Carbonate Fracture Network Characterisation. Fracture Distribution Prediction with Mechanical Stratigraphy and Fractals

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ABSTRACT

Carbonate rocks represent approximately half of the hydrocarbon reserves in the world, comprising prolific reservoirs within the so-called "giant oil and gas fields" (exceeding proved reserves of 500 million bbl for an oil field and 3 Tcf2 for a gas field) such as the North West Shelf of Australia and North Brazil.

Fracture networks in areas of low matrix porosity closely control reservoir potential in carbonate rocks. Furthermore, coarse-grained facies on carbonate platforms may show further porosity enhancement due to later fracturing and faulting. The processes leading to their generation and timing(s) are key to understanding the hydrocarbon potential of carbonate reservoirs.

Equatorial margins with developed carbonate platforms such as the North West Shelf of Australia and North Brazil are broadly analysed using borehole data and high-resolution 3D seismic data in order to characterise fracture and fault development through the Late Cenozoic, where development of halimeda carbonate reefs were prolific all over the world. State-of the-art seismic attributes and stress inversion methods are used to understand how the larger fault systems deform (i.e fracture) the carbonate platforms at smaller scales. Fracture characterisation and distribution is difficult to predict only using seismic data due to complex upscaling and downscaling effects. However, in the petroleum industry mainly at the exploration stage, seismic data is the primary source of data.

Mechanical stratigraphy and fractal theories are broadly analysed and discussed in order to determine their feasibility to model and predict fractures at different scales of observation. It is therefore crucial to use outcrop analogues from equivalent strata to generate a model using small-scale data (cm and m) from the field and large-scale data (km) from the seismic.

Fractured carbonate successions from the Cariatiz Reef (Sorbas Basin, southeast Spain) are used as field analogues. The fracture patterns such as length, spacing and aperture will be mapped at distinct locations. The data will provide valuable insights regarding the nature, scale and distribution of fractures in the sub-seismic scale.

An innovative methodology will be produced for fracture characterisation in oil and gas exploration fields where there is limited data. A new model will be created as a template for static fracture network models in carbonate reservoirs. The results will be used to characterise highly fractured carbonate oil and gas fields in similar geological settings.

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