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Quantitatively understanding the imprint of fractures in the seismic wave-field

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Understanding fracture connectivity in the shallow crust is of major importance for the development and production of hydrocarbon fields. Fracture datasets collected from wells have limited spatial coverage compared to remote sensing methods such as seismic imaging, Ground Penetrating Radar (GPR), electromagnetic recording, Terrestrial Laser Scanning (TLS), and Unmanned Aerial Vehicles ("drones"). In this study we focus on quantitatively understanding the imprint of several classes of realistic fracture network on the seismic wave-field.

The thin, often rough sheet-like form of fractures poses challenges for reliable imaging of fracture networks using seismic methods, and the seismic response can be significantly altered by the highly variable dip of the fractures. A number of studies have been published showing the effect of the presence of simple fracture configurations on the synthetic seismic wave-field. At present, however, due to the inherent complexity of real fracture networks, there is limited understanding regarding the extraction of network characteristics from seismic data.

Our work involves forward seismic wave-field simulation of a range of complex fracture networks derived from detailed quantitative characterisation of fractures in outcrop. We aim to build a library of calibrated examples from which to both develop understanding of the information contained in a seismic dataset related to the fracture network, and further research into the quantitative inversion and imaging of such information.