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Field measurements of pressure fluctuations on an instrumented wall: implications for channel-bed erosion

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Debris flows typically increase their volume and flow depth through entrainment of sediment. This produces hazardous flows which are also capable of eroding bedrock and changing the morphology of steep torrent channels. Few observations of entrainment are available to shed light on the mechanisms occurring in the field. Herein we describe pressure observations from a vertical array of six force plates, each 0.3 m x 0.3 m in size, installed in a 14 m long wall, oriented parallel to the mean flow direction, at the Illgraben debris flow observation station, Switzerland. The force plates, sampled at 2 kHz, allow determination of the mean and fluctuating component of the pressure at the lateral edge of a debris flow. The median pressure measurements are consistent with data from a large (8 m^2) force plate located near the wall. The fluctuating component of the pressure is typically an order of magnitude larger than the mean pressure at the front of the flow, and probably corresponds to the impact of large boulders (and possibly force chains produced by several boulders) with the force plates as they flow past the sensors. The fluctuating component of the pressure is largest at the head of the debris flow were the flow is not yet fully saturated with the liquid phase of the flow. After the passage of the front of the flow, the pressure fluctuations decrease in amplitude and are of similar magnitude to the median pressure value. Previously published measurements of debris flow erosion at the Illgraben torrent channel (Berger et al., 2011, J. Geophys. Res. Earth Surface) show that sediment erosion takes place at the front of the flow, coinciding with our observations of large pressure fluctuations at the front of the flow. We propose that the pressure fluctuations generated within the debris flow drive both sediment entrainment and bedrock erosion.