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## Trilobite and trace fossils biostratigraphy of the Cambrian successions of the Zanskar region, Northwest Himalaya

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The Zanskar region lies within the Tethyan belt of the Indian Himalaya and in conjunction with the adjacent classical Spiti Basin constitute the most and significant part of the northern margin of the Indian plate during the Cambrian period. The Cambrian sediments are well preserved and exposed along the Niri-Tsarap and Kurgiakh valleys in southeastern part of the Zanskar region and are classified under the Haimanta Group which unconformably overlies the crystallines of the Higher Himalaya (NANDA & SINGH 1977, SRIKANTIA *et al.* 1980, GAETANI *et al.* 1986, GARZANTI *et al.* 1986, MYROW *et al.* 2006). The basal Phe Formation (latest Precambrian-?Early Cambrian) of Haimanta Group rest tectonically along the Zanskar Shear Zone and represented by the argillaceous-arenaceous sedimentary successions. No age diagnostic fossils have been recovered from the Phe Formation and assumed stratigraphic age of this formation is latest Precambrian-?Early Cambrian. The overlying Parahio Formation is consists of shale, siltstone, sandstone cycles and dolomites bands prevailing in the upper part and interpreted as deposited in storm influenced environments from offshore marine to shoreface to fluvial settings (MYROW *et al.* 2006a). The overlying Middle Cambrian Karsha Formation is consists of massive dolostone and intercalations of thick – to thinly bedded marl, grainstone, packstone and dolomite beds, interpreted to deposit under shallow water carbonate platform condition. A large number of polymerid and as well as agnostid fauna were recovered from several stratigraphic levels of shale and thinly bedded limestone grainstone beds of Teta Member (Karsha Formation). The Karsha Formation is overlain by the shale and sandstone units of the Kurgiakh Formation. The definite latest Middle Cambrian trilobites of have been collected from the basal part of the Kurgiakh Formation.

In Cambrian successions of Zanskar region, trilobite fauna have been reported from the three stratigraphic levels. The first stratigraphic level occurs at the top part of the Parahio Formation and represented by *Hundwarella* and *Ptychoparia* assemblages zones of middle Middle Cambrian age (KUMAR 1998, SHAH *et al.* 1998, JELL & HUGHES 1997). The latest Middle Cambrian trilobite fauna of *Lejopyge laeivigata* and *Proagnostus bulbosus* zones occurs in top part of the Karsha (SINGH 2006 and 2008, HUGHES *et al.* 2008) and basal part of Kurgiakh formations (WHITTINGTON 1986, JELL & HUGHES 1997). The trilobite assemblage recorded includes *Hypagnostus* sp., *Peronopsis* sp., *Lisogoragnostus hybus*, *Lejopyge armata*, *Diplagnostus planicauda*, *Clavagnostus* cf. *trispinus*, *Parablackwelderia* sp., *Fuchouia* cf. *oratalimba*, *Fuchouia bulba*, *Neoanomocarella asiatica*, *Dorypyge perconvalis* and *Damesops sheridanorum* (SINGH 2008 and 2009). Till so far Early and Late Cambrian trilobite fauna have not been reported from the Zanskar region. However, in adjacent Spiti region, the Early Cambrian trilobite fauna, *Redlichia noetlingi*, has been reported from the float (HAYDEN 1904). In Early Cambrian succession where trilobite fauna have not been reported or not well preserved, trace fossils generally used for biostratigraphic age constraints. All described traces described below than the trilobite levels in Zanskar region are long ranging and belongs to Phanerozoic aspect, therefore the age constraint in lower part of the Haimanta Group is problematic. The definite Early Cambrian trace fossil *Tapherhelminthopsis* cf. *circularis* have been reported from the basal part of the Parahio Formation (HUGHES & DROSER 1992). However, recently the lowest occurrences of the ichnogenus *Phycodes*, recorded from the middle part of the Parahio Formation, were discussed for use in Precambrian-Cambrian boundary. Although, it is the lowest occurrence of this trace fossil genus yet known in the Cambrian successions of Zanskar (Tethyan Himalaya), its occurrence above the level bearing *Tapherhelminthopsis* cf. *circularis*

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emphasizes the fact that the lowest occurrence of this taxon in Himalayan successions does not necessarily constrain the position of the Precambrian-Cambrian boundary, beyond indicating that it likely occurs lower in the section (Singh, communicated). The ichnofossils distribution shows that within the Cambrian succession of Zanskar region traces generally occur in multiple horizons with low to high diversity. Integration of ichnological and sedimentological observations within a part of the Parahio Formation allows for the recognition of upper offshore to shoreface facies-related *Cruziana* and *Arenicolites* ichnofacies assemblages (SINGH 2008b, under revision). The irregular and distinct energy conditions due to repeated storm events are the key controlling factors for ichnofossils distribution and preservation. The high-energy storm event beds were suitable for the preservation of postdepositional *Arenicolites* ichnofacies. The sand-filled burrow *Planolites* are generally preserved on the base of the sandstone beds intercalated with fine grained shale. These burrows are preserved as shallow-tier. The predepositional ichnofossils of *Diplichnites*, *Dimorphichnus*, *Cruziana*, *Monomorphichnus*, *Teichichnus*, and *Diplocraterion* of *Cruziana* ichnofacies are well preserved in low-energy fair weather shale and grey-green silt-streaked shale alterations. In Parahio Formation no discrete set of tiers are observed perhaps there were two coeval communities. To a certain extent, it seems that deeper tier represents initial colonizers following a storm event, with most of the other ichnofossils recording business as usual. The ichnofabric indices in these deposits are ranges from ii3 to ii5 (SINGH, under revision).

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