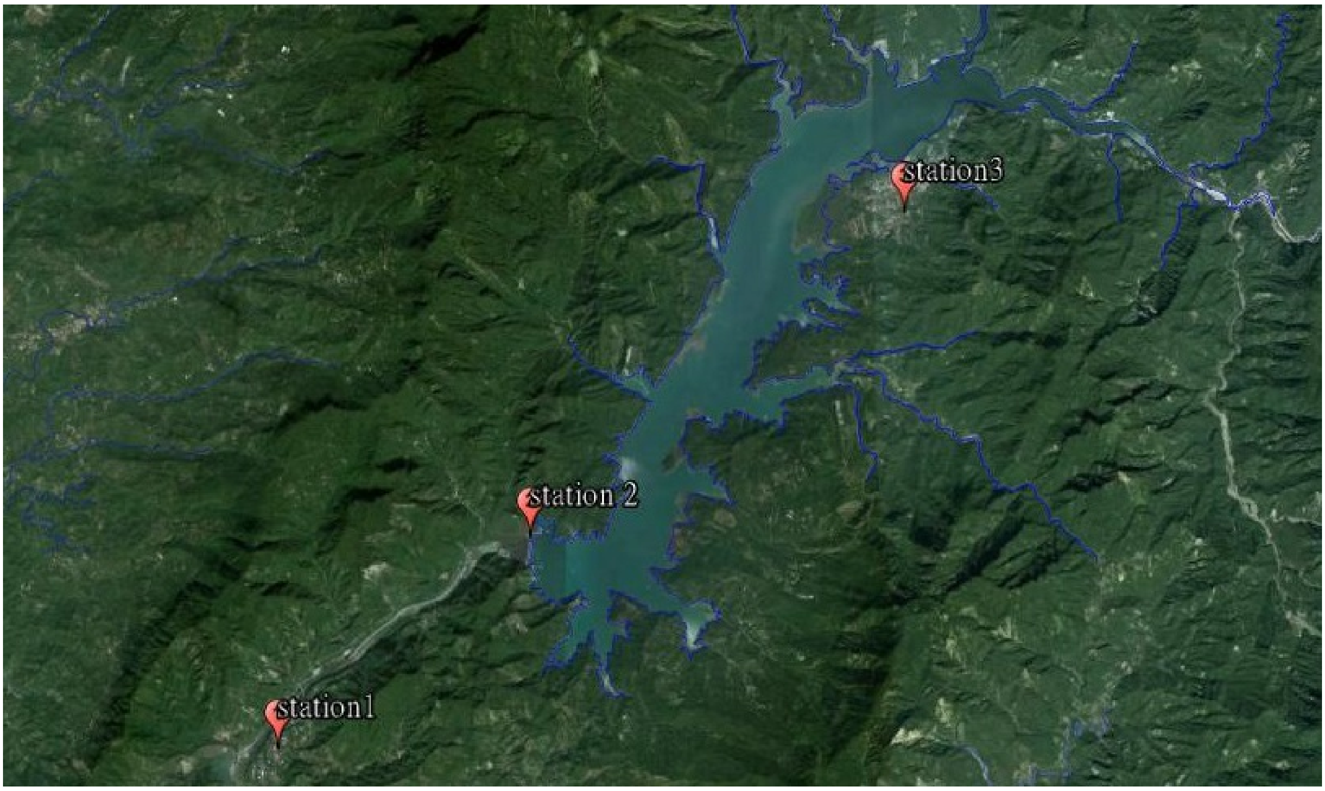
The study proposes a new method for estimating variation in reservoir sediment by gravimetry technique. The study area is located in Tseng-wen reservoir, which is the largest reservoir in Taiwan. Several field gravity surveys with FG-5 gravimeter have been carried out at three gravity stations surrounding the reservoir (shown in figure) during 2014~2016. The observed gravity values caused by the effects of ocean tide, polar motion, atmospheric pressure, and underground water will be well predicted and removed. The variation of Tseng-wen reservoir sedimentation derived from gravimetry technique will be compared to those derived from bathymetric Lidar. The purpose of the research is to develop a more efficient and economic method to measure the sediment variations in reservoirs, and subsequently bring contributions to soil and water conservation.

Keywords: gravimetry, reservoir sediment, FG-5 gravimeter



Density Structure beneath the Eastern Boundary Fault Zone of the Shonai Plain

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The Eastern Boundary Fault Zone of the Shonai Plain (EBFZSP), distributed along the boundary between the Shonai plain and Dewa hill, is located in the northwestern part of the Yamagata Prefecture. The NS striking EBFZSP is an active fault zone, which entire length of about 38 km. The east side of the fault zone is relatively up-lifting against the west side. The EBFZSP is divided into north and south based on the difference of the fault distribution type and activities. The shallow structure of the Matsuyama fault, the southern part of the EBFZSP, is clarified by seismic explorations. In this study, we report the gravity survey and the density structure analyses to explicate the subsurface structure and the forming history of the EBFZSP.

Gravity measurement was executed during 4-12 of August 2014 and 5-6 of March 2015 in and around the EBFZSP. The employed gravimeter is Scintrex CG-3M relative gravimeter. The exploration was also carried out along two seismic exploration lines. The total number of newly acquired gravity data are 177. All the existing gravity data available was also referred in the analyses.

After the traditional reduction process with reduction density as 2400 kg/m^3, the terrain correction with 10m-DEM and the slab correction for the long wavelength component was adopted. The horizontal and vertical 1st derivatives were calculated for the extraction of the geological discontinuities. We conducted the 2D talwani's method for the density structure analysis, and additionally the Tilt-Depth method was examined.

The Bouguer anomaly distribution in the study area is consistent with the geology, which shows low anomalies in the Shonai Plain and shows 50 to 60 higher values in the mountainous region. High horizontal gradient zone around 4 to 5 mGal/km and zero contour of the 1st vertical derivative lies in the Dewa hills, which develops at the eastern part of the fault zone. This gravitational characteristics are proved to be the Aosawa fault zone after the 2 dimensional density analysis. Compared with the distribution of the EBFZSP, the zero contour and the high horizontal gradient zone lies near (at most 3.5 km) the fault zone at the southern part. On the other hand, it is away (at most 9 km) at the northern part, where the fault zone is branching multiply.

The EBFZSP is thrust inclining eastward, which derived from the Aosawa Fault and migrating toward the plain. For the northern part, the complex derivation of the faults are shown in the surface topography and the faults are migrating more than southern part. On the contrary, the EBFZSP is directly derived from the Aosawa Fault and the subsurface structure is relatively simple for the southern part. Distance between the EBFZSP and the alignment of the gravity gradient characteristics is consistent with those structural difference between the northern and the southern part of the EBFZSP.

Keywords: Gravity Anomaly, Density Structure, Active Fault

The gravity anomaly data-set include the gravity data measured by Kanazawa university and published by many institutes

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We have released the gravity database using the measurement data by Kanazawa University, and this database is now available on web (Honda et al., 2012, J. Geod. Soc. Japan: http://earth.s.kanazawa-u.ac.jp/gravity_database.html). We made some efforts for visualization of the database, for example that users can see the gravity anomaly map on GoogleEarth$_{TM}$. We also constructed the high quality gravity anomaly data-set over Japan to discuss the potential of seismic activity in Japan, using our database and other data-set published by many agency (Honda et al., 2015, JpGU meeting).We improved the gravity database with the sea area by compiling the marine gravity measurement data around Japan. We used the MGD77 data-set published by Japan Oceanographic Data Center with the necessary correction like the major cross-over errors (Sawada et al., 2009, Rep. Hydro. Oceano. Researches). We are sure that this improvement is prospective for the research of the tectonic activities extending over the coast area.
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Keywords: Gravity Anomaly, Database

Heavy snowfall in East Antarctica and recent weakening of the Chandler wobble observed with the superconducting gravimeter at Syowa Station.

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Continuous gravimetric observations have been made with three successive generations of superconducting gravimeter (SG) over 20 years at Syowa Station (39.6E, 69.0S), Dronning Maud Land (DML), East Antarctica. The third-generation SG, OSG#058, was installed in January 2010. Five years of OSG#058 data from January 2010 to January 2015 were of high quality, with no missing data and with no step-like noise. So we could examine the long-period gravity variation precisely. Non-tidal gravity variations derived from the OSG#058 data showed significant correlation with the accumulated snow depth observed at Syowa Station. We inferred the gravitational effect of the accumulated snow mass (ASME) detected by OSG#058. Moreover, the accumulated snow depth at Syowa Station was found to represent heavy snowfall (the snow accumulation) in a broad region in DML, which was estimated from the Gravity Recovery and Climate Experiment (GRACE) satellite gravity data. Such snow accumulation around Syowa Station was detectable by OSG#058. A gravitational response to the Chandler wobble (CW) was deduced from the OSG#058 non-tidal gravity variations after correcting the ASME. The observed response agreed roughly with the predicted response in both amplitude and phase. We also found that recent CW weakened and its period gradually decreased. We will discuss the relation between the heavy snowfall in DML and the weakening of CW, which were observed with OSG#058.

Keywords: Superconducting gravimeter, Increase of snow accumulation in East Antarctica

Density structures estimated from gravity and airborne gravity gradiometry data in Kuju area, Oita prefecture

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An airborne gravity gradiometry survey was conducted by the Japan Oil, Gas and Metals National Corporation (JOGMEC) in the Kuju volcano and surrounding area, Oita prefecture, Japan. The density structure modeling was conducted using gravity data and the six components (G_{xx}, G_{xy}, G_{xz}, G_{yy}, G_{yz}, and G_{zz}) of airborne gravity gradiometry data. The high-density (2400 –2550 kg/m^3) areas were estimated below the middle and late Pleistocene volcanoes in the shouthern part of the study area at a depth of 0 to 2000 m below sea level. These high-density areas correspond to the distributions of the older Hohi volcanic rocks. Moreover, the high-density areas were detected in the northern area of the Hatchobaru geothermal power plant. These trends agree with the density structures estimated from the gravity data, but the differences can be seen in the shallower depth. It is possible that these differences is caused by the density of the gravity survey points and the spatial resolution between the gravity data and the airborne gravity gradiometry data.

Keywords: Gravity survey, Airborne gravity gradiometry survey, Density structure, Kuju volcano

