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Cambrian sequence of the Spiti Valley, NW Himalaya and its boundary problems

S. K. Parcha
Wadia Institute of Himalayan Geology
33, General Mahadeo Singh Road, Dehra Dun 248 001, India

ABSTRACT

The Cambrian sequences of Spiti basin are exposed in Pin-Parahio valleys and in the Kunzum La Takche section. They pass conformably downward into a thick sequence of Late Precambrian rocks. Various faunal assemblages have been recorded from these sequences; characteristic faunal gaps occur in the lower part of Lower Cambrian, lower Middle Cambrian and in Upper part of Middle and Upper Cambrian. These gaps are represented by barren zones. In Pin-Parahio sections the uppermost part of the Cambrian is marked by an angular unconformity but in Kunzun La section this unconformity is not as apparent as in Pin-Parahio, but the change in lithology is very prominent. This paper discusses the position of intra-system boundaries and the affinities of the fauna with other Cambrian sequences. It has been observed that the Middle and Upper Cambrian fauna contains elements similar to that found in Australia and Indochina and resemble other cosmopolitan genera.

INTRODUCTION

The Cambrian sediments stretch along the entire length of the northwestern Himalaya. A complete succession of sedimentary rocks from Cambrian to Cretaceous is found in Spiti valley. Within the Himalayan framework, this succession belongs to the Tethyan facies and is quite distinct from the Lesser Himalayan facies.

In the Indian Geology, Spiti is the classical area, where there is more or less a continuous sequence of fossiliferous Palaeozoic and Mesozoic rocks resting on crystalline basement. The Cambrian sequence of Spiti, like in other parts of Tethys belt, is continuous and conformable with upper Proterozoic; whereas in Central part of Himalaya (Kumaun and Nepal) this sequence shows a rapid vertical change in facies ranging from phyllite through conglomeratic quartzite to evaporite carbonate sequence; no such change is noticeable in Spiti.

The presence of fossiliferous Cambrian rocks in Spiti was earlier recorded by Hayden (1904). The fauna collected by Hayden was studied by Reed in 1910. The subsequent work on Cambrian fauna was carried out by Bhargava et al. (1982); Ranga Rao et al. (1982); Kumar et al. (1984); Shah and Paul (1987) and Shah et al. (1988, 1991). The Cambrian strata in the Spiti basin is exposed in Pin-Parahio valleys and in Kunzum La Takche sections. They pass conformably downward into a thick sequence of Late Precambrian lithologies (Fig.1).

In the present work an attempt has been made to work out the Lower-Middle and Middle-Upper Cambrian boundaries, on the basis of recent findings of trilobite, trace fossil and on the earlier reported forms. The systematic taxonomy will be published separately.

GEOLOGICAL SETTING AND LITHOSTRATIGRAPHY

The Spiti basin is the largest marine basin among the Tethyan basins of the Himalaya. It is the southwestern extension of the greater Tibetan basin. The basin exposing the Precambrian to Cretaceous sediments forms one of the best developed sections in the Tethyan-Tibetan belt.

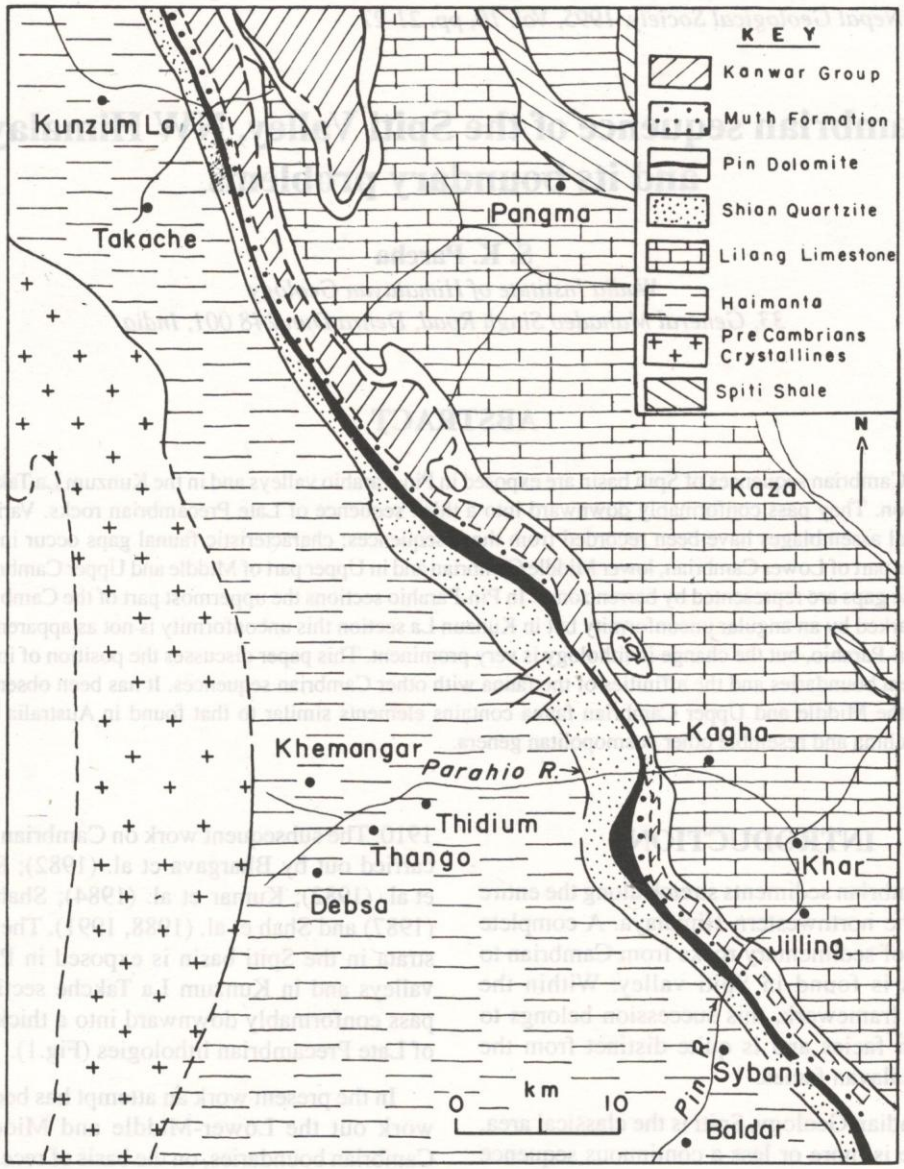

Fig. 1: Geological sketch map of parts of western Spiti (after Bagati, 1991).

The area was first studied by Stoliczka (1865). Later on Griesbach (1891) and Hayden (1904) carried out detailed, and comprehensive study of the stratigraphy of the Spiti basin. The sequence in between the crystalline at the base and the Muth Quartzite above was designated by Griesbach (1891) as the Haimanta System. Srikantia (1981) adopted a lithostratigraphic term as Haimanta Group. He further divided the Haimanta Group into three formations respectively the Batal, the Kunzum La, and the Thango. Ranga Rao et al. (1982) stated that the Haimanta Group cannot be subdivided on the regional basis, because the lithological units are not continuous laterally. The Haimanta Group ranges in age from Eocambrian to Lower Silurian. However, the present work deals only with the Cambrian strata of the Kunzum La Formation.

The Cambrian rocks in Spiti valley are exposed in the Pin-Parahio valley and in Kunzum La Takche section. Cambrian sequence passes downwards into

Precambrian and the entire sequence rests on Vaikrita Group. No precise boundary can be drawn between the Vaikrita Group and Haimanta Group. In the present work, the unfossiliferous part of the sequence was not studied in detail.

The lithostratigraphic column of Cambrian succession worked out during the present study is given in Fig. 2. Lithostratigraphically, it comprises shale, phyllite, slate, sandstone interbedded with pale green and brown quartzite, micaceous quartzite with thin lenticular interbeds of limestone and dolomite. There is, however, no sharp demarcation between the older and the younger sequence; the change is gradational extending for several hundred metres. However, an abrupt change in lithology from argillaceous to predominantly arenaceous nature (Shian Quartzite) takes places in all the sections at the top of Haimanta. In Pin-Parahio section, a distinct angular unconformity separates the two. Since no typical Late Upper Cambrian fossils are preserved in these sections, the time gap involved cannot be precisely determined.

FAUNAL SUCCESSION

On the basis of trilobite and trace fossil studies, various faunal assemblages have been documented from the Pin-Parahio valley of the Spiti (Table 1). It has been observed that the Lower Cambrian to Lower part of Middle Cambrian is poorly fossiliferous but from the Middle Cambrian to early Upper Cambrian the sequence is richly fossiliferous, constituting the Solvan and Menevian stages of Middle Cambrian and Maentwrogian stage of early Upper Cambrian. The two barren zones one at the top of late Lower Cambrian to early Middle Cambrian and the other at the top of Middle Cambrian have been observed in the sequence.

All these assemblage zones except the lowermost are defined based on the trilobite assemblages. *Diplichnites-Rusophycus* Assemblage however, is purely a trace fossil assemblage and bears a large variety of trace fossil assemblage. This is highly significant because no trilobite has been recorded so far from this zone or from underlying sequences.

On the basis of these faunal assemblages, an attempt has been made to elucidate various intra-system boundaries during the Cambrian period of this part of the Himalayan region.

BIOSTRATIGRAPHIC DISCUSSION

Lower Cambrian

The fauna of Lower Cambrian sequences in the Pin-Parahio valley and in the Kunzum La Takche section is relatively scanty for the purpose of determining the systematic biozonation. However, in all the Lower Cambrian sequences of Spiti, there is an extensive distribution of trace fossils and trilobite scratch marks below the trilobite horizon. The only trilobite so far identified from this sequence is *Redlichia noetlingi* which was obtained from a ravine near Sybang village of Pin valley. During the

Table 1: Faunal assemblages of the Kunzum La Formation

Lithostratigraphic Unit	Age	Assemblage Zone
Kunzum La Formation	U. Cambrian	*Olenus* Zone
	M. Cambrian	*Ptychoparia* Zone *Oryctocephalus-Pagetia* Assemblage Zone *Pagetia-Oryctocephalus* Assemblage Zone *Peronopsis* Zone
	L. Cambrian	*Redlichia Noetlingi Diplichnites, Monomorphichnus Phycodes, Dimorphichnus, Rusophycus* Assemblage Zone

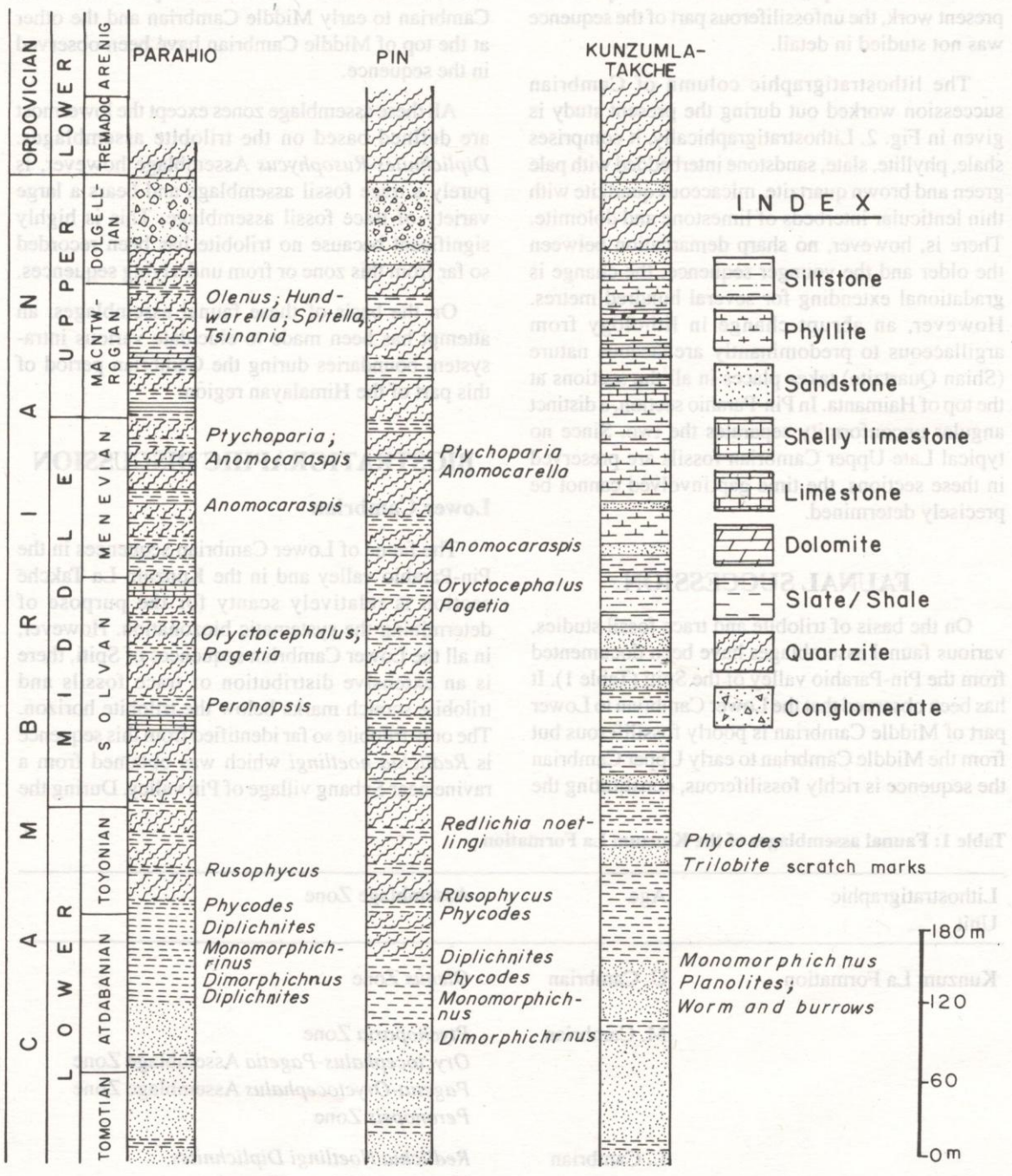

Fig. 2: Lithostratigraphic column of Parahio-Pin and Kuzum La Takche sections of the Spiti Valley.

present field studies, the exact horizon of the fossil could not be located.

The *Redlichia noetlingi* would correspond to the Sanshu stage of China and Korea (Kobayashi, 1967) and *Redlichia noetlingi* zone of Kashmir (Shah, 1982) and could be included in the Lower part of Toyonian. So far there is no record of trilobite fauna before this zone. In general, it has been observed that the sections in the Pin-Parahio valleys and in Kunzum La-Takche section, the horizons which are rich in trace fossils are devoid of body fossils and where body fossils are common, the trace fossils are rarely found. It seems that the absence of trilobite body fossils in trace fossil rich zones is a worldwide feature (Crimes, 1970).

The Precambrian - Cambrian boundary cannot be fixed with precision. It may be well below the trace fossil assemblage. The exact identification of the Precambrian - Cambrian boundary can only be possible if the Tommotian stage is identified. The trace fossil assemblage of Spiti can be correlated with the trace fossil zone of Kashmir where it occurs in Atdabanian stage (Shah and Sudan, 1983). The trace fossil horizons of Spiti may therefore represent Atdabanian (Lower Cambrian) to Toyonian age.

The faunal evidences are again lacking towards the upper part of Lower Cambrian. A barren zone of about two hundred metres thick is present before the appearance of the first Middle Cambrian trilobite horizon. Hence, the barren rock may represent the upper Lower Cambrian (Late Toyonian) and Lower Middle Cambrian age (early Solvan). Therefore the exact demarcation of Lower and Middle Cambrian boundary is not possible.

Middle Cambrian

The Middle Cambrian sequences of Spiti valley are extensively fossiliferous. The earliest Middle Cambrian fauna in the sequence belongs to *Peronopsis* zone. Its lower limit cannot be precisely fixed since the lower part of Middle Cambrian is unfossiliferous. This assemblage is overlain by *Pagetia - Oryctocephalus* assemblage. Shah and Paul (1987) have stated that the beds bearing Oryctocephalids can be correlated with the Templetonian stage of Australia due to the specific similarity between the Australian and Spiti forms. The Oryctocephalid fauna marks a characteristic horizon in Australia; stratigraphically its position in Australia is relatively higher than the Acme of *Redlichia* bearing zone. Opika (1968) has assigned its age as Templetonian. In North Korea and Indo-China, *Oryctocephalids* are found almost at the identical stratigraphical level. In association with *Oryctocephalids*, *Pagetia* occurs in Spiti while in Kashmir, *Pagetia* has also been recorded by the author but the genera like *Oryctocephalus* has not been reported from Kashmir though the comparable horizon bears a related genus *Tonkinella*. The *Tonkinella* marks a characteristic horizon not only in Kashmir but in several parts of Asia, notably in Korea, Indo-China and Chosen belt of China. The corresponding horizon in such widely separated regions as Australia, Siberia and North America bears *Oryctocephalus*. But the Spiti fauna does not contain *Tonkinella*. The *Oryctocephalus* beds of Spiti can therefore be correlated to the *Tonkinella* beds of Kashmir, which is the marker of the begining of Menevian.

The distribution does not seem to be geographically controlled but it appears to be a biofacies phenomenon.

The *Oryctocephalus - Pagetia* assemblage is overlain by the *Ptychoparia* assemblage zone. The transition between the two zones does not show overlapping of the characteristic taxa. The *Ptychoparia* zone represents the youngest Middle Cambrian. No typical late Middle Cambrian taxa has been reported so far from this sequence. The position of *Ptychoparia* has been interpreted by various authors in different ways. *Ptychoparia* has also been reported from Kashmir, China, Korea, East Yunan and from Salt Range. The genus ranges from Early Menevian to Late Menevian. A barren zone of about fifty metres thick overlies the *Ptychoparia* zone. There is no indication of facies change at this level. The barren zone only shows the absence of fauna. Lithologically, it remains unchanged and is succeeded by strata bearing typical early Late Cambrian trilobites. Therefore no exact demarcation of Middle and Upper Cambrian can be possible without the presence of fauna at this level.

Upper Cambrian

The Upper Cambrian of Spiti is represented by *Olenus* zone which is separated from the *Ptychoparia* zone by a barren zone while the former represents the middle part of Menevian and latter represents the Maentwrogian. Shah et al. (1988) have reported two species of *Hundwarella* from this Zone. It is an important stratigraphic indicator for the correlation of Cambrian of Spiti and Kashmir, because it is the only *polymerid* trilobite genus common to both the areas during the late Middle and early Upper Cambrian. It is also one of the most important faunal element for the stratigraphic correlation of Middle and early Late Cambrian sequences of Asia, because it is widely distributed in several Middle and Late Cambrian sequences of Asia. The *Olenus* zone of Spiti cannot be correlated with the *Damesella* Zone of Kashmir because except *Hundwarella,* there is no other form common in both zones even at generic level. The *Olenus* zone occurs at a slightly higher stratigraphic level than the *Damesella* zone of Kashmir (Shah et al. 1991). The beds bearing *Olenus* could be correlated to the upper part of Dresbachian and Maentwrogian of America and Wales. The upper part of Upper Cambrian does not contain any fauna. However, there is a distinct angular unconformity above the *Olenus* bearing beds, which is represented by reddish brown conglomerate accounting for the elimination of entire part of middle Late Cambrian to Early Ordovician in both Pin and Parahio sequences. After this unconformity there is a marked change in facies and the next fossiliferous beds bear Middle Ordovician brachiopods.

CONCLUSIONS

On the basis of these studies, it can be concluded that the fauna during the Cambrian period is not distributed in continuity. But the sequence is invariably punctuated by a considerable thickness of unfossiliferous strata, as a result of which the fauna of one horizon is completely distinct from the other. The Precambrian - Cambrian boundary cannot be identified due to the absence of Tommotian fauna. The Lower and Middle Cambrian boundary may lie somewhere between the *Redlichia* bearing beds and *Peronopsis-Pagetia* assemblage. Similarly, the Middle and Upper Cambrian boundary lies in barren part of the sequence which is present in between the *Ptychoparia* zone and *Olenus* zone, because the former is the characteristic of middle Middle Cambrian and the latter of early Upper Cambrian.

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REFERENCES

Bhargava, O.N., Kumar, G. and Gupta, S.S., 1982, Cambrian trace fossils from the Spiti valley Himachal Himalaya. Jour. Geol. Soc. India. v. 23, pp. 183-191.

Bagati, T.N., Kumar, Rohtash and Ghosh, S.K., 1991, Regressive transgressive sedimentation in the Ordovician sequences of the Spiti (Tethys) basin, Himachal Pradesh, India. Sed. Geology., v. 73, pp. 171-184

Crimes, T.P., 1970, The significance of trace fossils in sedimentology, stratigraphy and palaeoecology with example from Lower Palaeozoic strata. *In: Crimes, T.P. and Harper, J.C. (eds.), Trace Fossils,* Geol. Jour., Spec., v. 5, pp. 101-126.

Griesbach , C.L., 1891, Geology of the Central Himalayas. Mem. Geol. Survey, India, v. 23, pp. 1-232.

Hayden, H.H., 1904, The geology of Spiti. Mem. Geol. Surv. India, v. 36 (1), pp. 129.

Kobayashi, T., 1967, The Cambrian of eastern Asia and other parts of the continent. The Cambro-Ordovician formations and faunas of South Korea. Part X Sec. C. Jour. Fac. Sci., Tokyo. Univ. Ser., v. 24, pp. 49-344.

Kumar, G., Raina, B.K., Bhargava, O.N., Maithy, P.K. and Babu, R., 1984, The Precambrian boundary problem and its prospects, Northwest Himalaya, India. Geological Magazine, v. 121(3), pp. 211-219.

Opika, A.A., 1968, The Ordian stage of the Cambrian and its Australian Metadoxidiate. Bur. Miner. Resour. Australia Bull, v. 92, pp. 133-168.

Ranga Rao, Dhar, C.L., Rao, S.V. and Shah, S.K., 1982, Contribution to the stratigraphy of Spiti. Himalayan Geology, v. 12, pp. 98-113.

Reed, F.R.C, 1910, Cambrian fossils of Spiti. Palaeont. Ind. Geol. Surv. India, Ser. 15, v. 70 (1), pp. 1-70, pls. 1-6.

Shah, S.K., 1982, Cambrian stratigraphy of Kashmir and its boundary problems. Precambrian Research, v. 17(2), pp. 87-98.

Shah, S.K. and Sudan, C.S., 1983, Trace fossils from the Cambrian of Kashmir and their stratigraphic significance. Jour. Geol. Soc. India, v. 24 (4), pp. 194-202.

Shah, S.K. and Paul, S., 1987, Oryctocephalid fauna from the Cambrian of Spiti. Jour. Geol. Soc. India, v. 30(3), pp. 187-193.

Shah, S.K., Sudan, C.S., Parcha, S.K. and Raina, K. A., 1988, Revision of genus Hundwarella Reed and its significance in Himalayan Cambrian. Palaeont. Soc. India, v. 33, pp. 47-58, plate 1.

Shah, S.K., Parcha, S.K. and Raina, K. A, 1991, Late Cambrian Trilobite from Himalaya. Palaeont. Soc. India, v. 36. pp. 89-107.

Srikantia, S.V., 1981, The lithostratigraphy, sedimentation and structure of Proterozoic-Phanerozoic Formation of Spiti basin in the Higher Himalayas of Himachal Pradesh, India. *In: A.K. Sinha (ed.), Contemporary Geoscientific Research in Himalaya,* v. 1, pp. 31-52.

Stoliczka, F., 1865, Geological section across the Himalayan mountain from Wangtu bridge on the river Sutlej to Sungdo on the Indus, with an account of formation of Spiti accompanied by a revision of all known fossils from the district. Mem. Geol. Surv. India, v. 5(1), pp. 1-173.