Seismic Imaging of the SW South China Sea Deep Crustal Structure shows Evidence for a Ductile Lower Crust during Rifting.

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The South China Sea (SCS) is the largest marginal basin of SE Asia. Yet its mechanism of formation is still debated. 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. In June 2011, Chinese and French scientists conducted a joint geophysical experiment across the SW sub-basin of the SCS. A 1000-km-long wide-angle refraction profile (in red in Figure 1B above) has been acquired along the conjugate margins using a total of 50 Ocean Bottom Seismometers (OBS). A coincident multichannel seismic (MCS) line was also shot using a 6-km-long streamer and a 6600 cu.in. Airgun array.

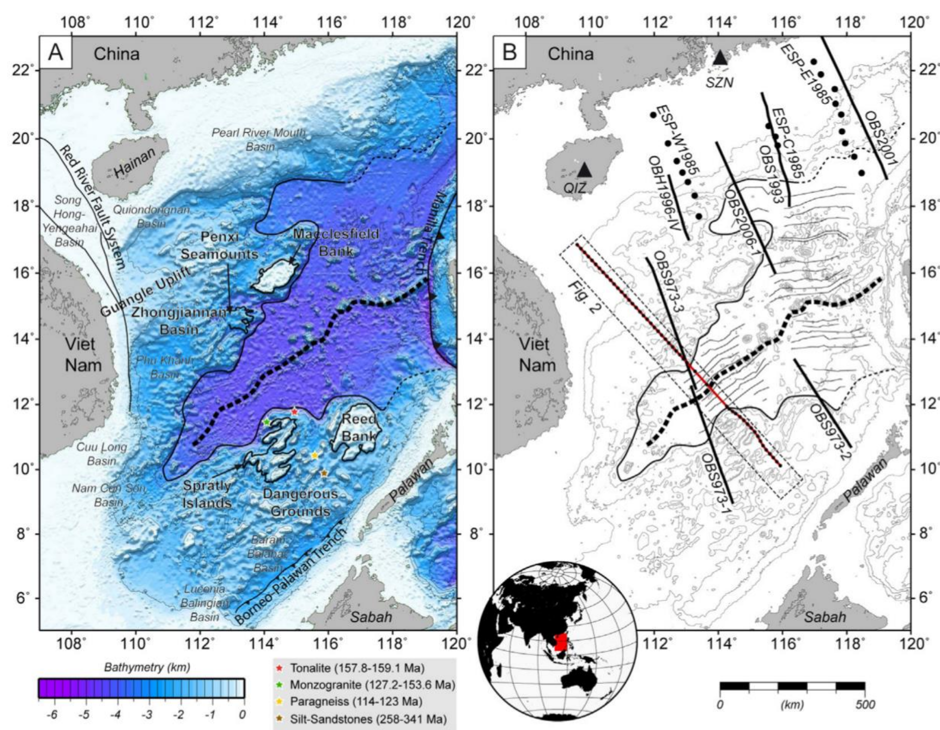
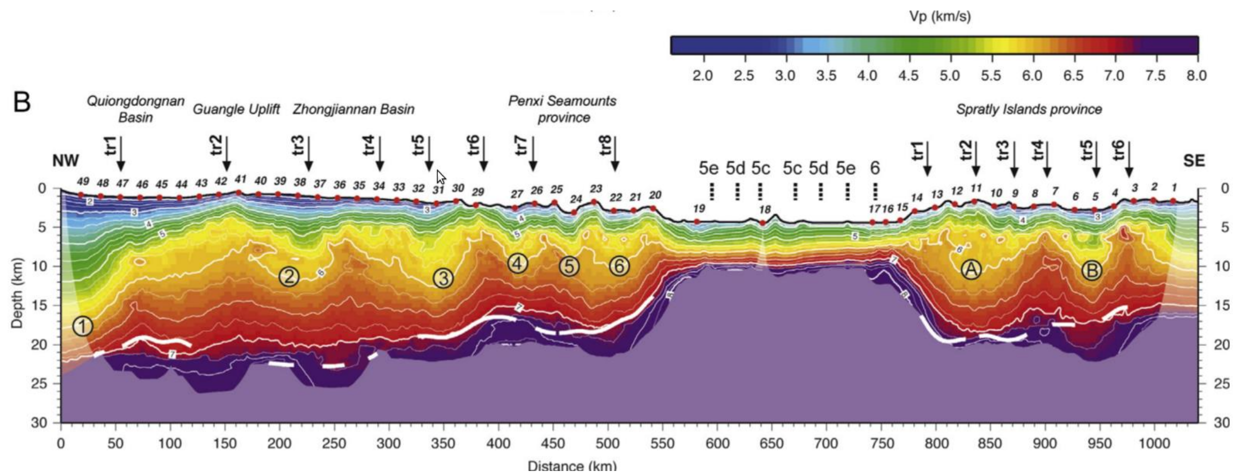


Figure 1: Map of the South China Sea. The red line corresponds to the OBS/MCS line. The corresponding refraction velocity model is displayed in Figure 2.

41,100 first refraction and 6,622 PmP reflection arrival traveltimes have been picked from the refraction dataset. A traveltime tomography inversion was first performed to obtain a 2-D velocity model of the crustal and upper mantle structures (Figure 2). Ray coverage is sufficient to image the entire crustal thickness down to the upper mantle. The Moho depth is displayed in white (Figure 2) in areas where the PmP Moho reflections are observed.

Figure 2: First-arrival traveltime tomography P-wave velocity model using the TOMO2D code.



Based on this new tomographic model, northern and southern margins are found genetically linked since they share common structural characteristics: an average 12-km-thick crust and crustal scale lateral velocity variations. Ongoing processing of the MCS line shows that these lateral variations correlate well with seismic reflection observations of the crustal structures. Small-scale normal faults (grabens and horsts, with a spacing of ~15-30 km) are often associated with an apparent tilt of the iso-velocity contours affecting the upper crust. The upper-middle crust shows clear high lateral velocity variations defining low velocity bodies (LVB, see circled digits or letters in Figure 2) bounded by large-scale normal faults (also referred as “Throughgoing crustal faulting”). Major sedimentary basins are located above the LVBs, interpreted as hanging-wall blocks (Figure 2). The Moho interface remains rather flat (less than 4°) over the extended domain, suggesting that large normal faults root in a ductile lower crust, where sub-horizontal reflectors are observed in the seismic reflection profile. 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). On both refraction and reflection seismic profiles, 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.