Fully Controlled Sampling Workflow for Multi-Scale X-Ray Imaging of Complex Reservoir Rock Samples to Be Used for Digital Rock Physics

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Abstract

Digital rock physics is a technique to simulate petrophysical properties and fluid flow parameters on digitized rock samples and, as such, requires multi-scale imaging from the pore scale to the plug scale (or core scale). This is straightforward for homogeneous sandstones, which often need only one scale of imaging because the size range of the pore network carrying the flow is very narrow. More heterogeneous rocks such as complex carbonates and tight sands require a sophisticated subsampling strategy including physical drilling, laser ablation, and multi-scale X-ray scanning with resolution from several micrometer down to nanometer size.

The challenge with complex rock types is that the facies of interest to be imaged at high resolution may be distributed somewhere inside the rock sample and has to be physically extracted once the region of interest is spotted. The facies of interest for high-resolution imaging of carbonates is mostly the microcrystalline rock phase (micrite; microporosity), which is distributed in the rock in varying amounts. In the case of tight sands very often the clay phase is of major interest. Especially, if the clay volume in the rock is very low the extraction of the target volume has to be very precise in the range of hundreds of microns.

Here we present a novel workflow for fully controlled subsampling of carbonates and tight sand reservoir rock samples for multi-scale 3D X-ray imaging at resolution from the microns to the tens of nanometers. The workflow is illustrated on one of the most challenging rock types in terms of subsampling and multi-scale imaging: a tight sand sample where minor and unevenly spread clay content governs the entire flow in the sample.