

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Valentina Ekimova

PhD Program: Petroleum Engineering

Title of Thesis: Experimental modeling of gas hydrates interaction with a salt solution in permafrost

Supervisor: Dr. Evgeny Chuvilin

Name of the Reviewer: Sergeev Dmitrii Olegovich

I confirm the absence of any conflict of interest

Date: 10-09-2022

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

The author presented a detailed and meaningful qualification work. It expands our horizon of knowledge about the dynamics in porous natural systems containing pore solutions, gases, gas hydrates and salts at the same time. The work contains an expanded literary review, the results of original experiments and the analysis of the results obtained. A conceptual basis for the understanding the interaction of salts, hydrates of aqueous ice and pore media in the soils is proposed.

This work is relevant for engineers who ensure the safety of oil production facilities in the conditions of changing permafrost condition.

Research methods that were used by the author were specially adapted to the original tasks and fully correspond to the modern scientific world level. The novelty of the data obtained promotes the understanding of the complexity of multiphase interaction in natural porous media.

In particular, Author obtained the important knowledge that the migration of salt ions into a frozen hydrate-containing sample occurs more intensively than in a sample without hydrates. This is especially important for permafrost paleo-reconstructing in oil and gas regions, as well as to prepare permafrost state forecasts with taking into account the climate technological pressing.

The overall level of publication is high. This work is recommended for the use of engineers involved in the development of oil and gas fields in the Arctic, as well as an educational and reference university manual.

When reading the work, a number of questions arise that require the communication and discussion.

1. The difference between objectives #1 and #3 is not clear, as well as the difference between #1 and #4.
2. The references to literature are inserted in non-uniform shape. Please, see, for example, its at the page 66.
3. It is not clear how the amount of hydrates in the volume of the sample of the soil was controlled. How was the volume homogeneity of the processes in the soil sample achieved? There were boundary effects in the sample? This could be verified by examining the cross section of the sample at different stages of the experiment.
4. It is not quite obvious, whether there are observations confirming the patterns in the processes shown in Fig. 39 and in Table 9.
5. It is strange that the porosity of the sands and clay are similar (see Tables 11 and 12).
6. The pressure growth should lead to a stop of the dissociation of hydrates, and not to the explosion (see p. 168, the last three lines). In addition, the studies conducted at the Department of Geocryology of Geological Faculty of Moscow State University and at the Institute of Environmental Geoscience RAS, showed the principal permeability of the permafrost for gases.
7. The submarine permafrost is not the media for the diffusion of seawater salts, because the diffusion will be very slow In silt, and the permeability of the such deposits is small for water migration (see p. 169).

The listed discussion moments do not reduce the overall scientific value of work. So, Valentina Ekimova corresponds to PhD qualifying level.

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