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Integrated approach for quantification of fractured tight reservoir rocks: Porosity, permeability analyses and 3D fracture network characterisation on fractured dolomite samples

Maarten Voorn (1), Auke Barnhoorn (2), Ulrike Exner (3), Patrick Baud (4), and Thierry Reuschlé (4)

(1) Department of Geodynamics and Sedimentology, University of Vienna, Austria, (2) Department of Geoscience and Engineering, TU Delft, The Netherlands, (3) Natural History Museum, Geology and Paleontology, Vienna, Austria , (4) EOST Strasbourg, France

Fractured reservoir rocks make up an important part of the hydrocarbon reservoirs worldwide. A detailed analysis of fractures and fracture networks in reservoir rock samples is thus essential to determine the potential of these fractured reservoirs. However, common analyses on drill core and plug samples taken from such reservoirs (including hand specimen analysis, thin section analysis and laboratory porosity and permeability determination) suffer from various problems, such as having a limited resolution, providing only 2D and no internal structure information, being destructive on the samples and/or not being representative for full fracture networks. In this study, we therefore explore the use of an additional method – non-destructive 3D X-ray micro-Computed Tomography (μCT) – to obtain more information on such fractured samples. Seven plug-sized samples were selected from narrowly fractured rocks of the Hauptdolomit formation, taken from wellbores in the Vienna Basin, Austria. These samples span a range of different fault rocks in a fault zone interpretation, from damage zone to fault core. 3D μCT data is used to extract porosity, fracture aperture, fracture density and fracture orientations – in bulk as well as locally. The 3D analyses are complemented with thin sections made to provide some 2D information with a much higher detail than the μCT data. Finally, gas- and water permeability measurements under confining pressure provide an important link (at least in order of magnitude) of the μCT results towards more realistic reservoir conditions.

Our results show that 3D μCT can be applied efficiently on plug-sized samples of naturally fractured rocks, and that several important parameters can be extracted. μCT can therefore be a useful addition to studies on such reservoir rocks, and provide valuable input for modelling and simulations. Also permeability experiments under confining pressure provide important additional insights. Combining these and other methods can therefore be a powerful approach in microstructural analysis of reservoir rocks, especially when applying the concepts that we present (on a small set of samples) in a larger study, in an automated and standardised manner.