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Matrix rheology effect on diffusion-controlled reaction-rims growth

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We present new experiments on the diffusion-controlled growth of orthopyroxene reaction rims between olivine and quartz. They aim at the effect of water in traces and the rheological effect exerted by the matrix surrounding the core-rim-structures. ΔV of the reaction is - 6% at the experimental conditions of 1000˚C, 1 GPa. This implies that stress is induced during rim growth. In a "soft" matrix a positive feedback is expected between rapid stress relaxation in the matrix and reaction rim growth. In contrast, in a "stiff" matrix rim growth may outrun matrix relaxation thereby isolationg the core-rim structure from the confining pressure.

Experiments were performed in a piston-cylinder apparatus with two different starting mixtures. Mixture 1 consists of olivine grains (125-200 μm diameter) in a fine-grained (11-20 μm) quartz matrix. Mixture 2 consists of quartz grains (125-200 μm) in a fine-grained olivine (c. 10 μm) matrix. Samples were prepared from San Carlos olivine (Fo90Fa10) and synthetic quartz. Any water present in the samples is only due to adsorption to the grain surfaces. Bulk diffusion coefficients of MgO (which is known to be the rate-limiting diffusing component in orthopyroxene rim growth), D^b_{MgO}, were determined from the measured rim widths.

If the starting mixtures are placed in two separate capsules side by side in the same assembly, diffusivity in rims around quartz grains is 100 times larger than around olivine grains. If the mixtures are put together in one capsule without any mixing of the two, diffusivity in the two pyroxene rim types draws near but is still 3 times larger in rims around quartz grains. These observations indicate that part of the difference in rim growth rates is due to higher water adsorption on the fine grained olivine. The

remaining difference can be interpreted as rheological effect. Considering the olivine matrix as “soft” and the quartz matrix as “stiff”, the rim widths reveal identical values of D^b_{MgO} = 2 x 10^{-16} $m^2 s^{-1}$ for both rim types.