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Origin of modality of volcanism

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Modality of magma composition is a primary control of volcanic activities and crustal formation such that magmatic activity of volcanoes directly depends on the differential path taken by the magma prior an eruption.
The long-standing debate on the origin of bimodal melts ("Daly gap") has been puzzling scientist for decades (e.g. Yoder 1973, Charlier et al 2011). Interbedding of two highly contrasting compositions with an intermediate member missing is not uncommon in nature. It suggests that two compositional end members coexisted at least for a short period of time prior to eruption; however the paucity of intermediate composition or its complete absence makes it difficult to believe that the end members have the same parent and raises the question of what happened to intermediate compositions. On the other hand, andesites are the most commonly erupted magmas and are believed to be a major component in crust formation.
Here, we present a feasible solution for the generation of "Daly gap" (compositional bimodality) and andesitic melts (compositional unimodality) based on the combination of high-pressure, high-temperature experiments with numerical modelling. We propose that modality of melts strongly depends on the composition of the parental melt, its differentiation path and, most importantly, its initial water content.
We show that "dry" (<2.3 wt% H_2O) magmas tend to produce bimodality due to a
cotectic reaction (more that one phase crystallising at the same time), whereas wet magmas (> 2.3 wt% H_2O) tend to produce unimodal intermediate compositions.
We have compared our model results with the distribution in compositions of St Vincent (Lesser Antilles) volcanic products. Natural compositions fitted models where wet high Mg basalts (4.5 wt% of initial H_2O) were intruded in the lower crust at a rate of 10 and 20 mm/year and differentiate over 0.4-2.0 Ma. This is in excellent agreement with independent age record and water estimates for St Vincent (Briden et al 1973; Bovier et al 2008). The results of this work resolve several long-standing debates in arc volcanism.

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