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Use of integrated analogue and numerical modelling to predict tridimensional fracture intensity in fault-related-folds.

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Fracture density pattern predictions with low uncertainty is a fundamental issue for constraining fluid flow pathways in thrust-related anticlines in the frontal parts of thrust-and-fold belts and accretionary prisms, which can also provide plays for hydrocarbon exploration and development. Among the drivers that concur to determine the distribution of fractures in fold-and-thrust-belts, the complex kinematic pathways of folded structures play a key role. In areas with scarce and not reliable underground information, analogue modelling can provide effective support for developing and validating reliable hypotheses on structural architectures and their evolution. In this contribution, we propose a working method that combines analogue and numerical modelling. We deformed a sand-silicone multilayer to eventually produce a non-cylindrical thrust-related anticline at the wedge toe, which was our test geological structure at the reservoir scale. We cut 60 serial cross-sections through the central part of the deformed model to analyze faults and folds geometry using dedicated software (3D Move). The cross-sections were also used to reconstruct the 3D geometry of reference surfaces that compose the mechanical stratigraphy thanks to the use of the software GoCad. From the 3D model of the experimental anticline, by using 3D Move it was possible to calculate the cumulative stress and strain underwent by the deformed reference layers at the end of the deformation and also in incremental steps of fold growth. Based on these model outputs it was also possible to predict the orientation of three main fractures sets (joints and conjugate shear fractures) and their occurrence and density on model surfaces. The next step was the upscaling of the fracture network to the entire digital model volume, to create DFNs.