

## **The Roles and Signatures of Discrete Explosions in Subaqueous and Other Eruptions**

JDL White (Department Geology, University of Otago, PO Box 56, Dunedin, New Zealand; ph. +64 3 479-9009; fax +64 3 479-7527; e-mail: [j.white@otago.ac.nz](mailto:j.white@otago.ac.nz))

Explosive volcanic eruptions include those driven by "continuous explosion" which fragment magma and disperse debris into the surrounding environment on a sustained basis, and those driven by discrete explosions. This dichotomy of style exists for both dry eruptions and those involving interactions with water, and for subaerial, emergent, and subaqueous eruption sites. It is a critical dichotomy both in terms of processes active within a vent, and of those that distribute and deposit debris formed by the eruption. Discrete explosions can result from bursting of strombolian "bubbles" rising through a semi-static magma column, from accumulation of vapour pressure within the magma as a result of microlite growth, or from interaction of magma with external water. The range of vulcanian phenomena remains under discussion, but strombolian explosions occur at high levels at the top of magma columns, whereas magma-water explosions occur at a range of depths in volcanic vents. Signatures of discrete explosions at depth within vent structures are many. Abundant country rock is common in their deposits, and arises from spalling of vent-wall rocks into temporary voids, or from explosive fragmentation driven by shock waves propagated from the explosion site(s). Low instantaneous magma supply rates or negative ones (withdrawal) facilitate these processes by opening void space below the surface, which in turn allows collapse of vent walls and hydrostatic influx of water to magma surfaces within the vent; collapse impacts may trigger phreatomagmatic explosions. Vent-filling tephra is also abundant in vent structures formed or modified by discrete explosions, and originates from deposition by fallback during gaps in eruption. The debris commonly displays evidence of multiple depositional events, reflecting the discrete, repetitive explosions and fallback. Debris from earlier fallback episodes is crosscut by zones of subtly different debris that have moved through the vent. Many of these crosscutting zones are inferred to record upward passage of material projected upward from sites of explosions (which could in principle be magmatic, but typically appear to have been phreatomagmatic); jets of debris arising from these sites extend into, and sometimes through, overlying, previously emplaced, debris in the vent structure. Other debris movement is downward, as material deposited near the periphery of the vent structure by fallback or vent-wall spalling shifts gravitationally into voids opened by expulsion of material from active explosion sites. Where explosively motivated jets of debris pass entirely through any previously deposited material within the vent structure, subaerial tephra jets of the type considered hallmarks of surtseyan activity may form. Observed jets of this sort have been largely, if not entirely, generated by

phreatomagmatic explosions, and typically trace parabolic paths marked by a stream of tephra and condensing moisture; some feed into pyroclastic density currents, but others produce only ballistic and wet-fall deposits. Subaqueously, such tephra jets condense in the water column, leaving behind a stream of dispersed tephra that moves as a particulate dispersion under the influence of gravity to form vertical density currents. These dilute, aqueous, currents propagate laterally when they impinge on the subaqueous depositional surface, and can deposit relatively well-sorted, well-bedded, successions of cold tephra that accumulate as mound-shaped edifices or shallow-sloping cones. Eruptions in which discrete explosions play an important role are common. We are gaining a better understanding of the ways in which magma drives, and is fragmented by, discrete explosions. For both subaerial and, especially, subaqueous eruptions, we have only incompletely tested models of particle ejection and dispersal. Of the processes within vent structures in which discrete explosions originate, our knowledge remains fragmentary at best.