Quaternary International xxx (2017) 1–15

Contents lists available at ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

Late Pleistocene-Holocene strain release by normal faulting along the Main Boundary Thrust at Logar in the northwestern Kumaon Sub Himalaya, India

George Philip*, Narayana Panicker Suresh, R. Jayangondaperumal

Wadia Institute of Himalayan Geology, 33 G.M.S Road, Dehradun, 248 001, India

A R T I C L E I N F O

Article history:
Received 31 March 2016
Received in revised form
13 May 2017
Accepted 15 May 2017
Available online xxx

Keywords:
Normal faulting
Late Pleistocene-Holocene
Trench excavation
Paleoseismological investigation
NW Himalaya
Main Boundary Thrust

A B S T R A C T

A prominent NW-SE trending linear fault, the Logar Fault, which vertically displaced the Quaternary alluvial fan (Logar fan) was delineated previously at Logar village in northwestern Kumaon Sub Himalaya. Based on the surface expression of the discontinuous scarp, and its expression on the satellite data, the fault has been further extended on either sides to a total length of ~9.5 km, which in part lies in the older Himalayan mega thrust zone of weakness, the Main Boundary Thrust (MBT). The distinctive south side up scarp maintains linearity throughout its length, cut across the Logar mega fan and thus form as a normal fault within the compressive regime. Logar normal fault has truncated and uplifted a remnant of the Logar fan by >15 m since its deposition ~20ka, based on the OSL dates of the fan sediments. A trench excavation survey across the Logar Fault scarp for paleoseismic investigation was carried out at Bairasari village. Variable height of the fault scarp along its strike suggests multiple faulting events that occurred along the same fault yielded a cumulative vertical height from 15–38 m. The OSL ages from the footwall show multilevel surfaces deposited between 20 and 8.7ka. However, in the hanging wall, the base of the vertically stacked deposits show an age ~20ka. The OSL age in the bottom unit of the trench in the hanging wall suggest commencement of post faulting deposition of the units after 20ka. In the footwall, younger ages of 11 and 8.7ka probably represent the youngest dated activity of the fault. The ages obtained across the fault shows that the 20ka deposits are displaced. The nature of faulting of Logar fan suggest its genetic link with seismic activity in this region. The geomorphic expression of the Logar Fault along the Himalayan mega thrust suggest subsequent tectonic activity along the MBT. The active Logar normal fault identified north of the Himalayan Frontal Thrust (HFT) indicates that elastic strain released within the hanging wall is not limited to the front, but it is dispersed above the decollement over a broad area.

© 2017 Elsevier Ltd and INQUA. All rights reserved.

1. Introduction

Himalaya, the highest mountain belt of the world, uplifted subsequent to the collision between Indian and Eurasian plates around 50Ma along the Indus-Tsangpo Suture Zone (ITSZ). Continued convergence of the Indian plate and crustal shortening produced linear to arcuate zones of tectonic deformation along the prominent boundary faults of the Himalayan orogenic belt (Gansser, 1964; Seeber and Armbruster, 1981; Lyon-Caen and Molnar, 1983; Valdiya, 2003). These crustal scale major tectonic features such as the ITSZ, Main Central Thrust (MCT), Main Boundary Thrust (MBT) and Himalayan Frontal Thrust (HFT) have contributed to the present day structural and topographic architecture of the fold and thrust belt of the Himalaya. At depth the MCT, MBT and HFT possibly join along the Main Himalayan Thrust (MHT of Zhao et al., 1993) which is considered as the decollement and along the moderately dipping ramp of MHT, large magnitude Himalayan earthquakes nucleate (Ni and Barazangi, 1984; Lyon-Caen and Molnar, 1985; Molnar, 1990; Yeats and Thakur, 1998; Mugnier et al., 2013). Many imbricate structures of the MBT in the Sub Himalaya (consisting of Tertiary group of rocks) developed due to the ongoing convergence along the Himalayan front.

The geodetic, GPS and seismic studies in the Himalaya have provided significant data on the ongoing crustal deformation and

* Corresponding author.
E-mail address: drgphilip@gmail.com (G. Philip).

http://dx.doi.org/10.1016/j.quaint.2017.05.022
1040-6182/© 2017 Elsevier Ltd and INQUA. All rights reserved.

Please cite this article in press as: Philip, G., et al., Late Pleistocene-Holocene strain release by normal faulting along the Main Boundary Thrust at Logar in the northwestern Kumaon Sub Himalaya, India, Quaternary International (2017), http://dx.doi.org/10.1016/j.quaint.2017.05.022

ARTICLE IN PRESS

convergence in the Holocene time on a regional scale. The GPS based measurements show that the India-Eurasia ongoing convergence rate is ~37–50 mm/yr (DeMets et al., 1994; Tapponnier et al., 2001; Banerjee and Bürgmann, 2002; Bilham, 2004; Bilham and Wallace, 2005; Jade et al., 2014; Kundu et al., 2014). Based on slip rates of faults from the Himalaya to Siberia, the finite element models prepared suggest that the convergence rates at the Himalayan front decrease from east to west (Peltzer and Saucier, 1996). Higher potential estimates of convergence rates in the western Himalaya have important implications for shorter recurrence intervals and the associated seismic hazard in the Himalayan foot hills (Oatney et al., 2001).

Convergence and shortening have been accommodated along various such thrust planes and have eventually resulted in generation of numerous active faults along which large-magnitude earthquakes generated (Nakata, 1989; Malik et al., 2003, 2010; Malik and Nakata, 2003; Kumar et al., 2006; Philip and Virdi, 2006). The tectonic landforms thereby developed indicate explicit crustal movements and deformation in the Sub Himalaya. Although most of the paleoseismic investigations made in the past decade have been focussed along the Frontal Himalaya (i.e. within the Himalayan Frontal Thrust zone), only few work have been carried out in the Sub Himalaya (Oatney et al., 2001; Kondo et al., 2008; Philip et al., 2011, 2012; Malik et al., 2015; Jayangondaperumal et al., 2016). Therefore, identification and mapping of tectonic landforms and active faults are significantly important for recognizing the potential of earthquake hazards of these zones.

Traditional paleoseismological investigations using trench excavation surveys have offered significant information on the behaviour of an active fault. However the paleoseismic events can be better understood by considering multiple parameters which include primary and secondary effects of the earthquakes (Stiros and Pirazzolit, 1995; Chen et al., 2004; Mörner, 2011). Using satellite data, supplemented with trench excavation survey, a prominent active fault, the Logar Fault, which vertically displaced the Quaternary alluvial fan, has been studied at Logar village (Figs. 1 and 2) in the MBT zone in northwestern Kumaon Sub Himalaya. This communication presents evidence of large magnitude paleoearthquake occurred along this fault in the Late Quaternary, with age constraints using luminescence chronology.

2. Data sources and methodology

CORONA satellite photographs and multi-spectral satellite data of the Logar area constituted the main data source for the present study. The DEM taken from the SRTM data found useful to map some of the major structures of the study area. The satellite images provided by Google™ was also used as they provide 3D expressions of the terrain. The landform map of the area was prepared using aerospace data. A trench excavation survey across the fault scarp was carried out for paleoseismological studies in Bairasari village, Logar Gad valley. Besides using Total Station, the trench log was prepared both by hand logging and by photo logging. Selected samples of the sedimentary units, collected from the exposed trench as well as from the nearby terrace and fan deposits, were dated by Optically Stimulated Luminescence (OSL) techniques using the facility at the Wadia Institute of Himalayan Geology, Dehradun.

3. Geological set up

The study area falls within the zone of the MBT in Kumaon Sub Himalaya (Fig. 2). The MBT, a major north dipping mega thrust, separating the Proterozoic rocks of the Lesser Himalaya from the early Tertiary sediments of the Sub Himalaya (Medlicott, 1864). Because of the thrusting of Proterozoic rocks over the Tertiary rocks, the MBT therefore act as a structural, lithological and orographic boundary between the Sub and Lesser Himalaya. The Lesser Himalayan rocks in the Kumaon Himalaya was subsequently mapped in detail by Valdiya (1980). The hanging wall of the MBT in the study area is occupied by the Proterozoic rocks of the Lesser Himalaya (the Bhimtal-Bhowali formation) with a definite tectonic

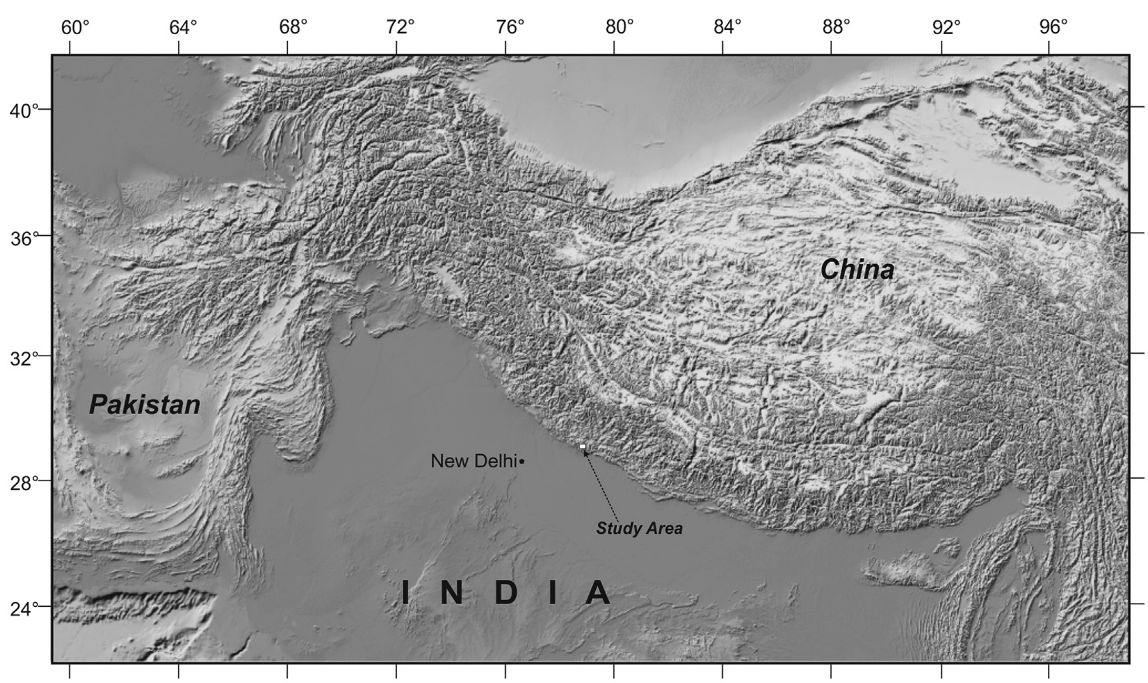

Fig. 1. Satellite image (DEM) showing the regional location of the study area.

Please cite this article in press as: Philip, G., et al., Late Pleistocene-Holocene strain release by normal faulting along the Main Boundary Thrust at Logar in the northwestern Kumaon Sub Himalaya, India, Quaternary International (2017), http://dx.doi.org/10.1016/j.quaint.2017.05.022

Download English Version:

https://daneshyari.com/en/article/7451076

Download Persian Version:

https://daneshyari.com/article/7451076

Daneshyari.com