



## **Earthquake triggered rock avalanches in the western Himalaya**

W. A. Mitchell

International Landslide Centre Department of Geography, Durham University, South Road, DURHAM, DH1, UK

Rock avalanches form the largest and most destructive type of slope failure within high mountains and are usually thought to be triggered by either high magnitude rainfall events or by earthquakes which generate large numbers of slope failures of as a co-seismic response. They have been recorded from many parts of the Himalaya, particularly the Karakoram; however, to date, there has been no large scale attempt to produce a comprehensive map of their distribution across the orogen or determine the causes of their formation.

The occurrence of rock avalanches in specific areas of the Himalaya which can be defined as high altitude desert suggests that their occurrence is unlikely to be associated by high magnitude rainfall events related to the summer monsoon but rather to the release of high strain associated with large earthquakes. From studies in other mountain areas, it appears that the generation of rock avalanches requires earthquakes with a magnitude approaching M8. This suggests that examination of the distribution of rock avalanches in a tectonically active area may be a method in the deciphering the palaeoseismic record of large to great earthquakes where there is minimal other geological evidence. This can be extended by using cosmogenic radionuclides to date specific rock avalanches and allow the establishment of the frequency of such events and by inference the timing of great earthquakes within the Himalaya.

At present there are few dates for rock avalanches in the Himalaya; one particular example occurs in Zaskar north of the main divide of the High Himalaya. Cosmogenic  $^{10}\text{Be}$  dates from quartz veins exposed on the surface of the rock avalanche give an error-weighted mean of  $7510 \pm 110$  calendar years BP. It is suggested that this marks the occurrence of a major earthquake in this area at this time demonstrating Holocene

activity on one of the fault strands associated with the Zaskar Shear Zone. Other rock avalanches have also been identified along the Karakoram Fault in Ladakh but these have not been dated; a similar situation exists for the >140 rock avalanches recognized within the Karakoram. It is suggested that the distribution and timing of rock avalanches within the Himalaya may allow the establishment of an earthquake history