Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Daniel Wamriew

PhD Program: Petroleum Engineering

Title of Thesis: Location and source mechanisms of induced seismic events

Supervisor: Professor Dmitri Koroteev
Co-supervisor: Professor Roman Pevzner, Curtin University

Name of the Reviewer:

I confirm the absence of any conflict of interest Dr. Ariel Lellouch (Alternatively, Reviewer can formulate a possible conflict)	**Date: 07-08-2022**

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

The dissertation by D. Wamriew describes the application of machine-learning approaches to the broad problem of passive seismic monitoring, including event detection, location, focal mechanism estimation, and velocity model updates. It is structured in a logical way, with applications increasing in complexity and targeting more and more ambitious goals. Overall, the dissertation is of high quality and represents a significant body of work that is relevant to the topic.

The methods used in this dissertation are cutting-edge and at the forefront of the discipline. Large volumes of training data were generated to train the networks, thus increasing their potential in handling the complexities of actual subsurface propagation. While many applications are still relatively preliminary and tested mostly on synthetic modeling, they do have immediate practical applications, as demonstrated by the solid publications arising from this dissertation.

I do recommend some changes that would, I think, benefit the thesis. They are in "logical" order and not necessarily by chapters.

1) I think the name of the thesis could be more representative, and in my opinion needs to include some component of machine learning as well as velocity model updates. Also, some of the applications are not for induced seismicity but for microseismic monitoring, so the name is a bit misleading.

2) The decomposition of the focal mechanism to isotropic, double-couple, and CLVD is also true for isotropic media, as far as I know; I think it would be better suited in that section.

3) Some discussion about the complexity of the subsurface structures (beyond 1-D anisotropy) and the ability of DL methods to handle such previously unmodeled complexities would, I think, be useful. If the field data is affected by a significantly more complicated (and unknown) velocity/density structure, how well will the workflows that you describe perform?

4) The coupling between moment tensor inversion and the velocity structure is known to be potentially significant. Could you elaborate on how your approach would work with only a reasonably accurate model?

5) Along the same line, I think that describing potential limitations of using ray tracing in generating a complete training dataset would be beneficial. There are cases (for instance, you can see some of my work on guided waves, but there are other cases) in which ray-based approaches cannot accurately represent recorded data.

6) In the FORGE dataset, there is a "ground truth" estimation coming from microseismic monitoring performed by Schlumberger. I know the work has already been published, and it may be too late, but it would be useful to compare your results to the microseismic catalog.

7) I do not ask to modify the thesis, but many of the validation examples are guilty of what is often called the "inverse crime" (using the same modeling tool for forward and inverse problems). I think that, for example, generating a testing dataset through wave equation modeling (instead of the same ray-tracing used for the training dataset) would be beneficial.

Good luck in the defense!

Ariel

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*