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Experimental observation of effects of pre-existing fabric on deformation behavior of perthitic feldspar

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Strong earthquakes predominantly occur near the brittle–ductile transition zone in the continental crust. Then, the deformation behaviors of rocks developed in the transition zone play an important role in earthquake nucleation. The deformation behaviors of perthitic feldspar, a widespread feldspar solid solution, are controlled not only by temperature and stress, but also by pre-existing microstructural features. The influence of pre-existing lamellar fabric orientation on the deformation behavior of perthitic feldspar is still unclear. We conducted experiments using a Griggs-type apparatus systematically investigate the deformation behavior of perthitic feldspar with different pre-existing lamellar fabric orientations. Samples were prepared with lamellar orientations at angles of 0°, 45°, and 90° relative to the maximum principal stress. Experiments were performed at a confining pressure of 1 GPa, a temperature range of 600–1050 °C, and strain rates ranging from 5×10^{-5} to 2×10^{-6} s^{-1}. Undeformed and deformed specimens were observed by SEM and EBSD. The mechanical data shows significant differences in peak strength among the three lamellar fabric orientations, with sample strength decreasing in the order of 45°, 0°, and 90° at the same temperature. All samples entered a plastic deformation regime above 800 °C (σ_d<Pc).Microstructural observations reveal that at low temperatures (<900 °C), pervasive brittle cracks crosscut both feldspar phases and are accompanied by localized ductile shear zones; at intermediate temperatures (900–950 °C), cracks are mainly confined within albite grains and are commonly oriented perpendicular to grain boundaries; at high temperatures (>950 °C), samples exhibit bulk plastic flow with a marked reduction in cracking. Notably, samples with a 45° lamellar orientation experienced pronounced bulk fragmentation at 1000 °C and 1050 °C. EBSD results show that K-feldspar does not develop significant changes in crystallographic preferred orientation during deformation, whereas albite exhibits progressively heterogeneous orientation patterns with increasing temperature, consistent with plastic deformation associated with subgrain rotation recrystallization. Together, the mechanical and microstructural results demonstrate that pre-existing lamellar fabric orientation exerts a significant influence on the deformation behavior of perthitic feldspar under brittle–ductile transition conditions, providing experimental constraints on strength anisotropy in feldspar-rich rocks.