Fracture network characterization and critically stressed fracture analysis in a naturally fractured tight gas sandstone analogue

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To meet the European Green Deal goals, natural gas is a required technology for the energy transition. With significant gas reserves hosted in tight gas reservoirs, the characterization of their natural fracture systems is important to unlock future reservoir potential.
With more than 150 years of subsurface mining, the Upper Carboniferous of the German Ruhr Basin is a well-documented, world-class tight gas sandstone reservoir analogue. Since porosity and permeability of the rock matrix is poor, reservoir quality is mainly controlled by fractures. To understand the directional dependency of fracture permeability, the characterization of the natural fracture network is necessary.
In this study, we use an integrated approach by combining outcrop analogue data with well data to obtain a detailed model of the natural fracture system and its associated attributes. UAV-derived 3D outcrop models are used to analyse fracture attributes. Well logs provide additional information on fracture properties at subsurface conditions. Fracture network attributes are compared to derive outcrop-to-well correlation quality. Critically stressed fractures are identified to understand fracture permeability anisotropies, since they mainly control fluid flow in fractured rock. Correlation of anomalies in gas logs and fractures described in core material, indicate conductive fractures in the subsurface. Results of the slip tendency analysis indicate WNW-ESE and N-S striking fractures as hydraulically conductive.
Results feed into a detailed model of the natural fracture network, providing a data base for future DFN modelling.