Geophysical Research Abstracts
Vol. 21, EGU2019-18071, 2019
EGU General Assembly 2019

Controls on melting and serpentinization at rifted margins: implications for continent-ocean transition natures and deformation styles

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In this study we use numerical models to analyze the amount and onset of melting and serpentinisation that occurs during rifting for different lower crustal rheologies and velocities. We suggest that the relative timing between the onset of melting and serpentinization controls whether the continent-ocean transition (COT) of margins will be predominantly magmatic or will consist of exhumed serpentinized mantle. Numerical experiments suggest there is a genetic link between margin architecture and the COT at ultra-slow extending margins (<= 10 mm/yr half-extension) that strongly depends on the lower crustal strength. Our results imply that very slow extension velocities (< 5 mm/yr half-extension) and a strong lower crust lead to margins characterized by large oceanward dipping faults, strong syn-rift subsidence and abrupt crustal tapering beneath the continental shelf. These margins can be either narrow symmetric or asymmetric and present a COT with exhumed serpentinized mantle underlain by some magmatic products. In contrast, a weak lower crust promotes margins with a gentle crustal tapering, small faults dipping both ocean- and landward and small syn-rift subsidence. Their COT is predominantly magmatic at any extension velocity and perhaps underlain by some serpentinized mantle. These margins can also be either symmetric or asymmetric. Importantly, our models predict that for weak asymmetric margins, magmatic underplating mostly underlies the wide margin, whereas for strong asymmetric margins, serpentinised mantle mainly underlies the wide margin. We also analyze how the heat released by melting and serpentinisation may change deformation style and compare with natural examples of the South Atlantic.