3-D Numerical Simulation of Island Arc Deformation Due to Steady Plate Subduction

*Yutaro Mori[1], Yukitoshi Fukahata[2]

1. Graduate School of Science, Kyoto University, 2. Disaster Prevention Research Institute, Kyoto University

Island arc-trench system is characterized by a pair of anomalies in topography and free-air gravity, which is high in the island arc and low around the trench. Although this feature is observed without exception in the world, physical mechanism of the formation of this feature has not been well understood. Fukahata and Matsu'ura (2016) calculated deformation of the island-arc lithosphere due to steady plate subduction for a 2-D problem and explained the deformation mechanism based on the combination of lithospheric rotation and gravity. However, 3-D geometry of the plate interface may have an important effect on lithospheric deformation. For example, a large negative gravity anomaly is observed around a bend of a trench axis (Sandwell and Smith, 1997). This feature has been well reproduced by a numerical model (Hashimoto et.al., 2008), but the physical mechanism of the formation has not been clarified yet.

In this study, we develop a 3-D numerical model based on elastic-viscoelastic dislocation theory and compute lithospheric displacement rates in the island arc-trench system caused by steady slip on a plate interface, which has a convex bend toward the island arc along the trench axis. Computed results show that the island arc lithosphere significantly subsides around the bend, where horizontal extension parallel to the trench axis is observed. This result suggests that the slip vectors that have the direction away from the bend along the trench in the overriding plate results in mass deficit around the bend and subsidence of the island-arc lithosphere.

Keywords: island-arc trench system, steady plate subduction, free-air gravity anomaly

