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LiDAR derived morphology of the 1993 Lascar pyroclastic flow deposits: implications for flow dynamics and rheology

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Pumice flows are potentially destructive volcanic events that derive from eruption column collapse and whose dynamics are poorly understood. The challenge in studying these flows is the lack of constraints on the dynamics, kinematics and initial conditions that controlled their emplacement. These parameters can be investigated through constrained by the morphological characteristics of the flow deposits. Here we present a study of the morphology of the pumice flow deposits resulting from the 1993 eruption at Lascar, Chile. The deposits were mapped in detail using a LiDAR device, which allowed for detailed characterisation of their morphology that consist of central channel and lateral levees, and terminate by a frontal lobe. In particular, the data set has been analysed in order to investigate how the geometry of the deposits flows varies as a function of distance from the lobe tip. We present an analysis of several of the Lascar pumice flow deposits (South East sector) having identified dimensionless groups of the available parameters which are then compared against published results from both experimental and numerical investigations. We find that the ratio of channel/levee height as a function of the ratio of levee separation/total width of the deposit has a characteristic curve for the pumice flow deposits. We estimate the velocity of the parent pumice flows to be of the order of 10 m/s using the morphological data and comparing this to experimental and numerical studies. A Froude number for the pumice flows of 2-2.5 compares well with estimates for pumice flows from other eruptions and also with experimental data. Aspect ratios for the levee-channel section of the pumice flow deposits are similar to those for laboratory experimental scale flows although aspect ratios for the frontal lobe are much larger for the natural deposits pumice flows than their small-scale analogues flows. Finally, we discuss the possible emplacement dynamics of the Lascar 1993 pumice flows. A pseudo Reynolds number based on the velocity estimation is found to be 4-40 times larger for the pumice flows than experimental-scale flows. This suggests that the frictional forces that retard the flows at large scale are relatively not as important compared to flows of a smaller scale. Mechanical effects such as fluidisation and mobilisation of material lying on the slopes could provide an alternative explanation for their ability to propagate on gentle slopes and cannot be ruled out.