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Seismic anisotropy of oceanic islands in East Sea of Korea from P-receiver functions: Implication for tectonic origin of the backarc basin

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The volcanic islands (Dok, Ulleung, and Jeju islands) in East Sea of Korea sit on a backarc basin behind the Japan island arc. East Sea of Korea consists of three ocean basins (Ulleung, Japan, and Sato basins) formed since pre-Oligocene. Of the three basins, Ulleung Basin is least studied and only previously considered to include remnant continental block in the northern end of the basin, where Dok Island and Ulleung Island are located. We investigate seismic evidence of an ancient rifting in a lithospheric structure beneath the islands and eastern margin of Korean Peninsula using teleseismic P-to-S converted phases. Seismic anisotropy in particular can be a signature of the mantle flow during the subduction and extension process. By computing and modeling receiver functions, we retrieve detailed crustal and uppermost mantle structure and anisotropy, and use these geophysical results to understand the origin of the islands and the tectonic evolution of the back-arc basin.

Our analysis shows three main results: (1) thicker than normal oceanic crust ($\sim$20 km) beneath the islands; (2) a dipping Moho under Jeju and Ulleung islands; (3) a presence of lithospheric seismic anisotropy under Jeju Island. In particular, a strike of dipping Moho varies within Ulleung Island (extending 50 km laterally), which can be explained by isostacy. This evidence supports the existence of ancient continental block within northern part of Ulleung Basin. Strength of anisotropy under Jeju Island is approximately 10 % in both P- and S-wave velocities with fast symmetric axis in about N20°E within the crust. Three islands all show dissimilar seismological properties despite of their temporal proximity to the formation and opening of the backarc. This heterogeneous character of the region can be explained by the injection of mantle volatiles in response to the dynamics of the subduction system.