Beyond Geometry: 2-D Structural Thermo-Kinematic Models of the Papuan Fold and Thrust Belt

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Abstract

The Papuan Fold Belt (PFB) exploration took off in 1986 with the Kutubu and following Hides discoveries, seventy-four years after the first well was drilled. 7bboe later, it continues to deliver today and is one of the most active conventional onshore resource exploration areas in the world. Exploration has progressed on the back of extraordinary surface-related challenges, with an almost exclusively helicopter-supported operation. As in most fold belts trap definition at reservoir level is the primary challenge. The PFB depicts thin-skinned, thick-skinned and combined thick/thin-skinned related structural geometries generated by multiple detachments. The stratigraphic pile behaves mostly as a harmonic mechanical beam but recent discoveries and appraisal/development wells indicate strain partitioning occurs particularly at the post reservoir Cretaceous Ieru Formation. The latter implies that in some instances surface structures do not directly relate to subsurface structural culminations. Furthermore, the linkage - geometric and kinematic - between the thick-skinned and thin-skinned structures continues to be an evolving matter of discussion amongst specialists. The kinematic story is faced with an additional obstacle: synkinematic sediments are rarely preserved in the fold belt. This discussion would be of academic interest if not for the fact that surface anticlines that involve our target reservoirs are being drilled-out and we are faced with finding hydrocarbons in deeper structural targets. We are relying on these deep targets to be the new frontier - not to mention the hinterland. Our more complex structures near or along the trend of a developed resource are ever more challenged in terms of defining them with our current seismic data and thus fall in the realm of “sound” structural interpretations or models. In the PFB a compounding issue relates to the economic

viability of the discovered resource driven by surface constraints and hydrocarbon phase. There are two main drivers here: gas for LNG; and the geologic (and geographic) extent of the liquids “play” as it relates to existing facilities. There is a large uncertainty related to geological controls that yield gas-rich versus liquid-rich traps. This is where testing the thermo-kinematic history of our models and interpretations can provide insight into the controls of the hydrocarbon phase. Additionally, we could test alternate kinematic models, synkinematic/erosional models and these could be calibrated to known discoveries. This presentation will illustrate, via 2D case studies-calibrated and un-calibrated, the workflow progression from trap definition, structural kinematics to charge modelling fluid flow and hydrocarbon phase prediction in the PFB.