Physical Modelling of Primary Stratigraphic and Structural Controls on the Evolution of the Papuan Fold Belt, Papua New Guinea, and Implications for Hydrocarbon Exploration

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ABSTRACT

The Papuan Fold Belt (PFB), Papua New Guinea, is under active hydrocarbon exploration. Reservoirs located to date are in relatively thin sandstone units encased in thick shales, with the hydrocarbons occurring in anticlinal traps and footwall cutoffs below thrust faults. These structures formed during tectonic transport of shelf and basin strata onto the continental platform during Plio-Pleistocene oceanic arc–continent collision. Some of the largest structures are interpreted to have resulted from thrust inversion of extensional faults formed during earlier crustal rifting.

Exploration in the PFB is difficult due to rugged topography, dense rainforest cover and karst, hindering surface mapping and collection of high quality seismic data. Consequently, interpretation of PFB structures relies heavily on comparison to analogs, such as structural styles seen in other fold belts and laboratory models.

We investigate the structural evolution of the PFB by scaled physical analog modelling using the centrifuge technique. The models are constructed with initial configurations that represent inferred mechanical-stratigraphic architecture of different portions of the Papuan platform margin, including lateral facies changes and syn-depositional extensional faults. During tectonic shortening, the models develop fold and thrust structures that are controlled by the mechanical architecture and thus replicate the sub-surface structures and hydrocarbon traps that may exist in the PFB.

Modelling provides a better understanding of the location, geometry and timing of development of structural traps in the analog system, and therefore helps to refine interpretations of the sub-surface structure of the PFB and improve exploration success.