

NEW METHODS OPEN NEW PERSPECTIVES ON MINERAL REACTIONS

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In petrological science substantial progress was made over the last two decades due to the extensive application of equilibrium thermodynamic methods to mineral parageneses. By definition, equilibrium thermodynamics deals with time invariant equilibrium states and does not take into consideration system geometry. In particular the role of grain- and inter-phase boundaries during mineral reaction and micro-structural and textural development is not accounted for in classical equilibrium thermodynamics. Reaction microstructures with a high degree of spatial organization such as reaction rims, symplectites, epitactic relations, shape and/or lattice preferred orientation are, however, commonly observed phenomena in metamorphic and magmatic rocks. The microstructural and textural features of rocks reflect the interplay of a number of petrogenetic processes. If the microphysics of these processes e.g. nucleation, component diffusion, grain growth, grain boundary migration, etc. can be unravelled, microstructures may provide information on reaction kinetics. By this way, they may shed light on the dynamics of reacting rock systems. A number of analytical methods, experimental techniques and theoretical approaches, which have hitherto been largely disregarded in mineralogical and petrological research, have large potential to substantially improve our understanding of reaction microstructures and textural relations in rocks

We present petrographic observations made on natural and synthetic reaction rims and symplectites. In particular, we focus on the insights on the mechanisms of chemical and self diffusion in polycrystals obtained from analytical techniques with high spatial resolution such as transmission electron microscopy (TEM) and depth profiling with secondary ion mass spectrometry (SIMS). We will also explore textural relations within reaction rims by crystal orientation mapping using electron back scatter diffraction technique (EBSD) and discuss the driving forces for texture development in growing polycrystal layers. Finally we will address the phenomenon of spontaneous nucleation and phase separation. We will compare phenomena of phase separation from natural and experimental materials with numerical models based on Cahn-Hilliard theory.