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Magmatism During Continental Breakup, Insights From the 3-D Structure of Seaward Dipping Reflectors

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ABSTRACT

Deepwater rifted margins are major hydrocarbon exploration targets, however our understanding of their formation is still developing. On volcanic rifted margins continental breakup is accompanied by the emplacement of thick sequences of continental flood basalts. In seismic reflection data these are imaged as Seaward Dipping Reflectors (SDRs). SDRs are important to the hydrocarbon industry for several reasons: i) they may contain reservoir intervals, ii) they overlie conventional syn-rift systems and hence may act as a seal, and iii) their emplacement will affect the thermal history of the syn and post-rift. Similarly, studying the structural evolution of SDRs is important for understanding how extension is accommodated in hot and thin lithosphere. Several recent studies have focused on their 2D structural evolution, and it is clear that SDRs are erupted from an axial magmatic zone with the seaward dips forming from a combination of magmatic loading and normal faulting. However, our understanding of their 3D structure is limited, despite its importance in determining the lateral variability of magma supply during breakup. Here we use a closely spaced 2D seismic grid from the Orange Basin, offshore SW Africa, to separate the SDRs into packages and map them in 3D. The volcanic lithology of these packages is confirmed through pre-stack velocity analysis and potential field modelling. We show that the location of the magmatic centres feeding the SDRs migrate through time via a series of abrupt jumps: During early SDR formation, magmatism was partitioned along-strike into a series of laterally offset segments. Each segment is approximately 30 km long, giving a similar configuration to the present day Main Ethiopian Rift. Following this initial stage of distributed magmatism, we observe the formation of a relatively continuous axial feeder zone. The formation of this continuous axial zone results in the abandonment of the now off-axis magmatic segments. This process requires rapid jumps in the location of magmatism, a process that has not been previously observed in the continent-ocean transition on magma-rich margins.