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Analysis of Marine Gravity Anomalies in the Ulleung Basin (East Sea/Sea of Japan) and Its Implications for the Architecture of Rift-Dominated Backarc Basin

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Marginal basins locate between the continent and arc islands often exhibit diverse style of opening, from regions that appear to have formed by well-defined and localized spreading center (manifested by the presence of distinct seafloor magnetic anomaly patterns) to those with less obvious zones of extension and a broad magmatic emplacement most likely in the lower crust. Such difference in the style of back-arc basin formation may lead to marked difference in crustal structure in terms of its overall thickness and spatial variations. The Ulleung Basin, one of three major basins in the East Sea/Sea of Japan, is considered to represent a continental rifting end-member of back-arc opening. Although a great deal of work has been conducted on the sedimentary sections in the last several decades, the deep crustal sections have not been systematically investigated for long time, and thus the structure and characteristics of the crust remain poorly understood. This study examines the marine gravity anomalies of the Ulleung Basin in order to understand the crustal structure using crucial sediment-thickness information. Our analysis shows that the Moho depth in general varies from 16 km at the basin center to 22 km at the margins. However, within the basin center, the inferred thickness of the crust is more or less the same (10-12 km), thus by varying only about 10-20% of the total thickness, contrary to the previous impression. The almost-uniformly-thick crust that is thicker than a normal oceanic crust ($\sim$ 7 km) is consistent with previous observations using ocean bottom seismometers and recent deep seismic results from the nearby Yamato Basin. Another important finding is that small residual mantle gravity anomaly highs exist in the northern part of the basin. These highs are aligned in the NNE-SSW direction which correspond to the orientation of the major tectonic structures on the Korean Peninsula, raising the possibility that, though by a small degree, they are a consequence of localized extension and extra crustal thinning at the time of basin formation. Alternative explanation is that they are the result of a small post-rift underplating at the base of the crust. Two important processes appear to have shaped the Ulleung Basin following its formation: post-rifting magmatism which occurred in the north, especially in the northeast sections of the Ulleung Basin, and the deflection of crust in response to preferential sediment loading towards the south. The median high in the basin may be a consequence of the flexural bending. Based on our evidence for almost-uniformly-thick crust, we argue that, unlike many other rift-dominated basins which exhibit large variations in crustal thickness, decompressional melting that took place during basin extension resulted in a widespread magmatic emplacement that not only smoothed but also enhanced the crustal thickness.