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July 28, 2021

To: Dr. Mariusz Majdanski
Deputy Director for Scientific Affairs
Institute of Geophysics
Polish Academy of Sciences

Re: Ph.D. Dissertation of Milosz Mezyk

Following, find my review of the doctoral dissertation of Milosz Mezyk entitled *Imaging the East European Craton margin by reprocessing and interpretation of the Poland SPAN reflection seismic profiles supported by machine learning*. Having read and considered the dissertation in its entirety, I have arrived at the following conclusions:

1. The candidate has a good grasp of general theoretical knowledge in the discipline of geophysics and artificial intelligence (machine learning).
2. The candidate has demonstrated the ability to independently carry out scientific research.
3. The solution to the problem addressed by the candidate as a whole is original.
4. The candidate should be admitted to a public defense of the doctoral dissertation.

You will find an elaboration of each of these conclusions in the attached addendum.

Sincerely yours,

White, Don

Digitally signed by White, Don
DN: C=CA, O=GC, OU=NRCAN-RNCAN, CN="White, Don"
Reason: I am the author of this document
Location: Ottawa, Canada
Date: 2021.07.28 08:43:14-04'00'
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Don White, Ph.D.
Geological Survey of Canada

Review of the doctoral dissertation of Milosz Mezyk entitled *Imaging the East European Craton margin by reprocessing and interpretation of the Poland SPAN reflection seismic profiles supported by machine learning*

The core element of this thesis is the reprocessing and geological interpretation of deep seismic profiles acquired across the margin of the East European craton. In support of this activity, the candidate has developed and applied machine learning applications for first-break picking (an essential but time-consuming step in seismic data processing) and for seismic attribute analysis (to support semi-quantitative seismic interpretation). The body of work has been published in a series of peer-reviewed international journal papers and an extended abstract for a prominent science and engineering conference. The primary result of the thesis is strong evidence that current models for structure within the EEC need revision.

General theoretical knowledge: based on the contents of the dissertation and associated journal publications, the candidate has demonstrated a good understanding of various aspects of geophysics, geology and the application of artificial intelligence methods. The successful seismic imaging achieved by the candidate demonstrates understanding of a broad variety of signal processing methods (e.g., see Table 1.1). Interpretation of the seismic images included the integration of auxillary seismic refraction information and potential field data. Underlying the interpretations is a grasp of crustal-scale geological processes that are potentially reflected in the seismic images. Furthermore, the adoption, adaptation and successful application of machine learning and data clustering algorithms demonstrates a knowledge of the underlying principles of these methods.

Independence of scientific research: The body of work included in the dissertation has been published in 3 co-authored journal papers and an expanded abstract. In each case, the candidate is the lead author and documented (via signed attribution letters) as having contributed 70%-85% of the work in each case.

Originality: The solution to the problem addressed by the candidate as a whole is original. Traditional methods of data processing and interpretation are employed, supported by some novel artificial intelligence applications. Seismic processing by its nature requires an iterative approach to data analysis which requires extensive selection and testing of processing parameters. Also, the interpretation and integration of the seismic data with other geological and geophysical to obtain a data-based geological model is a creative process. The two more innovative aspects of the work are the use of machine learning algorithms and data clustering analysis of seismic attributes.

The use of machine learning for the purposes of first-break picking has been around in some form since the late 1980's. It has received renewed attention in the last decade due to advances in AI algorithms and computational power. The approach taken in the dissertation utilizes machine learning to simultaneously analyze multiple seismic attributes to achieve binary classification. The simultaneous use of multiple seismic attributes is an innovative approach. Several AI methods are employed and compared for performance including deep neural networks (DNN), optimized distributed gradient boosting (XGBoost), and support

vector regression. To determine the parameters for model building, Bayesian optimization is employed. After comparison, the author settles on DNN due to better speed. The use of multiple attributes differs from the approach taken by Tsai et al. (2018).

Cluster analysis of seismic attributes has been widely investigated for the purposes of stratigraphic facies or structural classification in sedimentary basin environments. In contrast, it has rarely (if at all?) been utilized in the analysis of seismic facies for deep crustal data. This is an original component of the dissertation.

Admission to public defense of the doctoral dissertation: based on the demonstrated general theoretical knowledge, independent research and originality of the dissertation, as well as the publication record of this work, I recommend admission of the candidate to a public defense of the dissertation.