Geophysical Research Abstracts
Vol. 17, EGU2015-11399-1, 2015
EGU General Assembly 2015

Detailed chronology of a giant Pleistocene rock-avalanche sequence in the hyperarid southern Peru revealed by jointly applied 10Be and 3He cosmic ray exposure dating : The Study case of the Cerro Caquilluco landslide complex.

Zerathe Swann (1,2), Audin Laurence (1), Benavente Carlos (1,2), Braucher Régis (3), Blard Pierre-Henri (4), Bourlès Didier (3), Carcaillet Julien (1), Delgado Fabrizio (2), Lacroix Pascal (1), Murillo Valderrama Patricio (2), and Aster Team (3)

(1) Isterre, IRD, Univ. Grenoble Alpes, ISTerre, OSUG, Grenoble Cedex 9, France, (2) Instituto Geológico, Minero y Metalúrgico INGEMMET, Av. Canadá 1470, Lima, Peru, (3) Aix-Marseille Université, CNRS-IRD-Collège de France, UM 34 CEREGE, Technopôle de l'Environnement Arbois-Méditerranée, BP80, 13545 Aix-en-Provence, France, (4) CRPG, UMR7358, CNRS, Université de Lorraine, 54501 Vandoeuvre-lès-Nancy, France

Giant landslides are recognized to be remarkably abundant on the Western Andean front of southern Peru and northern Chile, especially in the Arica Bend region (e.g. Crosta et al., 2014a). This area is characterized by strong topographic gradients and subsequent incision of deep canyons, due to the evolution of the Andean range that provide suitable conditions for the development of such instabilities. The climate is hyper-arid (Atacama Desert), although rare but highly impulsive wet events have been evidenced since the Pleistocene. In parallel, this region is submitted to strong (Mw 8-9) and recurrent ($\sim$100 yrs) subduction earthquakes. Previous studies suggest that large landslides represent the main agent of erosion of the Western Cordillera, providing soft material for subsequent fluvial remobilization. However the lack of time constrains on the numerous fossil landslides identified away from major canyons still hamper to assess a real mass balance of sliding material versus the known fluvial erosion and tectonic uplift rates. Finally the role of landslides in the long-term erosion rates of the Andean range on its arid flank remains quantitatively unknown. Recently, two studies gave divergent opinions about the main factor supposed to control the slope failures in that region. Based on cosmogenic nuclides derived erosion rates, McPhillips et al. (2014) argue that the last Holocene climate variation did not have had any effect on the rate of landsliding, suggesting that here landslides are mainly triggered by earthquake. On the other hand, Margirier et al. (2014) have showed a temporal correlation between a failure episode of the giant Chuquibamba landslide and the Ouki wet climatic event identified on the Altiplano $\sim$100 ka ago.
In this study we focus on dating the Cerro Caquilluco rock avalanche complex described by Crosta et al. (2014). With a total volume of about 15 km3, a length of 43 km and an internal structure characterized by various depositional lobes suggesting sequential failures, this object appeared as a good target to bring additional knowledge on the previously exposed issues. Our goal was to use TCN and to sample a maximum of individual lobes to be able to discuss: (i) the time of recurrence of successive extreme events, (ii) the respective roles of past climate variations versus earthquake forcing on the landslide trigger, and (iii) the impact of these mass remobilizations on local erosion rates compared to fluvial erosion rates and tectonic uplift rates (both known in this region).
On average, three samples were extracted from individual meter-scale boulders sampled on seven different lobes of debris ($\sim$20 samples). Due to the lack of quartz in that volcanic lithology, 10Be was extracted from feldspaths for all samples. Half were additionally processed for 3He measurements on pyroxene, allowing to reduce the uncertainty on the derived exposure ages and to solve the production equation for both time and erosion variables. The obtained ages show a perfect consistency with the pattern of erosion, geomorphic surfaces and relative position of each lobes (i.e. younger from the toe to the top). These results highlight sequential failures staggered at the Pleistocene timescale, with some surprising time of recurrence ranging from 30 to 100 ka that may correspond to the main last climate variations in that region.

Crosta, G.B., Hermanns, R.L., Frattini, P., Valbuzzi, E., Valagussa, A., 2014a. Large slope instabilities in Northern Chile: Inventory, Characterisation and Possible Triggers. In: Proceedings of the 3rd world landslide Forum, 2–6 June 2014, Bejing, p 6. DOI: 10.1007/978/-3-319-04996-0_28.
Crosta, G.B., Paolo, F., Elena, V., Hermanns, R.L., 2014b. The Cerro Caquilluco–Cerrillos Negros Giant Rock Avalanches (Tacna, Peru). IAEG - Torino 2014, N°159.

McPhillips, D., Bierman, P.R., Rood, D.H., 2014. Millennial-scale record of landslides in the Andes consistent with earthquake trigger. Nature Geoscience, DOI: 10.1038/NGEO$_2$278.
Margirier, A. Audin, L., Carcaillet, J., Schwartz, S., 2014. Tectonic and climatic controls on the Chuquibamba landslide (western Andes, southern Peru). Earth Surf. Dynam. Discuss. 2, 1129–1153.