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The effect of tomographic imaging resolution on residual saturations during the drainage process

Wednesday, 2 June 2021 10:00 (1 hour)

Nowadays, digital rock physics (DRP) has enabled us to obtain comprehensive and accurate information from porous media and a better understanding of physics at the pore scale. Advances in the micro-computed tomography technology (μCT) have led to high-quality, high-resolution images from rock samples. However, this increase in image quality or resolution raises imaging expenditures. Thus, the choice of a proper resolution during X-ray tomography is a challenging task and is based on a compromise between accuracy and cost (money and time) [1,2]. It was shown that image resolution changes influence the permeability estimation from porous media [3,4]. Moreover, there is a critical resolution and sample size (or field of view, FOV) for accurate enough predictions of rock properties (e.g., porosity and permeability) when using DRP [5]. The representative elementary volume (REV) decreases and approaches a stable value at a very high resolution with improved image resolution [6]. Therefore, it is essential to obtain this critical resolution to determine the prediction accuracy.

This study investigates the resolution effect on the amount of residual saturation during brine/oil drainage in two sandstone and carbonate rock samples. Initially, high-resolution images of both rock samples are considered as the base μCT images. Several images at various resolutions are reconstructed by numerically changing the digital resolutions of the μCT images by ImageJ. The maximum sphere inscription algorithm extracts the pore network model (PNM) of each image. The amount of residual saturation is then calculated from the extracted PNMs by simulating the drainage process in OpenPNM and is then compared with that of high-resolution images.

Repeating the above steps for rock images with various resolutions shows that residual saturation gets stable above a resolution. This is because the large-size pores of the samples might not show to be in contact with other smaller pores at lower image resolutions. With increasing the resolution, the role of smaller pores and their connectivity to the pore network becomes more prominent. The results indicate that once the scan resolution is higher than a resolution for a given rock sample, the predicted residual saturations are accurate and representative. Thus, instead of acquiring high-resolution, high-quality μCT images at significant expenses, the results of residual saturation with relatively acceptable accuracy can be obtained at lower costs by finding the critical image resolution.

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Time Block Preference

Time Block A (09:00-12:00 CET)

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Primary authors: Mr KARIMI, Barzan (Department of Petroleum Engineering, Faculty of Chemical Engineering, Tarbiat Modares University, Tehran, Iran); Mr MOSHTARI, Mohammadreza (Department of Petroleum Engineering, Faculty of Chemical Engineering, Tarbiat Modares University, Tehran, Iran); SADEGHNEJAD, Saeid (Department of Petroleum Engineering, Faculty of Chemical Engineering, Tarbiat Modares University, Tehran, Iran); ENZMANN, Frieder (Geosciences Institute, Johannes Gutenberg-University, Mainz, Germany); KERSTEN, Michael (Geosciences Institute, Johannes Gutenberg-University, Mainz, Germany)

Presenter: SADEGHNEJAD, Saeid (Department of Petroleum Engineering, Faculty of Chemical Engineering, Tarbiat Modares University, Tehran, Iran)

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