An Extended Continuum From Magma-Poor to Magma-Rich Margins: Implications for Hydrocarbon Exploration

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ABSTRACT

Passive margins are often categorised based on the abundance of associated volcanism, often using paired end member terms such as ‘volcanic’ and ‘non-volcanic’, or the older, somewhat synonymous terms ‘active’ and ‘passive’ (e.g. Sengör & Burke, 1978) – referencing the role of upwelling lithosphere in rifting and volcanism. Recent observations from passive margins around the world indicate that the abundance of rift related volcanism is better described as a continuum, with many workers now favouring the terms ‘magma-rich’ and ‘magma-poor’ (e.g. Whitmarsh et al., 2001). However, even these terms fail to describe the large variability observed. Grouping all magma-rich margins together does not adequately describe the wide temporal variation of volcanism observed on magma-rich margins from pre- to syn- to post-rift. Building on existing observations, we focus on the temporal variations in volcanism on passive margins for five scenarios. (1) magma-poor margins, e.g. the Krishna-Godavari Basin (India), where there are minimal volcanics and they are not associated with rifting; (2) volcanism contemporaneous with early rifting, e.g. the Pelotas Basin (Brazil), where there is relatively minor sedimentary fill of syn-rift accommodation space, and extensive volcanics including SDRs; (3) volcanism contemporaneous with peak rifting, e.g. the Sergipe Alagoas Basin (Brazil), where SDRs fill much of the distal accommodation space, but in proximal areas there is significant sedimentary syn-rift fill; (4) volcanism contemporaneous with break-up, e.g. the Kutch Basin (India) and the North Atlantic, where the age of volcanics are coeval with the earliest oceanic crust; (5) post rift volcanism, e.g. the Gulf of Aden, where volcanogenic features clearly post-date the formation of oceanic crust. The continuum described implies that an initially magma-poor margin can be ‘overprinted’ by subsequent volcanism at any time during rifting as a result of the upwelling of hot asthenosphere at the base of the crust. This challenges previous interpretations, that magma-rich and magma-poor margins are distinct end members. Each of our scenarios has significant implications for hydrocarbon exploration. The timing of volcanism relative to rifting (and the asthenospheric upwelling it represents) affects both the clastic accommodation space and composition of the sedimentary fill, with significant implications for the thermal history and the prospectivity of pre-, syn- and post-rift plays.