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# Combining very-long-range terrestrial laser scanner data and thermal imagery for analysis of active lava flow fields

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In order to increase our understanding of the processes involved in the evolution of lava flow fields, detailed and frequent assessments of the activity and the topographic change involved are required. Although topographic data of sufficient accuracy and resolution can be acquired by airborne lidar, the cost and logistics generally prohibit repeats at the daily (or more frequent) intervals necessary to assess flow processes. More frequent surveys can be carried out using ground-based terrestrial laser scanners (TLSs) but on volcanic terrain such instruments generally have ranges of only several hundreds of metres, with long range variants extending to ∼1100 m. Here, we report preliminary results from the use of a new, ground-based Riegl LPM-321 instrument with a quoted maximum range of 6000 m.

The LPM-321 was deployed at Mount Etna, Sicily during July 2009. At this time, active lava flows from the waning 2008-9 eruption were restricted to the upper region of a lava delta that had accumulated over the course of the eruption. Relatively small (a few hundreds of metres in length) and short lived (of order a few days) flows were being effused from a region of tumuli at the head of the delta.

The instrument was used from three locations, Schiena dell' Àsino, the head of the Valle del Bove and Pizzi Deneri. From Schiena dell' Àsino, most of the 2008-9 lava flows could be observed, but, due to low reflectivities and viewing distances of ∼4500 m, the active regions of the flows were out of range. The longest return was acquired from a range of 3978 m, but successful returns at this range were sparse; for dense topographic data, data were best acquired over distances of less than ∼3500 m.

The active flows were successfully imaged from the head of the Valle del Bove (9 and 12 July, 2009) and Pizzi Deneri (6 July, 2009). Despite low effusion rates (∼1 m3s-1), topographic change associated with the emplacement and inflation of new flows and the inflation of a tumulus was detected in the repeat measurement from the head of the Valle del Bove. With the oblique views afforded by the ground-based instrument, the rough lava-channel topography results in irregular data spacing which can make the interpretation of laser-derived digital elevation models alone difficult. Nevertheless, fusing topographic data with thermal images allows active flow features to be clearly identified, and consideration of individual laser returns can permit new flows and purely inflated regions to be distinguished.

The very-long-range capabilities of new terrestrial laser scanners have significantly increased their usefulness for frequent measurement of inaccessible terrain. In the case of active lavas, combining data with thermal imagery can greatly assist in data interpretation and visualisation.