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Impacts of Magmatic Systems on Hydrocarbon Prospectivity: Examples from the Southern and Western Australian Margins

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ABSTRACT

Intrusive and extrusive igneous rocks pose important challenges to petroleum explorers working in many passive margin basins in Australia and beyond. This presentation draws on a host of examples, from seismic and well data, of igneous rocks that have influenced basin structure and prospectivity along Australia's southern margin (the Bass, Otway, Gippsland and Bight basins) and North West Shelf (the Browse, Carnarvon and Canning basins) in order to illuminate some of the main impacts of magmatism on petroleum systems. The southern Australian margin, which formed during Late Jurassic to Mid-Cenozoic separation of Australia and Antarctica, is an archetypal magma-poor rifted margin, but most basins along this margin 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, most notable at the Kipper Field, 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.