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GEOLOGY OF THE "AUTOCHTHONOUS FOLDED BELT", JAMMU AND KASHMIR HIMALAYA WITH SPECIAL REFERENCE TO THE PANJAL "THRUST"

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ABSTRACT

The stratigraphy and structure of a part of the 'Autochthonous Folded Belt', stretching from Uri in the Jhelum Valley in the west to Chauhra in the Ravi Valley in the east, is reviewed. the succession has been classified into Precambrian Gamir, Baila, Ramban, Bhimdasa and Sincha Formations which are unconformably overlian by Upper Palaeozoic to Lower Tertiary sequence of the Agglomeratic Slate, Panjal Volcanic, Zewan, Poonch-Mandi and Rajpur Formations. The Panjal 'Thrust' is a high angle major tectonic lineament dipping towards north and is traceable from near Dachhi to Rajarwain in the Jhelum Valley, Rajpur in the Mandi Valley, Bafliaz in the Suran Valley, Budial and north of Balmatkot in the Ans Valley, north of Bhimdasa, Digdaul north of Sincha, Bagga in the Chenab Valley to beyond Chauhra in the Ravi Valley to the east. The tectonic plane, considered earlier to be the trace of the Panjal 'Thrust' in the Chenab Valley, is found to be a major fault-the Sudh Mahadev Fault, within the 'Autochthonous Folded Belt'.

INTRODUCTION

The 'Autochthonous Folded Belt' is one of the three structural units recognised by Wadia (1931) in Poonch area in the Jammu and Kashmir Himalaya. It is bounded to the south by the Murree Thrust' separating it from the Tertiary rocks mainly Murree and Siwalik of the Foreland, whereas the Panjal Thrust' marks its northern limit with the 'Nappe zone' made up of older rocks forming the basement for the Tethyan sediments. The 'Autochthonous Folded Belt', according to Wadia (1928), is made up Carboniferous–Eocene rocks (table 1) and varies in width from a few meters to as much as 7 km. Later, (Wadia in Heron, 1937) extended his observations to Banihal-Ramban area in southeast where he recognised "the two great thrusts delimiting the autochthonous belt". According to him "instead of Salkhala series forming the sole of the Panjal thrust, a broad zone of Dogra slate abuts on the recumbent folds of Eocene to the southeast of Badar. The Dogra slate is in turn overthrust by the....Salkhala series". In recent years, the lithostratigraphy and position of the Panjal 'Thrust' in certain areas is a matter of critical discussion: some incorporated the 'Dogra slate' of Chenab Valley (Ramban Formation, Bhatia and Bhatia, 1973) in the 'Autochthonous Belt', and recognised the overthrust near Sincha and Digdaul (Wadia in Heron, 1937), north of Ramban as the Panjal 'Thrust' which brought the 'Salkhala' to rest tectonically above it; the stratigraphic position of the Ramban Formation was, however, considered to be between the 'Salkhala' and the 'Chamalwas' Formations by Bhatia and Bhatia (1973). No recumbent folding was observed in Poonch area and the rocks lying immediately to the north of Murree 'Thrust' are not of Eocene age as considered by Wadia (1928) but older to the Agglomeratic Slate and divisible into Gamir and Baila Formations (Rao et al, 1975). Rao and Rao (1979) and Karunakaran and Ranga Rao (1979) classified the rocks, in ascending order, into Upper Carboniferous Agglomeratic Slate Group consisting of Gamir, Baila, Agglomeratic slate and Panjal Trap formations, Lower Permian Zewan beds and Eocene Rajpur Formation. Rao and Rao, however, recognised the Panjal Trap at two stratigraphic levels, one at the base underlying the Gamir and the other overlying the Agglomeratic slate. Fuchs (1975) classified the rocks into black phyllite and slates, Simla (Dogra) Slate plus Langrial Limestone, Agglomeratic and Panjal Trap in ascending order. In Betar Valley, north of Poonch, Chaudhry and Ashraf (1980) classified the rocks into Upper Carboniferous Panjal Group, Permocarboniferous Gondwana Group, Paleocene Patala Formation and Eocene Mangala Hill Limestone and Kuldana Formations. Sharma *et al.*(1978) did not recognise the existence of the Panjal 'Thrust' and considered a complete and conformable sequence ranging in age from Precambrian 'Salkhala' to Triassic limestone. Later, Sharma *et al.*(1979) equated the 'Dogra Slate' of Ramban-Gulabgarh area with the 'Agglomeratic Slate' on the basis of fossil algae *Macroporella*. The existence of Panjal 'Thrust' was, however, recognised again by Sharma *et al.*(1982). The classification adopted by Verma *et al.* (1983) is given in table 2. They, like Rao and Rao, Karunakaran and Ranga Rao, and Shah (1980), maintained the position of the Panjal 'Thrust' where it was originally marked by Wadia.

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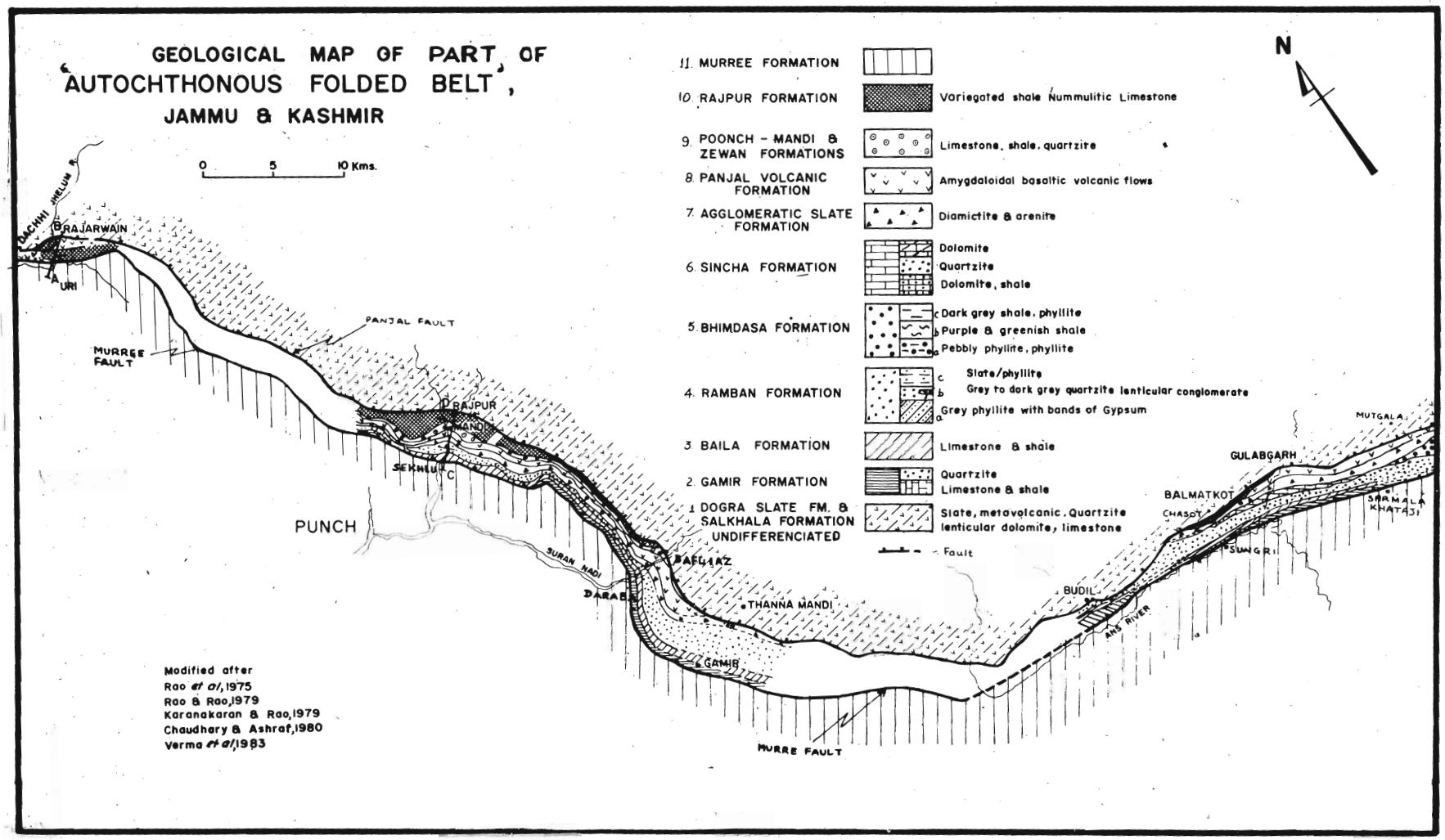


Fig. 1a. Geological map of 'Autochthonous Folded Belt' between and Gulabarh, Jammu and Kashmir Himalaya

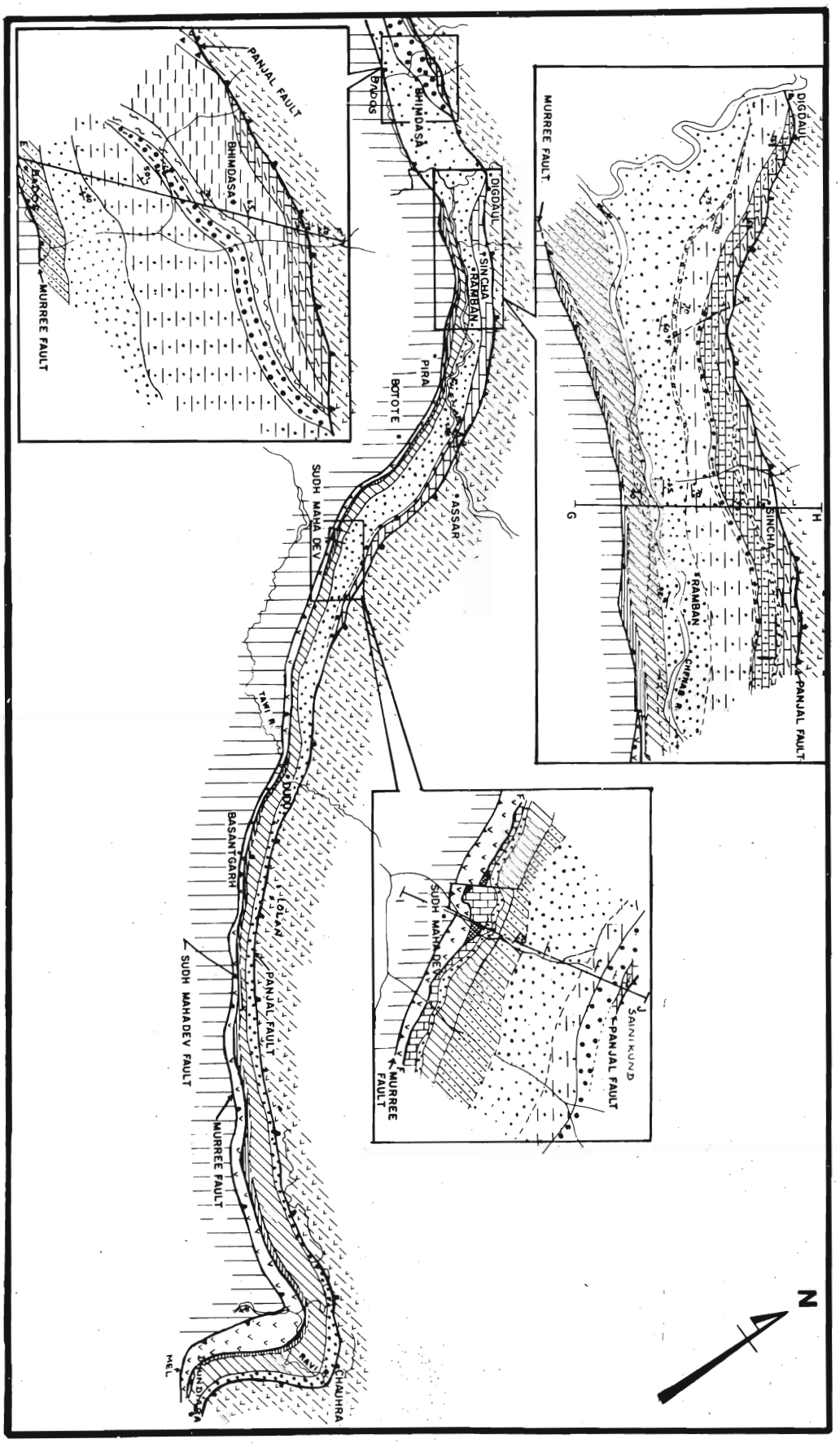


Fig.1b. Geological map of 'Autochthonous Folded Belt' between Bhimdasa and Chauhera, Jammu and Kashmir Himalaya.

Table 1. Lithostratigraphy of the 'Autochthonous Folded Belt', Mandi Valley (Wadia, 1928)

	Dogra Slate	
	Fault	
Eocene	Variegated purple and green shale Grey and black foetid limestone, Nummulitic	
	Unconformity	
Upper? Trias.	Massive, grey orinoidal semi-crystalline limestone weathering to cream or yellow	60.96
	Grey shelly limestone with lamellibranches	91.44 m
	Unconformity	
	Black sandy micaceous shale with numerous *Schizodus* casts and some impressions of polyzoa interbedded with buff and mottled sandy crystalline limestone with *Products, Spirifer* and comminted shell valves of other forms passing into Massive Units quartzite (6.96-9.14 m)	30.48-60.96 m
	Unconformity	
Upper Carboniferous	Variegated ash beds	
Panjal Trap	Massive amygdaloidal flows	
	Slate, conglomerate and ash beds Quartzite	
Agglomeratic slate	Green white sandstone Agglomeratic slate and tuffs Flaggy black clay slates	

To resolve the above controversies on lithostratigraphic classification and position of the Panjal 'Thrust', the authors carried out studies with the help of close geological traverses (Fig. 1 a & b) and the following eleven sections (Fig. 2) were measured and thicknesses of various formations were worked out.

i. Rajarwain in the Jhelum Valley
ii. Sekhlu—Mandi—Rajpur in the Mandi Valley
iii. Daraba—Bafliaz in Suran Valley
iv. Sungri-Chasot
v. Mutgala—Sarmola Khataji
vi. Bodas—Bhimdasa
vii. Ramban-Sincha
viii. Batote—Asser
ix. Sudh Mahadev—Sainikund
x. Basantgarh—Loan and
xi. Mel-Kunah—Dhundiara.

STRATIGRAPHY

As a result of above work, the stratigraphy worked out is given in table 3.

GAMIR FORMATION (Rao *et al* 1975): The formation is best developed between Daraba and Badas in the western part of the belt. Further in west, in Betar *Gad* and Jhelum Valleys, it is cut-off by the Thrust. In the eastern part, it reappears and continues from east of Ramban to beyond Chauhra in the Ravi Valley. It is conformably overlain by the Baila Formation. The basement of the formation is not exposed. Shah (1980, fig. 2) gave the following lithostratiography in the best exposed section in the Suran Valley:

6. Cream-white quartzite
5. Gritty quartzite with bands of conglomerate (15m)
4. Ferruginous quartzite with bands of cherty shale
3. Calcareous and flaggy quartzite with bands of limestone (195m)
2. Purple shale with thin calcite partings.
1. Massive white quartzite. *(+20m)*

Rao et al, (1975) estimated its thickness about 580 m and considered it to be older than Agglomeratic Slate. They differed with Wadia (1928) in not considering it to be of Eocene age. The present work has indicated an unconformity at the base of the Agglomeratic Slate, and in view of presence of primitive microbiota (under study by Dr. R.K. Avasthy) in the overlying Sincha Formation, the Gamir Formation appears to be Precambrian in age.

BAILA FORMATION (Rao *et al,* 1975): Conformably overlying the Gamir Formation, in the Suran Valley, is a succession of carbonate rocks, about 290 m thick, which constitutes the Baila Formation. It is conformably overlain by the Ramban Formation. The following lithostratigraphy has been observed:

3. Calcareous shale, greenish grey, laminated and well jointed with lenticles of limestone (80m)
2. Light grey to dark grey nodular limestone (30-120m)
1. Greenish grey to ash grey, black to carbonaceous at places in lower part, and calcareous with lenticles of limestone in upper part (30-90m).

RAMBAN FORMATION (Bhatia and Bhatia, 1973): The Ramban Formation (Dogra Slate of Wadia, in Heron, 1937) conformably overlies the Baila Formation and is unconformably overlain by the Bhimdasa Formation. The lower contact with the Baila Formation is well exposed in

Table 2. Lithostratigraphy of the 'Autochthonous Folded Belt' by Verma *et al* (1983).

Group	Formation	Member	Approximate age
	Rajpur	Variegated Shale Nummulitic Limestone	Paleocene-Eocene
Mandi	Upper Mandi	Member B	Jurassic
	Lower Mandi	Member A	Permo-Trias.
Panjal Volcanic	Panjal Trap		
	Agglomeratic Slate		Carboniferous
	Baila		Carboniferous and older
	Gamir		

the Mandi and Suran Valleys in the west and in the Ravi Valley to the east. In areas where the overlying Bhimdasa and or the Sincha Formations are not present, it is unconformably overlain by the Agglomeratic Slate as is well seen in the road cutting southwest of Mandi. The Ramban Formation, however, is best developed in Ramban area where it rests tectonically over the Panjal-Volcanic.West of Mandi, it along with the underlying Gamir and Balia Formations is cut-off by the Murree 'Thrust' and are not exposed in the Betar Valley (Chaudhry and Ashraf, 1980) and north of Uri in Jhelum Valley. In area east of Ramban, the Sudh Mahadev Fault brings it to rest tectonically over the Rajpur Formation as is well seen at Sudh Mahadev (Fig. 1b).

The following lithostratigraphy has been observed in the best developed section at Sudh Mahadev which may be considered as the type section:

3. Grey to dark grey shale/slate with bands of grey quartzite (1260 m)
2. Medium to fine-grained grey quartzite, grey slate, occasional pebble slate. Current bedding, ripple marks and mud-cracks. (400m)
1. Bluish grey phyllitic slate, grey shale/slate with bands of gypsum. (+ 380m)

Wadia (in Heron, 1937) correlated the above succession with the Dogra Slate of Poonch area (Wadia, 1928) grouped it with the rocks of the 'nappe zone' outcroping between the 'Salkhala seires' and the 'Autochthoncus belt'. This lithostratigraphic succession is distinctly different from that of the Dogra Slate of the type area in Betar Valley (Wadia, 1928) which comprises slate phyllite, quartzite with penecontemporaneous basic volcanic flows as has been rightly indicated by Bhatia and Bhatia (1973). All the previous workers (Wadia, 1928; Rao *et al*, 1975; Karunakaran and Ranga Rao, 1979; Rao and Rao 1979; Dutta *et al*, 1981; Verma *et al*, 1983) have grouped this succession with the overlying Agglomeratic Slate in the western part of the belt.

BHIMDASA FORMATION: Unconformably overlying the Ramban Formation, in area between Gulabgarh and Sudh Mahadev, is a succession of pebbly phyllite with purple and dark grey shale which is conformably overlain by a calcareous sequence. This succession along with the carbonate rocks was previously grouped with the Agglomeratic Slate in area west of Gulabgarh whereas, in the Chenab Valley, it was included in the Ramban Formation. This is now being separated out as a distinct lithostratigraphic formation named as the Bhimdasa Formation, well developed near Bhimdasa. The following succession has been noticed in the type section:

6. Dark grey to brownish, purplish to dirty white quartzite (81m)
5. Dark grey and greenish grey shale/slate with bands of quartzite (675m)
4. Purple and green shales, slates, purple micaceous siltstone (122m)
3. Pebbly shale/slate with rounded clasts of slate, quartzite (76m)
2. Grey shale/slate with thick bands (up to 2 m) of grey quartzite (45 m)
1. Grey pebbly shale/slate or boulder conglomerate with rounded clasts of quartzite measuring upto 30 cm in diameter (185 m).

The above succession is quite distinct from that of the Agglomeratic Slate. In areas where it is not developed along with the overlying Sincha Formation, the Agglomeratic Slate transgresses over the underlying Ramban Formation as is well seen in the Mandi section.

SINCHA FORMATION: The narrow belt of carbonate succession conformably overlying the Bhimdasa Formation and unconformably overlain by the Agglomeratic slate constitutes the Sincha Formation. It is well exposed around Sincha, north of Ramban where it is limited in north by the Panjal 'Thrust'. In western extension, it abuts against the Panjal 'Thrust' and is not exposed in the Highway section near Digdaul but reappears north of Bhimdasa. Further in west, the Sincha Formation is completely overlapped by the Agglomeratic Slate and has not been mapped west of Balmatkot. In east, it continues to Sudh Mahadev and is cut-off again further in east towards Chauhra. The lithostratigraphy noticed in the Sincha section is as follows:

6. Dark grey dolomite (+10m)
5. Dark grey to bluish grey dolomite, light grey sandy

dolomite (36 m)
4. Pinkish limestone (61m)
3. Dark grey to bluish grey dolmite, occasionally phosphatic (96m)
2. Bluish grey dolomite interbedded with grey limestone with zebra-type banding (77m)
1. Grey to bluish grey dolomite with lenticles of chert containing primitive microbiota (78m)

Locally, there is development of band of grey shale (21 m) and white current bedded quartzite (22 m) and is well seen in the Bhimdasa section. The Sincha Formation was earlier grouped with the 'Dogra Slate' (Wadia in Heron, 1937), Ramsu Formation (Vohra, 1966), Agglomeratic Slate (Sharma *et al*, 1976). Sharma *et al*, however, reported algae *Macroporella* and considered it to be of Carboniferous age. The present studies do not record such algal elements but show the presence of simple primitive sphaeromorphs in the lenticles of black chert present in the basal part of the succession. Such sphaeromorphs are known from late Precambrian sequences of Siberian Platform, USSR. Therefore, the Sincha Formation can not be of Carboniferous age as considered by Sharma *et al*. The detailed studies on microbiota are in progress.

AGGLOMERATIC SLATE FORMATION: The formation is exposed between Mandi and Gulabgarh unconformably overlying the Ramban Formation in the Mandi and Suran Valleys, and the Sincha Formation in Gulabgarh area. It is conformably overlain by the Panjal Volcanic in area west of Thannamandi. The Agglomeratic Slate abuts against the Panjal Thrust east of Gulabgarh whereas it is cut-off by the Murree Thrust west of Betar Valley and reappearing in Jhelum Valley north of Uri. The following lithostratigraphy has been noticed in the Mandi section.

6. white gritty quartzite (5 m)
5. Purple shale (2 m)
4. Gritty quartzite (4 m)
3. Dark grey shale (2 m)
2. Grey to dark grey diamictite with clasts of quartzite, slate, limestone and granite (40 m)
1. Conglomerate (5 m)

Dutta *et al*. (1981) assigned a late Palaeozoic age on the basis of their find of *Protoretepora* from Mandi section. This find, however, could not be substantiated by later work of one of us (GK). Verma *et al*, (1983) recorded *Spirifer* sp. and *Productus* sp., and assigned Middle to Upper Carboniferous age. This age assignment is anamolous to the ? Upper Carboniferous to Lower Permian age of the lithostratigraphically identical Agglomeratic Slate of Kashmir 'nappe' zone (Singh *et al*, 1982).

PANJAL VOLCANIC FORMATION (Panjal trap, Wadia, 1928): The Panjal Volcanic conformably overlies the Agglomeratic Slate and is well exposed in area lying between Gulabgarh and Uri. It is conformably overlain by the Zewan Formation excepting in Jhelum Valley, north of Uri where it is unconformably overlain by the Rajpur Formation. In area lying east of Sungri-Chasot, the Panjal Volcanic is cut-off by the Panjal 'Thrust'. Another band of the Panjal Volcanic has been noticed extending from Nainikhad in the Ravi Valley to Pira-Melra in Chenab Valley, south of Ramban running almost parallel to the Murree 'Thrust', and tectonically overlain by the Gamir Formation. At Sudh Mahadev, the volcanic is overlain by the Rajpur Formation. This tectonic plane, referred to here as the Mudh Mahadev Fault, has previously been considered to be the trace of the Panjal 'Thrust' (Wadia in Heron, 1937).

The Panjal Volcanic comprises fine-grained, greyish green to dark green, massive to viscular, amygdaloidal lava flows of andesitic to basaltic composition. The amygdules are of quartz, calcite and epidote. Ash beds with pellets of limestone and quartzite are also seen at several places.

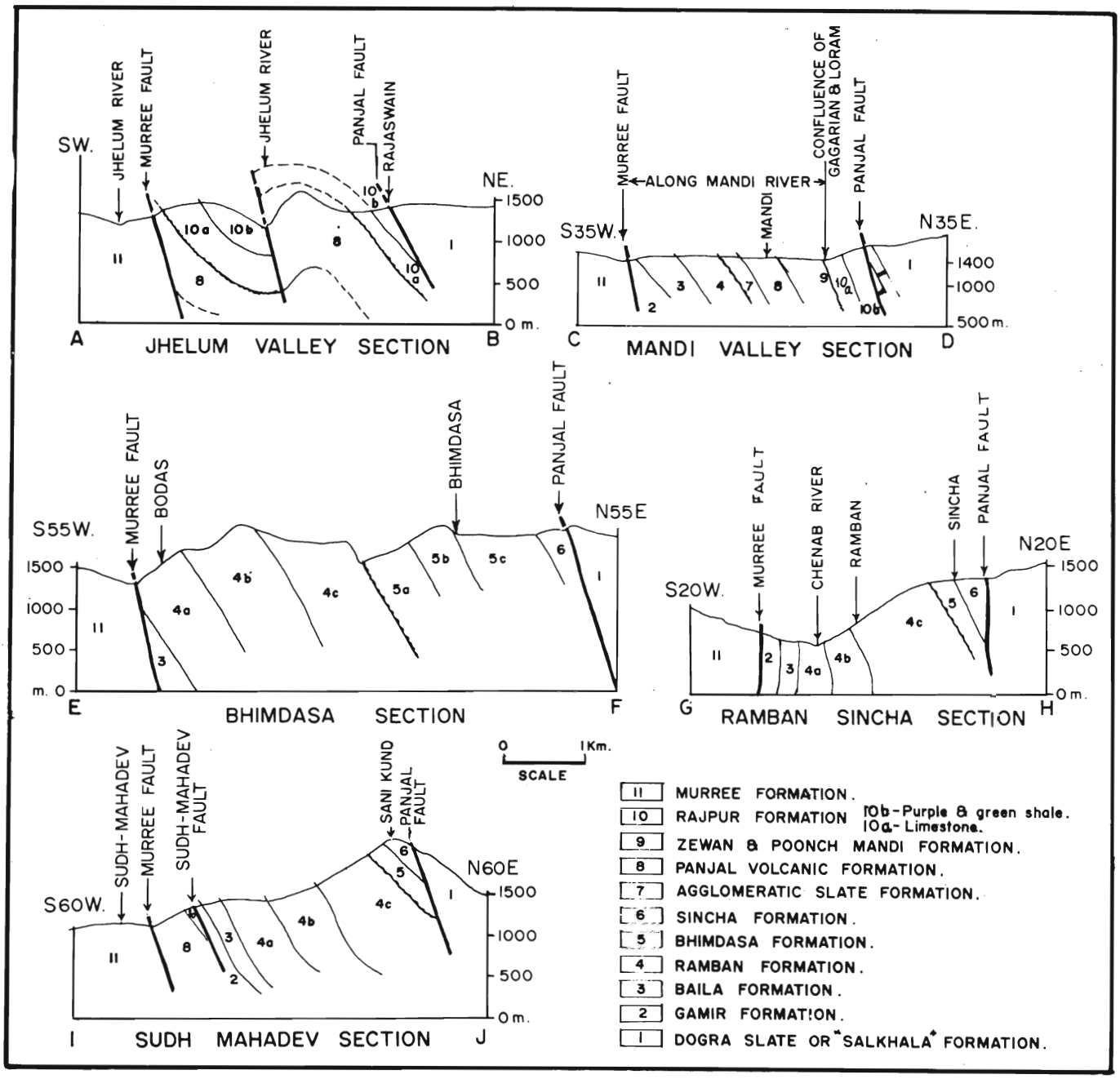
Srikantia (1973), assuming these volcanics to be the 'strike extensions of the Mandi-Darla Volcanics of the Main Shali structural belt', assigned Precambrian age. The present studies, on the other hand, show this volcanic to be sandwitched between the Agglomeratic Slate below and the Zewan and younger formations above, and therefore, can not be of Precambrian age. In the 'nappe zone', the Panjal Volcanic has been assigned to Early Permian age (Kumar *et al*, 1980; Singh *et al*, 1982). Rao *et al*, (1975) identified 'Panjal trap' at two levels, the older one underlying the Gamir. Perhaps they misinterpreted the narrow band of Panjal Volcanic between Pira and Nainikhad to be older Panjal Volcanic. As discussed above, this exposure of the Panjal Volcanic is the repetition due to the Sudh Mahadev Fault (Fig. 3).

ZEWAN FORMATION (Zewan series, Wadia, 1928; Zewan Formation, Rao *et al*, 1975; Lower Mandi Formation, Verma *et al*, 1983): This formation has a restricted distribution in the area and is exposed in Mandi—Daraba area only. It is overlapped by the Rajpur Formation in area west of Mandi. The Zewan Formation is divisible into two members (Verma *et al*, 1983), the lower is dominantly calcareous and can be correlated with the Zewan Formation of the 'nappe zone' whereas the upper, characterised by dark grey shale with minor limestone bands, is lithologically akin to the Khunamuh Formation.

POONCH MANDI FORMATION (? Trias of Wadia, 1928; Poonch Mandi Formation, Dutta *et al*, 1981; Upper Mandi Formation, Verma *et al*, 1983): The Zewan Formation is conformably overlain by a thick succession of carbonate rocks which were assigned to a probable Upper Triassic age by Wadia (1928). Rao *et al* (1975), Karunakaran and Ranga Rao (1979) and Rao and Rao (1979) considered this succession as part of the underly-

Table 3. General stratigraphy of the 'Autochthonous Folded Belt' (modified after Verma *et al.* 1983)

Formation	Member	Lithology	Fauna/flora	Age
Rajput	Variegated Shale . Nummulitic Limestone	Purple, red and green shale & siltstone Hard massive, grey to dark grey to sooty black black limestone and calcareous shale	*Nummulites* sp. *Assilina* sp. *Operculina* sp.	Paleocene to Eocene
		Unconformity		
Poonch Mandi		Light to dark grey shale & slate Gritty limestone, silty shale, hard yellowish weathered buff coloured limestone	*Palemnopsis* sp. Palaeonucula sp. Trigonia sp.	Jurassic
		Grey sandy limestone, fine to medium-grained quartzite	*Rhynochonella* sp.	Triassic
		Dark grey ferruginous shale, slate, grey to buff coloured limestone	*Fenestella* sp., *Polypora* sp, & bivalves	
Zewan		Coral limestone, green & purple coloured tuffaceous shale with bands of quartzite	*Productus* sp., *Waggenophyllum* sp. bivalves	Upper Permaian
		Dark grey to cream coloured semi-crystalline crinoidal limestone	*Protoretepora ampla* Fenestella sp., crinosidal stems, cephalopods, gastropods	
		Unconformity		
Panjal Volcanic		Green massive amygdaloidal to vesicular andesitic flows and ash beds		Lower Permian
		Unconformity		
Agglomeratic Slate		Greyish white quartzite, grits and sandstone Grey to dark grey dismictite with dense to sparsely distributed clasts Conglomerate		? Upper arboniferous to Lower Permian
		Angular unconformity		
Sincha		Light grey to grey sandy dolomite, pink and grey limestone, lenticular black chert and gypsum	Primitive microbiota	
	C	Grey-green shale/slate with bands of quartzite		
Bhimdasa	B	Purple & green shale/slate, micaceous siltstone		
	A	Grey pebbly shale/slate (diamictite) & slate with pebble to boulder-size clasts		? Precambrian
		Unconformity		
Ramban		Grey to dark grey shale/slate Grey quartzite with shale/slate Bluish grey phyllitic slate with bands of gypsum		
Baila		Thin bedded laminate limestone, nodular limestone with shale/slate		
Gamir		White to bluish grey quartzite, puple & green shale/slate with occasional thin bands of limestone Base not exposed		



(Fig. 3)

ing Zewan Formation. Dutta *et al.*(1981) referred it as the Poonch Mandi Formation of Triassic age whereas Verma *et al.* (1983) recording Triassic to Jurassic fossils renamed it as Upper Mandi Formation of Mandi Group. It is best exposed in the Mandi Valley where the following lithostratigraphy has been observed.

Grey argillaceous limestone	(+ 20 m)
Massive grey limestone	(39 m)
Upper: Grey to dark grey quartzite with thin lenticular bands of sandy limestone or calcareous grit yielding *Belemnopsis* sp., *Trigonia* sp. in upper part	(137 m)
Greenish to puplish shale	(25 m)
Lower: Grey arenite	(5 m)
Grey fossiliferous sandy limestone containing *Rhynchonella* sp. etc.	(35 m)
Purple hard shale	(10 m)

The Poonch Mandi Formation has been divided into two members, the lower made up of sandy limestone and quartzite which has yielded Triassic fossils (Verma *et al.* 1983), and the upper member is characterised by calcareous grit and sandstone, weathered to buff to brown colour, and dark grey argillaceous limestone, the basal

unit yielding Jurassic fauna (Verma *et al*, 1983). It is unconformably overlain by the Rajpur Formation.

RAJPUR FORMATION (Eocene of Wadia, 1928; Rajpur Formation, Rao *et al*, 1975; Hazara Formation, Rao and Rao, 1979; Subathu Formation Dutta *et al*, 1981; Patala, Mangala Hill Limestone and Kuldana Formations, Chaudhry & Ashraf, 1980). In the type section in the Mandi Valley at Rajpur, the formation rests unconformably over the Poonch Mandi Formation in south and is limited in north by the Panjal 'Thrust'. Further in west, in Jhelum Valley, the entire Zewan and the Poonch Mandi Formations are missing, and this unconformity is much more pronounced with Rajpur Formation resting over the Panjal Volcanic. Rao *et al* (1975) estimated its thickness about 530 m and divided it into two members—the lower, 207 m thick, is dominantly a carbonate succession with calacreous shale which is highly fossiliferous. The fossils recorded by Banerji and Saraswati (1983) include *Nummulites mamalia, N. thalicus, N. globulus, Assilina subspinosa, Alveolina oblonga, Lockhartia haimei, L. tipperi, Globigerina trichlinoides, G. triangularis, Globorotalia angulata, G. esnaensis, G.* sp. cf. *pseudobulloides* which are considered by them to be of Paleocene age. This carbonate succession appears to correspond to the Mangala Hill Limestone of the Betar *Gad* considered by Chaudhry and Ashraf (1980) of Eocene age. The coal bearing pyritous shale constituting the paleocene Patala Formation (Chaudhry and Ashraf, 1980) in Betar Valley are not recorded in the Mandi Valley and elsewhere.

The upper member, 323 m thick, is conspicuous by its variegated bright red to purple colour shale and siltstone. In Jhelum Valley, associated with it are lenticular bands of gypsum. This succession constitutes the Kuldana of Chaudhry and Ashraf (1980). Wadia compared this with the Hazara facies of the Eocene in Hazara area, now in Pakistan.

In the eastern part of the belt, near Sudh Mahadev, the Rajpur Formation is tectonically overlain by Gamir Formation due to the Sudh Mahadev Fault. Here, the Zewan and the Poonch Mandi Formations are again not developed and the Rajpur Formation rests directly over the Panjal Volcanic. Further east, in the Ravi Valley, it occurs unconformably over the Baila Formation as isolated outliers.

STRUCTURE

Of the two major tectonic lineaments delimiting the 'Autochthonous Folded Belt; the Murree Fault (Murree Thrust, Wadia, 1931) to the south and the Panjal Fault to the north (Calkins *et al*, 1975, Panjal Thrust, Wadia, 1931), the former is well recognised whereas the existence and the position of the latter has been a matter of discussion among workers. Within the belt no folding of the type interpreted by Wadia (1931) has been found, and the succession dips monotonously towards north excepting folding of minor nature as noticed in Jhelum Valley (Fig. 3). The studies of Rao *et al*.(1975) had also ruled out the existence of recumbent folding in the Poonch area. In addition to the two major faults delimiting the 'Autochthonous Folded Belt', there is another major reversed fault—the Sudh Mahadev Fault developed within the belt.

PANJAL FAULT (Calkins *et al*, 1975; Panjal Thrust, Wadia 1931). The fault plane separating the succession of 'Eocene zone of Nummulitic limestone and coaly and variegated shales with inlier masses of Permo-Trias and Panjal volcanic ' (Wadia, 1928, p. 294) from the Dogra slate zone in Poonch area was later designated as Panjal Thrust by Wadia (1931). According to him (Wadia, 1928), it is a low angle thrust plane dipping towards north. Wadia (in Heron, 1937) extended his studies to Banihal area in east and placed this 'thrust plane' south of 'Dogra slate' (the Ramban Formation) passing from near Pira to Sudh Mahadev and further in east. This position of the 'thrust plane' was maintained by almost all subsequent workers (Rao *et al*, 1975; Karunakaran and Ranga Rao, 1979). Srikantia (1973), and Srikantia and Bhargava 1974), however, considered the tectonic plane recognised by Wadia (in Heron, 1937) at Digdaul and Sincha to be trace of the Panjal 'Thrust', and included the 'Dogra slate' (the Ramban Formation) within the 'Autochthonous Folded Belt' and equated it with the Simla Group of Himachal Pradesh Himalaya.

The present studies have shown that the Panjal 'Thrust' is not a low angle thrust plane but a high angle reverse fault separating the rocks of the 'nappe zone' from the 'Autochthonous Folded Belt'. This observation is in conformity with that of Calkins *et al*.(1975) who arrived at similar conclusions in Hazara, Pakistan and rightly termed it as the Panjal Fault. In the present area, it is traceable from near Dachhi to north of Uri (near Rajarwain) in Jhelum Valley to Rajpur in Mandi Valley, Bafliaz in the Suran river, south of Thannamandi, just north of Budil, north of Balmatkot and Bhimdasa and extending further in east to join the tectonic plane at Digdaul and Sincha in the Chenab Valley. It continues further in east to beyond Chauhra in the Ravi Valley. In western continuation, it warps around the syntaxial axis (Wadia, 1931) Sharma *et al*, 1982) to join with the Panjal Fault. It is due to the Panjal Fault that the Agglomeratic Slate and younger successions are completely cut-off east of Bhimdasa and the Precambrian Sincha Formation and older succession come in contact with the 'Salkahala' in the Chenab Valley and to east of it.

MURREE FAULT (Murree Thrust, Wadia, 1931). Like the Panjal Fault, this major tectonic plane running almost parallel to it, is also a reverse fault dipping at varying angles from 45° towards north to almost vertical in cer-

tain areas.

SUDH MAHADEV FAULT (Panjal Thrust of Wadia in Heron, 1937): This fault plane corresponds to the tectonic plane referred earlier to as the 'Panjal Thrust' in Pira-Sudh Mahadev area of this belt. The present studies have now revealed that it is not the continuation of the Panjal 'Thrust' but is another major reverse fault running almost parallel to the two tectonic lineaments—the Murree and the Panjal Faults. It appears to merge with the Murree Fault in area west of Pira. It is due to this fault the Panjal Volcanic along with the overlying Rajpur Formation is tectonically overlain by the Gamir Formation. It is traceable from Pira to Sudh Mahadev to west of Chukkison in the Ravi Valley. The Rajpur formation at Sudh Mahadev abuts on either side against this fault.

AGE AND CORRELATION

It is evident from the present work that there are two lithological successions in the Autochthonous Belt separated by an angular unconformity. The older succession, comprising Gamir, Baila, Ramban, Bhimdasa and Sincha Formations, is devoid of megafossils whereas the younger one constituting the Agglomeratic Slate, Panjal Volcanic, Zewan, Poonch Mandi and Rajpur Formatioins, is fossiliferous ranging in age from ? Upper Carboniferous to Eocene. These two successions are correlatable with the rocks of the Autochthonous belt in Hazara, Pakistan and with that of the Kashmir 'nappe' zone, India (table 4).

In the older succession, the Gamir, Baila and the lower part of the Ramban Formation are correlatable with the Hazara Formation in the western part of the Syntaxial bend in Hazara, Pakistan (Calkins *et al*, 1975). The upper part of the Ramban Formation, which is dominantly arenaceous in nature, may be equivalent to the Tanawal Formation. Both in the Hazara and in the present area, there is a diamictitic or a conglomeratic horizon referred to as the Tanaki Boulder bed (Latif in Tahirkheli, 1981) and the Bhimdasa in respective areas. This may also indicate another unconformity within this succession. The overlying carbonate sequence constituting the Sincha Formation appears to be identical to the Sirban/Abbottabad/Kingriali Formation (Calkins *et al*, 1975; Tahirkheli, 1981) of Hazara where the latter is unconformably overlain by the Hazira Formation yielding Early Cambrian microfauna (Mostler, 1980). Though there are differences in opinion about the stratigraphic value of these fossils in Hazira Formation amongst geological investigators in Pakistan (some considering these to be derived from older sediments assign a younger age ranging from Carboniferous to Triassic (Galkins *et al*, 1975; Tahirkheli and Majid, 1977, and Tahirkheli, 1981), the presence of elements like *Sachites, Circotheca, Lophotheca, Hyolithellus*, known from Early Cambrian sequences elsewhere in the world, conclusively proves them to belong to Early Cambrian. The presence of simple, primitive microbiota in the Sincha Formation further supports this contention. The detailed studies on this microbiota are still in progress. Srikantia and Bhargava (1974), considering the Ramban Formation to be the Dogra slate correlated it with the Simla Slates of Himachal Himalaya. If this correlation is valid, the overlying Bhimdasa and the Sincha Formations may be equivalent to the Blaini and Krol Formations of Lesser Himalaya in Himachal Pradesh and Uttar Pradesh which have now conclusively been proved to be late Precambrian in age (Kumar, 1984). The Krol Formation is conformably overlain by Tal Formation yielding Early Cambrian fauna.

In Kashmir 'nappe zone', the lithostratigraphy of the Precambrian succession is not clearly understood. The lithologies similar to the Gamir, Baila, Rahban and Bhimdasa Formations are present in the sequence which has been referred to as the Salkhala 'series' (Wadia, 1934; Wadia in Heron, 1937). Vohra (1966) separated out the diamictite horizon from the Salkahala of Digdaul-Ramsu area to name it as the Ramsu Formation. This formation bears close lithological similarity with the Bhimadasa Formation. The carbonate rocks present in the upper part of the Ramsu Formation, though not well developed, may represent the Sincha Formation of the present area. The Ramsu Formation grades into the overlying Lolab Formation through intervening argillite sequence—the Machhal Formation (Charmalwas Formation, Sharma, 1976). The Lolab Formation, like the Hazira Formation, is Early Cambrian in age as it contains redlichid trilobites and hyolithids.

In the present area, the older succession is unconformably overlain by the transgressive unit—the Agglomeratic Slate which is considered to be? Upper Carboniferous to Lower Permian in age, and is correlatable with similar sequence of the Kashmir 'nappe' (Kumar *et al*, 1980; Singh *et al*, 1982). This suggests that the entire Lower Palaeozoic (including part of the Late Precambrian) succession is missing from this part of the belt, and the Palaeozoic unconformity is of great magnitude. In Hazara, Pakistan, however, there is development of thin succession of Lower Palaeozoic represented by the Hazira Formation which in turn unconformably overlain by the Jurassic rocks (Mostler, 1980).

The overlying sequencee of Panjal Volcanic to Poonch Mandi Formation represents the Lower Permian to Jurassic succession correlatable with similar succession of the Kashmir 'nappe'. The only difference being the absence of Gondwana beds—the Nishatbagh and the Mamal Formations which underlie and overlie the Panjal Volcanic in Kashmir, respectively. The absence of these formations may represent a brief period of non-deposition in present area before the transgression of the

Table 4. Correlation of the 'Autochthonous Folded Belt' of Jammu & Kashmir Himalaya with that of Hazara and Kashmir basin.

	Autochthonous Folded Belt		
	HAZARA (modified after Latif in Tahirkheli, 1981; Tahirkheli, 1980; Tahirkheli & Majid, 1977; Galkins *et al*, 1975)	PRESENT AREA	KASHMIR BASIN (KASHMIR "NAPEE") (after Kumar *et al*, 1980 & Singh *et al*, 1982)
Eocene Paleocene	Kala Chita Group	Rajpur Fm.	
Cretaceous	Khawagarh Limestone Lumshiwal Sandstone Chichali Formation	?	
Jurassic	Samana Suk Limestone Datta Formation	Poonch Mandi Fm. Upper	Wuyan Formation
Triassic		Lower	Khrew Formation
	Unconformity	Zewan Fm. Upper	Khunamuh Formation
		Lower	Zewan Formation
		Unconformity	Mamal Formation
Permian	Panjal Volcanic Fm.	Panjal Volcanic Fm.	Panjal Volcanic Formation Nishat bgh Formation
	Agglomeratic Slate Fm.	Agglomeratic Slate Formation	Aggloeratic Slate Formation
			Unconformity
Carboniferous	Unconformity		Fenestella Shale Formation Syringothyris Limestone Formation
Devonian			Aishmuqam Formation Muth Formation
Silurian			Margan Formation
Ordovician			Unconformity
Cambrian	Hazira Formation Unconformity Sirban/Abbottabad/ Kingriali	Sincha Formation	Karihul Formation Lolab Formation Machhal Formation
Precambrian	Tanakki Boulder Bed Unconformity Tanawal Formation Hazara Formation Salkhala Formation	Bhimdasa Fm. Unconformity Ramban Formation Baila Formation Gamir Formation ?	Ramsu Formation Unconformity Undivided 'Salkhala' and Dogra Slate (Wadia, 1928) ?

Zewan Formation during Upper Permian. In Hazara, the Triassic sequence is not developed and the Panjal Volcanic is unconformably overlain by Datta and Samana Suk Limestone Formations of Jurassic age which in turn are overlain by Cretaceous sediments (Calkins *et al*, 1975). The rocks corresponding to Cretaceous succession of Hazara are not recorded so far from the present area, and the Paleocene-Eocene succession—the Rajpur Formation unconformably overlies the Poonch Mandi Formation. The corresponding Tertiary sequence in Hazara constitutes the Kala Chita Group (Calkins *et al*, 1975).

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