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Research Advances

Application of High-Resolution Remote Sensing Technology in Quantitative Study on Coseismic Surface Rupture Zones: An Example of the 2008 M_w7.2 Yutian Earthquake

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Objective

Nowadays, high-resolution remote sensing technology has brought new changes to surveys of earthquakes, and the quantitative study of seismic faults based on this technology has become a trend in the world (Barzegari et al., 2017). An M_w 7.2 earthquake occurred in Yutian of Xinjiang on the western end of the Altyn Tagh fault on March 21st, 2008. It is difficult to access this depopulated zone because of the high altitude and only 1–2 months of snowmelt. This study utilized high-resolution remote sensing to examine the geometric and kinematic characteristics of the surface rupture zone produced by this event. It will cast new light on the application of high-resolution remote sensing to the quantitative research of earthquakes.

Methods

(1) To extract high-resolution DEM data and evaluating of elevation accuracy. Based on the Leica Photogrammetry module of ERDAS IMAGINE, we used Pléiades-HR 1A stereo images to generate high-density point clouds and high-resolution DEM data, and then evaluated the accuracy of DEM (Zhou et al., 2015). (2) To interpret surface rupture zone. According to the common seismic geomorphologies (seismic cracks, fault scarps, offset gullies, etc.), the fault rupture traces were revealed and the surface rupture extent and rupture characteristics were determined. (3) To measure the coseismic surface displacements. Topographic profiles of the offset geomorphologies from the high-resolution DEM data were plotted, and then the coseismic vertical displacements were measured. The coseismic horizontal displacements were also measured from the fusion high-resolution image.

Results

As shown in Fig. 1b, 1m*1m spatial resolution DEM was obtained from high density ground point clouds. Compared with the ground-based LiDAR DEM, its relative elevation accuracy reaches 0.51 m. The results show that the surface rupture of the 2008 Yutian earthquake has the following features (Figs. 1b–1f). (1) Geometry: the surface rupture is ~30 km long, striking nearly in north-south direction, which can be divided into three segments. (2) Kinematics: the displacement distribution exhibits asymmetry. The maximum vertical displacement is 3.6 m and the maximum horizontal displacement is 2.8 m. The vertical displacement of the south section is larger than that from field investigations (Xu et al., 2013). There exist reverse vertical displacements at local places.

Conclusions

The DEM elevation accuracy reaches a very high level, which is ample to explore the surface rupture behavior of 2008 Yutian earthquake. We find that the vertical displacement of the south section is larger than that from field investigations and the reverse vertical displacements appear at local places. Therefore, this work shows that the quantitative research on the seismic surface rupture zone which can be carried out effectively and accurately based on high-resolution remote sensing stereo technology.

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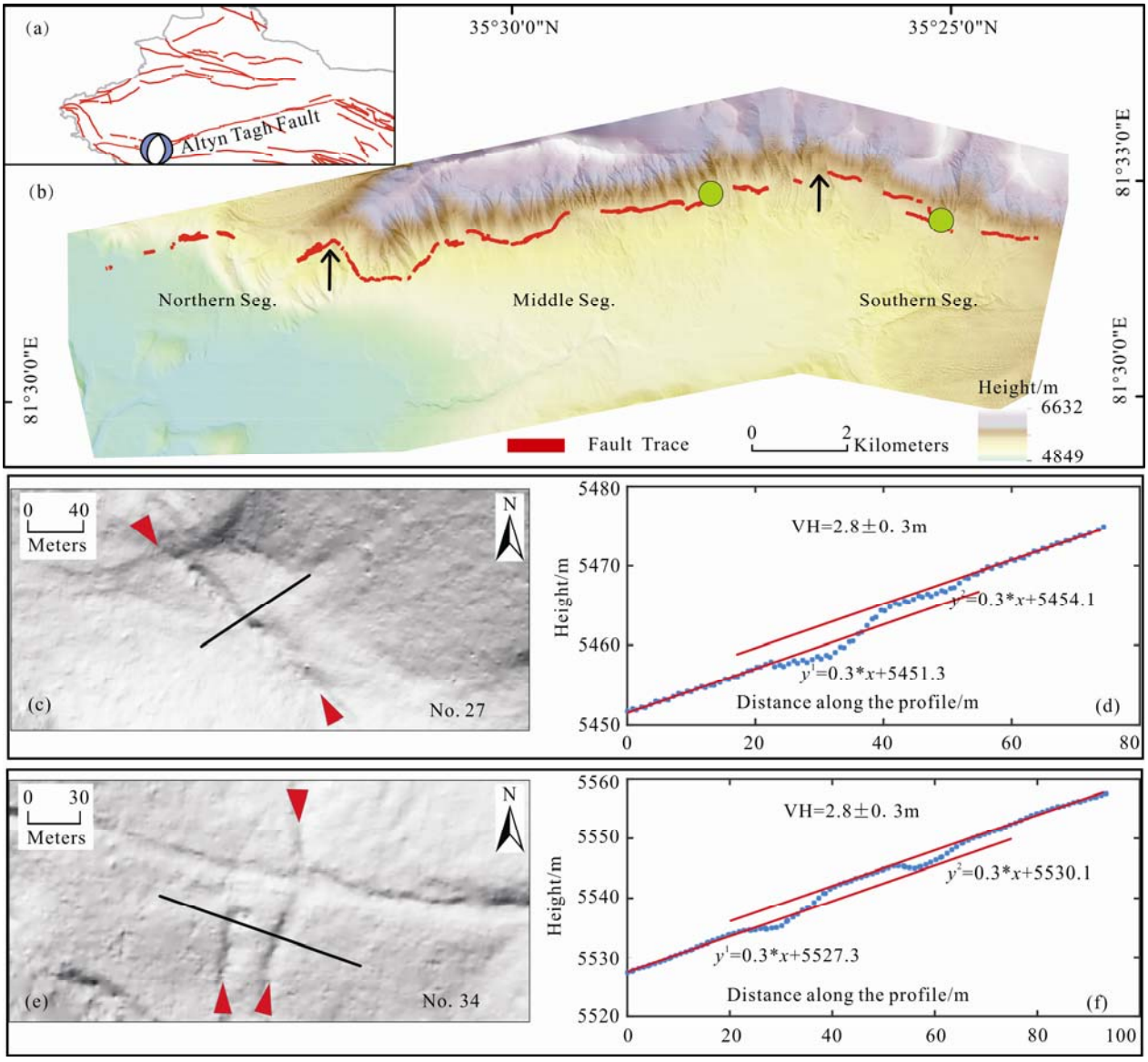

Fig. 1. (a), Tectonic setting of the 2008 Yutian Earthquake; (b), The base map is the DEM with 1m*1m spatial resolution generated from Pléiades-HR 1A stereo images, and its relative elevation accuracy is 0.51m. The green landmarks provide the locations of scarps measured; (c) and (e), The red arrows indicate the scarps measured with number 27 & 34, respectively, and the black lines are the paths of topographic profiles extracted; (d) and (f), The vertical displacements measured on topographic profiles.

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