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Effect of finite strain on partial melting of quartz-muscovite system: findings from torsion experiments

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In subduction zones the continental crust can experience different magnitude of deformations with varying strain rates under the same pressure and temperature conditions. Here we report results from a high-strain torsion experiment to show the nature of phase transformations and the amount of partial melt generation as a function of finite strain the crustal rock undergoes during the metamorphism. Experiments were performed with cylindrical samples of quartz-muscovite aggregates (7:3 volume ratio) at a constant temperature of 750oC and confining pressure of 300 MPa. The samples were subjected to finite shear up to 15. The mechanism of torsion experiment allows the sample to deform such a way that the finite shear strain remains zero at the sample centre, and linearly increases with increasing radius, while the mean stress is uniform diametrically. Accordingly, the strain rate increases from the center to periphery for a given angular displacement rate. The deformed specimen was cut along its diameter, and studied under back scattered electron detector with an SEM.

The deformed sample showed spatial variation of both in terms of mineral reactions and partial melt generation. Partial melt was virtually absent at the edge and the amount of which increased non-linearly with decreasing strain. The undeformed region at the centre preserved the initial microstructure and showed static mineral reactions producing euhedral grains of K-feldapar, sillimanite, biotite and spinel. With increasing strain, the microstructure gradually became homogeneous and the amount of dynamically crystallized K-feldspar increased in significant amount in association with anhedral biotite and spinel showing the composition of Granulite.