Where are the proto-South China Sea slabs? SE Asia plate tectonic and mantle flow insights from TERRA global mantle convection models

Yi-An Lin, Lorenzo Colli, and Jonny Wu
University of Houston, Earth and Atmospheric Sciences, Houston, United States of America (ylin51@uh.edu)

In this study we explored the contrasted plate tectonic reconstructions proposed for the proto-South China Sea and SE Asia. 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. Mantle flows generated from our geodynamic models suggest strong upwellings under Indochina during the late Eocene to Oligocene. Our models generated strong downwellings under the South China Sea in the late Cenozoic that did not support a deep-origin ‘Hainan plume’.

The following plate models 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).