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LITHOSTRATIGRAPHIC COMPARISON OF THREE DIAMICTITE SUCCESSIONS OF NEPAL LESSER HIMALAYA

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ABSTRACT

The Proterozoic Blaini-type of diamictite sequences have been identified from the Lesser Himalaya (Brookfield, 1987). A tillitic sequence called the Sisne Formation of Gondwana age was reported by Sakai (1983) from Tansen, the Western Nepal Lesser Himalaya. The newly reported Kokaha Diamictite and Sallyan Diamictite situated to the east and west of Tansen, respectively, exhibit some lithostratigraphic similarity with the Sisne Formation, though the underlying and overlying rocks are quite different.

The Kokaha Diamictite from the Barahakshetra area of Eastern Nepal is underlain by grey quartzite with coal seams and conglomerate lenses. Sometimes tuffs and agglomerates are also found together with the diamictite in some places. It is followed upsection by grey calcareous sandstone, siltstone and shale. The Sisne Formation from the Tansen area of Western Nepal overlies grey dolomite with a disconformity and is followed by the Taltung Formation separated by another disconformity. The Taltung Formation itself is composed of basic volcanics, conglomerate, sandstone and siltstone. A non-Blaini type of diamictite horizon called the Sallyan Diamictite from the Sallyan area of West Nepal occurs in low -grade metamorphic rocks. It disconformably overlies quartzite, meta-conglomerates and phyllites, and is transitionally followed by black carbonaceous slates. Lack of reliable fossils, metamorphism and strong deformation pose difficulties in correlating it with other diamictites.

INTRODUCTION

Medlicott (1864) recorded a tillitic horizon in the Lesser Himalaya of the Simla area (India) as the Blaini Formation. Pilgrim & West (1928) carried out further detailed lithostratigraphic studies and correlated it with the Lower Gondwana tillitic sequence of the Indian subcontinent. Following them, several other diamictite horizons identified later were also thought to be of the Gondwana age. As the age determination was not based on reliable fossil findings, it became one of the most controversial issues in correlating the widely distributed diamictite horizons of the Lesser Himalaya with the Blaini Formation and hence the Lower Gondwana tillitic sequences.

But, recently several reliable findings of early Cambrian and late Pre-Cambrian fossils from the Krol (Azmi & Pancholi, 1983; Singh & Rai, 1984; Mathur & Shanker, 1989) and early Cambrian fossils from the Tal (Azmi et al., 1981; Rai & Singh, 1983; Bhatt et al., 1985; Gopendra kumar et al., 1987; Mathur & Joshi, 1989) Formations in the Garhwal Lesser Himalaya and else where, clarified the confusion regarding the early inferences of the Gondwana age for the Blaini formation of the Krol Belt and it became a Proterozoic tillitic sequence.

Despite the above confusions in the western sector of the Himalayan arc, the diamictite horizons known from the Eastern Lesser Himalaya were easily identified as the Lower Gondwana diamictite horizons due simply to the well- preserved plant fossils. However, Gansser (1983) introduced the Diuri Formation consisting of the boulder beds from the south- east of the Bhutan Lesser Himalaya. He noticed the absence of coal and the presence of some gritty quartzite intercalations in the Diuri Formation, and compared it with the Late Precambrian- Cambrian tilloids.

The Nepal Lesser Himalaya, constituting the central portion of the Himalayan arc, was not much affected by this problem since there were no findings of diamictite until lately. In this respect the recent discovery of three diamictite horizons from different places of the Nepal Lesser Himalaya is remarkable. One of them is located in the Barahakshetra area of Eastern Nepal, the second diamictite horizon lies in the Tansen area of Western Nepal, and the third one is found in Sallyan District of Mid- Western Nepal (Figure 1). This paper reviews the diamictite horizon from the Tansen area, re-interprets the lithostratigraphy of the first known Gondwana rock sequence from the Barahakshetra area of Eastern Nepal containing another diamictite sequence, and discusses the diamictite horizon in the low-grade metamorphics of the Sallyan area.

Diamictite from Barahakshetra Group

Auden (1935) recorded the Gondwana rocks in Eastern Nepal for the first time on his geological map. Bashyal (1980 a & b) distinguished a new tectono-stratigraphic unit for these rocks as the Barahakshetra Formation and identified five lithostratigraphic units. But the present investigation of the region revealed that his youngest stromatolitic dolomite unit (Unit V of Bashyal, 1980a) is actually the oldest one and does not belong to the Gondwana rocks, as indicated by the sharp disconformity above it and the direction of younging from the columnar stromatolites found in the dolomite. Therefore, it was felt necessary to re-interpret the lithostratigraphy of the area, and his Barahakshetra Formation (excluding the dolomites) is renamed as the Barahakshetra Group.

The Lesser Himalayan rocks of the Barahakshetra area (Table 1 and Figure 2) are bounded by the Main Boundary Thrust (MBT) in the south from the Siwaliks and the Asganga Thrust bringing low- grade metamorphic rocks from the north. The Barahakshetra Group (Figure 2) crops out discontinuously due to intense deformation and imbricate faulting, and varies in thickness from tens of metres to about 500 m. It can be subdivided into the following formations (Figures 2 and 4).

Sapt Kosi Formation and Baraha Volcanics

The Pre-Gondwana Lukwa Formation (Figure 2) consisting of the grey dolomite with columnar stromatolites is abruptly followed upsection by the Sapt Kosi Formation with a sharp disconformity marked by an irregular erosional surface. The Sapt Kosi Formation comprises medium- to very thick- bedded grey and dark grey carbonaceous quartzite, dark grey carbonaceous shale and conglomerate with some light grey, dark grey and red chert and quartzite pebbles. Lenses and seams of coal are also characteristic of this formation.

Interlayered tuffs and agglomerates are observed on top of the Sapt Kosi Formation in the eastern sector of the Barahakshetra area. This unit is named as the Baraha Volcanics. Dark green to grey coloured tuffs are made up of poorly sorted lithic volcanic clasts of varying size. In the clasts are observed phenocrysts and microlites of potash feldspar. Quartz and sodic plagioclase with some biotite and pyroxene (Bashyal, 1980b, p. 473).

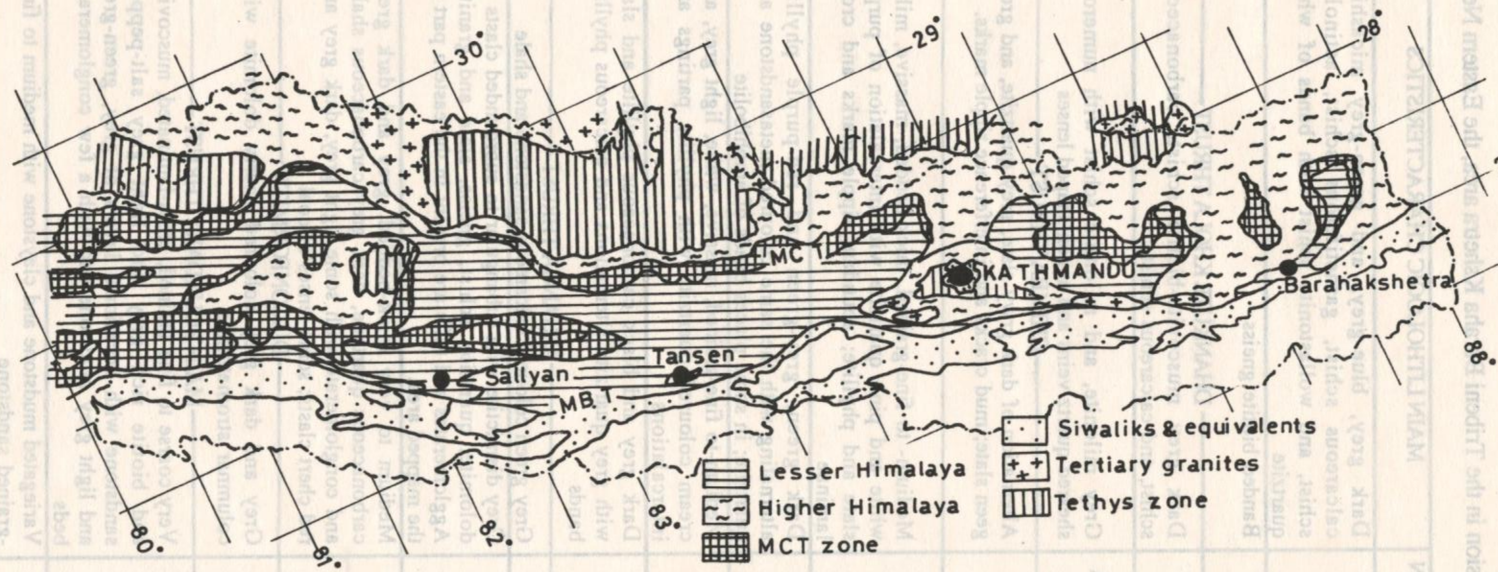

Figure1. Generalized geological map of Nepal showing the locations of diamictite horizons at Barahakshetra, Tansen, and Sallyan. Modified after unpublished map of Kizaki, in Tokuoka et al. (1986). MBT: Main Boundary Thrust, MCT: Main Central Thrust.

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Table 1 Tectono-Stratigraphic subdivision in the Tribeni Baraha Kshetra area, the Eastern Nepal Himalaya.

SUPER GROUP	GROUP	FORMATION	MAIN LITHOLOGIC CHARACTERISTICS	GEOLOGICAL AGE
	CHHINTANG	BELHARA	Dark grey, blue-grey, and green-grey micashist, calcareous schist, garnetiferous schist, actinolite schist, and wollastonite schist with bands of white quartzite	?PC
		JYAMIRE GNEISS	Banded biotite gneiss	
			DHANKUTE KHOLA THRUST	
	PHONGSAWA	MULGHAT	Dark grey muscovite-biotite schist, carbonaceous schist, and calcareous schist	?PC
		UKHUDANDA	Grey milonite, and milonitic schist with numerous sheared quartz veins and augen-shaped lenses	?PC
			CHIMRA THRUST	
TRIBENI	BHENDETAR	KARKI - CHHAP	Alternation of dark grwy slate, grey quartzite, and grey-geen slate; mud cracks and interference ripple marks.	?PC-?PZ
		SANGURE QUARTZITE	Medium- to fine-grained, thick-bedded, massive, milky white and pink quartzite with intercalation of purple slate and phyllite; abundant ripple marks and cross laminae	?PC
	LEOTI	CHIURIBAS	Dark green, grey-green and red-purple phyllite alternating with the same coloured metasandstone and quartzite; in some places bands of amphibolite	?PC
		PHALAME-TAR QUARTZITE	Medium-to fine-grained, massive, white, light grey, and cream coloured quartzite with phyllite partings and intercalations	?PC
		RAGUWA	Dark grey and black carbonaceous phyllite and slate with grey quartzite alternations and calcareous phyllite bands	?PC-?PCZ
			ASGANGA THRUST	
	BARAHA - KSHETRA	TAMRANG	Grey green coloured calcareous sandstone and shale	GONDWANA
		KOKAHA DIAMICTITE	Grey diamictite with subangular to subrounded clasts of dolomite, quartzite, schist, gneiss, slate and granite. Agglomerates and tuffs are present in the eastern part of the mapped area.	GONDWANA
		SAPT KOSI	Medium to very thick-bedded, grey and dark grey, carbonaceous quartzite, dark grey carbonaceous shale, and conglomerate with some light grey, dark grey and red chert clasts; some lenses of coal	LOWER GONDWANA
			DISCONFORMITY	
		LUKWA	Grey and dark grey coloured cherty dolomite with columnar stromatolites	?PC-PZ
			MAIN BOUNDARY THRUST	
	SIWALIKS	MIDDLE	Very coarse to fine grained, cross-laminated, muscovite and biotite rich grey and light grey salt-pepper sandstone with occasional layers of grey, green-grey and light grey mudstone and with a few conglomerate beds	NEOGENE
		LOWER	Variegated mudstone and claystone with medium to fine -grained sandstone	

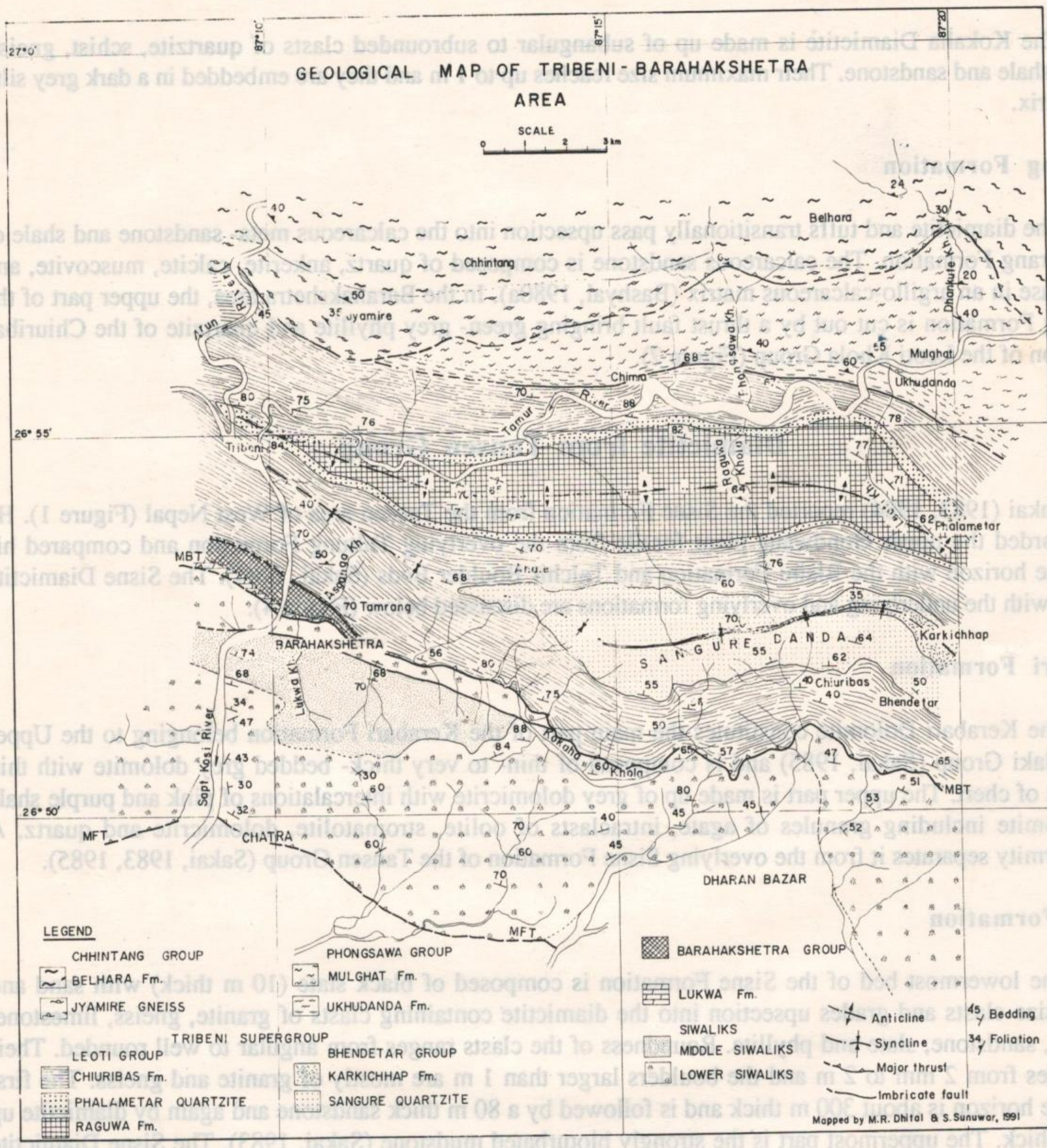

Figure 2 Regional geological map of the Tribeni-Barahakshetra area, Eastern Nepal Himalaya.

Kokaha Diamictite

The Sapt Kosi Formation is followed upsection by the Kokaha Diamictite with a sharp contact which is occasionally faulted. It is inferred to be a disconformity based on the contrasting lithofacies.

The Kokaha Diamictite is made up of subangular to subrounded clasts of quartzite, schist, gneiss, granite, shale and sandstone. Their maximum size reaches up to 1 m and they are embedded in a dark grey silty clay matrix.

Tamrang Formation

The diamictite and tuffs transitionally pass upsection into the calcareous meta- sandstone and shale of the Tamrang Formation. The calcareous sandstone is composed of quartz, ankerite, calcite, muscovite, and plagioclase in an argillo-calcareous matrix (Bashyal, 1980a). In the Barahakshetra area, the upper part of the Tamrang Formation is cut out by a thrust fault bringing green- grey phyllite and quartzite of the Chiuribas Formation of the Leoti Khola Group (Figure 2).

Diamictite from Tansen Group

Sakai (1983, 1984) reported the Sisne Formation from the Tansen area of West Nepal (Figure 1). He also recorded the upper Gondwana plant fossils from the overlying Taltung Formation and compared his diamictite horizon with the Blaini Formation and Talchir Boulder Beds (Sakai, 1984). The Sisne Diamictite together with the underlying and overlying formations are discussed below (Figure 4).

Kerabari Formation

The Kerabari Dolomite constitutes the main part of the Kerabari Formation belonging to the Upper Kaligandaki Group (Sakai, 1985) and is composed of thin- to very thick- bedded grey dolomite with thin interbeds of chert. The upper part is made up of grey dolomicrite with intercalations of pink and purple shale and dolomite including granules of agate, intraclasts of oolite, stromatolite, dolomicrite and quartz. A disconformity separates it from the overlying Sisne Formation of the Tansen Group (Sakai, 1983, 1985).

Sisne Formation

The lowermost bed of the Sisne Formation is composed of black slate (10 m thick) with sand and granule size clasts and grades upsection into the diamictite containing clasts of granite, gneiss, limestone, dolomite, sandstone, slate and phyllite. Roundness of the clasts ranges from angular to well rounded. Their size ranges from 2 mm to 2 m and the boulders larger than 1 m are mostly of granite and gneiss. The first diamictite horizon is about 300 m thick and is followed by a 80 m thick sandstone and again by diamictite up to 80 m thick. The uppermost part is the strongly bioturbated mudstone (Sakai, 1983). The Sisne Diamictite is followed upsection by the Taltung Formation with a disconformity in between them.

Taltung Formation

The Lower Member of the Taltung Formation is composed of fluvial cyclic deposition of conglomerate, sandstone, and shale. Most of the pebbles of the conglomerate are of basic volcanic rock and Quartzite. There are also several beds of tuff, tuffaceous shale and sandstones with some basic lava flows

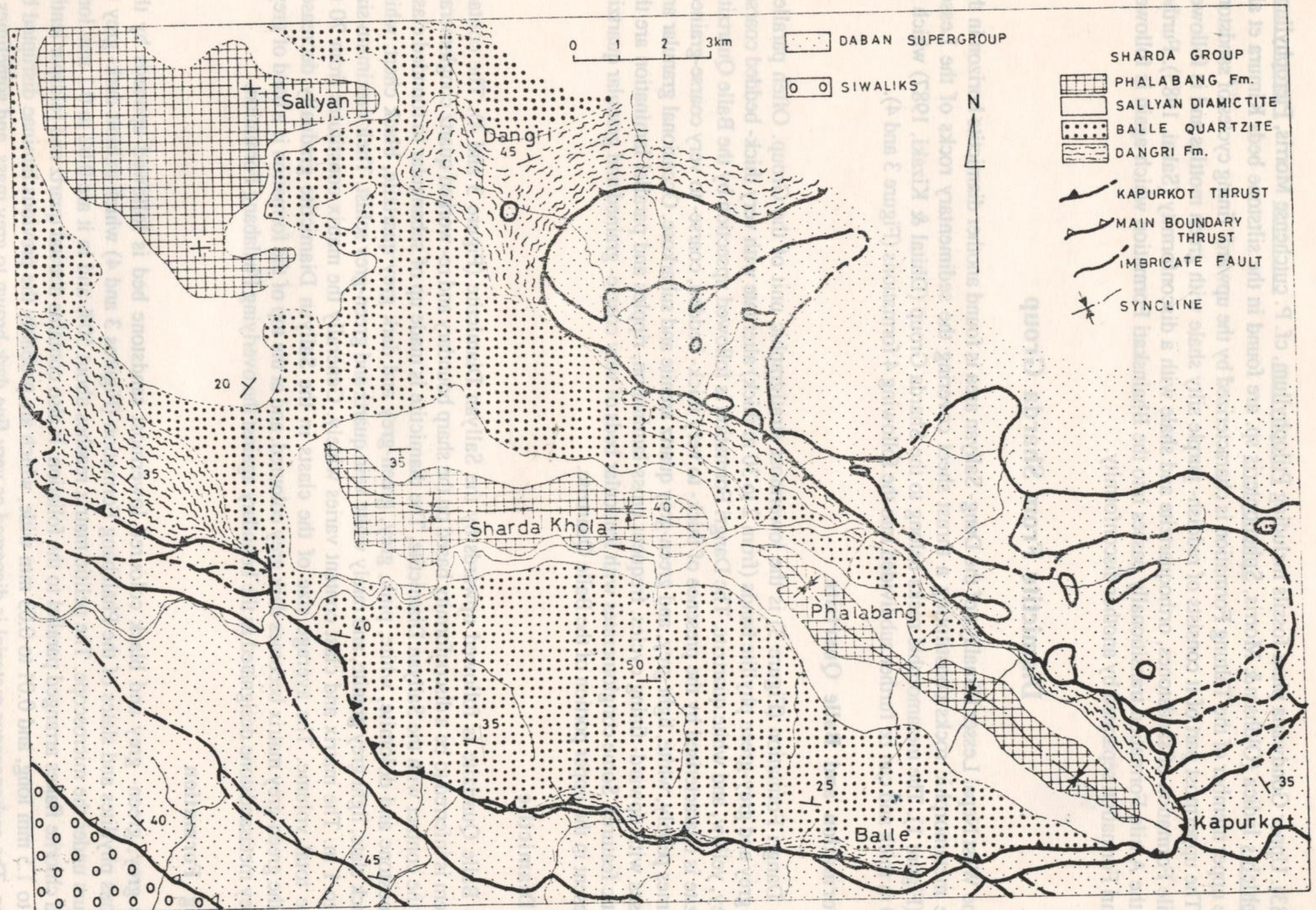

Figure 3. Geological map of the Dang-Sallyan area, the Mid Western Nepal Lesser Himalaya.

(Sakai, 1983). Upper Gondwana plant fossils including Ptilophyllum, cf. P. cutchense Morris, Pterophyllum, sp., Cladophlebis Indica (Oldham& Morris, Sphenopteris sp. are found in the siltstone beds Kimura et al., 1985). The upper member of the Taltung Formation is characterized by the upward- fining cycles of sandstone and shale. The uppermost part of it consists of reddish- purple silty shale with green mottles and is followed by the Amile Formation of sandstones, orthoquartzite and shale with a disconformity (Sakai, 1983). Further upsection, the Amile Formation transitionally passes into the Bhainskati Formation which again is followed by the Dumri Formation separated by another disconformity.

Diamictite From Sharda Group

In the West Nepal Lesser Himalaya of the Dang- Sallyan area is found another diamictite horizon in the low- grade metamorphic rocks constituting a thrust sheet covering the sedimentary rocks of the Lesser Himalaya (Figure 1). The metamorphic rocks belong to the Sharda Group (Dhital & Kizaki, 1987) which is about 2500 m thick and can be further subdivided into the following 4 formations (Figure 3 and 4).

Dangri Formation and Balle Quartzite

The Dangri Formation (Figure 3) is the lowermost stratigraphic unit of the Group. Often parallel-laminated, grey and grey-green phyllite bands (from 2 to 30 m thick) alternate with very thick- bedded coarse-grained grey, yellow, and white quartzite. The Dangri Formation is followed upsection by the Balle Quartzite. The Quartzite is characterised by the presence of thick- to very thick- bedded, coarse- to very coarse-grained, and sometimes pebbly, white, light grey, and green-grey quartz arenite and subarkose. Occasional granular and pebbly lenses with upward- fining cycles, frequent cross-lamination, ripples and parallel lamination are the characteristic features. Some conglomerates with lenticular beds of very coarse- grained and granular quartzite are also present in the upper portion of the Balle Quartzite.

Sallyan Diamictite

The Balle Quartzite is followed upwards by the Sallyan Diamictite (Figure 3 and 4). The contact between them is inferred to be a disconformity based on the sharp boundary and re- worked quartz conglomerate pebbles at the contact with the Sallyan Diamictite. The diamictite is made up of subangular to rounded clasts of grey limestone and dolomite, white, pink, grey, green-grey and dark grey quartzite, black chert, white marble, black slate, light grey granite, and rarely white vein quartz and green-grey schist. Their maximum size ranges up to 1 m. The matrix and clast content varies widely. Generally the matrix constitutes from 70 to 90% of the total volume. The average size of the clasts in the Sallyan Diamictite gradually decreases upsection, the green-grey matrix becomes dark grey coloured, and at the top of the formation is a band of grey-green or grey metasandstone designated as the boundary against the overlying Phalabang Formation.

Phalabang Formation

The grey, green- grey and black coloured lowermost sandstone bed is followed upwards by the carbonaceous phyllites and slates of the Phalabang Formation (Figures 3 and 4) which exhibit dark- grey to black colours under the microscope. The pelitic matrix reaches about 50% and in it are 0.02 to 0.1 mm long sericite and chlorite flakes arranged parallel to the foliation. It also contains detrital quartz and feldspar lentils from 0.04 to 1.5 mm long, and 0.01 to 0.03 mm wide, which are probably the previous laminae disrupted by the foliation. The carbonaceous material is dispersed as very fine dark-brown to grey mass, and sometimes it

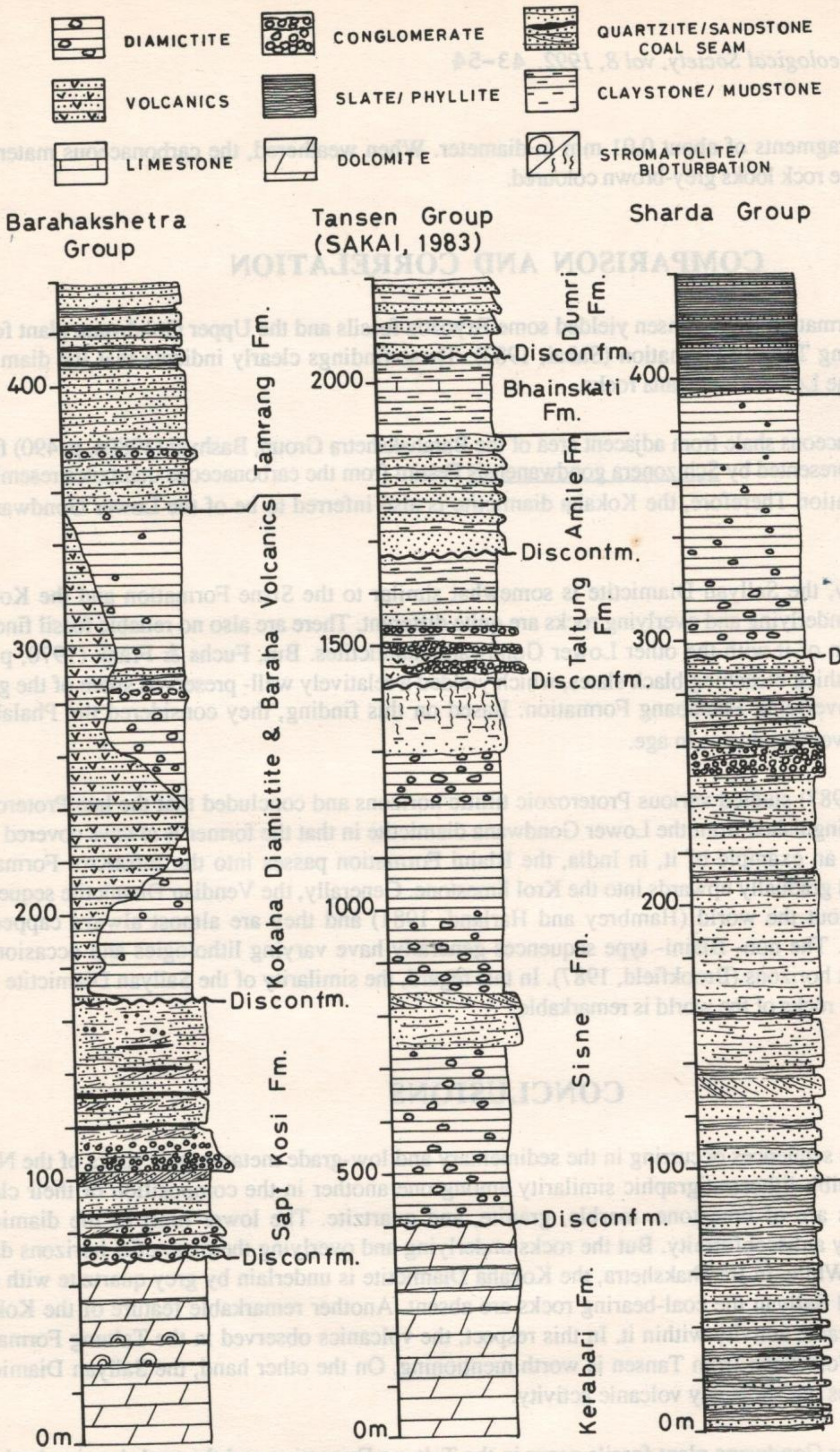

Figure 4. Lithostratigraphic columns of the diamictite sequences from the Barahakshetra Group, Tansen Group, and Sallyan Group . Disconf : Disconformity.

includes irregular fragments of about 0.01 mm in diameter. When weathered, the carbonaceous material is washed away, and the rock looks grey-brown coloured.

COMPARISON AND CORRELATION

The Sisne Formation from Tansen yielded some Bryozoa fossils and the Upper Gondwana plant fossils occur in the overlying Taltung Formation (Sakai, 1983). These findings clearly indicate that the diamictite horizon belongs to the Lower Gondwana rocks.

In the carbonaceous shale from adjacent area of the Barahakshetra Group, Bashyal (1980a, p. 490) found the Damuda flora represented by Schizonera gondwanensis Festim from the carbonaceous quartzites resembling the Sapt Kosi Formation Therefore, the Kokaha diamictite is also inferred to be of the Lower Gondwana in age.

Lithologically, the Sallyan Diamictite is somewhat similar to the Sisne Formation and the Kokaha Diamictite. But the underlying and overlying rocks are quite different. There are also no reliable fossil findings leading to correlation of it with the other Lower Gondwana diamictites. But, Fuchs & Frank (1970, p. 43) reported about 20 m thick bleaching black slates, which yielded a relatively well- preserved spore of the genus Vittatina from the overlying Phalabang Formation. Based on this finding, they considered the Phalabang Formation as the Lower Gondwana in age.

Brookfield (1987) studied various Proterozoic tillitic horizons and concluded that the late Proterozoic tillitic horizon is distinguished from the Lower Gondwana diamictite in that the former is always covered with a limestone cap. As an example of it, in India, the Blaini Formation passes into the InfraKrol Formation which, in turn, passes gradually upwards into the Krol limestone. Generally, the Vendian Diamictite sequences are uniform throughout the world (Hambrey and Harland, 1981) and they are almost always capped by carbonate sequences. The non- Blaini- type sequences generally have varying lithologies and occasionally contain carbonaceous horizons (Brookfield, 1987). In this regard, the similarity of the Sallyan Diamictite with the Lower Gondwana rocks of the world is remarkable.

CONCLUSIONS

The diamictite sequences occurring in the sedimentary and low-grade metamorphic rocks of the Nepal Lesser Himalaya exhibit lithostratigraphic similarity among one another in the composition of their clasts. Predominating clasts are of limestone, marble, granite, and quartzite. The lower limit of the diamictite horizons is marked by a disconformity. But the rocks underlying and overlying the diamictite horizons differ from place to place. While, in Barahakshetra, the Kokaha Diamictite is underlain by grey quartzite with coal seams, in Tansen and Sallyan the coal-bearing rocks are absent. Another remarkable feature of the Kokaha Diamictite is the volcanic activity within it. In this respect, the volcanics observed in the Taltung Formation overlying the Sisne Formation from Tansen is worth mentioning. On the other hand, the Sallyan Diamictite lying further west does not show any volcanic activity.

Well- preserved Upper Gondwana plant fossils occur in the Taltung Formation and the coal- bearing horizons below the Kokaha Diamictite yielded some Lower Gondwana plant fossils. Therefore, the Gondwana age is assigned to the above two diamictite sequences. Some relatively well- preserved spores of Vittatina have been reported from the Phalabang Formation overlying the Sallyan Diamictite (Fuchs and Frank, 1970). It is, therefore, called as the non- Blaini- type of diamictite succession taking into consideration of the controversies arising in correlating the diamictite sequences without good fossil control.

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