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Extraction and visualization of a fracture network using Micro-Computed Tomography

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Micro-Computed Tomography (μCT) measurements were conducted on 3 cm dolomite drill core plugs to gain knowledge about the distribution and orientation of a fracture network inside such plugs. μCT produces a 3D-image stack of 2D-images and these are used to reconstruct a 3D-Model of the fracture network representing the main pore space. The measurements are performed on a Rayscan 250 E at the University of Applied Sciences of Upper Austria (Fachhochschule Oberösterreich, FHÖO) using optimal recording parameters, to ensure the best spatial resolution and image quality. The resolution of the performed scans is around 20 μm. Each scan is acquired five times and then averaged to increase contrast and decrease noise artifacts. Due to the fact that the fracture apertures can be far below 20 μm, noise can be a main drawback to be able to segment the fractures. To decrease a further impact of noise we filter the images after image acquisition, by means of image histogram equalization and edge enhanced diffusion.

Segmenting the fractures and the fracture network is not trivial. Many different segmentation routines the one option giving by far the best results was the Frangi Filter 2D. This filter was written in the medical research field to trace blood vessels. From a data perspective blood vessels are rather similar structures to fractures. However, the results are intensity images so that we still have to use a global threshold. This step is done by the automatic Otsu threshold, which is not biased by any human input. From a segmented image it is possible to quantify the apertures, orientation and distribution of the fractures. Using this technique can provide deep insight into the deformation history and a geometrical dataset to calculate permeability of a fracture network, which is additionally calibrated with conventional thin section analysis.