Reviews and authors' response

Florian Fusseis
Rahl et al. Influence of water on crystallographic preferred orientation patters in a naturally-deformed quartzite

The authors present a combination of EBSD and FTIR measurements from a statistical set of quartz grains from a deformed quartzite from the Blue Ridge Anticlinorium in Virginia, USA. They find a correlation between water content and crystallographic orientation of the grains, which suggests that water content controls the activation of a specific slip system and thus challenges established assumptions concerning the controls on the emergence of crystallographic preferred orientations of quartz grains.
This is a well-written and -illustrated manuscript that reports relevant observations that contribute to a small chorus of studies that challenge established assumptions about the controls on crystallographic preferred orientations. The paper was originally written for publication in Geology, with the corresponding restrictions on word count and figure numbers. I would recommend this paper for publication in SE, pending some minor amendments:

- Provide a figure that shows the microstructure and establishes context.
- Figure caption of Fig. 1 refers to a panel G which doesn't exist. The statement "almost all grains exhibit…" is misleading, as only the grains in Fig. 1D-F show deformation lamellae, and in E and F these are practically not visible. Consider correcting the white balance on these photomicrographs?
- Provide details on how exactly the opening angle of the a-axis girdle was measured.
- How many datapoints have been contoured in Figs. 5b-d?
- Provide adequate and usable supplements with the necessary commenting.

Dear Dr. Fusseis,

We appreciate the time you have taken to assess our manuscript and provide constructive feedback.

We have improved the manuscript in response to your specific comments, as detailed below.

Thank you,

Jeffrey Rahl (on behalf of all authors)

- Provide a figure that shows the microstructure and establishes context.

This request was made by both reviewers; we have added a figure to illustrate the microstructure.

- Figure caption of Fig. 1 refers to a panel G which doesn't exist. The statement "almost all grains exhibit…" is misleading, as only the grains in Fig. 1D-F show deformation lamellae, and in E and F these are practically not visible. Consider correcting the white balance on these photomicrographs?

The erroneous reference to the wrong panel has been corrected. We have adjusted the text you highlight so it is not as misleading. Additionally, we have tinkered with the image properties (including the white balance) to try and better draw out these features.

- Provide details on how exactly the opening angle of the a-axis girdle was measured.

Text more clearly defining what is meant by an "a-axis opening angle" has been added.

- How many datapoints have been contoured in Figs. 5b-d?

These numbers have been added to the figure.

- Provide adequate and usable supplements with the necessary commenting.

We have made an Excel file with the data available on the Zenodo database, as well as a new animation showing the impact of water content on quartz CPO.

Dear Editor,
As requested, I have reviewed the manuscript titled "Influence of water on crystallographic preferred orientation patterns in a naturally-deformed quartzite" by Rahl et al., please find my general and specific comments below.
Rahl et al. present evidence from a naturally deformed quartzite that informs our understanding of the relationship between water content, strain, slip systems and rock texture. They show that the amount of water in quartz grains inversely correlates with a proxy for strain and that the dominant slip systems in grains changes with water content. Dry grains showing activity of basal <a>, prism
<a> (and possibly rhomb <a>), while wet grains show a decrease in activity of prism <a> and an increase contribution of prism <c> slip. From this they show clearly that applying opening angle thermometry on such a rock would be problematically sensitive to water content.
The dataset is statistically significant, the results clear and compelling, and the text excellently written. The authors have already revised the manuscript in response to three reviews and I think I
have little to add. I think that the main text could mostly be published as is, but I have provided some data presentation suggestions from the figures, a comment on the supplement and some very minor specific comments.
I congratulate Rahl et al. on an excellent piece of science that was a pleasure to read.
Best wishes,
James Gilgannon

Dear Dr. Gilgannon,

We appreciate the time you have taken to assess our manuscript and provide constructive feedback.

We have improved the manuscript in response to your specific comments, as detailed below.

Thank you,

Jeffrey Rahl (on behalf of all authors)

Data presentation comments

- Figure 1 - I think that an overview image that shows the overall quartzite microstructure would be of benefit to give the reader a sense of what kind of rock they are looking at. I read Singleton et al. (2020) so I have a rough idea but I think it would be better to see the specific rock microstructure you are analysing and discussing alongside the other detailed panels you present.

This request was made by both reviewers; we have added a figure to illustrate the microstructure.

- Figure 4 - I think that the colour coded figure in D should come first as it sets the key for all of the other plots. I also wasn't sure of how you got your slip system label for grains in this figure: does it come from pole figure fibre analysis (cf. Kilian and Heilbronner 2017 [doi:10.5194/se-8-1095-2017]) or your misorientation axes analysis? From how the text is written in section 5.1 it seems that the slip system labels in figure 4 are based on the IPF from figure 5. I wasn't sure if I had misunderstood this. If I haven't then I think you will need to change the order of the text to introduce the misorientation axes method results before figure 4.

Thank you for this comment. We had structured the paper with the idea that the misorientation analysis was not a result but rather a subsequent analysis, but we agree it is confusing and probably inappropriate to include interpretations in a figure that are not explained until a later figure. To address this, we moved the text explaining this analysis into the Methods section (which does seem appropriate) and text describing these results from the Discussion section into the Results section. We feel this will make the manuscript more intelligible.

Supplement
As it is, the supplement is unusable. I think you should provide the tabulated data in csv or excel files. PDF is the wrong format for that data.

We have made an Excel file with the data available on the Zenodo database, as well as a new animation showing the impact of water content on quartz CPO.

Specific comments
Line 75:
In the methods I would state how you calculated the ODFs: did you use a constant halfwidth or did you optimise between subsets?

The pole figures shown are based on contouring the orientation data, rather than being constructed from an ODF. This is noted in the text. However, we did construct ODFs for the a-axes opening angle analysis and added text noting this in our description of the opening angle analysis.

Line 147:
"This framework implies that that the drier grains…" feels like the wrong phrasing. It took me a while to clearly understand the sentence. I think you mean the framework of interpreting pole figures? What about something like:
"Plotting our data in pole figures with a strain axes reference frame implies that…

Thanks for the helpful suggestion, an improvement we have adopted.