ORAL PRESENTATION

Natural Fracture Systems in Carbonate Reservoirs

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Approximately 50% of all carbonate-reservoired oil and gas fields worldwide are naturally fractured. This number is high compared to their siliciclastic counterparts. It is therefore important to not only be able to predict fractures in carbonates, but also to understand their impact on production.

Whilst tectonic mechanisms are responsible for many of these fractured reservoirs, particularly in fold and thrust belts and foreland basins, one should not underestimate the impact of other processes that create fractures, and thus permeability, in carbonate rocks.

Karstification: karst processes result in stratiform, heterogeneous fracture systems which have typically been dissolution-enhanced. The resulting fracture network includes not only fracture propagation into roof and wall rocks, but also commonly results in thick breccia systems formed through cave collapse.

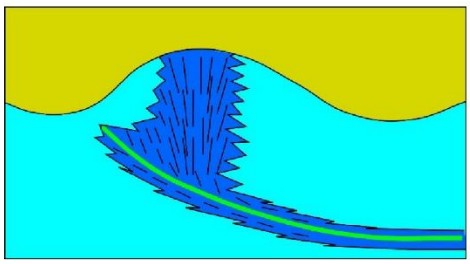
Evaporite collapse: evaporite collapse breccias are formed where anhydrite and/or gypsum are dissolved, and the overlying continuous strata of carbonate rocks collapse, generating dissolution-collapse breccia composed of carbonate clasts. Fracture systems associated with this mechanism are inherent in the overlying, foundered, carbonates as well as in the breccias themselves.

Fracture-related dolomitisation: fracture related dolomite bodies occur where hot, Mg-rich fluids move upwards through fractures, dolomitising the surrounding host carbonates (also known as hydrothermal dolomites). These “hot” dolomites can add additional matrix porosity, or reversely destroy porosity, to what would traditionally may be considered a tectonically-fractured reservoir, thus resulting in a Type 2 fractured reservoir. Fluid overpressure may also create local hydrobrecciation in the surrounding host.

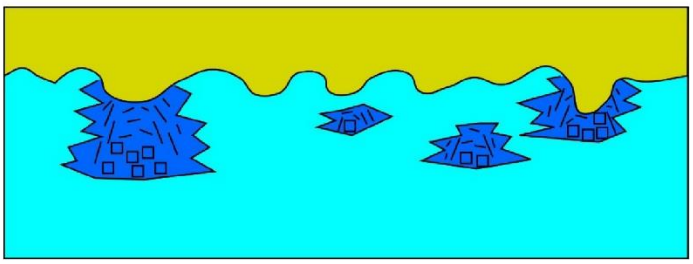
It is therefore critical to establish the mechanism responsible for creating fractures, since this will have a significant impact on the reservoir geometries and how the fractures are modelled (Figure 1). Tectonic fractures are predictable in a statistical sense, and can be modelled through understanding the structural evolution. Karst fractures can be predicted in a stratigraphic framework, can occur over thick intervals, but their fracture pattern is semi-random within the collapsed breccia zones. Evaporite collapse breccias and fractured intervals are thinner and stratigraphically controlled. Hydrothermal dolomites can be modelled within a structural framework, and with understanding the existing stratigraphic architecture.

The only way to unravel the complexity of fracture systems in carbonates is by careful diagenetic studies from core, and integrating well logs, seismic and analogues.

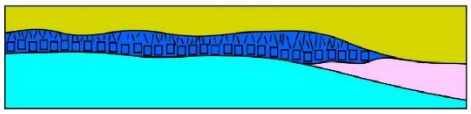
FRACTURE STYLES IN CARBONATES



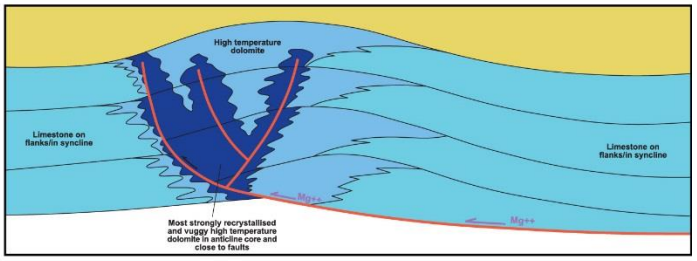
Tectonic fractures predictable and may be modelled in structural framework



Karst fractures/breccia: stratigraphically related but may be over a thick interval; fracture pattern semi-random within collapsed areas



Evaporite collapse breccia in thin, strongly stratigraphically controlled intervals; fracture pattern essentially random



Hydrothermal dolomitisation: fracturing related to structural setting, dolomitisation partially stratigraphically controlled

Figure 1 Summary of the four key fracture origins in carbonate reservoirs and impact on reservoir geometries