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Digital rock physics: A geological driven segmentation workflow for Ruhr sandstone

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Over the last two decades, Digital Rock Physics (DRP) has become a complementary part of the characterization of reservoir rocks due to, among other things, the non-destructive testing character of this technique. The use of high-resolution X-ray Computed Tomography (XRCT) has become widely accepted to create a digital twin of the material under investigation. Compared to other imaging techniques, XRCT technology allows a location-dependent resolution of the individual material particles in volume. However, there are still challenges in assigning physical properties to a particular voxel within the digital twin, due to standard histogram analysis or sub-resolution features in the rock. For this reason, high-resolution image-based data from XRCT, transmitted-light microscope, Scanning Electron Microscope (SEM) as well as inherent material properties like porosity are combined to obtain an optimal spatial image of the studied Ruhr sandstone by a geologically driven segmentation workflow. On the basis of a homogeneity test, which corresponds to the evaluation of the grayscale image histogram, the preferred scan sample sizes in terms of transport, thermal, and effective elastic rock properties are determined. In addition, the advanced numerical simulation results are compared with laboratory tests to provide possible upper limits for sample size, segmentation accuracy, and a calibrated digital twin of the Ruhr sandstone. The comparison of representative grayscale image histograms as a function of sample sizes with the corresponding advanced numerical simulations, provides a unique workflow for reservoir characterization of the Ruhr sandstone.