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Crustal structure of the conjugate margins of the SW South China Sea from wide-angle refraction seismic data

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The South China Sea (SCS) is the largest marginal basin of SE Asia. While the NE part of the SCS northern margin exhibits ∼400 km of extended continental crust, its SW part shows nearly 800 km of extended continental crust, which makes it one of the widest rifted margin in the world. The debate around the mechanisms of formation of such a wide margin is complicated by the lack of a long enough refraction seismic profile. In June 2011, Chinese and French scientists conducted a joint geophysical experiment on board the R/V Tan Bao across the SW sub-basin of the SCS. A 1000-km-long wide-angle refraction seismic profile was acquired along the conjugate margins using a total of 50 Ocean Bottom Seismometers (OBS). 41,100 first refraction and 6,622 PmP reflection arrival traveltimes have been picked. We performed a joint reflection and refraction traveltime tomography inversion to obtain a 2-D velocity model of the crustal and upper mantle structures.

Based on this new tomographic model, we show that the northern and southern margins share common structural characteristics: (1) an average crustal thickness of only 12 km, barely varying along the 800 km-long conjugate margin width, and (2) crustal scale lateral velocity variations. These lateral variations correlate well with seismic reflection observations of the crustal structures. The upper-middle crust shows clear lateral velocity variations defining low velocity bodies (LVB) bounded by large-scale normal faults. Major sedimentary basins are located above the LVBs, interpreted as hanging-wall blocks.

The Moho interface remains rather flat (less than 4°) over the extended domain, suggesting that large normal faults root in a ductile lower crust, allowing isostatic compensation of the large normal fault blocks. Along the northern margin, the wavelength of the LVBs decreases from 90 to 45 km as the total crust thins toward the Continent-Ocean Transition (COT). The COTs are narrow and slightly asymmetric: 60-km-long on the northern side, and no more than 30-km-long on the southern side.

Extension across the conjugate margins of the SW SCS is distributed on small-scale and large–scale normal faulting with a spacing of ∼15-30 km and ∼45-90 km respectively. These two wavelengths of extensional deformation may directly relate to the presence of competent layers, here, the upper-middle crust and the shallow upper mantle, separated by a ductile lower crust. The extreme and homogeneous stretching is distributed symmetrically over both conjugate margins.