Outcrop Analogues for Deformation within Permian Reservoirs in the Khorat Plateau Area

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Abstract

In the Khorat Plateau the sequence down to the base of the Triassic Kuchinarai Group (Norian) is generally reasonably well imaged. The top of the underlying section, is marked by the Indosinian I unconformity. Below the unconformity, seismic imaging is generally of lower quality, and commonly the internal structure of Permian carbonate reservoir is not well imaged, particularly on 2D data. While a simple post-Khorat Group anticline has given rise to the broad anticlinal shape of the field, the Indosinian deformation within the Pha Nok Khao and Si That Formations is more complex. 3D data permits more of the internal structure of these formations to be locally mapped, thrusts and folds can be identified, but details of the deformation style are commonly not very clear. The Saraburi-Pak Chong area (Khao Khwang Fold and Thrust Belt, KKFTB) provides an approximate outcrop analogue for deformation on the field-scale. The area of Sinphuhorm Field is estimated to range between 163 km^2 and 57 km^2. The area of Permian carbonates exposed around highways 21, and 1 north of Saraburi covers around 78 km^2. Consequently, the area provides insights into possible stratigraphic and structural variations that could exist across Sinphuhorm Field.

Key observations from the KKFBT are as follows: 1) although superficially the area of highways 21 and 1 appears to be one carbonate platform, they are actually probably three platforms of similar age that have been thrust together. 2) In between the carbonate platforms are deeper water shale-chert-mass transported carbonate dominated basins. 3) Structural styles within the carbonates include fault bend, fault propagation and detachment folds. There is evidence for multiple phases of deformation, involving structures of different orientation (E-W, NW-SE and NE-SW trending folds and thrusts). 4) Later strike-slip faults are superimposed on the earlier structures. 5) Palaeo-stress directions determined from calcite twin analysis also indicate multiple deformation episodes. 6) A simplistic mechanical stratigraphy of the carbonates splits them into massive units, well-bedded units, and dark well-bedded limestones with interbedded black shales. Each unit has accommodated shortening differently, with the latter unit exhibiting the most complex, disharmonic deformation. 7) The evolution of permeability within the structures through time is documented in part by a varied and prolonged history of calcite vein development. 8) Porosity loss during Indosinian deformation is virtually total, hence secondary porosity development post-Indosinian deformation appears to be crucial. However, given the highly deformed nature of the carbonates with important shale permeability barriers related to thrusts, as well as due to stratigraphy means that prediction of how later secondary porosity-creating fluids might traverse the carbonates will require a detailed understanding of the structural configuration.