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Research paper

Lesser Himalayan sequences in Eastern Himalaya and their deformation: Implications for Paleoproterozoic tectonic activity along the northern margin of India

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ABSTRACT

Substantial part of the northern margin of Indian plate is subducted beneath the Eurasian plate during the Caenozoic Himalayan orogeny, obscuring older tectonic events in the Lesser Himalaya known to host Proterozoic sedimentary successions and granitic bodies. Tectonostratigraphic units of the Proterozoic Lesser Himalayan sequence (LHS) of Eastern Himalaya, namely the Daling Group in Sikkim and the Bomdila Group in Arunachal Pradesh, provide clues to the nature and extent of Proterozoic passive margin sedimentation, their involvement in pre-Himalayan orogeny and implications for supercontinent reconstruction. The Daling Group, consisting of flaggy quartzite, meta-greywacke and metapelite with minor mafic dyke and sill, and the overlying Buxa Formation with stromatolitic carbonate-quartzite-slate, represent shallow marine, passive margin platformal association. Similar lithostratigraphy and broad depositional framework, and available geochronological data from intrusive granites in Eastern Himalaya indicate strikewise continuity of a shallow marine Paleoproterozoic platformal sequence up to Arunachal Pradesh through Bhutan. Multiple fold sets and tectonic foliations in LHS formed during partial or complete closure of the sea/ocean along the northern margin of Paleoproterozoic India. Such deformation fabrics are absent in the upper Palaeozoic–Mesozoic Gondwana formations in the Lesser Himalaya of Darjeeling-Sikkim indicating influence of older orogeny. Kinematic analysis based on microstructure, and garnet composition suggest Paleoproterozoic deformation and metamorphism of LHS to be distinct from those associated with the foreland propagating thrust systems of the Caenozoic Himalayan collisional belt. Two possibilities are argued here: (1) the low greenschist facies domain in the LHS enveloped the amphibolite to granulite facies domains, which were later tectonically severed; (2) the older deformation and metamorphism relate to a Pacific type accretionary orogen which affected the northern margin of greater India. Better understanding of geodynamic evolution of the northern margin of India in the Paleoproterozoic has additional bearing on more refined model of reconstruction of Columbia.

1. Introduction

The Himalaya is a young mountain chain arising out of continental collision between the Indian plate and the Eurasian plate since about 48 Ma before present (e.g. Le Fort, 1975). However, the Lesser Himalayan domain tectonically bound between the Main Central Thrust (MCT) and the Main Boundary Thrust (MBT) is constituted of deformed Proterozoic rock sequences dating back to ~1.8 Ga (Kumar, 1997; Yin et al., 2010a). The Indian shield in its peninsular part is also known to have widespread development of Proterozoic rock sequences in the intracratonic basins as well as fold belts (or mobile belts) that occur along the cratonic margins or

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joins. The (meta-) sedimentary sequences in the Lesser Himalaya are multiply deformed even in domains away from the major boundary thrusts – MCT and MBT. The MBT and MCT are known to accommodate large part of the Himalayan collisional shortening in the Darjeeling-Sikkim Himalaya (e.g. Bhattacharya and Mitra, 2009). Similar tectonic shortening has also been established for traverses across Bhutan and Arunachal Pradesh (Yin et al., 2010b; Long et al., 2012). Available geochronological data from intrusive rocks in the Lesser Himalaya of the Eastern Himalaya suggest a phase of deformation in this domain, which is pre-Himalayan (e.g. Sinha-Roy, 1973; Paul et al., 1982; Kumar, 1997). The Indian shield is suggested to have been involved in more than one supercontinent assembly and break-up since the Paleoproterozoic (e.g. Rogers and Santosh, 2004), and many authors have focussed on the Proterozoic Eastern Ghats and adjoining terrain along southeastern margin of India, or the Central Indian mobile belts (cf. CITZ), to unravel India's proximity or otherwise with other Gondwana fragments in the better known reconstructions on assembly/break-up of Pannotia-Gondwana (ca. 550 Ma), Rodinia (1100–900 Ma) or even older less well constrained Columbia (Mohanty, 2012; Santosh, 2012). In this paper we focus on the Lesser Himalayan Proterozoic sequences of Eastern Himalaya in Sikkim and Arunachal Pradesh (Fig. 1).

The southern and eastern margins of Peninsular India are associated with exhumed granulite terrains as in the Eastern Ghats or the southern granulite terrain, which are interpreted as products of continental collision linked to Rodinia assembly, and/or Pan-African orogeny (e.g. Collins and Pisarevsky, 2005; Collins et al., 2008). The Lesser Himalaya is not known to have granulite facies rocks. Thus it is open to question whether the earlier deformation in this belt is linked to any Alpine-Himalayan type collisional orogen, Andean type orogen, accretionary orogen or an intracratonic mobile belt typical of Precambrian cratons. An overview of the development of the precursor to Lesser Himalaya from Darjeeling-Sikkim and western Arunachal Pradesh, prior to the onset of Himalayan orogeny is presented here. The salient features of deformation in these sectors are analysed to distinguish between a supposed Proterozoic development and those related to Caenozoic Himalayan orogeny. New microstructural and mineral composition data on garnet porphyroblasts from Sikkim are also presented to comment on the distinctive character of the older kinematic framework as opposed to that related to Caenozoic deformation-metamorphism-migmatisation in the MCT zone.

2. Overview of the stratigraphy of the Lesser Himalaya

Structurally below and south of the Main Central Thrust (MCT) Proterozoic sedimentary successions are outcropped in the Darjeeling-Sikkim sector and in Arunachal Pradesh. These meta-sedimentary successions usually lie over the Palaeozoic–Mesozoic Gondwana rocks above the Main Boundary Thrust (MBT). The above successions are strongly deformed and metamorphosed, and in Arunachal Pradesh some of the metasedimentary rocks are intruded by ca. 1925 ± 23 Ma and 1536 ± 60 Ma old granites represented by Bomdila granite gneiss at Bomdila and Salari respectively (Dikshitulu et al., 1995; Kumar, 1997) attesting to Paleoproterozoic antiquity of these rock succession, namely the Bomdila Group (Table 1). In recent years, U-Pb zircon geochronology of the rock groups in western Arunachal Pradesh suggests Bomdila gneiss to be 1743 ± 4 Ma old (Yin et al., 2010b). Detrital zircon geochronology from western Arunachal Pradesh also corroborates that the upper part of the Lesser Himalayan succession (Lumla Formation/Dirang Formation) could be as old as 1600 Ma (Yin et al., 2006).

The main rock group in the Lesser Himalaya of western Arunachal Pradesh is the Bomdila Group intruded by the granite gneiss (Bomdila gneiss and other younger granites). The Bomdila Group consists dominantly of shallow marine sedimentary succession (now metamorphosed up to garnet-sillimanite grade) is subdivided into three formation rank units—the Khetabari Formation, the Tenga Formation and the Chilliepam Formation in ascending order (Kumar, 1997). The topmost formation represents a thick and extensive carbonate platform (Table 2), which

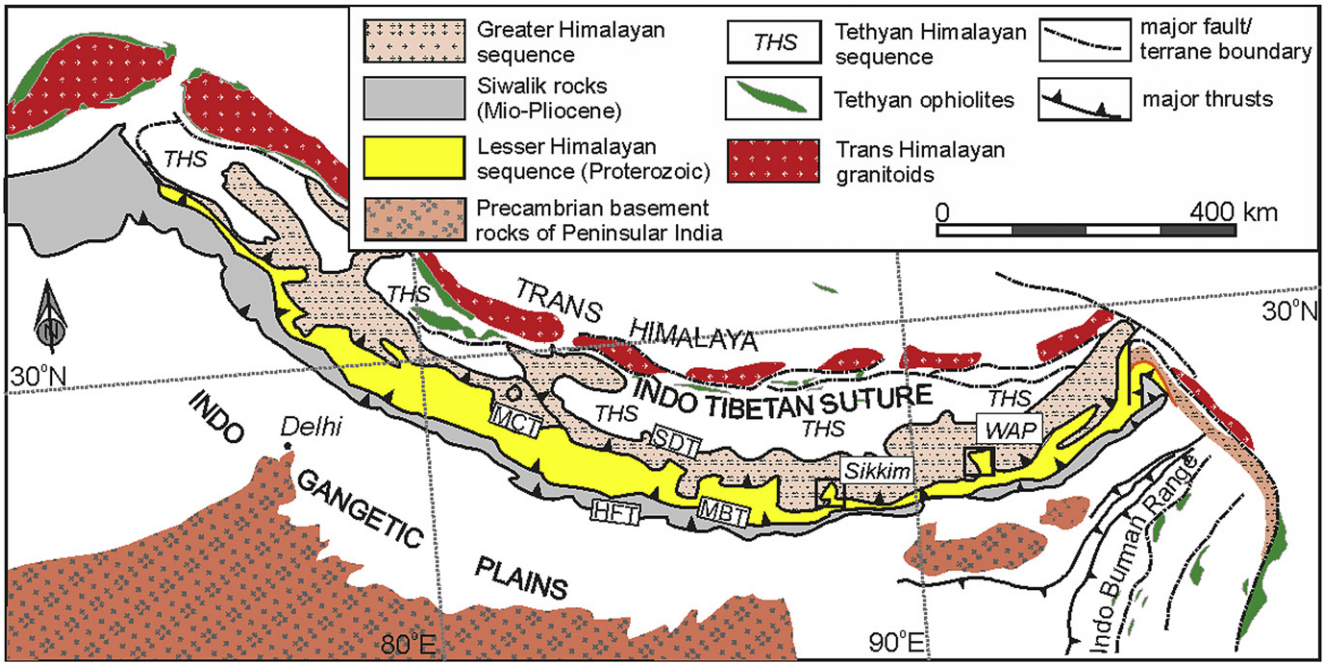

Figure 1. Simplified regional geologic map of the Himalaya (after Acharyya, 2007). Study areas in Sikkim and western Arunachal Pradesh (WAP) are shown boxed. HFT = Himalayan Frontal Thrust; MBT = Main Boundary Thrust; MCT = Main Central Thrust; STD = South Tibetan Detachment.