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Research Advances

New Discovery of Surface Rupture of Large Paleo-Earthquake along Northern Pagri-Duoqing Co Graben, Southern Yadong-Gulu Rift

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Objective

Since the Late Cenozoic, the most remarkable active tectonics interior of the Tibetan Plateau has been the north -trending rifts and NW-trending strike-slip faults especially in the southern-central Tibet. The Yadong-Gulu rift is one of the largest active faults of north-trending rifts in the southern Tibet. During the history, several large earthquakes occurred along this rift, such as 1411 Yangbajain earthquake (M=8.0) and 1952 Damxung earthquake (M_w=7.4). However, there is lack of documents of large earthquakes (M_w≥7) along its southern part. In this case, we took field investigation along the southern Yadong-Gulu rift and discovered a paleo-earthquake surface rupture along Pagri-Duoqing Co graben that may help to understand the seismic activity characteristics of Yadong-Gulu rift.

Methods

This paleo-earthquake rupture was first discovered from satellite images. Based on remote sensing data, the extension of this rupture was determined and the clear outcrop was selected for measuring and mapping. To obtain the displacements of the rupture, the Real-Time Kinematic Global Positioning System (RTK-GPS) was used to conduct linear topographic measurements during the field investigation. Besides, unmanned aerial vehicle (UAV) was used to capture the detailed map on the typical site. Combining with the displacements and length data, we estimated the possible magnitude of this paleo-earthquake based on the empirical formula.

Results

Interpretation of satellite images shows that the boundary normal fault of the Pagri-Duoqing Co graben can be divided into three parts depending on their geometric features, i.e., the Pagri, Duoqing Co and Chongba Yumtso faults (Figs. 1a–b). The surface rupture mainly developed along the Chongba Yumtso fault with a length of around 20 km, showing as an extensional deformation zone (Fig. 1b). The main Quaternary units in the area are multiple marines since the Last Glacial Maximum (LGM), alluvial fans, river terraces and tufa sediments, all of which were displaced by the normal fault. Therefore, the surface rupture is presented as scarps of the Late Quaternary units and fractures of tufa (Figs. 1c –e). North of the Chongba Yumtso, multiple lateral moraines and fluvio-glacial alluvial fans are offset by the fault together resulting typical fault scarps. Photos captured by the UAV suggest that the huge tensor fractures caused by the rupture are parallel to the main boundary normal fault striking north (Fig. 1d).

At this site, the tuff was faulted by a local graben, and two strench faults developed cutting across two river terraces. RTK-GPS measurements perpendicular to the rupture suggest that the largest co-seismic displacement was about 5 m (Fig. 1f). And the offset cross the tuff is at around 1–2 m. The lower offset may be related to the graben structure which shares some of deformation by the antithetic fault in the west. Based on the moment magnitude formula, the magnitude of the earthquake can reach to M_w 7.5 with the largest co-seismic offset, while it is M_w 6.6 from the length of rupture.

In addition, this paleo-earthquake may occur within the Holocene based on the latest glacial-fluvial terrace.

Conclusions

The Chongba Yumtso paleo-earthquake rupture was investigated by the interpretation of satellite images, UAV aerial photography and field investigation in detail. The results show that the rupture was 20 km long along the northern Pagri-Duoqing Co graben. And the rupture clearly presented as offset of multiple Late Quaternary units such as fault scarps, fractures. Besides, measurements by RTK-GPS indicat that the largest co-seismic offset may reach to 5 m based on the field investigation. From the empirical formula, the largest paleo-earthquake along the southern Yadong-Gulu rift could reach to M_w 7.5. This paleo-earthquake rupture

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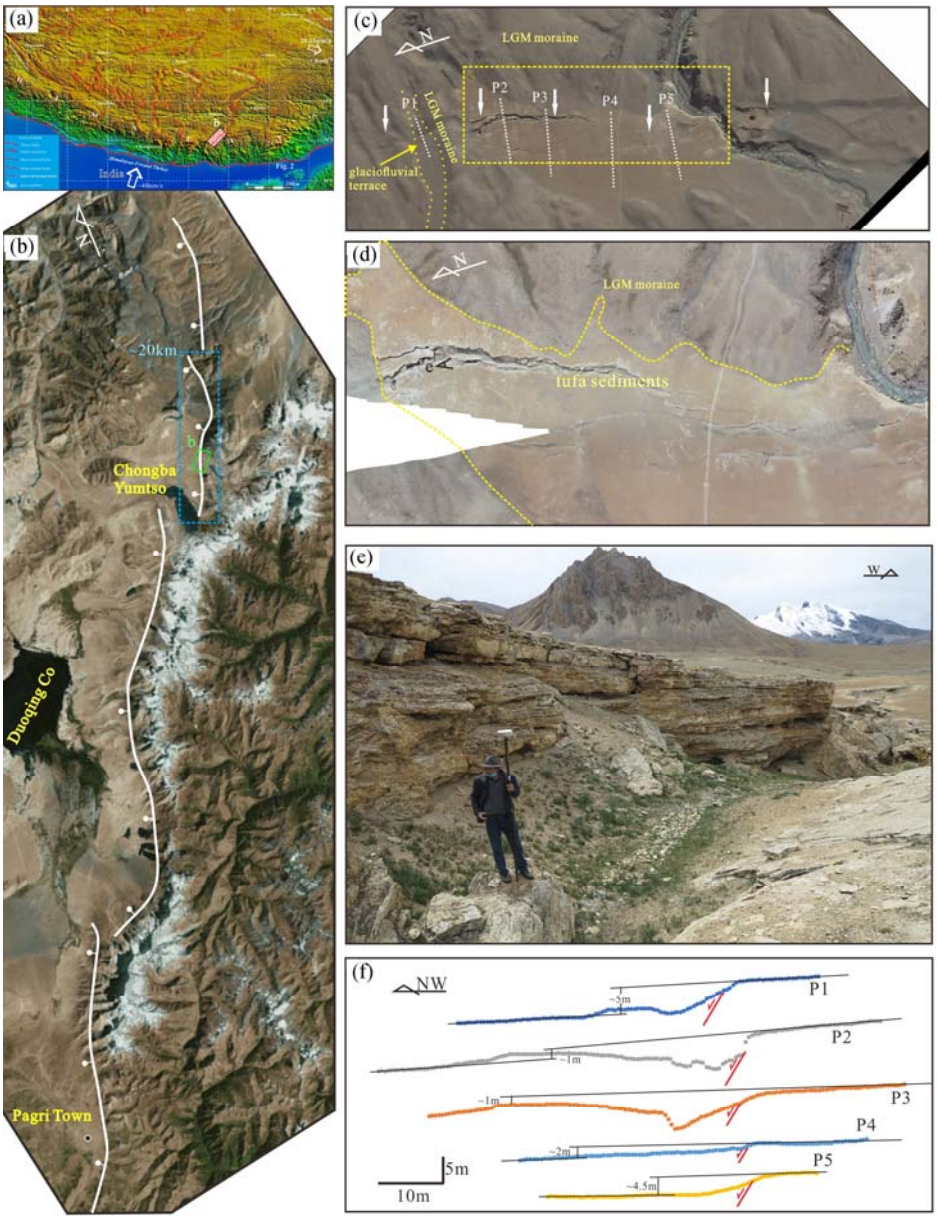

Fig. 1. (a) Simple tectonic map of north-trending rifts in southern Tibet; (b) structure of normal faults along the Pagri-Duoqing Co graben, southern Yadong-Gulu rift from Google earth images; (c) typical surface rupture along the Chongba Yumtso fault from Google earth images. The RTK-GPS measurements lines are also shown in this picture; (d) the break of tuff sediments picked by UAV; (e) the offset of tuff sediments within the surface rupture; (f) results of RTK-GPS measurements.

suggest that the southern Yadong-Gulu rift was a strong active fault since the Late Quaternary. Although the accurate age of this paleo-earthquake has not been ascertained, the large Holocene paleo-earthquake suggests that the southern Yaong-Gulu rift has the same potential of large earthquakes with the northern segment. Besides, the lack of historical earthquakes likely demonstrates high risks of large earthquakes along the southern Yadong-Gulu rift in the future. Therefore, more detailed work about the southern Yadong-Gulu rift is needed.

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