Basin-Scale Fluid Flow, Sealing, Leakage and Seepage Processes in the Gippsland Basin, Australia

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A multi-disciplinary study of the regional fluid flow, charge, sealing and leakage and seepage processes has been undertaken on the prolific Gippsland Basin, south-eastern Australia. The far offshore and onshore elements of the central basin, where most of the hydrocarbons are trapped, are linked by two prominent, east-west trending, fill-spill chains (the northern and southern fill-spill chains; NFSC, SFSC) which converge in the far eastern part of the offshore basin and then extend onshore. North and south of the central basin, on the flanking terraces, migration is typically to the northeast and southwest respectively. Charge history and 2D and 3D modelling have shown that the first hydrocarbon charge into all of the giant fields in the basin, including the gas fields, was oil. In the late Neogene, progradation of carbonates from the northwest increased the thermal maturity of the source kitchens, resulting in strong gas generation, the flushing of the pre-existing oil charge from many traps and its displacement further up the respective chains. Top seal containment is lost around the flanks of the offshore basin and also across much of the onshore.

Consequently, the migrating hydrocarbons begin leaking along zones of failing top seal integrity. Prominent suites of gas chimneys occur along these zones; onshore, this seepage is detectable as a prominent zone of surface seepage and uranium enrichment at the terminal edge of the major fill-spill chain. Offshore, on the northern and southern terraces, these leakage zones have been characterised by the integration of gas chimney mapping, and sniffer and SAR data. This study has allowed the development of a robust understanding of the basin-scale fluid flow processes within the Gippsland Basin and the observations and approaches can be applied to the assessment of other basins for both the evaluation of hydrocarbon potential and geological carbon storage potential.