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Department of Geology Honours Report on the workshop titled

**Seismicity induced by human technological activities and the related seismic hazard**

Presented by the Institute of Geophysics Polish Academy of Sciences and the UP Natural Hazard  
Centre, Department of Geology

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Submitted by:

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## **1. Introduction**

Anthropogenic hazards, hazards triggered by human activities, pose significant risks to the environment, infrastructure, and human populations. Understanding and effectively managing these hazards is crucial for sustainable development and the well-being of communities. This course focused on exploring anthropogenic hazards, particularly in the context of seismic activities and earth movements.

Seismology, the study of earthquakes and seismic waves, played a central role in examining the impact of human activities on the occurrence and intensity of seismic events. By monitoring and analysing seismic activity, it becomes possible to assess the extent to which human actions, such as mining, hydraulic fracturing, or underground explosions, contribute to induced seismicity.

During the course, students were introduced to the Episodes Platform, a powerful tool that facilitates the monitoring and assessment of seismic events related to anthropogenic activities. This platform, utilized in a workshop held at the University of Pretoria in collaboration with the Institute of Geophysics Polish Academy of Sciences in 2023, provided students with practical experience in analysing and interpreting seismic data to evaluate the risks associated with human-induced seismicity.

This introduction highlights the significance of studying anthropogenic hazards, specifically within the context of seismic activities. It underscores the importance of understanding how human actions can trigger seismic events and the necessity of monitoring and assessing these events to implement appropriate protocols and regulations. The integration of the Episodes Platform into the course curriculum enabled students to develop practical skills in analysing seismic data and evaluating the impact of anthropogenic activities on seismicity.

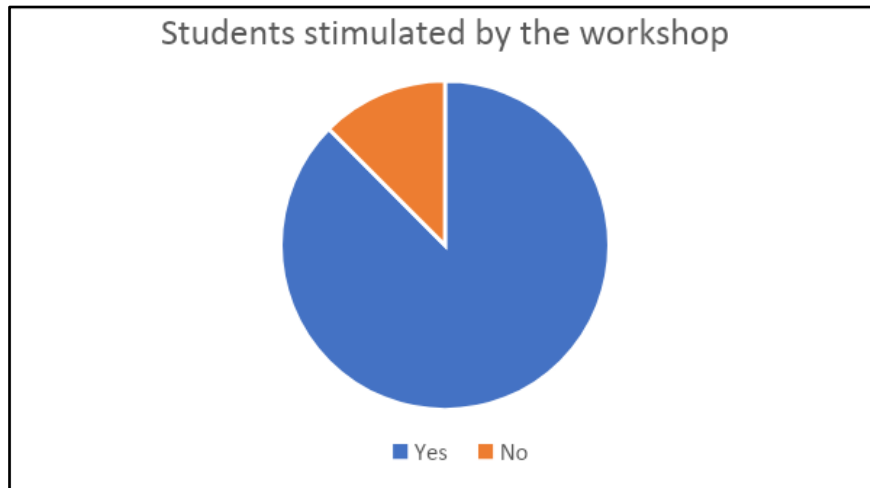
## **2. The workshop: what was learned in terms of theory**

We examined the theory discussed in the induced seismicity workshop by utilizing a questionnaire. The purpose was to gauge the students' comprehension of the presented information and gather feedback on potential areas for improvement.

Out of the total of 22 students who participated, 16 students completed the questionnaire, resulting in an engagement rate of approximately 73%. When asked if they were familiar with the term "induced seismicity," 13 out of the 16 respondents (81%) indicated that they were familiar with the term and could provide an explanation. The remaining 3 students were unfamiliar with the term, and we further investigated why they struggled to understand it. Based on their responses, two main reasons emerged. Firstly, these students found the workshop unexciting, which hindered their ability to retain any information. Secondly, and perhaps more concerning, some students provided low-quality responses, stating "no" simply to avoid elaborating on their lack of understanding.

Additionally, when students were asked whether the workshop stimulated their learning and comprehension of human-related seismicity, the majority responded positively, as depicted in figure

1. Only 2 students reported that the workshop did not stimulate their learning. This finding aligns with the notion that those who struggled to retain information about induced seismicity may have been influenced by a lack of engagement during the workshop.

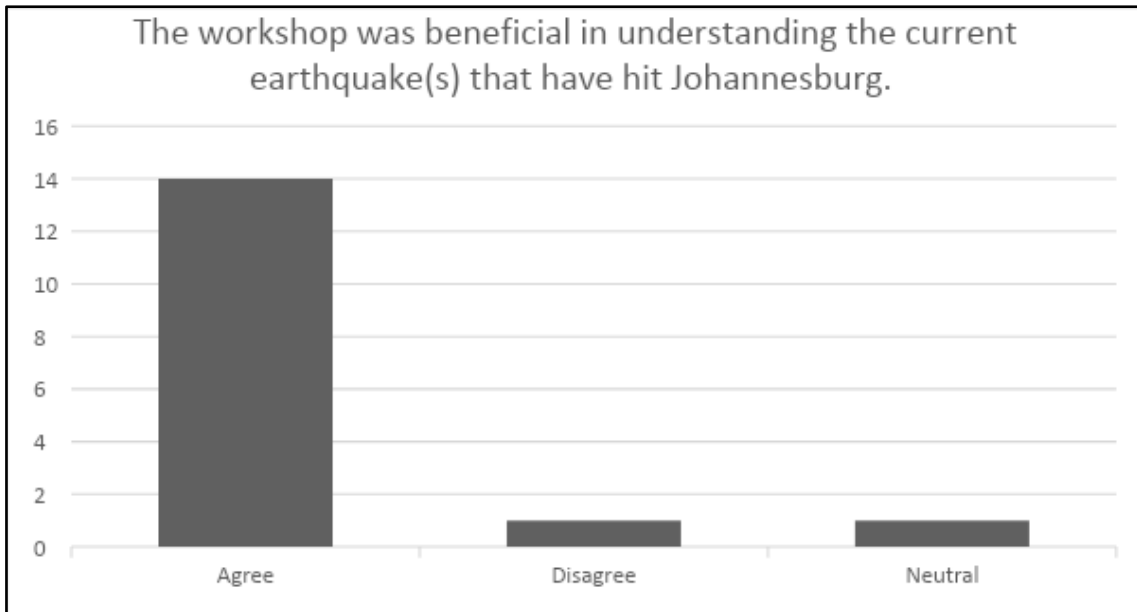


**Figure 5:** 16 students' replies to being asked if they were stimulated by the workshop.

However, many students demonstrated the ability to accurately explain the term, indicating a solid understanding of the fundamental concept conveyed in the workshop. This suggests that the workshop successfully taught the students about induced seismicity.

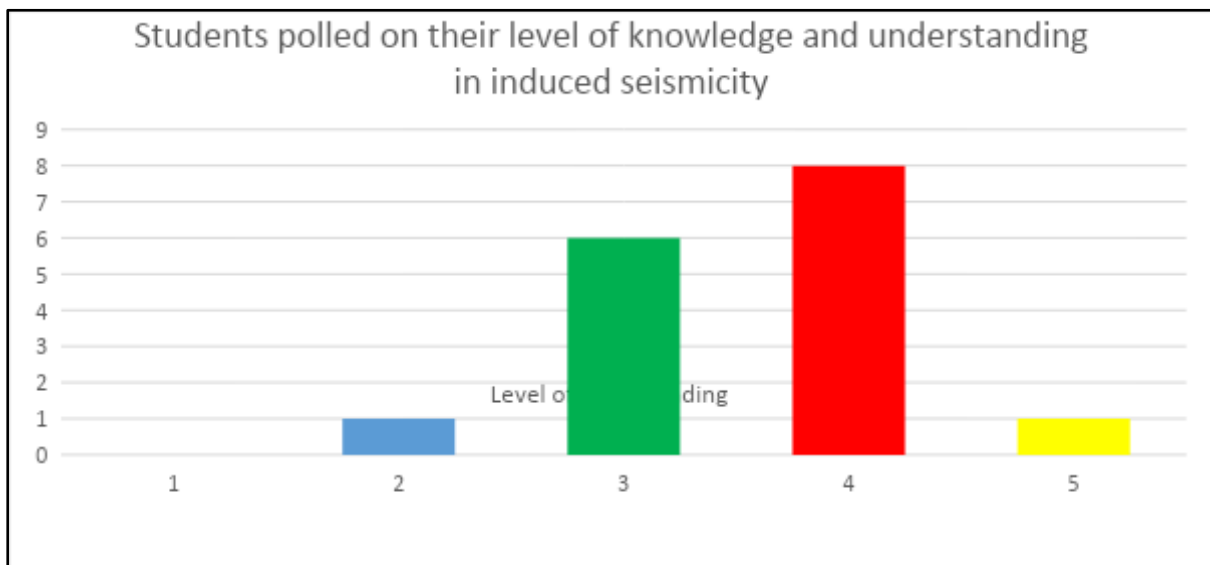
Furthermore, students were asked if they were familiar with any human activities in their vicinity that could potentially cause induced seismicity. This question aimed to explore their understanding of how human actions can induce seismic events. Some students mentioned examples such as hydraulic fracturing near large bodies of water like dams or groundwater seepage. They explained how water infiltration into cracks and fractures could trigger faults and potentially lead to tremors or earthquakes. Among the students who reported knowledge of seismic activities nearby, the majority referred to mines or mining-related operations, with some noting noticeable tremors or earthquakes in the region. The significant presence of mines in the Gauteng area, both active and decommissioned, supports these observations and indicates that the workshop has contributed to the students' understanding of the causes of tremors and earthquakes in their area.

Furthermore, in relation to the recent earthquake near Johannesburg, specifically outside of Benoni, students were asked whether the knowledge gained from the workshop helped them understand why this earthquake may have occurred and if it could have been caused by human activities in the area. The results indicated that most students found the workshop beneficial in understanding the earthquake. Out of the 16 respondents, 14 students (88%) agreed that the workshop aided their understanding, while only one student expressed uncertainty and an inability to comprehend the recent earthquake in Johannesburg. These findings are presented in Figure 2.



**Figure 6:** 16 students prompted as to whether their understanding of the recent earthquake in Johannesburg was aided through the induced seismicity workshop.

Students were queried about their ability to effectively explain the concept of induced seismicity to individuals who had no prior knowledge of the term, aiming to assess their understanding of the theory. Most students (13 out of 16 - 73%) displayed ease in explaining the term, indicating a comfortable grasp of the theory taught throughout the workshop. Three students mentioned that they would face difficulties in explaining the term to someone unfamiliar with it, further supporting the notion that most students felt confident with the concepts presented.



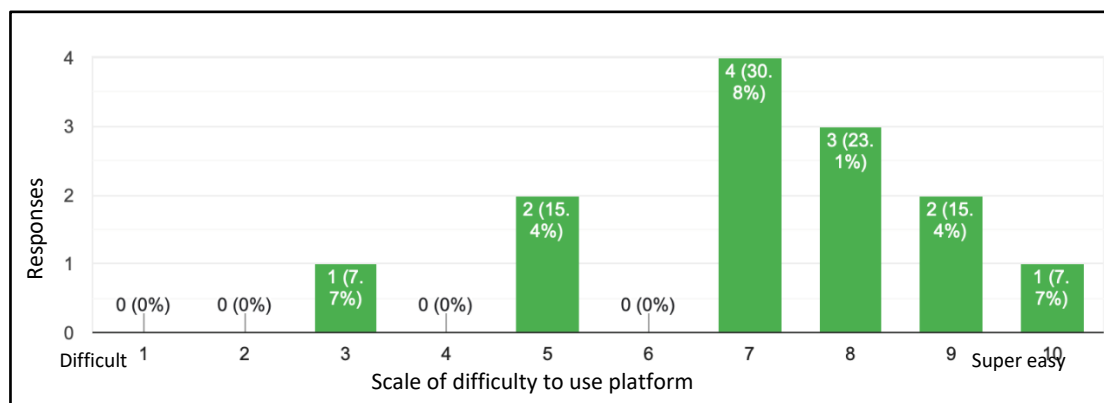
**Figure 7:** 16 students polled on their level of knowledge and understanding in induced seismicity.

In addition, students were requested to rate their knowledge and understanding of the workshop content on a scale of 1 to 5. Among the 16 responses, one student rated their understanding as a 2, implying a lack of substantial comprehension. Six students assigned a rating of 3, indicating a moderate

level of knowledge and understanding. Eight students (half of the responses) rated their understanding as a 4, suggesting a very high level of comprehension, while one student awarded a rating of 5, denoting exceptional understanding of induced seismicity. When these ratings were averaged, the resulting value was 3.5625 out of 5, corresponding to 71.25 percent. This average implies an overall fairly good level of understanding regarding induced seismicity. Considering these findings in conjunction with the earlier results, it can be inferred that the workshop was beneficial and successful in teaching students about induced seismicity.

### 3. What was learnt in terms of the online platform and the workspace?

A survey was sent out to evaluate the student’s perspective on the platform and their overall experience of the workshop presented. The survey asked participants to rate how easy or difficult the platform was to use on a scale from 0 to 10, with 10 being super easy and 0 being extremely difficult. From the results, it showed that 30.8% of the students found it somewhat easy to use, rating it a 7 out of 10; 23.1% rated it 8 out of 10; 15.4% rated it 9 out of 10 and another 15.4% rated it 5 out of 10 meaning the platform was not straightforward to use. These values, and some others, can be seen in figure 1.

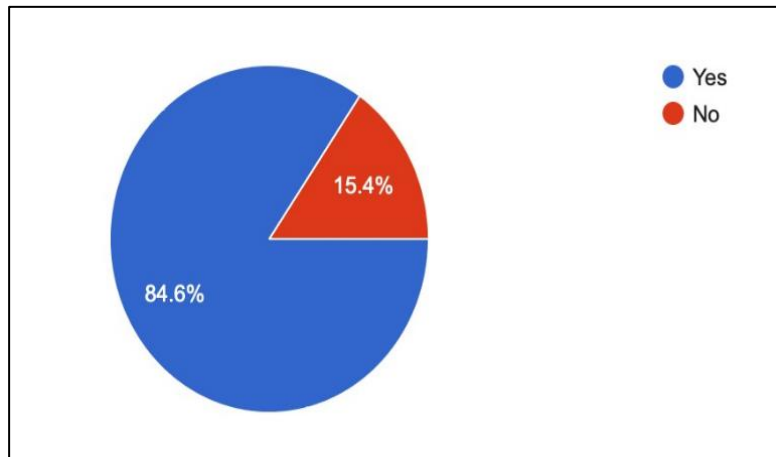


**Figure 12:** Graph showing the students responses to how difficult to the platform was to use

When testing and exploring a new platform such as Episodes, it is important to assess the ease of use for future participants. In the survey conducted, one of the questions posed was, ‘Were you able to quickly understand how to perform tasks or actions within the online workspace?’. The majority response to the question was ‘yes’, with 92% of the class agreeing on this. This indicates that the platform was highly praised for its user-friendliness and demonstrates that it was well received by the class.

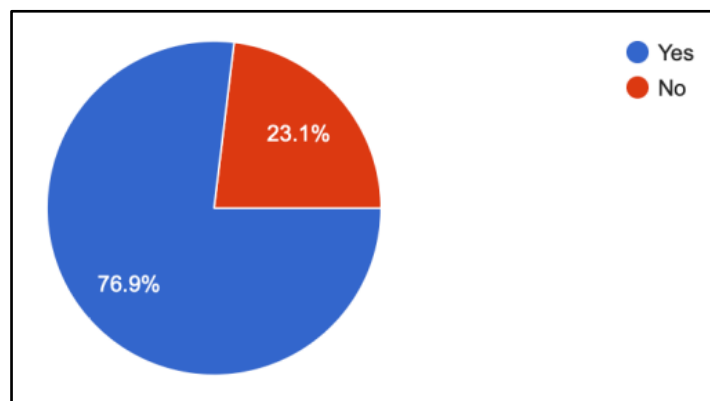
The gaining of new knowledge and skills are considered to be essential objectives of a presented workshop. The survey asked participants to indicate whether or not the workshop was beneficial in terms of gaining new knowledge and skills by simply selecting “yes” or “no”. The results revealed that 84.6% of students found the workshop to be beneficial, whereas only 15.4% of students did not find

the workshop to be beneficial. These percentages are well represented by Figure 1. Thus, the majority of students that attended the workshop found it to be beneficial in terms of acquiring new knowledge and skills and subsequently fulfilling the objectives of the workshop.



**Figure 13:** Pie chart illustrating the student responses regarding whether or not the workshop was found beneficial in terms of gaining new knowledge and skills.

When students were asked if the workshop provided any valuable information that can be applied in their future work as a professional, 76.9% of the students answered yes proving the workshop as being helpful and informative. Seismology is widely used in geophysics in recording and predicting earthquakes and working to mitigate impact of earthquakes and assessment of seismic hazards in mines.



**Figure 14:** Pie chart illustrating the student responses to whether they can use information learnt in the workshop in their professional life.

Due to the ratings of how difficult or easy the participants found the platform; some suggestions were made in terms of how it can be improved to make the Episodes Platform and Workspace easier to use. 53,9% of the students said that the platform was somewhat easy to use by rating it 7/10 or 8/10 on a difficulty scale. However, the students provided some ways that they feel can make the platform more user-friendly. Performance update should be made to the platform to allow weaker machines to

access it. In this workshop, the students had to use the university computers because their personal laptops would be too slow to power the platform. Two suggestions were made for the Workspace in order to improve the filing system and procedure tabs to make the workspace more organised. The workspace creates a new file for every directory that is made, even when similar steps are conducted which clutters the Workspace Tree. In terms of the Workspace, to make it easier to move between it and the AH Episodes, the Workspace page should automatically open to a new tab. Once the program has run an analytical procedure, it should be clearer on the user feedback and confirmation of a successful process completion. Another suggestion that could help users of the platform is to have YouTube tutorial videos available so people can look up how to complete a task with easy explanations and demonstrations. These suggestions would make the platform more user friendly and easy to use. Another suggestion was made by a participant to enhance the program, which is for the computer to automatically locate the best peaks once the data has been imported into the Workspace.

A later question in the survey asked, 'What did you enjoy the most about the platform?', with majority of the responses stating that they enjoyed how accessible the platform was. Other common comments for this question suggest that the students enjoyed the accessibility to geological information as well as being able to generate and use seismographs with relative ease. The filtering tool was mentioned as a positive, in that the students were able to quickly find the information needed using this. Additionally, numerous participants emphasized the real-world applicability of the platform.

The overall consensus regarding the workshop was positive. The feedback from the students indicated that they enjoyed the workshop, especially the presenters and the interactivity of the workshop. The students perceived their instructors as friendly, eager to teach and extremely enthusiastic. In addition, the students enjoyed the good spirited interactions between themselves and the instructors. A number of students enjoyed the tasks/assignments that were conducted during the workshop, especially the task concerning the seismograms. Learning about seismicity, specifically in certain areas of Europe was enjoyable since the university mainly focuses on seismicity in South Africa. Students found that the information presented was easy to understand and enjoyed learning about the online platform.

Most students found the workshop to be very informative and served as an opportunity to gain new knowledge on seismology and its application, improved their understanding of earthquakes and their associated terminology. The workshop was very interactive, and the presenters were helpful and made it easy to understand with interactive questions and assignments. Although there were a few glitches with the performance of the software overall the seismology workshop was a good and educational experience.

#### **4. Conclusion:**

In conclusion, the Anthropogenic Hazards workshop held at the University of Pretoria provided students with valuable knowledge and skills in understanding anthropogenic hazards, particularly in

the context of seismic activities and earth movements. The workshop introduced the Episodes Platform, which plays a significant role in monitoring and analysing seismic events for effective risk assessment and mitigation. Although South Africa is located on a tectonically inactive craton, the workshop highlighted that contrary to conventional wisdom South Africa still experiences a noticeable frequency in seismic activity and of significant magnitude. The workshop also showed that the observed seismicity in the region is primarily influenced by anthropogenic factors.

Students demonstrated a solid understanding of induced seismicity and its connection to human activities such as mining and hydraulic fracturing. The workshop received positive feedback, with students finding it informative, interactive, and applicable to their future professional work. Although there were suggestions for improving the user-friendliness of the platform, overall, the workshop successfully achieved its objectives of educating students about seismology and its practical implications.