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Mechanisms for asymmetric back-arc basin distribution: stagnant slabs and slab induced mantle flow

Tomoeki Nakakuki[1*], Erika Mura[2]

[1]Earth Planet Sys Sci, Hiroshima Univ, [2]Earth Planet Sys Sci, Hiroshima Univ

The most of back-arc basins are located in the western Pacific region. Dynamical mechanisms for this asymmetrical distribution have not been revealed because driving forces for generating the back-arc basin has not been well understood. We here pay our attention for the relationship between the back-arc basin and stagnant slab distribution because the mechanism to generate stagnant slab is inconsistent with an eastward wind model (Doglioni, 1993) for the back-arc basin formation. In this study, we examine back-arc lithosphere deformation induced by the backward slab motion due to the self-gravitational instability using numerical simulation. Slab interaction with the phase transition is considered as a mechanism to generate the subducted slab rollback (Nakakuki et al., 2010). We construct two-dimensional (2-D) models of integrated subduction system with a dynamically subducting lithosphere under a movable and/or deformable overriding lithosphere based on our previous study. Weakening of the back-arc lithosphere due to hydration from the subducted slab (Peacock, 1991; Iwamori, 1998) is introduced to the models. Yield strength of the hydrated back-arc lithosphere is treated as a varying parameter to examine driving force magnitude of the trench retreat and its effects on back-arc opening speed and duration. We found that the overriding plate motion driven by the basal drag from mantle wedge flow induced by the descending slab has a key role that determines compression or extension of the back-arc lithosphere. Viscous drag of the slab-induced flow tends to generate back-arc compression because the viscous drag promotes oceanward motion of the overriding plate. Back-arc extension is therefore generated only when the overriding plate motion is prevented from the oceanward motion resisting to the viscous drag. This immobility of the overriding lithosphere may be partly generated by large surface area of the Eurasia plate.

Keywords: subduction, back-arc basin, stagnant slab, mantle convection