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Along-margin variations of magmatism at volcanic passive margins: Numerical models of continental extension with rift propagation barriers

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Seaward-dipping reflectors (SDRs) constitute a first-order feature of volcanic rifted margins and are imaged in seismic reflection profiles of the North and South Atlantic. Recent studies describe distinct along-strike variations in the distribution of SDRs, where abundance of volcanic material could be spatially linked to transfer fault systems. These segmented the propagating rift that later developed into the ocean, and are interpreted as rift propagation barriers.

Here we present 3d numerical forward models of a segmented rift system suggesting a causal link between segment boundaries and magmatic volume variations. Our results explain along-strike variations in magmatism by significant rift-parallel mantle flow across segment boundaries. This rift-parallel flow is caused by a lateral pressure gradient between sequentially opening segments. The along-strike flow of hot material near the segment boundary leads to elevated temperature and thus decompression melting if compared to the segment interior. This takes place without enhancing crustal thinning near the transfer zones and generates peaks in overall pre–break-up melt volumes. We conclude that delayed rift propagation at inherited structures can play an important part in enhancing and localizing volcanic activity by controlling the mantle flow beneath the rift axis.