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Analysis of accuracy in photogrammetric roughness measurements

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Regarding permeability, one of the most important features of shale gas reservoirs is the effective aperture of cracks opened during hydraulic fracturing, both propped and unpropped. In a propped fracture, the aperture is controlled mostly by proppant size and its embedment, and fracture surface roughness only has a minor influence. In contrast, in an unpropped fracture aperture is controlled by the fracture roughness and the wall displacement. To measure fracture surface roughness, we have used the photogrammetric method since it is time- and cost-efficient. To estimate the accuracy of this method we compare the photogrammetric measurements with reference measurements taken with a White Light Interferometer (WLI).
Our photogrammetric setup is based on high resolution 50 Mpx camera combined with a focus stacking technique. The first step for photogrammetric measurements is to determine the optimal camera positions and lighting. We compare multiple scans of one sample, taken with different settings of lighting and camera positions, with the reference WLI measurement. The second step is to perform measurements of all studied fractures with the parameters that produced the best results in the first step. To compare photogrammetric and WLI measurements we regrid both data sets onto a regular 10 μm grid and determined the best fit, followed by a calculation of the difference between the measurements. The first results of the comparison show that for 90 % of measured points the absolute vertical distance between WLI and photogrammetry is less than 10 μm, while the mean absolute vertical distance is 5 μm. This proves that our setup can be used for fracture roughness measurements in shales.