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# How does the lithosphere deformation mode during continental breakup affect mantle exhumation and subsidence history?

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Mantle exhumation at magma-poor rifted continental margin requires that continental crust ruptures prior to the onset of significant decompression melting. Both the relative timing of crustal rupture and melting, and therefore mantle exhumation, and rifted margin subsidence are dependent on the deformation mode of the continental lithosphere stretching and thinning leading to breakup. Fletcher et al. (2009) showed that for the Iberia-Newfoundland rifted margin, modelling of continental lithosphere stretching and thinning by pure-shear resulted in decompression melt initiation before continental crustal-rupture, while stretching and thinning by upwelling-divergent "corner flow" resulted in crustal-rupture before melt initiation. Observations at rifted continental margins (including Iberia-Newfoundland rifted margin) suggest a complex rifting evolution that cannot be explained by simplistic end-member pure-shear or "corner flow" deformation modes of lithosphere thinning and stretching (Péron-Pinvidic and Manatschal, 2009). By analogy with the deformation processes occurring at slow spreading ocean-ridges (Cannat, 1996), a more realistic lithosphere deformation mode for magma-poor continental breakup is extensional faulting for the colder brittle upper 12-15km above upwelling-divergent "corner flow" for the remaining lithosphere and asthenosphere. We use a kinematic numerical model of continental lithosphere thinning and stretching to examine decompression melt initiation, continental crustal rupture and subsidence for such a hybrid lithosphere deformation model represented by pure-shear deformation in the topmost brittle lithosphere above upwelling-divergent flow. We explore the relative contributions of pure-shear and upwelling-divergent "corner flow" deformation and its sensitivity to deformation rate, pure-shear half-width, the "corner flow" Vz/Vx ration and mantle potential temperature. The kinematic numerical model that we use represents lithosphere and asthenosphere deformation as flow, which is used to determine material and thermal advection, and subsequent thermal equilibration and melting. Melting is predicted using the parameterisation of Katz et al. (2003). Melt extraction is assumed to be perfectly efficient. Numerical experiments carried out with the kinematic hybrid model show that melt generation is predicted to occur after continental crustal rupture only if the half-spreading rate, the "corner flow" Vz/Vx ratio, the decoupling depth between pure-shear and upwelling divergent flow, the pure-shear half-width and the potential temperature are low. Combination of low values of these parameters enhances crustal rupture before melt generation and leads to mantle exhumation. The sensitivity of subsidence history during continental breakup to lithosphere deformation mode and melting is also examined.