Continental oceanic crustal transition at the rifted margin around Lutzow Holm Bay, East Antarctica, from airborne gravity anomaly

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The rifted margin around Lutzow Holm Bay is a key area to reveal the breakup of Gondwana because this area is considered to be a junction of Africa, India, Madagascar, and Antarctic continents from the reconstruction model of Gondwana. In January 2006, the National Institute of Polar Research (NIPR) and the Alfred Wegener Institute (AWI) have conducted Japan-Germany Joint Airborne Geophysical Surveys over this area. The survey of 1000 km-long north-south trending flight lines with the spacing of 20 km, covered the area of 500,000 km2 using aircraft Polar2 (Dornier 228) of AWI. In this study, we will show the comprehensive crustal thickness variations over the area from the calculated airborne free-air gravity anomalies. Then, we will estimate the continent ocean boundaries and discuss the regional difference in the crustal stretching process and magmatism during the breakup of Gondwana.

The position of the aircraft was recorded by two GPS receiver for the post-processing. Differential GPS positions were calculated for each flight by kinematic GPS positioning using the Trimble Geomatic Office software (Trimble Navigation Limited). Free-air gravity anomalies were calculated by subtracting the normal gravity field data from the observed gravity field data with the corrections applied for the instrumental drift, the Etovos effect and the gravity effect caused by the different flight levels. Then, Bouguer gravity anomalies were calculated by subtracting the predictable gravity signal due to the density boundaries from the obtained free-air gravity anomalies. The bathymetric data collected on board Icebreaker Shirase during the Japanese Antarctic Research Expeditions, the ice thickness variations collected by ice-penetrating radar during this airborne survey and the global digital map of sediment thickness data (Laske and Masters, 1997) were used for this calculation. Moreover, the crustal thickness variation was estimated from the calculated Bouguer anomalies over the area around the continent-ocean boundaries.

We have clarified the variations in the crustal thickness over the continental ocean boundaries around Lutzow Holm Bay. The crustal thickness along the NNW-SSE direction of the Gondwana breakup (Nogi et al., 2004), abruptly decreases from 28-33km on continent side to 8-14 km on the ocean side. And the average direction of the maximum gradient of the crustal thickness is almost same as the direction of the Gondwana breakup. This decrease of the crustal thickness is affected by the process of the crustal transition from continental to oceanic crust during the Gondwana breakup. Continental rifting consists of the crustal stretching and the magmatism to create new oceanic crust. So, we interpreted the start of this abrupt decrease of the crustal thickness as the continent ocean boundary. The variation in crustal thickness along the direction of the Gondwana breakup divided three parts. At the continental side of the continent ocean boundaries, the crustal thickness is more than about 28-33 km with continental crust, while at the ocean side, there are two regions which crustal thickness changes abruptly and gradually further ocean side. In the part of the abrupt crustal thickness change, the regional differences exist in the scale of about 50 km along the strike of continent ocean boundaries. There are two regions which have relatively lower Stretching factor B of about 2-3 and relatively higher about 3.5-5. The region of the lower stretching factor 2-3 corresponds with bathymetric high of 1000-1500m. The gradient of the crustal thickness change is the relatively smaller about 0.2. On the other hand, in the region of the higher stretching factor 3.5-5, no such bathymetric high is observed and the gradient of the crustal thickness change is the relatively higher about 0.4. These differences in the crustal thickness variation can be brought from the regional difference in the mantle potential temperature.