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GEOLOGICAL OBSERVATIONS ALONG MOTOR ROAD FROM BUTWAL TO RAMDIGHAT, CENTRAL NEPAL

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ABSTRACT

The present paper briefly deals with the lithostratigraphy and structure of the area along the motor road between Butwal and Ramdighat in central Nepal. The area consists geologically of six formations: from the base upwards the Angaha Khola Formation, Ramdi Formation, Kokat Formation, Kerabari Formation, Charchare Formation and Tansen Formation. The lower four formations are considered to be lower to middle Paleozoic and the upper two formations to be upper Mesozoic in age. These formations are distinct from the Midland meta-sediment Group to the north. The Tansen zone composed of these formations, as well as the Piuthan zone on the west, is a peculiar geologic unit of the Nepal Himalayas.

INTRODUCTION

Nepal is generally divided topographically and geologically into several zones parallel to the main Himalayan trend: from south to north the Churia Range (the Siwalik zone),the Mahabharat Lekh, the Lower Himalayas(including the Midlands) and the Higher Himalayas. Among them the Mahabharat Lekh* (geologically the Mahabharat zone), comprising a rather rough and steep mountains with maximum altitudes up to 3,000 meters, is bounded by the Churia Range on the south and by the Midlands on the north.

The route surveyed, a part of the motor road connecting Pokhara in the Midlands to Bhairawa in the Terai Plain, is situated in the Mahabharat Lekh. Our survey along the route from Butwal to Ramdighat on the northern bank of the Kali Gandaki river, was carried out for a week in winter, 1980.

TOPOGRAPHICAL FEATURES AND GEOLOGICAL SIGNIFICANCE OF THE PRESENT AREA

The Mahabharat Lekh contrasts to each other in eastern Nepal and western Nepal; the Mahabharat zone in eastern Nepal consists mainly of granites and high-grade metamorphic rocks which constitute the nappes derived from the Himalayan gneiss zone to the north, and in other hand the zone in western Nepal is composed of weakly- to non-metamorphic rocks (Hashimoto *et al.*, 1973; Maruo *et al.*, 1979). Such a difference between the eastern and western Mahabharat Lekh is also discernible topographically. In the eastern part the main rivers such as the Tamur, the Sun Kosi, the Trisuli and the Kali Gandaki delimit it on the north where these rivers are forced to turn westwards or eastwards by the Mahabharat Lekh, while the

* Lekh means a range in Nepali.

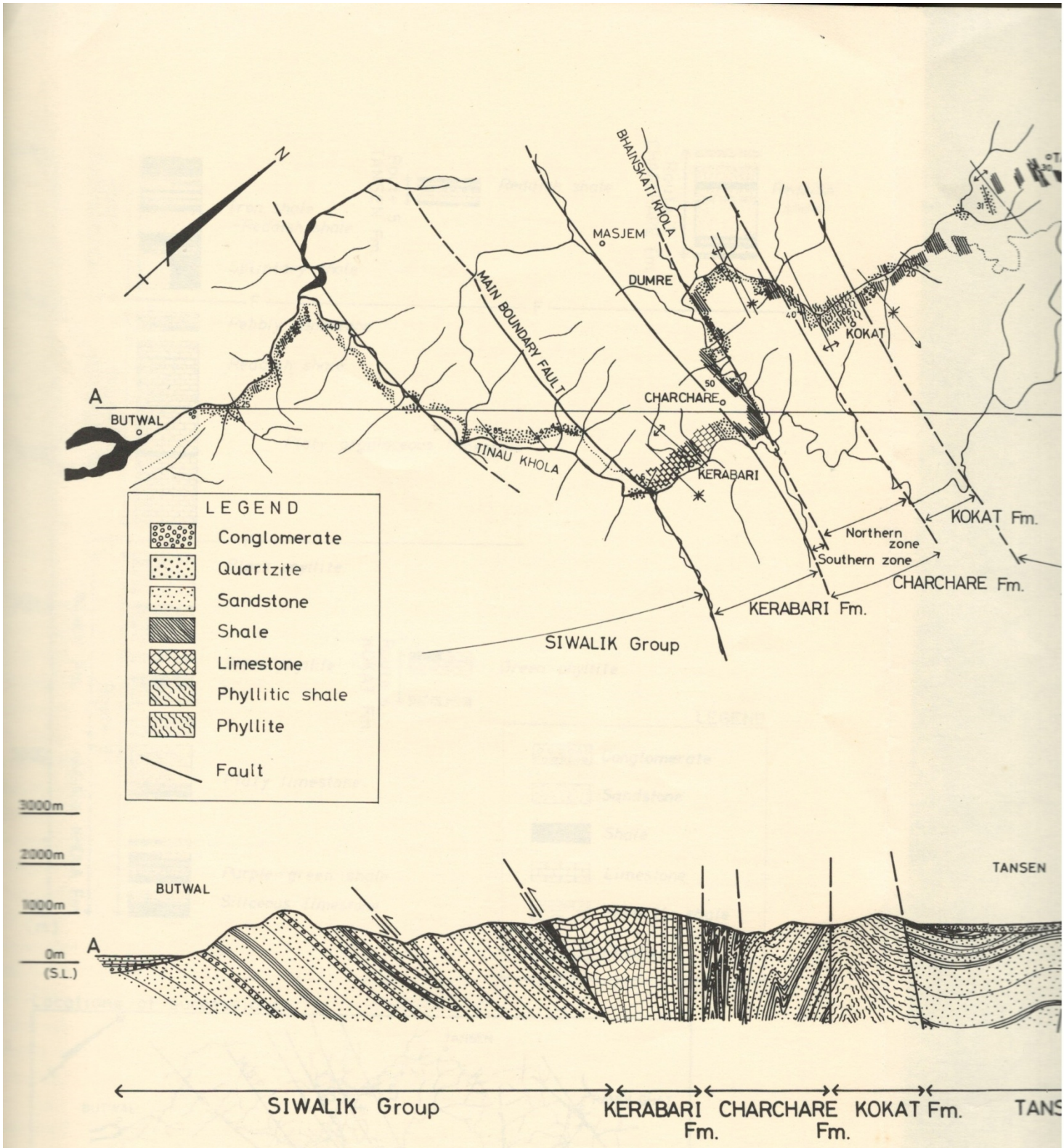
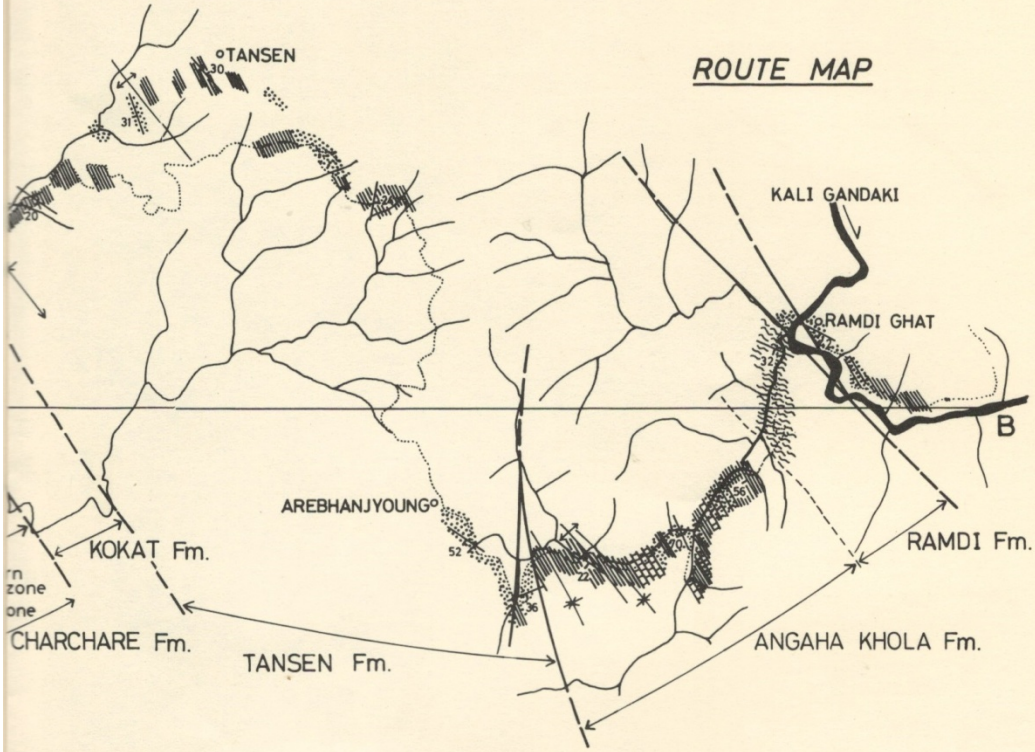
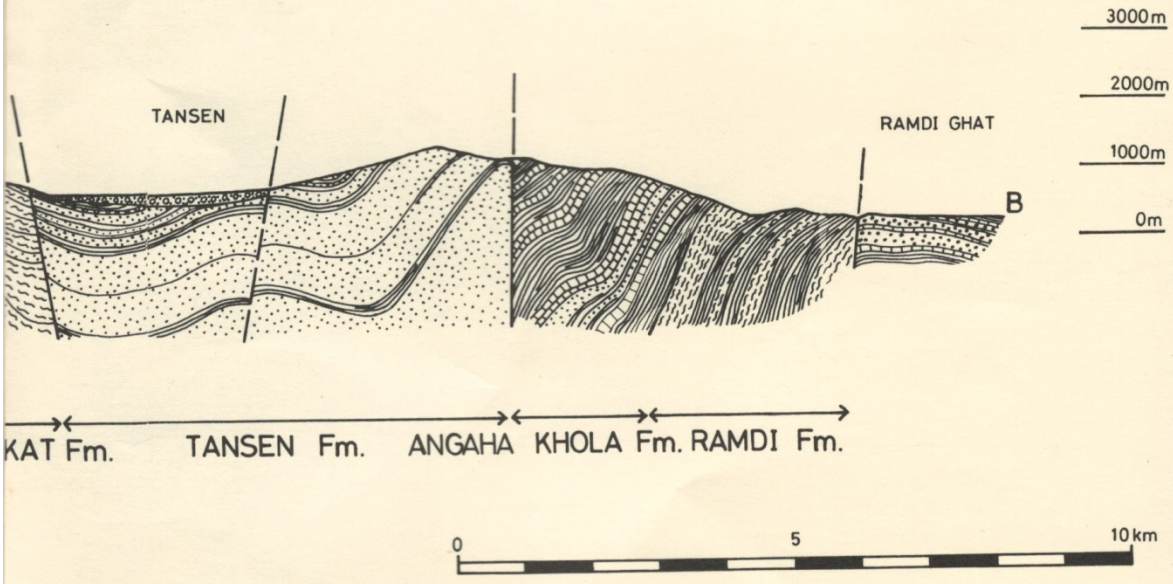


Fig.1 Geological route map and cross-section from Butwal to Ramdghat, central Nepal.

ROUTE MAP



CROSS SECTION



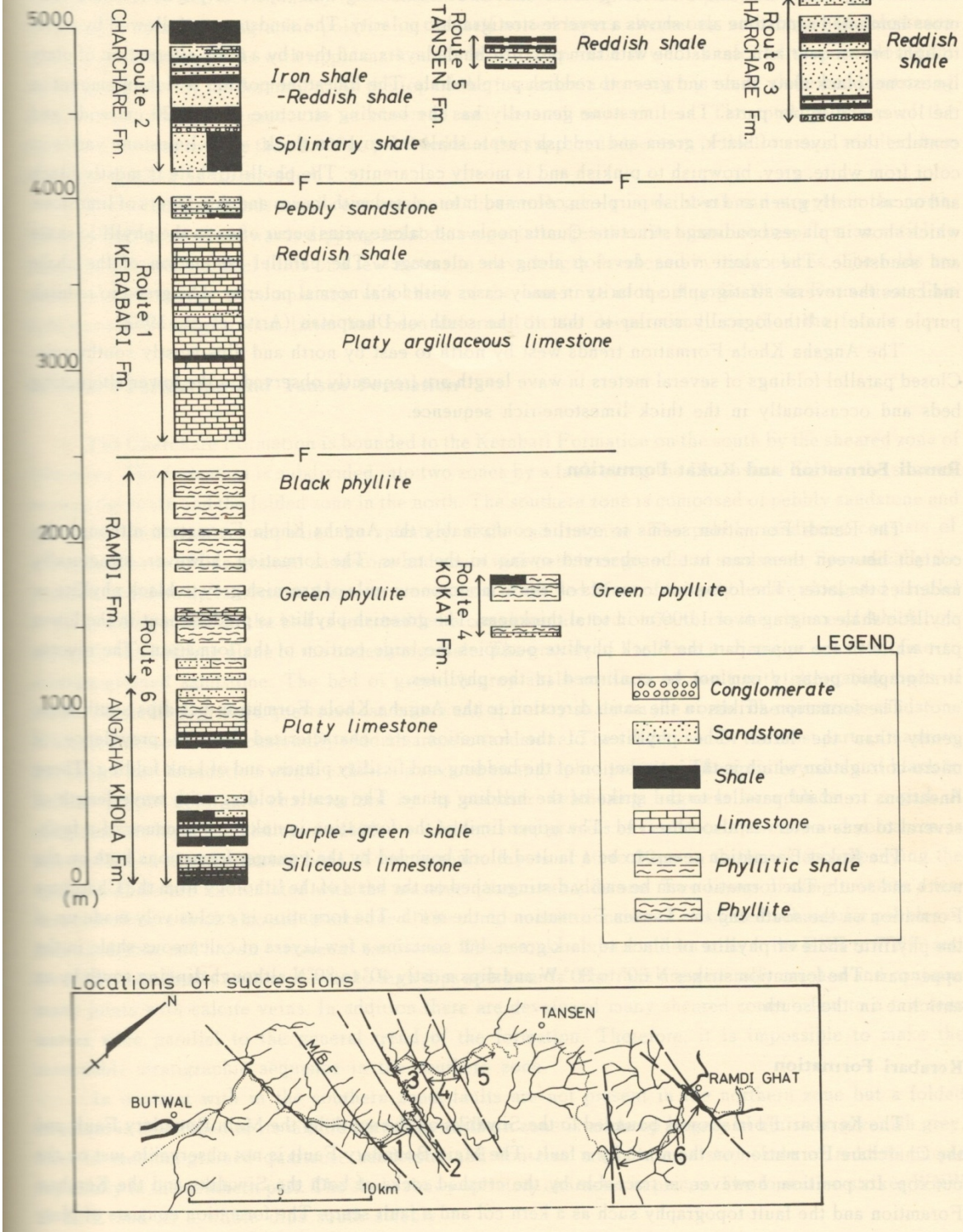


Fig.2 Lithostratigraphic columnar sections of the present route.

alternation grades into laminated fine-grained sandstone containing thin layers of phyllitic shale. The cross-laminated sandstone also shows a reverse stratigraphic polarity. The sandstone is followed by white to light brown quartzitic sandstone with thin phyllitic shale layers, and then by a thick alternation of platy limestone, black slaty shale and green to reddish purple shale. The limestone portion is rich in amount in the lower and upper parts. The limestone generally has the banding structure of 3 to 20 cm wide and contains thin layers of black, green and reddish purple shale 0.5 to 1 cm thick. The limestone varies in color from white, grey, brownish to pinkish and is mostly calcarenite. The phyllitic shale is mostly black and occasionally green and reddish purple in color and intercalated with lenses and thin layers of limestone which show in places boudinage structure. Quartz pools and calcite veins occur often in the phyllitic shale and sandstone. The calcite veins develop along the cleavages. The parallel lamination of the shale indicates the reverse stratigraphic polarity in many cases with local normal polarity. The green to reddish purple shale is lithologically similar to that to the south of Dhorpatan (Arita et *al.*, 1982).

The Angaha Khola Formation trends west by north to east by north and dips mostly southwards. Closed parallel foldings of several meters in wave length are frequently observed in the lower alternating beds and occasionally in the thick limestone-rich sequence.

Ramdi Formation and Kokat Formation

The Ramdi Formation seems to overlie conformably the Angaha Khola Formation although the contact between them can not be observed owing to the talus. The formation, however, structurally underlies the latter. The formation consists of thick monotonous pile of greenish grey to black phyllite or phyllitic shale ranging over 1,000 m in total thickness. The greenish phyllite is predominant in the lower part while in the upper part the black phyllite occupies the large portion of the formation. The reverse stratigraphic polarity can not be confirmed in the phyllites.

The formation strikes in the same direction to the Angaha Khola Formation but dips south more gently than the latter. The phyllites of the formation are characterized by the prevalence of micro-corrugation which is the intersection of the bedding and fissility planes, and of kink folding. These lineations trend subparallel to the strike of the bedding plane. The gentle folding with wave length of several to tens meters is also observed. The upper limit of the formation is unknown because of a fault.

The Kokat Formation seems to be a faulted block bounded by the younger formations both on the north and south. The formation can be easily distinguished on the basis of the lithology from the Charchare Formation on the south and the Tansen Formation on the north. The formation is exclusively made up of the phyllitic shale or phyllite of black to dark green, but contains a few layers of calcareous shale in the upper part. The formation strikes N 60° to 80° W and dips mostly 40° to 80°N although dipping south by an anticline in the south.

Kerabari Formation

The Kerabari Formation is bounded to the Siwaliks on the south by the Main Boundary Fault and the Charchare Formation on the north by a fault. The Main Boundary Fault is not observable just on the outcrop. Its position, however, is traceable by the crushed rocks of both the Siwaliks and the Kerabari Foramtion and the fault topography such as a kern col and a fault scarp. The formation consists of platy grey to dark argillaceous limestone with subordinate amounts of layers and lenses composed of flinty calcareous shale and fine-grained sandstone. The limestone belongs to calcilutite or calcarenite. Thin layers of calcareous shale of 5 to 10cm thick increase in amount towards the upper part. The coarse-grained quartz

sandstone bed is also occasionally interbedded. The limestone represents a platy structure of 2 to 30cm thick and a normal stratigraphic polarity in the well sorted layers alternating with layers of calcareous shale. Quartzose sandstone with ripple mark and reddish brown shale as well as calcirudite are predominant in the upper part of the formation. At the top of the formation a brown grey sandy shale bed containing pebble-sized gravels of sandstone is observed and sheared more or less. The total thickness of the formation reaches to more than 1,000m, provided that the supposed repetition of the formation resulted from the local folding is disregarded.

The formation trends nearly east-west and dips north gently in the south and steeply in the north. This, as well as the southwards dipping axial cleavage, indicates that the formation may form an anticline inclined to north. Parallel folds of a few meters in wave length developed in many places. The folds are rather accordion-type in comparison with those of the limestone in the Angaha Khola Formation. This difference may suggest that latter has been deformed in the deeper condition than the former.

Charchare Formation and Tansen Formation

The Charchare Formation is bounded to the Kerabari Formation on the south by the sheared zone of 10m wide. The formation is subdivided into two zones by a fault along the Bhainskati Khola : the sheared zone in the south and the folded zone in the north. The southern zone is composed of pebbly sandstone and quartzose sandstone accompanied by splintery shale and limonite. The pebbly sandstone consists of alternating beds of fine-grained sandstone and shale with pebble or granule of sandstone. Sporadically the rounded boulders up to 20cm in diameter are scatterd in the bed.Most of the pebbles are elongated parallel to the bedding plane. In the bed is interbedded a conglomerate bed of 6m thick, the surface of which cuts obliquely the bedding plane of the underlying shale. The gravels of 1 to 10cm in diameter consist of fine- to medium-grained sandstone. The bed of greenish grey shale contacts by fault with alternating beds of coarse- to medium-grained quartzose sandstone and splintery shale on the north. The quartzose sandstone is black, greenish and occasionally reddish arkosic sandstone. The sandstone, for the most part, is massive, but shows rare lamination which exhibits a reverse stratigraphic polarity. The splintery shale of black to reddish purple color are characterized by its peculiar weathering fragment as a blade or a gad. A conglomerate layer, consisting of pebble- to boulder- sized gravels of sandstone, quartzite and volcanics, is interbedded in the alternating beds. A few limonite layers of 10 to 30cm in thickness accompanying the splintery shale are intercalated with the massive quartzose sandstone. Two layers of conglomerate a few tens centimeters thick also are interbedded. The conglomerate consists of elongated subangular pebbles of dark sandstone and brown calcareous sandstone. These rocks of the southern zone strike ENE to WNW and are folded isoclinally with moderate to high dips southwards. The rock are generally crushed and contains many joints with calcite veins. In addition there are developed many sheared zones a few to a few tens meters wide parallel to the general trend of the formation. Therefore, it is impossible to make the reasonable stratigraphic sequence in the southern zone.

In contrast with in the southern zone, faults are not present in the northern zone but a folded structure is developed in its middle part. The northern zone is made up largely of bluish to greenish grey, fine- to medium-grained quartzose sandstone and contains much intercalated shale of reddish purple especially in the southern part. The shale shows splintery character in places. The formation strikes WNW to ENE and as a whole dips south steeply.

The Tansen Formation seems to form an anticlinorium plunging east. The south flank of the anticlinorium is cut by a fault and the north flank is gently folded into small-scale anticlines and synclines. The formation consists of greenish phyllitic shale in the north flank and of medium- to coarse-grained

quartzose arkosic sandstone accompanied with reddish purple shale, which resembles in lithology that of the Charchare Formation, in the core of the anticlinorium.

DISCUSSIONS AND CONCLUSIONS

As mentioned above the stratigraphy and age of the formations in the present area in the Mahabharat zone are of much significance for the Himalayan geology. The present authors, however, could not find fossils available. Therefore, the lithostratigraphy of the present area will be discussed with reference to the results of Fuchs and Frank (1970) and Kayastha and Aryal (1978)*. Table 1 shows the stratigraphic sequence of the present area and its correlation with those established by Fuchs and Frunk (1970) and Kayastha and Aryal (1978).

Judging from the graded bedding of the Angaha Khola Formation, it is obvious that the formation shows a reverse sequence. Furthermore the Ramdi Formation rests on the Angaha Khola Formation with conformity. Fuchs and Frank (1970) assigned the both formations to their Chandpurs and the platy limestone bed of the Angaha Khola Formation to their Krols which were considered to form tectonic wedges in the Chandpurs. However, such a tectonic contact between the platy limestone and the surrounding clastic sediments in the Angaha Khola Formation can not be observed. No leading fossils have been found in the Angaha Khola and Ramdi Formations and also in their equivalent, the Chandpurs, in other areas of the Himalayas. Fuchs and Frank (1970), taking the sedimentary successions in all the zones of the Himalayas into account, concluded that the Chandpurs are of upper Silurian to Devonian age and in consequence are correlated with their Chail Formation to the north which was supposed to be an upper Silurian to Devonian molasse by them. On the other hand the Chail Formation seems to correspond to the lower to middle Midland meta-sediment Group of Eocambrian age (Hashimoto *et al.*, 1973). Furthermore Kayastha and Aryal (1978) assigned the Precambrian to lower Paleozoic to the Angaha Khola and Ramdi Formations and the overlying Kerabari Formation. At this point of the study the present authors favour the view of Fuchs and Frank (1970), that is, the Angaha Khola and Ramdi Formations are considered to be of lower to middle Paleozoic in age. The present authors, however, can not agree with the view that both formations are the equivalent to the Chail Formation to the north.

The Kokat Formation was dealt with as the lowermost part of the Tansen Formation by Kayastha and Aryal (1978). The formation, however, seems to be older than the Tansen Formation as already mentioned. Therefore, the present authors intend to correlate tentatively it with the Ramdi Formation.

There can be no doubt as to the equivalence of the Kerabari Formation and the Krols. The Krols are certainly assigned to the upper Paleozoic in age (Gansser, 1964; Fuchs and Frank, 1970).

The Charchare Formation of the present paper corresponds to the Bhainskati Formation and original Charchare Formation of Kayastha and Aryal (1978). North of Masjem village Fuchs and Frank (1970) found coquina consisting of lamellibranch shells in their Tals which are estimated to be the western extension of the Charchare Formation and considered the age of the Tals to be the Jurassic to Cretaceous.Consequently the Charchare Formation is also probably of Jurassic to Cretaceous age. There,however, can be some doubt about the age of splintery shale with limonite layers in the southern zone of the Charchare Formation: there is a probability that the splintery shale may be correlative with the Subathus of Eocene age because of their lithological similarity (Wadia, 1975). If this is the case, the

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* This is on the basis of the geological route map and cross-section of Sunauli-Pokhara road (Sidhartha Rajmarga) which were distributed on the International Geodynamics Conference (Working group 6) held at Kathmandu in 1978.

Table 1 Correlation of lithostratigraphic sequence.

	Kayastha and Aryal (1978)	Present authors	Fuchs and Frank (1970)
Cretaceous–Eocene	Tansen Fm	(Dagshai ?)	Dagshai
	fault		(L.–M.Miocene)
	Charchare Fm	Charchare Fm	unconformity
	fault	(Tansen Fm)	Tal
	Bhaiskati Fm		(Jur.–Cret.)
	fault	fault	unconformity
Precambrian(?)–Low. Paleo.	Kerabari Fm	Kerabari Fm	Krol
			(Permo–Carb.)
	fault	fault	fault
	Angaha Khola Fm	Ramdi Fm	Chandpur
		(Kokat Fm)	(U.Sil.–Dev.)
	conformity	conformity	
	Ramdi Fm	Angaha Khola Fm	Chandpur +Krol

splintary shale is presumed to form tectonic wedge in the Charchare Formation. The Tansen Formation, which was designated as the uppermost formation in the present area by Kayastha and Aryal (1978), seems likely to be correlative with the Charchare Formation based on the lithological similarity.

In conclusion all the formations exposed along the present route are different from the Midland meta-sediment Group of the Lower Himalayas to the north and constitute the southern part of the Tansen zone which is bounded to the Kekmi- Bhandipur zone of the Midland metasediment zone on the north by the Kali Gandaki fault (Arita *et al.*, 1982).

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