PROSPECTS OF DELINEATING TERMINAL PROTEROZOIC AND PRECAMBRIAN-CAMBRIAN BOUNDARY IN THE NORTH-EASTERN HIMALAYA

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ABSTRACT

The prospects of delineating a tentative Precambrian-Cambrian boundary in the Buxa-Miri Group of the eastern Lesser Himalaya was documented by Tewari(1984b). Since then, no attempt is made in this direction. The Terminal Proterozoic and Precambrian-Cambrian boundary is now well established in the Blaini-Krol-Tal sediments of the Central sector of Lesser Himalaya. A similar detailed and multidisciplinary integrated study of stromatolites, trace fossils, acritarchs, Ediacaran biota and stable isotope geochemistry and chemostratigraphy is required in the Ranjit window (Sikkim-Darjeeling) and, Siang district of the E and NE Himalayas for demarcating Terminal Proterozoic and PC/C Boundary.

INTRODUCTION

The Terminal Proterozoic and Precambrian-Cambrian boundary is of fundamental importance in earth's early biosphere. The Terminal Proterozoic and Precambrian-Cambrian boundary biota and events are well recorded in the Blaini Krol-Tal succession of the lesser Himalaya (Central sector) in north India. The precise demarcation of the PC/C boundary in the upper-most Krol and the Lower Tal Formation is now more or less established and is a candidate section for Neoproterozoic III and the Precambrian-Cambrian event stratigraphy. (Singh and Rai, 1983, Shankar *et al.*, 1997, Tewari, 1984a, b, 1991, 1993a, b, 1996a, b). The Krol-Tal PC/C boundary section has the maximum potential for global correlation based on palaeontological and carbon isotopic changes across the PC/C boundary (Aharon *et al.*, 1987, Brasier and Singh, 1989, Tewari, 1991, Kumar and Tewari, 1995). Fig 1 shows the sketch geological map of the Eastern Himalaya (after Srivastava *et al.*, 1987) in which the distribution of Buxa-Miri Group rocks from Sikkim to Arunachal Pradesh is shown. The Precambrian-Cambrian biota and events are discussed here and an attempt is made to demarcate PC/C boundary in the East Himalaya based on existing palaeobiological records.

PALAEOBIOLOGICAL RECORD OF TERMINAL PROTEROZOIC -AND PRECAMBRIAN-CAMBRIAN BOUNDARY

The Terminal Proterozoic Lower Krol (Krol A) is essentially a sequence of thinly laminated shales and siltstones with wave dominated shallow marine sedimentary structures like wavy bedding, ripple bedding, ripple drift lamination etc. The palaeobiological records include sheet mega algae, *Vendotaenia, V. antiqua, Krolotaenia, K. gnilovskayi* (Tewari, 1993a, b) and possible metazoan from *Chuaria, Beltanelliformis* from Nainital and Nigalidhar synclines (Tewari, 1991, 1996b). The organic walled microfossils (OWM's) are found in the black bedded and chert nodules from Infra Krol-Krol A succession of Nainital and Solan areas include *Eomycetopsis, Siphonophycus. Obruchevella, Animikiea,*

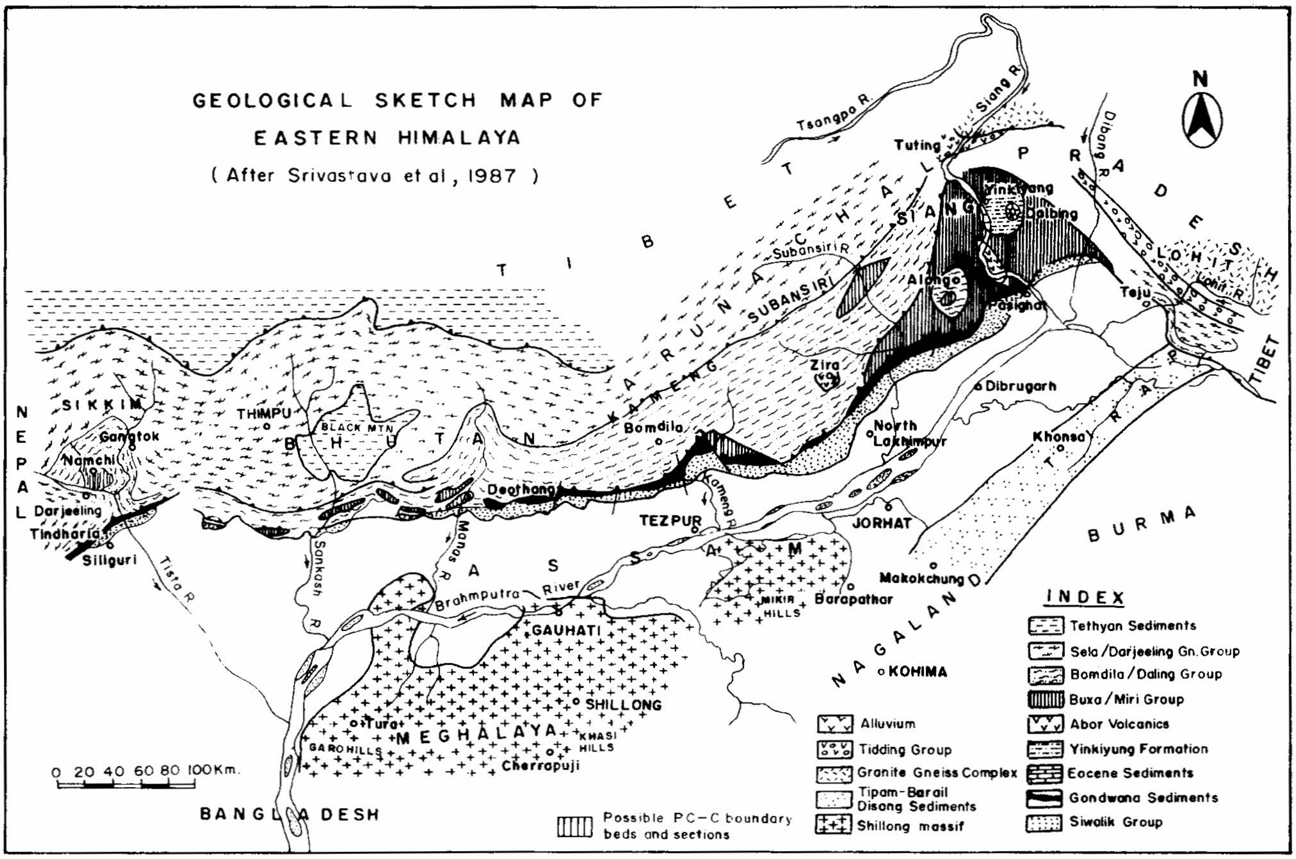

Fig 1.

Myxococcoides, Huronispora, Eosphaera and *Melanocyrillium* (VSM's) (Kumar and Rai, 1992, Tiwari and Knoll, 1995, Venkatachala *et al.*, 1992).

The Middle Krol (B) Formation is represented by red and green shales with thin bands of Limestones. The palaeobiological information is scarce from Krol B except doubtful algae. The Upper part of the Krol Formation (C, D, E Member) has yielded rich and diverse assemblage of Vendian/Ediacaran stromatolites, algae, trace fossils, vendotaenids and impressions of soft bodied medusoids and frond like forms of Ediacaran age (Tewari, 1989, 1991, 1993a, b, 1996a, b, Mathur and Shankar. 1989). The Upper Krol carbonates are microbially formed peritidal deposits. Krol C is a high energy carbonate shoal (dominantly oolitic) deposit with minor development of *Ministromatolites* and *Oncolites*. (Tewari and Qureshy 1985). Krol D is characterized by the development of stromatolite bioherms, biolaminated deposits, small microbial reefs with dominantly thrombolitic clotted fabric formed by *Renalcis cyanobacteria* (Tewari and Joshi, 1993). The Vendian taxa of stromatolites recorded in the Upper Krol formation of Nainital and Mussoorie synclines include *Paniscollenia, Linella, Tungussia, Stratifera, Irregularia, Nucleela, Linocollenia, Minicolumellae* (microstromatolites), *Yugmaphyton, Valdiyaphyton* and *Aldania* (Tewari, 1989, 1991, 1993a, b, 1998a, b). A detailed study of the micro structures of these stromatolites have shown that the *Vermiform* microstructure appeared for the first time in the Krol stromatolites (Tewari and Joshi, 1993). The stromatolite recorded from the Buxa Dolomite of the eastern Himalaya (Acharya, 1974) is not a typical Riphean taxon, have Vendian morphological characters (Tewari, 1984

b), therefore, a detailed systematic study of microstructures is essential (Tewari, 1984b, 1998a). Valdiya (1980) has also attempted regional correlations and suggested a Riphean age for the Buxa stromatolites. Tewari (1992, 1996a) has published a detailed correlation of the Buxa Dolomite and considers Krol Dolomite (Vendian) as equivalent of Buxa Dolomite.

EDIACARAN BIOTA IN KROL FORMATION

The shales, shaly dolomites and siltstones of Krol E represent the uppermost lithounit of the Krol sedimentary cycle. Ediacaran fossils like *Cyclomedusa, Pteridinium, Kimberella, Zolotytsia, Charniodiscus, Irridinites, Beltanelliformis* trace fossils like *Gordia, G. meanderi* and vendotaenid algae *Tyrasotaenia* is recorded from the upper part of the Krol Formation in the Nainital, Garhwal, Mussoorie, Korgai and Nigalidhar synclines (Shankar *et al.*, 1997, Tewari, 1989, 1991, 1993a, b, 1996a, b). These impressions are well preserved in the thinly bedded greyish, pink and black shales which are also characterised by the presence of fine laminations, rhythmites and lenticular bedding indicating subtidal to intertidal depositional environment for these beds. The stalk and the attachment disc of the frond like forms *Charniodiscus* is not found in a a single specimen since the area has been involved in multiple deformation during Himalayan orogeny (Tewari, 1996a, b). On the basis of occurrence of Ediacaran and other fossils a Terminal Proterozoic (Neoproterozoic III/Ediacaran) age is now assigned to the Krol Formation of the Lesser Himalaya (Tewari, 1991, 1993a, b, 1996a, b). The **Ediacaran System** is represented by Krol Formation (**Krolian Period**) which overlies the Blaini Formation (Eocambrian/Varanger glacial beds (Tewari, 1991, 1996 a, b). Mesoproterozoic biota and isotopic signatures have been recorded from Deoban Group (Tewari, 1996b, 1997a). There is a strong possibility of occurrence of Ediacaran fossils in the Buxa sediments of the eastern Himalaya, similar to the Krol Formation of the Central Himalaya. Ediacaran medusoids have been recently recorded from Garbyang Formation of the Tethys Himalaya in Kumaun (Tewari, 1997b, 1998a). Precambrian-Cambrian boundary is also demarcated in the Garbyang Formation (Tewari, 1997b).

SMALL SHELLY FOSSILS AND STROMATOLITES IN TAL FORMATION

The Krol Formation underlies the Lower Tal Formation which has yielded early Cambrian diversified small shelly fossils of Tommotian/Meischucunian Zone I of China (Brasier and Singh, 1989). The Chert Phosphorite Member of the Lower Tal Formation from Mussoorie Syncline contains *Protohertzina, Circotheca, Trapezotheca, Anabarites, Sachites* etc. found at the base of the Cambrian. These characteristic early Cambrian forms are not recorded from the Nainital syncline but the forms like *Coleoloides, Olivooides, Hyolithellus*? *Turchutheca* has been recorded form Sherwood Member (Krol) and Giwalikhet Member (? Tal) (Bhatt and Mathur, 1990). The Giwalikhet Member has also yielded *Chuaria* cf. *circularis* in the black carbonaceous shales (Tewari, 1996b). Tommotian stromatolite taxa *Collumnaefacta vulgaris, Aldania* (Jurusania) *mussoorica, Boxonia gracilis, Compactocollenia, Colleniella, Conophyton durmalacus, Stratifera* oncolites and algae *Obruchevella* is recorded from Chert Phosphorite Member of the Lower Tal Formation (Tewari, 1984a, b, 1989, 1991, 1993b, 1996a), exposed in Durmala and few forms in Surkhet block. The microgastropods, brachiopods, trilobites and abundant trace fossils of Lower Cambrian age have been recorded from the Middle and Upper Tal Formation (Singh and Rai, 1983, Rai and Singh, 1983). The Lower Cambrian brachiopods *Obolella* sp., *Lingulella* sp. and the stromatolite forms *Ilicta talica, Collumnaefacta korgaiensis, Aldania birpica* and macrooncolites have been reported from the thin bands of the limestones and shales within the Phulchatti Quartzite which is the youngest unit of the Tal Formation (Tewari, 1989, 1993b, Tewari and Mathur, 1997). The Tal stromatolite taxa (Lower Cambrian) are characterised by the presence of **patchy** and **vermiform** to **grumous** microstructures. This change in microstructure from **vermiform** in the Krol (Vendian) to the **grumous** in the Lower Tal stromatolites has a bearing on defining the Precambrian/Cambrian boundary (Tewari, 1993b,

Tewari and Joshi, 1993). Early Cambrian trace fossils *Skolithos* and *Planolites* have been recorded from the Miri Quartzite of the eastern Himalaya (Tandon *et al.*, 1979). Jain *et al.*, (1974) have worked out in detail the stratigraphy and structure of the Siang district, Arunachal Pradesh which can be now focussed for a systematic approach and integrated effort towards delineation of Precambrian/Cambrian boundary in the North-Eastern Himalaya. Pashighat-Along-Yinkiyong section is such a potential profile in Siang dome (window) where Buxa/Miri Group is well exposes (Fig. 1).

PRECAMBRIAN-CAMBRIAN BOUNDARY IN THE EASTERN HIMALAYA

The precise position of the Precambrian-Cambrian boundary in the Krol Tal sequence is still a matter of debate and should also be looked in eastern Himalaya. (Fig. 1) Following the guidelines and recommendation of the International Geological Correlation Programme (IGCP-29 and IGCP 303 Working Group)/International Union of Geological Sciences, the Precambrian/Cambrian boundary should lie between the Meischucunian Zone I and Zone II based on small shelly founa assemblage of China and first appearance of trace fossil ***Phycodes pedum*** in Fortune Head, Newfoundland Canada. In India, the Meischucunian Zone I corresponds to the uppermost part of the Chert-Phosphorite Member. Meischucunian Zone II is missing and Meischucunian Zone III small shelly fossils and **redlichid** trilobites (***Redlichia*** cf. ***noetlingi*** and ***Tungusella*** cf. ***obesa***) and brachiopods (***Obolus, Obolella, Lingulella, Magnicanalis*** etc.) have been reported from the Arenaceous Member of Tal Formation (Kumar *et al.*, 1983). The abundance of Lower Cambrian trace fossils including trilobite body fossil is found in the Arenaceous Member. Therefore, in the pending record of Meischucunian Zone II, small Shelly fossils, the Precambrian/Cambrian boundary may be placed between Chert Phosphorite Member and the Arenaceous Member of the Tal Formation and identical sections in other parts of Himalaya. However, the recent decision of IGCP in IGC Kyoto, Japan in 1992 (Brasier *et al.*, 1994) to put the PC/C Boundary on the basis of trace fossils in Fortune Head Section, Canada has been ratified and the boundary has to be redefined calibrating with trace fossils like ***Phycodes pedum*** in all Himalayan and global sections. Hence, a systematic study of trace fossils from Central, Eastern Lesser and Tethys Himalaya is quite significant for delineating Precambrian/Cambrian boundary.

CONCLUSION

The Buxa-Miri sequence of the eastern Himalaya in Sikkim and the Ranjit Valley, in Darjeeling, and Siang Dome (window),Arunachal Pradesh in the NE Lesser Himalaya (Fig. 1) are potential areas for study of the Terminal Proterozoic and Precambrian-Cambrian transition. A future integrated study of extensive search for trace fossils from the Miri Group and stromatolites acritarchs Vendotanids and Ediacaran biota form the Buxa dolomite synchronised with carbon isotope and chemostratigraphy would be very promising for a Precambrian-Cambrian boundary section in the Eastern Himalaya.

ACKNOWLEDGEMENTS

I am thankful to Dr. V.C. Thakur, Director Wadia Institute of Himalayan Geology, Dehra Dun for providing facilities and permission to publish the paper. Mrs. Prabha Kharbanda is thanked for ably typing the manuscript.

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