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Formation of porphyroblastic textures

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Primary texture formation in many porphyroblastic rocks is the cumulative effect of the evolution and interaction of features produced by diffusion-controlled nucleation and growth (DCNG). When crystallization rates are limited by the kinetics of intergranular diffusion, each growing porphyroblast is surrounded by a zone from which nutrients have been depleted and in which the chemical affinity for reaction is reduced. As reaction proceeds, these diffusionally depleted zones expand, impinge, and eventually coalesce. Nucleation is inhibited or suppressed within these zones, and impingement of zones for neighboring crystals creates competition for nutrients. New computer codes for numerical simulations of DCNG capture these fundamental grain-scale processes with remarkable fidelity.

Porphyroblast size and number density depend strongly on metamorphic grade, because they are determined principally by the kinetic tradeoff between nucleation of new crystals (favored at low T) and growth of pre-existing crystals (favored at high T). Crystal size distributions (CSDs) vary from pseudo-normal to pseudo-log normal, depending on the heterogeneity of the precursor nutrient distribution. CSDs formed by initial nucleation and growth processes are not appreciably modified by subsequent annealing, because driving forces are too small.

Intergranular diffusive fluxes (and thus growth rates) depend upon intrinsic diffusivities, but also upon the solubility of diffusing components in the intergranular medium, and upon the interconnected porosity, which is a function of matrix grain size. Precursor grain size and any matrix grain coarsening that may occur during reaction therefore exert influence on crystallization kinetics and textures; these effects can be large. The effect on porphyroblastic textures of deformation during crystallization has not been fully explored, but the hypothesis that deformation eliminates diffusional controls on porphyroblast growth by accelerating transportation of nutrients was disproved in one studied instance of synkinematic garnet growth.