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The development of structures in analogue and natural debris avalanches

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All types of rockslide-debris avalanches present a plethora of internal structures that are also well observed on the surface. Many of these are seen as faults and folds that can be used to determine deformation history and kinematics. We present two sets of simple and well-constrained experiments of reduced basal friction laboratory rockslides, equivalent to a highly deformed simple shear layer, with plug-flow. These follow the original ramp-slide work of Shea and van Wyk de Vries (Geosphere, 2008). The experiments used a curved ramp where materials accelerate until reaching a gently-sloped depositional surface and a constantly inclined ramp with a more regular slope and longer slides. A detailed description of deposit structures, their sequential formation and morphology is then used to investigate the transport type and deformation chronology from slide initiation to runout stopping of avalanches. Results using a curved ramp show accumulation and thickening at where the slope decreases. The thickened mass then further remobilises and advances by secondary collapse of the mass. Such a stop-start process may be important in many mountainous avalanches where there are rapid changes in slope. The constantly inclined ramp shows shearing and extensional structures at the levees and a set of compression and extension structures in the middle. We noted that frontal accumulation during flow occurs as materials at the front move slower relative to those in the medial and proximal zones. This also leads to secondary frontal collapse, and helps to maintain a thicker mass that can flow further. Descriptions and analyses of these structures are then applied to the kinematics and dynamics of natural examples. We study the 2006 Guinsaugon Rockslide event in the Philippines and find that frontal accumulation and secondary avalanching had also occurred and were important in determining the distribution and runout of the mass. Frontal bulking and collapse may also have occurred at the Tacna Avalanche, Peru and the Pajonales-Aracar event in Argentina.