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Breakup mechanism of the northern central continental margin of the South China Sea

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Based on geophysical studies and scientific ocean drilling along the North Atlantic rifted continental margins, two end-members of the rift-to-drift process were established: Volcanic rifted margins with anomalous magmatism versus magma-poor (non-volcanic) margins with extremely limited magmatism associated with continental breakup. In addition to a characteristic upper crustal structure showing seaward dipping reflector sequences (SDRS), the volcanic rifted margins also host a lower crust with anomalously high seismic velocity (Vp higher than 7 km/s). This lower crust is often referred to as underplated highly mafic material. Serpentinized mantle lithosphere has been proven to exist at the conjugate non-volcanic rifted margins of Iberia and Newfoundland, demonstrating a profound contrast to the structure of volcanic rifted margins. In brief, volcanic rifted margins are hypothesized to be associated with deep mantle plumes, while non-volcanic, Iberia-Newfoundland type margins are linked to deep faults that allow water penetrating into the lithospheric mantle. The latter causes a profound weakening of the continental lithosphere in support of final breakup. Interestingly, the northern continental margin of the South China Sea (SCS) between longitude 114.5^{o} and 116.5^{o} host features that might be similar to both of the two end-members defined in the North Atlantic. Wide-angle seismic studies suggest that below the inner margin, crustal underplating of high velocity material is present, while syn-rift as well as post-rift intrusive features can be seen by reflective seismic data and have in places been verified by industry drilling. However, the profound volcanism and associated SDRS formation are entirely lacking within the continent-ocean-transition (COT), and thus classification as a volcanic rifted margin can be ruled out. Instead, the COT exhibits a profound thinning of the continental crust towards the ocean crust of the SCS, showing some similarity to the Iberia type margin. The crustal thinning is caused by low-angle faults that have stretched the upper continental crust. However, there are indications of lower crustal flow toward the SCS, although this requires further work. Alternatively, these extensional faults may have reached the lithospheric mantle and generated serpentinized material in a similar fashion as seen off Iberia. It will require deep drilling and sampling of characteristic basement units within the COT to distinguish between a breakup model involving lower crustal flow towards the COT as opposed to deep faulting underpinning serpentinization of the subcontinental lithospheric mantle. Four months of drilling by IODP to address this question is scheduled for 2017. The IODP drilling has the potential to support a third breakup mechanism theorized by modelling in addition to the two types of rifted margin already constrained by drilling, i.e., volcanic, plume supported versus Iberia-type magma starved.