

# **Digital Rock Physics for Elastic Property Prediction in Carbonate Source Rocks**

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## **Abstract**

Organic matter and source rocks that contain organic matter are challenging to characterize in the physical laboratory, because of their high nanoscale heterogeneity. Digital rock physics, which is an image-based computational technique, can be used as a powerful complementary method to study the physical properties of rocks. We demonstrate multi-disciplinary analysis of unconventional reservoirs at the nanoscale, with emphasis on elastic properties, leading to field-scale characterization via appropriate upscaling.

There are significant differences in mineralogy, matrix-geometry, and pore-structure between sandstones, which are “conventional” reservoir rocks, and source rocks or “unconventional” plays. Micro-CT images have been successfully used for digital characterization of sandstones, especially for transport properties, because large pore-throats dominate the fluid flow. The compliant crack-like pores and grain-contacts that dominate the elastic response are difficult to image, making digital elastic evaluation of sandstones challenging. The “unconventional” organic-rich carbonate mud rocks we studied have a calcite-dominated matrix with small amounts of quartz, pyrite, and clays. In addition, fluids occur in the pores of thermally matured organic matter known as kerogen. Here, Focused-Ion-Beam Scanning-Electron-Microscopy was used to image the source rock structure since significant micro- and nano-scale heterogeneity exists.

The challenges in multi-physics characterization of unconventional are, interestingly, quite different from those in conventional rocks. Source rock transport properties are difficult to measure, understand, and simulate because of their low porosity and tiny pore-sizes. However, the microstructure of source rocks is more conducive to elastic property computations, the main advantage being the similarity in size between the stiff (inorganic) elastic components and the soft (organic) elastic components. Almost all the samples that we studied exhibit elastic anisotropy, which is typical of source-rocks. However, the preferred, bedding-parallel orientation observed at larger scales is not sufficiently captured at the nanoscale and require further investigation at the micro-scale.