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Lithosphere Extension Prior to Continental Breakup in the South China Sea: Comparison with the Atlantic Type Rifted Margin

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Total continental lithosphere extension prior to breakup and sea-floor spreading in the South China Sea (SCS), a marginal ocean basin, ranges from approximately 360 km in the NE to 580 km in the SW. In contrast, total continental lithosphere extension prior to breakup for the Iberia-Newfoundland rifted margins is no more than 180km. SCS extension leading to continental breakup is between x2 and x3 greater than for the Atlantic margin type.

In the case of Atlantic type margins, lithosphere deformation transitions from initially wide rifting to more localised stretching and thinning, a process termed necking. The necking domain at rifted continental margins, so produced, typically has crustal thickness of 25 km proximally decreasing to 10 km distally. Further lithosphere stretching and thinning due to hyper-extension and the onset of decompression melting results in the rupture and separation of continental lithosphere, the creation of a divergent plate boundary, and the initiation of sea-floor spreading.

The SCS shows very wide domains of thinned continental crust with thicknesses between 25 and 10 km; widths of thinned crust much greater than those of Atlantic type margins. These wide regions of thinned crust on the SCS margin take the form of crustal boudinage with multiple sag basins underlain by highly thinned crust separated by basement highs underlain by less thinned crust.

The localisation of lithosphere deformation before breakup, during the formation of Atlantic type margins, is due to failure of the initially strong cold lithospheric mantle lid. The same mechanism of localisation cannot occur to generate necking in the SCS; the SCS was formed by rifting of volcanic arc lithosphere in which the lithospheric mantle was already hot.

We attribute the very wide regions of continental crust with thicknesses between 25 and 10 km in

the SCS, very much wider than for Atlantic type margins, to a weak inherited lithosphere rheology which favours extensional boudinage of the continental crust rather than crustal rupture and separation, and distributed rather than focused decompression melting of wet mantle from the inherited volcanic arc setting.