Influence of Basin Architecture and Mechanical Stratigraphy on Structural Styles Within the Greater Juha Area of the Papuan Fold and Thrust Belt, Papua New Guinea

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ABSTRACT

The remote and inhospitable Papuan Fold and Thrust Belt (PFTB) in Papua New Guinea is one of the youngest yet least well-documented fold and thrust belts on Earth. Mesozoic rift architecture, pre-collisional margin geometry, associated variations in mechanical stratigraphy and an evolving Cenozoic compressive stress field have all contributed to the evolution and resulting structural complexity of the PFTB; but the relative role of each is largely unknown. Improving our understanding of these controls requires improved characterisation of structural styles along the length of the PFTB, particularly outside of the Kutubu oil and gas fields. Here, we describe more than 100 km of geological traverses and associated analyses in the frontal Juha-Muruk-Lavani (Greater Juha) area of the North West Fold and Thrust Belt that add significantly to the contemporary geological and geophysical dataset for the region. We have developed a robust quasi-3D model, with associated cross-sections showing that the exposed Cenozoic Darai Limestone is well-constrained with very low shortening < 21% despite > 3 km of surface uplift. In contrast, Darai Limestone within the neighbouring Kutubu Fold and Thrust Belt is characterised by ~40% Darai shortening and structural elevations < 1.5 km. Our structural analysis provides evidence of major inversion, detachment and triangle zone faults within the Greater Juha area. We suggest pre-existing rift architecture is the primary influence on the structural evolution of the area. The mechanical properties of the stratigraphic column have an important secondary control and this can be demonstrated using thermo-mechanical forward models that are also crucial to explaining the limited shortening in the competent Darai Limestone. Throughout the Greater Juha area we have also identified pervasive arc-normal oriented structures that may be related to Mesozoic rift-related transfer structures. These structures were subsequently inverted to form tear faults that accommodate lateral variations in shortening along the length of the PFTB. The characterisation and better understanding the spatio-temporal evolution of structural styles has already contributed to exploration success in the Greater Juha area. Further work is likely to reveal the true hydrocarbon potential of the underexplored PFTB.