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Rhyolite segregation, accumulation and escape assisted by tectonic shortening: the magnetic and mineral fabric record of the Huemul pluton, Chile

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The different timescales of volcanism (seconds to kyrs) and tectonism (Myrs) have resulted in models of subvolcanic rhyolite production that do not incorporate tectonic deformation, despite ample evidence that deformation promotes segregation of liquids. The shallow (<7 km), 6.4–6.2 Ma Huemul pluton (Chilean Andes) preserves magmatic fabrics that indicate deformation-assisted segregation of rhyolite. The Huemul pluton comprises three compositional domains that are genetically related: high-silica granite (the extracted rhyolite), granite (a parent-like magma) and quartz monzonite (the residual silicic cumulate). Anisotropy of Magnetic Susceptibility analyses reveal oblate magnetic fabrics characterized by NNW-striking, subvertical magnetic foliations that cross-cut contacts between compositional domains. This suggests ESE-directed shortening while the pluton was partially molten, consistent with Miocene regional structures (NNW-striking folds and reverse faults) in the area. In the quartz monzonite, magnetic lineations plunge moderately to the NNW, away from the high-silica granite, and the Shape-Preferred Orientation of early feldspars is parallel to the magnetic lineation. Microtextures indicate that the feldspar lineation was developed while suspended in melt, and record interstitial melt flow from the quartz monzonites toward the high-silica granites on the top of the reservoir. Locally, magnetic lineations in the high-silica granite are subvertical and parallel to vertically elongate miarolitic cavities, suggesting the presence of channels which aided rapid rhyolite mobilization coeval with vertical decompression. Numerical modeling of early feldspar clustering and crystallinity yield ∼38% of interstitial volume loss in the quartz monzonite and no volume loss in the granite, consistent with previous compositional and textural analyses indicating that the quartz monzonite is a silicic cumulate, product of rhyolite extraction from a granite-like parent. We explain our fabric and textural observations with a model in which shortening is accommodated by interstitial melt flow at slow rates. We speculate that shortening-assisted melt segregation may interact with other segregation mechanisms (e.g., volatile exsolution) to achieve rapid segregation of large volumes of rhyolite over volcanic timescales. This example from the Huemul pluton illustrates that fabric studies are a valuable contribution to linking plutonism, tectonic deformation and volcanism.