

## ***Interactive comment on “Characterization of a complex near-surface structure using well logging and passive seismic measurements” by Beatriz Benjumea et al.***

### **Anonymous Referee #1**

Received and published: 9 March 2016

Manuscript “se-2016-19” by Benjumea et al. presents a shallow site characterization of a location in Hontomin, Burgos, Spain, using geophysical methods. Among the methods used are well logging (gamma log and sonic log for P- and S-wave velocities) as well as passive seismic array methods using ambient noise (shear velocities via dispersion curves (FK-method), autocorrelation (SPAC-method), and H/V method). The compact study is an application of well-established methods and thus an (engineering) showcase of using different geophysical method to derive subsurface structure (also to combine logging information and surface-base passive seismic methods). The paper does not deal with method development

The study area is dominated by a complex structure and carbonate rocks. Oil explo-

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ration took place in the past (availability of boreholes), however, current interest in the region is related to CO<sub>2</sub> sequestration. One interesting complication of the subsurface is a surficial high velocity layer and a velocity inversion at greater depth.

The paper is clearly structured, the written English is (with some smaller exceptions) good (see below). The paper presents new data. The individual methods seem to be properly and sufficiently explained. The majority of the figures is good, however, some figures need to be improved (see below). The abstract is informative and concise.

Overall, I think that the study is interesting from the method-point-of-view (combination/ comparison of different techniques), however, it is a rather specific study focusing on a particular location (limited regional/local scope). I suggest to add some more critical notions regarding the suitability of the particular passive seismic methods which would be interesting for researchers planing similar studies elsewhere. In conclusion, I think that the manuscript is worth to be published in Solid Earth after some moderate revision.

Major issues:

1) P2, L19-24, P12, L6, and P14 last sentence: The authors state that results from the passive methods could be used for statics corrections (I assume for P-wave reflection seismics). Even if the depths are correct (however, they have a rather large uncertainty; see below) the P-velocities are also needed (however, not provided by these methods). So, its use for statics corrections might be rather small. Furthermore, I doubt that the depth resolution e.g. of the H/V method is accurate enough for statics. For example, you need a good value of the shear velocity to convert frequencies to depths (which might be difficult to obtain). In any case, also the other methods (FK & SPAC) have rather uncertainties for layer depths (easily visible e.g. in Figure 8). Please add some more discussion and/or mention these potential limitations.

2) Could you say something about the conversion of the group velocity (derived from the dispersion) to layer velocity (material property)? Maybe also important for the last

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paragraph of the Discussion section discussing differences between the velocity derived by sonic log and those by array techniques.

3) P3, L24ff: Why is the information regarding “adaptation of oil acquisition techniques to shallow applications” important? If it is important for the article, please provide more information. If not, please skip this information. In any case, it’s difficult to understand in the current form. Are “oil acquisition” and “oil logging” the correct terms?

4) Figures 3 and 8 seem to be direct printouts of the program code and are of poor quality. Labels/annotations are too small; color scale in Figure 3 missing. Please revise.

5) Figure 9: Labels too small. Please revise.

6) Figure 11: I strongly suggest to only show interpolated values in regions with data coverage! Please fade out (or leave out - white) regions without data points. Furthermore, some of the high values in these plots seem to be caused by just one data point – please check (or remove if outlier).

7) Figures 1, 2, 10, and 11: Please add a scale. Additionally, please state in a label or in the caption what kind of coordinates are shown (I assume UTM?).

8) Section 3.2.1: From this text I cannot understand how you derive the plots in Figure 3. Please add information.

9) Could you add some conclusions which of the passive seismic methods are – based on this study – better suited and which not. Summarizing strengths and weaknesses of the individual methods? Could be interesting for readers planning similar studies (last paragraph of conclusion section).

Minor issues:

P1, L11: “...decreasing seismic velocity with depth is expected.”: Well, velocities increase again for some larger depths... Its just a layer with reduced velocity. Please

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rephrase.

P2, L3: please add “fluids” after “insolubles” (the latter is just an adjective)

P2, L29: Please add “The” before “Tectonical”.

P3, L11: “outcropping” instead of “outcrop”

P4, L21: Please insert “has” before “shown”.

P5, L8 ff.: I suggest to rephrase the sentence “In areas characterized...”: “In areas characterized by sediment over hard-rock, the H/V spectral ratio peak frequency is associated to the soil resonance frequency (Nogoshi and Igarashi, 1970).

P7, L3: please insert “the” before “SPAC”

P11, L13: Please insert “logs of the” before “GW3” and replace “location” by “borehole”.

P11, L13: Please replace “with the result of” by “which showed”

P11, L24: Please replace last sentence by: “Maximum thickness of the layer with 500 m/s shear-wave velocity varies between 40 and 45 m (Figure 11a) and of the layer with 290 m/s between 20 and 25 m (Fig. 11b)

P11, L31: Please insert “our” before “understanding”

P4, L15: Remove “a” before “wavenumber”, and insert “specific” instead.

P13, L7: Replace “passage” by “transition”

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