Where are the proto-South China Sea slabs? SE Asian plate tectonics and mantle flow history from global mantle convection modeling

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In this study we explored the contrasted plate tectonic reconstructions proposed for the proto-South China Sea and SE Asia, including Philippine Sea plate tectonics near Japan. We implemented four different end-member 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. Our preferred model had a smaller PSP overriding a vanished ocean south of Japan; this model produced slab anomalies south of the Ryukyu trench at ~400-800 km depth that best match seismic tomography.

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). We digitally re-built in GPlates (Boyden et al., 2011) the implemented the plate models as a set of continuously closing plates in order to generate a global self-consistent velocity field to be assimilated 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 SE Asia. For the tomography models S40RTS and LLNL-G3Dv-JPS we explicitly accounted for their finite resolution (Ritsema et al., 2011; Simmons et al. 2019).

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