Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.36806

The glomerocryst family album: glomerocryst diversity in dacitic magmas and its implications for petrogenesis

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Crystal mush systems have gained increasing attention over the last 20 years as a way of explaining the generation of silicic magmas. Glomerocrysts have been used consistently to provide supporting textural evidence of fragments of crystal-rich cumulate mushes entrained into the host magma after mush reheating and/or magma injection. However, a detailed analysis comparing the mineralogical and textural characteristics of glomerocrysts, both within a single eruptive unit and across successive eruptions in a temporally constrained silicic submarine volcano, has not yet been undertaken.

We developed and applied a new integrated approach for glomerocryst characterization that combines optical microscopy, SEM-EDX (TIMA), EMPA, and chemical data interpretation software. This has been applied to a suite of stratigraphically constrained dacite lavas from Brothers caldera, Kermadec arc. Key glomerocryst attributes that are measured include: chemical composition, mineral phases, grain size/shape and textural relationships following accurate, pixel-based classification. This integrated approach improves glomerocryst characterisation by combining petrological and chemical data.

Five distinct glomerocryst populations are identified based on modal mineralogy, diameter (~300 µm to 2 mm), mineral textures, and composition. The glomerocrysts occur in two main types: (1) monomineralic glomerocrysts composed solely of plagioclase, and (2) polymineralic glomerocrysts containing plagioclase, clinopyroxene, orthopyroxene, and magnetite. Image analysis enables detailed characterisation of glomerocryst morphology and the shape and textures of individual crystals. Cracking is a distinctive feature of the larger glomerocrysts.

Plagioclase compositions show limited variation with subtle oscillatory zoning and rare sieve texturing. Zoning within individual crystals in glomerocrysts is typically limited to ≤5 mol% An or Mg#. The exception is rare, highly anorthitic plagioclase cores where compositions change sharply from An_{90} to ~An_{52}. Labradorite is the dominant composition with minor occurrences of andesine, bytownite and anorthite. By contrast, augite (Mg# 68-75) and enstatite (Mg# 63-73) show only subtle Fe-Mg compositional zoning in glomerocrysts. Titanomagnetite (Ulv_{24-40}) is consistently homogeneous and unzoned. These results show that several distinct glomerocryst populations coexist within an otherwise compositionally consistent dacitic magma. This points to complex open-system processes operating within a crystal mush beneath Brothers volcano.