Geophysical Research Abstracts
Vol. 21, EGU2019-972, 2019
EGU General Assembly 2019

Partial melt and reversed shear zone microstructural evolution

Amicia Lee, Geoffrey Lloyd, Taija Torvela, and Andrew Walker
University of Leeds, Institute of Geophysics and Tectonics, School of Earth and Environment, Leeds, United Kingdom (earall@leeds.ac.uk)

Coexistence of melt with regions of high strain (e.g. shear zones) is a common feature of many orogenic belts but the exact mechanism(s) and relative timing(s) of the formation of syn-melt shear zones and in particular how strain partitions in partially molten rock remain poorly understood. Nevertheless, in-situ partial melting is known to cause a strength decrease and drive the formation of lithological heterogeneity in the middle and lower crust. The Øksfjord peninsula in the Seiland Igneous Province (SIP) of the North Norwegian Caledonides is a field example of syn-kinematic partial melting. SIP consists of a suite of deep-seated rift-related magmatic rocks emplaced into the Sørøy Group metasediments during the opening of the Iapetus Ocean. Subsequent micro-orogenies resulted in partial melting of the metasediments due to biotite dehydration. Here we show how a 1.2 km thick migmatized shear zone documents microstructural reversal due to partial melting.

Coexistence of deformation and melt microstructures suggests a complex geological history for the Øksfjord peninsula. In contrast to conventional expectations, we observe a reversed grain size distribution with finer grains at the shear zone edges and coarser grains in the centre. Optical microscopy alongside EBSD calibrated palaeopiezometry identifies mid-temperature, high stress deformation microstructures at the shear zone edges and high-temperature, low stress deformation microstructures in the shear zone centre. Whilst these microstructural variations suggest a sharp temperature gradient, such gradients are unlikely to form over narrow shear zones.

We suggest that strain localised towards the centre of the shear zone during a regional temperature increase, which also initiated partial melting. The high temperatures and crystallization from melts promoted further growth of already relatively coarse grained restite phases in the shear zone. As the partial melt absorbed the majority of the stress, the shear zone centre records high temperature, low stress deformation microstructures. Once all the melt crystallized and/or escaped and the temperature decreased, the centre of the shear zone was 'strong' relative to finer grained margins. As the temperature decreased, and the stress absorbed by the solid phases increased, the finer grains proved easier to deform and hence localised strain along the shear zone boundaries. Unlike other partial melt shear zones (e.g. Western Gneiss Region, Norway; Lee et al., 2018), where melt organisation promoted grain size reduction and pinning of grain growth, in the SIP grain growth in the shear zone centre transferred stress to shear zone edges to permit continued deformation.