Rebuttal Letter

Dear Suzan van der Lee, dear reviewers,

We are very grateful for your comments and the time you have spent reviewing and editing the manuscript. It is greatly appreciated.

We have addressed all the reviewers' comments point by point, as outlined in our response below, where the reviewer comments are given in gray and our answers in black. We have uploaded the following files:

1. A “clean” version of the revised manuscript without highlighted markings/changes.
2. A PDF version of the revised manuscript in which changes/markings/edits are highlighted.
3. The response letter containing our response to the reviewers' comments.

We have also updated the Acknowledgments and added references where appropriate. A non-technical summary was added. We hope that the revised version is now acceptable to Seismica and look forward to their decision.

Best regards

Torsten Dahm, Marius Isken, Claus Milkereit, Christoph Sens-Schönfelder, Felix Eckel, Xiaohui Yuan, Miriam Reiss, Adrien Oth, Georg Rümpker, Luca De Siena, Pinar Büyükakpinar, Patrick Laumann, Hao Zhang, Brigitte Knapmeyer-Endrun, Stefan Mikulla, Ralf Bauz, Sebastian Busch, Martin Hensch, Bernd Schmidt, Gesa Petersen, Simone Cesca

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Reviewer C:

Review of A seismological large-N multisensory experiment to study magma transfer of intracontinental volcanic fields: The example of the Eifel, Germany by T. Dahm and others

This is a well-written paper describing a seismic experiment conducted over the Eifel, Germany. This is an extensive experiment to provide valuable data for studying physical properties and processes related to intracontinental volcanic fields. The paper address issues related to the motivation for the experiment and the details related to the experiment design. Importantly, the paper clearly states the goals for seismic monitoring and how each aspect of the network design related to the stated goals. For someone hoping to use the data in the future, the paper has an extensive section describing data quality control and a description of sensor response and data availability. To assess the network design, the paper shows examples of how the network design meet scientific requirements for future studies. In showing these examples, many analysis techniques are utilized with little detail—reviewers are referred to other papers. Since the paper is meant to describe the network and potential scientific applications, this is okay but sometimes frustrating. I look forward to seeing the scientific papers (with Methods sections) to come out that utilize this great dataset.

I find this paper well-written, well-motivated, and easy to read and follow. I recommend accepting. Here are a few minor comments.

- *Will the QField app be available for adaption for other experiments? This seems like a nice tool.*
  Yes, Qfield is an open-source software and available to the community. We will provide a template project with the paper to be used by other projects. We now added the "open-source" keyword to the text to emphasize broad availability.

- *In lines 258 to 260, you state that Phasenet performed best among the pickers. Can you include a figure in the supplement that supports this assessment?*
  Thank you for the suggestion. A figure has been added to the supplement, which is referenced in the main manuscript.

- *It is curious that the short-period stations produce what I would say are better RFs than the broadband station (Fig. 14). Could this be related to filtering of the broadband sensor?*
  Short-period sensors, such as the geophones, have been shown to be useful for receiver functions (see Fig. 2 in Yuan et al. 1997 and Fig. 3 in Ward and Lin 2017). As also shown in Fig. 13, for large earthquakes, the ground velocity of the geophones can easily be restored to the teleseismic frequency range well below the corner frequency, making the geophone records comparable to broadband data. Due to the large number of stations, the geophone receiver functions have a higher signal-to-noise ratio than those of the broadband stations. In addition, the broadband stations are distributed over a larger area and have therefore recorded more structural heterogeneity than the geophone stations, most of which are located close to the volcanic fields. We added a sentence to the text to make this clear.

Figures:

- *Figure 1a: The labels in red, especially LSV, are obscured by the other symbols. I am also not sure what labels R, W, and UM are highlighting. Please include a description in the caption*
  Sorry for the poor figure caption. We have revised the figure description, and simplified the figure and made labels better visible.

- *Figure 10, please add labels for Laacher See, Rieden, and Wehr where they project on the cross-section.*

  The figure 10 has been improved and labels were added to the map and cross section.

Here are a few typos that I caught:

- *Line 102, Figure 4 should be Figure 2*
- *Line 233 og to of*
- *Line 265 add Qseek within the Isken reference. You describe the method without giving it a name and then in line 273 you refer to Qseek*
- *Line 335 Wlaker should start the sentence—pull out of the parentheses*

- *Line 347 not sure what autarc should be* **(replaced by stand-alone)**

Thank you for the careful reading and hints to typos. All were corrected, including some additional ones we found. References also updated and given.

Reviewer F:

Review of the manuscript "A seismological large-N multisensory experiment to study the magma transfer of intracontinental volcanic fields: The example of the Eifel, Germany" by T. Dahm et al. submitted to Seismica.

The manuscript is an interesting case study, which is worth publishing after correcting or clarifying the following points:

Figure 1: The figure shows many details, which are not explained in the figure caption. The texts in red are difficult to read, e.g., what is SG or WF? I am missing any reference in Figure 1b (and the text) to another recently active European volcanic zone: the Massif Central in France.
Thank you for the careful reading and your suggestions. We have now simplified the figure and revised the figure caption and explain all abbreviations. An overview inlet was added where also other distributed fields are indicated, e.g. Garrotxa and Massif Central. The text in the manuscript is adapted. The database used to plot Fig. 1b does not include information on the Massif Central. We are sorry for this, but it is not our work and would exceed the purpose of this work.

Line 50: what is a VEI 6 eruption?
We introduced the abbreviation now (Volcanic Explosivity Index VEI). Thank you for the hint.

Figure 2: please mention that the network names are FDSN network names. The permanent network code HE stands for the University of Helsinki. I don't think that there is a permanent Finnish network in Germany.

Thank you for this, and sorry. The figure has been corrected

Line 96: I guess it should be written "4.5 Hz short period geophones"

We added "geophones" as suggested to make the instrument type naming consistent across the different sections.

Line 102: what do you mean by 'dark fibre cable'?

We changed the text to "unused telecommunications cable (dark fibre)

Line 117: one "network" is too much
done

Figure 5: Please give the units for the responses (I guess velocity proportional). What do you mean by 'amplitude ratio'?

Thank you for the remark. We added the unit to the figure and added additional explanation to the figure caption: "Triangles mark the breakpoints of the poles and zeros response, the

filled circles mark the frequency for which the sensitivity value is reported. Input unit of all three instrument responses is m/s, output unit is counts."

Lines 207/208: the cited references to the travel-time calculations describe methods but not the used velocity model.

We added the information that the IASP91 velocity model was used to estimate arrival times of the phases.

Line 233: 'og' -> 'of'

done

Figure 12: 'Mean delay times and station corrections'? I guess you mean that the mean delay times were used as station corrections – or?

We reformulated the caption – thank you for pointing this out

Lines 291/292: a citation of an article from 1997 is not really 'In recent years'

Yes, 1997 is not very recent, but we prefer to keep this reference, as this was the first paper showing how short-period sensors can be used for receiver functions. We changed the sentence accordingly.

Line 358: 'arrival times picks' -> 'arrival time picks'

done

Line 360: there are no LET results shown in the article

We have submitted the LET study using this dataset as one individual paper, but unfortunately it is still under review right now. The sentences in the manuscript are now modified as it is not necessary to discuss details on LET here. For reviewers interested in, or wanting to check Vp and Vp/Vs ratio velocity models from our LET study, we have also uploaded our first results on Zenodo repository (https://zenodo.org/records/14843290).

Lines 386 / 387: where are these results?

See our the response to point above.

Supplement:

Figure S.1: the mis-orientations look partly quite similar. The result of using a compass when installing the stations?

We do not see a very clear trend of misorientations, but that is possible. Hand-held compasses are not very precise, +- 5-10° deviation from true North are not unusual. Further, if the declination at the site is not considered, this introduces an additional approx. 3-4° deviation between magnetic and geographic north. We do not interpret this further, because of the limited resolution of our tests.

Figure S. 2 (also in the movies): what are the radial units of the fk-plot? What component was used to calculate the fk-results?

We added the information to the text that the vertical component is used for the fk-analysis. The polar plot shows backazimuth vs. slowness (s/deg).

Movies: I have the feeling the explained onsets belong often to phases with quite small amplitudes and core phases have very large amplitudes on the transverse component…. maybe some overinterpretation of the data?

Thank you for the comment. The marked arrivals mark theoretical phase arrivals computed with a global seismic velocity model. They are not interpreted from the observations. This was not clear from the plot description, therefore we modified the text accordingly.

Rebuttal Letter

Dear Suzan van der Lee,

Thank you for your suggestions to further improve the version R1 of our manuscript.

We have addressed all your suggestions and provide a point by point response below. Additionally to editors suggestions, we updated the Figure 5a and its caption to show the transfer function of 120 s Trillium and 20 s Trillium sensors, as both types of BB sensors were deployed during the experiment.

We have uploaded the following files:

1. A “clean” version of the revised manuscript without highlighted markings/changes.
2. A PDF version of the revised manuscript in which changes/markings/edits are highlighted.
3. The response letter containing our response to the editors’/reviewers' comments.

We hope that the revised version R2 is now acceptable to Seismica.

Best regards

Torsten Dahm, Marius Isken, Claus Milkereit, Christoph Sens-Schönfelder, Felix Eckel, Xiaohui Yuan, Miriam Reiss, Adrien Oth, Georg Rümpker, Luca De Siena, Pinar Büyükakpinar, Patrick Laumann, Hao Zhang, Brigitte Knapmeyer-Endrun, Stefan Mikulla, Ralf Bauz, Sebastian Busch, Martin Hensch, Bernd Schmidt, Gesa Petersen, Simone Cesca

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Editor :

I hope this email finds you well. I have reached a decision regarding your revised submission to Seismica, "A seismological large-N multisensor experiment to study the magma transfer of intracontinental volcanic fields: The example of the Eifel, Germany: Eifel Large-N". Thank you once again for submitting your work to Seismica.

Thank you for using the reviewers comments to improve your manuscript. Based on comparing your revised manuscript with the review comments, your revised manuscript will likely be suitable for publication after the following minor additional revisions:

A) Fig S5:

1.Many "pickers" are used in this Figure. Please add a simple table that explains what each picker is and a cite a reference for it. Please also explain how the manual picks were made (e.g. on which component and on individual seismograms or as part of a record section that uses a preliminary epicenter)?

Thank you for the suggestions. First, we now increased the plotting range to improve readability of annotations. We cite the package SeisBench, on which our test of ML models is based. We do not test “pickers”, but use 3 ML based architectures for which the weights of the ML model coefficients were derived for different training datasets. This is now better explained in the supplementary material, and references are given. We also improved the figure caption and clarify that the waveform example is a Z component. Note that this is only one example, while the statistical test is based on hundreds of picks for which P. Laumann, one of our co-authors, estimated manual picks of P and S waves using three component data individually for each station.

2. What point is S5a helping you make? Only 5 of the 14 pickers have visible annotation traces. What is the reason for showing a trace with a weak S wave? Please show horizontal components also or perhaps delete part a of the figure.

The Fig. S5a shows only one example of a waveform. In the main text, other waveform examples are displayed. The Fig. S5a was added to the supplement on request of a reviewer comment. Since the manuscript is neither on ML picker training or developments nor on a systematic testing of ML models, we feel the information provided is sufficient. The main results for our purpose is displayed in the statistical analysis in Fig. S5b.

3. Why is high confidence considered best when the S wave is weak? Wouldn't accurate confidence be better than high confidence?

The median values for different ML models cannot be discussed with one waveform example – they reflect the outcome of a statistical analysis of many hundreds of ML pickers and their residuals to manual picks. ML models with high confidence values have a high likelihood to correctly associated P and S picks. If these model additionally show small differences to manual picks, they can be considered as most reliable, at least for the purpose of earthquake location. Note that systematic differences between manual and ML pick times can exist, depending on the way manual picks are estimated. However, they would not effect the hypocenter location but only the origin time of events.

B) *W.r.t. the sentence add on Fig. 14, do you mean " Geophone receiver functions also often benefit from the greater station density, which can result in a higher SNR in their stack than broadband stations."?*

Thank you for this – we corrected the sentence accordingly.

C) *Fig S2.*
1. Thank you for pointing out the quantity and units (slowness in s/degree) of the radial axis of the upper-right plot. Please update the figure or figure caption with this information.

We updated the information in the figure caption – thanks.

2. I appreciate this info is in the text (it doesn't need to be if it's in the figure caption). if you keep it, please fix "backazumuth" to "backazimuth".

corrected

D) *Section 4.2*
It is of course perfectly fine to cite a 1997 reference, but then please do not say "in recent years" as well.

We changed the sentence to

"Short-period stations have proven successful in extracting proper RFs (e.g., Yuan et al., 1997), and their use has increased significantly in recent years (e.g., Ward and Lin, 2017)”