

Interactive comment on “Experimental grain growth of quartz aggregates under wet conditions and its application to deformation in nature” by Junichi Fukuda et al.

Anonymous Referee #2

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The manuscript “Experimental grain growth of quartz aggregates under wet conditions and its application to deformation in nature” submitted by Fukuda et al. for publication in SE is presenting a study on grain growth experiments on two different quartz samples that vary in grain size and porosity. Their experiments are performed at different pressure, temperature and time conditions. The study presents two new grain growth laws for quartz. The relevance to natural metamorphic conditions is discussed.

The manuscript is well and clearly written, the data are well presented. The topic and results are relevant for all fields in Geosciences that are concerned with the rheological behaviour and material properties of rocks and thus well suited for publication in “Solid

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Earth”.

From my point of view there are three aspects that would need some more consideration/discussion:

(1) It would be necessary that the authors early in the manuscript state, how they use the term “grain growth” with respect to grain boundary migration and driving forces. At some point a contrasting juxtaposition/discussion of the processes of grain boundary migration driven by the reduction in interfacial free energy and grain boundary migration driven by the reduction in stored elastic strain energy (i.e., reduction in dislocation density) would be helpful. In this context the wording “contribution of grain growth to deformation” used several times in the manuscript and the title “Experimental grain growth. . .and its application to deformation. . .” might get clearer.

(2) The authors also discuss non-hydrostatic conditions in their experiments, especially in the context of dissolution-precipitation and epitaxial growth: is there any systematic relation of the shape of the growing crystals and/or crystallographic orientation with respect to sample shape and/or position in the experimental apparatus or to platinum jacket, or similar? As the authors also analysed the microfabric, a few words on this topic might be useful. In this context also formation of “growth rims” in the sense of epitaxial crystallization by precipitation from the pore fluid should be compared and contrasted to grain growth.

(3) When discussing the relevance for natural conditions and application of paleopiezometers some information on how to evaluate the contribution of grain growth in nature, for example as opposed to strain-induced grain boundary migration during recrystallization, would be valuable. I feel, this should be discussed by citing previous studies published on this topic.

A few specific comments/suggestions are listed as follows:

Abstract

Page 1, line 10: Delete the first word of the abstract “The”

Page 1, line 11: please specify “large porosity” or rephrase

Page 1, line 12: please specify “dense” or rephrase

page 1, line 19: What is the contribution of grain growth to plastic deformation? See point (1)

Introduction

Here, I feel that some aspects on grain boundary migration driven by the reduction in strain- and surface energies, i.e. a contrasting juxtaposition of strain-induced grain boundary migration (or recrystallization) and grain growth, would be helpful, see point (1).

Page 2 line 16: Again: What is the contribution of grain growth to deformation? See point (1) Samples

Page 3, line 21: A few more information of the sample of novaculite would be helpful. Why is the term “quartzite” used, is it a metamorphically overprinted novaculite?

Discussion

Page 8, lines 20/21: Please reorganize, the influence of porosity is discussed later in detail.

Page 8 line 26-31: Please discuss, why/where dissolution and why/where precipitation should take place. Why is at specific sites epitaxial growth occurring? See points (1, 2)

Page 9, line 2: Please discuss why the dihedral angle effects grain growth. If the dihedral angle changes at the different conditions, what is the effect on the process of grain growth? For example any discussion on the interfacial free energy would be good here (see point 1).

Page 9, line 8: That grain growth of quartz takes place by grain boundary migration

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assisted by H₂O is not new, please state references. Here, the term grain boundary migration occurs for the first time in the manuscript – too late for a paper on grain growth. . . (see point 1)

Page 9, lines 11/12: When considering non-hydrostatic conditions: is there any control of principal stress directions on crystallographic orientation and/or shape of the growing crystals? See point (2)

Page 9, line 13: Please provide some more information on the island-channel structure transport and its role on grain growth.

Page 10: Any discussion on how to evaluate that grain growth took place in natural rocks would be helpful. This relates to the comparison on grain boundary migration driven by the reduction in stored elastic strain energy (i.e. reduction in dislocation density) versus grain boundary migration driven by the reduction in interfacial free energy, as well as formation of growth rims, see point (3)

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