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Reappraisal of Cenozoic crustal evolution of the northern margin of the South China Sea by Land-Sea correlation

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The extended continental crust overlain by sedimentary basins at the northern margin of South China Sea (SCS) is considered to be a perfect site for the studies of rifting mechanism and lithospheric evolution. Our group constructed crustal-scale cross sections running from ∼250 km inland to the oceanic crust of SCS by synthesizing geological data from field investigations, industrial wells, seismic profiles and models derived from gravity and magnetic data.

Our synthetic cross sections suggest that upper-crustal structures in the offshore area largely resemble their onshore counterparts – both showing two levels of décollement. A major one (<15 km) controls basal faults resting on the brittle-ductile transition; they allow the rotational sliding of crustal blocks and also the exhumation of mid-crust level materials (gneiss and granitoids). The shallower décollement (<8 km) hosts distributed listric–normal faults that accommodated local extension. Their development led to tilting of Paleozoic strata and provided major sites for basin formation (e.g. Luoding Basin; Sanshui Basin and Kaiping Basin; all NE-trending). In the Mirs Bay Basin along the shore, tilting of late Cretaceous – early Tertiary formations indicates a post-Eocene NE–SW extension. Offshore, in the Pearl River Mouth Basin, the upper crust is thinned by a factor of about 1.5. This section of crust exhibits a greater spacing between the major detachments, more extensive secondary detachments, resulting in several ENE-trending sags, filled with Miocene–Pliocene sediments. This implies continuation of extension after the cessation of seafloor spreading. On the other hand, the lower crust seems to maintain a relatively uniform thickness along the section until it makes a jump below the shelf and gradually thins towards the oceanic crust.

Based on the above observations and the estimated rate of lithospheric extension from literatures, we suggest a three-stage model to explain the evolution of this margin – 1) Continental rifting from the Late Cretaceous to mid Eocene which generated the lacustrine basins that are present onshore and offshore, 2) Oligocene thinning mainly accommodated by the plastic deformation of the lower crust and probably the lithospheric mantle which gave rise to the COT when both the regional extension and the seafloor spreading were at their peak, and 3) post-early Miocene basement drop/ subsidence of the crust between the shore and the shelf. The origin of this localized extension is unclear. We suggest a combined effect of the sediment flux from the Pearl River and the cooling of the adjacent ∼20 Ma–old oceanic crust as origin.