

Recurrent rock avalanches progressively dismantle mountain ridges in Longmen Shan, China most recently in the 2008 Wenchuan earthquake

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Consiglio Nazionale delle Ricerche

Location and regional geological setting

Study site: Yangjia gully, Beichuan County
31°58'25.10"N 104°34'51.30"E

NE-SW trending Longmen Shan range
– active thrust fault belt between the
Tibetan Plateau and Sichuan Basin

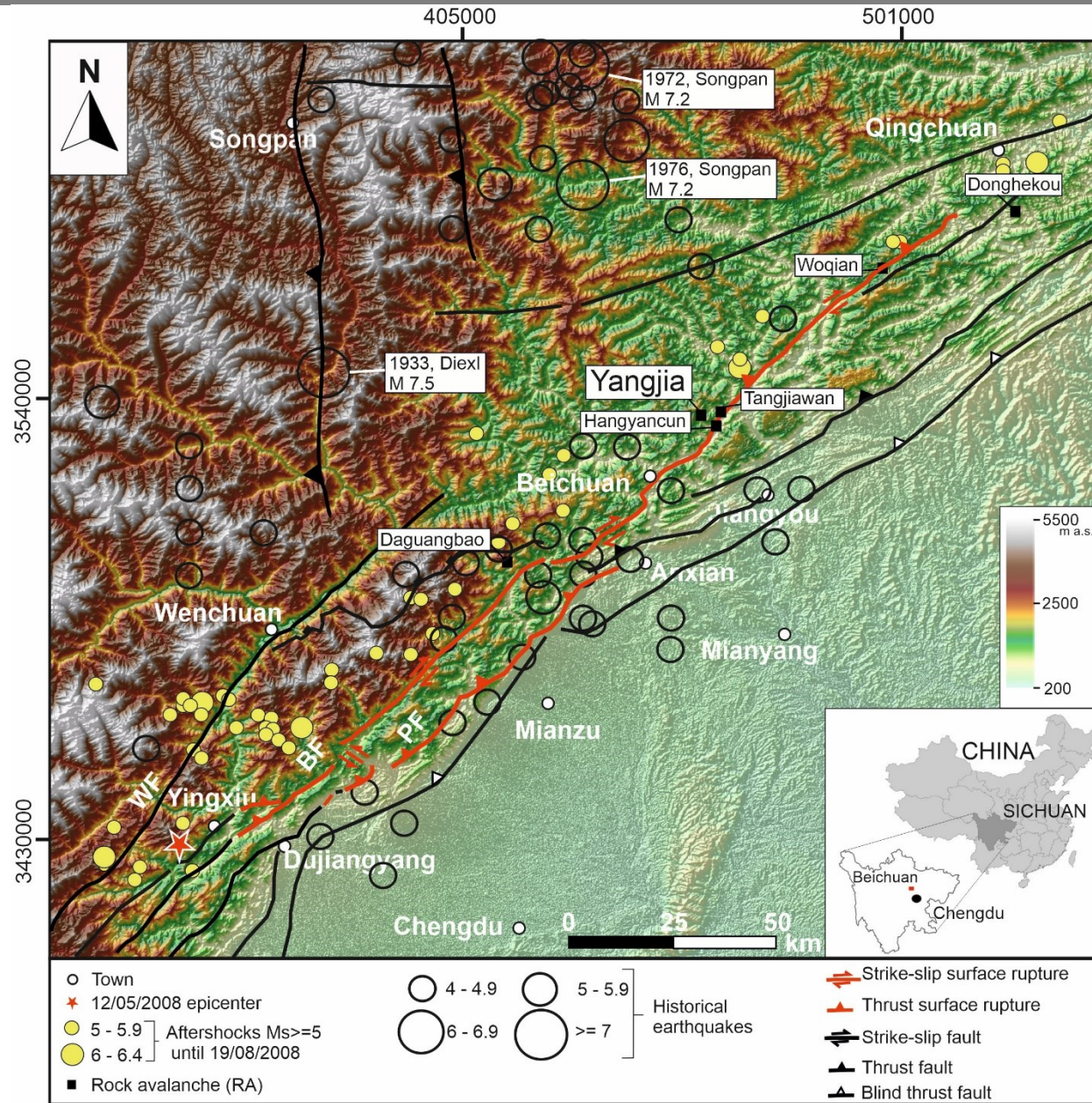
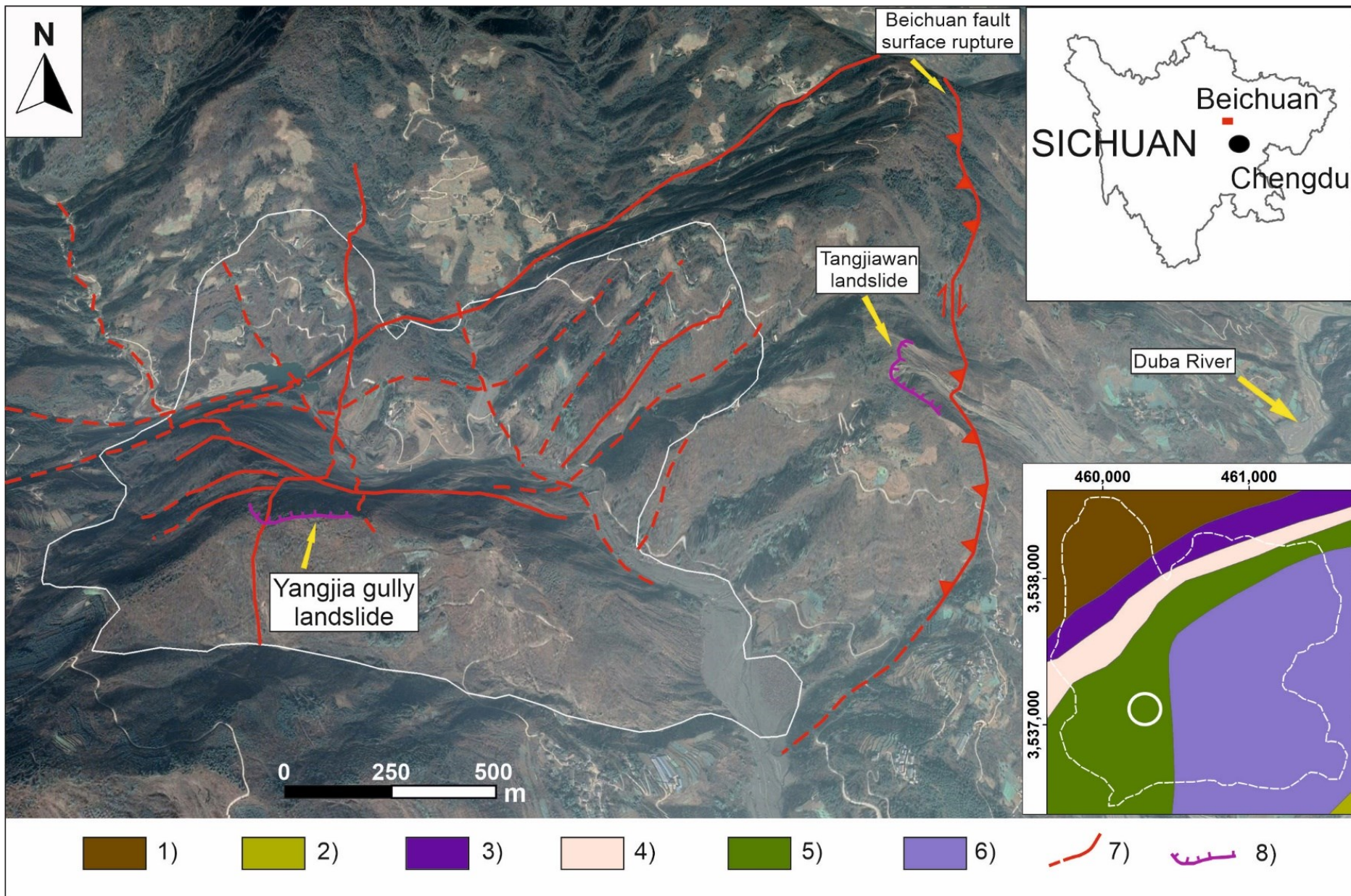


Figure from Wasowski et al. 2021
Geomorphology

Faulted landscape and fractured/sheared rocks: slate & meta-limestone

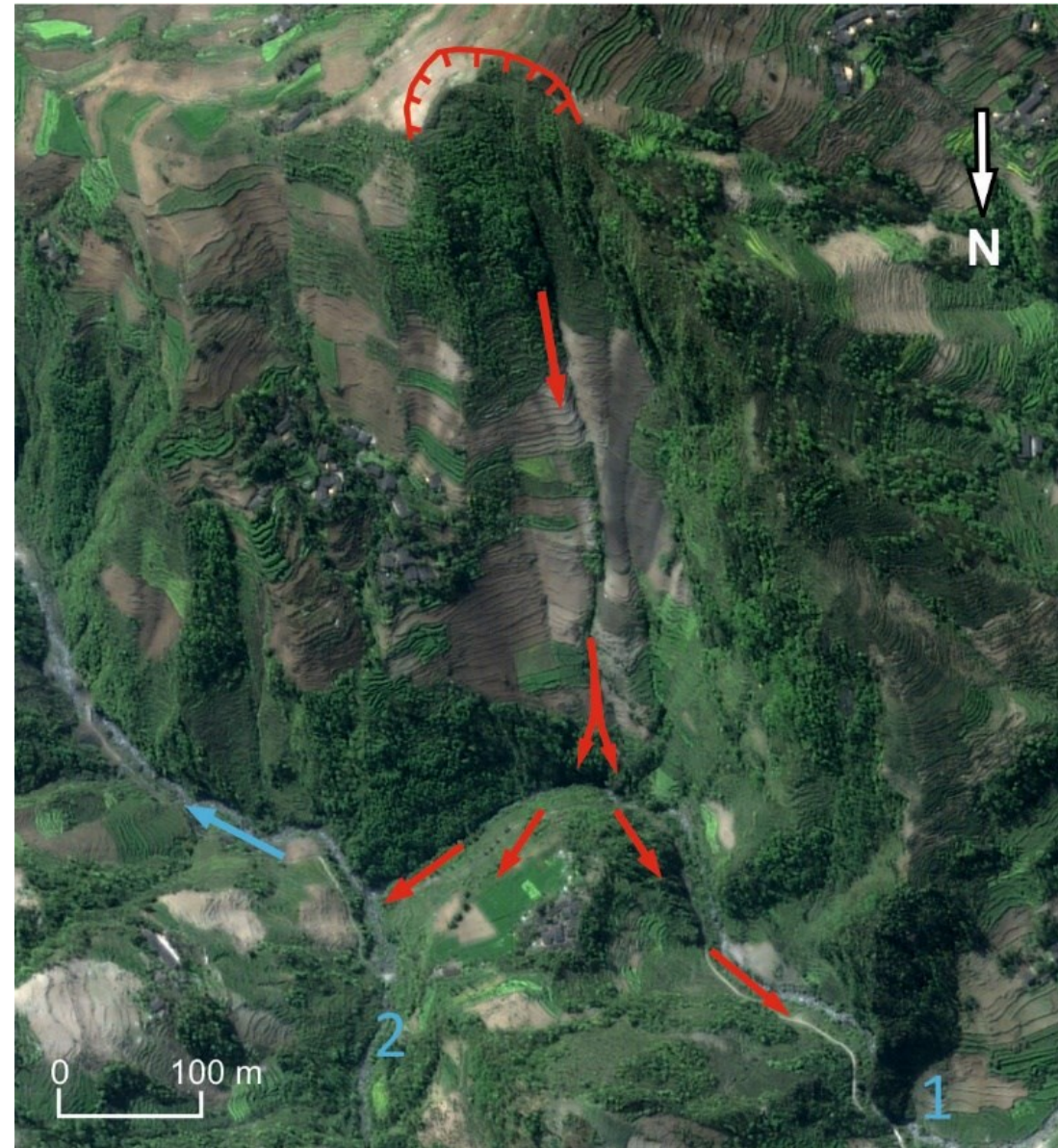


Before the 2008 Wenchuan earthquake – apparently tranquil landscape

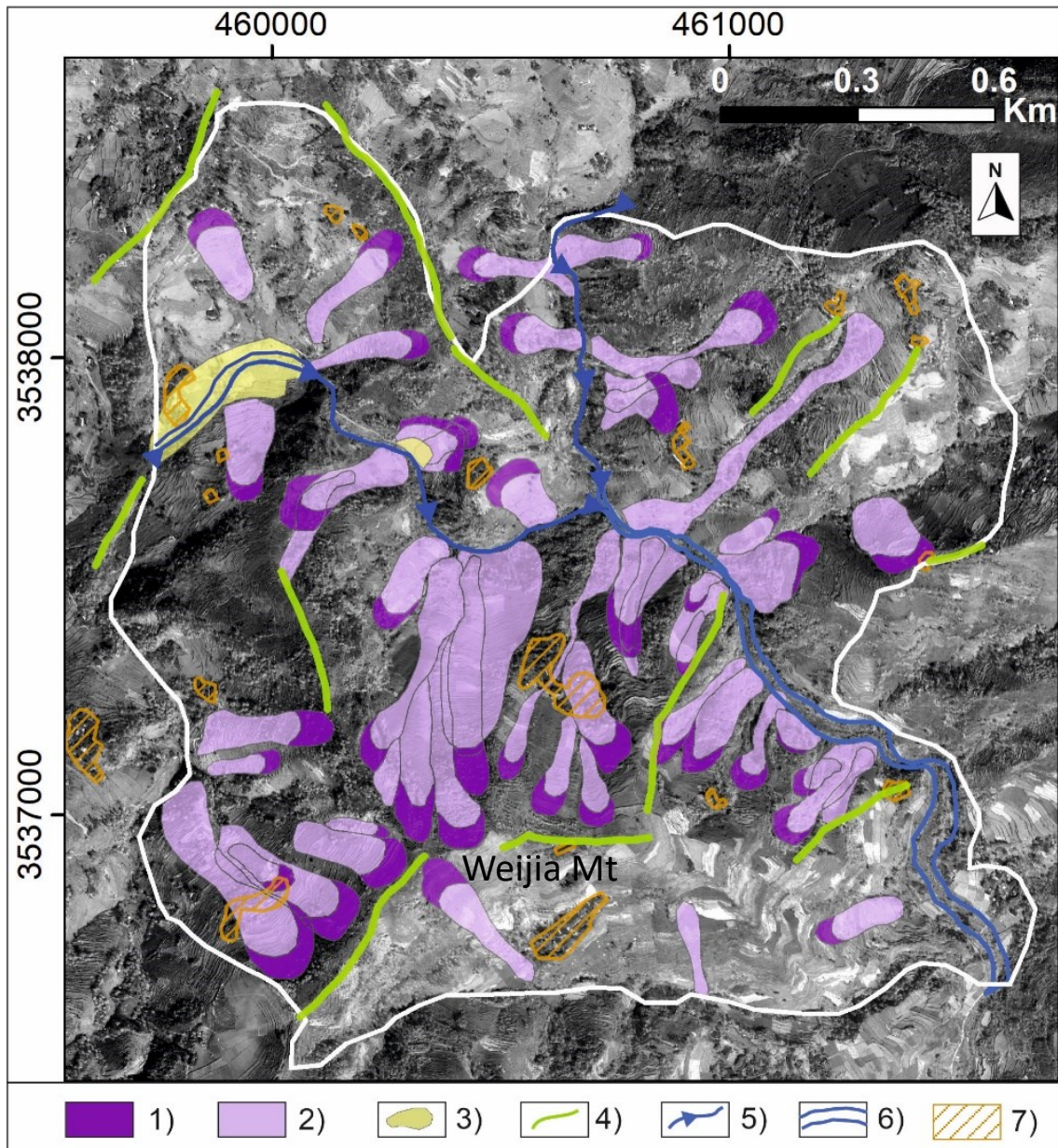


2005 IKONOS image

Old & **2008** Yangjia gully rock avalanches originated at top of Weijia Mt



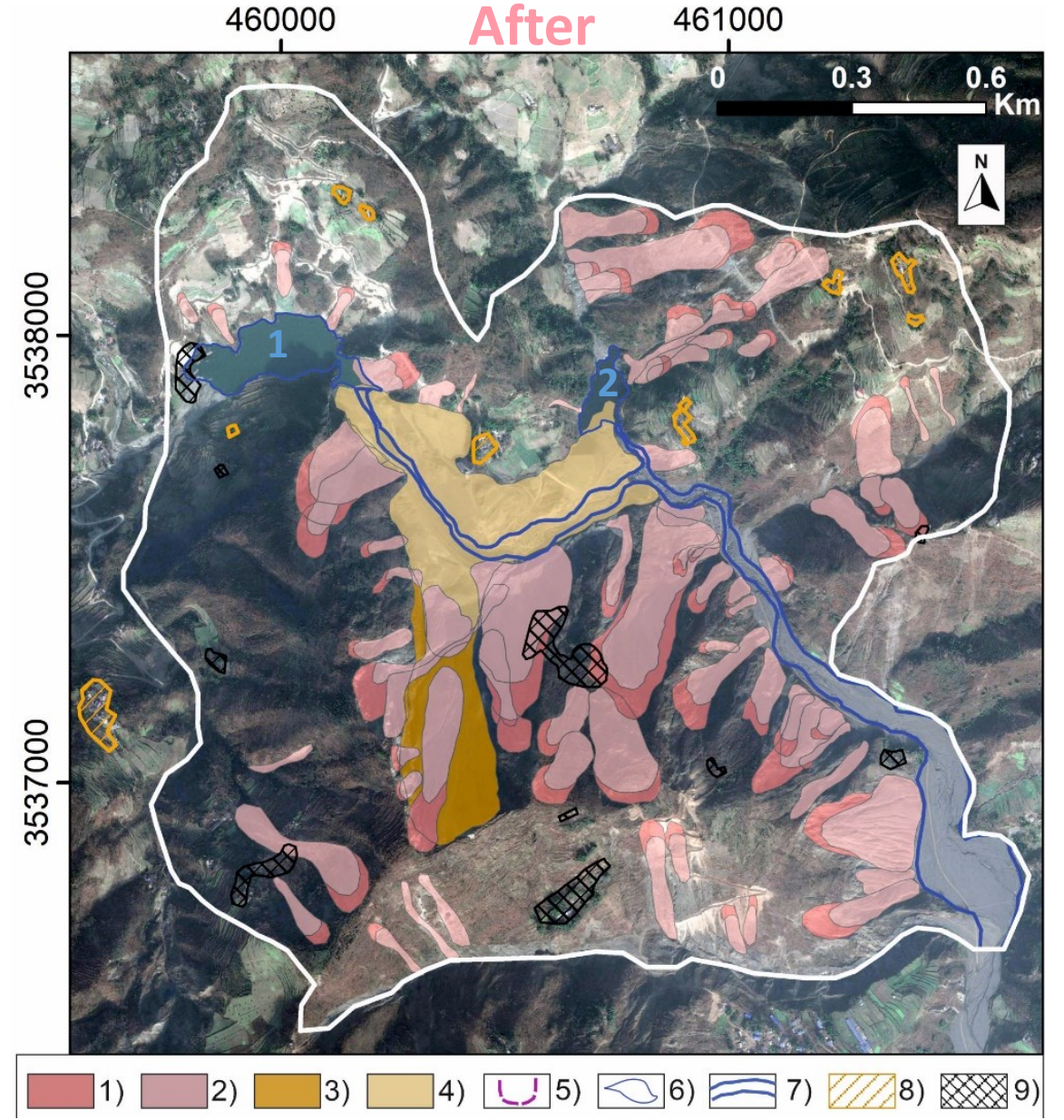
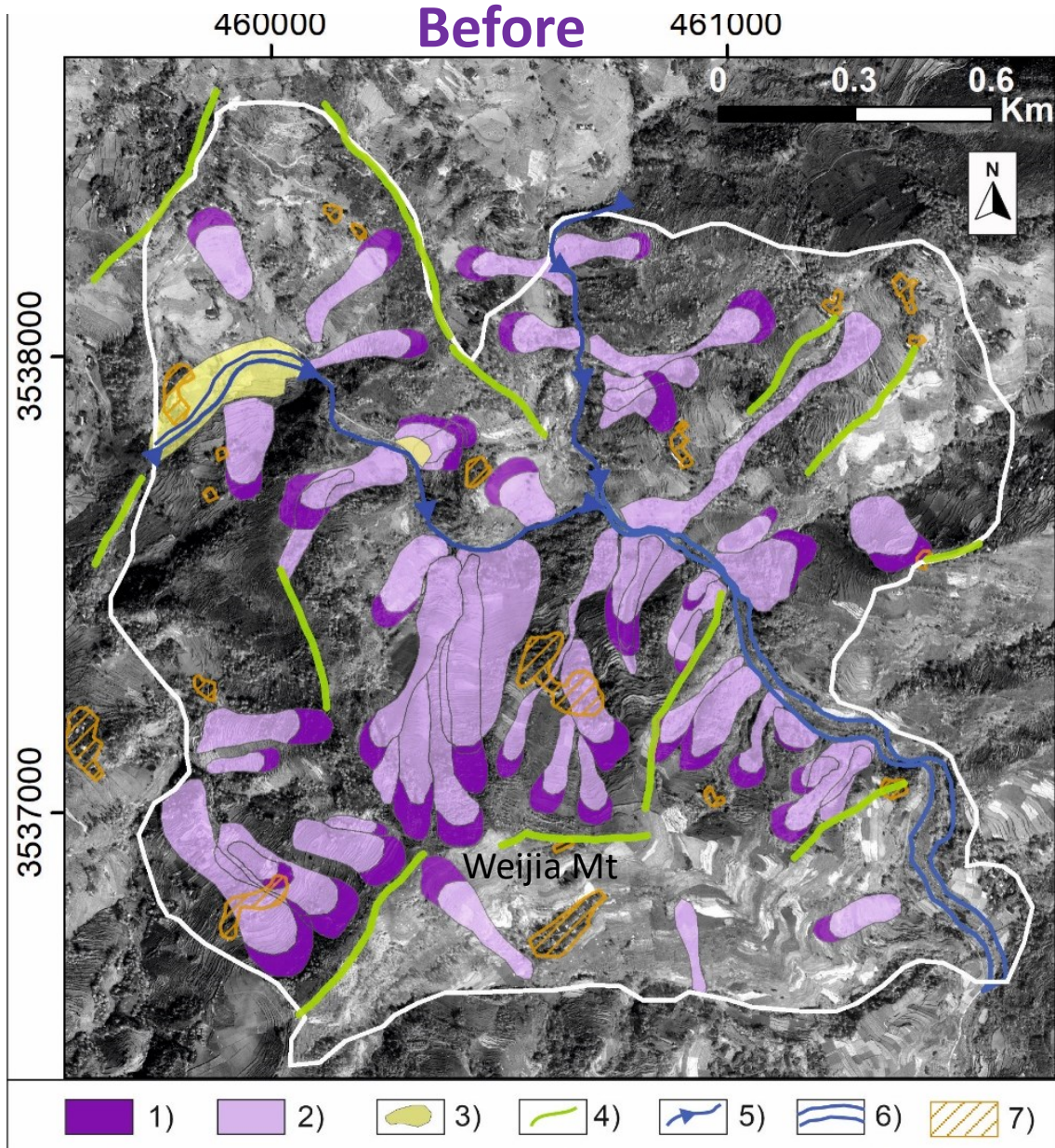
Geomorphic context before 2008 Wenchuan earthquake – many landslides!



Landslides (violet)
Prominent ridges (green)
Alluvial terrace (yellow)
Groups of houses (brown)

2005 IKONOS image

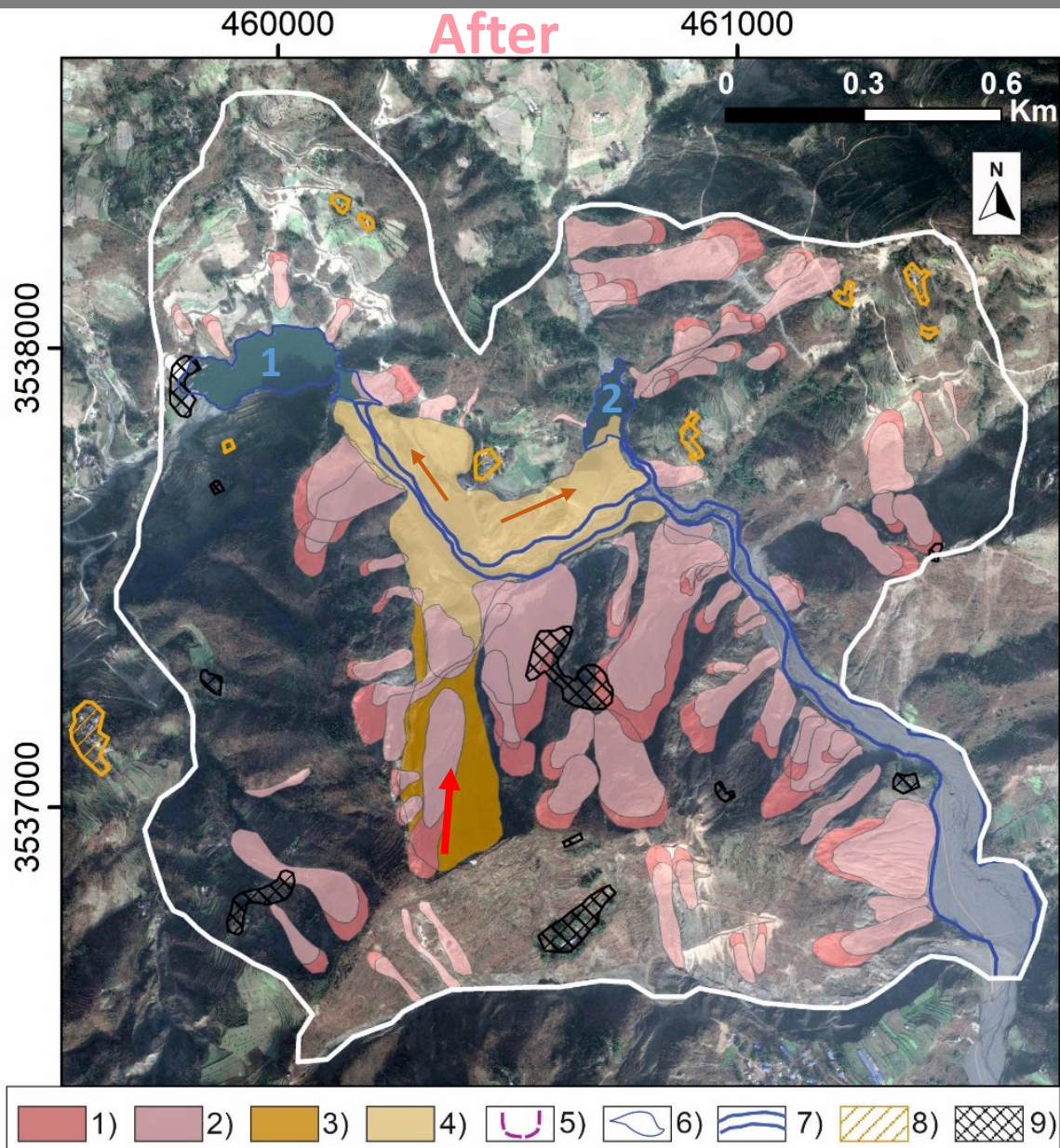
Landscape change **After** 2008 Wenchuan quake – similar landslide distribution



Comparison of pre- and post-2008 landslide inventories

- Many pre-2008 landslides; most seem deep-seated and inactive on 2005 IKONOS image
- The same slopes failed again during the 2008 Wenchuan earthquake

2008 co-seismic Yangjia gully rock avalanche



2008 landslide dam (2) and vestiges of older rock avalanche deposit (1)



Recurrence of rock avalanches from the same gully-facing, terminal portion of Weijia Mt ridge

4/2005

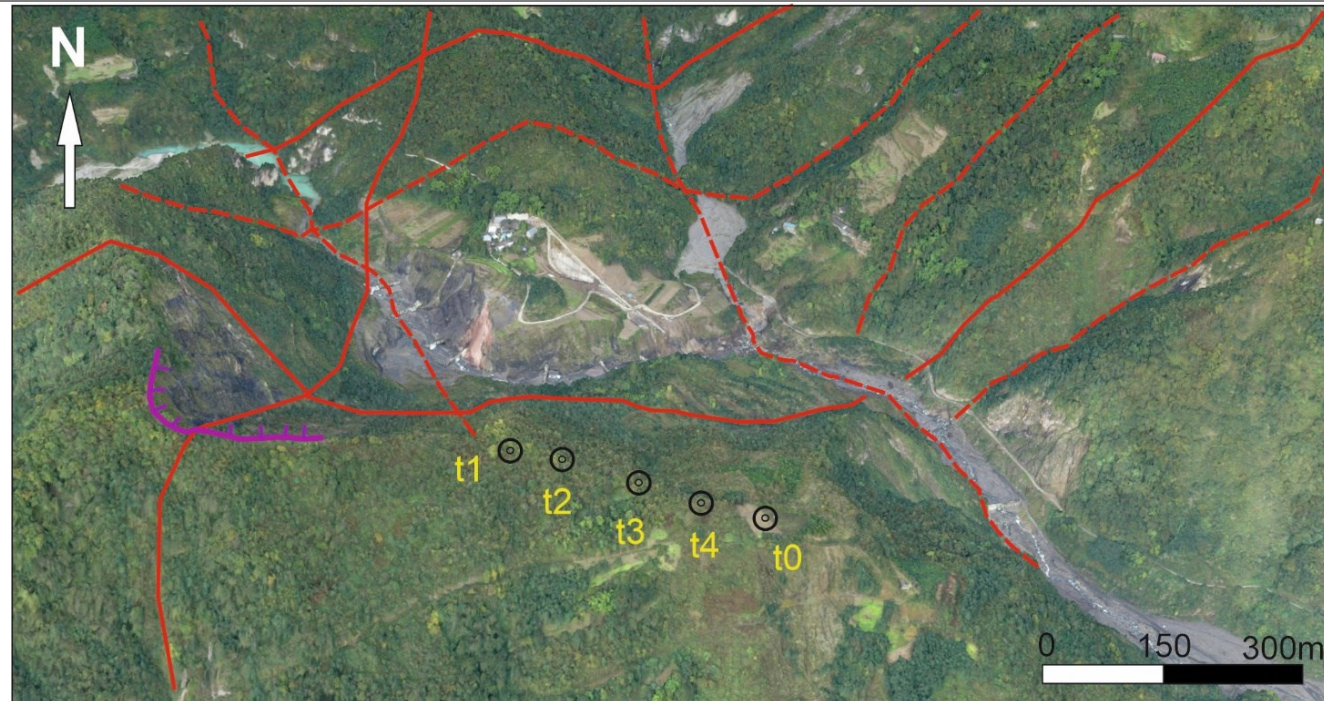


Stratigraphic record + deposit sedimentologic characteristics + local geomorphic context
→ the recurrence of catastrophic slope failures and landslide damming in the Yangjia gully

1/2010



Is Weijia Mountain particularly prone to seismic failure?



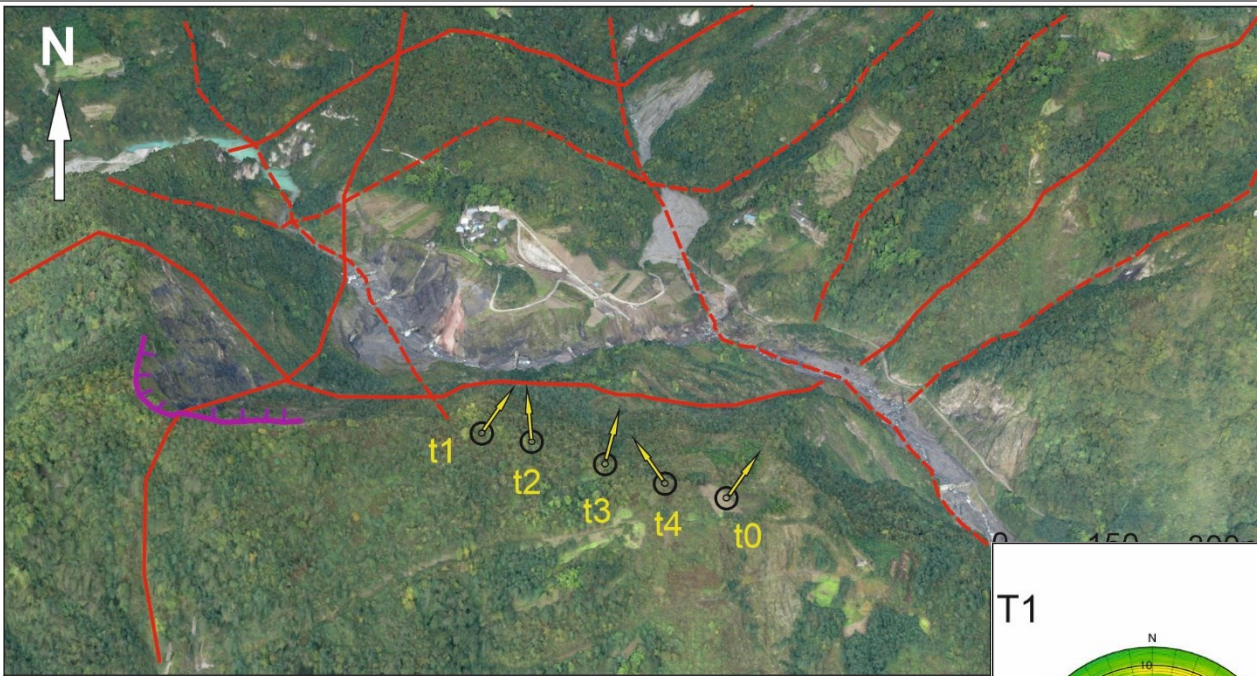
To seek the answer, we used **portable tomographs** and recorded ambient noise on top part of Weijia Mt adjacent to the 2008 rock-avalanche source.

Note: Analysis of ambient noise can be useful for the reconnaissance assessment of slopes subject to seismic amplification and hence induced failures (e.g., Del Gaudio et al., 2014)



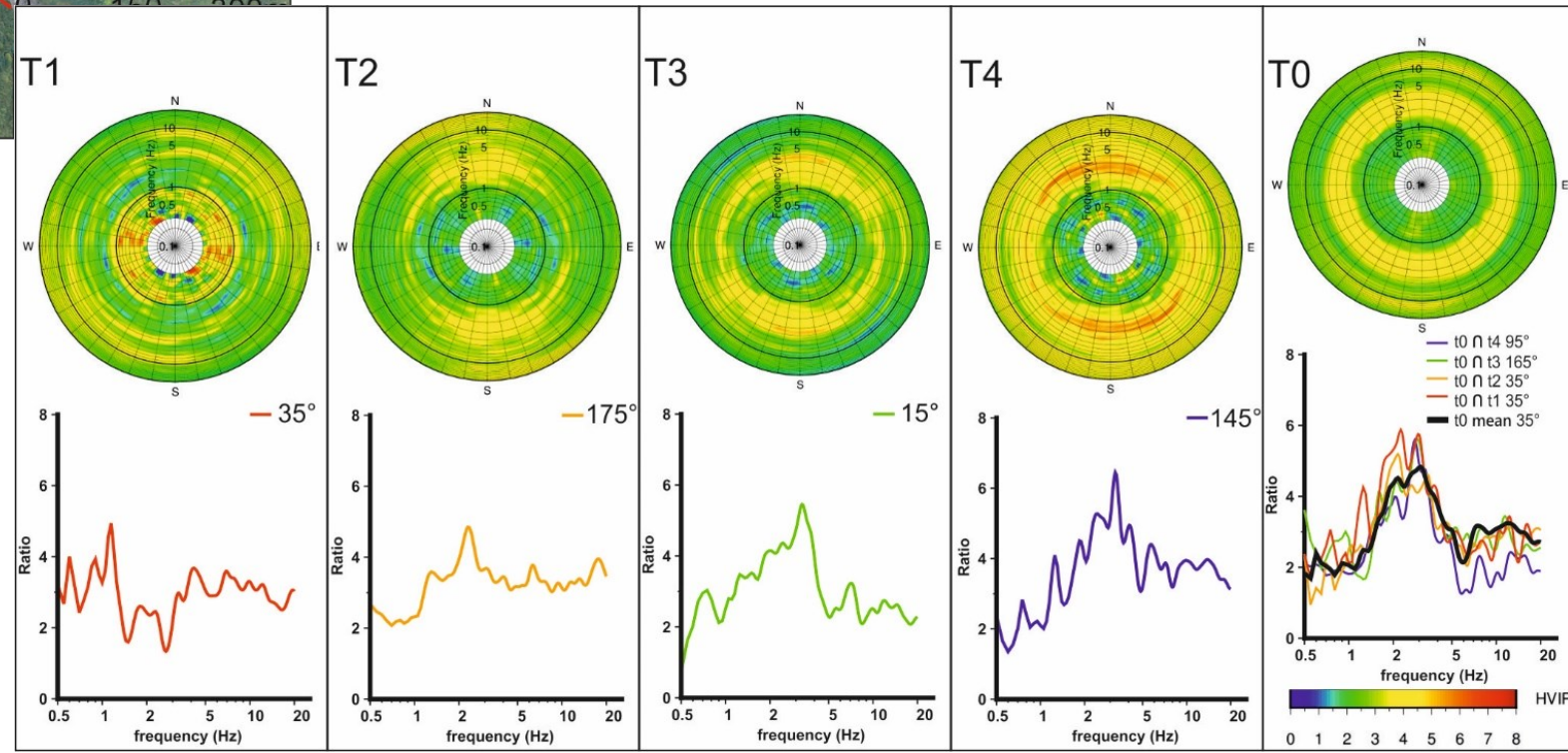
Evidence of 2008 earthquake-induced ridge damage: persistent extension fractures along ridge top and shattered ground

Yes, the results of ambient noise analysis → significant amplification + directivity



Consistent presence of significant H/V peaks with values >4 at a frequency range 1- 3.5 Hz, relevant for triggering large slope failures

Yellow arrows = direction of max. amplification



If you would like to know more

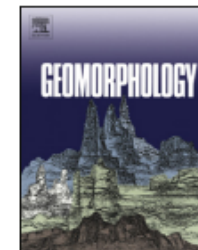


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Recurrent rock avalanches progressively dismantle a mountain ridge in Beichuan County, Sichuan, most recently in the 2008 Wenchuan earthquake



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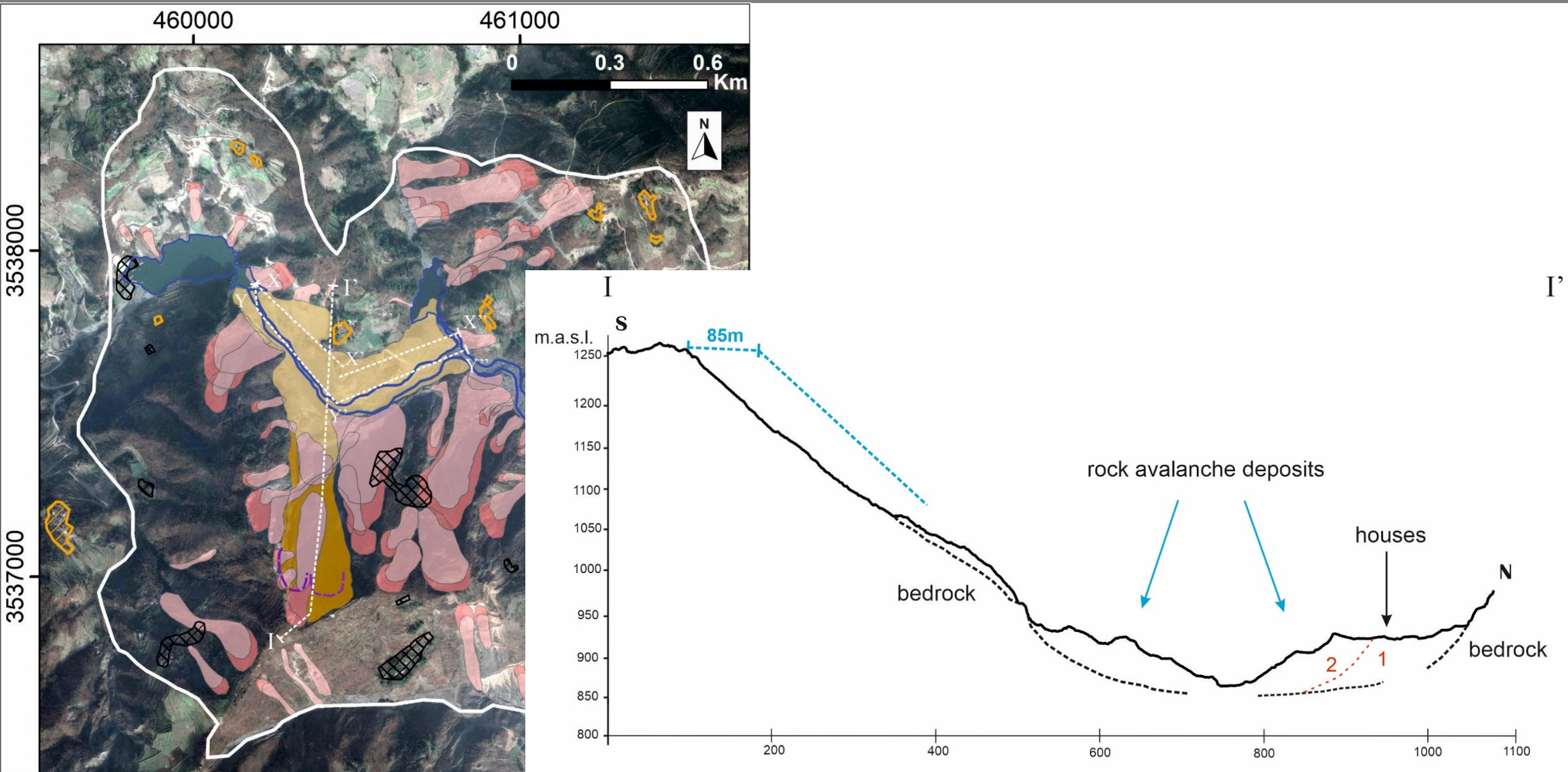
ABSTRACT

Large earthquake-triggered landslides, in particular rock avalanches, can have catastrophic consequences. However, without accelerometer records, the recognition of slopes prone to such failures remains difficult, because slope-specific seismic response depends on many factors including local topography, landforms, structure and internal geology. We address these issues by exploring the case of a rock avalanche of >3 million m^3 triggered by the 2008 Mw7.9 Wenchuan earthquake in the Longmen Shan range, China. The failure, denominated Yangjia gully rock avalanche, occurred in Beichuan County (Sichuan Province), one of the areas that suffered the highest shaking intensity and death toll caused by co-seismic landsliding. Even though the Wenchuan earthquake produced tens of large (volume > 1 million m^3) rock avalanches, many of which resulted in dangerous landslides, few studies so far have examined the pre-2008 history of the failed slope or reported on the stratigraphic record of mass-movement deposits exposed along local river courses. The presented case of the Yangjia gully rock ava-

Concluding remarks

- The common location of landslide source areas at mountain tops noted not only in the case of the large 2008 co-seismic slope failures, but also in previous large magnitude earthquakes
- But the actual seismic response of high-relief mountain ridges still poorly known, as permanent accelerometer stations are rarely located on such sites (and strong motion records from hillslope accelerometer monitoring are still limited)
- The expeditious nature of ambient noise measurements → the feasibility of wide-area investigation BUT the selection of slopes potentially susceptible to catastrophic seismic failure should rely on both regional- and local-scale geological and topographic insight

2008 Yangjia gully rock avalanche – longitudinal profile



Yangjia gully rock avalanche – profile across landslide dam

