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Vertical tomomorphometric analysis of Etnean lava flows

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The morphology of lava flows depends on several parameters such as the rheology of erupted material, lava discharge rate and pre-eruption topography. The use of high resolution digital elevation models (DEMs) for volcanoes' morphometry makes available a powerful source of data for a detailed description of lava flow shape. As a rule, the collection of morphometric measurements from a topographic source requires the visual identification of lava flows and related features, which is time consuming and not univocal. A procedure is presented to support and speed-up this analysis. A 2 m-cell-size, LIDAR-derived DEM of Mount Etna volcano (Italy) is used as test case. The focus is on the morphology of single flow units. Shaded relief images of the DEM are used to approximately trace the axes of single flow units, which are stored in a database. Afterwards, a custom GIS routine is applied to draw a series of sections orthogonal to flow axes and a profile for each section is calculated. For each flow unit, profiles are drew in a custom XZ reference system where the X axis is the planimetric distance from the flow axis and the Z axis is the elevation above sea level. Each profile is processed as a function in the form of $z = f(x)$, and the points of relative maxima and minima of the second derivative are calculated. These points are used in a semi-automatic procedure in the XZ reference system which allows an optimized detection of morphological elements of flow units (e.g. flow margins and levees top). Detected elements, in turn, are used to automatically measure morphological parameters such as flow width, flow height, channel width, levees height, etc. Collected data allow a thorough exploration of the shape of Etnean lava flow units with straightforward implications for lava flow numerical modeling.