Thermomechanical milling of lithics in volcanic conduits

Michelle E. Campbell[1], Kelly Russell[1], Lucy Porritt[2]

[1]University of British Columbia, Canada, [2]University of Bristol, United Kingdom

E-mail: michelle.e.campbell@gmail.com

Accessory lithic clasts recovered from pyroclastic fallout deposits are an underutilized resource for understanding the processes operating in volcanic conduits. Lithic clasts result from syn-eruptive fragmentation of conduit wall rocks and are entrained into the rapidly ascending stream of erupting material. Here, we use the size, morphological and textural properties of accessory lithic clasts to elucidate processes operating in volcanic conduits during explosive eruptions.

The pyroclastic fallout deposits of the 2360 BP eruption of the Mount Meager Volcanic Complex in British Columbia, Canada, contain two main types of accessory lithic clasts: i) rough and subangular dacite clasts, and ii) smooth and rounded monzogranite clasts. We have quantified and described the morphological properties of these two clast types using a variety of techniques, including 2-D image analysis, 3-D laser scanning, and SEM-based textural analysis. We identified three main processes that contributed to shaping lithic clast morphology and surfaces: 1) ash-blasting of clasts suspended within the volcanic flux, 2) high-energy impacts between clasts or between clasts and conduit walls, and 3) thermal spalling of exterior surfaces due to heating of clasts. The extent to which these processes affect a given clast depends on the total time an individual clast resides in the conduit prior to its evacuation. The residence time of a clast is, in turn, controlled by its size and depth of incorporation. Here, we use previously established eruption parameters for the 2360 BP eruption (e.g. column height) to compute transit times of accessory lithics within the volcanic conduit.

By combining field data of lithic sizes with our modelled residence times we have constrained the diameter of the eruption conduit to 40-45 m – a parameter that is normally quite difficult to quantify. Furthermore, we establish a qualitative understanding of the relative roundness of the two types of accessory lithic clasts. The dacite source rocks are so shallow (0 to 550 m) that entrained dacite clasts have very short (<2 minutes) residence times regardless of their size. Conversely, monzogranite lithic clasts are sourced from depths of at least 700 m, and perhaps even deeper than 2 km, so the highly smoothed and rounded nature of many of the observed monzogranite lithics is the result of a prolonged residence time within the dynamic conduit environment. For example, a 30 cm diameter dacite clast incorporated at a depth of 0.5 km would have had a residence time of $\sim$ 30 seconds, while the residence time of a monzogranite clast of equivalent size entrained at 2 km depth would have been $\sim$ 10 minutes.
Ultimately, we suggest that the size, shape and surface properties of accessory lithics should find increasing use in constraining many different parameters related to volcanic eruptions, such as conduit diameter, eruption duration and depth of fragmentation.

©IAVCEI 2013 Scientific Assembly. All rights reserved.