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Interactive comment on "Seismic wave propagation in anisotropic ice – Part 2: Effects of crystal anisotropy in geophysical data" *by* A. Diez et al.

Anonymous Referee #2

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General Comments: In this manuscript Diez et al address the connection between the crystal orientation fabric of ice and seismic velocities using previously derived relationships (See Seismic wave propogation in anisotropic ice - Part 1...) and newly acquired active source seismic data. The manuscript uses sparsely spaced (50 m) COF observations from a deep Antarctic ice core to calculate the expected P-wave velocity profile, and then compares these results with those obtained from an active source borehole seismic experiment. This forms a useful test of the methods developed in Part 1, and the authors are open in their discussion of the sometimes mixed results and methods limitations. The paper then embarks on a useful comparison of radar and seismic observations, where the authors focus on which radar reflection events are generated by

COF contrasts and which are likely due to conductivity. Limitations to the study include the low spatial resolution of the COF data, and the alternating girdle/cone structures and resulting rapidly changes in estimated velocity introduced by the method. However, as a whole the paper makes a useful contribution to the cryospheric literature and makes useful suggestions for geophysical practitioners.

Some statements made in the paper are not as strongly supported by the observations presented as they should be. For instance, the conclusion that changes in COF are laterally discontinuous is an example of a common geophysical logical fallacy - the absence of evidence is not evidence of absence (just because we don't image it, doesn't mean it isn't there.) The COF structures imaged in the radar data are close to the noise floor. In comparison, the radar reflectivity due to conductivity changes are much higher than the noise floor. These factors alone are enough to make the COF reflection appear less continuous.

Similarly, statements on the possible dependence of velocity on frequency, or grain size are not well explored. Ice is currently considered essentially non-dispersive at the frequencies of interest here (e.g. Ice Physics, Hobbs, 1974). Determining a dispersive nature warrants more than a comparison of the results presented here and a single other borehole sonic-logging experiment. The correlation with grain size should be quickly ascribe as non-causal and does not need to be repeated in the conclusions. The correspondence of changes in grain size with changes in COF is the likely cause of any misleading correlation (as noted by the authors.) (There is, however, a second-order effect due to the dependence of ice viscosity on grain size (Goldsby and Kohlstedt, JGR, 2001) and the influence this may have on COF evolution.)

The velocity profile derived from COF shows a large amount of variability. The authors provide a plausible explanation for this due to limitations in the COF data set, and changes imposed by the methodology. The manuscript continues to state that the fit is good, or consistent. I think they should be more exact with their language. The fit is good in the upper 1800 m once the optimal elasticity tensor has been determined,

and only fair in the lower portion of the core. The filtered (boxcar) COF-derived velocity provides a better fit throughout the core.

Minor comments: The abstract needs a sentence near the start outlining the comparison made between radar and seismic reflectivity as this is a significant part of the paper. (Or move and reword/clarify the sentence that begins on line 10. 'With this validation ...')

Section 2.2 The first paragraph should be clear about what seismic data are presented in this study. (There is no vibroseis data presented here.)

Sec 4. It is not surprising that repeat shooting at the same location leads to changes in the source signature. The type of and size of adjustment (static) required should be detailed. (Note that no difference is visible in shot 44 in 4a, enlarge figure?).

Sec 4. pp 4406, L21. An increase in frequency content with depth is somewhat surprising.

pp 4406, L25. Change 'damping' to 'attenuation' (and elsewhere).

Sec 4.1 pp4407, L13-14 This excitation is not apparent in the figure (zoom?)

L15 The fit between the 'filtered' EDML and VSP interval velocities is good.

Change Bennett 1988 to 1968.

Sec 5.2 PP4413 L8. 'both' three are given above.

pp4413 L20. '20 m' 50 m sampling, where does the 20 m come from?

pp4414 L20. See Gow and Meese '07 J. Glac and other physical properties studies from ice cores for grain-size and COF changes at the base of ice cores. (Migration recrystallization.).

Figures. Fig 4. Show zooms of important regions. Fig. 7. caption needs work, shift letters to the start of relevant sentences. Shift sentence 'The seismic trace...' to text

along with other detail that does not describe the figure. Fig. 8. Label reflectors.

Technical Comments. The paper needs detailed proofreading for grammar.

Interactive comment on The Cryosphere Discuss., 8, 4397, 2014.