Micro- and Nano-Scale Pore Structure in Gas Shale Using Xμ-CT and FIB-SEM Techniques

Mohamed Garum*

Cardiff School of Engineering, Cardiff University, Cardiff, CF24 3AA, United Kingdom

Shale is a complex rock composed of a complex mixture of matrix minerals and kerogen and having a complex pore microstructure. The pore microstructure is highly dependent upon the scale at which it is considered. Such a microstructure is important for the assessment of the potential of gas shales based on the connectivity and pores at each scale and the ability of the rock to be hydraulically fractured. In this work, the three-dimensional (3D) structure of shale has been investigated at both microscopic and nanoscopic scales on the same sample for the first time using (i) a combination of serial sectioning, using focused ion beam (FIB) milling and scanning electron microscopy (SEM), and (ii) X-ray micro-computed tomography (Xμ-CT). The reconstructed matrix, kerogen, and pore space volumes from each approach showed significant scale-dependent differences in the microstructure. The shale samples displayed a high kerogen content with high connectivity. Porosity in the shale rock sample was observed to be prevalent in either the inorganic matrix, the kerogen, or both. Furthermore, the porosity from the reconstructed shale volumes was found to vary with locations, as sampled by FIB-SEM, within the shale samples taken for Xμ-CT.

Biography

Mohamed Garum, Doctor in Materials Characterization and Process Engineering

He obtained his BSc (First Class Honours) in Petroleum Engineering at the University of Tripoli (2014, Libya), which was followed by he worked with Harouge and AKAKUS oil operations companies in the area of crude oil and estimation of reserve until 2016. In 2017, he was awarded an MSc with distinction in Information and Communication Technology Management from Cardiff Met University- Cardiff in 2017. Following this, he went on to complete his PhD in Multi-scale 2D/3D imaging for Characterization of Microstructural Properties within rocks (Digital rocks) with aiming to understand the fliud flow behavoir, PSD, and pore connectivity / networks within rock at School of Chemical and Process Engineering from the University of Leeds (2021, UK).

In recent years his research interests have focused on imaging techniques, including Multi-scale 2D/3D imaging and characterization materials over different scales (sub-nano scale to cm-scale) as well as upscaling from nm-scale to mm-scale with aims to build novel and advanced 2D/3D digital approaches and correlative experiments to fully understand materials properties/ behaviour and also to understand complicated pore networks within materials cross multiple scales (nm to cm). This will achieve the goal of enabling economic growth and environment protection via many applications of clean energy extraction and storage.

Dr Garum is currently a member of the SPE, EGU, EAGE and LSP.

