General Overview:

This manuscript presents the outcomes of a seismic reflection study carried out in the Pärvie fault system. The manuscript is well written and uses precise terminology, although a few sentences in the text are too reiterative or require slight rewriting. Some figures are not clear and the captions require rewording. This work complements the one carried out by Juhlin et al. (2010) and produces deeper images of the target faults. However, I am missing more discussion about the differences in the results amongst these two experiments, especially giving that the new experiment has successfully increased the imaged depth of the faults in almost 5 km.

One of the objectives of this experiment is to provide subsurface information to the DAFNE project. The authors should describe in more detail how the results of this work would affect the planning of this drilling project, both in the introduction and in the discussion/conclusion. The integration of the seismic image with the earthquake data is also a very attractive outcome that should be expanded by the authors if possible. I would suggest adding a cross-section figure of the study area, based in the seismic image and showing the characteristics of the proposed fault models. This could provide a clear summary of the conclusions of your work and will help the reader to understand your interpretation.

Specific comments:

P: page number; L: line number

<u>Abstract</u>

P538, L1-12: One third of the abstract describes the geological setting of the study area, and this is far too long. You should focus on the specific problems/hypotheses that you will be resolving in the paper; if the reader wants more information about the area or the seismic regime it will search it inside the paper.

L9-11: The word "fault" is repeated 4 times in this sentence. Please rewrite.

L16: "which followed the 2007 line" could be omitted.

L20: Please use pronounced or strongly, but not both (it is redundant).

L25: Explain the purpose of these wells better.

<u>1 Introduction</u>

The current order of the paragraphs in the Introduction is slightly confusing. Consider starting from the description of the area in large scale to a focus on the specific problematic addressed in your work. Also, briefly mention the approach used to address these problems (e.g., standard seismic processing).

P539, L17: Fig 1 does not show the geophysical studies that you refer in the text, please revise.

L21: Add "…the faults at depth <u>and their extent</u>." or similar.

P540, L2-3: "…sub-horizontal reflections from the area…" Which area? The Burträsk? The Pärvie? Please clarify this sentence. It is confusing to know which area you are describing.

L20-23: You are making a comparison with the Juhlin et al 2010 experiment, but you have not described that experiment yet (i.e., you cannot use "more powerful" or "sparser" if you have not described "than what"). Giving that one of the major features of this work is the comparison with the Juhlin experiment, the authors could give more details about this previous experiments, especially in those factors that have changed. This includes marking the Juhlin et al 2010 profile in the maps (at least in Fig 1) or if it is located in the same place, mention it in the text.

L23-25: "Several kilograms… operated hammer". This sentence is too vague, please rewrite.

P540 L28 to P541 L5: These are the conclusions of your work. The introduction is not the place to describe the results of your experiment, but to state the purpose and objectives of your research and the possible outcomes.

2 Tectonics and seismicity of the area

P541, L15: This sentence is too long, divide it. For example: "…end glacial fault**; this is** consistent with…".

L16-23: Summarize this part, it contains too many details (e.g., the sentence "After dismantling of the…" can be removed).

P541 L25 to P542 L2: Please rewrite this sentence.

P542, L2: "Cross-sections show that…". Which cross-sections? Do you have any figure or references for this statement?

L4-6: Figure 1 does not show the dip of the zone of earthquakes, nor their depth. Please consider adding this information to Figure 1.

L23: You use UTM coordinates in your maps and now lat/long. Please be consistent.

L17-29: This paragraph refers to the Fennoscandian stress field (hence large scale). Please reorganize this section so it begins with the description of the big picture and then reduce the scale towards the local scale (study area).

3 Seismic acquisition

P543, L15: Please add the percentage of wells with full charge and minimum (instead of "In some shots", "in x% of the shots".

L16-18: "Table 1…" to "… (See Fig. 1)" Put this two sentences at the beginning of the section. Its current place lies in the middle of the source description and interrupts the reading. Also notice that Figure 1 does not show the Juhlin et al. (2010) experiment. Please add it if possible.

L19-21: Any comments on the reuse of the boreholes and its effect in the data?

L27: Figure 2 does not show the shots and receivers. Please rewrite.

4 Seismic data processing

P544, L4: Why did you apply an inner trace mute? Please explain. Also, please add a comment about noise sources found in the study area, if any (if not make it clear as well).

L11: Please add a comment on the maximum time shift obtained with the residual static calculation (i.e., add "(less than X ms)" after "significant improvement.").

L17: Figure 5 only shows 5 seconds of record, and figs 6 and 9, 15 seconds. Did you process the data down to the 27 seconds recorded? Did you crop the data? If so, mention it in your work flow. Also, did you find any interesting feature in the deepest part?

L21-24: Do the authors anticipate any potential problems derived from the use of such variety of velocity models used? If so, please comment.

L24: I have no access to Lindblom et al., (2014), because at the date of this revision the paper is under revisions. Giving that you are using a velocity model extracted from their work, it would be nice to show this velocity model in your manuscript, or at least expand the description in the text. This becomes especially important when you discuss the differences in reflectivity between the faults.

L25: The sentence "Table 2 shows…" should be the first sentence in the Seismic Data Processing part. You have been describing the work flow since the beginning and thus it should be referred at the beginning of the paragraph.

P545, L2: Which velocity model are you talking about in this sentence? Please rephrase.

5 Interpretation

I suggest the addition of a subtitle here: "5.1. General Interpretation" (or similar) and change "Reflectivity of the faults" to 5.2.

P545, L6: Are you using the same nomenclature when describing the faults (i.e. R1, R2 etc.) than Juhlin et al. 2010? If so, please clarify. If not, be careful because it is very confusing for the readers.

L22: I have not access to Mikko et al., 2014.

P546, L1-6: Juhlin et al., 2010 describes in detail the potential origin of these sub horizontal reflections. Please expand this interpretation using your own images (which are now deeper).

L5-6: "A similar interpretation…" this sentence is too vague. Please rewrite.

5.1 (5.2.?) Reflectivity of the faults

P546, L12: Add references for these statements.

P547, L1-7: This is the theory, but what about in the Pärvie fault system? Is there any data that could clarify this? Perhaps well/core data? Is this one of the objectives of the DAFNE project? Please, clarify.

L10: "If a fault is still active…" Please rewrite.

L8-17: I cannot see the reduction in thickness of the R3 fault. In general, this paragraph needs rewriting.

<u>6 Discussion</u>

P547, L20-21: "…while Juhlin… to about 2-3 km" This portion of the sentence should go in the introduction.

L22: "In Fig. 9…" This sentence should go in the figure caption of Figure 9, here it is not necessary.

L23: Please expand the explanation on why you cannot see fault R2 in your image.

L25: Add "(red dots in Fig. 9)" after "…the location of earthquakes".

P548, L4: This is a good outcome of your work. Are there any similar examples in literature?

L7: Why do the earthquake activities indicate this? Because they are more spread? Please expand this.

L11: Add "seismic" in between "deeper events".

L16-24: What was the original idea of the DAFNE project and why it has now changed? Target depths? Will your work have an impact in the planning of the sampling activities (i.e., could any of your models be checked with the drilling? Please explain.

<u>7 Conclusions</u>

P548, L26: Remove the first sentence. "A deep seismic survey was carried out to better understand the Pärvie fault system…".

P549, L3: "The N/S ratio was good" Add "thanks to the use of explosive source".

L4: "processing method" Add "down to 15 seconds".

L5: Remove "in the subsurface".

L6: "using Stolt migration…" Add "and a velocity model extracted from…".

L10: Be careful: the difference in thickness alone does not explain the difference in reflectivity. Please rewrite.

L14-17: Please rewrite this subparagraph.

Table 1

Add: number of shots, traces recorded, trace length, % of shots with full charge

Table 2

Add step numbers to the processing steps, so you can refer to them in the figures.

Figure 1

The background map does not add significant information to the figure. A topographic map would provide clues about the characteristics of the terrain, the elevation etc. Mark the Pärvie fault and the

subsidiaries and/or use the nomenclature used later in the text (i.e., R1, R2 etc.). Mark the location of the previous seismic survey (Juhlin et al., 2010).

Figure 2

Remove the crosses in the background map. Mark the Pärvie fault and the subsidiaries and/or use the nomenclature used later in the text (i.e., R1, R2 etc.). Mark the location of the previous seismic survey (Juhlin et al., 2010).

Caption: add that this mentioned weak reflection marked on the map correspond to receiver 105 if this is the case; if not mark the zone of the weak reflections. Add the topographic background if possible.

Figure 3

Caption: Add the meaning of the black arrows. Are these shots raw or processed? Until what step? Please write it in the caption.

Figure 5

Caption: Add the meaning of the black arrows

Figure 6

Caption: Add the meaning of the black arrows and the two ellipses. Why do you say "6000 m/s approximately"? Are these shots raw or processed? Until what step? Please write it in the caption.

Figure 7

Mark R1 and R3 in the figure, with an arrow instead of a red line if possible.

Figure 8

Correct "ultramafic" in the caption.

Figure 9

Change the color of the earthquakes or of the fault sticks. The question marks are not visible.