Reviewer Number 1

General Comments

Concise and clearly written. The topic is of wide interest, and is introduced well. Some of the figures are too small and/or are poorly labelled. Captions are commonly disorganized, and do not actually describe the content of the different parts of the figure. The photographs, in particular, are commonly not very clear or helpful.

With regards to the reviewer's comments on figures, this partly reflects that their resolution was reduced during the online manuscript upload process. The final manuscript will have much better-quality figures. We have addressed the specific comments that the reviewer has with figures below, and think that these also help with the general concerns raised in this comment.

#1 I would have liked to have seen a physical explanation for why vertical unloading during exhumation should favour the development of the foliation-parallel fractures. The paper does not do this, so citing this scenario as an "explanation" is not particularly convincing.

We acknowledge that there is uncertainty in whether it is unloading and the release of confining pressure during hanging-wall exhumations that forms foliation-parallel fracture per se (e.g. Engleder et al 1985), or if they are generated by other mechanisms such as seismic shaking (as discussed in Townend et al 2018). Therefore, in the revised version of this manuscript, we will clarify that these points are an interpretation, not an explanation.

Nevertheless, the point that these fractures formed at *low confining pressures (regardless of the actual mechanism) is well-founded. Our discussion of the relationship between foliation and rock fracturing takes account of both fracture fill and deformation experiments of anisotropic rock (Donath et al 1961, Nasseri et al 2003, Paterson and Wong 2005). These experiments find that this relationship depends on (1) the mechanical anisotropy that the foliation imposes (i.e. lithology), (2) the angle between the maximum principal stresses (σ_1) and the foliation, and (3) the confining pressure during rock fracturing (Lines 276-279).*

At Stony Creek, this spatial change of fracturing occurs within the same lithology leading us to exclude point 1 (Figure 7). The highly variable stress state around the Alpine Fault (e.g. Upton et al 2017) makes it difficult to exclude point 2. However, if the 1-2 km wide network of foliation-parallel fractures did extend to appreciable depths, then this should be detected by reductions in seismic velocity (e.g. Jones and Nur 1984). Conversely, the low velocity zone around the Alpine Fault has a width of only 60-200 m (Lines 363-366, Eccles et al 2015). This leaves us to infer that point 3 must have influenced the formation of foliation-parallel fractures to at least some extent (lines 309-312).

Differences in fracture fill also supports this argument. Foliation-parallel fractures are open with no evidence of offset, so likely formed in tension. In the absence of high pore fluid pressures, this is likely to reflect low confining pressures (See also comment #1 to reviewer #2). Compositional and microstructural analysis of the gouge-fill frequently noted in fractures not aligned to the foliation, indicate that they formed in shear and potentially at any depth in the seismogenic zone (Williams et al. 2017).

#2 Similarly, the explanation of "development of fault wedges" (where? how?) or dynamic earthquake stressing from below, as causes for variously oriented gouge filled fractures in the damage zone is not well enough discussed or supported, in my opinion.

To keep the manuscript succinct, we did not to go into detail on the mechanisms that can account for variably oriented gouge-filled fractures around the Alpine Fault. Instead we cited previous studies that explain these mechanisms in more detail. However, we can introduce more discussion if necessary. Below we give a more complete account of these ideas, which could be included at the editor's discretion.

The interpretation that gouge-filled fractures form within 'fault wedges,' builds on previous studies conducted on these Alpine Fault outcrops (Cooper and Norris 1994, Norris and Cooper 1995, 1997, 2007, Barth et al 2012, Upton et al 2017). These authors documented that along-strike variations in stress induced by topography result in partitioning of the transpression deformation that is accommodated across the

Alpine Fault, so that shallowly dipping thrust sheets/fault wedges form (Cooper and Norris 1994, Barth et al 2012). Notably, Norris and Cooper (1997) and Barth et al (2012) observed that the shallow dipping principal slip zones (PSZs) in thrust segments are poorly orientated to facilitate transpressional movement, and that some of this motion may be partitioned away from the PSZ onto subsidiary faults (described as 'gouge-filled shears' by Norris and Cooper 1997) in the immediate hanging-wall. Cooper and Norris (1994) also interpreted that 'gouge-filled shears' at Gaunt Creek facilitated imbrication, tectonic thickening and rotation of the Alpine Fault thrust sheet, as it moved across the irregular topography of the footwall gravels.

The fill, extent (<100 m from the fault, Norris and Cooper (1997, 2007)) and thickness (1-5 cm, Norris and Cooper (1997)) of these 'subsidiary faults' or 'gouge-filled shears' are the same as the gouge-filled fractures documented in this study (Figure 8). This leads us to conclude that these fracture sets are equivalent to one another. A combination of reverse, dextral, dextral-normal and normal offset across these fractures has been documented (Cooper and Norris 1994, Norris and Cooper 1995, 1997, Barth et al 2012). In a uniform stress state, it would be anticipated that fractures with this range of shear-senses would have a range of orientations. In the case of the Alpine Fault, where along-strike variations in stress state exist (Upton et al 2017), it is also reasonable to consider that the patterns of fracture orientation would be further complicated. This is discussed further with respect to comment #2 by reviewer #2.

An alternative (though non-mutually exclusive) mechanism for the formation of these fractures is the role of dynamic off-fault stresses that arise during rupture propagation. The importance of the feedbacks between rupture propagation, rock fracturing, and the changes that this imposes on a rock mass's mechanical properties are being increasingly recognised (e.g. Cappa et al 2014, Huang et al 2014, Weng et al 2016, Perrin et al 2016).

Major (<M_w 8) ruptures along the Alpine Fault (Sutherland et al 2007) would surely be capable of inducing such damage. It is not clear exactly how this would manifest, given we that we have no records of the properties of an Alpine Fault earthquake (e.g. rupture propagation direction, extent, stress-drop). Nevertheless, one must suppose that there is an up-dip element to the rupture propagation direction that would place the hanging-wall in compression (c.f. Ma and Berzoa 2008). This would result in small and incremental amount of shears along these fractures (as opposed to them forming in tension), consistent with how we infer the gouge-filled fractures form. The seismogenic thickness of the crust limits the spatial extent to which coseismic damage can be generated (Ampuero et al 2017). Therefore, the relatively thin seismogenic crust in the Alpine Fault's hanging wall (10 +/- 2km, Boese et al 2010), is broadly consistent with the narrow (~100 m) inner damage zone we report.

Abstract

Abstract is concise and clearly stated on the whole.

Line 21: Suggest "principal slip zones [of]" is moved ahead of "Alpine Fault"

This will be corrected

Line 38: suggest "rather than the footwall" is added to the end of this sentence.

This will be corrected

Introduction

To the point and well stated.
Goals are clearly identified.

Line 69-70: brackets in brackets Line 74: add "s" to "Alpine fault"'

This will be corrected

Tectonic Setting

Lines 95-100: Along-strike changes in slip rate are not what has led to the tri-partite division of the Alpine fault. This statement is quite misleading.

This can be revised to state that the along-strike division of the Alpine Fault reflects "fault properties," not slip-rates. We also note more recent studies have suggested that the Alpine Fault can be divided into 5 sections (Barth et al 2013) and this will be accounted for.

Line 108: replace "form" with "occur in spatial sequence towards the fault" After "(Figure 2)" start a new sentence. At the beginning of this, replace "which are" by "These".

This will be corrected

Line 111: For clarity, insert a comma after "metabasitic mylonites". Also, the subsequent "or" should be replaced by "and"

This will be corrected

Line 112. Start a new sentence at "reflect" [i.e., "These reflect.."]

This will be corrected

Line 117: Insert "brittle overprint" after "This"

This will be corrected

Line 122: "projection of outcrops" is unclear in meaning or logic, as written. "Measurements" of what?

We acknowledge that the term "projection of outcrop-derived measurements," is misleading and will be removed. Instead, we will be explicit that the regional orientation of the Alpine Fault reported here is based on the presumption that the foliation should parallel the shear zone boundary in such a high strain zone. The fault orientation is thus parallel to the average orientation of the mylonitic foliation (055/45 SE; e.g. Sibson et al 1981; Norris and Cooper 2007). This is similar to the fault orientation measured at depth from geophysical surveys (Stern et al 2007). We will also note there is some evidence of the Alpine Fault potentially locally dipping at <62° (Toy et al. 2017)

Why does a seemingly artificial projection process at the surface require a planar zone at >4 km depth? What are the assumptions?

These points were fully addressed by Norris and Cooper (1995) as cited. Their hypothesis was developed mainly from field mapping, however, it is also supported by sandbox models. In particular, these authors note that the depth extent to which topography can affect the stress field is equal to 1-2x the scale of the valley relief. Given that the valley relief of the Southern Alps immediately adjacent to the Alpine Fault is ~2000 m, then a <4 km joining depth for the partitioned near-surface sections was considered appropriate (Norris and Cooper 1995).

More recent mapping of Alpine Fault surface traces using LiDAR (Barth et al 2012, Langridge et al 2014) and results from numerical modelling (Upton et al 2017) also support the idea that the Alpine Fault is segmented in the near-surface. However, they indicate that segmentation may only extend as deep as 0.5 km, and we will note this too.

We emphasise that this study does not seek to develop or critically evaluate these models. Rather, these ideas are presented here to justify our methods for estimating the true distance of our field measuring stations from the Alpine Fault (Lines 161-163). Nevertheless, if the editor advises it, we can include the ideas discussed above (though at a cost to the succinctness of this manuscript). Furthermore, we can also account for an end-member case in which the Alpine Fault is not segmented (i.e. it dips at 45° at the surface) and find it does not significantly influence our results (see comment for Line 163).

Line 125: I disagree that the AF necessarily has a dip of 45 degrees at >4 km, or that the data mentioned by the authors demonstrates this, and I note that the statement is not supported by any references.

As noted in the previous comment, we will now explicitly cite the data that support a ~45° dip of the Alpine Fault (Simpson et al 1994, Norris and Cooper 1995, Barth et al 2012, Upton et al 2017) and note that the dip may actually range from 30-62° (Norris and Cooper 1995, Toy et al. 2017).

Methodology

In Section 3.1 need to start out by pointing out the known shallow dip of the fault at DFDP-1?

The dip is based on projection of the fault dip at outcrop and that sampled in the boreholes (Townend et al 2013). We will revise this section to explain this.

Line 140: If the DFDP-1 holes are up to 150 m deep, why was only 25 m of core investigated for this study? Explain.

This method requires intervals of both good quality BHTV and CT drill-core images, and which have sufficient fractures (>2 per core section) that could be matched to estimate the rotation.

Most significantly, only 70 m of drill-core was recovered across the two DFDP-1 boreholes. This entails that significant intervals of the boreholes were not cored (as shown in Figure 3) and so they do not have drill-core CT scans. Where core was recovered in DFDP-1A, the BHTV images were of poor quality, so it was not possibly to reliably pick geographically oriented fractures. Conversely, within the relatively intact DFDP-1B footwall (depths >128 m), too few fractures were recognised to allow core reorientation. We will revise the methods section to outline this.

Line 152. Insert comma after “Appendix A”

This will be corrected

Line 156. “Distances” is vague. How measured, in what direction?

These are orthogonal distances from the fault trace (see comment for Lines 163).

Line 160: They were measured not “collected”

This will be corrected

Line 163: What uncertainties in the measured quantities (e.g., fracture density) are introduced by assuming a generic “thrust” fault dip of exactly 30 when the actual fault dip may be different than that?

It is accepted that there is an inherent uncertainty in our damage zone width estimates given the uncertainty of the orientation of the Alpine Fault at depth (see comment for line 122). In a revised manuscript, we can present estimates of damage zone width assuming an end-member case in which the fault is not segmented and dips at 45° from the surface (i.e. the regional orientation) as shown in the table below. The widest damage zone estimate that this fault dip indicates is 205 m (Havelock Creek) and it is <170 m wide across all other transects. Note, we do not consider the fault dip predicted by DFDP-2B (62°; Toy et al 2017) to be relevant to our field transects. This borehole was sampling the Alpine Fault at distances 1-2 km from the fault, whereas our field transects are all within 500 m of the fault. The result from DFDP-2B may however, have implications for the to the Amethyst Borehole datasets, as discussed for the reviewer’s comments for line 180.

In summary, although the reviewer is correct that there is some uncertainty in our results (which we can account for), this does not unduly influence our interpretation that the Alpine Fault has a relatively narrow damage zone. We can include this analysis in the revised manuscript.

Station	*Distance from Alpine Fault dipping at 30° (m)*	*Distance from Alpine Fault dipping at 45° (m)*
Gaunt Creek 1	***27***	***33***
Gaunt Creek 2	***92***	***99***
Gaunt Creek 3	***118***	***126***
Gaunt Creek 4	*147*	*161*
Stony Creek 1	***7***	***7***
Stony Creek 2	***73***	***95***
Stony Creek 3	*103*	*131*
Stony Creek 4	*251*	*311*
Hare Mare Creek 1	***101***	***106***
Hare Mare Creek 2	***151***	***170***
Hare Mare Creek 3	*250*	*269*
Havelock Creek 1	***24***	***34***
Havelock Creek 2	***48***	***62***
Havelock Creek 3	***154***	***205***
Havelock Creek 4	*160*	*213*
Bullock Creek	*517*	*721*

Table 1: Range of estimates of orthogonal distances between field stations and the Alpine Fault, assuming it dips between 30 to 45°. Based on the observations of Norris and Cooper, (1995), our preferred estimates are for the Alpine Fault dipping at 30°. Those stations considered to be part of the damage zone (i.e. >1 gouge-filled fractures per metre, as defined section 5.2) are in bold

Line 164: an extraneous comma.

This will be corrected

Line 166: it is a method, not a “methodology”. The “-ology” is a little pretentious, in my opinion.

This will be corrected

Line 180: I disagree that Norris and Cooper (1995) demonstrated that the Alpine fault dips c. 45 below the Amythyst tunnel locality. Also, “circa” is a time term, not a spatial or angular term.

As noted for the comment at line 163, we will now allow for the full range of possible dips of the Alpine Fault at this locality (30-62°). These estimates imply that the AHP lies 0.7-2.0 km from the Alpine Fault. We will remove the erroneous use of “circa” and use “~” instead

Line 181: See my statement above regarding line 163 and uncertainties tied to an assumed fault dip.

See reply to above comment

Lines 187-190: “intense fracturing” adjacent to “minor” faults is not measured, nor was it captured in the cores (due to their poor recovery). For the paper, only quite intact cores (i.e., the least fractured intervals) were imaged by CT from which corresponding fracture densities were derived. How representative are these fracture density estimates
likely to be? Are they maxima or minima?

Shouldn’t this sampling bias be acknowledged and implications for using the results be mentioned?

The main purpose of the AHP CT scans was to investigate fracture orientations ~1 km from the Alpine Fault, not fracture density. As the reviewer notes, any estimates of fracture density we make will be a biased as we only scanned the most intact core. Furthermore, we cannot reliably determine natural from induced fractures in the drill-core (Lines 257-26).

As such, we only describe fracture density in qualitative terms (Lines 185). This is based on the initial (cited) core descriptions (Geotech et al 2006, Savage 2013) that find that fracture density is strongly heterogeneous and is dependent on the presence of faults, as we also qualitatively demonstrated in Figure S3 (where we could scan a core section containing a fault). Therefore, we remain confident in the interpretation and analyses we have carried out

Lines 198-200: This statement is only true if the top vs. bottom of each piece of core was marked as they came out of the ground. Please elaborate.

The orientations are obtained from drill-core logs and are accurate to ±5° and we recognise that this should be explained. These core logs do not note how the orientations were measured. Nevertheless, the foliation orientations that they report (and the fact this is broadly constant about 060/70 SE) are consistent with orientations obtained from inside the Amethyst Tunnel itself (Savage 2013). Furthermore, we are most interested in the angular relationship between fractures and foliation, not the absolute orientations themselves. Our findings are, therefore, not significantly influenced by uncertainty in the true orientation of these fractures.

Line 199: What is the "known orientation," how was it measured, and what are the uncertainties in this assigned dip/ or dip direction?

See reply to previous comment

Results

Line 214: What are the criteria used to distinguish "fractures" from "foliations" in the BHTV? To what degree can one be confident that these criteria "work"? How about your comparison of the BHTV plots with the cores?

In this study, we do not distinguish between fractures and foliation in the BHTV images (except in the cases where fractures in the BHTV images can be directly matched with those recognised in the CT images (Figure 4)), and we will revise the text so that it simply refers to BHTV 'features' (as opposed to 'fractures' such as at lines 208 and 511). Indeed, as noted this may explain why there is some difference in the orientations gathered from the CT and BHTV datasets (Line 214).

Line 217: What is meant by "type of fracture"? Vague and unclear. Do you mean "host rock type"?

This should be revised to "fracture fill," which are based on the CT number of the fracture fill and classified in Table 1 of Williams et al. (2016).

Line 221: It would be good and appropriate here to site a statistical measure of fault attitude "clustering" rather simply stating qualitatively that one subset of the data is "more clustered" than the other. The plots are not very convincing on their own.

To quantitatively assess the clustering of fractures around the Alpine Fault, the resultant vector method described in Priest (1993) can be used. Here, the magnitude of the resultant vector from all fracture orientations is normalised by the number of fractures, with values approaching 1 indicating a high amount of clustering and vice versa. Vectors for individual fractures are weighted by the Terzaghi correction and so there is no misorientation bias in these results.

The results of this analysis are outlined in the table below and can be included in a revised manuscript. They indicate that fractures adjacent to the Alpine Fault (i.e. in the DFDP-1 CT scans) are less clustered than those outside it (i.e. in the Amethyst Hydro Project), consistent with qualitative analysis of the stereonets (Figures 5 and 11). We interpret that the relatively clustered DFDP-1 BHTV feature orientations reflect the sampling of both fractures and foliation (see comment for lines 214), and so is not a true indicator of fracture clustering around the Alpine Fault.

It is not possible to perform such an analysis with the field datasets, as an insufficient number of fracture orientations were measured at each site for a reliable quantification of clustering to be made. Furthermore, there are local variations in the foliation orientation between these sites (Figure 7). This means it is not possible to aggregate orientations from multiple sites to quantitatively assess clustering (i.e. foliation-parallel fractures won't all plot in the same place across different sites). Nevertheless, the trends they qualitatively indicate (that fractures are more clustered further from the fault) are consistent with the DFDP-1 and AHP datasets. Therefore, we are confident that the field datasets are representative of fractures *around the Alpine Fault, and that they can robustly determine the distance from the fault where changes in fracturing style occur.*

Dataset	***Mean vector trend***	***Mean vector plunge***	***Resultant (2 s.f.)***
DFDP-1 CT scan reoriented fractures	*078*	*68*	*0.58*
DFDP-1 BHTV features	*098*	*51*	*0.72*
AHP CT scan fractures	*162*	*51*	*0.76*

Table 2: Results of quantitative analysis of fracture clustering, using method outline by Priest (1993).

Line 251: Be exact. This is in the Alpine Schist.

That AHP sampled the Alpine Schist, a sub-member of the Haast Schist, and this can be stated in the revised manuscript.

Discussion

Lines 269-274.Authors refer to the field-observed fractures at >160 m from fault as being “mostly open.” Given they are observed at the face of an outcrop in a high rainfall setting, can one be sure that they do not have gouge in them at depth a short distance below the exposed ground surface? See your lines 258-259. Do youreally know that they are open?

Such weathering of gouge from fractures at the outcrop scale is unlikely to have occurred, as gouge-filled fractures are still frequently observed in outcrop, even at >160 m from the fault (Figure 8). The point we wish to make is just that fractures with this fill are particularly abundant <160 m from the fault (See Figure 7). For the reviewer’s concern to be true, then weathering must have been selective and only affected fractures >160 m from the fault, which seems implausible.

In the Amethyst road tunnel, which is >160 m from the fault, many of the observed foliation-parallel fractures are gouge filled

The reviewer’s observation of foliation-parallel gouge-filled fractures in the Amethyst Tunnel is actually consistent with our field observations, which include mention of gouge-filled fractures ~500 m from the fault at Bullock Creek (Figure 8e, line 232). As noted above, it is density of gouge-filled fractures that interests us. Such an observation in the Amethyst Tunnel would only conflict with our results if these fractures were consistently found to have densities of >1 fracture/metre (as noted in lines 257-259, our datasets cannot constrain the ratio of open to filled fractures in AHP drill-core, and we make no attempt to do this).

Lines 306-307: I am unconvinced that the transect data has demonstrated a “confining pressure” cause/effect for foliation-parallel fracturing/or not. This is an interpretation not a fact.

We agree that this should revised to an interpretation. Also, see reply #1 to this reviewer

Line 332: I have no idea what “broadly oriented” means.

This should be revised to a wide range of orientations

Lines 321-322 and Line 331: These statements seem to contradict one another: The fracture density is spatially constant but it isn’t(?). Please clarify and be exact and consistent.

The point we wish to make is that total fracture density is relatively constant across our field transects (Lines 321-323), but that the density of gouge-filled fractures is particularly high within <160 m of the fault (Figure 7, Lines 332). That fractures with a particular fill are used to define damage zone width is not new. See for example Mitchell and Faulkner (2009), who use the density of ‘fluid inclusion planes’ to define damage zone width and ignored the density of open fractures (which did not show a scaling relationship with distance from, the fault). Revisions of this manuscript can clarify these points.

Line 336: “They are considered necessary” By whom? Why? This is weak and inexact language.

See reply to comment #2 to this reviewer

Line 348: I have no idea what an “intensive” fracture is.

This can be revised to “high density of”

Line 368: depends on your definition of “fault zone” As you point out, this is not an absolute or clearly defined quantity. And what do you mean by “total” fault zone width? Are there other measures of “partial” fault zone width?

Correct, we should revise this to say that fault zone guided waves sample a zone of low seismic velocity around a fault. These data have been used elsewhere to infer the thickness of fault zones, but there is debate on this (Cochran et al 2009, Mitchell et al 2012)

Line 379: unclear what is meant by “this set”

By this, we mean the multiple minor faults mapped in the hanging-wall of the Alpine Fault. This text can be revised to clarify this point.

Both these faults and the diffuse (at distances ~5 km from the fault) seismicity that has been recorded around the Alpine Fault (Chamberlain et al 2017) reflect deformation in its hanging-wall as it accommodates some component of the Australian-Pacific plate motion. However, we infer that this deformation is taking place outside the Alpine Fault, sensu fault core-damage zone models (see also reviewer #2 comment for lines 189-190).

Lines 390, 393, 394: more apparent self-contradictions: Is the distance <360 m or is it c. [sic] 500 m? This is VERY confusing. The role of gouge infilling/ or not in these descriptions is not well explained.

This section can be revised to clarify our ideas. Namely that there is no relationship between proximity to the Alpine Fault and fracture density for distances of <500 m. But, there is a distinct drop off in the density of fractures with a gouge-fill within 160 m of the fault (Figure 7a). We also note, that in a revised manuscript, we will incorporate ideas recently published in Townend et al (2018) based on wireline logs collected during the second phase of the Deep Fault Drilling Project (DFDP-2). Here they present a hierarchical model for the structure of the Alpine Fault, in which the <160 m wide zone of a high density of gouge-filled fracture represents an “inner damage zone” and is surrounded by wider (1-2 km?) zone of open foliation parallel fractures.

Line 397: “development of fault wedges” is a vague physical “explanation” for the occurrence for a spatial zone of gouge-filled fracturing. This interpretation has not been well explained or justified.

See reply to comment #2 to this reviewer

Fig. 1. I disagree that “all active onshore faults” are depicted in this figure. The heavy black line (road) is not labelled or explained, and it is shown far too bold, in my opinion. The road should not be the most conspicuous line feature on this map (but is), in fact it should probably not be shown at all. Why is the transport route even relevant? Lettering/font in the key is too small to be legible.

This should have been correctly stated as showing the faults from the New Zealand Active Fault database (Langridge et al 2016). However, on reflection given that part (a) is an inset, it is quite difficult to see all these faults, nor do they provide critical information. In the revised figure (below), we will only show the major continental faults on the South Island of New Zealand (i.e. the Alpine Fault and Marlborough Faults).

The road is labelled in part (b). However, we agree that it is given undue prominence, and its weighting should be reduced (below). State Highway 6 forms a useful reference in this (unpopulated) region and its inclusion is justified. Lettering will be clearer for a full quality version of this image included in a final publication.

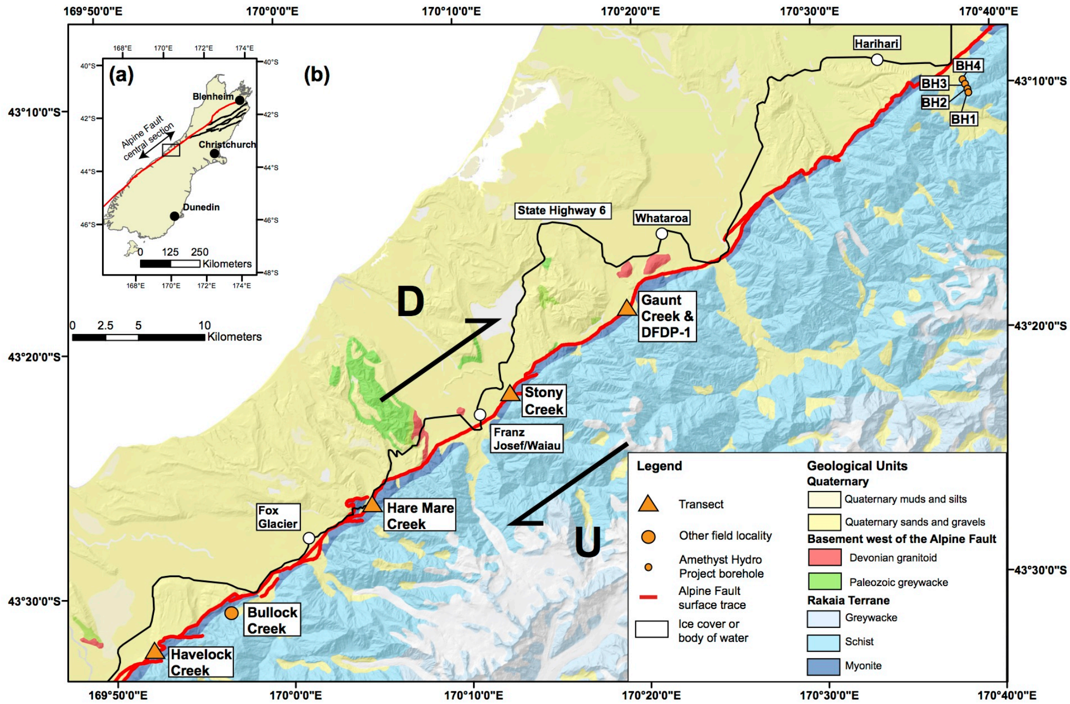


Fig. 2. Location of image in part a) is not stated.

This sample was taken from Gaunt Creek, and this information will be included in a revised manuscript.

Fig. 5. Yellow symbols in c) are faint and hard to read. Same for purple symbols in d) and red symbols in a). Symbols are illegibly tiny and the lettering in the key are too small.

This can be easily addressed by changing the colour of these symbols. Note too that the final version of the manuscript will have significantly higher quality images.

Fig. 6. Where were the samples in a, b, and c collected? What intervals? OK I now see this is stated at the bottom of the caption (It makes more sense to cite the interval for parts a, b, c as part of the caption for parts, respectively. This is more efficient. Caption for c should say "In this sample [of what rock type?], fractures show a preference to be aligned: : :"

This can be easily corrected. We can also specify that the rock types are all ultramylonites.

Fig. 7. Pole symbols and lettering in b are too small.

We will increase the size of pole symbols. The lettering size is of sufficient size in full quality versions of this figure.

Fig. 8. This caption is disorganized, inexact, and confusing. The photos are of limited use at the scale they are presented and they lack adequate labelling and discussion. What are the yellow arrows pointing to? The features in each photo should be labelled on the figure and sequentially and individually discussed and in the caption. What is the scale of g)? e) is almost unreadably muddy. The caption should identify what particular samples were chosen for the CT scans in the lower row of images (parts c, f, and i) and how these 3 chosen CT scans may relate to any of the other samples or field photos in this figure.

The purpose of this figure is to depict the three main types of fractures (separated into columns) noted from field observations and DFDP-1 core. We have revised the figure to emphasis this (below) and will amend the *figure caption too. We have also added yellow arrows to parts (a), (b) and (e) to specify the fractures we wish to highlight. Arrows in part (6) have also been modified as they show shear sense, not fractures.*

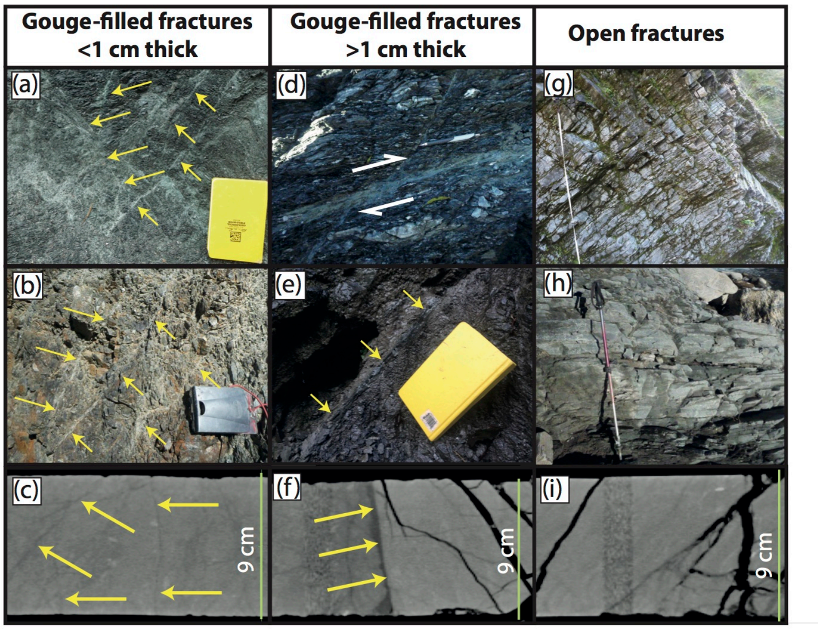
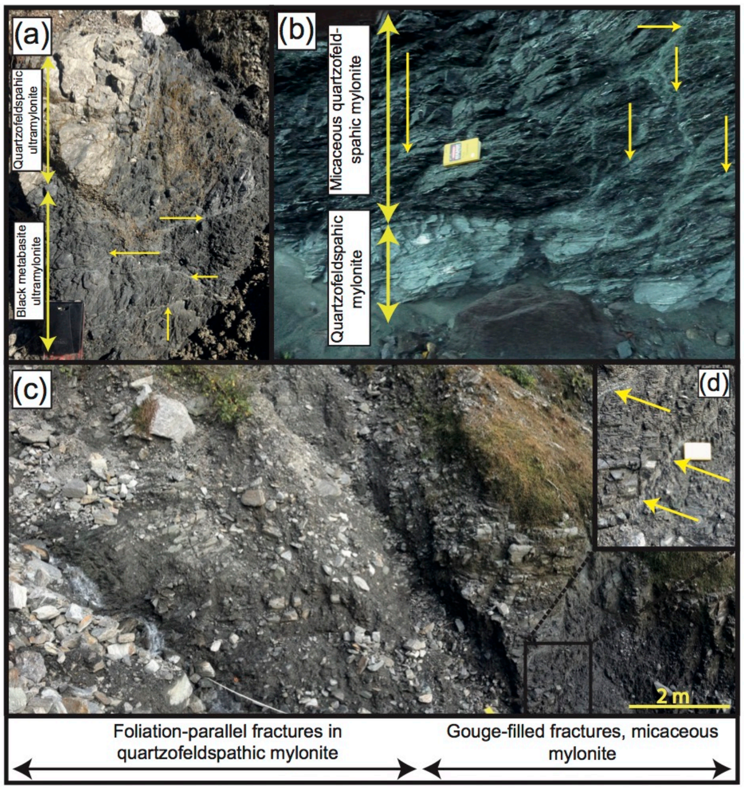


Fig. 9 “Coincident with lithological diversity” is inexact and physically nonsensical. How can something coincide with a “diversity” Do you mean a contact? I can’t see any :gouge filled fractures” in part

“Coincident with lithological diversity” can be revised to “changes in fracture density at lithological contacts.” In a revised version of the figure (below, part d) we have included an additional part which shows gouge-filled fractures in part c.



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