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Interaction of the solid Earth and the Antarctic ice sheet

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The Antarctic ice sheet, which relates to the global climate changes through the sea level rise and ocean circulation, is an essential element of the Earth system for predicting the future environment changes. Thus many studies of the ice sheet changes have been conducted by means of geomorphological, geological, geodetic surveys, as well as satellite gravimetry and satellite altimetry. However these studies thus far conducted have been affected by the large uncertainties of GIA (Glacial Isostatic Adjustment), which is the rheological response of the solid Earth to the ice mass loading. Therefore the precise estimation of the GIA effects is an urgent and the most important task for these studies. The effects of GIA, on the other hand, include valuable information about the rheological properties of the solid Earth. Thus the observational studies of the GIA effects should greatly contribute to investigate the inner structure of the Earth. GIA as a keyword to investigate the interaction between the solid Earth and the ice sheet changes is an important research target not only for a practical requirement of predicting global changes but also for a more pure scientific interest to know the structures of the deep Earth's interior.

In view of these points, we plan to conduct geomorphological, geological and geodetic surveys in the inland mountain areas and the coastal areas in East Antarctica, where the in-situ data for constraining GIA models are very few. In addition, we will conduct very precise monitoring of the land movements at Syowa Station using space geodetic observations such as SLR (Satellite Laser Ranging) and VLBI (Very Long Baseline Interferometer) as well as sea bottom geomorphological surveys on continental shelves using new technology of ROV (Remotely operated Vehicle) and AUV (Autonomous Underwater Vehicle). Combining these observations with the analyses of the sea bottom cores obtained by the bowling surveys on the continental shelves, various satellite data analyses and numerical modeling, we will precisely estimate the response of the solid Earth due to the GIA effects and corresponding sea level changes. These procedures lead us to a precise GIA model and constructing a reliable ice melting history after LGM (the Last Glacial Maximum) and the viscoelastic structure of the Earth's interior.

To achieve the above target, we mainly plan to conduct the following research items;

(1) glacial topographic surveys, geological surveys, gravity measurements, and GNSS measurements in Yamato Mountains,

(2) reevaluations of the glacial topography in Sor-Rondane Mountains, Belgica Mountains, and Yamato Montains by combining the in-situ data thus far obtained with the newly developed DEMs (Digital Elevation Model) using satellite data,

(3) continue the geodetic observations including the tide gauge monitoring at Syowa Station,

(4) absolute gravity measurements and GNSS measurements at the outcrops along the coastal area near Syowa Station,

(5) micro glacier topography analysis of the detailed airborne photographic data obtained by an unmanned aerial vehicle near the outcrops,

(6) improving the accuracies of the retreat ages of the ice sheets using the cosmogenic nuclide exposure ages of the basement bowling samples and the moraine rocks,

(7) precise monitoring of the present day ice sheet movements and sea level changes by means of InSAR, satellite gravimetry and altimetry.

Including all these observations, data analyses and various modeling, we finally aim at the quantitative reconstruction of the ice melting history over the last millions years, and the improvement of the models for predicting the future global changes.

Keywords: ice sheet, sea level change, Glacial Isostatic Adjustment, ice sheet melting history, East Antarctica, viscoelastic structure