Peculiar shapes of submarine landslide deposits and their relationship with the flow dynamics

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Abstract

The form of submarine landslide and debris flow deposits is seldom analyzed quantitatively or at least semi-quantitatively with regard to the dynamics of the mass flow. Because the dynamics of submarine landslides is still largely mysterious and since it is unlikely to observe a submarine landslide during the flow, it is tempting to deduce some dynamical condition from the analysis and aspect of landslide deposits. In this paper we consider two peculiar shapes observed in some deposits: the ring-shaped deposits, and the oriented blocks.

Ring-shape deposits appear like a regular ring shape with a circular frontal ridge higher than the part behind. These forms are typical of mass movements occurring in slopes characterized by a sudden change in the slope gradient along the main flow direction. Specifically, the ring-shape deposits usually settle in extremely flat areas at the toe of steep slopes, a slope morphology that is common in closed or semi-closed basin like lakes or fjords. Furthermore, these deposits are characterized by a very short runout (distance between the source area and the final part of the deposit) if compared with completely subaerial counterparts. We suggest that such landform is the result of the landslide mechanism of emplacement which is strongly affected by the post-failure landslide dynamics. We relate the ring-shape with a strong drag resistance, implying a relatively low velocity.

Oriented blocks are also observed in some submarine debris flows. They are asymmetric blocks whose main axis appears to have a non-random orientation. The existence of hard blocks rafted by a mobile debris flow has been documented in a number of case studies, but we are not aware of any systematic study on the block orientation. We predict that blocks should orient themselves with the main axis perpendicular to flow in the central part of the debris flow tongue, and may achieve a parallel orientation at the sides of the debris flow, where the velocity gradient is high. This analysis may provide information on the velocity gradient within the debris flow.