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Mineralogical, geochemical, and textural indicators of crystal accumulation in the Adamello Batholith (Northern Italy)

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Abstract

In this study, we quantitatively investigate crystal-melt segregation processes in two upper-crustal, intermediate-to-silicic plutons from the Tertiary Adamello Batholith, Italian Alps, by combining (1) an estimation of the amount of crystallized interstitial liquid using cathodoluminescence images, phase maps, and mass-balance calculations with (2) quantification of crystal preferred orientation using electron back-scatter diffraction. Cathodoluminescence images, phase maps, and plagioclase profiles are used together to distinguish early grown primocrysts from overgrowths formed after the rheological "lock-up" of the magma bodies. Mass-balance calculations, taking into account mineral compositions and bulk-rock chemistry, are used as an additional means to quantify the amount of trapped melt. The following features are indicative of crystal accumulation (or melt loss) in some parts of the batholith: (1) The amount of crystallized interstitial liquid can be low and negatively correlated with crystal (and shape) preferred orientations. Locally, up to ca. 27% melt may have been lost. (2) Significant intracrystalline deformation in plagioclase (up to ca. 13° of lattice distortion) is present in strongly foliated samples, resulting from compaction in a highly crystalline mush. These mineralogical and textural features indicative of variability in the degree of crystal accumulation in some areas of the Adamello batholith may explain the highly scattered bulk-rock geochemical patterns (particularly in trace elements). However, the precise quantification of the amount of melt loss remains challenging in felsic plutons, because of the compositional deviation from liquid lines of descent due to multi-scale variations in the degree of crystal-melt segregation and the fact that magmatic textures indicative of crystal accumulation can be subtle.

Keywords: Adamello, crystal cumulate, crystallized interstitial liquid, intermediate-to-silicic batholith, phase maps, cathodoluminescence