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Integrating 3-D Seismic Data and Multiple, Independent Remote Sensing Technologies to Constrain Near-Surface Hydrocarbon Migration and Seepage Rates and Leakage Mechanisms on the North-western Australian Margin

Two hydrocarbon accumulations, Skua and Cornea, straddle the boundary between the fault-reactivated Bonaparte Basin and the largely unreactivated Browse Basin. To understand both the near-surface migration/leakage characteristics of these contrasting fields and the relative efficacy of the tools used at detecting and quantifying different types and rates of seepage, SAR, sniffer, airborne laser fluorosensor (ALF), and airborne hyperspectral data were acquired and integrated with 2-D and 3-D seismic data over both fields. Over the fault-reactivated Skua oil field, seismic data show that the leaky Neogene fault segments are small (<1,000m long); these produce localised SAR, sniffer, and ALF anomalies which all clearly define the accumulation. Leakage occurs via point source, relatively intense, liquid hydrocarbon seepage. In contrast, leakage around the Cornea oil and gas accumulation occurs via capillary failure of the top seal. Dry gas leaks in two distinct regions: low gas-flux chimneys form at the apices of basement blocks, where the seal is thins slightly, whereas very large amounts of gas leaks ~10km inboard from the field, where the seal thins significantly. Little oil seeps from the field itself (probably because of relative permeability issues or "capillary sieving effects") but instead mostly leaks ~30km inboard, at the edge-of-seal. Volume dependant, relatively large pixel/low sensitivity tools such as SAR and sniffer, are unable to detect the Cornea field. ALF, however, clearly detects the field, probably because gas leaking from the chimneys carries thin oil films to the sea surface, which are detected by the high sample (1.5m)/high sensitivity ALF tool.