



## **Large landslides induced by the 2008 Wenchuan earthquake and their precursory gravitational slope deformation**

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2008 Wenchuan earthquake induced numerous large landslides, of which many large landslides had been preceded by gravitational deformation. The deformation could be detected by linear depressions and convex slopes observed on satellite images taken before the earthquake. Ground truth survey after the earthquake also found the gravitational deformation of rocks, which could be predated before the earthquake.

The Daganbao landslide, the largest landslide induced by this earthquake, occurred on a slope of bedded carbonate rocks. The area of the landslide, based on measurements made from the ALOS/PRISM images is 7.353 km<sup>2</sup>. Its volume is estimated to be 0.837 km<sup>3</sup> based on the comparison of the PRISM data and the SRTM DEM. It had an open V-shaped main scarp, of which one linear part was along a high angle fault and the other was approximately parallel to the bedding strike. The upslope edge of the V-shaped main scarp was observed as 2- km long linear depressions along the ridge-top on satellite image before the landslide. This indicates that this slope had been already destabilized and small movement occurred along the bedding planes and along the fault before the event. The Wenchuan earthquake pulled the final trigger of this landslide. The major sliding surface was along the bedding plane, which was observed to dip 35° or slightly gentler. It was warped convex upward and the beds were fractured, which suggests that the beds were slightly buckled before the landslide. This deformation may correspond to the formation of the linear depression.

The Tangjiashan landslide in Beichuan, which produced the largest landslide dam during the earthquake, occurred on a dip slope of shale and slate. The geologic structures of the landslide was observed on the side flanks of the landslide, which indicated that the beds had been buckled gravitationally beforehand and the sliding surface was made along the bedding plane and a joint parallel to the slope surface. The buckling deformation was brittle deformation and different from the ductile deformation that accompanied the nearby tectonic folds. The Formosat II and SPOT images on Google Earth indicate that this landslide occurred on a slope with spur-crossing depressions with upslope-convex traces. This topography also indicates that this slope had been deforming by slow rock creep before the earthquake.

The gravitational deformation before the landslides above stated appeared as linear depressions or spur-crossing depressions, both of which expressed small displacement in comparison with the size of the whole slope. This may suggest that they were at a critical state just before the catastrophic failure.