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Application of the Cahn-Hilliard-type approach to the development of oscillatory zoning in minerals

Katharina Schmidt[1], **Lucie Tajmanova**[1], and Lyudmila Khakimova[2]
[1]Institut für Geowissenschaften, Universität Heidelberg, Heidelberg, Germany (katharina.schmidt@geow.uni-heidelberg.de)
[2]Skolkovo Institute of Science and Technology, Moscow, Russia

Preservation of mechanically-controlled microstructures can help us to unravel the long-term stress state in geological materials. To better understand the stress state in such a microstructure, we need to quantify the processes in a coupled, chemo-mechanical, point of view. One of such a mechanically-controlled microstructure is oscillatory zoning in high-temperature metamorphic rocks. The presented example is a sharp zoned plagioclase of 150 x 200 μm size with thin compositional lamellae of 1-10 μm alternating from the core towards the rim. This microstructure is interpreted to be mechanically-controlled, since conventional diffusion failed to preserve the observed microstructure within timescales that would be reasonable from a regional geology point of view. In contrast, considering that chemical diffusion is coupled to mechanical deformation the observed zoning can be maintained over the geologically-relevant timescales.

Despite of the recent valuable progress in our understanding of these microstructures, the mechanisms controlling its evolution from slowly cooled rocks are still not complete. Here, we numerically investigate the coupled, chemo-mechanical, effect that generates oscillatory zones mechanically maintained over geologically relevant timescales. We test the possibility of modelling oscillatory zoning in minerals that is similar to the exsolution process. We apply a classical Cahn-Hilliard-type equation where we add more complexity considering the impact of deformation during the process.