



## **Landslides induced by the 2005 northern Pakistan Earthquake and long-term gravitational slope deformation**

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Northern Pakistan Earthquake (Mw7.6), which occurred at 8:50 am on 8 October, 2005, induced many landslides along the earthquake fault, Balakot-Garhi (or Balakot-Bagh) fault, trending NW-SE for about 70 km. We studied landslides near the south-eastern half of the fault, which runs in the Miocene Murree Formation consisting of alternating beds of sandstone and mudstone. Field survey and the interpretation of satellite images before and after the earthquake showed that many of the landslides induced by the earthquake were preceded by long-term gravitational slope deformation with several types; flexural toppling, buckling, and sliding. The Dandbeh slide (Hattian slide) with a volume of 27 million m<sup>3</sup>, one of the largest slide by this earthquake, was a slide of the axial part of a downslope plunging syncline. It had been a complex of smaller elongated landslide bodies before the earthquake, and the lowermost slides were undercut by a stream, which seems to have rejuvenated because there are continuous knick lines several tens of meters high above the riverbed. Many slope failures occurred along the upstream of the Jhelum River, which flows down near the earthquake fault; they occurred in the lower parts of large gravitationally deformed slopes. Most common deformation was flexural toppling, which occurred on slopes as large as 1 or 2 km<sup>2</sup> and made long downslope facing scarplets along ridge tops. The deformation made many fractures within rock masses and made large volumes of debris, which failed. Another type was buckling; some buckled strata slid down catastrophically by the earthquake.