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Development of melt networks in rocks and accompanying rheological changes of the bulk rock

The microstructure of rocks plays an important role in determining the rheological properties and usually help to reveal the processes that lead to the observed microstructure. Numerous processes can be active during the formation of a rock and they may be active simultaneously or in series. Some processes change the microstructure significantly and may obliterate any fabrics indicating the previous history of the rocks. One of these processes is grain boundary migration (GBM). During static recrystallization GBM may produce a foam texture that completely overprints any earlier rock fabrics and GBM actively influences the rheology of a rock, via its influence on grain size and defect concentration. Much of the theory on GBM derives from material sciences and in particular metallurgy but these theories can not easily be transferred to geological materials due to the complexity of geological grain boundaries.

If a liquid phase, like a melt, is also present in the aggregate, an order of complexity is added. Above a certain wetting angle, melt pockets behave simply as another static phase and melt pockets should not be interconnected. However, even at low wetting angles melt can accumulate and move through a rock. Below a certain wetting angle, melt is interconnected by tubes or channels that allow rapid transport within or out of the aggregate. Under static conditions, i.e. crystallization and annealing, the melt has a defined wetting angle at triple junctions (where two solid grains are in contact with melt). Contrary to what is commonly assumed, numerical simulations show that the wetting angle is not a constant but is dynamically adjusted during the evolution of a microstructure. This has a great impact on the behaviour of melt in a rock. Temporarily this may lead to wetted grain boundaries even so the predictions just from the wetting angle do not show this.

Furthermore, the impact of under- or overpressured melt pockets within a rock has mainly been neglected. Melt pockets usually show a significant under- or overpressure (also depending on the wetting angle) and can lead to huge stress concentrations within a rock.

In this seminar I will show experimental results and numerical simulations of melts with high wetting angles. I will analyse the behaviour of such a melt in rocks and the implications for melt transport (segregation, accumulation and transport) through a rock.