The development of structures and morphology in analog debris avalanches: Implications for natural examples

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Exposure of a volcanic flank to one or a combination of tectonic activity, magmatic intrusion, and weakening of the edifice by hydrothermal alteration and gravitational spreading can cause flank destabilisation. One or a combination of earthquake, magmatic intrusion or meteoric event can trigger the collapse of a destabilised flank generating a large landslide or a debris avalanche. The emplaced debris avalanche deposit (DAD) has internal structures also well observed on the surface as faults and folds. These structures can determine the kinematics and dynamics of avalanche emplacement. The identification and characterization of the surface features of DADs by remote sensing is an important component for studying possible scenarios for debris avalanche causes, and their triggering and emplacement mechanisms. We present sets of analog debris avalanche experiments on curved and straight inclined ramps to study the development and formation of the different surface structures and morphology from slide initiation to final stop. In curved ramp experiments, materials accelerate until reaching a gently sloped depositional surface where deposit thickens. The thickened mass then further remobilizes and advances by secondary collapse of the thickened mass. Such a stop-start process may be important in many mountainous avalanches where there are rapid changes in slope. We observed that frontal accumulation is produced during flow as materials at the front move slower relative to those in the medial and proximal zones and helps maintain a thicker mass that flows further. When the front destabilizes, secondary collapse happens. On a constantly inclined straight ramp, analog slides are longer than on curved ramp and show continued extension by horst and graben structures forming a rib-and-ridge morphology and transtensional grabens. Strike-slip shearing at the levees and sets of compression and extension structures in the middle are observed in both set-ups. Here we present mapping and identification of these features by visual interpretation of optical satellite imageries and aerial photographs, field observations, and using available geophysical data in natural DAD including the 2006 Guinsaugon rockslide-debris avalanche (Philippines), Mt Meager rockslide debris avalanches (Canada), and Storegga Slide (Norwegian margin) and previously unmapped DAD in Tacna (Peru).