Geophysical Research Abstracts
Vol. 18, EGU2016-12631, 2016
EGU General Assembly 2016

Reservoir-scale stratigraphic controls on the distribution of vertical fractures: insights from a 200-m thick carbonate platform exposure (Sorrento peninsula, Italy)

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Through-going fractures cutting across numerous beds are often invoked to match large-scale permeability patterns in tight carbonate reservoirs. Despite the importance of these structures for fluid flow simulations, there are only few field analogues allowing estimating many of their parameters, including spacing and vertical extent, which are instead required to populate reservoir models. This is mostly due to the fact that the study of these reservoir-scale fractures requires very wide outcrops that for several reasons, including logistics, are rarely analysed. Nevertheless, recent improvements in the construction of digital models of outcrops can greatly help to overcome many logistic issues. In this work, we present the results obtained from combined field and remote sensing observations of a 300-meters wide and 200-meters high carbonate platform reservoir analogue in the Sorrento peninsula (Italy). The outcrop consists of a nearly vertical cliff exposing alternating gently-dipping shallow-water limestones and dolomites characterized by the presence of several vertical fractures of different size and hence with different vertical connectivity. In order to gather both stratigraphic and structural (i.e. fracture) data, we integrated field measurements and stratigraphic logs with a remote sensing study carried out on a digital model of the cliff, made by means of multi-view stereo-photogrammetry. This combined field and remote sensing study has allowed us to recognize that major bed-perpendicular through-going fractures are vertically discontinuous due to variable segmentation and fracture distribution within the country rock. In particular, we observed that large (i.e. tens of meters in height) fractures pass across medium to thick beds (bed thickness > 30 cm), while they arrest against packages made of thinly stratified layers of dolomites. In essence, through-going fractures arrest on weak levels, consisting of thinly bedded layers interposed between packages made of several thick beds, exactly like bed-confined fractures arrest on less competent interlayers. Strain compatibility is maintained by intense fracturing of the thin-bedded packages, where a large number of closely spaced, stratabound minor fractures accommodate bed-parallel extension.