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Solid Earth Discussions



# *Interactive comment on* "Structure of Suasselkä Postglacial Fault in northern Finland obtained by analysis of local events and ambient seismic noise" *by* Nikita Afonin et al.

**Anonymous Referee #2**

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This paper presents a seismological study of a postglacial fault in Finland instrumented by a local seismic network of 12 seismometers. The array recorded during 20 months. After rejecting the mine blast events, the authors found 40 natural seismic events, with tens of them originating from the postglacial fault. The authors studied the ambient noise recorded by the array. The deduced a 5 m thick quaternary sedimentary layer from H/V ratio analysis. By inverting group velocity dispersion curves extracted from ambient noise cross-correlations, they showed that the seismic velocities in the vicinity of the fault are significantly lower than further away. They concluded that even if the postglacial fault seems non-active from a regional seismic network point of view, a more careful a closer analysis shows that these faults are still active and that they did not heal since their creation 9000-15000 years ago.

The topic of this study is of great importance to characterize the seismic hazard in a certain areas where hidden or supposedly non-active faults can present a serious threat for the populations. It clearly shows that often, regional seismic networks don't have the sensitivity to detect micro-seismicity evidencing the potential activity of such faults. Some areas that were thought safe may actually be not.

I am a little bit less enthusiastic about the ambient noise analysis, both the H/V analysis and the dispersion curves measurements from the noise cross-correlations needs some clarifications.

I am quite surprised by the high frequency resonance frequency at 30 Hz, which seems very high compared to what is usually found in the literature. Parolai et al. (2002, BSSA) derived an empirical law for the relationship between the depth of the layer and the resonance peak and found that a 5 m layer would resonate between 5 and 10 Hz. However, their shear-wave velocity is different. Can you explain how you found this value of 5 m: is it an inversion, a fit from empirical relationship?

For the dispersion analysis, I suggest to show some Frequency-Time analysis diagrams, so that the reader can see by himself the fundamental mode and the first overtone because they are not obvious from the correlation waveforms shown in the paper.

Also, I understand that the dispersion curves can be noisy and hard to pick, but I would suggest to do a full 2D inversion of the individual dispersion curves to compute group velocity maps of the area covered by the array. These maps can then be inverted at depth to produce a 3D velocity model of the fault zone. The results would be more convincing than the inversion of two ad hoc averaged dispersion curves to show the low velocity around the fault.

These are the main reasons why I would ask for a major revision before publishing this paper.

Specific comments:

- Page 2, Lines 25-28-30: the acronym of ‘postglacial fault’ should be define at the first occurrence and be consistent all along the text (use always PGF for instance).

- Page 5, lines 3-4: Provide a figure showing examples of the two waveform groups along with their spectra.

- Page 5, line 28: typo → ‘f’rom

- Page 6: The description of the beamforming procedure is not clear. Do you perform the beamforming of the cross-correlations or on the raw seismic noise? What do you call ‘surface wave parts’ (line 15). You should consider to write the beamforming equation you used to make everything clearer. - Page 7, line 13: why don’t you use the whitening, it is often necessary to use it in order to obtain reliable correlation functions and dispersion curves. You should at least try both, with and without to see the difference.

- Page 7: The explanation of the asymmetry of the correlation functions is dubious. It is not the distance between the stations that creates this asymmetry, but the noise sources strength azimuthal distribution.

- Page 7, line 24: Specify what type of velocity you are measuring (group or phase).

- Page 8, lines 3-6: The inter-station distances for group 1 pairs may be significantly smaller than for group 2 pairs (and with a main NW-SW orientation). Can the difference of velocity be explained by the difficulty to pick the dispersion curves for short distance station pairs or from a bias due to a predominant direction of noise sources. Using the whitening could also help to ‘homogenize’ the nose source distribution.

- Page 8, line 15: remove the first ‘seismic’

- Page 8: You use the Neighbourhood Algorithm to invert the dispersion curves at depth: what parameters do you invert (how many are they?) and what parameters boundary do you used?

- Page 9, line 23: typo, 1200 m

- Page 9, line 23: Can this high velocity layer seen at 1200 m for both models be an artifact due to the fact that you set the depth parameter boundary for the last layer around 1200 m, so the inversion cannot find a deeper layer?

- Figure 1: Show an inset of a larger view of the geographical area show in the main figure. You should also consider to use the same coordinate system and coordinate boundary for all the map that you show in the different figures.

- Figure 2: Merge figure 2 and 3 and show the fault on the map.

- Figure 4 and 5: use a logarithmic color scale to better show the details of the spectrograms. And use always the same amplitude limits to help for the comparison between the different panels.

Figure 6: Plot the dates in abscissa instead of the number of days. We we see the figure we believe that the data point are continuous whereas there is a big gap between the dates. It's misleading.

Figure 9: Show the Frequency-Time diagram with the picked dispersion curves on top of it

Figure 10: Show every dispersion curves from both groups along with their respective average.

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