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Contrasting magmatism at volcanic rifted margins: Implications from thermo-mechanical modeling

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Volcanic rifted margins are characterized by voluminous magmatism during continental breakup. Despite their common characteristics including seaward-dipping reflectors (SDRs) and high-velocity lower crust body (LCB), volcanic margins also exhibit large variations in structural style and amount and distribution of magmatism. For example, the Greenland – Norwegian (Type I) conjugate margins are narrow and have thick SDR and LCB layers as well as thicker-than-usual oceanic crust. In contrast, the Southern South Atlantic (Type II) margins are very wide (>250 km) and have thick SDR but normal oceanic crust. Factors controlling such variations remain controversial. In this study we perform high-resolution thermo-mechanical simulations to investigate volcanic margin formation. The thermo-mechanical models are coupled with melt prediction and surface processes in order to simulate inter-bedding of volcanic flows and sediments during SDR formation. We model deposition of extrusives as melt sediments followed by sedimentation of normal deposits. The fraction of extruded melt (Fext) is assumed to be 50% during rifting and 20% during spreading. We tested parameters including mantle potential temperature, crustal rheology and sedimentation rate. Our results show that mantle potential temperature has a first-order effect on the thickness of oceanic crust and magmatic lower crustal bodies. Both sedimentation rate and crustal rheology affect the total volume of SDRs. In particular, with a weak crustal rheology, the continental crust tends to experience a long period of rifting and develop wide margins and thick SDR sequences. We illustrate that our models are comparable with natural examples as along the North Atlantic and Sothern South Atlantic margins.