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Your review report

Manuscript

Detection of fractured zones, faults and caves by 3Dmuon tomography based on high resolution muographic measurements in the Buda Hills,Hungary

Feedback for the author(s)

Comments to the author(s)

This paper presents an extensive study using high-resolution muography to investigate the subsurface fracture and cavity system in the Buda Hills, Hungary. The authors report impressive work, with data collection spanning 600 active days across 43 detector positions, yielding over 15 million muon tracks and more than 800,000 directional muon intensity measurements. Their results demonstrate the potential of muography in geological, hydrogeological, and geotechnical applications. However, despite the possible scientific merit and the importance of the topic, the manuscript in its current form is not suitable for publication and requires substantial restructuring and content clarification.

The main concerns and recommended revisions are
1. Structure and Readability. The paper follows an unconventional and confusing structure, introducing the results before thoroughly discussing the methodology. This approach makes it difficult for the reader to understand the basis of the conclusions. My recommendation is to reorganize the paper to follow a logical progression: Introduction, Methodology (including measurement techniques, data acquisition, and validation), Results, Discussion and Conclusion

2. Lack of Explicit Methodology. The methodology section is insufficient, as it primarily references previous work by the same research group instead of clearly describing the procedures used in this study. The authors should explicitly detail the following aspects: the muon detectors' specifications, the steps taken to filter, calibrate/analyze the data, and finally, the methods used to verify the accuracy of the results.

3. Absence Discussion of Simulations. The manuscript states that simulations were used to verify the measurements but does not provide details on the simulation framework, input parameters, or assumptions. The authors should clarify the simulation type (e.g., Monte Carlo methods, GEANT4, or another simulation framework to propagate muons through the geophysical object), input parameters, and boundary conditions. Discuss whether the simulations

were used to model the expected muon flux or validate the density reconstruction.

4. Limited Explanation of Bayesian Discrete Tomography. The paper mentions that Bayesian discrete tomography was used for density reconstruction but does not summarize the mathematical approach, referring readers to other publications. The authors should briefly explain the Bayesian approach, the criteria for selecting prior distributions and regularization parameters, and a better discussion of uncertainties and resolution limitations.

5. Scientific Contribution and Novelty. The study successfully applies muography in a fractured carbonate region, revealing a near-vertical NE-SW fracture system and identifying a large cavity. While the results are valuable, the novelty compared to previous muography studies is not well articulated. The author should clearly state how this study advances the field beyond existing literature by comparing findings with other muographic studies.

Confidential feedback for the Editor

Your recommendation	• ***Revise***
Is the study design appropriate to answer the research question (including the use of appropriate controls), and are the conclusions supported by the evidence presented?	• ***No, but these points can be addressed with revisions***
Comments	***This paper presents an extensive study using high-resolution muography to investigate the subsurface fracture and cavity system in the Buda Hills, Hungary. The authors report impressive work, with data collection spanning 600 active days across 43 detector positions, yielding over 15 million muon tracks and more than 800,000 directional muon intensity measurements. Their results demonstrate the potential of muography in geological, hydrogeological, and geotechnical applications. The study claims to successfully apply muography in a fractured carbonate region, revealing a near-vertical NE-SW fracture system and identifying a large cavity. While the results are valuable, the novelty compared to previous muography studies is not well articulated. The author should clearly state how this study advances the field beyond existing literature by comparing***

	findings with other muographic studies.
Are the methods sufficiently described to allow the study to be repeated?	• ***No, but these points can be addressed with revisions***
Comments	***The methodology section is insufficient, as it primarily references previous work by the same research group instead of clearly describing the procedures used in this study. The authors should explicitly detail the following aspects: the muon detectors' specifications and the steps taken to filter, calibrate, and analyze the data. Finally, they should explain the methods used to verify the accuracy of the results.***
Is the use of statistics and treatment of uncertainties appropriate?	• ***No***
Comments	***First, the manuscript states that simulations were used to verify the measurements but does not provide details on the simulation framework, input parameters, or assumptions. The authors should clarify the simulation type (e.g., Monte Carlo methods, GEANT4, or other simulation framework), input parameters, and boundary conditions. Discuss whether the simulations were used to model the expected muon flux or validate the density reconstruction. Second, the paper mentions that Bayesian discrete tomography was used for density reconstruction but does not summarize the mathematical approach, referring readers to other publications. The authors should briefly explain the Bayesian approach, the criteria for selecting prior distributions and regularization parameters, and a better discussion of uncertainties and resolution limitations.***

Has guidance been provided on how overstated claims should be rewritten?	• ***Yes, I have suggested how the text can be rewritten***
Is the presentation of the work clear?	• ***No, it's not suitable for publication unless extensively edited***
Comments	***The paper follows an unconventional and confusing structure, introducing the results before thoroughly discussing the methodology. This approach makes it difficult for the reader to understand the basis of the conclusions. I recommend reorganising the paper to follow a logical progression: Introduction, Methodology (including measurement techniques, data acquisition, and validation), Results, Discussion and Conclusion.***
Are the images in this manuscript (including electrophoretic gels and blots) free from apparent manipulation?	• ***Yes***

Confidential comments to the Editor

All comments are for both the editor and the authors