Nucleation and growth of metamorphic minerals in contact aureoles

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Thesis Abstract

Nucleation and growth of metamorphic minerals are the consequence of changing P-T-X-conditions. The thesis presented here focuses on processes governing nucleation and growth of minerals in contact metamorphic environments using a combination of geochemical analytics (chemical-, isotope-, and trace element composition), statistical treatments of spatial data, and numerical models.

It is shown, that a combination of textural modeling and stable isotope analysis allows a distinction between several possible reaction paths for olivine growth in a siliceous dolomite contact aureole. It is suggested that olivine from this metastable reaction implies metamorphic crystallization far from equilibrium. As a major consequence, the spatial distribution of metamorphic mineral assemblages in a contact aureole cannot be interpreted as a proxy for the temporal evolution of a single rock specimen, because each rock undergoes a different reaction path, depending on temperature, heating rate, and fluid-infiltration rate.

A detailed calcite-dolomite thermometry study was initiated on multiple scales ranging from aureole scale to the size of individual crystals. Quantitative forward models were developed to evaluate the effect of growth zoning, volume diffusion and the formation of submicroscopic exsolution lamellae (<1um) on the measured Mg-distribution in individual calcite crystals and compare the modeling results to field data. This study concludes that Mg-distributions in calcite grains of the Ubehebe Peak contact aureole are the consequence of rapid crystal growth in combination with diffusion and exsolution.

The crystallization history of a rock is recorded in the chemical composition, the size and the distribution of its minerals. Near the Cima Uzza summit, located in the southern Adamello massif (Italy), contact metamorphic brucite bearing dolomite marbles are exposed as xenoliths surrounded by mafic intrusive rocks. Brucite is formed retrograde pseudomorphing spherical periclase crystals. Crystal size distributions (CSD’s) of brucite pseudomorphs are predented for two profiles and combined with geochemistry data and petrological information. Textural analyses are combined with geochemistry data in a qualitative model that describes the formation periclase. As a major outcome, this expands the potential use of CSD’s to systems of mineral formation driven by fluid-infiltration.