Solid Earth Discussions

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# Comment on se-2021-116

Anonymous Referee #1

Referee comment on "Radial anisotropy and S-wave velocity depict the internal to external zone transition within the Variscan orogen (NW Iberia)" by Jorge Acevedo et al., Solid Earth Discuss., https://doi.org/10.5194/se-2021-116-RC1, 2021

This study presents results of an ambient seismic noise imaging in the northwest of Iberia. Based on the observed discrepancy between the Rayleigh and Love-wave group velocity and corresponding shear velocity models, a radial anisotropic model is also presented. The manuscript ends with discussion trying to interpret both the isotropic shear velocity model and the observed radial anisotropy in details and in relation with internal and external structures of the area. The manuscript is well written and structured in which careful prepossessing of data and selecting cross-correlations and dispersion measurements has been done. In general, publication of the manuscript is recommended after revision according to the following points and comments.

**Major comments:**

1- It's not clear that from which inter-component the Rayleigh-wave dispersions were obtained. Only from the ZZ? or RR? or both? as shown in Figure 3. In Figure 4, the Rayleigh group velocities out of ZZ are shown. How different or similar are the Rayleigh group velocities out of the RR, and in comparison with the Love-wave velocities? Would it result in the similar Rayleigh Love wave discrepancy as the ZZ?

In this study, ambient noise data from 3-components seismic stations was used. It seems the data quality of the horizontal components were good enough to reconstruct the Love-wave velocities (from TT). I am curious why the authors haven't used the great opportunity to benefit all of the possible inter-components containing the Rayleigh-wave, which are ZZ, RZ, ZR, and RR. Therefore, my recommendation (unless there's been a

serious issue with the data!) is to use all of these four inter-components cross-correlations and to obtain the dispersions of Rayleigh-wave as a production of these four inter-components (e.g a production by logarithmic stacking in the period–group velocity domain introduced by Campillo et al., 1996; see for instance Zigone et al., 2015). This would provide more reliable group velocity of the Rayleigh-wave, and therefore to improve the reliability of the Rayleigh-Love discrepancy.

2- The authors have mentioned the significance of the azimuthal anisotropy resulted in their previous study (Acevedo et al., 2020). Anisotropic structures in general might not be well explained neither by radial anisotropy alone nor by azimuthal anisotropy. Since results of azimuthal anisotropy (fast orientation and delay time) in the study area is present, and also in order to have a better picture of the anisotropic structures, both radial and azimuthal anisotropy should be discussed. More particularly, the distribution of fast-polarization orientation over depth (at each period) in comparison with Radial anisotropy could be discussed in terms of deformation history and regional tectonic regimes of the area associated with late Variscan shear zone and /or Alpine convergence. However, there is little discussion in this matter (line 434-435). I therefore suggest including the depth variation of the fast orientations superimposed on the radial anisotropy pattern at each depth (Figure 7) and add more discussion based on such comparison. The author could try to address questions, for instance, how the fast-polarization orientaion varies from surface to depth while radial anisotropy is increasing? Is there a relation between radial and azimuthal anisotropy at the region where there is a change from negative to positive RA (contrasts observed under GTOMZ, CIZ and CZ; line 421-422)? In lines 463-465 as the authors discussed the cause of positive radial anisotropy by the horizontally sheared fabrics, here the depth pattern of fast orientations could help in better understanding such effect.

**Other comments:**

Introduction:

3- Line 71; "The ANI reflects the variation of the seismic velocities of the bulk rock …" seems not a correct statement. Other passive seismic imaging techniques that use earthquake data can also provide images of velocity variation of subsurface structures.

4- Line 72; "…, which is controlled by their elastic parameters". How about temperature? Please modify or ignore this statement.

5- Line 73-75; Earthquake-based tomography can also provide images of upper crustal structure. A main advantage of ANI is data availability, particularly in regions with low seismicity -where not enough regional/local earthquake occurring- and also as an alternative to high cost active survey.

6- Please provide an earlier study as reference in line 27-28 (e.g. Silver, 1996). The same in line 29; here you could use e.g. Mainprice et al., 2000.

7- Line 30; please remove Shapiro et al., 2004 as it's not a proper reference for anisotropy.

8- Line 61; please provide reference for "Overall, the part of the Variscan belt that crops out in the Cantabrian Mountains (CM) represents one of the most complete sections of this orogen in Europe, …"

Geological setting:

9- Line 135; "Overall, the part of the Variscan Belt that crops out in the CM represents one of the most complete sections of this orogen in Europe …" This is a repeated sentence. Please remove it.

10- Section 2.3 seems a bit long and include a lot of geology. Particularly, explaining the four distinguished domains from line 156 till line 179; Are all of these are necessary for the discussion? Could you make it shorter?

Data and Method:

11- It's not clear how many stations in total were used. 13 temporary (portable) but two of them were permanent?! In case they were all temporary, you may remove the word "permanent" in line 196.

12- Have you used all stations between June 2019 and February 2020? I suggest making the Sec 3.1 more clear and including information about how many stations in total, from which network in details, and in which the time period the continues seismic recordings were used.

13- How you assessed any sessional effect in the cross-correlation functions? Perhaps you could assess it in a way in Figure S1, and to add a sentence about it to the text.

14- Please provide more example of inter-station dispersion curve (as in Figure 2d) in Supplementary material.

15- I could not quite understand "… defining a constant S-wave velocity…" in line 272. Please make in a clearer way.

Discussion:

16- In line 353, "…both the surface and shear-wave ones…", do you mean both the surface-wave group and shear velocities?

17- What does the "RA style" refer to? in line 404 and in a couple of other lines. It's confusing.

18- How did you obtain the angels 60-90 and 0-30 degree for dipping features (line 406)? Are these numbers estimated from the shape of the positive and negative anomalies in the cross-section (Figure 8c)? If so, I recommend avoiding giving quantity of the dipping structures because such image can differ by changing smoothing parameters of the inversion or even in plotting.

Conclusion:

19- Line 472-474; "The observed discrepancy between the measurements from Rayleigh and Love waves impeded the possibility of performing a joint inversion …" not really clear what you mean. It is possible to perform joint inversion using the dispersion measurements from Rayleigh and Love to derive both isotropic and anisotropic Vs models. It's fine that joint inversion was not the purpose of this study. But it would not be the reason that why you have used Rayleigh and Love-based separately derived Vs model to infer Radial anisotropy. Please rephrase the sentence or might move it to the end of the conclusion and as suggestion for a later study.

**Figures**

Figure2:

20- Even though the Fig2a with its colors related to Fig2e and 2f is quite helpful, it is too small for representing the station location and geometry. Please provide a larger figure showing all the station's location with different symbol color for each network. Such a figure could be added to Figure 1.

Figure3:

21- With regard to my comment No.1, the ZR and RZ Cross-correlations could to be shown in fig.3.

**Suggested reference:**


- Campillo, M., Singh, S., Shapiro, N., Pacheco, J., and Herrmann, R.: Crustal structure South of Mexican Volcanic belt based on group velocity dispersion, Geofis. Int., 35, 361–370, https://doi.org/10.1016/j.crte.2011.07.007, 1996.
- Mainprice, D., G. Barruol, and W. Ben Ismail (2000), The seismic anisotropy of the Earth's mantle: From single crystal to polycrystal, in Composition, Structure and Dynamics of the Lithosphere{Asthenosphere System, Geophys. Monogr. Ser., vol. 117, edited by S. Karato, A. Forte, R. Liebermann, G. Masters, and L. Stixrude, p. 237, AGU.
- Silver, P. (1996), Seismic anisotropy beneath the continents: probing the depths of

geology, Annu. Rev. Earth Planet. Sci., 24, 385, 432.
- Zigone, D., Ben-Zion, Y., Campillo, M., and Roux, P.: Seismic Tomography of the Southern California Plate Boundary Region from Noise-Based Rayleigh and Love Waves, Pure Appl. Geophys., 172, 1007–1032, https://doi.org/