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Geophysical evidence for fluid flow in the Laminaria High, Bonaparte basin, Northwest shelf of Australia

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Seismic amplitude anomalies ("bright spots") can result from changes in acoustic impedance caused by the presence of fluids and/or lateral changes in lithology. In this study, 3D seismic interpretation and well log data is used to investigate the nature and causes of seismic amplitude anomalies within the shallow subsurface on the Laminaria High on the north-west shelf of Australia. Here, the anomalies are associated with active faults that cut the seabed. Previous studies suggest that fault reactivation and fault geometry have an important role in causing hydrocarbon leakage from a deeper reservoir and that bends on the larger faults will influence the localization of shear strain, increasing the risk of leakage. However, these studies did not examine the influence of fault growth during reactivation on fluid migration, or how post-rift and syn-rift sedimentation may have influenced fluid leakage.

In our study, preliminary results suggest that not all active faults are associated with amplitude anomalies or dry/partially-filled hydrocarbon traps at depth, implying that there could be a different mechanism for the creation of the amplitude anomaly observed on the Laminaria High. Specifically, these anomalies may be the result of preferential cementation, or the presence of gas trapped within sediments at or near the seabed, possibly originating from gas generation due to biogenic activity in recently deposited sediment.

Detailed amplitude maps are extracted from syn- and pre- faulting seismic horizons down to the top reservoir level in order to understand the spatial extent of the high amplitude anomalies within the stratigraphic succession. The first two amplitude maps for the seismic horizons beneath the seabed show high amplitude anomalies associated with the same active faults that are present on the seabed, but with some different characteristics along these faults. Then we extract number of deeper amplitude maps to the top of reservoir, to reveal whether the high amplitude anomaly shown on the amplitude map of the seabed continues downward at greater depths or whether it is restricted to very shallow features near the sea bed. In addition we undertake a fault reconstruction to investigate how the evolving fault geometry may have influenced fluid migration on the Laminaria High.