Controls on Syn- and Post-Breakup Igneous Activity at the Magma-Poor Rifted Southern Australian Margin

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ABSTRACT

Intrusive and extrusive igneous rocks present important challenges to exploration and production in basins at rifted continental margins. Most efforts to characterise the styles of igneous activity and their interactions with petroleum systems in rifted margin settings have understandably focussed on 'magma-rich' margins, where lithospheric stretching is accompanied by large volumes of syn-breakup decompressional melting. However, volcanic and intrusive rocks also occur at many 'magma-poor' margins, where thick sequences of flood basalts are typically absent and hence seismic imaging of igneous systems is often excellent. The southern Australian margin, which formed during late Jurassic-mid Cenozoic separation of Australia and Antarctica, is an archetypal magma-poor rifted margin, but most basins host igneous rocks ranging in age from the mid-Cretaceous to Holocene. This magma-poor margin thus provides an excellent opportunity to examine the controls on syn-to-post-breakup igneous activity. The Gippsland Basin is the most prolific hydrocarbon province at this margin, and igneous activity during the late Cretaceous spans the syn and post-breakup phases of margin evolution. The igneous record includes generally small-volume sills, volcanoes and basaltic lava fields, some of which act as seals to large gas accumulations, and is largely clustered around the northern, basin-bounding rift-fault system, indicating a strong structural control on the distribution of magmatism. Elsewhere along the margin, igneous activity mostly occurred post-breakup, and whilst in some basins (e.g. the Otway Basin) there is strong evidence for structural control on the location of volcanoes and sills, in others (e.g. the Bass Basin) igneous activity shows no apparent relationship with known faults. The most extensive intrusive sill complexes occur in the Bight Basin, where mid-Eocene magmatism occurred ~30 Myr following breakup but synchronous with a major increase in seafloor spreading rate. In the Otway and Bass basins few sills are observed, and both Holocene volcanoes in the onshore Otway Basin and buried submarine volcanoes of Miocene age in the Bass Basin appear to be largely dyke-fed. There is strong evidence that both extrusive and intrusive rocks have constrained the migration of hydrocarbons in the basins of the southern Australian margin, and another defining characteristic is the strong spatial link between igneous rocks and fields with high CO2 content.