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Ph.D Thesis review of Tomasz Topór entitled

"Lower Silurian shales of the Baltic Basin (Poland): reservoir parameters and methane storage potential as a function of thermal maturity"

This Ph.D. thesis focusses on Lower Silurian organic rich shales, a promising target for unconventional shale oil and gas in Poland, making the thesis topic important geologically as well as economically. The thesis consists of three original research papers, all published in the peer reviewed international journals, one in the journal FUEL and the other two in the International Journal of Coal Geology. Both journals have high impact factors, which is impressive. Tomasz Topór is the first author of all the three papers. Each paper has multiple co-authors. His contributions, beyond writing the papers, are that 70 to 100% of the analytical work and interpretation were performed by him. Therefore, I would consider all three papers to be mainly his. The topics discussed in the three papers are very broad thematically and analytically. The thesis focuses on the Baltic Basin but can easily be applied to any other sedimentary basins worldwide. This strengthens the thesis significantly.

The first paper is a methods paper, that introduces the Dual Liquid Porosimetry method. The method is building on Kuila et al 2014, of which he is co-author of. The method by Kuila et al. 2014 is a classical method of using water saturation to determine porosity. Topor's paper builds on that by adding a second immersion fluid light kerosene. The paper convinces the reader that the Dual Liquid Porosimetry methods should be considered when looking for shale gas and shale oil potential. An

advantage of the method is that it appears easy to use without the need for advanced and expensive analytical tools.

The second paper focusses on the evolution of pores and pore-size distributions during organic matter maturation and how that influences the methane storage potential in the shale-gas reservoir. The interpretation is that mesoporosity, pores that are 2-50nm in diameter, and microporosity, pores that are <2nm in diameter, are mainly controlled by the maturation of organic matter, similar to most organic rich shales. What is a little surprising that the role of the clay minerals is minimal. In Figure 6A there is a clear positive correlation between microporosity and Total Organic Carbon (TOC) supporting the argument. However once the organic matter is reduced using 6% NaOCl (Sodium hypochlorite), the microporosity stays more or less the same without a clear reduction in microporosity. The SEM pictures support their argument for the larger mesopores and macropores, pores larger than 50nm. The micropores cannot be seen due to the resolution of the SEM.

The third paper focusses on the assessment of the data found in the other two papers, adds quantitative mineralogy with a few other data sets (e.g. high-pressure CH_4 adsorption analyses) and comes up with a conclusion of the "sweet spot" of the methane storage potential. To make the assessment a multi analytical approach is used. With these methods the porosity evolution and thermal maturity of the organic matter as well as the hydraulic fracturing potential of the Lower Silurian shales are very well characterized. The conclusions, using these multi-variable constraints, are that the amount of potential recoverable CH_4 is estimated to be between 213 and 534 bln m^3 and the best locations are wells 11 and 16, which are reasonable in my opinion. It is interesting that well 15 which lies inbetween the two wells does not fall into the same group.

Despite the three papers having undergone a formal review, I have a few questions for the candidate that have not been discussed in the papers:

1. The samples were collected from drill cores that have been drilled about 50 years ago. Does that influence the results of the mineralogy, porosity and poresize distribution analyses? If yes, how does that influence the interpretation of the "sweet spot".

2. In the Dual Liquid Porosimetry method water and light kerosene were used as saturation-immersion fluids. Briefly discuss the interaction both of these have with smectite, illite, and illite-smectite. How were differences in the liquids and the mineral variability addressed in the assessment of the porespace.

3. The pore space analyses were done in the laboratory, however the insitu conditions are very different. What assumptions were made and how was the extrapolation to the insitu conditions performed?

In conclusion the quality and quantity of the science shown in this thesis is excellent. This thesis advances the scientific understanding of the complexity of the Lower Silurian Shales in the Baltic Basin. In summary the reviewed thesis meets merit and the formal requirements for a PhD degree. I recommend the dissertation for a public defense.

Sincerely,

Georg Grathoff