Addressing Granitic Basement Reservoir Heterogeneity In Cauvery Basin: An Integrated Fracture Modelling Approach

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ABSTRACT

Commercial presence of hydrocarbon has recently been established in Archean basement of Madanam, Pandanallur and Pundi fields of Cauvery Basin,a pericratonic basin within the domains of the Southern Granulite Terrane. The real challenge lie in understanding the uniqueness of fracture connectivity which is again directly related to distinct heterogeneity observed in basement lithology, prevailing stress fields and the fracture anisotropy. The present study describes a workflow adopting an assimilative approach involving seismic and geological concepts, well data (petrophysical and geo- mechanical data) and geo-cellular stochastic modelling which helped derive conceptual 3D fracture model of Cauvery basement reservoir in aforementioned fields. The l model thus prepared calibrates reasonably well with hydrocarbon accumulation pattern in basement wells tested in the area and has been of immense help in planning and drilling exploratory and development wells in the area.

  Cauvery basement reservoirs underlie a regional unconformity and almost all lie on an uplift or high. The uplifts or buried hills, that form the basement reservoir, are simple basement highs (or hills), upthrown sides of faulted blocks, horsts, or basement highs within a graben. Tectonically, the basin is divided into a number of sub-parallel horsts and grabens, trending in a general NE-SW direction. A number of E-W trending shear zones formed in Mid Neo-Proterozoic have affected the entire Cauvery basement. Post Pre-Cambrian tectonism viz., N-S faulting in Permo-Triassic, NE-SW main rifting phase in Upper Jurassic-Lower Cretaceous and NW-SE faulting in Lower Cretaceous have their inherent signatures on basement fault and fracture patterns. Geomatic studies indicate that areas of intersection of post Pre-Cambrian faults overlying older Pre-Cambrian shear zones are areas where maximum fracture intensity is observed.

  Focal mechanism and fault plane solutions indicate regional maximum horizontal stress direction varying between NW-SE to ENE-WSW. After Early Cretaceous, since no major tectonic event is found to occur in the basin, the maximum horizontal stress direction (SHmax) is considered to be the same as the in-situ stress. In-situ stress directions as deduced from Drilling Induced Fractures and borehole breakouts in wells drilled in different fields show frequent rotation of in-situ stresses which more or less follow the regional stress maxima. Morphotectonic analysis and kinematic studies have demonstrated that that the E-W shear trends are the most reactivated trends under the present day stress regime and an overall strike slip stress regime prevails in Cauvery basement fields. It was also inferred that the fracture set oriented in NW-SE and E-W direction are more prone to being critically stressed and are likely to remain open. This trend is probably the most important trend instrumental in migration , remigration or non-migration of hydrocarbons and hence having significant bearing in heterogeneity observed in flow potential of basement reservoirs across different fields. Analyses of mafic and felsic content in basement as well as fracture anisotropy

variations vertically and spatially, provide answers for prolific nature of basement reservoirs in Madanam and Pundi areas compared to Pandanallur and Mattur..

The need for addressing the heterogeneity in Cauvery basement reservoirs led to collation of separate workflows for creation of a robust fracture model combining seismic attributes with petrophysical, geo-mechanical and geological inputs . Calibration of the 3D fracture model with well data in the form of masterlog data, cores, image and shear logs, and validated by PLT and reservoir tests have led to more accuracy in the static model, which in turn helped predict fracture networking and provided real time solution to guiding successful wells through basement and planning well stimulation jobs. This multi-pronged approach is the most realistic tool for basement exploration in complex basement reservoirs as in Cauvery.