Four-dimensional fracture distribution in the Cooper Basin using image logs

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Abstract

An understanding of four-dimensional fracture distribution in the Cooper Basin can be used to optimise the development of well placements and fracture stimulation treatments used in tight gas and shale gas reservoirs. Comprehension of the paleo-stress, current stress, natural fractures and tectonic history of the basin can facilitate the exploitation of hydrocarbon resources in the basin.

Natural fracture distribution and orientation were analysed using borehole image logs of 13 wells in the NW of the Cooper Basin. Additionally, in situ stress was evaluated in these locations, and paleo-stress evolution was interpreted based on the structures analysed.

Through drilling-induced tensiles fracture and breakouts observed in the image logs, the maximum horizontal stress is oriented WNW-ESE in Patchawarra Trough and Sub-Patchawarra Trough. It has been observed that older and deeper buried formations have a higher number of fractures per thickness ratio (fracture density) than shallow formations. Stress history is recorded in ancient formations; therefore, the age of the formation may affect the number of fractures per thickness. However, the contribution of lithology must be taken into consideration. Rocks with low tensile strength have a more common rock failure than stiffer lithologies. Correspondingly, fine-grained lithologies such as siltstone, shale and mudstone have more natural fractures than sandy lithologies.

Various fracture sets were determined in the analysed wells. The NW-SE extension fracture sets of Adelaidean rifting were observed in two wells. This was followed by a compression of Kanimblan/Alice Springs, which is proposed to accompany the WNW-ESE strike-slip regime. The NW-SE compression fracture sets of Permian formations were related to the Sakmarian uplift. The Daralingie uplift is also proposed to be evident in the analysed image logs. Local heterogeneous kinematics are suggested to affect the Daralingie uplift, and it is associated with an extension event. The Hunter Bowen Orogeny ended the deposition of Cooper Basin formations. It has been suggested that E-W compression events affected the basin during the Late Cretaceous. During the Cenozoic Era, E-W to N-S compression might have affected the basin, as shown by the N-S and NE-SW compression fracture system in the analysed image logs. Present-day maximum horizontal stress is attributed to the NW-SE compression and extension fracture sets of the Eromanga Formations.

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