

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: GEORGY A. PESHKOV

PhD Program: PETROLEUM ENGINEERING

Title of Thesis: IMPROVING THE ACCURACY OF THERMAL HISTORY IN BASIN MODELLING: REDUCTION OF UNCERTAINTIES IN PETROLEUM SYSTEM ANALYSIS

Supervisor: Professor Dimitry Pissarenko

Co-supervisor: Dr. Evgeny Chekhonin

Name of the Reviewer: Prof. Alexei Buchachenko

I confirm the absence of any conflict of interest



Date: Nov 19, 2021

The purpose of this report is to obtain an independent review from the members of PhD defense Jury before the thesis defense. The members of PhD defense Jury are asked to submit signed copy of the report at least 30 days prior the thesis defense. The Reviewers are asked to bring a copy of the completed report to the thesis defense and to discuss the contents of each report with each other before the thesis defense.

If the reviewers have any queries about the thesis which they wish to raise in advance, please contact the Chair of the Jury.

Reviewer's Report

Reviewers report should contain the following items:

- Brief evaluation of the thesis quality and overall structure of the dissertation.
- The relevance of the topic of dissertation work to its actual content
- The relevance of the methods used in the dissertation
- The scientific significance of the results obtained and their compliance with the international level and current state of the art
- The relevance of the obtained results to applications (if applicable)
- The quality of publications

The summary of issues to be addressed before/during the thesis defense

From the very beginning I must declare that not being an expert in the field of the thesis submitted by Georgy Peshkov in completion of the Skoltech doctoral program in Petroleum Engineering, I can hardly provide in-depth assessment of his work. However, in many respects owing to the good quality of writing, main goals, approaches used and major conclusions and recommendations are transparent even for a non-specialist. For this reason I feel myself able for reviewing the thesis quality and its compliance to the Skoltech PhD degree requirements.

It is clear that nowadays exploration of hydrocarbon reservoirs and oil recovery become more and more expensive. A new field development project may not come to life without preliminary economic estimation based on in-field geophysical testing followed by reservoir simulations. The more comprehensive and accurate is the acquired data set and the more realistic is the simulation model, the better are the hints for oil producers. The thesis by Georgy Peshkov seeks for improvement of the petroleum systems simulations by accounting for the thermal history of the basin. Despite the author advocated less ambitious goal of evaluating the uncertainty of such simulations, I feel that his work goes a bit further, as it suggests improved simulations workflows, attracts new geophysical data and identifies the weakest points of the common simulation approaches. On the other hand, it is easy to comprehend the reservations: scarcity and uncertainty of existing data indeed prevent the general assessment of proposed improvements, while the claim for more sophisticated geophysical tests would increase preliminary investments.

The thesis text is very well structured and well written. As I have already mentioned, the composition and exposure allows non-experts to catch the essential ideas, comprehend the problems and understand the solutions. At the same time, very detailed description of each applied task certainly makes the work not only clear, but also reproducible for professionals. The thesis starts with the formulation of the goal and objectives, importance of which is further elucidated in the literature review in Chapter 1. Stressing on four key points, uncertainty of customary geothermal characteristics, underestimated role of the gravity analysis in thermal history reconstruction and the need in simultaneous consideration of structural and thermal data, as well as the role of model dimensionality, it sets the structure of the rest of the text, consisting, accordingly, of the four Chapters. Each presents new simulation workflow and considers one-two applications illustrating its implementation with variable models for basin structure or thermophysics. These examples are highly non-uniform due to amount and quality of the reference geophysical data, but conclusions drawn from them are formulated in terms of uncertainties thus being well justified. Partial conclusions follow each Chapter, sometimes sub-Chapters, and summarized in the final Chapter 6 together with recommendations. Appendices provide useful technical and illustrative information. One should not be an expert to estimate the high qualification of the author capable to solve so complex tasks, provide their logical presentation and make perfect judgement on the validity and generality of the achieved results.

The list of publications includes 6 items, three of which are the conference papers. Two research articles are published in the top-rank (Q1) professional journals of exact relevance to the thesis topic. The third one was published in the Q3 journal of a broader scope, good for attracting attention to the topic in a wider audience. Georgy is the first co-author in four publications.

Overall, the publication list exceeds the minimum requirements of the Skoltech PhD programs and further confirm the qualification of the author.

I have little to comment on the thesis text, except noting some formatting inaccuracies like broken figures and tables. Layout of the Fig. 12 is especially bad preventing one to understand the meaning.

Two questions emerged in my mind are rather general and may deserve not more than in vivo discussion at the defense.

1. Consideration of basin history are weakly coupled to the chemical composition of deposited organic matter, transformed to hydrocarbons, which only appears in the work under the vague term of maturity. Would it be instructive to make more use of geochemical data in thermal history reconstruction?
2. At present, suggested workflows look more like recommendations for researchers for customized exploration of each particular basin and petroleum systems. Can the author express his thoughts on whether or not they can seed the improvements of conventional simulators?

That said, I gladly and responsibly recommend the thesis submitted by Georgy Peshkov for public defense.

Provisional Recommendation

I recommend that the candidate should defend the thesis by means of a formal thesis defense

I recommend that the candidate should defend the thesis by means of a formal thesis defense only after appropriate changes would be introduced in candidate's thesis according to the recommendations of the present report

The thesis is not acceptable and I recommend that the candidate be exempt from the formal thesis defense