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A paleo-seismological study of the Dauki fault at Jaflong, Sylhet, Bangladesh: Historical seismic events and an attempted rupture segmentation model

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ABSTRACT

A paleo-seismological study was conducted at Jaflong, Sylhet, Bangladesh, which is on the eastern part of the Dauki fault. The geomorphology around Jaflong is divided into the Shillong Plateau, the foothills, the lower terraces, and the alluvial plain from north to south. Because the foothills and lower terraces are considered to be uplifted tectonically, an active fault is inferred to the south of the lower terraces. This fault, which branches from the Dauki fault as a foreland migration, is known as the Jaflong fault in this paper. The trench investigation was conducted at the southern edge of the lower terrace. The angular unconformity accompanied by folding, which is thought to be the top of the growth strata, was identified in the trench. An asymmetric anticline with a steep southern limb and gentle northern limb is inferred from the back-tilted lower terrace and the folding of the gravel layer parallel to the lower terrace surface. The timing of the seismic event which formed the folding and unconformity is dated to between AD 840 and 920.

The trench investigation at Gabrakhari, on the western part of the Dauki fault, revealed that the Dauki fault ruptured in AD 1548 (Morino et al., 2011). Because the 1897 great Indian earthquake ($M \geqslant 8.0$; Yeats et al., 1997) was caused by the rupture of the Dauki fault (Oldham, 1899), it is clear that the Dauki fault has ruptured three times in the past one thousand years. The timing of these seismic events coincides with that of the paleo-liquefactions confirmed on the Shillong Plateau. It is essential for the paleo-seismological study of the Dauki fault to determine the surface ruptures of the 1897 earthquake. The Dauki fault might be divided into four rupture segments, the western, central, eastern, and easternmost segments. The eastern and western segments ruptured in AD 840–920 and in 1548, respectively. The 1897 earthquake might have been caused by the rupture of the central segment.

1. Introduction

The Dauki fault which passes along the southern margin of the Shillong Plateau is an E–W trending reverse fault inclined to the north (Fig. 1a). The 1897 great Indian earthquake ($M \geqslant 8.0$; Yeats et al., 1997) is one of the four great earthquakes that have occurred in the Himalayan front over the past one hundred years (Yeats et al., 1997; Ambraseys and Bilham, 2000). This high-intensity distribution suggests that the 1897 earthquake was caused by the rupture of the Dauki fault (Oldham, 1899; Molnar, 1987; Yeats et al., 1997). However, there is no evidence of surface ruptures on the Dauki fault (Yeats et al., 1997). The Sylhet Trough on the south of the Shillong Plateau exhibits a remarkable negative Bouguer gravity anomaly of over −70 mgal, whereas the Shillong Plateau shows a positive Bouguer gravity anomaly of over +20 mgal (Rahman et al., 1990; Narula et al., 2000; Rajendran et al., 2004). This finding indicates that the Sylhet Trough is subsiding through the repeated ruptures of the Dauki fault, and the thick Quaternary sediments that are presently accumulating. The Shillong Plateau has a differential topographic profile with a southern steep slope and a northern gentle slope (Fig. 1b). This finding is indicative of the tectonic geomorphology of the Dauki fault (Morino et al., 2011). This evidence suggests that the Dauki fault is active during

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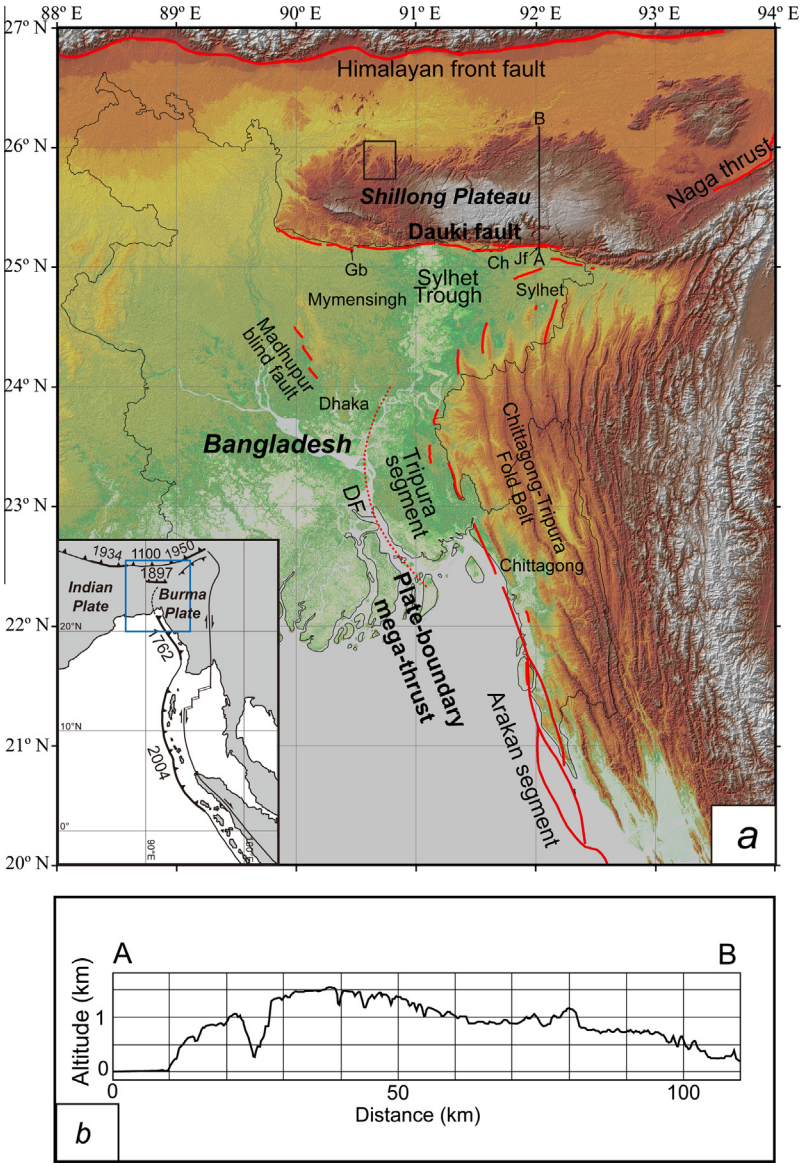

Fig. 1. (a) An active fault map of Bangladesh. The Dauki fault passes along the southern margin of the Shillong Plateau. The plate boundary mega-thrust between the Indian and the Burman plate around Bangladesh is divided into the Tripura and the Arakan segments. The broken line represents its deformation front (DF). The fault traces of the Arakan segment and the deformation front are after Maurin and Rangin (2009). The rectangle to the northwest of the Shillong Plateau represents the area of the paleo-liquefaction study after Sukhija et al. (1999). The shaded background map is made using the elevation data of the Shuttle Radar Topography Mission (SRTM). Gb: trench site at Gabrakhari (Morino et al., 2011), Jf: trench site at Jaflong, Ch: Chhatak, (b) A topographic profile of the Shillong Plateau across the trench site at Jaflong in the N–S direction. The line A–B is shown in Fig. 1a.

the Late Quaternary time period. However, previous studies suggested that the Dauki fault has not ruptured in the historical past (Chen and Molnar, 1990; Kayal, 2001; Rajendran et al., 2004), although no tectonic geomorphological or paleo-seismological surveys were performed.

Morino et al. (2009, 2011) first identified the active Dauki fault in the trench at Gabrakhari Village and suggested that the Dauki fault ruptured in AD 1548, though it was a small secondary fault that had branched off from the main fault. The 1548 earthquake, which is the first large earthquake recorded in Bangladesh, shook both Sylhet and Chittagong (http://www.banglapedia.org/HT/E_0002.HTM, last accessed on 18 December 2013). Another opinion is that the mega-thrust between the Indian and Burman plate, the Tripura segment or deformation front (DF) shown in Fig. 1a, generated the 1548 earthquake (Steckler et al., 2008). However, if the mega-thrust was the seismic source of this earthquake, Dhaka or nearby Sonargaon, the capital at the time, would have received severe damage. However, there are no historical records of the damages to Dhaka in 1548, although the records might be unreliable. The timing of the seismic event at the Gabrakhari trench site by Morino et al. (2011) is credible because the radiocarbon ages are based on samples of charcoal, peat, and wood fragments that are proper for dating. However, Morino et al. (2011) is also unable to explain the damages to Chittagong in 1548. Synthetic paleo-seismological studies of the Dauki fault and the plate boundary mega-thrust are necessary to reveal the seismic source of the 1548 earthquake.

It is essential to the paleo-seismological study of the Dauki fault to find the surface ruptures of the 1897 earthquake. Although the paleo-liquefactions in 1897 are evident around Gabrakhari, on the western part of the Dauki fault (Morino et al., 2011), there is no evidence of any surface ruptures in 1897. It is unclear whether the Dauki fault around Gabrakhari did not ruptured in 1897, or whether a subsurface rupture of the Dauki fault did not reach the