Geophysical Research Abstracts
Vol. 17, EGU2015-4654, 2015
EGU General Assembly 2015

Microstructure and permeability of the Whitby Mudstone (UK) as an analogue for the Posidonia shale (NL)

Maartje Houben (1), Auke Barnhoorn (2), Martyn Drury (1), Colin Peach (1), and Christopher Spiers (1)

(1) Department of Earth Sciences, Utrecht University, Netherlands (m.e.houben@uu.nl), (2) Department of Geoscience & Engineering, Delft University, Netherlands

In order to make gas productivity from a shale economically interesting we should find ways to better connect the in-situ pore network to the natural occurring and mechanical induced fractures in the rock. When trying to improve gas productivity a first aim is to understand gas storage and gas flow potential through the rock by investigating the microstructure and measure the matrix porosity and permeability of the unfractured shales. Using a combination of methods we have characterized the porosity and permeability of the Jet Dogger section of the Whitby Mudstone Formation (UK), which we use as an analogue for the Posidonia Shale (NL). The Posidonia shale is a possible unconventional source for gas in Northern Europe.

A combination of Precision Ion Polishing (PIPS) and Scanning Electron Microscopy (SEM) has been used to investigate the microstructure and the pores. Microstructurally the circa 8 meter thick Jet section of the Whitby Mudstone Formation can be subdivided into a fossil rich (>15 %) top half with an organic matter content of 7-10% and a sub-mm laminated (alternating clay-rich, carbonate-rich, not necessarily fossils, layers) lower half were the organic matter content varies from 0.3-16%. In addition, any possible flow in the rock has to go through the fine-grained clay matrix (all grains $< 2\ \mu$m) due to the fact that all larger grains are completely surround by this matrix. Visible PIPS-SEM porosity (pore diameter > 100 nm) is in the order of 0.5-2.5% and is not connected in 2D. Furthermore, overall more than 40% of the visible porosity is present within the clay matrix (sometimes even up to 80%). Porosity and pore size distributions for pores with smaller diameters ($2 <$ diameter < 100 nm) were determined using Ar and N_2 gas adsorption. The adsorption porosity was in the order of 1-5%, were we found 1-2.5% porosity for the top half of the section and 2-5% porosity for the bottom half. Ar gas permeability of the samples was measured on 1-inch diameter cores using Ar-gas-permeametry with a pressure step of 0.2 MPa. The permeability measured was in the order of $2 \cdot 10^{-19}$ – $1 \cdot 10^{-17}$ m^2 at a confining pressure of 0.8 MPa. The top half of the section (less porous) showed a slightly lower permeability ($2 \cdot 10^{-19}$ –$3 \cdot 10^{-18}$ m^2) than the lower half of the Jet Dogger section ($1 \cdot 10^{-18}$ – $1 \cdot 10^{-17} m^2$).

The PIPS-SEM porosity is apparently unconnected on the scale used for imaging and any flow through these rocks has to go through the clay matrix. A connected network of nano-scale pores connected to the micro-scale (PIPS-SEM) pores should be present because of the fact that we measured a through flow of gas. Relationships between the permeability and Ar-porosity and permeability and microstructure were, however, not systematic.