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TI: [Strange Attractors: Symbiosis in Magma Crystallization](#)

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AB: Volcanic products commonly contain crystal clots and preferential associations of solid phases. These mineral associations respond to the chemical environment during crystal nucleation, growth, and coarsening. Interpreting this record and assessing the implications for mush zone dynamics requires an understanding of the energetics of co-crystallization. Intimate intergrowth of compositionally and structurally dissimilar phases may arise if chemical potentials are elevated by gradients in the concentrations of rejected components, i.e., constitutional supercooling, CS. Alternatively, mineral intergrowths may ameliorate the phase transformation by providing energetically favorable sites for nucleation, e.g., epitaxy. In order for compositional gradients to develop and cause CS crystallization, crystal growth must be rate-limited by diffusion in the melt. Secondary phase nucleation is homogeneous in the boundary layer of a primary phase during CS. Thus, no particular crystallographic orientation relationship is expected between the phases, and all faces of the primary crystal advancing at similar rates should provide equally probable sites for nucleation of a secondary phase. Rejected components are mutually beneficial in pairs related by CS; this mechanism may be important if the frequency of mineral associations correlates with degree of compositional dissimilarity. In contrast, epitaxial relationships indicate heterogeneous nucleation of a secondary crystal at a crystal-melt interface in response to large interfacial energy (σ). A preferred orientation relationship may occur among phases if σ is strongly anisotropic. Finally, epitaxy is expected to be important if co-crystallizing minerals share lattice characteristics. We examine crystal intergrowths in the groundmasses of natural and experimental samples using BSE imaging, EPMA, and EBSD orientation mapping to assess preferential mineral pairings, size relationships, compositional complements, and crystallographic alignments. Grain segmentation facilitated by orientation mapping suggests that crystal number densities may be overestimated using conventional BSE imaging. Preliminary results from near-liquidus basalts and hornblende reaction rims in Mount St. Helens dacite indicate a strong tendency for pyroxene and titanomagnetite to co-crystallize by the CS mechanism.

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