New Plays in the Himalayan Foreland Revealed by Kinematic Forward Modeling and Structural Restoration: An Example from the Ratana Field, Potwar Plateau, Northern Pakistan

Khalid Shoaib[1], Nathan Eichelberger[2], Steven Tobias[3], Zaheer Zafar[1], Stuart Burley[4]
[1]Orient Petroleum; [2]StructureSolver; [3]NearFX, LLC; [4]University of Keele

9.29.2020 - 10.1.2020 – AAPG Annual Convention and Exhibition 2020, Online/Virtual

Abstract

The Ratana Field in the Potwar Basin of northern Pakistan has been in production since 1993 with proven reservoir intervals in Eocene and Permian carbonates and Jurassic clastics. The field is a structurally complex thrust-related anticlinal play in which interpreting the geology from seismic sections is challenging. By combining quantitative structural geology methods with innovative geophysical workflows, we identify a new syn-rift play in Cambrian strata below the established fold-thrust belt reservoir intervals. In this presentation, we show how coupling kinematic forward modelling (including fault-bend-fold and trishear models) and structural restoration techniques with thinned fault attributes, automatic fault extraction and animation techniques provides new insights into the petroleum prospectivity of the Potwar Basin. First, thinned fault attributes were used to quickly define the fault framework for the structurally complex Ratana Field. This field is a contractional anticline bound by opposing E-W thrust faults. The dominant thrust vergence direction of the entire structure changes along strike. Key seismic sections were restored across the structure using known horizon correlations from well logs at the reservoir level. The restored seismic stratigraphy reveals that the underlying seismic section beneath the field has strong evidence of stratigraphic thickening across the main thrust. Kinematic forward structural models fitted to the seismic stratigraphy within each section

indicate that the reservoir structure is a reactivated normal fault system. This result is consistent with previous studies from the Potwar Basin which show that changes in the basal decollement are associated with pre-existing basement normal faults. These early normal faults provided a frontal ramp for the later development of thrust sheets. Since kinematic forward models define the intermediate stages of structural development, animating through these stages shows that the expanded interval is likely comprised of syn-rift strata deposited during Cambrian extensional faulting. The overlying reservoir interval was deposited after rifting during a tectonically quiescent period. The Cambrian rift was later inverted to form the trapping Ratana anticline during Miocene to Recent Himalayan orogenesis. Along-strike variations in the reservoir anticline geometry directly correlate with variations in the extent of the syn-rift interval that now cores the anticline. This suggests that the initial Cambrian rift structure and syn-rift sediment accumulations exerted a first order control on development of the modern Ratana Field reservoir structure. Finally, it is shown how this multi-disciplinary integration has led to the recognition of new play opportunities of Cambrian syn-rift strata below the established reservoir interval.