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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 Sergey Stanchits

I confirm the absence of any conflict of interest (Alternatively, Reviewer can formulate a possible conflict)	**Signature:**  **Date: 16-02-2021**

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

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 the submitted dissertation, the author presented a study of the porous structure of organic-rich carbonates, organic-rich clay shales, heavy-oil carbonates, and permafrost soils by Nuclear Magnetic Resonance (NMR) method both in ambient and in formation conditions. Presented results are qualitative, the overall structure of the dissertation clearly describes the novelty of results obtained.

Due to kerogen content, low porosity and permeability, conventional laboratory methods are not applicable for petrophysical analysis of rocks obtained from unconventional formations. NMR technique provides the most reliable assessment of hydrocarbon deposit properties and allows the most accurate determination of the porosity, rock wettability as well as oil and water saturation. In her work, Aliya has developed and adapted the existing workflows for local formations and permafrost soils. The developed method was successfully applied to the analysis of the Domanik and Bazhenov rock samples, and the results of a comparison of different methods are shown in the dissertation. Presented study contains the results of numerous experiments, such as CO_2 diffusion study using high pressure high temperature (HPHT) NMR, the analysis of the unfrozen water content in permafrost samples in ambient and reservoir conditions, etc. Aliya suggested laboratory workflow for routine and specific core analysis for different lithotypes of the rock samples. Presented study can be considered as a significant contribution to the assessment of the petrophysical properties of the rock and can be used for evaluation of the efficiency of enhanced oil recovery (EOR) methods.

There are five main chapters in the dissertation, each is assigned to a separate research direction. A literature review, scientific value and industrial relevance of the proposed studies are presented in the Chapter 1. Chapter 2 describes methods used and the objects of study. Chapter 3 presents the results of the special core analysis by NMR technique. Chapter 4 contains the method of unfrozen water content determination in frozen soils and sands. Chapter 5 focuses on diffusion results obtained in high pressure and high temperature (HPHT) experiments, and Chapter 6 presents results of practical applications of NMR technique in thermal EOR experiments. At the end of the dissertation, a discussion of the obtained results, conclusions, and recommendations are provided.

The content of the dissertation and the methods implemented are definitely consistent with the PhD study topic. The obtained results are significant and represent a step toward improving the existing approaches to modeling. The results of the study are significant not only in Russian Federation, but also at the international level; definitely, they correspond to the current state of the art.

Most of the results were obtained in the frame of research projects sponsored by grants and industrial partners. Therefore, the results have a reasonably high practical value. The results of the dissertation are published in reputable peer-reviewed journals indexed in Scopus and WoS.

Minor remarks:

1. I recommend making a double-check of all the references in Chapter 1;
2. I suggest restructuring the introductory part of dissertation (sections 1.2.2-1.2.4), considering the option of slightly shortening the literature review part;
3. Section 2.3. I recommend adding a paragraph describing the NMR measurement limits in terms of visible fluid volume and pore size;
4. Section 3.1, 3.2. I recommend adding separate conclusions for these sub-chapters;

5. Section 5.4. I recommend to provide more details regarding the calculation of the diffusion coefficients;
6. Chapter 7. I recommend to highlight the novelty of the study in the Conclusions section;

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*