

Deformation and reaction of crustal rocks under high-pressure, high-temperature conditions

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In the plagioclase-rich lower continental crust, hydrous epidote-group minerals will, among other phases, replace plagioclase once minor amounts of fluids are available (Goldsmith 1981). It has previously been shown that reacting plagioclase aggregates are significantly weaker than their unreacted counterparts at otherwise identical conditions (Stünitz & Tullis 2001). Yet, it still remains unclear if the observed weakening is due to the nucleation and growth of inherently weaker product phase, e.g., epidote-group minerals, or due to inhibited grain growth in a polyphase aggregate as a result of Zener pinning. Our working hypothesis was the former: Epidote-group minerals are inherently weaker than plagioclase under the same experimental conditions. To test this hypothesis, we experimentally investigated the relative strength of pure epidote and pure plagioclase aggregates at a confining pressure of 1 GPa, two different temperatures (550 and 650 °C) and two different strain rates ($5 \cdot 10^{-5}$ and $5 \cdot 10^{-6}$ s⁻¹) using a Griggs apparatus. Furthermore, epidote-group minerals will be initially much smaller than plagioclase, they are replacing. Hence, we also investigated potential strength differences due to differences in grain size by deforming aggregates with a grain-size range of either ≈ 90 –135 μm or < 25 μm . Under identical conditions, epidote aggregates are significantly stronger than their plagioclase counterparts even when partially reacted. Furthermore, we observe that reaction can induce a change in deformation behavior from distributed cracking to faulting in our epidote aggregates.

Goldsmith JR (1981): The join $\text{CaAl}_2\text{Si}_2\text{O}_8$ – H_2O (anorthite-water) at elevated pressures and temperatures. - *Amer Mineral* 66, 1183–1188

Stünitz H, Tullis J (2001): Weakening and strain localization produced by syn-deformational reaction of plagioclase. - *Internat J Earth Sci* 90, 136–148. <https://doi.org/10.1007/s005310000148>