Micro–CT Imaging—A Powerful Tool for Screening and Rapid Quantification of Rock Properties

Ajayendra 'AJ' Kumar, Zheng Gan, Lucien Morales, Ted Griffin, and John Dacy

Core Laboratories, 6316 Windfern Rd., Houston, Texas 77040

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EXTENDED ABSTRACT

The micro–CT (computed tomography) is a powerful petrophysical tool which uses high intensity x-rays to create closely-spaced high resolution images. In core petrophysics, micro–CT imaging is used for multiple purposes, from screening plug samples for specialized testing to assessment of reservoir quality by modeling certain rock properties.

Depending on the objectives, images can be acquired at various resolutions, ranging from 20 to 0.3 microns. Resolution is a function of source-detector spacing, scan time, and proximity of the sample to x-ray source. In general, the highest resolution imaging necessitates smaller sample size. For example, a typical core analysis plug sample can be scanned at a 20 micron resolution whereas micro-plugs, which are 5 millimeter in diameter, can be scanned at a 0.5 micron resolution. Figures 1 and 2 provide illustrations of sample sizes and corresponding images acquired using a micro–CT.

On plug samples, excellent visualization of geologic features and drilling induced anomalies are achieved with a 20 micron resolution scan. High resolution imaging data, when viewed interactively on slice-by-slice basis, assists in the sample selection process and screening for sophisticated, reservoir-condition flow studies and geomechanical testing. This high resolution 3D imaging of core plugs helps geoscientists better understand variations in the pore system properties that may impact both laboratory analysis and reservoir performance. Figure 3 highlights the heterogeneity in a plug sample and why it should not be chosen for a core flood test. At this resolution, quantification of vug porosity, fracture porosity, fracture aperture, etc. can also be performed.

Micro–CT scans at higher pore scale resolutions help resolve features as small as 0.3 microns. Image acquisition and segmentation at such resolutions aid in grain and pore system characterization. This operator independent characterization results in a host of image-derived data with help of industry standard segmentation software. When consolidated with appropriate physical measurement-based models, petrophysical data such as permeability, capillary pressure, and electrical properties can be quantified. Because these models are constrained by physical measurements, the modeling confidence level is improved. Figures 4–7 illustrate comparisons between physical measurements and mi-

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cro–CT modeled properties. These scans and property quantifications are also ideal for friable to unconsolidated samples, large sized drill cuttings, or in cases when core recovery is poor. The rock-based, digital, physically-constrained models provide data that relate well to conventional core analyses.

Acquisition and segmentation of a single set of images are needed for sample analysis. Overall turn-around-time is reduced for quantification of properties, given the efficiency of these rock-based physically-constrained models on moderately powerful computers. Rapid access to key petrophysical properties helps operators make time-dependent critical decisions.

This presentation will demonstrate what micro–CTs are capable of, from a core plug level scanning and screening to ultra-high resolution scans of small samples, leading to quantification of routine and special properties.

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