ON THE UPPER MURREE—LOWER SIWALIK PROVENANCE

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Introduction: Immediately after the deposition of Murrees, Siwaliks were deposited without any break. The validity of the basis adopted by earlier workers for boundary demarcation between Upper Murrees and Kamlials in Potwar region was commented upon by Anderson (Sahni and Mathur 1964). He expressed the difficulty of drawing a consistent boundary between the two. Cotter (1933) remarked that no two geologists seem to be in complete agreement as to where to mark the boundary. He therefore suggested that the Kamlials should be included within the Upper Murrees, and hence the base of Siwaliks should be shifted to Kamlial-Chinji boundary.

In Kathua, Jammu and Udhampur districts of Jammu province of J&K also, the Kamlials are not differentiable from the Upper Murrees because both these units exhibit the same lithology i.e., an alternating sequence of grey, greenish grey and purple sandstones, clays and siltstones. In an effort to differentiate the two, sandstones representative of Upper Murrees and Lower Siwaliks of Kishanpur Nagrota Mandli-Ramchand areas were collected for laboratory studies. Studies of zircon types of these sediments were carried out to determine the source rocks; and the palaeocurrent studies were carried out with a view to understand the palaeogeography of the area and to determine the sediment source and sediment dispersal pattern. The main object of these studies is to determine if it is possible to differentiate the Upper Murrees from Lower Siwaliks for demarcation of boundary between the two.

General geology: Upper Murree and Lower Siwaliks are very well exposed north of the Kishanpur Nagrota-Mandli section of Udhampur-Dhar road. (Fig. 1) The geological sequence of the rock formations in the area is given below:

Formation		Description
Middle Siwaliks		Grey, medium grained sandstones, with subordinate buff, ash grey and purplish clays.
Lower Siwaliks	Kamlial stage	Brown, red and orange clays with grey purple, fine grained sandstones.
	Chinji stage	Hard, fine grained, grey, purple greenish-grey sandstone, clays and siltstones.
Upper Murrees		Hard, fine grained, purple, greenish grey, and grey sandstones, clays and siltstones.

The rocks exposed immediately above the Middle Siwaliks with a thrusted contact from Kishanpur Nagrota to Mandli are Upper Murrees, because they show sedimentological characters (Zircon types and grain size studies) very closely resembling the undoubted Upper Murrees exposed north of the Main Boundary fault in the Udhampur area. These Upper Murrees are conformably succeeded by Kamlials; and both these units exhibit similar lithological characters. The Kamlials pass conformably into the Chinji stage and the latter is distinguished by the dominance of

clays in comparison to sandstones. The beginning of Chinji stage is also marked by a change in the grain size of sandstones and incoming of bright red clays.

The entire area is a major anticline and the studied part forms its northern faulted limb.

Studies of zircon types: The heavy minerals of both Upper Murree and Kamlial sandstones are zircon, tourmaline, garnet, epidote, apatite, biotite and magnetite. Heavy residues of Chinji sandstones consist mainly of garnet, tourmaline, chlorite and zircon in order of decreasing abundance. Zircon is the most important common heavy mineral of both Upper Murree and Lower Siwalik sandstones, and it has in recent years been regarded as one of the most important provenance indicators (Tyler, 1940), Poldervaart (1950), Wyatt Michael (1954). In Upper Murrees, and Lower Siwaliks varied types of zircon crystals are found. These are mostly bounded by first order (110) and second order prisms (100), first order pyramid (111) and ditetragonal pyramid (311). The forms however differ in their arrangement. In Murrees most of the zircon crystals are highly euhedral and show very little or no

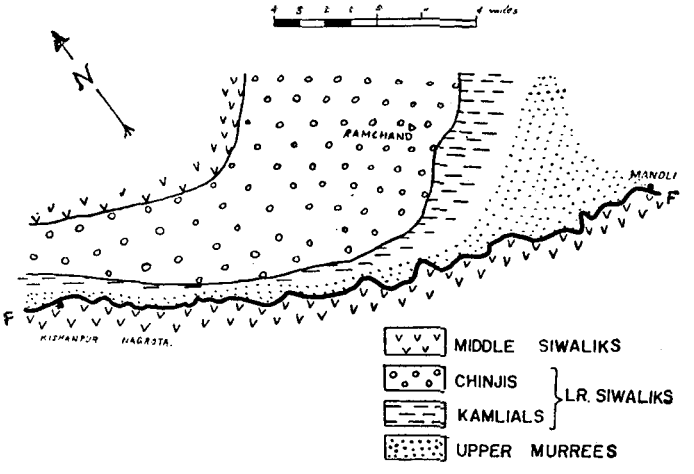

Figure 1. Geological sketch map of Kishanpur Nagrota Ramchand-Mandli area, Jammu Province, J & K State.

rounding of corners; in other words these crystals show no effect of wear and tear by transportation. Varied types of crystal habits in zircons of Upper Murrees and Kamlials possibly indicate that they have come from more than one source. Zircon 'abrasion index,' which is the frequency of zircon euhedra indicating abrasion during transportation, is higher in Upper Murrees than in Lower Siwaliks. The percntage of zircon euhedra in most samples of Upper Murrees is fairly high: that in Kamlials moderate, and in Chinji quite less. This shows that zircon bearing sediments of Upper Murrees were deposited from a nearer source and at a quicker rate than those of Lower Siwaliks, and as such abrasion effect of transportation could leave no or very little mark on Murree zircons, moderate mark on Kamlial zircons and appreciable in Chinji zircons.

The zircons of Lower Siwalik sandstones are comparatively more rounded than those of Upper Murrees. Kamlials mostly contain moderatly rounded zircons and

less commonly euhedral angular crystals; while Upper Murrees contain mostly euhedral angular to subangular zircons and less commonly subrounded complete zircons. This mixing up of rounded and highly euhedral zircons in both confirms the earlier conclusion that materials came from different sources for Upper Murrees as well as Kamlials. The degree of elongation (b/a ratio) of Upper Murree zircons ranges from 0.50 to 0.70 and of Lower Siwaliks from 0.55 to 0.80.

Studies of heavy residues and of zircon types indicate that Upper Murree and Kamlials (?) had nearby igneous source rocks, preferably granites, and a far off metamorphic source rocks like quartzite, granitic gneisses and schists. If Kamlials had the same source rocks as Upper Murrees, then there must have been differences in the sediment travel distance and in the rate of diposition of the two. There is also a possibility that Kamlials may be reworked Murrees.

Abundance of angular garnets and scarcity of zircons in Chinji sandstones indicate that contribution for Chinjis was mainly from a metamorphic terrain.

Palaeocurrent analysis: The reconnaissance palaeocurrent study of Upper Murrees and Lower Siwaliks of the area was carried out with a view to determine the sediment source. This study of the vectorial properties of the sediments may help in differentiating Upper Murrees from Lower Siwaliks.

Palaeocurrent analysis has been made by utilising all the following criteria of current flow:

1. Cross beddings.
2. Ripple marks.
3. Flute casts.
4. Micro-cross lamination.
5. Orientation of clay pellets.

The cross bedding which has an ubiquitous occurrence is confined mostly to the sandstones; in most cases it is defined by grain size or by the alignment of clay pellets. The cross beds of Upper Murrees and Kamlials are all mostly of tabular, intermediate and trough type. The forsets of these have moderate curvatures, while of those of Chinji stage have gentle curvatures, tangential to the base with concavity upward. Occurrence of parallel foresets ending with overlying and underlying normal bedding at sharp angles is much uncommon. Generally many cross bedded units occur one above the other, but solitary sedimentary units underlain and overlain by normal bedding are also found. The thickness of each cross bedded unit in Murrees and Kamlials varies from 1 cm to 14 cm, while in Chinjis it varies from 20 cm to 2 metres. The angle of inclination of foresets with the bedding varies from 12° to 35°.

A total of 100 sq km area was studied. It comprises outcrops of Talin NW of Jandriari and NW of Kaliyal. In cross bedded strata, the following measurements were taken.

1. Dip and strike of the foreset.
2. Dip and strike of the normal bedding.
3. Thickness of the cross bedded unit.

Well exposed foreset planes of cross bedded strata are quite common in Chinji sandstones while these are quite rare, obscure and faint in Kamlials and Murrees. It is only in ravines and nalas that exposures with clear foreset planes are observed. Tilt

correction has been applied to the azimuthal data because the beds occurring in the area of investigation are dipping from 10° to 70°. The azimuthal data for each formation was grouped and plotted on circular histograms (Fig. 2). The histograms exhibit east to west and north to south current direction for Upper Murrees and Kamlials and north to south for Chinji rocks.

Micro cross lamination was observed in both Upper Murree and Kamlial sandstones; in most cases it indicates ENE to WSW current direction.

Ripple marks are frequent in both Upper Murrees and Kamlials and show preferred orientation. These rhythmic undulations are of both symmetrical and asymmetrical nature and indicate westerly current direction.

Flute casts are wide spread sole marks and are most useful structures as a guide to the direction of current flow. These have been found on very fine grained sandstones/siltstones of Chinji stage. These indicate southerly current flow.

Clay pellets orientation has been observed in medium grained Chinji sandstones. These show WNW-ESE alignment and their maximum projection plane dips in WSW direction. It means that current flow was from ENE to WSW.

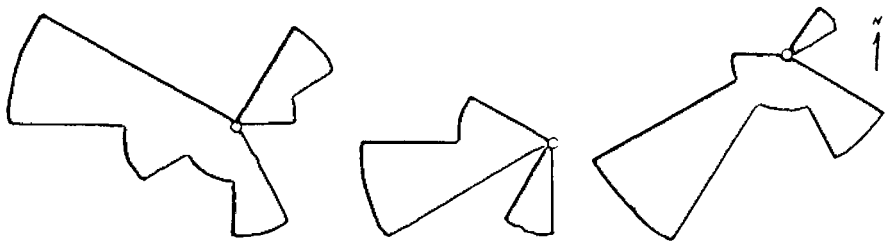

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Figure 2. Current roses. 1. Circular histogram of Upper Murrees. 2. Circular histogram of Kamlials. 3. Circular histogram of Chinjis.

Discussion: Studies of heavy residues and zircon types indicate that the source rocks of Upper Murrees were mainly granites and grantic gneisses. Kamlials had the same source as the Upper Murrees, or these might be reworked Murrees which got uplifted immediately after the termination of Murree deposition. Beginning of Chinji stage was marked by an increased contribution from the metamorphic rocks. It can otherwise be said that from Upper Murree to Upper Chinji there was gradual reduction in the igneous rock contribution. In the circular histograms of Upper Murrees there are the least number of azimuths in the eastern side and in the northern side. Tanner (1955) has shown that the portion of the circular histogram showing least number of azimuth is indicative of the direction of sediment supply. The Upper Murree and Kamlial histograms indicate that material came from northern as well as eastern side while Chinji histogram shows sediment supply mainly from north.

In the conformable sequence of Upper Murree, Kamlial and Chinji sediments, there seems to be a gradual shift of source area from east to north of its present geographic position. Also it is known that there was a gradual increase in the metamorphic contribution from Upper Murrees to Upper Chinjis. It can be inferred that the metamorphic source area was mainly in the north and igneous area in the east. Earth movements which occurred immediately after Upper Murree deposition probably resulted in the shifting of the source area from eastern side to northern side.

Conclusion: 1. It is possible to differentiate Upper Murrees, Kamlials and Chinjis on the basis of the studies of zircon types in the laboratory.

2. Studies of heavy residues and zircon types indicate a major igneous contribution for Upper Murrees and Kamlials and a major metamorphic contribution for Chinji rocks.
3. The sediments comprising Upper Murrees and Kamlials were derived mainly from northern and eastern side while for Chinji state contribution was mainly from the northern side.
4. It is probable that pre-Miocene igneous rocks of Ladakh range and Precambrian schists, gneisses and quartzites possessing huge granitic intrusive bodies of Kashmir, Punjab and Kumaon Himalayas exposed in the northern and eastern side have contributed to give rise to Upper Murrees and Lower Siwaliks.

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ON THE OCCURRENCE OF A RING DYKE IN THE TUSHAM IGNEOUS COMPLEX, HISSAR (HARYANA)

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The purpose of this communication is to report and describe the occurrence of a ring dyke from the Tusham area (Fig. 1) located in the NW part of Indian shield about 120 kms WNW of Delhi. No detailed work on the area has been done but for the scanty references made by McMahon in the years 1884 and 1886, who described the petrography of the rocks exposed, namely, felsites, quartz porphyry, granites and quartzites, and schists and correlated the acid volcanics and granites with the Malanis. These acid volcanics and granites are included in the trans-Aravalli rock sequence and form a part of north-western part outcrops of true shield elements, which as isolated occurrences are not visibly connected with the main shield mass.