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Tectonic studies and crustal shortening across Easternmost Arunachal Himalaya

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ABSTRACT

The Easternmost Arunachal Himalaya has a complex geological and tectonic setting due to triple junction of Indian Plate, Eurasian Plate and Myanmar Platelet. In this region, high degree of crustal shortening is observed, Tethyan Himalaya part is missing and Siwaliks has been eroded completely. Here, we present an updated geological map of the Easternmost Arunachal Himalaya and a balanced palinspastic cross section through the Himalayan thrust-fold belt, along Roing–Hunli–Anini section. The crustal shortening in this area has been accommodated in the present geologic setting by northward thrusting of litho-units consequently developing a duplex below Hunli Village. Balanced palinspastic cross sections reveal that about 16.2 km thick roof over Hunli window has been eroded implying extreme exhumation, erosion and fast un-roofing processes that landscaped a window at Hunli and a klippe at Mayodia. In comparison with other parts of Himalaya, crustal shortening in the Easternmost Arunachal is maximum with a shortening strain of 83.28% which may be related with the bending around the Eastern Himalayan Syntaxis. It has been observed that crustal shortening in the Lesser Himalaya Sequence in the area is around 81.46%.

1. Introduction

The loftiest Himalayas owe their origin to the Cenozoic continent–continent collision between Eurasian Plate and Indian Plate (Yin and Harrison, 2000; Yin, 2006). The crustal shortening in the Himalaya between these two continents based on neo-tectonic deformation (Lave and Avouac, 2000; Malik and Mohanty, 2007) and global positioning system (GPS) motion rates (Bilham et al., 1997; Jade et al., 2007; Burgess et al., 2012; Verma and Bansal, 2012) shows an approximately 20 mm/yr. of convergence. Crustal shortening studies by numerous researchers (Schelling and Anita, 1991; DeCelles et al., 2002; Mitra et al., 2005; Long et al., 2010; Yin et al., 2010a) proposed different percent shortening strain along strike of Himalaya.

The Easternmost part of the Himalayan orogeny exhibits a sharp curve in regional strike direction from NE–SW to NW–SE around the Eastern Himalayan Syntaxis (EHS) at the Siang Antiform (Wadia, 1931; Singh, 1993; Acharyya, 1998; Valdiya, 1998.). In plate tectonic model, the Easternmost Arunachal Himalaya is considered as a complex triple junction zone that joins the Indian and Eurasian plates with Northern end of Myanmar Platelet (Fig. 1). These complex geologic and tectonic settings initiated a debate about tectonic evolution of the Eastern Arunachal Himalaya. A group of researchers believed that the Eastern Arunachal block (~Mishmi Block) is a continuation of the Western Arunachal Himalaya and metamorphic rocks from the Indian Plate occurs structurally below the Indus-Yarlung-Tsangpo Suture (Gansser, 1964; Thakur and Jain, 1975; Acharyya, 1980; Singh and Chowdhury, 1990; Burg et al., 1998; DiPietro and Pogue, 2004; Misra, 2009).While another group considers the Eastern Arunachal block (~Mishmi Block) as a part of Eurasian Plate (Mogok Metamorphic Belt, MMB) (Gururajan and Choudhuri, 2003; Sarma et al., 2009). Subsequently, Gururajan and Choudhuri (2003), tectonically divided the area into three units, the Mishmi Crystallines as an extended part of the Eastern Himalaya; the Eastern Belt of Lohit Plutonic Complex (LPC) as northward directed extension of MMB of the Central part of Myanmar and Western Belt as part of the Gangdese Batholith of Ladakh. Subsequent modifications on geology of the region were given by Misra (2009) whereby tectonic units based on stratigraphy and litho-contacts were established from cross-sections along a longitudinal profile. Any studies on crustal shortening and their deformation in this part of the Himalaya are still not yet explored.

Considering these aspects further discussion is needed however due to its inaccessibility and its remoteness, the Eastern Arunachal has received little attention so far. This research study focuses on three main aspects, (a) determining whether the Easternmost

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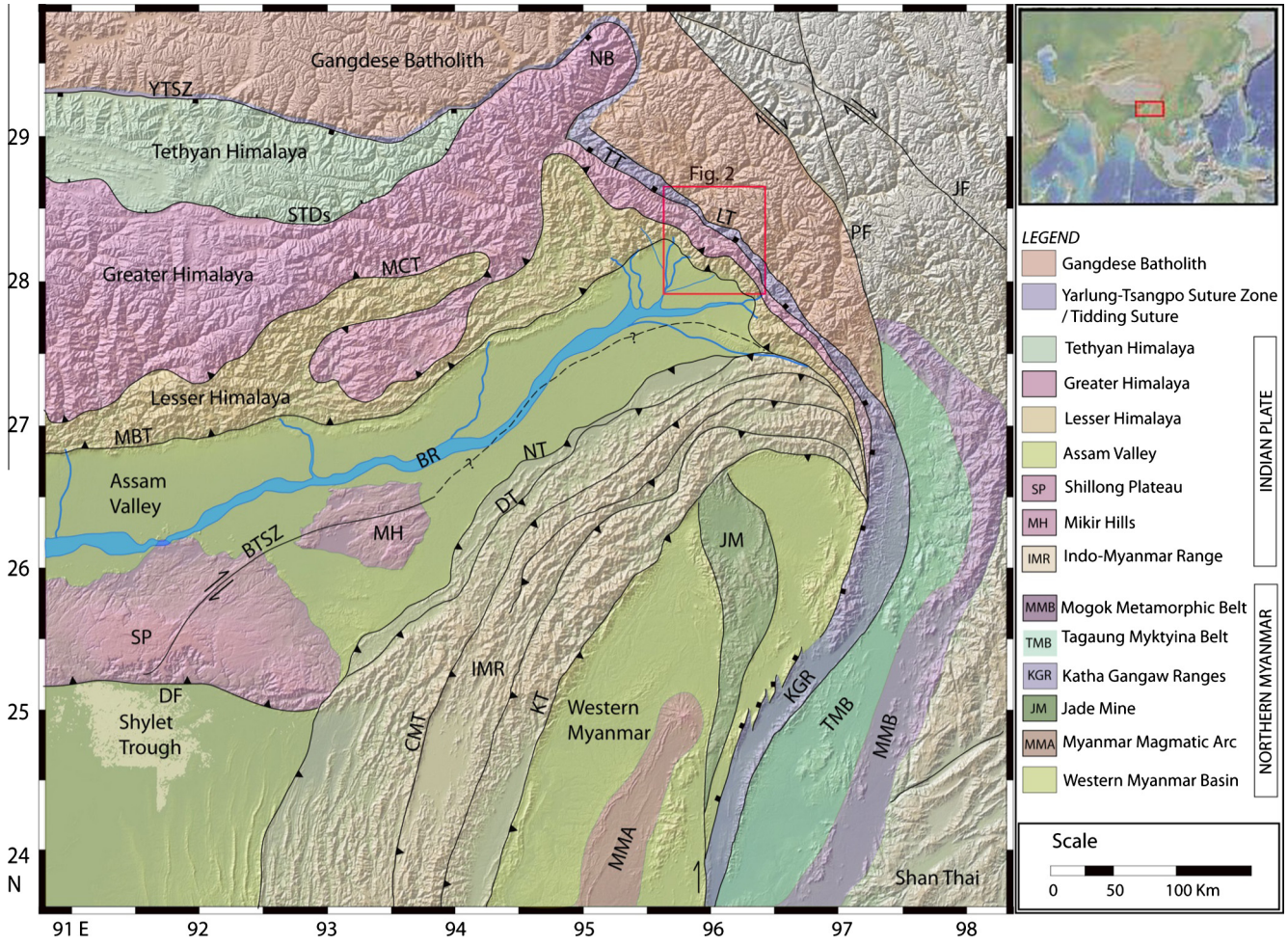

Fig. 1. Geological map of Arunachal Himalayas and surrounding region (Modified after Searle et al., 2007; Yin et al., 2010a; Ningthoujam et al., 2012). YTSZ – Yarlung Tsangpo Suture Zone; NB – Namcha Barwa; STD – South Tibet Detachment; MCT – Main Central Thrust; MBT – Main Boundary Thrust; SP – Shillong Plateau; BTSZ – Badapani Trysad Shear Zone; MH – Mikir Hills; DF – Dauki Fault; BR – Brahmaputra River; LT – Lohit Thrust; TT – Tidding Thrust; PF – Pugu Fault; JF – Jaile Fault; NT – Naga Thrust; DT – Dishang Thrust; CMT – Churchandpur Mao Thrust; IMR – Indo Myanmar Range; KT– Kabaw Thrust; JM – Jade Mines Belt; KGR – Katha-Gangaw Ranges; TMB – Tagaung-Myiktina belt; MMB – Mogok Metamorphic Belt.

Arunachal is part of the Himalayan thrust-fold belt or the northern tip of Arakan-Yoma Fold Belt (AYFB) or the northern tip of Myanmar Platelet, (b) determining shortening magnitude along the thrust-fold belt for analysing how the cenozoic continent–continent convergence was accommodated and (c) determining a minimum shortening estimate by way of balanced palinspastic reconstruction along Roing–Hunli–Anini longitudinal profile in Dibang Valley (Fig. 2). This new details on crustal shortening hopes to fill a significant gap for tectonic studies in this part of the region and allows us to compare crustal shortenings with other parts of the Himalayas.

Our paper endeavours to offer estimation for crustal shortening in the Easternmost Arunachal by introducing an updated geologic map. Balanced cross section of the area was prepared on the basis of field mapping to elucidate structures offering minimum shortening in this fold-thrust belt (Fig. 5).

2. Mapping methods

This paper will introduce an updated geologic map of the area based on data collected from field. The map concentrates on areas located between Mishmi Thrust in the South and Walong Thrust in the North. Field data were collected along the Roing–Hunli and Hunli–Anini traverse from south to north across strike profiles AB and CD respectively (Fig. 2) and projected on balanced palinspastic cross section (Fig. 4). Survey of India toposheets 82 P/14 and 82 P/15 on scale 1:50,000 were used as the base map for mapping. The mapped data were correlated and integrated with previously published geological maps (Gururajan and Choudhuri, 2003; Misra, 2009) and seismic studies (Mitra et al., 2010; Hazarika et al., 2012) of the area.

3. Geology and tectonic settings

3.1. Regional geology

The Easternmost Arunachal Himalaya has a complex geological and tectonic setting for being the triple junction of Indian Plate, Eurasian Plate and Myanmar Platelet in this region. The collision process created the Himalayan Thrust-Fold Belt (HTFB) and Arakan-Yoma Fold Belt (AYFB) in Indian Plate Margin; Jade Mine Belt (JMB), Katha-Gangaw Ranges (KGR), Tagaung-Myiktina belt (TMB) and Mogok Metamorphic Belt (MMB) in Northern Myanmar (Fig. 1).

3.1.1. Himalayan thrust fold belt

Broadly following from south to north, the geology of Himalaya is divided into:- (a) Sub-Himalaya Siwaliks (SHS); (b) Lesser