Geophysical Research Abstracts
Vol. 15, EGU2013-2871, 2013
EGU General Assembly 2013

Erosion of a yield-stress fluid

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Bed erosion induced by rapid gravity flows of complex fluids, such as mudflows or avalanches, remains still poorly understood. A specificity of these natural flows is that, mostly, the material forming the static bed has mechanical properties similar to those of the flowing material (mud/mud, snow/snow). In this experimental study, yield-stress fluids are implemented to model both the eroding flow and the eroded bed with an original approach that captures the process of erosion in terms of solid-fluid transition. The hydrodynamics of erosion is studied in an inclined channel configuration, where a yield-stress fluid flows on a thick layer of the same fluid having an equal or a greater yield stress. In this work, we chose to use a micro-gel polymer (Carbopol) because of its elasto-viscoplastic rheology and its transparency, which is exploited for internal visualization techniques such as Particle Image Velocimetry (PIV). Our approach aims to investigate the dominant physical mechanisms of erosion by combining an accurate rheological characterization of the yield-stress fluid using a rheometer (Hershel-Bulkley law), with the observation of the morphological evolution of the system substratum / flow and the local measurement of related hydrodynamic parameters. The main goal is to relate the erosion law at the substrate/flow interface with the constitutive law of the complex fluid involved, in order to refine this latter in the vicinity of the transition between the quasi-static and the liquid regimes.