Landscape relaxation after the 2008 Sichuan earthquake: insights from cosmogenic nuclides

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The discovery of the existence of complex interactions between surface denudation and tectonics in active mountain ranges has been a major paradigm shift for orogenic processes research, with major implications at different space- and time-scales. Quantifying denudation rates acting on mountainous topography has become an important research objective, and recent studies show that the denudation budget can be dominated by intense and rare events rather than by a progressive and steady evolution. Interactions between tectonic and denudation processes over short time-scales have also been under close scrutiny recently due to the detailed documentation of co-seismic landsliding after major earthquakes such as Chi-Chi (1999) or Wenchuan (2008). The latter is a very good example of such intense co-seismic shaking with a pronounced geomorphic imprint.

This M_w 7.9 earthquake ruptured a nearly 300 km long fault zone along the Eastern edge of the Tibetan plateau, resulting in more than 70 000 deaths. Massive and widespread deep-seated landsliding were a salient characteristic of this event, causing numerous fatalities, destruction of infrastructure and hazardous transient damming of rivers. Based on high resolution maps of co-seismic uplift from InSAR and estimates of total landslide volume from remote sensing, some studies suggest that the erosive impact of the earthquake might have been greater than the topographic buildup. These observations raised fundamental questions about the actual role of such large shaking as constructive or destructive mountain building processes.

In order to assess the geomorphic importance of this earthquake we have started to monitor the evolution of ^{10}Be concentration in rivers draining the Longmen Shan range, which is the area that was affected by the most intense co-seismic shaking. Our aim is to obtain quantitative information about the response of denudation processes following a major co-seismic event and associated landsliding, and we take advantage of the existence of pre-earthquake ^{10}Be concentration measurements for a limited number of basins along the Longmen Shan range, which provide a base level for the signal before the disturbance.

A comparison of the concentrations before and after the earthquake shows a significant dilution associated with sediments provided by the landslides. From the limited number of basins available we do not observe any significant correlation between the magnitude of this dilution and the geomorphic properties of the basins or the experienced intensity of the co-seismic shaking. The available time-series show that the ^{10}Be concentrations are

increasing quickly over the years following the earthquake and the extrapolation of the trends suggest that a pre-2008 level could be reached in the next 5 to 10 years. Such short relaxation time-scale is comparable to what was observed for other events such as the sediment flux response following Chi-Chi earthquake. Our on-going sampling will allow to refine the understanding of this post-seimic response and in particular the influence of the Summer 2013 exceptional monsoon event.