Physical constraints for effective magma-water interaction along volcanic conduits during silicic explosive eruptions

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Aravena et al. (2018) breathed fresh air into understanding the role of external water in silicic phreatomagmatic eruptions with their hypothesis that significant involvement of external water is only feasible above the level of primary fragmentation of the magma. We discuss here strong supporting evidence that primary fragmentation does not involve external water from the microtextures of the pyroclasts erupted from the two ‘type’ examples of large-scale interaction of silicic magma with external water.

In both the Askja (Iceland, A.D. 1875) and Taupo (New Zealand, A.D. 181) eruptions, ‘wet’ phreatomagmatic (phreatoplinian) phases involving interaction with external water are enclosed by pyroclastic units of ‘dry’ or magmatic origin (Fig. 1). Askja phreatoplinian unit C lies between subunitial unit B and Plinian unit D; i.e., in a succession of increasing eruptive intensity. Taupo phreatoplinian unit 3 lies within a similar escalating sequence between modern Plinian unit 2 and powerful Plinian unit 5. All of these phases erupted rapidly vesiculating viscous magma (a second phreatomagmatic unit at Taupo unit 4 is from a different vent erupting largely outgassed magma). These phases were used to frame the definition of a new eruption style called ‘phreatoplinian’ by Self and Sparks (1978). A key issue for more investigation is whether flashing of the external water to steam also fundamentally changed the grain size of the erupted pumice, by promoting a secondary fragmentation in the conduit and/or plume, as opposed to whether its role was limited to influencing processes of transport and deposition of unmodified preexisting clast populations fragmented by vesiculation.

In summary, an intriguing consequence from Aravena et al.’s study is that neither of these ‘type’ phreatoplinian eruptions can be termed phreatomagmatic in the true sense of the word because the contact of external water was not with magma but rather with a two-phase gas/pyroclast mixture. Perhaps the alternative name ‘hydrovolcanic’ is the only acceptable alternative?

REFERENCES CITED


