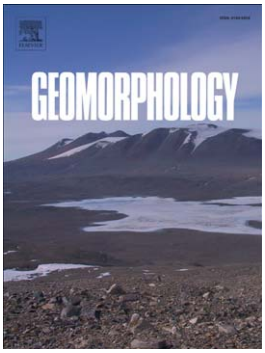

Effect of excess pore pressure on the long runout of debris flows over low gradient channels: A case study of the Dongyuege debris flow in Nu River, China

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Effect of excess pore pressure on the long runout of debris flows over low gradient channels: a case study of the Dongyuege debris flow in Nu River, China

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Abstract

Debris flows with long reaches are one of the major natural hazards to human life and property on alluvial fans, as shown by the debris flow that occurred in the Dongyuege (DYG) Gully in August 18, 2010, and caused 96 deaths. The travel distance and the runout distance of the DYG large-scale tragic debris flow were 11 km and 9 km, respectively. In particular, the runout distance over the low gradient channel (channel slope < 5°) upstream of the depositional fan apex reached up to 3.3 km. The build-up and maintenance of excess pore pressure in the debris-flow mass might have played a crucial role in the persistence and long runout of the bouldery viscous debris flow.

Experiments to measure pore pressure and pore water escape have been carried out by reconstituting the debris flow bodies with the DYG debris flow deposit. The slurrying of the debris is governed by solid volumetric concentration (SVC), and the difference between the lower SVC limit and the upper SVC limit can be defined as debris flow index (I_d). Peak value (K_p) and rate of dissipation (R) of relative excess pore pressure are dependent on SVC. Further, the SVC that gives the lowest rate of dissipation is regarded as the optimum SVC (C_v^o). The dissipation response of excess pore pressure can be characterized by the R value under C_v^o at a given moment (i.e., 0.5 h, 1 h or 2 h later after peak time). The results reveal that a relatively high level of excess pore pressure developed within the DYG debris-flow mass and had a strong persistence capability.

Further research shows that the development, peak value and dissipation of excess pore pressure in a mixture of sediment and water are related to the maximum grain size (MGS), gradation and mineralogy of clay-size particles of the sediment. The layer-lattice silicates in clay particles can be the typical clay minerals, including kaolinite, montmorillonite and illite, and also the unrepresentative clay minerals such as muscovite and chlorite.