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Analysis and simulatin of rock avalanche sequence in the Cerro Caquilluco landslide (Tacna, Peru)

Giovanni B. Crosta (1), Paolo Frattini (1), Elena Valbuzzi (1), and Reginald L. Hermanns (2)

(1) Universita' degli Studi di Milano - Bicocca, Earth and Environmental Sciences, Milano, Italy (paolo.frattini@unimib.it, +39 02 6448 2073), (2) NGU, Norges Geologiske Undersøkelse, Trondheim, Norway

The Cerro Caquilluco (Tacna, Peru) rock avalanche complex has a total volume of about 15 km3 and a length of 43 km, extending from 3900 m a.s.l to 530 m a.s.l.. Based on geomorphological interpretation and lithological evidences, we reconstructed a possible rock-avalanches sequence consisting of at least nine major events. For each event, we calculated the mobilized volumes through the comparison of pre- and post-failure morphology. We argue that the first rock avalanche event corresponds to the Cerrillos Negros rock avalanche, characterized by a distal tongue shaped lobe, 11 km long, 3 km wide and 25 to 60 m thick (rough volume estimate 1.15 km^3), deposited along the piedmont surface (average slope: 2˚). The reconstruction of pristine pre-failure morphology was accomplished by mimicking the preserved morphology close to the source area, and by removing the deposited volumes from the rock avalanche path. For this, we made the hypothesis that the old paleosurface was already eroded by valleys progressively moving upstream during a wetter climate, as suggested by Hoke et al (2007) for similar conditions in northern Chile. The reconstruction of the pre-event morphology required several attempts to fit the eroded and the deposited volumes. Finally, a total mobilized volume of about 10.2 km^2 was obtained for this event. For the successive scenarios of slide retrogression, we used the morphologies obtained by previous scenarios as pre-failure morphologies, and we calculated, by difference with current topography, the lobe volumes. The volumes of single rock avalanche episodes decrease from the first to the last event, roughly following a power-law decay. This behavior is comparable to that described by Utili and Crosta (2011) for retrogressive instabilities in rocky cliffs. The rock-avalanche events have been simulated, to verify the different scenarios in terms of spreading area and maximum runout, by using SPH (Smooth Particle Hydrodynamics) and Finite Element codes. Different equivalent fluid models were tested and a frictional rheology was finally selected. The results of numerical model are presented and compared with mapped runout.

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Utili S, Crosta G B (2011) Modeling the evolution of natural cliffs subject to weathering: 1. Limit analysis approach. Journal of Geophysical Research: Earth Surface (2003–2012), 116(F1).