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LETTER

Subsolidus isothermal fractional crystallization

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ABSTRACT

In theory, multicomponent silicate liquids of minimum or eutectic composition should crystallize their solidus phases simultaneously and in their invariant proportions. In reality, the crystallization of those liquids of granitic composition produces sequential assemblages and normal fractional crystallization of solid solutions when crystallization commences at or along an isotherm well below the solidus of the system. The sequence of mineral assemblages derives principally from their relative stabilities, as measured by the Gibbs free energy change for the reaction of melt to crystals in the metastable region below the liquidus surface, rather than chemical concentration alone. Whereas crystallization close to the solidus ($\Delta T \approx 50$ °C) promotes the simultaneous (eutectic) crystallization of quartz and feldspars that leads to the formation of granite, large liquidus undercooling ($\Delta T \approx 200$ °C) produces sequential assemblages from the margins to centers of melt bodies. The liquidus undercooling that drives subsolidus isothermal fractional crystallization is the single-most important process for the generation of zoned granitic pegmatites.

Keywords: Granite, pegmatite, liquidus undercooling, fractional crystallization, internal zonation