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A question of scale: how emplacement observations of small, individual lava flows may inform our understanding of large, compound flow fields

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The early stages of effusive volcanic eruptions, during which lava flows are lengthening, are often closely monitored for hazard management. Processes involved in lengthening are therefore relatively well understood, and lava flow development during this phase can be modelled with some success[1,2]. However, activity may continue after the lavas have reached their maximum length, leading to flow inflation, breakouts and possibly further lengthening of the flow field[3,4]. These processes can be difficult to observe during activity, and may result in highly complex flow morphologies that are not easily interpreted post-eruption.

The late-stage development of compound flow fields is therefore important, but is currently an understudied area. The scale of this activity may vary greatly, and probably depends in part on the eruption duration. For example, the largest flow field emplaced during the 2001 eruption of Mt. Etna, Sicily, reached its maximum length of 6 km in 8 days, then was active for a further 2 weeks only. This 'late-stage' activity involved the initiation of two new channels, a few tens of metres wide, which reached lengths of up to ~2 km. In contrast, the 2008-9 Etna eruption emplaced 6 km long flows within ~6 weeks, then activity continued for a further year. During the last few months of activity, small transient flows were extruded from ephemeral vents, several of which could be active at any given time. Observations of the late-stage activity this flow field as a whole allowed the influence of parameters such as effusion rate and topography on the overall morphology to be studied[5]. Furthermore, the scale of the individual flow units (a few metres wide, a few hundreds of metres long) meant that additional close-range measurements of their short-term development could be carried out, and the results are discussed here.

We observed the behaviour of three such flow units, which were fed by a single ephemeral vent, over a 26-hour period within the last month of the 2008-9 Etna eruption. These were monitored using a time-lapse camera, only ~50 m from the vent, that collected images every 3 minutes. From the suite of images collected we observed flow inflation, changing surface textures, overflows, the formation of surface flows and breakouts, and the switching of activity between channels. These data provide unique insights into the processes that lead to the cessation of activity of small flows, and the initiation of new flow units. This approach, whereby processes are studied on small spatial and short temporal scales, may inform our interpretation of complex morphology in larger flow fields, such as that emplaced during the 2001 Etna eruption. Although the flow units in this case were an order of magnitude larger, the sequence of events leading to the initiation of new channels may be very similar.

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