Skoltech
Skolkovo Institute of Science and Technology

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Aliya Mukhametdinova

PhD Program: Petroleum Engineering

Title of Thesis: Investigation of reservoir properties of unconventional reservoirs using low-field nuclear magnetic resonance

Supervisor: Associate Professor Alexey Cheremisin

Name of the Reviewer: Professor Dimitri Pissarenko

I confirm the absence of any conflict of interest	**Date: 21-02-2021**

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

The PhD thesis manuscript by Aliya Mukhametdinova entitled "Investigation of reservoir properties of unconventional reservoirs using low-field nuclear magnetic resonance" is clearly written and well structured. It contains a comprehensive overview of state-of-the-art methods of fluid saturated rock characterization based on various NMR techniques. The manuscript is comprised of Introduction, five chapters, and Conclusion. The main topic of the dissertation is highly relevant in the modern context of hydrocarbon production technologies from unconventional reservoirs both from the point of view of new NMR measurement techniques and instruments, as well as regarding technical capabilities to assess and characterize production potential of such reservoirs. The author addresses unconventional formations present in Russia, such as Bazhenov and Domanik shales, and also considers carbonate formations containing heavy oils, as well as a special case of permafrost bearing soils. Besides NMR methods, the author uses a range of advanced rock characterization techniques such as computed tomography, SEM, and Rock-Eval pyrolysis. The main results obtained during the thesis project are principally related to a detailed comparative analysis of sensitivity, resolution and fluid discrimination capabilities by NMR based measurements compared to other standard and advanced core characterization techniques. This analysis

was performed for a range of different lithotypes, rock wettabilities, and fluid saturations. The study on characterization of unfrozen water in permafrost formations is not directly related to hydrocarbon production but has a value for the studies related to rock and soil mechanical properties in the Arctic regions.

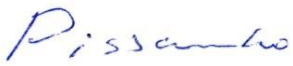
The experimental work reported in this thesis was performed in accordance with modern methodology of laboratory investigations, and the interpretation of experimental results was done up to the current international standards and practices. The produced results are relevant from the point of view of modern techniques of investigation of porous materials and rocks using NMR measurements, and as a contribution to the development of new characterization and production technologies for unconventional hydrocarbon reservoirs.

During the thesis, the author has contributed to eight publications in peer-reviewed international journals, and has participated in nine international and Russian conferences with presentations and posters. These numbers fully satisfy formal Skoltech's requirements to PhD candidates with respect to publications. The manuscript of the thesis was significantly improved since it was first presented in 2020 following the remarks of the jury members, and it now addresses all the critical comments made at that time.

In summary, I recommend the presented PhD thesis for defense.

Best regards,

Dimitri Pissarenko



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

Provisional Recommendation
V *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*