

Interactive comment on “Drill bit noise imaging without pilot trace, a near surface interferometry example” by Mehdi Asgharzadeh et al.

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I appreciate the time and effort by reviewer 1 to correct my paper and I will strive to address all of his concerns to the best of my knowledge. I have organized my answers to follow each question individually and the changes in manuscript are given by page and line numbers so that the reviewer can find them in the attached pdf file that will eventually make my revised manuscript. I hope, I have answered all the questions but please let me know if you have more questions to be answered or discussed.

Question 1. There are works in literature on optimal focusing of drill bit signals only from geophone data to create a reference trace (for example as proposed by Haldorsen et al., 1995, *Geophysics* 60, 978-997). The approach followed by authors is different in my

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understanding as they use only one near-geophone reference trace. For completeness of the work authors should consider and comment also this approach.

Answer: I mentioned this method in the introduction (page 4, lines 18-26). Their method requires large offsets on the surface in order to obtain moveout separation required in focusing analysis. Our dataset has very short offset of about 180 m on East side and 90m on the West side of well BH001.

Question 2. Could you please specify better which type of bit is used in the experiments? I understand a Hammer bit with periodic hammering action (e.g., as in figure 3). Also roller bits have a percussive action. Please describe better

Answer: The drilling method was Reverse Circulation (RC). I have added information about the mechanism in part 2 (page 5, lines 10-13), passive seismic survey acquisition.

Question 3. Just a comment on the analogy with Vibroseis sweep. The vibroseis sweep typically is designed to contain, by definition and construction, ‘non repeatable’ components. In figure 3 you show a very repeatable in time hammering signal. So your statement at line 13 of page 2 seems not appropriate, even if the use is similar. May be after deconvolution. I suggest to rephrase in some way

Answer: I added a reference for this ((Poletto and Miranda, 2004) on page 2, line 13. I have seen this at page 291 of that book.

Question 4. Comment for Figure 3a. I understand that this is correlation and stacking. However I see only causal signal parts (I suggest to specify the zero of cross-correlation time). So, may be I’m wrong, but I would interpret that this is correlation and stacking and also Deconvolution applied. Please specify better when you correlate, stack (I assume without shifts) and deconvolve the data in the example

Answer: I think you mean Figure 4a as figure 3a shows raw data. Yes, the traces in fig. 4a are cross correlated and deconvolved in one combined process called interferome-

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try by deconvolution (Vasconcelos and Snieder, 2008). I have added more description in the paper (page 10, lines 11-16).

Question 5. Again comment for Figure 3a. The data quality is good. However not clear the interval of stacking. Only few meters of bit descent, or all the data recorded along all the drilled interval? This is a very important information, because you can focus different events. Please introduce details

Answer: Data recorded for the entire well (0-70 m) is cross correlated. However, intervals as small as a few meters could produce the same results but a little noisier.

Question 6. In relation to previous comment, I'm wondering if you want to focus the rig as a source or focus the bit as a source (as I would understand from Fig 1). It strongly depends on stacking of stationary and non-stationary components, as chosen by you. Both can be valid, however please specify

Answer: Here we are using the bit signal as the source. We isolated the bit signal by FK filtering as demonstrated in Figure 3. The bit location in the borehole are in the stationary phase position and the crosscorrelations can be stacked to build the virtual shots. We confirmed this in Fig. 4 by making a comparison with active data.

Question 7. In the work of Poletto et al. 2011 ("Drill-bit SWD and seismic interferometry for imaging around geothermal wells" SEG San Antonio Expanded Abstracts, 4319-4324), a similar approach and use of the drill bit source is shown (in this case with pilot data). However the main point is if the coverage illumination for stationary interferometry conditions is met. This, when you want to recover by interferometry stacking the surface related multiples to extend the illumination. In Poletto et al (2011) for example the extension is shown, with merging of conventional drill bit SWD and interferometric drill bit SWD data in a well experiment. However in this case the retrieval of the interferometric drill bit signal (only by stacking before migration) does not depend on the subsurface model (as was verified in this work as an approximation).

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Answer: (sorry if I didn't understand the question very well) Unfortunately we didn't have pilot accelerometer recordings in our experiment to convert drill bit data to IVSP dataset and use it to verify our interferometric image. However, we could still produce virtual shots on the surface by interferometry and migrate the results as we do with active source data and compare the results with surface seismic migration results.

Question 8. The stationary condition, indeed is not needed if you use the Cross-correlogram migration. However in this case you have to use a subsurface model. In this case, depending on the interferometric approach, you are dependent on the model estimation, unlike the virtual source. If you apply in complex areas this is something you try to recover, I would image. So, comments on these aspects should be given

Answer: We used Kirchhoff migration of virtual data using a simple velocity model. We already showed that the bit signals are indeed in their stationary phase positions in Figure 4a. One would carry out a focusing and velocity analysis if enough offset were available and moveouts were significant for more accurate velocity estimation and image construction. Here, the offsets are very limited and such analysis are not an option.

Thanks again for your review and I hope my answers can address your concerns. With my regards Mehdi Asgharzadeh

Please also note the supplement to this comment:
<https://www.solid-earth-discuss.net/se-2019-35/se-2019-35-AC1-supplement.pdf>

Interactive comment on Solid Earth Discuss., <https://doi.org/10.5194/se-2019-35>, 2019.

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