Dear Editor and Referees,

We sincerely thank the referees for the careful reading of our manuscript and for their thoughtful and constructive comments. We appreciate your recognition of the relevance of our study, as well as the positive evaluation of the manuscript's organization and clarity. We thank you for identifying areas where the manuscript could be strengthened.

Below, you find the replies to the comments and questions (original comments in black and replies in red). We have corrected the typos found and made the changes suggested for figures. We also reviewed the discussion to decrease repetitive terms.

On behalf of all authors,

Kind regards,

Danielle Silva Souza

**Referee #1 Comments**

Dear Editor and authors,

This paper provides new results of static *versus* deformation experiments that aimed at exploring the relationships between antigorite dehydration and deformation processes, particularly to test the hypothesis of dehydration embrittlement to account for intermediate-depth Earthquakes. This type of study is particularly welcome to better understand such a type of earthquake, origin of which is still enigmatic and highly debated (I am myself quite doubtful about this hypothesis). Although some references are missing, the paper is well written and correctly organized with the description of new features, such as the production of olivine veins through coeval dehydration and deformation, which deserve to be published. However, I see a critical bias in the experimental setup that, to me, compromises the publication. Indeed, the authors describes an incipient dehydration of antigorite within its stability field at 3 GPa and 530-560 °C, i.e., quite far from the antigorite-out boundary. Although discussing this point, they do not provide any rational explanation of this feature, which strongly suggests that dehydration results here from an experimental artefact. In the absence of an oxygen buffer within the platinum capsule, it is indeed very likely that some hydrogen escaped from the capsule during the experiment, giving rise to a loss of $H_2O$, which would explain why antigorite is changing into olivine at grain boundaries. Although interesting to explore the feedback between deformation and antigorite dehydration, the amount of water released has nothing to see with the one occurring during antigorite

dehydration within the field of antigorite-out, for which a massive $H_2O$ released is expected. Hence, focusing on the role of incipient (i.e., minor) dehydration is here not applicable to the conditions of intermediate-depth Earthquakes, particularly to test the hypothesis of dehydration embrittlement. I also have other minor comments below.

Reply: We appreciate the reviewer raising this interesting possibility; however, we question whether the proposed mechanism can explain our observations. Initially, the antigorite sample is fluid-undersaturated and is held at temperatures below the bulk dehydration reaction. Although hydrogen can diffuse through Pt, for this to drive dehydration hydrogen must first be transported from structurally bound OH in the antigorite to the Pt capsule. If hydrogen loss through the Pt were responsible for the observed dehydration, we would expect the effect to be greatest in antigorite in direct contact with, or close to, the Pt foil, resulting in a dehydrated rim or reaction gradient progressing inward from the capsule wall. Such a spatial relationship is not observed: dehydration products occur throughout the sample and are not preferentially concentrated adjacent to the Pt capsule.

Furthermore, for loss through the Pt to induce breakdown of antigorite in the centre of the sample, hydrogen-bearing species would have to be transported over millimetre length scales through the initially solid, fluid-undersaturated assemblage to the capsule boundary. In the absence of an interconnected fluid phase, this would require sufficiently rapid solid-state or grain-boundary transport to communicate the low hydrogen chemical potential imposed at the Pt boundary throughout the sample on the timescale of the experiments. We therefore consider it unlikely that hydrogen loss through the Pt capsule can account for the observed spatially distributed incipient dehydration.

**Minor comments/concerns**

- Introduction or method section: a PT graph of the antigorite stability field with respect to the experimental conditions would be welcome to be added to introduce the topic and investigations.

Reply: Thank you for the suggestion, and we have added a P-T graph of antigorite stability field with respect to the experimental conditions in the methods section.

- Line 24: some important references are missing, including Raleigh and Paterson (1965), Yamasaki and Seno (2003) and Peacock (2001).

Reply: We thank you for bringing these references to our attention and recognizing their relevance. We have now included them in line 24.

- Line 79: "Backscatter", not "backscattered". And what do you mean by "Qualitative EBSD"?

Reply: We thank the referee for identifying the typo. The text is corrected. We used qualitative term because for antigorite the indexing percentage is lower than recommended standard for EBSD data (97%), after several rounds of chemical/mechanical polishing with colloidal silica and after testing different crystal structures the best indexing archived was 60 % using the antigorite superstructure from the Oxford database.

- Figure S3: Upper- or lower-hemisphere pole figures? Both are written. The Pole figures also do not look like the ones you can get using MTEX (they look like a screenshot of the Aztec software). But if you used MTEX, I strongly recommend to change the color bar and add isocountours on pole figures, so that any fabric (if applicable) will bring better out.

Reply: We initially used MTEX to generate the plots, and later we switched to AztecCrystal. We apologize for the confusion created. All pole figures provided are made on AztecCrystal with a lower hemisphere projection. We have corrected the figure S3 caption.

- Line 143: "Backscattered", not "Back-scattered".

Reply: Thank you for pointing that out. Corrected.

- Line 148: Again, it's confusing what type of software you have used to treat your EBSD data (MTEX or AZTEC)?

Reply: As mentioned in the answer to the comment on the figure S3 Aztec was used to plot the provided EBSD figures in the manuscript and supplementary figures.

- Line 206: Maybe I missed the point, but I did not find the duration of the experiment M909.

Reply: The duration of the experiment at temperature is 120 minutes as shown in table 1.

- Line 229: Needle-like crystals.

Reply: Corrected.

- Figure 6: The sample number is M923, not M928, right?

Reply: We thank the referee for identifying the typo. Yes, the correct sample number is M923 and the text has been corrected.

- Line 288: "Cluster length **IN** the bin".

Reply: Corrected.

- Figure 9c: $10^{-6}$ or $10^{-5}$/s

Reply: We thank the reviewer to point that out.The text in the figure is $10^{-6}$/s fontsize is now edited.

- Line 305: "this is caused **BY** the transformation..."

Reply: Corrected.

- Figure 10: Please, make sure that planes and axes are properly written, i.e., not with curly bracket. For olivine (orthorhombic), it should be only axes, so between [], and for antigorite (monoclinic), it should be planes for a and b, and axis for c ((100), (010), [001]). Also, what are Fx, Fy and Fz?

Reply: We respectfully disagree with this point. Crystal symmetry does not prescribe which pole figures must be presented. Rather, the selection of pole figures depends on which crystallographic planes or directions within a given phase provide information relevant to the processes under investigation, such as deformation mechanisms. In the case of antigorite, the (001) plane is particularly important because it corresponds to the layer plane of the antigorite structure. This plane is slightly different to the [001] direction, although the two are closely related.

Fx, Fy and Fz are Kearn's factors they describe the strength of texture in a single sample direction and can be calculated to any crystal direction. The subscripts x, y and z denote the axes of the sample coordinate. The sum of Fx, Fy and Fz is always equal to 1. For example, the Kearn factor Fx of c axis [001] describes the tendency of crystals to align with the x sample direction.

- Line 316: "This study **IS** caused..."

Reply: We thank the referee for the suggestion for correction, however, we feel that the original wording in the sentence "This study is aimed at investigating..." fits the intended meaning of the sentence better.

- Line 356: Again, the formalism of the axes/planes is confusing. Please check.

Reply: We thank the referee for pointing out this issue. The planes are written now as (hkl) and axes [hkl].

- Line 364: the reference of Nagaya et al. (2014; EPSL) is missing.

Reply: We appreciate the referee's suggestion on this missing reference. We added to the reviewed manuscript.

- Line 384: Using "fast" or "slow" to define the change in strain rate is confusing and not appropriate, because in any case, the experimental conditions are way faster than the expected strain rates in subduction zones (except for co-seismic events).

Reply: The use of the terms fast and slow was chosen to denote experiments performed at with one order of magnitude difference in calculated strain rate. We agree that the strain rates at laboratory scales are faster than in nature, however we wanted to point out that this difference also affects the microstructures produced. For clarity in this sentence fast and slow have been replaced by the respective calculated strain rates, and when necessary high or low strain rates to avoid repetition.

- Discussion: I often found repetitions in this section. For instance, you mention the same thing in line 390 and line 410. I recommend to rework the discussion to avoid this.

Reply: We thank the referee for the constructive feedback. We reviewed and edited the manuscript to decrease repetitions.

- Line 416: I am just wondering if some EBSD could be done on the olivine veins, which would be very instructive in terms of deformation mechanisms.

Reply: EBSD measurements in the olivine veins were attempted. However due to grain size of olivine (from nm to ~2 μm) was very challenging to obtain reliable SEM-EBSD data. Maybe TEM-EBSD would be an alternative, however we believe such investigation is out of the scope of the current manuscript and will be investigated in future publications.