

Microstructural and Mineralogical Aspects of Deformation in the Mungaroo Formation, NW Shelf, Australia

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Detailed structural logging of core has been undertaken from twenty wells intercepting the late Triassic Mungaroo Formation, a major hydrocarbon reservoir in the Northern Carnarvon Basin, NW Shelf, Australia. Structures were distinguished as faults, fault zones, fractures and stylolites, each variably characterized by cataclasis, pressure solution, clay smear, disaggregation and mineralization. Stylolites tend to increase in frequency with depth. They also occur in clusters that are closely paralleled with clusters of other deformation features; an association interpreted to be due to increased deformation processes allowing pressure solution to occur within thin clay rich layers near brittle structures. The frequency of these structures increases towards major seismically resolved faults. The number of major faults within the vicinity of a well also influenced the number of sub-seismic structures within that well, with higher frequencies associated with larger numbers of major faults. It was interpreted from this that sub-seismic structures were distributed around larger faults within the reservoir. In selected wells microstructural analysis of fault rock has been undertaken using optical microscopy, automated mineral analysis, SEM-CL and Electron Backscatter Diffraction (EBSD) to identify and characterise the deformation processes. EBSD analyses indicate that fault zones in clay poor arenites are characterised by cataclastic grain size reduction in contrast to more clay rich quartz wackes where crystal plasticity processes of deformation dominate. Trace minerals (zircon, pyrite and Ti oxides) as well as organic matter are residual to the pressure solution that results in stylolitisation. These phases are therefore concentrated along stylolites to much higher abundances compared with the host rock.

Porosity and permeability reduction that accompanies stylolitisation is further enhanced by neoformation of fibrous and platy illite within the stylolites. Most of the deformation features have produced significant reductions in fault rock porosity and permeability. This occurs through a range of processes including precipitation of diagenetic minerals (eg illite in stylolites; carbonates and clays in fractures), quartz and feldspar grain size reduction and clay smearing. The understanding of deformation processes is critical in the evaluation of the resulting microfabrics and their effects on reservoir quality.