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PhD Thesis Review

Author: Anna Tymińska

Title: "Limitations of first P-wave onset method of full seismic moment tensor inversion and impact on effective application in anthropogenic seismicity studies".

Description of the reviewed work.

The reviewed work is a study consisting of 69 pages of text, including a title page, table of contents, introduction, statement of the purpose of the work, five chapters constituting the body of the work, discussion of the results, conclusions, bibliography, list of figures and list of tables. The bibliographic list includes approximately 60 published items.

The author presents a comprehensive and detailed review of methods for interpreting the seismic moment tensor, MT. Seismograms recorded by the seismic network are used to estimate seismic MT.

Ms. Tymińska devotes much attention to understanding the nature of non-shear components of the full MT solution for tremors recorded by local seismological networks. In studies of natural seismicity occurring on faults, in most cases, it is sufficient to adopt a double-couple source model. The author indicates that such an approach is not recommended for studying induced seismicity, because we may be dealing with mechanisms of a non-double-couple, non-DC, of a seismic source. At the same time, the author indicates that the non-DC solution may be the result of imperfections in the inversion process.

The author devoted a significant part of her work to a detailed and comprehensive study of possible causes of errors in the MT estimation. Below is a list of possible sources of error:

- Error related to the approximate nature of the velocity model for P waves.

- The configuration of the seismic network also has a significant impact on the quality of the MT solution. In a series of synthetic tests, the author examines how station the azimuth coverage and the uncertainty of the location affect the non-DC solutions.

- The author generates synthetic noise to assess its impact on the quality of the MT solution. For this purpose, the synthetic noise is added to the real signal.

- The author made a very detailed assessment of the error resulting from the omission of the intermediate field when modeling seismograms in the areas of induced seismicity.

- Jackknife station rejection tests are performed to identify the most important stations for the MT inversion.

The study used data from four networks. Two of them are underground mines located in Poland, and the other two are artificial reservoirs in Vietnam.

Overall assessment of the doctoral dissertation.

The dissertation is a significant and original contribution to understanding errors occurring in the full inversion of the MT. It gave the author experience in interpreting data that, like most data, are characterized by an insufficient number of stations, which is particularly troublesome when trying to determine the depth of earthquakes.

The main objective of conducting synthetic tests was to verify the reliability of MT solutions of seismic source mechanisms that are non-double-couple. The analyses and conclusions drawn from the studies are justified.

I have paid special attention to the author's research on the influence of the intermediate field on the P waveform. In principle, at large distances from the seismic station to the seismic source, we model only the far field. The author showed that at small distances between the station and the source, characteristic of induced seismicity, the influence of the intermediate field should also be taken into account.

I am glad that the author is not afraid to use data from Global Navigation Satellite Systems stations. This shows her progressive approach to scientific research. Although these data had little impact on the moment tensor inversion results, they enriched the author's professional experience.

Critical comments on the work.

I tried to understand the author's opinions on interpreting the non-DC component of the full MT solution. However, I did not find a clear statement. The work contains several conclusions concerning a specific network or a specific earthquake but does not make any generalizations. This nature of the conclusions probably reflects the difficulty of taking a clear position on the interpretation of the non-DC component.

The paper does not present any observed seismograms. Several examples of seismograms will allow the reader to independently assess a number of their features. For example, is a single pulse the best approximation of the source time function? One can also evaluate the noise characteristics.

Most of the noise preceding the first arrival of the P wave is not white noise. Seismic noise has structure, so taking into account the past properties of the noise signal, one can predict future values of the signal.

The author stated that the amplitudes calculated for the LGOM area were usually larger than the measured ones. So why did the author not attempt to estimate the site effect amplitude for the LGOM network, using, for example, the spectral ratio method?

If the candidate plans to publish her work, I suggest that the figure captions include a full description of all symbols that appear in the figures. This additional explanation will make the work easier to read and understand. It is not enough that the symbol is explained somewhere in the text.

The analysis of the impact of the TRBC station on the MT solution showed how important it is to consider all information from the station located close to the seismic source (Fig. 9). Therefore, the Jackknife method should be used with some limitations.

My critical remarks are not intended to diminish the scientific achievements presented in the work but can be used by the author to present the results of the work more clearly.

Recommendation

In my opinion, Ms. Anna Tymińska's doctoral dissertation meets the requirements. Therefore, she deserves a public defense of her doctoral dissertation within the meaning of the provisions of the Act of July 20, 2018 - Law on Higher Education and Science (Journal of Laws of 2018, item 1668, as amended).

In connection with the above, I am appealing to the Scientific Council of the Institute of Geophysics of the Polish Academy of Sciences to enable Ms. Anna Tymińska to continue the qualification procedure for the award of the doctoral degree.

Anna Cichowicz