

First of all, we would like to thank the reviewer for his comments and suggestions. Below we list our detailed answers and changes in manuscript. Lines numbers mentioned here are according to new revised manuscript.

## GENERAL COMMENTS

This paper addresses a critical topic: how to build effective velocity models in hard rock settings in order to improve the quality of the resultant images. This is exciting to read about, and hopefully is a useful starting point for velocity model building the hard rock world as seismic imaging becomes more frequent. The comments from previous reviewers appeared generally very well thought out and in my opinion the changes that the authors made to address these were valuable, and generally added to the manuscript.

One area where I believe that reviewer #2s comments were perhaps misunderstood was in regards to the introduction, where the reviewer suggested that the authors include additional references by other researchers, but the authors instead removed references that some of them had contributed to. I believe that these references were useful to the reader and suggest they should, in fact, be included in the final draft. The authors should additionally include references to other published FWI efforts in hard rock, such as the paper “Acquisition and Processing of Wider Bandwidth Seismic Data in Crystalline Crust: Progress with the Metal Earth Project” from 2019. Certainly the authors could, at their discretion, also add other papers (by authors unaffiliated with the current work) on 3D seismic undertaken in exploration settings including work by E. Adam, G. Turner and H. Schijns, for example, which I believe was part of the intent of reviewer #2s comment.

**Author’s response:** We would like to thank the reviewer for providing their valuable thoughts and pointing out concerns regarding the references. We have accepted the suggestions and updated the citations accordingly (L40-42 and ‘references’ section accordingly). Regarding the specific citation related to the FWI application in the hardrock environment, best to our knowledge, this is first such attempt in establishing a workflow for building high-resolution velocity model. The suggested publication “Acquisition and Processing of Wider Bandwidth Seismic Data in Crystalline Crust: Progress with the Metal Earth Project” unfortunately only discusses about the low-frequency data acquisition acquired with the aim of velocity model building using FWI which then will be ultimately used during prestack depth migration (PreSDM) to obtain better imaging results. But neither FWI nor PreSDM has been applied or showcased, therefore we think it does not really match with the theme of the article.

## SPECIFIC COMMENTS

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### Comment from referee:

1) Amend “shots” and receivers” in Fig 1 and Fig 2 to, respectively, “shots and receivers” and “receivers only” to improve clarity.

### Author’s response:

Suggestion accepted.

**Changes in manuscript:** L127, L205

2) L127 – it would be useful to clarify if this sweep was a linear sweep or low-dwell (or other), as the reader will likely be wondering about the quality of low frequency information available for FWI.

**Author's response:**

Available information has been added in the revised manuscript.

**Changes in manuscript:** L119

3) L198 – it would be helpful to include the elevation range of the receivers/shots within the survey as the depth of the slices shown subsequently is not currently clear.

**Author's response:**

Suggestion accepted.

**Changes in manuscript:** L207-208.

4) L285 – the FWI was run from 6-25 Hz, but the sweep started at 10 Hz, and some geophones had a 28 Hz frequency. It would be useful for the authors to comment on how much information was actually present in the data at these lower frequencies.

**Author's response:** Additional information has been added in the revised manuscript.

**Changes in manuscript:** L240-242

5) In the discussion it would be helpful to address any observations the authors may have made on ideal acquisition parameters, to inform future trials. Eg. Would the authors have used lower frequency geophones or a lower starting frequency on the sweep in future work? Were there any issues with blending different receivers in the inversion?

**Author's response:** Thank you very much for pointing out this. We have tried to cover this point already in the manuscript in terms of ideal acquisitions setups for future and other technical details that we would like to be incorporated in future studies. We have now incorporated more details specific to hardrock environment, please see L549-553.

**Additional change in manuscript:** Figure 8 (it has figure captions missing)