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## Numerical modelling of quartz-biotite aggregates: Insights on strain weakening and two-phase flow laws

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Strain weakening is a prerequisite for localization of strain and therefore crucial for the understanding of shear zone evolution. In the context of progressive deformation of multi-phase aggregates, it is unclear whether the change in geometry and orientation of the involved phases leads to structural or geometric strain weakening and thus may control strain localization. Consequently, the question arises how the ductile flow of two-phase rocks can be described or determined. To contribute to a better understanding of the knowledge gaps outlined above, two-dimensional numerical shear experiments of quartz-biotite aggregates were conducted at varying temperatures, background strain rates and fluid pressure ratios. Textural variations after a shear strain of  $\gamma \approx 10$  appear to be dependent on the viscosity contrast between the minerals involved. To estimate whether a numerical experiment is undergoing strain weakening or strain hardening (or both), the temporal evolution of the mean second invariant of the deviatoric stress tensor was tracked. The results suggest that strain weakening occurs if biotite-inclusions are distinctly isolated and that it is more effective under conditions with larger viscosity contrasts between matrix and inclusions. However, the stress drops in numerical experiments with purely structural / textural strain weakening are rather low (−1.1 to −6.4%) compared to other strain weakening processes. It appears that phase rearrangement and change in phase geometry with evolving strain is of minor importance for the occurrence of strain weakening. Based on the numerical experiments and assuming a power-law relationship between stress and strain, the flow-law parameters of quartz-biotite aggregates with different biotite contents were determined. The results are in the range of existing experimental and analytical mixed-aggregates flow-laws. However, the variations between the different flow-laws show that further research is required, for which numerical models as used in the present study could serve as basis.