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 1

The manuscript "Earthquake swarms frozen in an exhumed hydrothermal system (Bolfin Fault Zone, Chile)" submitted by Masoch et al. describes microstructures from epidote-prehnite sealed hybrid veins within granitoids from the Bolfin Fault Zone, Chile. Magmatic quartz clasts in the veins contain various deformation microstructures: (1) deformation lamellae characterized by an undulating, lamellar change in extinction position in transmitted polarized light and darker CL, (2) healed microcracks characterized by fluid inclusion trails in single quartz grains and dark CL as well as (3) fractures in quartz sealed with feldspar and quartz (veinlets).

These deformation features are firstly observed in the host rock. The deformation lamellae and the quartz-healed veinlets (i.e. thin veins) are present within the magmatic quartz nearby (i.e., within 1 cm distance) the epidote-rich veins. The veinlets are sealed by epitaxially quartz ± feldspar.

These deformation microstructures occur in association with shear zones related to the Bolfin Fault Zone. Together with the observation that veins contain fragments of former veins, the quartz deformation microstructures are taken to record cyclic cataclasis and sealing and is interpreted as an ancient seismogenic hydrothermal system. The topic is timely and of significant interest to the readers of Solid Earth.

However, from my point of view, the presentation, interpretation and discussion of the deformation lamellae, healed microcracks and veinlets in magmatic quartz, where especially the deformation lamellae are taken as one important argument for transient high stresses, should be improved before publication. The specific comments are as follows:

A better presentation and correlation/distinction between *deformation lamellae, healed microcracks and veinlets* in the magmatic quartz would be necessary, as the microstructures record different processes. Especially, a correlation of the lamellar change in extinction position (i.e. "deformation lamellae") in polarized light micrographs with the marked change in CL shown in the impressive Figures 4 d, f, h, would be important. The lamellar change in extinction position is shown from four quartz grains in the images Fig. 3d, e, S1a, b and S2, which are of relatively low magnification. The correlation with the CL images is, however, only shown for the quartz grains in Figs. S1a, b, d and S2/Fig. 6j, where the deformation lamellae are not that well visible, as the thin sections are 100µm thick.

The slight difference in orientation across the deformation lamellae is hardly seen in the optical images especially in 100 µm-thick thin sections. The deformation lamellae are instead clearly highlighted by CL imaging (as shown in the "impressive Figures 4 d, f, h" to use the reviewer's words) and the crystallographic mismatch typical of deformation lamellae is well captured by EBSD mapping (Fig. 5). To account for the reviewer request of a better documentation of the deformation lamellae, we therefore added the EBSD maps of the other examples of deformation lamellae in the Supplementary Material. These images are much more useful than the optical images.

Furthermore, Fig. 3d shows fluid inclusion trails in a quartz grain, thus interpreted as healed microcracks. It would be good to also show a CL image of this grain, to see the difference in CL related to the healed microcracks and to the deformation lamellae.

We will add the corresponding CL image of the microstructure in Fig. 3d as Supplemental Material.

As both, healed microcracks and deformation lamellae, appear to be characterized by darker CL in relation to the host, a distinction from CL images alone is not possible.

In CL images, the healed microcracks and the deformation lamellae show quite distinct features: (i) the deformation lamellae resent a gradual dark shade, while the healed microcracks are homogeneously black; the deformational lamellae have a blurred boundary in contrast with the neat, sharp boundary of the healed microcracks; (ii) the healed micro-cracks continue in the neighbor minerals as quartz and feldspars; (iii) there is also a clear overprinting relationship between deformation lamellae and healed micro-cracks: indeed, the latter systematically crosscut the deformation lamellae. We will add this list of distinctive microstructural features in the text.

The BSE images Fig. 4 a, c, g, e, are not helpful, as they show no contrast. Maybe BSE images at higher magnification and better contrast would help to show at least the "veinlets" sealed also with feldspar, as described in the text (e.g. line 155-160) with reference to the Figures 4f, 6i, 6j, S1, which however, are not really helpful to distinguish the veinlets from the healed microcracks, as no other phases are indicated.

The meaning of the BSE images was exactly to highlight the complete healing of veinlets (i.e., healed micro-cracks) within quartz by new quartz. We agree that probably the four BSE images are too many and not of great help and we will add some figures with details of the quartz –feldspar gain boundary to show the extension of the healed veinlets in quartz and feldspars as Qz-Felds healed micro-cracks.

Maybe some confusion arises also because the text does not distinguish between epitaxially healed microcracks in quartz, e.g. characterized by "fluid inclusion trails" in a quartz grain with one main extinction position as shown in Fig. 3d, and "quartz-healed" veinlets with other phases like albite and K-Fsp (e.g. line 155-160). It would be good to present also data of the other phases in the veinlets, I did not find a figure showing these?

We will rephrase the main text to make this difference clear between the healed veinlets (in quartz) and the Qz-Feld-healed micro-cracks (extending from quartz into the neighbor feldspars.

The *EBSD data* presented in Figure 5 are not suited to characterize the slight oscillatory change in crystallographic orientation, which would be expected across the deformation lamellae. The misorientation profiles are not very specific and could also represent the usual "noise" of deformed quartz with internal misorientation/undulatory extinction. The gradual increase in misorientation angle to the reference orientation in profile 1 (blue line) is probably not related to the deformation lamellae. A correlation of the misorientation profiles with GROD, GOS or relative misorientation maps would be necessary to relate the slight changes in orientation across the lamellae.

The misorientation across deformation lamellae is usually very small (1-3°). Thus, the misorientation is affected by the precision of EBSD measurements. However, it is quite clear the systematic variation in

crystallographic orientation which overlaps with the CL dark banding. To better highlight this match, we will add a band reporting the CL variations across the profile at the base of the misorientation profile of Fig 5c.

Were more EBSD measurements performed then those from Fig. 5? Are the observed deformation lamellae generally of (sub)basal orientation and what is the angle to the basal plane? This information would be important for the discussion.

Many more EBSD maps have been produced. If considered necessary, we can add other maps in the supplementary material. Only basal deformation lamellae have been identified in the studied samples.

The discussion on the deformation lamellae in *Chapter 5.1* is misleading: The two planar shock effects in quartz, Planar Fracturs (PFs) and Planar deformation features (PDFs), from meteorite impactites are very different from deformation lamellae. PFs are cleavage cracks in quartz and are typically not associated with a change in extinction position, as deformation lamellae are. PDFs are very straight, following specific crystallographic planes (they can be curved but only if the grain orientation is changing respectively), very fine lamellar (typically without a change in extinction position, i.e. without misorientation along the lamellae) and occur in sets of different orientations. Basal PDFS in quartz are mechanical Brazil twins (only resolvable by TEM) and rhombohedral PDFs are characterized by localized transformations from/to diaplectic glass. A comparison to the undulating dark lamellae in CL observed here appears very distracting and misleading from my point of view.

The discussion of PDFs was actually added as response to a former friendly review and was not included in the original draft. We agree that this discussion is misleading and will delete it.

Instead, a much more specific and careful discussion of (sub)basal deformation lamellae, short wave length undulatory extinction and fine extinction bands in quartz, the indication of the respective formation processes (relevance of dislocation glide, pile up of dislocations, influence of microcracking (!) etc.) as well as a discussion on the deformation conditions (transient high stresses?) would be very important and relevant here.

We will add a more extended discussion of the (sub)basal deformation lamellae, short wave length undulatory extinction and fine extinction bands in quartz.

Further comments:

Line 30-32: I think that also Nüchter and Stöckhert, 2007, 2008 (references see below) are very relevant studies on the topic of transient permeability and fluid flow related to seismic activity recorded by quartz veins, which should be discussed here.

We agree and will add this reference, and related discussion, in the main text.

Line 78, please rephrase, as this might be mistakeable. I assume that here the initiation of the fault system is meant and not the nucleation of an earthquake.

We will rephrase the sentence to make our idea clearer.

Line 135, Fig. 2a) the hybrid extensional-shear veins and alteration halos are not well visible in the figure

We will label them to make their more visible.

Line 153-170 please rewrite this paragraph and describe the microstructures more specifically: e.g., I recommend to not use "planar features" which is very unspecific and maybe mistakeable by the very specific term "planar deformation features" in shocked quartz from meteorite impactites. This is especially as the microstructures shown in Fig. 3e and 4 are not really planar except maybe of the healed microcracks in Fig. 3d, see specific comment 1 above. Usually the term "deformation lamellae" is referring to lamellar undulatory extinction with the lamellae subparallel to the basal plane, i.e. the plane at high angle to , as described here. The term short wave length undulatory extinction is referring to wavy, lamellar undulatory extinction also subparallel to other crystallographic planes (m, r, z).

As explained in the response above, we agree that the PDFs should not be discussed in our manuscript.

Line 155-160: I strongly recommend to distinguish fractures in quartz sealed also with other phases (i.e. veins, or if you wish veinlets) from epitaxially healed microcracks in quartz (Fig. 3d)

Actually, we believe that this distinction in made quite clearly, but we will further improve the text to avoid any misunderstanding.

line 165: are all observed deformation lamellae of (sub)basal orientation? What is the angle of the lamellae to the basal plane?

See previous response.

Line 169-170: the epitaxy of the healed microcracks is better to see in Fig. 3d, by the same extinction position of the grain (but please label the healed microcracks, see below). Where is the veinlet in Fig. 5a, which is corresponding to the grain in Fig. 4d, please indicate the veinlet in both images. In the BSE image also no veinlet is visible, which should indicate the presence of different phases, as feldspar. Again, an optical micrograph could be much more helpful…

As commented above, we will substitute some of the BSE images of Fig. 4 with some detailed BSE images showing micro-cracks healed by quartz and feldspars.

3 d, e: Please indicate also the healed microcracks in Fig. 3d. It would be very interesting to see the CL images of these two grains, especially Fig. 3d, to see the difference in CL related to the healed microcracks and to the deformation lamellae.

We will add some arrows to indicate the deformation lamellae and the healed micro-cracks (i.e., veinlets). We will also add the corresponding CL images in the Supplementary Material.

4: The undulating lamellae dark in CL are very impressive. Yet, the figure does not allow to distinguish between deformation lamellae, veinlets or healed microcracks, as all three microstructures are obviously characterized by the wavy lamellae of dark CL and in BSE all three microstructures do not show up. I would expect that at least the different phases and grains in veinlets should be visible in BSE, but for that a better contrast/resolution would help. Also, in optical micrographs, all three microstructures should easily be distinguishable. Thus, I strongly recommend to exchange the BSE images with meaningful optical micrographs.

See response above.

Line 185 caption to Fig. 4: what do you expect from BSE image? The z-contrast can show other phases, e.g. in your veinlets, but no veinlets filled with albit/K-Fsp are shown? The orientation contrast may show deformation microstructures, but not in this resolution…, see also specific comment 1 above.

See response above.

Line 195/EBSD data, see specific comment 2 above.

See response above.

Line 216: fig. 5h? fig. 6h?

Fig. 6h.

6 b: the idiomorphic zoned epidote does not really show up in the figure?

It is. We will add some labels to make it clearer.

6e S-C foliation?

We will improve the labels showing the S and C planes.

6g) idiomorphic crystals? Triple junctions, of course there are triple junctions in a 2D picture of a polyphase aggregate, what is the relevance?

Some broken idiomorphic epidote crystals are marked by the dashed white lines. Triple junctions can be related to pressure solution creep.

6 i, j where are the veinlets, as referenced in line 219, there are wavy dark lamellae in the CL images, but whether these are deformation lamellae, healed microcracks or veinlets with other phases does not get clear from these two images.

We will label them to make these figures clearer.

Lines 260-285 please rewrite this paragraph, see specific comment 3 above

We agree with the reviewer. See detailed responses above.

line 397, where are the quartz-healed veinlets in S1?

They are marked by fluid inclusion trails. We will label them.

Figure S1, 2: the deformation lamellae are hard to be resolved in the micrographs of the 100µm-thick thin sections.

See response above about the comparison of the spatial resolution of SEM-CL and optical microscope images.

Recommended references:

Nüchter, J.-A., and B. Stöckhert (2007), Vein quartz microfabrics indicating progressive evolution of fractures into cavities during postseismic creep in the middle crust, J. Struct. Geol., 29, 1445–1462.

Nüchter, J.-A., and B. Stöckhert (2008), Coupled stress and pore fluid pressure changes in the middle crust: Vein record of coseismic loading and postseismic stress relaxation, Tectonics, 27, TC1007, doi:10.1029/2007TC002180.