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Research Paper

Kink band microstructures in Mica in the Dafla Formation of the Siwalik Group of rocks, West Kameng District, Arunachal Pradesh

Geology

KEYWORDS : Micaceous sandstone, Dafla Formation, Siwalik belt, Arunachal Pradesh

Tapos Kumar Goswami : Department of Applied Geology, Dibrugarh University, Dibrugarh 786004, Assam

ABSTRACT

The Neogene Siwalik sequence of western Arunachal Pradesh comprises northward dipping thrust sheets structurally below the Main Boundary Fault (MBT) and above the Main Frontal Thrust (MFT). In the foreland propagating thrust package, the compact and micaceous Dafla sandstone –shale-clay stone sequence is thrusted over the semi consolidated Subansiri sandstone –clay sequence. Near the zone of cataclasis the micaceous Dafla sandstones show microscale kink folds. These kink bands verge in the same direction of the vergence of the mesoscale folds in the Dafla sandstones. Both mobile and fixed hinge kink bands are observed showing lot of variation in the angles. At the initial stage the high water pressure under elevated confining pressure may play a vital role in the development of these kink bands. At the initial diagenetic temperature where mica shows considerable ductility the quartz and feldspar grains show brittle fracturing in response to the compression parallel to the (00)1 basal plane of mica.

Introduction

The Siwalik foreland basin fringes the Arunachal Himalayan range along more than 250km from Bhutan in the west to the Roing in the east. Structural architecture of the Siwalik belt in the western and Central Himalayas have been intensively studied (Valdiya, 2003; Mugnier et al, 1999; Husson and Mugnier, 2003 Najman 2006; Singh, 1999 ; Srivastava, D.C. and Jhon, G.,1999; Srivastava, P. and Mitra, G., 1994) However, there is no data of the geometry of the thrust system in the Siwalik belt in the Arunachal Himalaya. The Arunachal Himalayan segment of the Himalayan orogenic system is located east of Bhutan between 91°30′ and 96°E longitude. The present area of investigation area between longitude 91° 32' E - 97° 30' E and Latitude 26° '28 N - 29° 30' N includes the Bhalukpong-Elephant road section of West Kameng District of Arunachal Pradesh (Fig.1). The Sub-Himalayan Siwalik fold and thrust belt comprises four lithotectonic units between MBT and MFT (Kelty et al, 2004).These are Kimi, Dafla, Subansiri and Kimin Formations (Kumar, 1997). In the Kameng sector, Tipi Thrust is interpreted to be an intraformational thrust within Subansiri Formation contrary to interformational between Dafla and Subansiri Formation (Yin et al, 2006). The Dafla Formations is thrusted over the Subansiri Formation relatively at higher structural level.

In Arunachal part, geologic investigations based on field studies lack detail descriptions of each lithounit, especially geometry of the structural development therein and there is an urgency of description of these structures in the context of modern day knowledge and interpretations of these structures in the context of continental collsional tectonics (Acharyya et al, 1983; Kelty et al, 2004; Valdiya, 2003;; Srivastava and Mitra, 1994, Bagati T N 1991; Virdi, 1994; Mugnier et al, 1999; Singh, 1999; Srivastava and Jhon, 1999; Yin, 2006). The purpose of the present work is to draw a correlation between the outcrop scale structures of the fold and thrust belt and the micro scale kink bands developed in the micaceous Dafla sandstones near the zones of cataclasis.

Geology of the area

The entire fold and thrust belt shows a large scale ramp and flat geometry. The Lesser Himalayan sequence including the Gondawanas thrusted over the Siwalik Group of rocks along the Main Boundary Thrust (MBT) near Pinjali Nala (Fig.2). The prominent tectonic plane in the north is the Main Boundary Thrust which separates the Lesser Himalayan sequences in the north from the Siwalik sequences in the south, while in the south the Siwalik sequence is juxtaposed over the alluvial planes of Brahmaputra River along a prominent tectonic contact known as Main Frontal Thrust (Nakata, 1972). The north dipping Bhalukpong Thrust (Yin et al, 2006) and the Tipi thrust lie within the Tertiary Siwalik sequences. The Bhalukpong Thrust can be proposed as HFT1.Therefore the Siwalik sequences is sandwiched between the two prominent thrusts. The outcrop scale structures indicate lots of thrust related folds, duplex structures, fault propagation folds and fault bend folds. This indicates progressive nature of deformation. In the microscopic scale, the lithological control is well documented by elongated quartz grains, bent micas, kinking in the micas, strain quartz grains, deformation lamallae, micro-fractures and their orientation patterns. Therefore the mesoscopic or outcrop scale structures are mimicked by the minor or grain scale structures.

The Dafla formation comprises sandy and argillaceous facies association thick to medium bedded, hard, compact, jointed sandstone alternating with thin fissile grey shales, compact claystone, carbonaceous shale, coaly lenses with subordinate siltstone laminations

The Subansiri Formation consists of semiconsolidated to consolidated sandy and argillaceous facies comprising massive to medium bedded friable, salt and peepery sandstones with peebly sandstone and current bedded medium grained sandstone alternating with fissile to compact shale, claystone, sandy clay and soft stone.

The study of the detrital models of the sandstones indicates that the Dafla sandstones are texturally wake in nature, mostly quartz wake to lithic greywake, whereas the Subansiri sandstones show arenitic texture having quartz supported framework grains and classify as quartz areanite and sublithic arenite.

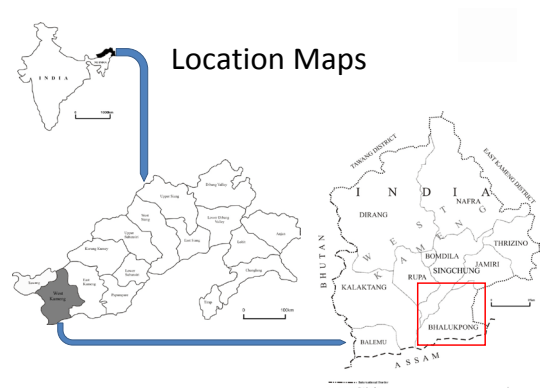

Fig. 1 Map of India, map of Arunachal Pradesh and Location map of the area

Kink band geometry

Kinks form in multi layers with high viscosity contrast and bonded contacts (i.e. high frictional resistance to sliding along the contacts). Compression parallel to the layers produces conjugate kink bends at 55 – 60° to the compression. Loading oblique to the layers (up to 30°) produces asymmetric kink bands. Microscopic to mesoscopic kinks and crenulations of bedding occur in soft clay and shale beds of the Dafla Formation of the Siwalik Group of rocks.

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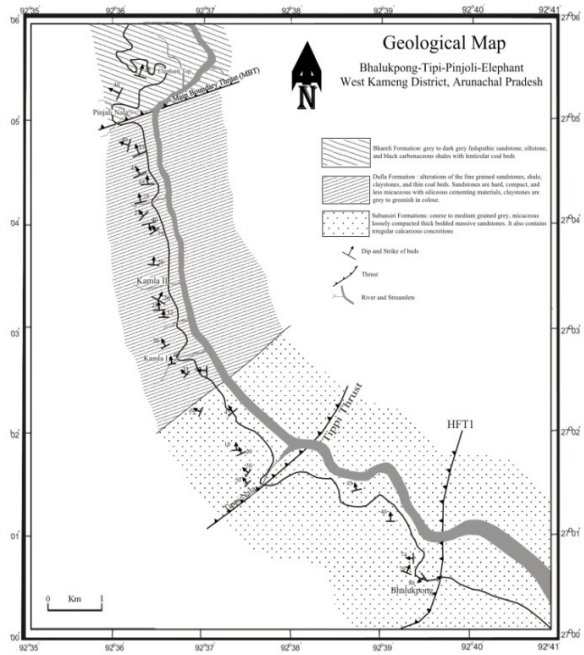

Fig.2 Geological map of the Siwalik sequences along Kameng River section, Arunachal Pradesh

Folding and kinking in the micas are frequent. Kinking and layer parallel slip in the micas are associated with deflection of the basal planes. Diagenesis and maturity of sediments can be correlated on the basis of the temperature dependant changes e.g. lignites in Subansiri and semi bright to bright coaly lenses (lignite-bituminous) in Dafla sandstones. It is observed that most of the kink band boundaries (KBB) are dipping northerly in the gently south dipping parts of the mesoscopic folds. In the steeper limbs of the folds the movement is observed to be towards north and KBB dips steeply towards east or west. This indicates that the layer parallel shortening becomes oblique for shear to take place parallel to the fault plane.Both straight and curved hinge lines of the kink bands are observed (Fig.3a) Most of the vergences are towards southerly direction; however, in Fig.3b the movement is westerly indicates that the shortening is oblique resulting a fault plane parallel shear. The KBB is dipping northerly in Fig.3b.The quartz grains are fractured and the south verging sigmioids are thrusted one sigmoids above another (Fig.3c).

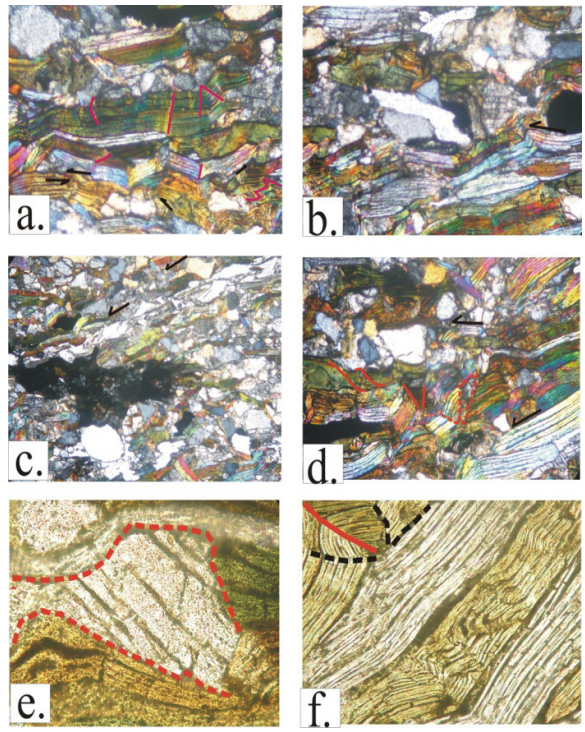

Fig.2 Geological map of the Siwalik sequences along Kameng River section, Arunachal Pradesh

Conjugate kink bands in biotite (Fig.3f) and thrusting of the biotite grains also observed in Fig.3d. The quartz grains fracturing with curved fracture plane are common. Quartz grains showing duplex structure are also observed (Fig.3e) indicates that under the condition where mica grains are showing ductile deformed the quartz grains are exhibiting brittle fractures and authigenic grains becoming sigmoidal in the plane of shear showing dextral senses.

Conclusions

The mesoscopic kink fold geometry in the micaceous Dafla sandstones of Siwalik fold and thrust belt in the Kameng river section is mimicked in the microscopic scale by the mica layers. The vergence of the kink bands are mostly towards south. Both mica and quartz grains are deformed under the same PT conditions under moderate confining pressure and strong north south horizontal stress. However while the mica layers are showing ductile deformation the detrital quartz grains are fractured. However the authigenic quartz grains are completely sheared and are sigmoidal with top to south dextral sense of shear.

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