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Solid Earth Discussions

Interactive comment on "Brittle grain size reduction of feldspar, phase mixing and strain localization in granitoids at mid-crustal conditions (Pernambuco shear zone, NE Brazil)" *by* G. Viegas et al.

Anonymous Referee #2

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Referee comment on the manuscript "Brittle grain size reduction of feldspar, phase mixing and strain localization in granitoids at mid-crustal conditions (Pernambuco shear zone, NE Brazil)" submitted by G. Viegas et al.

General comments

The authors describe feldspar and quartz microstructures from one granitoide sample of the Pernambuco shear zone in Brazil. The sample has been investigated by polarized light microscopy and scanning electron microscopy, including EBSD-analytics.

Generally, the text is well written and the investigated microstructures are interpreted in terms of deformation mechanisms and deformation conditions. The findings are interesting, however, from my point of view the argumentation is not always coherent and especially the discussion needs to be specified in important points that are listed as follows:

1. The authors argue that the deformation occurred at "fluid-absent conditions" (page 2954, line 27) on the basis of the observation of missing metamorphic reactions of fractured feldspar. On the other hand they argue that after grain size reduction, diffusional creep of the polyphase feldspar matrix is the main deformation mechanism and quartz precipitated in cavities – which clearly would require the presence of a fluid phase. This contradiction needs to be discussed.

2. The authors refer to a switch in deformation mechanism from brittle deformation to diffusional creep during the formation of shear bands. At the same time they discuss that stress and strain rate conditions are constant. Furthermore, on page 2976, line 1-7, the authors refer to seismic rupturing. How can this be compatible with constant stress and strain rate conditions?

3. The topic of strain localization and differences in strain rates needs to be discussed more carefully and more specifically with respect to the specific microstructures.

The observations described are somehow contradictory: On the one hand it is stated on page 2971, line 1: "in contact to fractured and boudinaged feldspar porphyroclasts, quartz veins fill gaps, and is squeezed within fractures and boudin necks". On the other hand they discuss that the quartz veins deform at lower strain rates, compared to the polyphase feldspar matrix.

The authors argue that quartz grain sizes in the matrix are smaller than in thin quartz ribbons, which are in turn smaller than those in larger veins. The grain sizes are used to infer the flow stresses, although following their argumentation, quartz dispersed in the matrix formed by precipitation – and not by dislocation creep with dynamic recrystal-

lization, required to apply the recrystallized grain size paleopiezometer. Furthermore, a discussion is needed whether the differences in grain sizes in the monomineralic quartz ribbons and veins may be due to later modification by grain growth: grain growth in the ribbons is hindered by the presence of phase boundaries at the contact to the matrix; the width of the ribbons is at least in parts restricted to the size of one quartz grain (Figure 13). Also, the authors need to take cutting effects into account, when they refer to “thin ribbons” and “veins”. By the way, where is the difference in thin ribbons and larger veins, just the width? More specific descriptions and figures would help.

Specific comments:

Abstract

- Lines 5/6: “ . . .<15 μm in size)..“: Please specify: e.g., diameter or long axis?

- Line 9: "..thin ribbons. . .“: please specify, how thin?

- Lines 13/14 ". . .from the transposed veins. . ..“ Which one? They are not introduced yet.

- Line 16: "oriented growth. . .“ of, please specify, what is the orientation?

- Lines 19/20: "assuming that the C‘ shear bands deformed under constant stress. . .“. . . difficult during fracturing and subsequent switch to diffusional creep

- Line 21: please specify the observation/argumentation that would indicate why the strain rate would be one magnitude higher for the polyphase aggregate in contrast to monophase quartz ribbons?

2. Geological setting and sample description

- What are the ambient P, T conditions and time constraints of magma emplacement

- Page 2957, line 23 “EPSZ”: what does this abbreviation mean?

- Page 2958, line 7: Give sample coordinates

- Page 2958, line 11: “high-temperature”: please specify, what is the T?

- Page 2959, line 3: “high aspect ratio”: please specify, how high?

4.1.1. Domain 1: feldspar porphyroclasts

- Page 2961, lines 3, 4: “feldspar porphyroclasts have elliptical....shapes” : please consider that porphyroclasts are 3D-objects!

- Page 2962, line 1: should it be “Feldspar porphyroclasts are never, NOT even partially...”?

5. Discussion

- Page 2968, line 9: how was the pressure of 4.5-5 kbar inferred?

- Please consider, that temperature indicating the growth of metamorphic phases need not necessarily be the temperature of deformation

- Page 2969, line 1-8: Please consider strain rate variations

5.3 Monomineralic quartz ribbons...

- Page 2971, line 1: “fractured and boudinaged feldspar porphyroclasts, quartz veins fill gaps, and is squeezed within fractures and boudin necks”: this indicates that the quartz ribbons have a lower viscosity, i.e. deformed by a higher strain rate, compared to feldspar. The opposite is discussed a few sentences later..., however, from the text it does not get clear enough, which microstructures the authors refer to, when speaking of ribbons, veins and polyphase matrix..., the figures do not really help here!

- Page 2971, lines 1-10: Discussion that quartz dispersed in the matrix is smaller than in quartz ribbons, and grain size in thin quartz ribbons is smaller than in larger veins: a discussion is needed whether this may be due to later modification by grain growth: grain growth is hindered by the presence of adjacent phase boundaries. Here, the authors refer to Figure 8, where, however, the grain size is not really visible... AND

quartz in matrix is formed by dissolution-precipitation processes, at least as discussed on the next page 2972, line 19-29, see comments below...

5.5. Strain localization in the ultrafine-grained polyphase matrix

- page 2974, lines 7-10: Rybacki and Dresen, 2004 mostly refer to anorthite-rich feldspar, however, here the anorthite component is relatively low. Please discuss a potential influence.

- page 2974, lines 11-20: I do not understand, how you can infer the flow stress of the shear band by the grain size of quartz dispersed in the matrix? The grain size paleopiezometer can only be applied for steady-state dislocation creep. On page 2972, line 19-29 it is stated the quartz dispersed in the matrix is precipitated in cavities. By the way, precipitated from which fluid?

- page 2975, lines 5-12: I do not understand this part: the argumentation starts with quartz grain sizes in monomineralic ribbons and veins and inferred stresses from paleopiezometry (without referring to grain growth, see above). In which way do these results suggest that deformation is accommodated in the fine-grained matrix, which localizes strain via diffusional creep?

- page 2975, line 19: “recrystallized feldspars”: the authors did not show evidence of recrystallized feldspar and in the conclusions?

- page 2976, line 4, 5: “(2) relatively dry conditions that inhibited crystal plasticity in feldspar.” Why would dry conditions inhibit crystal plasticity? This is not discussed.

Figures:

Scale bars are very hard to see in the Figures, please display them in a uniform size and font...

Interactive comment on Solid Earth Discuss., 7, 2953, 2015.