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Ground penetrating radar survey on the cross-stratified overbank deposits from the 2006 eruption of Tungurahua volcano, Ecuador.

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The deposits of the 2006 pyroclastic density currents (PDCs) at Tungurahua are organized as 1) massive, coarse-grained deposits confined to valleys of the drainage network and 2) cross-stratified, ash-dominated overbank deposits from dilute PDCs. These overbank deposits are exceptionally well preserved and show dune bedforms shaping the surface of the outcrops. In order to gain insights into the depositional mechanisms of the latter, we combined a terrestrial laser scanner (TLS) survey with a ground penetrating radar (GPR) dense network of profiles.

The GPR survey permits to look at the internal cross stratification patterns in a non-destructive way. Three antennas with frequencies at 250, 500 and 800 MHz, respectively, permitted to image down to 10, 7 and 3 m depth. While the 800 MHz antenna was found to be very efficient to image cross-lamination, the 250 MHz antenna permitted to recognize major flow units. The GPR dataset profits from the TLS topography data, which are integrated in the processing of the data. From a dense array (profiles at 10 cm spacing) over different types of dune bedforms with the 800 MHz antenna, we manage to reconstruct the 3D internal patterns. Using the 250 MHz antenna, >50 profiles (20-80 m length) over a zone ca. 300*300 m permit to reconstruct and follow the major flow units on the overbanks and their 3D evolution as well as the pre-eruptive paleosoil.

Notable results are: (1) the revelation of several units of dense pyroclastic flow deposits below the dilute PDC deposits on the overbanks. This may indicate that the valleys were filled by the time of deposition of the dune bedforms, a result not inferred in previous studies. Moreover, the number of units is greater than previously accessed. (2) For dune bedforms, the root of a structure is found to be located deeper than expected with striking spatial stability during the whole deposition stage, indicating that these bedforms are triggered by basal topographic disturbance. (3) Looking at their 3D patterns, most dune bedforms have a monotone profile, ruling out genesis from currents with different orientations. (4) In some outcrops however, cross-stratifications evolve laterally from stoss-erosive through aggrading to stoss-aggrading, implying that a single dune bedform can show both downstream and upstream migrating crests during the same stage of the flow. (5) Several structures cannibalized by a larger one show proof that the bed rapidly accommodates temporal changes in the dynamics of the currents.