We thank the reviewer for their comments which we will address in the revised version of our manuscript and which will help us to improve its quality. See the attached file for our reply to the **reviewer's comments (bold font)**.

Reviewer 2

The manuscript by Masoch et al deals with the microstructures from a fault zone in northern Chile related with tectono-magmatic and hydrothermal activity. The authors claim that the deformation modes recorded therein could be representative of processes at stake in active swarm systems. Even though the idea of relating the features visible in this fault zone is not totally new and already proposed in the previous papers from the same group on this locality, I found the study well conducted, adequately documented and rather convincing. There are probably several ways of interpreting the finite structures recorded in this fault zone. Future work will tell if those are indeed swarms -or not-. The discussion and the genetic model is mostly supported by the observations even though some re-wording and clarification is needed in places (see below). I also believe that the microstructures should perhaps be described with greater care. Overall I recommend publication after moderate revisions.

I think that the authors should better explain the part on the internal versus external fluid infiltration, and locate the epidote-bearing domains in their figure 8. Because epidote formation requires the incoming of large amounts of calcium, I believe that a better discussion of this aspect would bring water to their mill when it comes to discussing fluid infiltration after the first fracturing event. Have similar epidote-rich veins been described elsewhere in Northern Chile (or elsewhere) as a consequence of deeper emplacement/cooling of a plutonic body? Can you discard the possibility that the fluid source comes from the currently downgoing subducting plate?

By using hydrogen and oxygen stable geochemistry, we constrained that epidote-forming fluids derived from surficial, evaporated (i.e., basin-derived) fluids. Part of our dataset is presented and discussed in Masoch (2023) (see chapter 4 of the thesis). Thus, we discard the hypotheses proposed by the reviewer. However, we investigated different fault-zone rocks (e.g., chlorite-rich cataclasite, pseudotachylytes, epidote-rich fault-veins, hydrothermal breccias) of the Bolfin Fault Zone and hydrogen-bearing minerals of the magmatic rocks cut by the fault. Consequently, we rather prefer to not enclose our isotopic data to this manuscript because they constitute an independent study about the conditions of fluid-rock interaction during fault zone growth.

The interpretation of fault zone structures in terms of slip velocity is hazardous. It is currently impossible to tell whether breccias or cataclasites result from slip at seismic strain rates in the absence of pseudotachylytes. I suggest a more careful writing.

We agree with reviewer. However, ancient seismicity along the BFZ is documented by widespread occurrence of pseudotachylytes and, as documented in this work, microstructures typical of high-stress conditions (i.e., wall-rock quartz deformation lamellae and wall-rock pulverization) associated with the described sheared fault-veins.

Detailed points:

L.14: fault-veins / epidote faulting: what do you mean? Please clarify. Not clear enough for an abstract.

With fault-veins, we mean hybrid-shear veins. We will make these aspects clearer in the abstract.

L.17-21: the abstract lacks material that enables understanding how you came to these conclusions.

We will rephrase and include material to the abstract to make it more clear.

L.65: linkage zone? What do you mean?

We mean "zone of fault linkage". We will modify it in the next version of the manuscript.

L.129: replace by 'EBSD data was processed using the MTEX…'

We will modify the text as suggested by the reviewer.

L.132: why such a low (6 nA) current?

Because these working conditions were the best to get detailed resolute images.

L.135: you mean alkali devolatilization? (instead of migration)

Yes, we will modify the text in the revised version of our manuscript.

L.202: (Al-rich; light: Fe-rich) there is something missing here

(*Dark*: Al-rich; light: Fe-rich).

L.211: show the pores!

Pores are shown in Fig. 6d, 6f and 6g.

L.216: there is no figure 5h! check again the figure calls. Do you mean 6h?

Yes. We thank the review for noting this typo.

L.267: 'high stresses': how high?

Trepmann and Stöckhert (2013) reached confined pressure up to 2.7 GPa in their experiments.

L.269: how slow?

We mean strain rate slower than what expected for co-seismic deformation.

L.282: 'the latter hypothesis': clarify to which hypothesis you are referring to

We refer to the hypothesis that most quartz deformation lamellae we observed are possibly related to high-stress conditions rather than slow low-temperature crystal plasticity. We will make this point clearer.

L.295-298: It is not clear to me how high stresses can be reached here in hybrid veins, since mode ii veins by definition require higher fluid pressures than pure shear veins

Indeed, we refer to the high-stress perturbation at the crack tip propagating at seismic speeds. We will clarify this in the revised version.

L.305: rephrase: too long and not clear

We will rephrase the sentence to make it clearer.

L.314-317: Yes, but this study deals with dissolution precipitation of the host metasediments towards the host. In this study you suggest permeability increments associated with fluid advection.

We agree with the reviewer but a previous reviewer suggested to take in consideration these works and we discuss them.

L.326: any evidence for pressure-solution at this stage that could account for elemental redistribution?

No, we did not observe any evidence of pressure-solution in the wall-rocks.

L.351: see Angiboust et al. (2015, G-cubed) for another example where an epidote-rich cataclazed fault system is described, forming as a consequence of transients increase in pore fluid pressure in a sheared system. See also Oncken et al. (2021, geosphere) for further evidence of foliated cataclasites as a key fault zone material in deep plate boundary systems. See also Muñoz-Montecinos et al. (EPSL, 2021).

We will take in consideration these papers in the revised version of our manuscript.

L.353: foliated, fluidized cataclasites and breccias may also form at sub-seismic strain rates (see Oncken et al., 2021). I would be more careful in the writing here.

We will be more careful in our statement.

L.370: check syntax in this sentence (perhaps you mean 'by an increase of the rate of fluid pressure…')

Yes, thanks for noting this misleading sentence. We will modify the text in the revised version of our manuscript.

L.372: which type of deformation events?

Independent events of extensional faulting followed by fault reactivation.

L.384: coexist (no 's')

Yes, thanks for noting this typo. We will modify the text in the revised version of our manuscript.

L.430: the presence of suspended clasts within cataclasite should not be viewed alone as a solid evidence for seismic slip

We agree with the reviewer. Indeed, we specified that this microstructure is a possible marker of paleo-earthquake.

Bird & Spieler (2004, rev. Min. Geochem) could be a useful reference when it comes to demonstrating that your veins were once part of a supra-plutonic environment.

See response above about fluid sources.

Figure 1: how do you define the 'weakly fractured unit'? is there a statistical criterion or is it purely arbitrary? Also, explain better your difference between chloritized/Fractured and chlorite-rich cataclastic: foliated and massive, in the caption of the map.

The structural units forming the BFZ are presented in detail in Masoch et al. (2022) and their classification was based on a quantitative analysis. In that work, we defined the different units based on the following structural features: preservation of original magmatic features of the host rocks, alteration degree of the host rocks, spacing of fractures, veins and faults, relatively abundance of veins and faults, mineral assemblage sealing and decorating veins and faults, and clast/matrix proportion in the fault rocks.

Figure 3: better label minerals and features as explained in the caption

We will improve the labelling.

Figure 4: what are the analytical conditions used for obtaining these CL images?

The working conditions at which the CL images were acquired are described in the methods section of our manuscript.

Figure 5b: how many points considered for this pole figure? figure 5a: why not showing the misorientation map instead? It would be more useful here. What is the Y direction and what is the reference frame?

We plotted 833 points in the pole figure. Fig. 5a shows the orientation of the deformation lamellae compared to the crystallographic orientation of the host quartz grain. Microstructural observations were conducted parallel to the fault lineation (X direction) and orthogonal to the fault/vein wall (X-Y plane), as specified in the methods section.

Figure 8: part (a) title: propagation (not progation). The three lines (crystal plasticity, dynamic fracturing …) are not well positioned and not very easy to understand in the frame of this sketch.

We will make the figure clearer. We thank the reviewer for highlighting the typo.

Figure 9: ok but this figure does not consider the reactivation of the fault

We will modify the figure taking in consideration fault reactivation.

References

Masoch, S., 2023. Structure, evolution and deformation mechanisms of crustal-scale seismogenic faults (Bolfin Fault Zone, Northern Chile). PhD thesis. Università degli Studi di Padova.

Masoch, S., Fondriest, M., Gomila, R., Jensen, E., Mitchell, T.M., Cembrano, J., Pennacchioni, G., Di Toro, G., 2022. Along-strike architectural variability of an exhumed crustal-scale seismogenic fault (Bolfin Fault Zone, Atacama Fault System, Chile). J. Struct. Geol. 165, 104745. https://doi.org/10.1016/j.jsg.2022.104745

Trepmann, C.A., Stöckhert, B., 2013. Short-wavelength undulatory extinction in quartz recording coseismic deformation in the middle crust – an experimental study. Solid Earth 4, 263–276. https://doi.org/10.5194/se-4-263-2013