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Characterizing porosity of selected Early Palaeozoic shales from the Baltic Basin: organic petrology, gas adsorption and WIP and KIP approach.

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The porosity in the selected Ordovician and Silurian mudstones from the Baltic Basin collected from three wells (W1, M1, B1 and O_3) was examined in a suite of 78 samples representing the Kopalino, Sasino, Prabuty, Pasłęk (including Jantar Member) and Pelplin Formations. Organic petrology, mineral composition along with N2 low-pressure adsorption (NLPA), water and kerosene immersion porosimetry (WIP and KIP, respectively) as well as image analysis techniques were used to determine pore volumes, pore sizes and pore-size distributions and to evaluate factors controlling porosity.

The majority of the investigated samples represent argillaceous mudstones. Only a few samples from O_3 and W1 are different lithologically and represent siliceous-argillaceous, calcareous, or calcareous-argillicaous mudstones. The samples are characterized by total organic carbon (TOC) content ranging from 0.13 to 7.20 wt. % and vitrinite reflectance (Ro) ranging from 1.02 to 1.22%, indicating late mature rocks within condensate – wet gas window. Total porosity measured using WIP is in the range from 4.6 % to 10 %, while KIP gave values from 1.5 % to 8.9 %. NLPA technique on the 75 μm size fraction revealed that mesopores area is in the range from 10.59 to 34.34 m2/g, while mesopores volume ranges from 0.024 to 0.062 cm3/g. Correlation between mesopores surface area and Ro is weak, but in general the surface area of mesopores is the largest in the least mature samples. Moreover, as indicated by gas adsorption data, both pores greater than $\sim$30 nm and smaller than $\sim$4 nm are important contributors to the total mesoporess surface area.

In general, rather weak correlation between different mudstone constituents (including kerogen types) and porosity measured by means of various techniques (WIP, KIP and NLPA) reveal that there is no single factor controlling porosity in the investigated suite of samples. This conclusion is also confirmed by image analysis performed on large-scale high-resolution BSE images for selected representative samples. However, for mesopores, the dominant contribution comes from organic matter for the Jantar, Prabuty and Sasino Formations, as indicated by NLPA technique. Furthermore, importance of clay minerals for macropore volume is indicated by WIP and KIP technique.

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