Structural Evolution of South West Abu Dhabi: Implications for Exploration and Development

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Abstract

Introduction

Three-dimensional structural restorations and strain models were built in a field south Abu Dhabi to improve our understanding of the tectonic evolution, contribute to the development and validation of 3D geomechanical models, support field development, and exploration in adjacent blocks. The interpreted structural evolution shows the development of folding and faulting, the fault inversion over geologic time, and strain evolution. The strain distribution and failure mechanics of faults constrained and validated the differential stresses in the structure, the stress rotations around the faults, and the variability of stress magnitudes as a function of elastic rock properties, poroelasticity, and deformation. The constrained 3D stress model will be utilized for wellbore stability analyses, drilling optimization and risk management, re-assessment of completion strategies, and evaluation of the potential reactivation of faults and fractures due to reservoir depletion.

Results and Conclusions

Mid-Late Cretaceous folding began earlier than reported in the literature. Reverse and strike-slip faulting is related to two discrete, closer in time, Late Cretaceous-Eocene ophiolite emplacement events to the east with the reverse faults younger than strike-slip. WNW-ESE dextral strike-slip faults across the crest show no evidence of rotation from regional trends. Recent fault movements are younger to the ESE across the structure. Strike-slip faults reactivated InfraCambrian basement zones of weakness and they are hybrid flower structures, with stems rooted in the pre-Mesozoic basement. The strain patterns resulting from strike-slip deformation align with fractures described in image logs across the field. A set of conjugate NW-trending, sinistral strike-slip faults is likely of similar age to the dextral faults. Field-bounding reverse faults reactivated pre-existing extensional structures and are younger to the east. At least 5 unconformities, from Simsima to Mauddud, record flexural slip folding during the Late Cretaceous. 4. NE-trending folds in the restored Dammam section are associated with the Eocene-recent Alpine 2/Zagros collision. This structural restoration and strain modeling improved our understanding of the field structural evolution Results from this paper suggest that a 2-step faulting history generated strain that is consistent with observed faults and fractures interpreted from seismic and image logs. This work has relevance for geomechanical modeling, wellbore stability, risk analysis for fault and fracture reactivation, and for understanding structural timing and associated petroleum system risks.