Contribution ID: **504** Type: **Oral Presentation**

Multi-scale Confocal Imaging Approach Applied to Study the Complex Pore Systems in Middle-Eastern Carbonates

Tuesday, 31 May 2022 12:00 (15 minutes)

Carbonate rocks are well-known to be highly heterogeneous which represents a major challenge for subsurface characterization, which is a critical component of energy and earth science applications including enhanced oil recovery, CO2 sequestration and geothermal system evaluation. The first step toward establishing realistic model of carbonates is to integrate quantitative analysis of the pore space. Our work focused on capturing the pore-geometry parameters required for pore-network modeling. We used fluorescence confocal laser scanning microscopy (CLSM) for its capabilities in producing high resolution images, down to 0.1 µm, with a sufficient depth of investigation for providing an adequate 3D representation of the carbonates pore-network model.

We imaged etched fluorescent epoxy pore casts using CLSM to produce 3D images to obtain high-quality 3D images that can describe the connectivity of multi-scale pore types, particularly where microporosity connects macro-porosity, and to quantify local porosity and permeability. Thus, we captured the pore space at multiple scales with two objective lenses, 10X air (NA = 0.3), and 20X oil immersion (NA = 0.8), to resolve micro- and macro-pores. The lower NA objective has a wider field of view albeit with a lower resolution, while the higher NA objective enables the imaging of finer, micro-scale features. To register the multi-scale confocal images we used an approach that computes an affine transformation for co-registration of two image datasets using an iterative optimization algorithm (Fig 1). Our goal was to achieve digital registration in order to make use of the high-resolution images to achieve more accurate pore segmentation and estimation of petrophysical properties.

The porosity estimation from the 3D images of the pore space indicated that the lower-resolution objective (10X air) tends to overestimate (+15%) the pore volume. The lack of resolving power of the 10X objective could have impaired the ability of the grayscale confocal images to properly identify microporosity and lead to misinterpretation of the micritized grains. These effects were more pronounced in the permeability estimation. While the higher resolution images, from the 20X objective, proved to capture more accurate petrophysical properties the lower resolution images with the wider field of view are very useful in the qualitative description of the carbonates pore system. Hence, our proposed multi-scale confocal imaging approach can provide a more complete quantitative description of the pore system of carbonates with the ability to highlight the interconnectivity between micro and macro-porosity, and can contribute to improved characterization of micritic carbonate rocks.

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References

Time Block Preference

Time Block B (14:00-17:00 CET)

Participation

In person

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Track Classification: (MS10) Advances in imaging porous media: techniques, software and case studies