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Anisotropic spatial clustering and ordering of olivine and orthopyroxene during rheological weakening conditions

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The spatial distribution of mineral grains is commonly analyzed using the contact surface method following Kretz (1969). In a random distribution, the frequencies of grain and phase boundaries follow the binomial distribution. A higher than expected proportion of phase boundaries means ordering, a lower than expected proportion means clustering. The method has been extended by Heilbronner & Barrett (2014) to handle anisotropic distributions. Here, we want to explore how grain size reduction and continued nucleation of new grains affect the spatial distribution in a deforming two-phase aggregate.

In numerically produced two-phase aggregates, random nucleation of grains A and B results in an isotropic random spatial distribution, irrespective of the grain size of A and B. If this fabric is passively strained, the spatial distribution remains random. However, if the grain size of A and B is reduced in situ (i.e. without moving the grain to a new location), as for example by dynamic recrystallization, the spatial distribution becomes clustered. If only one of the phases undergoes grain size reduction, the frequencies of grain and phase boundaries yield inconsistent results. In other words, whether or not the spatial distribution is consistent contains information about the sequence of events (nucleation, recrystallization). Furthermore, grains generated by heterogeneous nucleation and dynamic recrystallization are aligned with respect to the active stress field and finite strain, respectively, leading to anisotropic ordering or clustering. Hence the anisotropy of the spatial distribution ('ordering tensor') has the potential for recording stress and strain directions.

Reduction in grain size and increasing ordering of ol and opx grains lead to a change of deformation mechanism described by a strain rate dependence on stress with a lower exponent and on grain size with a higher exponent, producing strain weakening during grain size sensitive creep (Tasaka et al. 2017). With the more detailed analysis proposed here, paying attention to the influence of grain size and the anisotropic nature of ordering and clustering, we observe that diffusion creep is present from the start, and a 'saturation ordering' corresponding to a mechanical steady state is reached at low shear strain values.

- Kretz, R. (1969). On the spatial distribution of crystals in rocks. Lithos 2: 39–66.
- Heilbronner, R. & Barrett, S. (2014). Image Analysis in Earth Sciences, Springer Verlag, Berlin, Heidelberg.
- Tasaka, M. et al. (2017). Rheological weakening of olivine + orthopyroxene aggregates due to phase mixing: Part 2. JGR: Solid Earth, 122, 7597–7612, doi: 2017JB014311