

Solid Earth Discuss., referee comment RC1
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Comment on se-2021-143

Anonymous Referee #1

Referee comment on "Angle-domain common-image gathers from Fresnel volume migration" by Tomi Jusri et al., Solid Earth Discuss.,
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The paper presents a method to generate angle-domain common-image gathers using Fresnel volume migration (FVM) and phase-slowness vectors obtained from traveltimes gradient field, the latter used to bin the migrated data with the correct angles. The two methods are not new and have been published previously, but the combination of the two is new to the best of my knowledge. The paper is well-written and organized, and the figures are of good quality and support the text. Unfortunately, the real benefits and advantages of the proposed method over the classic Kirchhoff prestack depth migration (KPSDM) remain to be demonstrated. The synthetic and real data examples selected to illustrate the usefulness of the method to generate AVA-compliant gathers and thus AVA analysis are not convincing.

The synthetic model comprising only two layers is extremely simple. Obviously, there are merits in using simple models. They allow for a better understanding of the method and easier comparison with theoretical results (i.e. analytical AVA results). Unfortunately, the results and comparison with KPSDM results for such a simple model lead to the following question: why should anyone use FVM to generate angle-domain common-image gathers if results are almost identical to that of KPSDM (see figure 8 g, h, and i)? Whereas figure 8 might re-assure readers that the method provides as good results as KPSDM, it fails to demonstrate any advantages. The problem is not the method but the simplistic model, which excludes the potential interference of smeared migration artifacts on AVA data. The impact of such interference on AVA curves (which should be more significant for KPSDM) can only be demonstrated by using a slightly more complex model with several geological layers. Such an example is necessary to show how FVM can help and improve AVA analysis.

The application of AVA analysis to hard rock environments is certainly interesting but also very challenging. The common-angle stacks shown in Figure 11 confirm this. As a reader, I wonder what useful AVA information can be extracted from those gathers. Assessing the added value of FVM over KPSDM for such data remains highly subjective. The FVM common-angle stack shown in the zoomed-in area of figure 8 looks more coherent but

only over a limited range of angles. No reliable AVA analysis can be performed with this data. So, how does it help demonstrate the usefulness of FVM for AVA analysis? Why even show it? A field example from a less complex geological environment with supporting petrophysics (i.e. wireline logs for quantitative analysis) is needed. The authors propose this as future work. I would argue that this is needed in this paper.

I recommend a major revision. This should provide enough time to include examples that can effectively help support the promising methodology presented in this paper.

Minor question: The weights in equation 2 are a function of zeta and tau, but only tau is found on the term on the right-hand side. Am I missing something?