Sequence stratigraphic controls on reservoir-scale mechanical stratigraphy of shallow-water carbonates

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Studies on mechanical stratigraphy of shallow-water carbonates have shown that the distribution of fractures can be controlled by depositional facies, sedimentary cycles/sequences, and diagenesis. Understanding the role of these sedimentary controls is therefore crucial in the characterization of matrix-tight reservoirs, where fractures may represent the main conduits for fluid flow. Nonetheless, the relation between fracture distribution and sedimentary controls is not always investigated at scales that are relevant to reservoir and fluid-flow characterization.

In this dissertation, is provided a solution to this problem by integrating sequence stratigraphic analysis with the multi- scale fracture characterization of two carbonate platform exposures outcropping in the Sorrento Peninsula (southern Italy). These outcrops represent the surface analogue of subsurface hydrocarbon reservoirs of the Basilicata region (southern Italy), and consist of nearly vertical cliffs (hundreds of meters wide and high) exposing shallow-water limestones and dolostones, crossed by several sub-vertical fractures ranging in height from few centimetres up to few tens of metres. Due to the partial inaccessibility of this cliff, field measures have been combined with remote sensing on virtual outcrop models. The study allowed to identify the key control exerted by sedimentary sequences on the thickness of mechanical units and the position of their boundaries, which implies that sequence stratigraphy can be used to predict the distribution of large-scale fractures.

The applicability of this concept has been tested on a subsurface dataset from the Basilicata region. Performing a sequence stratigraphic analysis on image logs calibrated with core data, the main mechanical boundaries were predicted in a portion of fractured stratigraphic units. The thickness of predicted mechanical units showed a clear relation to the distribution of fractures. Indeed, in the investigated stratigraphic interval, an increase in the mean thickness of mechanical units corresponds to an increase in the mean spacing of fractures, of a comparable order of a magnitude.

The main outcome of this study is the proposal of a new approach to estimate large-scale fracture intensity in carbonate reservoirs, based on the evaluation of the thickness of mechanical units through sequence stratigraphy.