Skoltech
Skolkovo Institute of Science and Technology

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Valentina Ekimova

PhD Program: Petroleum Engineering

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

Supervisor: Dr. Evgeny Chuvilin

Name of the Reviewer: Mikhail Grigoriev

I confirm the absence of any conflict of interest Doctor of Geography Mikhail Grigoriev	**Date: 18-09-2022**

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 presented theses are a good scientific study, which contains all the signs of a completed dissertation work. The structure of the dissertation is quite logical, justified and does not cause serious objections.

The topic of the dissertation corresponds to its actual content.

This work is very relevant due to the fact that gas hydrate formations in the Arctic can be destabilized both as a result of permafrost degradation due to climate warming, and during the migration of salt solutions into frozen sediments containing hydrates.

The research methods used in the dissertation are quite appropriate

The scientific significance of the results obtained is fully consistent with the international level.

The reviewed thesis is devoted to a very important problem related to the assessment of the interaction of gas hydrates and saline solutions in the permafrost stratum. This study was conducted using experimental modeling of the processes of interaction of frozen hydrate-saturated sand sediment with salt solutions. The object of the study was model sandy soils selected in the Arctic region, where the existence of gas hydrates is assumed. Experimental modeling of the mechanism of dissociation of pore gas hydrates in frozen deposits as a result of salt migration at different pressures is a very important method for assessing the role of salt transfer in the destabilization of gas hydrate formations and methane emissions in the Arctic permafrost.

The reviewer would like to note the following main scientific results obtained by the author of the dissertation:

- A new method for determining the concentration of water-soluble salts in sand deposits through moisture activity is proposed.

- A new method for studying the interaction of hydrate-saturated frozen sediment with a solution of salts has been created, as well as a method for studying temperature changes during the interaction of frozen hydrate-saturated rocks with a salt solution.

- A scheme of phase transitions of water in frozen sands saturated with stable and metastable hydrates is proposed, and the influence of temperature on this process is analyzed.

- On the basis of experimental data, the concept of destabilization of gas hydrate formations in in the Arctic continental and shelf permafrost is proposed.

The main goal of the current study is the experimental study of the mechanism and patterns of interaction of gas hydrates with salt solutions in the pore space of hydrate-saturated reservoirs under various thermobaric conditions.

The author conducted a serious compilation of previous articles on the topic of dissertation research (338 references). Valentina Ekimova has published, mainly in co-authorship, in highly rated journals, quite a lot of articles regarding the research of gas hydrates and salt solutions in frozen sediment.

The presented work contains a Map of the permafrost distribution in the Arctic zone of the Russian Federation (Fig. 1, HydroSpetsGeologya. Information Note with an Assessment of the Current State of the Subsoil in Significant and Man-Made Disturbed Conditions of the Territory of the Arctic Zone of the Russian Federation), where the southern boundaries of the Arctic (?) permafrost are shown up to almost 60° north latitude, which is completely incorrect.

In general, the presented theses of Valentina Ekimova represent an interesting and important scientific research. I wish her a successful 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*