Fault dilatation behaviour in the Kupe field, Taranaki Basin, offshore New Zealand

B.R Ilg[1], S. Ellis[1], M. Arnot[1] and A. Nicol[1]

Many petroleum fields are located somewhat paradoxically on or adjacent to heavily faulted active plate boundaries. One such example is the Kupe field in the offshore eastern Taranaki Basin. When fields are cut by active faults they are commonly thought to be susceptible to dilatation-induced leakage. Relay ramps and associated damage zones may increase permeability around faults further enhancing migration and increasing risk to sealing within the field. However, the presence of hydrocarbon reservoirs adjacent to some active faults suggests that active faults must locally be sealing at least. In this study we utilise a 3D seismic reflection volume, numerical modelling, and fault seal modelling to investigate the relationships between fault geometries and their effect on permeability and leakage within and around the Kupe field.

Seismic interpretation of the reprocessed Kerry 3D seismic reflection volume has revealed numerous incipient, en-echelon arrays of steeply dipping, NE-striking, conjugate faults. Time-slices reveal that a number of the faults are associated with linear features imaged within a few milliseconds TWT of the seafloor. In plan view, low velocity anomalies are often spatially associated with fault tip segments that are sub-parallel to Sh_{max} (derived from borehole data), possibly indicating gas migration on these structures. In cross-section, low velocity anomalies are associated with clusters of antithetic faults above master structures that cut to source-rock depths. These observations suggest that incipient, plate boundary-related faults may be at risk for leaking in the Kupe area. However, the field contains several pools of hydrocarbons and preliminary evaluation suggests that in spite of relatively long and possibly active fault traces, the low velocity zones (sites of potential gas migration) are apparently confined to a critical range of orientations that may change with depth.

We will present results including seismic interpretation, dilatational fault seal modelling, and numerical modelling. Interpretation and modelling results constrain the evolution of the characteristic geometry of the incipient fault population, the distribution of low velocity anomalies within the 3D volume and the implications for the geological evolution and technical development of petroleum systems in the Kupe field.

1 GNS Science, PO Box 30368, Lower Hutt, New Zealand
b.ilg@gns.cri.nz

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