Counting currents: correlating flow units to understand how pyroclastic density currents wax and wane in time and space

DOWEY, Natasha <http://orcid.org/0000-0002-9231-4781>, KOKELAAR, Peter and BROWN, Richard

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Dowey (née Smith), N.J.[1], Kokelaar, B.P.[2] and Brown, R.J.[3]

[1]Department of Geography, Geology and Environment, University of Hull, Hull, UK, HU6 7RX
[2]Department of Earth, Ocean and Ecological Sciences, University of Liverpool, Liverpool, UK, L69 3GP
[3]Department of Earth Sciences, Durham University, Durham, UK, DH1 3LE

The number of pyroclastic density currents (PDCs) generated during an eruption is typically interpreted using stratigraphic evidence for a hiatus in flow that defines discrete "flow-units". However, PDCs are unsteady and non-uniform, potentially complicating interpretation of flow units with distance from the vent. Full understanding of the number and behaviour of PDCs during an eruption can be important for hazard assessment but is generally lacking due to a paucity of proximal ignimbrite exposures.

This study interrogates PDC behaviour in time and space by correlating well-exposed proximal and distal counterparts of the 273 Ka Poris ignimbrite on Tenerife. Previous work has shown that only one flow hiatus is recorded in the proximal succession [1], whereas the distal succession, 15-20 km away, records at least three [2,3].

Correlation was undertaken by identifying temporal correlatives in lithofacies architecture, known as entrachrons [4], and verified with XRF analyses. Entrachrons include (1) green obsidian fragments in the proximal Plinian fallout and the lowermost distal Plinian unit (Hidalga M.), (2) distinctive accretionary lapilli with grey cores in a proximal discontinuous ash layer and a distal lapilli tuff (Magua M.), (3) a lithic-block layer marking caldera collapse in the proximal and distal successions, and (4) an abundance of mafic and banded pumices above the lithic-block layer. A proximal hybrid unit and an upper distal Plinian fallout unit (Caballos M.) both contain distinctive pale green pumice clasts and are linked geochemically by their relatively low Zr content.

The distal Poris succession records the passage of at least four density currents, whereas the proximal succession records just two. The correlation and lithofacies analyses show that the first PDC was relatively short-lived and is recorded similarly in proximal and distal locations. The second PDC evidently was highly energetic, sustained and unsteady. Periodic waning of this later current formed two widespread hiatuses in the distal zone, recorded in an ash bed and a second Plinian unit, while deposition continued proximally. During these waning events, proximal deposition was particularly unsteady, creating stratification and localised hiatus. This work highlights caveats of flow unit interpretation and identifies potential for future experimental work modelling deposition from highly unsteady pyroclastic density currents.

References:

[1] Smith and Kokelaar (2013) Bull Volc 75:768
[2] Brown and Branney (2004) Bull Volc 66:392
[3] Brown and Branney (2013) Bull Volc 75:727
[4] Branney and Kokelaar (2002) Geol Soc Mem 27