A simple model of oscillatory zoning in magmatic plagioclase: Development of an isothermal undercooling model

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ABSTRACT

According to the model of Sibley et al. (1976), the alternate switching of the crystal surface between smooth and rough states results in a drastic change in the growth velocity and the subsequent development of oscillatory zoning (OZ). In the present paper, we develop the isothermal undercooling mechanism of the Sibley et al. model and calculate the magnitudes of the amplitude and wavelength of OZ to check the validity of the Sibley et al. model. We assume that the growth velocity depends on the roughness of the crystal surface. The roughness is expressed as a function of the surface area, and it is found that the growth velocity varies twice due to the switching. We also assume that the surface states change when steady states are achieved or when the growth and diffusion velocities are balanced. Simulating the diffusion-reaction on the supposition that the thickness of the diffusion layer is fixed, we determine the concentrations at which the switching takes place. We simulate the OZ growth based on these mathematical considerations. The results show that the magnitudes of the calculated amplitude and wavelength agree with those observed in nature.

Keywords: Oscillatory zoning, plagioclase, crystal growth, isothermal undercooling