

Evolution of chemical and physical properties of mixed arc magmas

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Many intermediate arc magmas arise as a result of mingling between mafic and silicic melts that may be genetically unrelated. Recharge involving mafic melts is commonly cited as the trigger for new or renewed eruptive episodes, and a mechanism for rejuvenating stalled silicic crystal mush in the mid-crust. This process has a profound effect on the chemical and physical properties of the whole volcanic system. Using geochemical microanalysis and textural observations, it is possible to identify distinct compositions of minerals and glass that reflect different elements of the volcanic system. There is abundant evidence of physical and chemical contamination of the silicic magma on the micron-scale during mingling, and entrainment of deeper plutonic material. Disequilibrium reaction textures and overgrowth rims indicate direct contact between crystals from the silicic magma and the mafic melt, including sieved plagioclase, coarse breakdown textures in hornblende and clinopyroxene overgrowth on quartz and orthopyroxene. Anomalous glass compositions overlap with the residual glass of some mafic enclaves, indicating mingling between mafic and silicic melts. Microlite/ microphenocryst compositions overlap with mafic enclave mineral compositions, suggesting incorporation of mafic crystals into the host magma.

During ascent, the mingled magma experiences volatile exsolution and decompression crystallisation. We discuss and present evidence for the chemical variations that take place in the magma during ascent through the volcanic system, including the controls on changing oxidation state due to degassing and crystallisation, and evidence for the exsolution of a dense brine. We also draw together constraints on the timescales of these processes and consider their effects on the physical properties of the evolving magma. We discuss the implications of these findings for our understanding of andesite petrogenesis and eruption triggering and style.

Clinopyroxene and its relationship to rapidly erupted, carbonate-rich magmas in Calatrava, Spain

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Rapidly erupted alkaline, ultramafic magmas such as those occurring in intraplate settings offer a unique opportunity to understand lithosphere structure and rock petrogenesis. Such volcanism erupts rapidly from the mantle, entraining a dense load of xenolithic material forming up to 30% of the rock [1]. The discovery of abundant examples of carbonate-rich volcanism containing magmatic carbonate in association with ultramafic silicate glass [2], highlights the role of carbonate and carbon-rich fluids in the formation of these magmas. However, a comprehensive understanding of the petrogenesis of such magmas remains elusive and petrological observations of variably resorbed, originally euhedral crystals are just one indication of a complex magmatic history.

Clinopyroxenes from a rapidly-erupted carbonatitic tuff in Calatrava, Spain have been analysed for their major and trace element composition. Clinopyroxenes are ideal candidates for understanding melting processes as they host a significant quantity of trace elements and the partitioning behaviour is relatively well characterised. The tuff has a wide textural range of clinopyroxene which occurs alongside calcium-carbonate within fresh melilititic silicate glass. Within glassy lapilli, carbonate occurs as globules and also as a matrix between lapilli fragments.

Clinopyroxenes have Mg# 0.68-0.80 and span a wide range of major element compositions. Clinopyroxenes do not overlap with the major element composition of mantle xenolith-derived clinopyroxenes erupted in similar volcanism in Calatrava, suggesting that no clinopyroxene originates from the disaggregation of mantle xenoliths.

Melts calculated to be in equilibrium with a range of clinopyroxenes illustrate the variation of the melt composition before and up to eruption. Our data suggest that large 'xenocrystic' clinopyroxenes relate to the early stages of magma formation. Resorption of once euhedral crystals can be attributed to disequilibrium resulting from changes in composition of the melt prior to eruption.

[1] Humphreys, et. al, (2010), *Geology* **38** (10), 911-914, [2] Bailey & Kearns (2012), *Min. mag.* **76**(2), 271-284.