

Biostratigraphy and biogeography of the Tethyan Cambrian sequences of the Zaskar Ladakh Himalaya and of associated regions

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The Cambrian sections studied so far exhibit 4 km thick and apparently conformable successions of Neoproterozoic and Cambrian strata in Zaskar - Spiti basins. The Cambrian sediments of this area are generally fossiliferous comprising trilobites, trace fossils, hyoliths, cystoids, archaeocythid and brachiopod, etc. In parts of Zaskar - Spiti and Kashmir region rich trilobite fauna is collected from the Cambrian successions. The trilobites constitute the most significant group of fossils, which are useful not only for the delimitation of various biozones but also for the reconstruction of the Cambrian paleogeography of the region.

The Zaskar basin together with a part of the Spiti basin forms not only the largest succession of the Tethyan sequences in the Himalaya, but also exposes one of the best developed sections. The complete successions of rocks ranging in age from Precambrian to Eocene are exposed in the Zaskar area of Ladakh Himalaya. The Cambrian sediments in this basin are exposed in Tangzee yogma, Tangzee Kogma, Kuru, Purni - Phuktul, Kurgiakh sections of the Suru valley and Karsha section of the Zaskar valley.

On the basis of the faunal studies of icnofossils and on polymerid as well as agnostid trilobites, various faunal assemblage zones have been worked out from these sections.

The Himalayan Cambrian successions were whitherto considered to be deficient in agnostid trilobites. During recent years a variety of agnostid taxa have been reported from the Cambrian succession of the Zaskar basin. Agnostids constitute the most important index fossils for the global correlation of Cambrian successions. In the Zaskar Himalayan belt, the agnostid fauna is well preserved in the Middle Cambrian succession of Tangzee-Kuru- Purni-Phuktul and in the Kurgiakh sections of Lingti and Suru valleys. Preliminary studies reveal the presence of *Baltagnostus*, *Clavagnostus*, *Peronopsis*, *Hypagnostus*, *Diplagnostus*, *Lejopyge* and *Goniagnostus* a characteristic taxa of Hsuehuangian to Changhian stages of the Middle Cambrian.

In Spiti valley the agnostid fauna collected from the Parahio section (Parcha 1999) is represented only by *Peronopsis* and *Baltagnostus*, which indicates the Hsuehuangian stage of Middle. However, the agnostid fauna is not as widely present as in the Zaskar and Kashmir regions.

The record of *Diplagnostus* from Zaskar (Whittington 1986) and from northwestern part of Kashmir (Shah et al. 1995) is significant because it marks the boundary between the Middle and Late Cambrian. In the Zaskar basin, the *Diplagnostus* is also found associated with *Lejopyge*, which is more significant in order to establish the Changhian - Kushanian (Late Middle Cambrian-early Late Cambrian) boundary in this region. *Diplagnostus* is known to occur in the *Lejopyge laevigata* Zone in Australia. In the Yangliugang Group of Chiangian Belt in Sweden it extends from South Korea across southwestern China into North Vietnam. In

North America *Diplagnostus* has been reported from the *Lejopyge laevigata* Zone which characterizes the latest Middle Cambrian. In the Lingti valley of the Zaskar area the presence of *Lejopyge* sp. is also of stratigraphic importance as it underlies the characteristic early Late Cambrian faunal elements. In the Magam section of Kashmir the *Diplagnostus* occurs at the top of the *Shahaspis (=Bolaspidella)* Zone of Jell and Hughes (1997), that is overlain by the *Damesella* Zone, which contains characteristic faunal elements of Changhian early Late Cambrian age. The genus *Damesella* is also reported from the Kushanian stage in China, the Tiantzun Formation in Korea and from *Agnostus pisiformis* Zone of the Outwood Formation in Britain.

The agnostid fauna reported from Kashmir and Zaskar regions occurs more or less at the same stratigraphic levels as in Australia, China, Kazakhstan, Sweden and North America. Therefore, it is useful in demarcating the intrasystem boundaries within the Himalayan Cambrian successions of Zaskar and Kashmir and also for the global correlation.

In almost all well preserved Cambrian successions of the world most of the workers find the Middle - Late Cambrian boundary in between *Lejopyge laevigata* Zone and *Agnostus pisiformis* biostratigraphic Zone. In Kashmir as well as Zaskar basins, therefore, this boundary can be marked on the basis of the occurrence of genus *Diplagnostus* in association with *Lejopyge*. In the Spiti region however, these agnostids have not been reported so far.

The trilobite fauna of the Himalayan Cambrian successions ranges from Early Cambrian (Templetonian) stage to early Late Cambrian (Mindyallan) stages of Australia. The Early Cambrian fauna is well preserved both in the Lesser as well as Tethyan Himalayan successions. Whereas, the Middle to early Late Cambrian fauna so far is known from the Tethys Himalayan successions of Zaskar - Spiti, Kashmir, and Bhutan. The proposed biostratigraphic zonation is based on the trilobite fauna collected so far from these regions. The trilobite fauna studied so far do not indicate any significant environmental change during the Cambrian period. So far no fossils have been reported from the upper part of Late Cambrian, whereas, latest part of Late Cambrian is marked by an angular unconformity in the Zaskar - Spiti region and by the facies variation in Kashmir.

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