EGU2020-45
https://doi.org/10.5194/egusphere-egu2020-45
EGU General Assembly 2020

Ultrahigh resolution 3D imaging and characterisation of nanoscale pore structure in shales and its control on gas transport

Mohamed Garum, Paul Glover, Piroska Lorinczi, and Ali Hassanpour
University of Leeds, University of Leeds, School of Earth and Environment, Leeds, UK (pmmsg@leeds.ac.uk)

Cost-effective and environmentally sensitive shale gas production requires detailed knowledge of the petrophysical characteristics of the shale from which the gas is extracted. Parameters such as the kerogen fraction, pore size distributions, porosity, permeability, the frackability of the rock and the degree to which natural fracturing already occurs are required in order to be able to estimate potential gas reserves and how easily it can be extracted. Innovative imaging techniques, including Focused Ion Beam Scanning Electron Microscopy (FIB-SEM) and Nanoscale X-Ray Tomography (nano-CT), can be used to characterise the microstructural properties of shale. Here we report using FIB-SEM serial sectioning and nano-CT on approximately cubic samples of side length about 25 µm. The resolution of the FIB-SEM scanning is approximately 20 nm, while that of the nano-CT is about 50 nm, providing between 125 and 1953 million voxels per scan. These ultra-high resolution techniques have been shown to be effective methods for the analysis and imaging of shale microstructure. Each technique can provide data over a different and separate range of scales, and with different resolutions. Results analysed so far indicate that pores which seem to be unconnected when imaged on a micrometre scale by micro-CT scanning, are connected by thin pathways when imaged at these higher resolutions. This nano-scale connectivity is responsible for the small but non-zero permeability of gas shales to gas flow, which is typically measured in the range 5 nD – 200 nD. The volume, size, aspect ratios, surface area to volume ratio and orientations have all been calculated from the scanned data as a function of scale. These data indicate an extremely complex, heterogeneous, anisotropic and multimodal pore nanostructure and microstructure for the shales, with structure at all scales contributing to both gas storage and gas flow. Further work analysing the connectivity of the microscale and nanoscale pore spaces within the rock is underway. We believe that the combination of nano-CT with FIB-SEM on the same sample has the potential for providing an enhanced understanding of shale microstructure, which is necessary for modelling elastic behaviour, gas storage, gas desorption and gas flow in gas shales.

Keywords: Gas shale, FIB-SEM, nano-CT, porosity, permeability, Kerogen, pore volume, size distribution, pore aspect ratio and surface area to pore volume.

How to cite: Garum, M., Glover, P., Lorinczi, P., and Hassanpour, A.: Ultrahigh resolution 3D

imaging and characterisation of nanoscale pore structure in shales and its control on gas transport , EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-45, https://doi.org/10.5194/egusphere-egu2020-45, 2019