

REVIEW: BRISBOURNE ET AL., DOWNHOLE DISTRIBUTED ACOUSTIC SEISMIC PROFILING AT SKYTRAIN ICE RISE, WEST ANTARCTICA.

MARCH 2021

Brisbourne et al present results from the first Antarctic Distributed Acoustic Sensing (DAS) experiment. The manuscript is a useful contribution. It focuses on a novel method with the potential to make a significant scientific contribution. The preliminary results presented provide some constraints on the compressional wave velocity of the lower half of the ice column, and an estimate of seismic quality factor. The manuscript's main intent is to act as guide for future experiments and it provides an extensive list of recommendations. The manuscript is generally well written and presented but there are a few areas that would benefit from improvement. My main comments pertain to communicating the justification for this type of experiment, discussion/comparison with other borehole seismic methods, and consistency in the data presented.

1. MAIN COMMENTS

Introduction

The introduction could be improved by better justifying this style of experiment. First, the connection between velocity, amplitude, and crystal orientation fabric (COF) needs to be outlined. Readers will be confused by the use of a seismic method where ice core physical properties are available. To address this, the introduction should emphasise where DAS is possible but direct measurements are not. The introduction should also outline what DAS brings that other seismic methods don't. This will require other borehole seismic methods (clamped borehole seismometers, direct measurements of recovered core, acoustic borehole logging) to be summarised. Highlighting the suitability of DAS deployments in irregular hot water drilled holes where other seismic methods are not possible is a real selling point for this method. The other justification often used is to inform surface observations and improve surface based methods. Does DAS provide any advantages here? The description of fabric evolution is also brief. Presenting the typical ice divide COF progression would be helpful here as would a mention of how impurities, temperature, and strain, influence fabric evolution. Addressing these points should make the manuscript more accessible. At present the first two paragraphs of the introduction are not so relevant for the rest of the manuscript, although a focus on COF could make them so.

Data and results presented

Data are presented from a range of offsets. It would be helpful if a consistent set of offsets were used. 0, 200, 400, 600 m would makes sense. As it is, in Fig. 2 we see the bandpassed checkshot with and without FK&Decon, then a zoom of the 100 m shot, then the 500 m offset shot. In

Fig 3. we see the 150 m shot and synthetics. Then in Figure 4 we see results from the 0, 50, and 100 m shots and in Figure 6 we see estimates for 200 m and 400 m offsets. Presenting the same offsets make it easier to follow along and give the reader more confidence.

The diamond shaped noise source is nicely explained.

As these data are new to most of us, it would be good to see the waveform of the arrival. In my experience the devil is in the picking. It would be instructive to see waveform wiggles overlain with picks. After conversion to velocity would be the most useful.

Is it possible to present the results in Figure 6 in a similar way to the field data displayed in Figures 2, and 3? If so it would make interpretation by the readers much easier.

2. MINOR POINTS

L46 ‘gravitaionally driven’ is too general. Be explicit about what’s not going on and why that’s useful.

L47 ‘preserve recent’ and the not so recent. COF evolution depends on the existing state. Unravelling the strain history is not as straightforward as this statement suggests.

L54 ‘as with all surface geophysics’ is a sweeping statement. Again be explicit.

L138 and Fig2 b) reverse-moveout coherrent noise has made it through the FK filter implying the not just positive dips preserved or maybe filter tapers.

L151 ‘snow compacting’ – snow compacting and metamorphosing.

L198-199 First 2 sentences of this para belong in the introduction.

L210-212 What is the impact of the assumption of straight ray-paths. It would be good to assure the reader this is insignificant.

L238–244. If I follow this correctly each trace is replaced by a stack from a 10 m bin after the removal of traces that fail to cross correlate at > 0.95 . With this procedure if the central trace is the outlier trace it will remain dominant. Also, this stacking will lower the frequency content. Will this change the result? Regardless of this the reader should know what percentage of traces were removed by the editing procedure.

L264-265 ‘...and seismic methods provide...’ citation needed.

L282 ‘Skytrain’ – SIR (for consistency).

L287 refer to Fig 6 c).

L287–290. Please elaborate on this. If possible, seeing these results in the same gather form as Figs 2 3 would be very helpful.

L293 ‘..very small’ How small? Possible to pick in real data?

L376-377 ‘multimode’ – multi-mode (for consistency) also introduce/define single-mode and multi-mode and elaborate on benefits.

L384-385 ‘As variation....is therefore critical’ Combine this with recommendation 1).

3. FIGURES

See comments above regarding presenting similar offset shots and results.

Figure 1. Coordinates required on either b) or c), preferably both.