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Asymmetric rifting, breakup and magmatism across conjugate margin pairs: insights from Newfoundland to Ireland

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Continental extension, subsequent rifting and eventual breakup result in the development of passive margins with transitional crust between extended continental crust and newly created oceanic crust. Globally, passive margins are typically classified as either magma-rich or magma-poor. Despite this simple classification, magma-poor margins like the conjugate West Orphan Basin, offshore Newfoundland, and the Rockall Basin, offshore Ireland, do exhibit some evidence of localized magmatism, as magmatism to some extent invariably accompanies all continental breakup. For example, on the Newfoundland margin, a small volcanic province has been interpreted near the termination of the Charlie Gibbs Fracture Zone, whereas on the conjugate Irish margin within the Rockall Basin, magmatism appears to be more widespread and has been documented both in the north and in the south. The broader region over which volcanism has been identified on the Irish margin is suggestive of magmatic asymmetry across this conjugate margin pair and this may have direct implications for the mechanisms governing the nature of rifting and breakup. Possible causes of the magmatic asymmetry include asymmetric rifting (simple shear), post-breakup thermal anomalies in the mantle, or pre-existing compositional zones in the crust that predispose one of the margins to more melting than its conjugate. A greater understanding of the mechanisms leading to conjugate margin asymmetry will enhance our fundamental understanding of rifting processes and will also reduce hydrocarbon exploration risk by better characterizing the structural and thermal evolution of hydrocarbon bearing basins on magma-poor margins where evidence of localized magmatism exists. Here, the latest results of a conjugate margin study of the Newfoundland-Ireland pair utilizing seismic interpretation integrated with other geological and geophysical datasets are presented. Our analysis has begun to reveal the nature and timing of rift-related magmatism and the degree to which magmatic asymmetry exists between these conjugate margins. The main implications from this work are that different processes may have operated during and after rifting on these conjugate margins. This concept should be carried forward when conducting conjugate margin studies elsewhere, particularly when exploring for hydrocarbons as prospectivity on one margin may not be predictive for its conjugate as different thermal and structural regimes may have been in operation during conjugate basin evolution.