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Interactive comment on "Full waveform inversion of short-offset, band-limited seismic data inthe Alboran basin (SE Iberia)" *by* C. Gras et al.

Anonymous Referee #2

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Full waveform inversion of short-offset, band-limited seismic data in the Alboran basin (SE Iberia) Clàudia Gras1, Daniel Dagnino1, C. Estela Jiménez-Tejero1, Adrià Meléndez1, Valentí Sallarès1, and César R. Ranero2 1Barcelona Center for Subsurface Imaging, ICM, CSIC, 08003, Barcelona, Spain 2ICREA, Passeig de Lluís Companys, 23, 08010, Barcelona, Spain Correspondence: Clàudia (gras@icm.csic.es)

Review: General: The authors present the application of a Full-Wave Inversion (FWI) applied to streamer data. To estimate an initial velocity model for the FWI they used three iterations of a joint Travel-Time Tomography) TTT mainly based on diving waves with an additional Top of Basement (TOB) reflection. To be able to pick the travel times of the diving waves at shallow depth below seafloor they used a 2 step Downward Continuation (DC). In the first step they DC the receivers in the shot-gather domain to a

variable seafloor depth. In a second step they DC the shots in the constructed receiver-gather domain to the seafloor and resorted back to shots again. By this procedure they are able to get travel time information of the diving waves close below the seafloor. The FWI used the original shot gathers with the joint TTT velocity model as initial velocity. The data were inverted cascaded from 6 Hz up to 16 Hz with increments of 0.5 and 1 Hz. The individual processing steps are documented by a seismic multichannel profile with a streamer length of 6km in the eastern Alboran Basin. The seafloor is at ~1.8km depth and the TOB ~3.2km. The results of a pre-stack depth migration with the TTT and TTT+FWI velocity models are compared. The final velocity model from TTT+ FWI shows a very detailed structure around the TOB and a high velocity anomaly in the central sediment basin which correlate very well with the seismic image. The DC strategy presented here may solve the initial velocity problem close to the seafloor for many inversion methods as the inversion result largely depend on the starting model. Alternatively pre-stack migration reflection travel time inversion methods can only help if continues reflections exist below the seafloor. In cases with complex sediment layering or 3D scattering the strategy presented here could help if the streamer length and the seafloor depth are adequate. The paper is well structured, well written and interesting for a big community dealing with inversion and interpretation from seismic data.

Specific Comments: One aspect in this paper is the DC of MCS used as a starting model for the FWI. The results look very good for the real data but difficult to quantify. I would expect to see a synthetic shot-gather with the DC result. The Fig. 2b and 2d looks as if both are syn. modeled which is ok for a general scheme picture. A 2-step DC of fig.11a or 11b would be for this paper more appropriate especially for the discussion of how much offset of the diving wave show useful information.

Individual Comments/Corrections: Page 2 Line 19 Correction: . . . near offset reflected alone. Comment/Correction: This is not fully correct especially with a streamer length of 6km at this target depth. Iterative prestack depth migration with the combination of reflection tomography velocity updating and the local reflector dip is a robust method if reflection continuity exists laterally as well as vertically. Please reformulate Line 15-19 with the special situation of only one TOB basement reflection event. Page 2 Line 25 Correction: I think it should be: have no low energy content below 4-5 Hz Page 2 Line 29 Correction: . . .Singh, 2017), Page 2 Line 33 Correction: Shah et al., 2012

Page 6 Line 18-19 Comment: Another effect could happen by large shot point distances. Here the receiver gathers may be spatially aliased.

Page 7 Line 20 Question: By introducing a free surface with a source / streamer depth of 10m in general a source or receiver ghost will be modelled. Did this not happen because of the limit of 20 Hz and the corresponding grid spacing? Page 7 Line 26 Correction/Question: Please explain T/6 and 6T and how do you remove it?

Page 10 Line 23 Correction/Comment: almost 6 km? I would choose something like 3.5-4.5 km. Here a synthetic model would help (See Specific Comments above) Page 10 Line 25-26 Correction/Comment: Picking reflection travel times on unmigrated data especially at TOB were many diffraction originates seems dangerous. Additional a local reflector dip may influence the velocity. Please explain in more detail how the reflections were included in the TTT (floating reflector?) because it seems not to be a standard reflection tomography approach (see e.g.: Enhanced velocity estimation using gridded tomography in complex chalk, M. Sugrue, et al., Geophysical Prospecting, 2004, 52, 683–691

Page 13 Line 30-31 Correction: By Quality factor you mean the anelastic/intrinsic Attenuation Q. The inversion of Q removes time variant phase distortion (dispersion) generated by the earth‘s rock properties (amplitude and phase correction), it does not belong to the class of geometrical corrections. Value of 100 seems reasonable (100-200 for wet sand).

Page 15 Line 32 Correction: this high velocity layer within sediments can already be seen in the final TTT Fig. 7d. but not as strong and detailed as by the FWI.

Page 16 Line 25 Correction: there are not known salt deposits

Figure 2b and 2d Correction: velocity labels difficult to read. Position the annotations at the end of the arrows.

Figure 7 Correction: inversion step. (d)

Figure 14a and 15a Comment: the seismic sections could have less gain at least on a paper print.

Please also note the supplement to this comment:
https://www.solid-earth-discuss.net/se-2019-46/se-2019-46-RC2-supplement.pdf

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