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Hummocks in large avalanches: how they form and what they mean

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Hummocks are an integral part of most large slope instabilities, whether they be fast emplaced or sluggish. We use analogue modelling, and field characterisation on a number of volcanic and non volcanic large landslides to study the formation of hummocks and explore their importance in understanding landslide kinematics and dynamics. Using beautifully exposed hummock cuts in the Iriga volcano (Philippines) we explore and characterise the internal structure of hummocks from proximal to distal regions and in different lithologies. We compare the information with scaled analogue models. Hummocks initiate from extensional faulting as the landslide begins to form. As motion continues large blocks individualise and move apart creating an initial hummock distribution. Hummock size is a function of position in the initial landslide, that is modified by subsequent hummock break up. Small hummocks are at the front and large ones at the back. Individual hummocks tend to get wider as the avalanche spreads after the initial stages of break up, but decrease in height. The internal structure of a typical hummock is that of normal faults that flatten into low angle detachments at the hummock base, where they merge with the basal landslide shear zone. When landslides become compressive, due to confinement or more gentle slopes, thrusting creates anticlinal hummocks, and in areas of transverse movement hummocks will contain strike-slip flower structures. All these structures together with the models are consistent with a general brittle-slide emplacement model for the studied cases. Where hummocks do not form, nor any fault like feature, a more fluid flow type of emplacement is possible.