Geophysical Research Abstracts, Vol. 7, 10119, 2005
SRef-ID: 1607-7962/gra/EGU05-A-10119

Stress induced anisotropy of reaction rims

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A simple rate equation holds for the diffusion-controlled growth of reaction rims where under constant P, T-conditions rim thickness increases linearly with the square root of time. The driving force behind rim growth is the gradient in chemical potentials of the diffusing components across the reaction rim. If deviatoric stress is present, chemical potentials at reaction fronts may depend on the geometric relations between the stress tensor and the reaction interfaces. In the absence of plastic deformation this can affect the rate-controlling chemical potential gradients and thereby rim growth rates. It is expected that application of deviatoric stress may result in asymmetric reaction rims.

To test this hypothesis we do rim-growth experiments in a Griggs-type deformation apparatus with an external load applied on geometrically well defined samples. The reaction chosen is olivine + quartz = orthopyroxene, which is the most extensively studied example of reaction rim growth under isobaric conditions. Starting materials are synthetic quartz and natural olivine (San Carlos olivine; Fo90Fa10). ΔV of this reaction is - 6% at the experimental conditions of 900˚C and 1.5 GPa. Under the applied external load orthopyroxene growth occurs at identical rates into both directions from the initial quartz-olivine interface as indicated by a growth zoning in Fe-content of the pyroxene. This implies that SiO_2 is the least mobile diffusing component, in accordance with the dry conditions of our runs. Our first results indicate that there is in fact a positive feedback between compressive stress and rim growth rates and that the effect is large enough to be measured in rim growth experiments.