Where are the Proto-South China Sea Slabs? SoutheastAsia Plate Tectonic and Mantle Flow Insights from TERRA Global Mantle Convection Models

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Abstract

In this study we explored the contrasted plate tectonic reconstructions proposed for the proto-South China Sea and southeast Asia. We implemented four different endmember plate models into global geodynamic models to test their predicted mantle structure against tomography. All models reproduced the Sunda slabs beneath Peninsular Malaysia, Sumatra and Java and the proto-South China Sea (PSCS) slabs beneath present Palawan, northern Borneo, and offshore Palawan; some models also predicted slabs under the southern South China Sea. PSCS slabs generated from double-sided PSCS subduction and earlier Borneo rotation generated a slightly better fit to tomography but pure southward PSCS subduction was also viable. A smaller Philippine Sea plate (PSP) with a short ~1000 km restored northern slab (i.e. Ryukyu slab) was clearly superior to a very long >3000 km slab. Mantle flows generated from our geodynamic models suggest strong upwellings under Indochina during the late Eocene to Oligocene. Strong mantle downwellings under the South China Sea in the late Cenozoic that did not support a deep-origin 'Hainan plume'. The following plate model variants were assimilated in the geodynamic models: (1) southward vs. double-sided PSCS subduction; (2) early Borneo counterclockwise rotations during the Oligocene to Early Miocene vs. later rotations (mid- to Late Eocene and Early Miocene); (3) a smaller Philippine Sea plate restored with a shorter ~1000 km northern slab vs. a longer >3000 km slab. This study assimilates four different plate models into the numerical

model TERRA (Bunge et al., 1998). The implemented plate models were digitally built in GPlates (Boyden et al., 2011) as a set of continuously closing plates in order to generate a global self-consistent velocity field for assimilation into the convection models. The temperature fields were converted to seismic velocities assuming a Pyrolite composition and equilibrium mineralogy. We quantify the correlation between our geodynamic models and seismic tomography within Southeast Asia and show dynamic topography predictions from our models.