

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Georgy 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 Dimitri Pissarenko

Co-supervisor: Dr. Evgeny Chekhonin

Name of the Reviewer: Professor Sergey Stanchits

I confirm the absence of any conflict of interest



Date: 19-11-2021

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

In his Ph.D. thesis, Georgy Peshkov presented the study of thermal history reconstruction, which aims to reduce uncertainties in petroleum system analysis and to improve the predictive power of basin and petroleum system modelling. Reliable information about the values of rock thermal conductivity and heat flow density is extremely important for accurate basin modelling. In his Ph.D. study, Georgy demonstrated how to apply the thermal properties measured on the core samples by optical scanning in laboratory conditions to a basin model. He proposed the following three workflows to improve the accuracy of thermal history reconstruction: (i) reduce the uncertainty for 2D thermal modelling by combining thermal and structural solutions; (ii) improve the accuracy of 3D thermal modelling by combining the thermal and back stripping-based structural solution; (iii) incorporate gravity data and heterogeneous basement maps into the model to reconstruct the basal heat flow density. The application of these three workflows can significantly reduce the uncertainties of thermal modelling, as Georgy has demonstrated by the example of West Siberian and some other basins modeling.

The thesis is well-written, 154 pages long and contains six chapters, including detailed literature review, and the analysis of the impacts of reducing uncertainties in geothermal characterization based on aforementioned three workflows.

The content of the dissertation and the implemented methods are entirely consistent with the topic of the Ph.D. study.

I have a few questions to Georgy Peshkov related to the text of the thesis.

- Could you please provide the thermal model calibration of your basin model presented in section 3.3.3 of the Thesis for both the present-day temperature and vitrinite reflectance?
- I think it would be interesting to see the calibration results of both your work and the work of earlier researchers on the same graph. My guess is that such a comparison can improve the visibility of your research findings and make your results more meaningful.
- In section 4.2.2, sub-section Model1 vs. Model 2, Densities of the basement (p.63) the following is written: "*We also estimated that variations in the radiogenic heat production may change the corresponding heat flow values by less than 2% due to the difference in the crust thickness.*" Are you sure that 20km column height of mafic vs granite in "*heterogeneous crust*" causes only a 2% difference in the heat flow? Could you please explain?
- In Table 2, you referenced to the results of the thermal properties of the core samples measured in ambient laboratory conditions, mentioning the need to apply experimentally obtained thermobaric corrections. How accurately these corrections can be estimated, and how significant could the effect of the uncertainties of these corrections be to the final thermal basin modelling results?

Overall, Ph.D. study of Georgy Peshkov certainly represents a significant step forward in improving the predictive capability of basin and petroleum system modelling. Georgy Peshkov demonstrated this by participating in a joint grant from the Russian Foundation for Basic Research (RFBR) and Research Council of Norway, in a grant from the Ministry of Science and Higher Education of the Russian Federation aimed to create of a world-class scientific center "*Rational development of liquid hydrocarbons of the planet*", as well as in commercial projects with the companies Lukoil-Engineering and Rosneft. The results of the study were presented at 3 International conferences and published in 3 papers in Q1/Q2 ranking journals.

Provisional Recommendation

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