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Deformation-facilitated melting of plagioclase

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Geological processes involving deformation and/or reactions are highly influenced by the rock grain size, especially if diffusion-controlled processes take place such as long-range metamorphic reactions and diffusion creep. Although many processes, inducing grain-size reduction, are documented and understood at relatively high stresses and low temperatures (e.g., cataclasis) as well as at lower stress and higher temperature conditions (e.g., bulging, subgrain rotation), deformation twinning, a plastic deformation mechanism active in various minerals at lower temperatures, has been neglected as cause for grain-size reduction so far. We conducted experiments on natural plagioclase-bearing aggregates at 2.5 to 3 GPa confining pressure and temperatures of 720 to 950 °C using two different deformation apparatus, a DDIA and a Griggs press, as well as a piston-cylinder apparatus. Regardless of the apparatus type, we observe the breakdown of plagioclase into an eclogite-facies paragenesis, which is associated with partial melting in the high pressure, high temperature domain of the eclogite facies. In contrast to the sample that experienced hydrostatic conditions in the piston-cylinder press, the deformed samples reveal melt patches inside of several plagioclase grains. These patches coincide with the occurrence of deformation twins in plagioclase that formed due to differential stress. The ability of plagioclase to form deformation twins and their exploitation for melt initiation significantly lowers the effective grain size of plagioclase-rich rocks and thus impacts their reactivity and deformation behavior.