



## **Phase morphology and bulk strength in power-law materials**

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The strength of a polyphase aggregate depends on the constitutive laws of the phases present, the arrangement of those phases, and environmental conditions such as temperature and stress. In this contribution, we consider the degree to which the arrangement of the phases influences the bulk strength of geological materials. Calculations using current single-mineral experimental data indicate that the absolute and relative strength differences between the upper and lower theoretical bounds vary widely with mineral pair and environmental conditions. For example, at 850°C, some pairs, such as plagioclase-clinopyroxene, are highly sensitive to phase morphology, whereas others, such as quartz-plagioclase, are not. Using a finite element implementation of asymptotic expansion homogenization and assuming power-law flow for the phases present, we can calculate the bulk strength of natural microstructures across macroscale strain gradients. We find that phase morphology does not change sufficiently in most cases to be the dominant factor in bulk strength variation. Thus on its own, phase morphology in an aggregate of power-law materials does not appear to be a major control on bulk strength under typical viscous geological conditions. However, phase morphology does affect microscale stress and strain rate patterns which in turn can induce microscale variations in constitutive laws and diffusional pathways. These factors, including reactions and changing deformation mechanisms, are strongly influenced by phase morphology and do cause strength variation in rocks. As a result, any parameterization of rock strength cannot rely on morphology alone, but also needs to account for microscale variation in deformation mechanisms, including – in most instances – mass transfer.