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RESEARCH ARTICLE

SEQUENCE OF VALLEY DEVELOPMENT OF ALAKNANDA AND ITS TRIBUTATIES & QUATERNARY SEDIMENTATION, GARHWAL HIMALAYA, PARTS OF CHAMOLI TEHRI UTTAKASHI & PAURI UTTAR PRADESH (UTTRARKHAND STATE) INDIA

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Abstract

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The sedimentological study in Alaknanda and its tributaries in upper Ganga basin has been attempted in parts of de Uttarkashi,Chamoli, Pauri and Tehri districts in parts of QA sheet 53Jand 53 N on 1:50000 scale of Garhwal Himalaya U.P; presently known as Uttrakhand State of Union of India. The area of Upper Ganga basin consisting of Alaknanda,Bhagirathi,Bhilangna, Nandakini, Mandakini, Pindar, Dhauli- Ganga Bal- Ganga , Madhmeshwar Ganga and Berhi Ganga The Alaknanda is characterized by six terraces AT1_AT6 followed by Bhagirathi with five terraces BT1_BT5, Bhilangna BHT1_BHT4 Nandakini four terraces NT1_NT5, Mandakini MT1_MT6 /Pindar PT1_PT3 /Dhauli-Ganga DGT1_ DGT3 /Balganga three terraces BGT1, to BGT3, Madhmshwar Ganga MDT1, to MDT2Ganga two terraces and Berhi Ganga one terrace BRT_1, amidst these Alaknanda is trunk stream and others are tributaries. The sequence of valley development and Quaternary sedimentation in Alalknanda and its tributaries is established in stratigraphic sequence has been attempted for the first time. The area genetically comprised of terraces of three domains, viz. Glacial, Fluvio-glacia and Fluvial which represent distinct environment of sedimentation of Pleistocene, late Pleistocene and Holocene time during Quaternary period. The Glacial terraces are identified at an average elevation of 1150 m above MSL, the fluvio-glacial terraces at an average elevation of 975m above MSL and fluvial terraces at an average elevation between 650 to 900 m above m.s.l, type area is attempted in to understand the nature of Quaternary sedimentation in these valleys in increasing antiquity. The statistical parameters of sediment of fluvial terraces of Alaknanda revealed tha the average mean size for AT1 is 1.550 Ø (medium sand) and it varies from -0.3240 Ø to 2.250Ø (coarse sand to fine sand), for AT2 average mean size is -0.5350Ø (coarse sand) and it ranges from -1.742Ø to 1.565Ø (very coarse to medium sand),AT3 the average value is 1.760Ø whereas it ranges between -0248 to 2,650 Ø The average and range values of means size of Alaknanda terraces (ATo to AT3) predominantly consist of both coarser and finer sediments, whereas younger terraces (ATo to AT1) primarily consist of very fine sand. The

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mean size of sediment in sequence of terraces except in AT2 has strong tendency to decrease in decreasing antiquity i.e. from AT3 to AT1 towards the younger terraces. The progressive increase of finer sediments towards younger terrace revealed the constant and steady decrease in load carrying capacity of Alaknanda from early to late history of river sedimentation. The anomalous values of mean size in the terrace AT3 indicate sudden reactivation in energy condition of the channel system during sedimentation perhaps due to tectonic dislocation in watershed region of Alaknanda which is also manifested in disposition of sediment in vertical column of AT3 terrace in the valley. The average value of standard deviation for terrace AT0 is 0.3740 Ø (well sorted), whereas it varies from 0.2530 to 0.4665Ø (well sorted). The average value for AT1 is. 0.3.320Ø it ranges from 0.255 Ø to 0.440 Ø, average value for AT2 – AT6 is 0.3.35 Ø and it varies from 0.348 to 0.555 Ø . The average value for terrace AT3 is 0.6120Ø (moderately sorted) and it varies from 0.540 Ø to 0.710Ø (moderately sorted). The average and range value of (S) indicate that sediments are poorly sorted to very well sorted. The sorting index of sediments appears to be related with size of sediments. The correlation between these two parameters revealed that the higher terraces AT2, AT-3 contrastingly consist of coarser clastic and are mostly moderately sorted, as compared to AT1 to AT2, AT3, AT3 which comprised of medium to fine, sediments and show significant improvement in sorting. The size distribution curve indicates variable unimodel to bimodal nature of sediments. The probability plots indicate that the sediments load of AT2 to AT3 consist of traction (average 82%) and little of suspension whereas AT1 to A2 both of traction and suspension (average 55% and 45% respectively). This variation from AT1 to AT3 revealed strong fluctuation in the current velocity of the channel and steady decrease in the kinetics of river from early to late history of sedimentation (Khan1975). The average value of standard deviation (S) from AT3 to AT1 shows sharp progressive improvement in sorting of sediments which may be due to (i) due to repeated reworking of sediments (ii) due to increase load in mean size of sediments, (iii) progressive static environments of sedimentation towards later phases, perhaps due to low energy condition of channel during sedimentation. The average value of skewness is + 0.123Ø positive skewed), for skewness AT1 skewness is (positive skewed), where it varies from -0.626 to 0.225 Ø (negative skewed to very negative skewed), for AT2 AT3, AT3, AT4) the average is +0.385 (positive skewed) and varies from 0.440 to -0.975 Ø (very negative skewed) and varies from 0.145 to -0.328 (negative skewed to positive skewed). The average value of skewness revealed that the sediments of older terraces are strongly negative skewed, whereas the sediments of younger terraces are positive skewed. The negative skewness is considered to be the resultant of high energy environment and the winnowing action of the sand, whereas the positive is the reversal of former. The relative skewness range of the sediments from negative skewed to positive skewed from older to younger terrace revealed the steady decrease in the load carrying capacity of channel and current velocity towards the late history of river sedimentation in the Narmada valley (Khan 1987) The average value of Kurtosis for terrace AT1 is 0.385 Ø (very platykurtic) it varies from 0.285 Ø to 0.370 Ø i.e. (very platykurtic), for terrace AT2 the average value is 0.385 Ø (very platykurtic) and it varies from 0.3600 Ø to 0.4560 Ø (very platykurtic), for terrace AT2 , AT3, AT4) the average value is 0.5240 Ø (very platykurtic) and varies

from 0.385 Ø to 0.681 Ø (platykurtic to very platykurtic) for terrace AT3, the average value is 0.639 Ø (very platykurtic), and varies from 0.6325 Ø to 0.755 Ø (platykurtic to very platykurtic). The younger terraces ATo to AT1 show the lower values of Kurtosis whereas the older AT2 to AT1 the higher values. The values decrease from older to younger terraces which suggest that the sediments from older to younger terraces become mesokurtic to very platykurtic. The relatively lower values of Kurtosis towards younger terraces indicate that the sediments were derived from more than one source

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Introduction:-

The Geological and sedimentological study in Alaknanda and its tributaries has been attempted first time in parts of Uttarkashi,Chamoli, Pauri and Tehri districts, an area of 10000 Sq.kms in parts of QA sheet 53J and 53 N on / 1:50000 scale has been covered in Garhwal Himalaya U.P; presently known as Uttrakhand State of Union of India.

The area of study is approachable via Dehradun and Rishiksh, which is nearest rail heads of Northern Railway. These heads are connected by good moterable roads leading to famous pilgrimage centre Badrinathh , Kedarnath , Gangotri and Janmnontri. The state highway No 54 which is connecting Rishikesh and Badrinath bifurcates at Rudraprayag along Mandakini river and terminates at Kedarnath via Sonprayag.. The Tehri is about 85 kilometers from Rishikesh on state high way No 53 connecting Rishikesh Tehri Uttarkashi Gangotri.This road runs along Bhagirathi River between Tehri and Gangotri, it bifurcates at Dharasu and connects Bhagirathi valley to Yamuna valley crossing the water divide at Ravi Pass. In addition to these there are all weather roads which connect Kathgodam to Karanpryag via Ranikhet, Dwarhat and Adi-Badri from east and Mussoori via Dhanaulti to Tehri from west to Alaknanda and Bhagirathi valleys respectively. (Plate No_.1 & _2)

Previous Work

The area of Upper Ganga basin consisting of Alaknanda,Bhagirathi,Bhilangna, Nandakini, Mandakini, Pindar, Dhauli- Ganga Bal- Ganga , Madhmeshwar Ganga and Berhi Ganga. Amidst these Alaknanda is trunk stream and other are tributaries. These streams emerge from different glaciers in Himalaya descend in sinuous to meandering channel pattern, in their courses they traverse through entrenched valleys, and deep gorges leaving glacial fluvio-glacial and fluvial terraces in decreasing antiquity; due to uplift and climatic changes in the area; representing different phases of sedimentation in Quaternary period.

Padhi and Sharan (1972) Dubey (1972),Dubey (1974a) , Shukla Khan & Dubey (1974) Khan (1972-73) Khan (1974), Khan et.al (1974-75) Sinha & Khan (1975) ,Sinha & Khan (1975-76), Dubey (1974) Sinha & Khan (1976) Khan (1981), Khan (1987) (Khan, 1974, 2022,2022, 2023). have carried out geological and geomorphological and sedimenological studies in parts of Alaknanda,Bhagirathi,Bhilangna, Nandakini, Mandakini, Pindar, Dhauli- Ganga Bal- Ganga , Madhmeshwar Ganga and Berhi Ganga.The present work is part of comprehensive study carried out about two decade as part of official assignment (1972 to1981) of geological survey of India.

Present Work

The present paper is an attempt to trace integrated evolution of fluvial terrace their stratigraphy, their correlation and sedimentological aspects in type area of Alaknanda and Bhagirathi in Upper Ganga Basin during Quaternary period.

The area under study has witnessed the intensive erosional and depositional activity subsequent to recession to glaciers which has entirely modified the pre-existing, topography and given rise to present shape to the area., Khan, (1975) and Khan et al, 1981).The fluvial terraces of Alaknanda and its tributaries are developed and evolved in response to tectonic changes and cyclic uplift of watershed region of upper Ganga during Quaternary times, (Khan 1987) The glacial, inter glacial and post glacial climatic conditions, have also played the vital role in morphogenetic shaping of present day complex. (Khan 1981). On the merits of evolution of fluvial terraces the sequential order of valley development in upper Ganga basin is established (Khan 1987). (Table No_1 &_2)

The Statistical Computations

The statistical analysis of sediment sample of the Alaknanda valley and particle size distribution curves were expressed on a Φ scale. Folk and Ward's (1957) graphical method was adopted to calculate mean size (Mz), sorting (σI), Skewness (SKI) and Kurtosis (KG). This method involves the measurement of several percentiles from cumulative curves (Φ5, Φ16, Φ25, Φ50, Φ75, Φ84 and Φ95). The formulae are as follows:

$$\Phi = -\log_2 G$$

where G = the grain size (mm)
(i.e. sieve mesh opening)

Mean size

$$M_z = \frac{\Phi 16 + \Phi 50 + \Phi 84}{3}$$

Sorting

$$\sigma_I = \frac{\Phi 84 - \Phi 16}{4} + \frac{\Phi 95 - \Phi 5}{6.6}$$

Skewness

$$SK_I = \frac{\Phi 16 + \Phi 84 - 2\,\Phi 50}{2(\Phi 84 - \Phi 16)} + \frac{\Phi 5 + \Phi 95 - 2\,\Phi 50}{2(\Phi 95 - \Phi 5)}$$

Kurtosis

$$K_G = \frac{\Phi 95 - \Phi 5}{2.44(\Phi 75 - \Phi 25)}$$

The computed textural parameters of sediments and their binary relation applied as tool in differentiating the various environments of Quaternary sedimentation in Moila R.J. et.al. (1968) the same key is used as tool to analyze and differentiate sediments of various domains in Narmada valley.

The statistical parameters and their interpretation in stratigraphic sequence succession wise are given below.

1. Statistical parameters of Fluvial terraces (AT1 – AT6) in stratigraphic column in type area - Gauchar (30^0 17' 30" – 79^0 10'00") Srinagar (30^0 12 '00 – 78^0 47 00') Alaknanda Valley.

The Fluvial terraces of Alaknanda Valley

The Alaknanda originates at a height of 3641 meters below Bala kun peak 16 km. upstream of Badrinath form the two glaciers of Bhagirath Kharak and Satopanth. The two glaciers rise from the eastern slopes of Chaukhamba (7140 Meters) peak, Badrinath and its satellite peaks.

These peaks separate the Gangotri group of glaciers in the west. The major portion of the Alaknanda basin falls in Chamoli district from its source upto Hellang (58 Km), the valley is treated as upper Alaknanda valley. The remaining part of the area is known as lower Alanknanda valley. While moving from its source, the river flows in a narrow deep gorge between the mountain slopes of Alkapuri, from which it derives its name. All along its course, it drains with its tributaries. Saraswati joins the Alaknanda 9 Km downstream from Mana,.Khilrawan Ganga join it below the Badrinath shrine and Bhuynder Ganga below Hanuman Chatt. It is Alaknanda, the trunk stream of Ganga System forms at Vishnuprayag by two tributaries, viz. Vishnu Ganga and Duauli Ganga rising from snowy peaks north of Badrinath and Niti at average elevation of 3,897 m and 5,330 m respectively in Central Himalayas.. The river descends in straight/sinuous to meandering channel pattern through the deep gorges across the Himalayan ranges, with sinuosity index ranging from 1.95 to 2.6 for meandering segment. It is joined by Bhagirathi at Devprayag. It is further joined by numerous other tributaries in its traverse in Himalaya till it finally debouches in the intermountain valley at Rishikesh. The important tributaries joining Alaknanda between Vishnuprayag and Rishikesh are, Berhi Ganga at Chinka, Nandakini at Nandaprayag, Pindar at Karanprayag, Mandakini at Rudraprayag and Bhagirathi at Deoprayag, downstream of Deoprayag it is known as Ganga.

The Alaknanda has formed six prominent regional terraces AT1-AT6 in the valley. The AT1, being the youngest and AT6, being the oldest terrace in the area. Each of these terraces is separated by the scarp both of linear and curvilinear in nature facing towards river. These terraces are both erosional and depositional in nature and display divergence and convergence in their relative disposition. The depositional terraces are widely developed and have occupied the larger area in the valley around Srinagar Kaliyasaur, Kirtinagar Pharases, Dungri, Gulab Rai, Nagresu, Gauchar and Langasu, Sunala and characteristically found to be restricted within the meander of Alaknanda. The complete sequence of terraces in the valley is seen at very few places viz. around Srinagar, Koteshwar, Rudraprayag, Nagrasu and Gauchar which give almost the complete account of tectonic and climatic changes in the area. Whereas at other places one two or three terraces are preserved and many other have been eroded away. This therefore, indicates incisive as well as rapid migrating nature of the stream. These terraces are both paired and unpaired and display convergence and divergence in their relative disposition. The divergence and pairing in general is seen in the older terraces viz. AT6, AT5, and AT4, whereas the younger terraces viz. AT1, AT2 and AT3, display convergent in their disposition and mostly remained unpaired. The divergence and pairing in the older terraces indicate the abrupt and sudden incision of the valley floor due to relatively sudden upraise of head ward ends of the Alaknanda and consequent climatic changes, in the early Holocene times. The convergence and un-pairing in younger terraces, on the contrary, indicate decrease in rate of uplift and long interval climatic change towards the later phases of sedimentation in the valley. The pairing, un-pairing and relative disposition of terraces as whole in Alaknanda suggests the constant and steady decrease in rate of uplift in Himalaya from early to late Holocene time. Khan (2018)

The average total thickness of fluvial terraces in Alaknanda is 118 m. The highest terrace i.e. AT6 1s noticed at an average elevation of 795 m from m..s..l.. and 150 m from the present day course of the river. The average thickness of individual terrace is 16.25 m., 22.25 m., and 27.22 m., 25 m., 21.25 m., 15 m., respectively. In the upstream areas, the thickness of these terraces is constantly reduced and ultimately the profile of these terraces pinches out against the higher terraces of fluvio-glacial origin..

The cuspate terraces revealing a dip of 2° to 3° are formed by incision of several loops at different elevation on the same side of valley. These suggest multiple rejuvenation through the micro episodic change in discharge and micro pulsation of unwrapping in head ward ends of Alaksandra (Khan, 1974, 2022, 2023). (Plate No_1 &_ 2 ,5)

The discussion of statistical parameters is based on the study of 120 sediment sample collected 20 each from fluvial terraces of Alaknanda (AT1- AT6) in the Gauchar Section. The AT1 is being the youngest terrace close to the present day course of river, whereas AT6 is the oldest and highest terrace above the present day course of river. These terraces constitute the complete sequence of sediments of fluvial domain measuring about 110 m deposited in valley.

Mean Size (MZ)

The average mean size for terrace AT0 is 2.225 Ø (fine sand), where it varies from 1.532 to 3.235Ø (medium sand to very fine sand). Average mean size for AT1 is 1.550 Ø (medium sand) and it varies from -0.3240 Ø to 2.250Ø (coarse sand to fine sand), for AT2 average mean size is -0.5350Ø (coarse sand) and it ranges from -1.742Ø to 1.565Ø (very coarse to medium sand), AT3 the average value is 1.760Ø whereas it ranges between -0248 to 2,650 Ø The average and range values of means size of Alaknanda terraces (ATo to AT3) predominantly consist of both coarser and finer sediments, whereas younger terraces (ATo to AT1) primarily consist of very fine sand.

The mean size of sediment in sequence of terraces except in AT2 has strong tendency to decrease in decreasing antiquity i.e. from AT3 to AT1 towards the younger terraces. The progressive increase of finer sediments towards younger terrace revealed the constant and steady decrease in load carrying capacity of Alaknanda from early to late history of river sedimentation. The anomalous values of mean size in the terrace AT3 indicate sudden reactivation in energy condition of the channel system during sedimentation perhaps due to tectonic dislocation in watershed region of Alaknanda which is also manifested in disposition of sediment in vertical column of AT3 terrace in the valley.

Inclusive Graphic Standard Deviation

The average value of standard deviation for terrace AT0 is 0.3740 Ø (well sorted), whereas it varies from 0.2530 to 0.4665Ø (well sorted). The average value for AT1 is. 0.3.320Ø it ranges from 0.255 Ø to 0.440 Ø, average value for AT2 – AT6 is 0.3.35 Ø and it varies from 0.348 to 0.555 Ø . The average value for terrace AT3 is 0.6120Ø (moderately sorted) and it varies from 0.540 Ø to 0.710Ø (moderately sorted). The average and range value of (S) indicate that sediments are poorly sorted to very well sorted. The average value of standard deviation (S) from AT3toAT1 shows sharp progressive improvement in sorting of sediments which may be due to (i) due to repeated reworking of sediments (ii) due to increase load in mean size of sediments, (iii) progressive static environments of sedimentation towards later phases, perhaps due to low energy condition of channel during sedimentation. The sorting index of sediments appears to be related with size of sediments. The correlation between these two parameters revealed that the higher terraces AT2, AT-3 contrastingly consist of coarser clastic and are mostly moderately sorted, as compared to AT1 to AT2, AT3, AT3 which comprised of medium to fine, sediments and show significant improvement in sorting. The size distribution curve indicates variable unimodel to bimodal nature of sediments. The probability plots indicate that the sediments load of AT2 to AT3 consist of traction (average 82%) and little of suspension whereas AT1 to A2 both of traction and suspension (average 55% and 45% respectively). This variation from AT1 to AT3 revealed strong fluctuation in the current velocity of the channel and steady decrease in the kinetics of river from early to late history of sedimentation (Khan1975).

Inclusive Graphic Skewness (SKI)

The average value of skewness from terrace AT0 is +0.260Ø (positive skewed), where it varies from -0.655 to + 0.285Ø (skewed to positive skewed), for AT1 the average skewness is + 0.123Ø positive skewed), where it varies from -0.626 to 0.225 Ø (negative skewed to very negative skewed), for AT2 AT3, AT3, AT4 the average is +0.385 (positive skewed) and varies from 0.440 to -0.975 Ø (very negative skewed) and varies from 0.145 to -0.328 (negative skewed to positive skewed). The average value of skewness revealed that the sediments of older terraces are strongly negative skewed, whereas the sediments of younger terraces are positive skewed. The negative skewness is considered to be the resultant of high energy environment and the winnowing action of the sand, whereas the positive is the reversal of former. The relative skewness range of the sediments from negative skewed to positive skewed from older to younger terrace revealed the steady decrease in the load carrying capacity of channel and current velocity towards the late history of river sedimentation in the Alaknanda valley (Khan 1976,1981,1988) (Plate No_3)

Inclusive Graphic Kurtosis (KG):

The average value of Kurtosis for terrace AT0 is 0.275Ø (very platykurtic) it varies from 0.285 Ø to 0.370 Ø i.e. (very platykurtic), for terrace AT1 the average value is 0.385 Ø (very platykurtic) and it varies from 0.3600 Ø to 0.4560 Ø (very platykurtic), for terrace AT2 AT2, AT3, AT4) the average value is 0.524 Ø (very platykurtic) and varies from 0.385 Ø to 0.681 Ø (platykurtic to very platykurtic) for terrace AT3, the average value is 0.639 Ø (very platykurtic), and varies from 0.6325 Ø to 0.755 Ø (platykurtic to very platykurtic). The younger terraces ATo to AT1 show the lower values of Kurtosis whereas the older AT2 to AT1 the higher values. The values decrease from older to younger terraces which suggest that the sediments from older to younger terraces become mesokurtic to very platykurtic. The relatively lower values of Kurtosis towards younger terraces indicate that the sediments were derived from more than one source

2. Statistical parameters of Ffluvial terraces (B1 – BT3) in stratigraphic column in type area – Tehri (30^0 28' 22" : 78^0 22' 48") Bhagirathi Valley

The Fluvial terraces of Bhagirathi Valley

The Bhagirathi is the major tributary of Alaknanda. It rises from Gangotri glacier north of Uttarkashi around Gaumukh in the Central Himalaya at an elevation of about 3665 m and joins Alaknanda at Deoprayag the river descends in sinuous to meandering with an average sinuosity index of order of 1.30. The river all along the length of 160 km. It has formed the terraces of three domains Viz. glacial fluvio-glacial and fluvial. The fluvial domain comprised of five major terraces which are time equivalent to the five terraces of Alaknanda, the trunk stream of Ganga system. These terraces are designated BT1, to BT5. The BT1, is youngest terrace and BT5, being the oldest in the valley. These terraces are mostly fill and cut type and are both erosional and depositional in nature. The older terraces BT3 to BT5 are elongated, rectangular in shape and have paired equivalents on both the flanks of valleys, whereas the younger terraces BT1 and BT2 are semi circular and crescent in shape, non-cyclic in nature and are restricted within the meander of Bhagirathi.

The type development of these terraces is seen at very few places in the valley Viz. Uttarkashi, Dunda, Chinyalisaur Chamb, Tehri, whereas other places such as Sarot Seansu and Nagor one or two levels of terraces were seen, which appears to be due to exposure of the area to extensive post depositional activities. The total average thickness of these terraces in the val1ey is 36 m. The average relative thickness of these terraces in Uttarkashi and Tehri section is 6.5, and 5 m respectively. (Khan, 1974, 2022, 2023 (Plate No1& 2)

The discussion of statistical parameters is based on the study of 100 sediment samples collected 20 each from the three terraces of Bhagirathi BT1 to BT5 in the type locality in Tehri. The BT1 is being the youngest terrace, whereas BT3 is the oldest and highest terrace. These terraces constitute the complete sequence of sediments of fluvial domain measuring about 110 in the Bhagirathi valley.

Mean Size (MZ)

The average value of mean size of the terrace BT1 is 2.300 Ø (fine sand), and it varies from 1.535 Ø to 3.232 Ø (medium sand to very fine sand). The average value of mean size of terrace BT1 is 0.543 Ø (coarse sand) and varies from -0.325 Ø to 2.225 Ø (very coarse to fine sand). The average value of mean size of terrace BT2 is BT2, BT2, and BT3 is 1.410 Ø (medium sand) and it varies from -0.645 Ø to 2.255 Ø (very coarse to very fine sand). The average value of terrace BT3 is 1.950 Ø (medium sand) and it varies from -0.495 Ø to 3.442 Ø (very coarse to very fine sand). The relative average and range values of mean size indicate that the younger terraces BT1 to BT3 predominantly consist of medium to fine sand and older terraces BT2 to BT3, very coarse to very fine sand. The mean size constantly increases from BT1 to BT3 except little variation; which is indicative of high energy condition of channel and high load carrying capacity towards the early history of sedimentation..

Inclusive Graphic Standard deviation

The average value of standard deviation for terrace BT1 is 0.339 Ø (well sorted), it varies from 0.243 Ø to 0.433 Ø i.e. the sediments are (well sorted to very well sorted) and varies from 0.226 to 0.435 Ø (well sorted to very well sorted), average value for terrace BT2 is BNT2, BT2, BT2 is 0.450 Ø well sorted) and it ranges between 0.288 Ø to 0.460 Ø (well sorted to very well sorted), average value for BT3 is 0.639 Ø (moderately sorted) and varies from 0.538 Ø to 0.763 Ø (moderately sorted to very well sorted). The sediments of (BT3 to BT1) show improvement in sorting upward, the decreasing value of sorting coefficient towards younger terraces indicating that the sediments of these terraces show improvement in sorting, which appears to be related with (i) mean size of sediments, (ii) load carrying capacity of channel (iii) and static environment of sedimentation perhaps due to less turbulent nature of channel towards the latter phases of sedimentation in the valley. The significant improvement in sorting in decreasing antiquity towards younger terraces appears to be related with mean size which decreases sharply down ward. The size distribution curve revealed the bimodality of the sediments, whereas the probability plots indicate the older terraces BT2 and BT3 consist of average 72% of traction and 28% of suspension load; where the younger terraces BT1 to BT3 62% suspension and 38% traction load. The relative percentage of traction load decrease upwards. The average relative values of sorting and load characteristic of all the terraces revealed that there was decline in energy conditions of the channel towards late history of sedimentation.

Inclusive Graphic Skewness (SKI)

The average value of skewness for terrace BT1 is +0.175 Ø (very positive skewed) where it varies from -0.850 Ø to 0.340 Ø (very negative skewed to very positive skewed), for terrace AT1 average value is -0.210 Ø (positive skewed) and it varies from -0.315 to -0.725 Ø (very negative skewed to very positive skewed).Average value for terrace BT2, BT-2, BT-2 is 0.440 Ø (very positive skewed) and it varies from 0.294 Ø to 0.455 Ø (positive skewed to very positive skewed), for the terrace BT3 average value is 0.636 Ø (very positive skewed) and it varies from 0.535 Ø to 0.760 Ø (very positive skewed). The sediments of older terraces viz. BT2 – BT3 are strongly negative skewed whereas the sediments of younger terraces are strongly positive skewed, the negative skewness is considered due to higher energy environment, whereas the positive of low energy environment. Average value of skewness progressively decreases in increasing antiquity, i.e. from older terraces BT3 to younger terrace BT1 which reveal the strong tendency of sediments to become from negative skewed to positive skewed, thereby indicating steady decrease in energy condition of Bhagirathi towards the latter stages of sedimentation.

Inclusive Graphic Kurtosis (KG)

The average value of Kurtosis for terraces BT1 is 0.212 Ø (very platykurtic) and it varies from 0.265 Ø to 0.365 Ø very (platykurtic). Average value for BT1 is 0.366 Ø (very platykuritc) and it varies from 0.292 to 0.576 Ø (very platykurtic). Average value for is BT-2, BT-3, BT-4 0.545 Ø (very platykurtic), whereas it varies from 0.263 to 0.656 Ø (very platykurtic). Average value for terrace BT3 is 0.785 Ø (platykurtic) and it ranges from 0.762 Ø to 0.910 Ø (mesokurtic to very platykurtic). The sediments of older terraces viz. BT3 and BT2 show the higher values of Kurtosis, whereas, the younger terraces BT0 to BT1 the lower values which reveal that sediments are (mesokurtic to very platykurtic) in nature respectively. The values decrease in increasing antiquity whereas the relative average values in older terraces reveals the sediments were primarily derived from more than the multi source postulated to be from rocks of central crystalline and other group the younger terraces from one source, Khan (1984),(khan1988) inferred from pre-existing Quaternary deposits of glacial / fluvio-glacial deposit. (Plate N0_4)

3. Statistical Parameters of Fluvial terraces (BH1-BH4) in stratigraphic column in type area –Ghanshali (30^0 25' 00": 78^0 40' 00") Bhilangna Valley.

The Fluvial terraces of Bhilangna Valley

The Bhilangna is a tributary of Bhagirathi. It originates from ice clad peaks of Central Himalaya at an elevation of about 3200 m and joins Bhagirathi at Tehri. It display sinuous to meandering channel pattern all along its course of 75 km and embraces the terraces of three regimes, viz. glacial, fluvio-glacial and fluvial, deposited in three distinct environments during the Quaternary times.

The Fluvial terraces is designated as BHT1, to BHT4, the BT1, is being the youngest terrace and BHT4, is the oldest in the valley. These terraces are mostly deposition in nature and exhibit divergence and convergence in their relative disposition, the former is more conspicuous in older terraces BHT3 and BHT4, whereas the later in the younger terraces. The type development of these terraces in the valley is seen around Tehri, Dewal. Asena and Ghansali. Dubey, (1972) Khan (1981). ((Khan, 1974, 1975 2022, 2023). The total average thickness of these terraces is about 55 m whereas the relative thickness is 16, 15, 18, 16 m respectively

The discussion of statistical parameters of fluvial terraces of Bhilangna is based on the study of 40 sand samples collected from terraces from BHT1 to BHT4 between Ghanshali and Tehri. The BHT1 is being the youngest terrace, whereas BHT4 is the oldest and highest terrace. These terraces constitute the complete sequence of sediments of fluvial domain measuring average about about 45 m deposited during different phases of sedimentation in Bhilangna valley in Quaternary time. The results of statistical parameters are discussed below:

Mean Size (MZ)

The average value of mean size of terrace BHT1 is 2.135 Ø (fine sand) and it ranges from 1.635 Ø to 3.250 (medium to fine sand). Average value of mean size of terrace BHT1-BHT4 is 1.625 Ø (medium sand) and it ranges between -0.435 Ø to 2.286 Ø (very coarse sand to fine sand). The average value of mean size of terrace BHT3 is 1.155 Ø (medium sand) and ranges from -0.625 Ø to 1.742 Ø (medium sand to very fine sand).

The average and range values of mean size reveal that the sediments of older terraces BHT1-BHT4 and BHT1 consist of very coarse to very fine sand, where as younger terrace and BHT2 predominantly medium to fine sand. Except with very little variation, the mean size of sediments progressively increases in decreased antiquity of terraces which appears to be related with (i) repeated reworking of sediment, (ii) steady decrease in load carrying capacity of channel towards the latter stages of sedimentation. The variation in mean size suggests the fluctuation in energy condition of channel system perhaps due micro climatic changes in watershed region. .

Inclusive Graphic Standard Deviation

The average value of standard deviation for the sediments of BHT1 is 0.285 Ø (very well sorted) and it ranges from 0.255 Ø to 0.377 Ø (well sorted to very well sorted). Average value of sorting for the sediments of terrace BHT1-BHT4 is 1.635 Ø (moderately sorted) and it ranges from 0.233 Ø to 0.375 Ø (well sorted to very well sorted). Average value for the sediments of terrace BHT1 is 0.376 (well sorted) and it ranges from 0.285 to 0.455 (well sorted to very well sorted). The average and relative range values of standard deviation indicate that the sediments of older terraces BHT3 are moderately sorted to well sorted BHT1-BHT4 well sorted to very well sorted and BHT1 well sorted to very well sorted. The sediments show progressive improvement in sorting in decreasing antiquity from older to younger terraces appears to be related energy condition of the channel, which constantly decreases towards the later phases of sedimentation. The size distribution curve reveals more than one population of sediments whereas the probability plot reveal that the terraces BHT1-BHT3 average consist of 55% and 45% traction and suspension load respectively. The traction load decreases in decreasing antiquity of terraces in the valley.

Inclusive Graphic Skewness (SKI)

The average value of skewness for terrace BH1 is +2.25 (positive skewed). It ranges from -0.765 Ø to 0.455 Ø (very negative skewed to very positive skewed). Average value of skewness for terrace. BHT1-BHT4 is +0.1.65 Ø (positive skewed), it ranges from -0.585 Ø to 0.235 Ø (very negative skewed to positive skewed). Average value for terrace BHT3 is +0.328 Ø (very positive skewed), it ranges from -0.0377 Ø + 0.5655 Ø (very negative skewed to very positive skewed).The sediments of terrace BHT1 is strongly negative skewed where as the sediments BHT1-BHT3 are progressively positively skewed. The negative skewness is resultant of high energy condition whereas the positive skewness indicates low energy. The average and relative range values of skewness from BHT1-BHT3 indicates, there is constantly decrease in energy condition of channel in decreasing antiquity in valley towards the late history of sedimentation.

Inclusive Graphic Kurtosis (KG)

Average value of Kurtosis for terrace BHT1 is 0.185 Ø (very platykurtic) it ranges from 0.235 Ø to 0.330 Ø (platykurtic). Average value for BHT1-BHT4 is 0.325 (very platykurtic) and ranges from 0.263 Ø to 0.540 Ø (very platykurtic). Average value for terrace BHT3 is 0.617 Ø (very platykurtic) and varies from 0.755 Ø to 0.885 Ø (platykurtic to very platykurtic).The sediments of BHT3 are platykurtic to very platykurtic and of BHT1-BHT3 are very platykurtic in nature. The average value of Kurlosis decreases upwards in increasing antiquity, which indicate a normal peakedness of sediments as well strong concentration of grains about median diameter. The relatively lower value of BHT1 indicates that most of the sediments were derived from close proximity and nearest provenances.

4. Statistical parameters of Fluvial terraces (nt1 to nt4) in stratigraphic column in type area of Ghat-Nandaprayag (30^0 27' 22": 78^0 22' 48") section, Nandakini Valley

The Fluvial terraces of Nandakini Valley

The Nandakini, rises from Semudra Glaciers drainage the western slopes of Trishul mountains (3660 m) in the Central Himalaya. It descends down in sinuous to meandering pattern, with sinuosity index ranging from 1.20 to 1.25. It also passes through the straight segment of the valley and tight meanders and joins Alaknanda at Nandaprayag. It comprises three distinct groups of terraces deposited entirely in different environment, viz. glacial, fluvio-glacial and fluvial. In the fluvial domain four prominent regional terraces in Nandakini have been identified which are time equivalent of the four younger terraces of Alaknanda the trunk stream and the Bhagirathi, Bhilangna, and other major tributaries of the Ganga system.

These Fluvial terraces are designated as NT1, NT2, NT3, and NT4, NT1 is the youngest and NT4 being the oldest in the valley, NT0 is the low surface of the present day flood plain of the stream. These terraces are both erosional and depositional in nature. The terraces NT4, and NT3, and have generally the divergent in mutual relation, whereas NT2 and NT1, have convergent relation., the NT4 and NT3, are mostly cyclic in nature and NT1 is non-cyclic and characteristically restricted within the meander of channel. The full sequence of terraces is very rarely preserved in the valley such as around Nandprayag, Rajwaki, whereas at other places one or two level of terraces is seen. It is possibly due to frequential lateral shift of the channel, extensive lateral cutting and subsequently repeated reworking of the terrace sediments in the environments of increasing discharge and steep gradient towards the later phases of river sedimentation.The top terraces NT1- NT4, are observed between elevation of 1080 to 1100 m above m.s.l The total thickness of fluvial terraces in the valley is 60 m whereas the average relative thickness of individual terraces 10, 20.25, 23.21 and 22.40 respectively. ((Khan, 1974, 1975 2022, 2023).

The discussion of statistical parameters of fluvial terraces of Nandakini is based on the study of 40 sediment samples each collected from the terraces NT1 to NT4 in the type area between Nandaprayag _Ghat section. The NT1 is being the youngest terrace and NT3 is the oldest. These terraces constitute the complete sequence of sediments of fluvial domain measuring about 60 m deposited in Narmada valley. The results of statistical parameters are discussed below:

Mean Size (MZ)

The average value of mean size of the terrace NT-1 is 2.235 Ø (fine sand) and it ranges from 1.575 Ø to 3.275 Ø (very coarse to very fine sand). Average value of mean size of terrace NT1 to NT4 is 1.725 Ø (very coarse sand) and it varies from -0.455 Ø to 2.365 Ø (very coarse to very fine sand). Average value of mean size of terrace NT2 (medium sand) and it ranges from -0.635 Ø to 1.635 Ø (very coarse sand to medium sand). Average value of mean size of terrace NT3 is 1.270 (medium sand) and it ranges from 0.755 Ø to 1.633 Ø (coarse to medium sand). Average and relative range values of mean size of sediments of Nandakini terraces indicate that the older terraces NT4 and NT3 predominantly consist of very coarse to medium sand, whereas NT2 predominantly very coarse to fine sand and NT-1 fine sand. The mean value sharply decrease in decreasing antiquity from older to younger terraces NT1 to NT2, which indicate the progressive decease in sediment carrying capacity of channel towards the late history of sedimentation.

Inclusive Graphic Standard Deviation

The average value of standard deviation for terrace NT-1 is 2.52 Ø (very well sorted) and it varies from 0.252 Ø to 0.420 Ø well sorted to very well sorted. Average values of standard deviation for terrace NT1 is 0.238 Ø (very well sorted) and it varies from 0.230 Ø to 0.360 Ø (well sorted to very well sorted). The average value for terrace NT2 is 1.345 Ø(well sorted) and it varies from -0.032 Ø to 1.630 Ø (poorly sorted to very well sorted). The average value for terrace NT3 is 1.272 Ø (poorly sorted to moderately sorted, and varies from 0.073 Ø to 2.212 Ø moderately sorted to very poorly sorted. The average value of standard deviation revealed that the sediments of terrace NT3 are poorly sorted and the sediments of terrace NT2 are well sorted. The sediments of terrace NT1 and NT2 are very well sorted. The sediments show significant improvement in sorting in decreasing antiquity of terraces in the valley. The relative range of standard deviation indicate that the sediments of NT3 are poorly sorted to moderately sorted NT2 poorly sorted to very well sorted, NT1 well sorted to very well sorted to very well sorted.

As a whole the sediments demonstrate strong and progressive tendency to become coarser finer in increasing antiquity in the valley. This appears to be inverse relatation with the mean size of sediments. The average values and relative values of standard deviation indicate that inspite of fluctuation in the energy condition of the channel; there is a marked and progressive improvement in the sorting from older to younger terrace in Nandakini Valley.

Inclusive Graphic Skewness (SKI)

The average value of skewness for terrace NT-1 is +0.292 Ø (positive skewed), it varies from -0.765 Ø to + 0.452 Ø (negative skewed to positive skewed), average value of skewness for terrace NT2 NT2, is +0.134 Ø (positive skewed) where as it ranges from -0.595 Ø to 0.245 Ø (negative skewed to positive skewed). The average value of skewness for terrace is +0.183 Ø (positive skewed) and it varies from -0.415 Ø to +0.233 Ø (negative skewed to very positive skewed), average value for NT3 is +0.198 (positive skewed) and it varies from -0.262 Ø to +0.272 Ø (negative skewed to positive skewed). The relative average and relative range values of skewness show strong tendency of sediments to be positive skewed indicative of progressive low energy environment of sedimentation towards the latter history of sedimentation.

Inclusive Graphic Kurtosis (KG)

The average value of Kurtosis for terrace NT-1 is 0.239 Ø (very platykurtic), it ranges from 0.220 Ø to 0.318 Ø (very platykurtic), for terrace NT1 average value is 0.322 (very platykurtic) and it ranges between 0.235 Ø to 0.575 Ø (very platykurtic), for terrace NT2 average value is 0.423 (very platykrutic) and it varies from 0.362 Ø to 0.562 Ø (platykurtic), for terrace NT3 average value is 0.683 (platy kurtic) and it varies from 0.775 to 0.872 (platykurtic to very platy krutic). The average values and relative range values of Kurtosis of sediments of terraces NT1 to NT3 reveal that inspite of variation; there is a tendency of sediments to become platykurtic to very platykurtic in increasing antiquity in the valley. The decreasing values of kurtosis upwards suggest the sediments of most of terraces were primarily derived from single source inferred to be from genisess granite and other central rocks.

5. Statistical parameters of Fluvial terraces (MT1 to MT4) in stratigraphic column in type area Rudraprayag (32^0 30' 00 – 79^0 57'30") Agastmuni (30^0 23' 25" : 79^0 00' 55") section Mandakini Valley.

The Fluvial terraces of Mandakini Valley

The Mandakini rises from the Gangotri group of glaciers in the north of Sonprayag around Kedarnath at an elevation of 3562 m and mingle with Alaknanda at Rudraprayag. All along its length it has formed the stepped sequence of terraces of three distinct domains viz. glacial, fluvio-glacial and fluvial. In fluvial domain three prominent regional terraces have been identified which are designated as MT1, to MT3 and are time equivalent to the three terraces of Alaknanda and other tributaries (Khan1981). These are polyclic depositional terraces and their wide development is seen around Barhi Bhatwari, Sauri, Agustmuni, Rampur and Tilwara. These terraces portrays divergent and convergent relation amidst each other and are generally semicircular, elongated, semi-circular to circular in shape and are both cyclic and non-cyclic in nature. These terraces conspicuous embraces sedimentary features such as graded bedding, cross bedding both planer and trough type, lamination, graded lamination, cut and fill features, around Agastmuni, Tilwara, Behri, Saurgarh, Sauri and Bhatwari. The total average thickness of fluvial terraces in the valley between Kund Chatti and Rudraprayag is about 40 m. The highest terrace is observed at an average elevation of 810 m above m.s. (Khan, 2022, 2023).

The under mentioned discussion is based on the study of 60 sediment samples collected 10 each from fluvial terraces (MT1-MT-3) in Mandakini valley from the stratigraphic sequence measuring about 40 m. The results of statistical parameters are discussed below:

Mean Size (MZ)
The average mean size of sediment MT1 to MT3 is 0.09 Ø (coarse sand), it varies from -2.75 Ø to 2.83 Ø i.e. the sediments consist of very coarse to fine sand. The maximum value of mean size is -2.815 Ø around Agustmuni. The mean size shows sharp decrease in size to ward up ward of ground surface from the basement. It shows decrease in its value but with strong fluctuations, which is appears to be due to the mixing of sediments brought by tributaries. It is seen that the mean size constantly decreases with size fluctuations. The mean size display sharp rise in size of sediment persistently in increasing antiquity increases in size of sediments and its variation in these deposits indicate steady decline in energy condition of channel system.

Inclusive Graphic Standard Deviation
It is a measure of sorting which reflects the consistence in the energy level of depositing medium in respect of sediments Mandakini terraces MT1 to MT3. The average standard deviation is 3.33 Ø(very poorly sorted). It varies from 2.00 Ø to 4.35 Ø i.e. the sediments are poorly sorted to extremely poorly sorted. The relative variation and average distribution indicate that 23% of sample is poorly sorted, 55 very poorly sorted and 22% are extremely poorly sorted. The sediments however, show slight improvement in sorting down the stream. As a whole the sediments of these deposits are extremely assorted and heterogeneous in nature and increases in decreasing antiquate in valley.

Inclusive Graphic Skewness (SKI)
It denotes the symmetry of grain size frequency distribution. The symmetry curves posses zero value, these with excess fine material show positive value with these excessive coarse material have negative value. The average skewness MT1toMT3 sediments are -0.063 Ø i.e. the sediments are negative skewed. It ranges from -0.43 Ø to +0.53 Ø i.e. the sediment are negative skewed to positive skewed, which indicate the tendency of gradual decrease in value of skewness in upstream direction as result of retreat of glacier activities and decrease in the transport capacity. The 57% of the sample shows the negative value and 43% positive value. The sediments of MT3 are very positive skewed to very negative skewed which seems to be due to mixing of sediments brought by cumulative glacial fluvio -glacial and fluvial activities.

Graphic Kurtosis (KG)
It indicates the peakedness of curve lower value of kurtosis (platykurtic) points towards broad peak, while value of kurtosis (leptokurtic) denotes pronounced peak in the centre. The Mandakini terraces MT1toMT3 value of kurtosis in the sediments is highly variable. The average value is 0.718 Ø (platykurtic); whereas it varies from 0.47 Ø o 1.12 Ø (very platykurtic to leptokurtic) the average value suggest the fluctuation in the energy condition of the stream channel and most intense assorting in the sediments prevailed during the deposition. Inspite of strong variation in kurtosis in the area, there is tendency in increase in kurtosis value towards downward in decreasing antiquity in valley.

6. Statistical parameters of fluvial terraces (PT1 to PT3) in stratigraphic coloumn in type area–Karanprayag (30^0 15’ 30” : 79^0 13’ 00”)_Simli (30^0 13’ 30” : 79^0 36’ 20”) section Pindar Valley.

The Fluvial terraces of Pindar Valley
The Pindar rises from Milamand Pindar glacier from the Nandadevi group in Central Himalaya, at an elevation of 3621 m. It traverses across the Himalayan ranges and descends down through steep gorges forming straight sinuous to meandering channel pattern and joins its trunk stream Alaknanda at Karanprayag.

The Pindar all along its major part of traverse maintains straight course, between Kheta and Dewal, it almost drains in WNW - ESE direction. At Dewal it takes an acute turn changing its course to NNE - SSW, which further down stream of Nandikesri again swings in WNW- ESE direction and maintains it upto Karanprayag, where it mingles with Alaknanda. In between Dewal and Nandikesri the course of Pindar appears to have been controlled by NNE - SSW trending fault, which up stream of Dewal also control the course of Kali Ganga a small tributary of the Pindar. All along its length it shows swelling and pinching in width, which varies from 500 to 680 m between Kheta and Dewal, 600 to 700 m between Dewal and Theralli, 500 to 650 between Theralli to Narayanbag and between

Narayanbag to Nalgaon the stream passes through the straight segment of deep gorge, having steep sides of valley flanks and smallest average width is 260 m.The Pindar downstream of Nalgaon the width of valley broadens out to the range from 670 to 850 m.. ((Khan, 1974, 1975 2022, 2023).

In Pindar valley between Theralli - Simli and Karanprayag three prominent regional terraces have been identified. These are designated as PT1, to PT3. The PT1, being the youngest and PT3 being the oldest terrace in the valley (Khan, 1975). These terraces are correlated with the three younger terraces of Alaknanda and other tributaries. These terraces were formed by combined and intermittent processes of aggradations and degradation associated with different phases of sedimentation of fluvial regime. The process is repeated thrice in the valley during the Holocene times. The highest terrace is observed at an elevation of 830 m above m.s.l. and 60 m from the present course of channel. The total thickness of these terraces in the valley is 55.5 m whereas the average relative thickness of individual terrace is 15 , 20 and 20 m (PT_1, to PT_3) respectively.

Mean Size (MZ)

The average mean size of sediments of terraces PT1-PT3 is 1.033 Ø (medium sand). It varies from -2.50 Ø to 3.12 Ø i.e. the sediments consist of very coarse to very fine sand. The size distribution of these deposits in the study area is extremely irregular and erratic out of 25 samples 15% of sample show range of mean size of order of 0.73 Ø – 0.52 Ø, 21 Ø, 0.23 Ø to 0.75, Ø 25%, 0.72 Ø to 1.73 Ø, , 1.74 Ø to 2.55 Ø and 19% beyond 2.53 Ø. The sediments in the vicinity of Simli Kheta and Dewal along a stretch of 20 kilometer show range of order of 1.25 Ø to 2.75 Ø with local variation. The sudden rise in mean size of Pindar show mean size values are of order 0.50 Ø to 0.15 Ø which indicates the intensive mixing of sediments brought from the flash stream resulting from the relating of glacier at different point in the valley. The sudden anomalous variation in mean size is attributed to the adding of a large bulk of sediments perhaps brought by sub-glacier resulted due to melting of glacial and climatic changes.

Inclusive Graphic Standard Deviation

The average standard deviation is 1.565 (extremely poorly sorted).The standard deviation of sediments of terraces PT1-PT3 varies from 0.95 Ø to 2.55 Ø i.e. the sediments are poorly sorted to very poorly sorted.. Out of 30 samples 8% are moderately sorted, 10% poorly sorted and 82% are very poorly sorted. The sediments near the source are conspicuously exhibit poor sorting and show significant improvement down the stream with local variation. As a whole the sediments are poorly sorted to very poorly sorted and heterogonous in nature sand are typically of fluvio glacial oxygen.

Inclusive Graphic Skeness (SKI)

The average of SKI is 0.077 Ø i.e. the sediments are fine skewed. The sediments o PT1-PT3 show skewness ranging from -0.48 +0.96 Ø i.e. the sediments are skewed very negative skewed very positive. Out of the total 30 samples of these terraces 55% are very skewed positively, 23% skewed positive and 22% are skewed very negative. The assemblage of variable of skeness suggests the heterogeneous association of the sediments ranging from fine sand to gravel size. The skeness in general increase down stream with occasional variation. It is perhaps due to repeated reworking of the sediments towards of stream side by flash stream resulting from the glacier. The sample shows skewness between the range -0.40 Ø to 0.30 Ø which indicates conspicuous heterogonous assemblage typical of fluvio-glacial domain reading (Khan 1981).

Graphic Kurtosis (KG)

The average KG of PT1-PT3 is 1.316 Ø (leptokurtic). It ranges from 476 Ø to 1.52 Ø platykurtic to very leptokurtic among these 75% of the sample fall in very mesokurtic 25% leptokurtic. The assemblages of these classes of kurtosis suggest the dominance of coarse sediments (Folk 1957). Most of the samples show the kurtosis value between 0.92 Ø – 1.23 Ø except in the area around Simli where the sedimentation is perhaps affected by lateral of sediments brought by the rejuvenated stream of the high kinetic nature which brought unusual sediment load. It seems that sediments were transported and deposited in the oscillating kinetic sedimentation.

7 Statistical parameters of Fluvial terraces Dhauli Gganga (DHT1-DHT3) in stratigraphic column in type area Joshimuth- Tapoban (30^0 29' 00" : 79^0 37' 30") section.

The Fluvial terraces of Dhauli Ganga Valley

The river Dhauliganga rises from the Nitti Pass at about 5070 meters. Its lies between the Kamet groups of peaks in the west and Nandadevi group in the east. The Dhauli takes a northern course at Malari. Between Malari and Tapovan, it is almost a narrow gorge with perpendicular cliffs on either side.The Dhauli Ganga is fed by Girthi

Ganga at Kurkuti and Rishi Ganga 500 m. below Reni. It joins Vishnu Ganga, near Joshimukh and down the Vishnuprayag it is known as the Alaknanda. The river has, conspicuous straight sinuous to meandering course and descends down through the tight gorges with the steeply rising valley flanks. The river has formed three prominent fluvial terraces besides several channel and land form elements. These terraces are genetically both erosional and depositional in nature and have been designated as DHT1, to DHT3. The DHT_1, is being the youngest and DHT3 is oldest terrace. The total average thickness of these terraces is 22 m and relative average thickness of these terraces is 10, 8 and 6 m respectively ((Khan, 1974, 1975 2022, 2023).

Mean Size (MZ)

The average mean size for the sediments of fluvial terraces of Dhauli Ganga DHT1-DHT3 is 2.453. whereas, it varies from -0.492 Ø to 4.5430 Ø. The mean size shows the significant consistency in its value in the stretch of upper stream segment in Malari-Tapoban section corresponding to the steep slope of the river bed, down the stream Tapoban there is sharp change in gradient of channel which affected mean size, it decreases, ,it appears to be due to change in bed slope Dhauli Ganga. In the lower segment mean size strongly fluctuates for about 15 kilometers which corresponds to the sudden convexity in the river bed assumed due to Neotectonic activity in the area. It seems that the mean size of fluvial sediments sharply follow the bed slope, pointing to exponential longitudinal profile, thus increases in mean size upward of terraces of Dhauli Ganga DHT1-DHT3 is result of decrease in both transporting capacity and velocity of the river system towards the later phases of sedimentation in the valley.

Inclusive Graphic Standard Deviation

The average standard deviation for sediment of fluvial terraces Dhauli Ganga DHT1-DHT3 is 0.695 Ø (moderately sorted) and it ranges from 0.153 Ø to 1.524 Ø i.e. the sediments are very well sorted to poorly sorted) from DHT1-DHT3. The rise in variation in and around Jodshimuth downstream appears to be due to mixing of sediments brought by local tributaries. The sharp improvement in sorting is noticed downstream seems to be related with the repeated reworking of sediments and slope element. The sudden decline in sorting co-efficient appears to be due to either the non-transport of larger grain down current or due to loss of bed slope of Dhauli Ganga in this segment of valley. The significant increase in sorting in down current of Jodshimuth with around the confluence with Alaknanda indicates repeated reworking of sediments perhaps due to re-activation of channel energy in the valley. The collective and cumulative sorting of sediments decreases in increasing antiquity of sediment sequence in valley.

Inclusive Graphic Skewness (SKI)

The average skewness of fluvial sediments of Dhauli Ganga DHT1-DHT3 is 0.00285 Ø. It ranges from -0.894 Ø to 0.994 Ø i.e. the sediments are course to fine skewed. The skewness exhibits tendency of gradual increase in value down stream with local variation. This suggests relative increase of fine sediment down the stream of Tapoban. The sediment upstream of Tapoban is negative skewed perhaps it is due to mixing of sediments of fluvio glacial origin brought by net work of subsequent streams in upper watershed of Dhauli Ganga. .

Inclusive Graphic Kurtosis (KG)

The kurtosis of fluvial sediments of Dhauli Ganga DHT1-DHT3 Dhauli Ganga is highly variable, it ranges from 0.623Ø to 1.725Ø (Platykurtic to very leptokurtic) and an average value 1.425 Ø (Leptokurtic). The average value suggests the fluctuation in the energy condition of the channel system throughout sedimentation. The mean value of kurtosis revealed the more incentive sorting of central part of size distribution curve than the tails. There is strong tendency in increase of kurtosis value down stream.

8. Statistical parameters of Fluvial terraces (BL1 to BLTl3) in stratigraphic column in type area Chinka Bal Ganga alley.

The Fluvial terraces of Bal Ganga Valley

The Bal-Ganga is a small tributary of Bhilagna. It rises from the ice clad peak (10746) in the Central Himalaya southwest of Kedarnath. This stream has formed three prominent fluvial terraces, beside the glacial and fluvio-glacial terraces in the upper reaches which occur in the form of isolated and dissected caps. These fluvial terraces are mainly depositional in nature and are designated as BLT1, to BLT3, the BLT1, it is being the lowest and youngest terrace, whereas BLT3, the oldest terrace. The relative average thickness of these terraces is 5, 10 and 7 m respectively. ((Khan, 1974, 1975, 2023).

The discussion of statistical parameters as mentioned below is based on the study of 30 sediment samples collected from the Quaternary section of fluvial terrace BLT1toBL3 Bal Ganga River. The average measured thickness of terrace deposit in the valley is about 10 mts.

Mean Size (MZ)
The average mean size of sediments of terrace BLT1toBLT3 is 2.422 Ø (fine sand) it varies from 1.233 Ø to 3.292 Ø (medium sand to silt and clay) which indicate wide range of sediment. The relative average and range value of mean size reveal the upward fining sequence of sediment typical of fluvial nature.

Inclusive Graphic Standard Deviation (S)
The average value of standard deviation of sediments of terrace BLT1-BLT31 is 0.266 Ø (very well sorted). It ranges from 0.223 Ø to 0.333 Ø (well sorted to very well sorted). The relative average and range values of sorting of sediments indicate well sorted to very well sorted in nature.it appears to be related with decrease in mean size and increase in the finer clastic towards later phases of sedimentation.

Inclusive Graphic Skewness (SKI)
The average value of skewness for sediments of terrace BLT1-BLT31 is 0.353 Ø (positive skewed) and it varies from 0.333 Ø to 0.492 Ø (positive skewed). The different values of skewness reveal the strongly positive skewed nature of sediments in increasing antiquity of stratigraphic sequence. As such that the sediments are strongly fine skewed, thereby indicate decrease in load carrying capacity of channel towards later phases of sedimentation in the valley.

Inclusive Graphic Kurtosis (KG)
The average value of kurtosis for sediments of terrace BLT1-BLT31 is 0.294 Ø (very leptokurtic) and it varies from 0.273 Ø to 0.322 Ø (very leptokurtic to extremely leptokurtic). The sediments in general are very leptokurtic to extremely leptokurtic in nature and as such indicate the single source of their derivation.

9. Statistical parameters of fluvial terraces (MDT1-MDT2) in stratigraphic coloumn in type area betwen Kedarnath south of Okhimuth Madhmeshwar Ganga valley

The Fluvial terraces of Madhmeshwar Ganga Valley
The Madhmeshwar Ganga is a tributary of the Mandakini. The stream originates from glacier southwest of Kedarnath and joins Mandakini near OkhimukhIt. It is controlled by NNE-SSW trending lineament. The stream has formed two prominent river terraces, each separated by scarp. These are depositional in nature and are fill and cut type. The shapes of these terraces are semi-circular, which is mostly restricted in the channel meander and non-cyclic in nature. These terraces are designated as MDT1, to MDT2, from younger to older terraces respectively. The relative thickness of these terraces is 8 and 10 m respectively (Khan 1981).

These terraces constitute the complete sequence of sediments of fluvial domain measuring about 12 m deposited in Madhmeshwar Ganga valley during Quaternary period. ((Khan, 1974, 1975 2022, 2023).

The discussions of grain size parameters of fluvial terraces of Madhmeshwar Ganga is based on 20 sediment samples collected 10 each from MDT1-MDT2, the MDT1 is being the youngest terrace and MDT2 being the oldest and highest terrace.

Mean Size (MZ)
The average value of mean size of terrace MDT1 is 2.324 Ø (fine sand) and it ranges MDT1-MDT2

Between 1.435 Ø to 3.253 Ø (very coarse to very fine sand). The average mean size of terrace MDT1 is 1.872 Ø (medium sand) and varies from -0.518 Ø to 2.352 Ø (very coarse to very fine sand). The average mean size for terrace MDT2 is 1.925 Ø (medium sand) and it varies from -0.425 Ø to 2.545 Ø (coarse to fine sand).The distribution of average values of mean size revealed that younger terrace MDT1 pre-dominantly comprises fine sand, where as MDT-2 medium sand and as a whole these terrace consist of very coarse to very fine sand. In general finesse of sediments increases towards younger terraces which indicate torrential nature of channel and steady increase in load carrying capacity to towards the formation of younger terraces in valley.

Inclusive Graphic Standard Deviation

The average value of standard deviation of terrace MDT1 is 0.367 Ø (well sorted) and it varies from 0.225 Ø to 0.429 Ø (well sorted to very well sorted), average value for terrace MDT1 is 0.263 Ø (very well sorted). It range between 0.235 Ø to 0.335 Ø (well sorted to very well sorted), average value of terrac MDT2 is 0.335 Ø (very well sorted) and varies form 0.249 Ø to 0.436 Ø (well sorted to very well sorted).The relative average values of standard deviation indicate that sediments of terraces MDT1- MDT2 are well sorted to very well sorted. The sorting of sediments as a whole shows improvement towards the younger terrace which seem to be inversely related with the mean size. The little variation in the sorting in and mean size indicates reactivation in the energy of channel system during sedimentation.

Inclusive Graphic Skeweness (SKI)

The average value of skewness of terrace MDT is +0.243 Ø (positive skewed) and it varies from -0435 Ø to +0.545 Ø (very negative skewed to very positive skewed), average value of terrace MDT1 is +0.265 Ø (negative skewed) and it MDT1- MDT2 varies from 0.354 Ø to 0.423 Ø (very negative skewed to very positive skewed). The average value of MDT2 2 is + 0.184 (positive skewed) and it ranges between -0.725 Ø to 0.422 Ø (very negative skewed to very positive skewed). The average values of skewness of sediments terrace MDT1- MDT2 are positive which reveal over all fluctuating energy system of channel. The over all values of skewness increases in decreasing antiquity of terraces, i.e. the sediments have got strong tendency to be positively skewed towards late history of sedimentation in the valley.

Inclusive Graphic Kurtosis (KG)

The average value of Kurtosis of terraces MDT1-MDT2 is 0.267 Ø (very platykurtic) and it ranges from 0.219 Ø to 0.385 Ø (very platykurtic). The average value of terrace MDT1 is 0.455 Ø (very platykurtic) and it varies from 0.265 Ø to 0.544 Ø (very platykurtic). The average of average value of terrace MDT2 is 0.439 Ø(very platykurtic) and varies from 0.333 Ø to 0.573 Ø (very platykurtic). The over all average and range values of kurtosis revealed the pre-dominantly vary platykurtic nature of sediments in the valley. The over all decreasing values of kurtosis in decreasing antiquity suggest the source of derivation of sediments from central crystalline rock

10. Statistical parameters of Fluvial terraces BR1) in stratigraphic column in type area south east of Tapoban (30^0 23’ 00”: 79^0 25’ 10”)

Berhi Ganga Valley.

The Behri Ganga is a tributary of Alaknanda, it originates from glaciated top in the Central Himalaya in upstream of south east of Tapoban and joins Alaknanda between Joshimath and Chamoli it is known as the Alaknanda. The river has conspicuous straight ENE-course and descends down through the tight gorges with the steeply rising valley flanks. The river has formed one prominent fluvial terrace besides several channel and land form elements. These terraces are genetically both erosional and depositional in nature and have been designated as BRT1 is being the youngest is oldest terrace. The average thickness of these terraces is 5 m and relative average height is 8fromriver bed. ((Khan, 1974, 1975 2022, 2023).

The discussion of statistical parameters is based on the study of 10 sediment samples, collected from one fluvial terraces Behri Gang BRT1 sediment sequence.. This terrace constitute the complete sequence of sediments of fluvial domain measuring about 5 m. deposited in channel and flood plain environments in the valley.

Mean Size (MZ)

The average mean size for Bal Ganga BRT1 is 2.450 Ø where as it varies from 1.370 Ø to 3.158 Ø (medium to fine sand), for Bal Ganga BRT1 the average mean size is 1.962 (medium sand) and it varies from -0.425 Ø to 2.15 Ø (medium to very coarse sand).The mean size of sediment in general decreases down the stream, which indicates typical fluviatilte environments of sedimentation. The steady decrease of mean size down the current reveals the decline load carrying capacity of channel during late stages of sedimentation in the valley.

Inclusive Standard Deviation

The average value of standard deviation for sediment of terrace Bal Ganga BRT1 is 0.265 Ø (very well sorted) and it varies from 0.252 Ø to 0.418 Ø(moderately sorted to very well sorted) for average is 0.251 Ø (very well sorted). indicate well sorted nature of sediments, which show improvements of sorting to be related with decrease in mean size and increase with finer sediments towards late history of sedimentation in the valley.

Inclusive Graphic Skewness (SKI)

The average value of skewness for terrace Bal Ganga BRT1 is +0.3210 Ø (very positively skewed) and it varies from -0.355 Ø to +0.520 Ø. The relative average and range values of skewness of Bal Ganga terrace indicates strong tendency of sediments to become skewed negative due to the high load carrying and transporting capacity of river during the initial stages of sedimentation (Khan et al 1980).

Graphic Kurtosis (KG)

The average value of Kurtosis for sediment of terrace Bal Ganga BRT1 is 0.275 Ø (very platy-kurtic) and it varies from 0.210 to 3.22 (Platykurtic to very platykurtic). The average and relative range values of kurtosis indicate platykurtic to very platykurtic nature of sediments however, a sharp decrease in kurtosis value towards younger terraces reveal the strong tendency of sediments to be vary platykurtic in nature.

Conclusion:-

The sedimentological study in Alaknanda and its tributaries in upper Ganga basin has been attempted in parts of de Uttarkashi,Chamoli, Pauri and Tehri districts in parts of QA sheet 53Jand 53 N on 1:50000 scale of Garhwal Himalaya U.P; presently known as Uttrakhand State of Union of India. The area of Upper Ganga basin consisting of Alaknanda,Bhagirathi,Bhilangna, Nandakini, Mandakini, Pindar, Dhauli- Ganga Bal- Ganga , Madhmeshwar Ganga and Berhi Ganga The Alaknanda is characterized by six terraces AT1_AT6 followed by Bhagirathi with five terraces BT1_BT5, Bhilangna BHT1_BHT4 Nandakini four terraces NT1_NT5, Mandakini MT1_MT6 /Pindar PT1_PT3 /Dhauli-Ganga DGT1_ DGT3 /Balganga three terraces BGT1, to BGT3, Madhmshwar MDT1, to MDT2

Ganga two terraces and Berhi Ganga one terrace BRT_1, amidst these Alaknanda is trunk stream and others are tributaries.The sequence of valley development and Quaternary sedimentation in Alalknanda and its tributaries is established in stratigraphic sequence and discussed for the first time.

Age	Stages of valley development	Quaternary sedimentation	Environment of sedimentation
Recent to Holo-cene		Flood Plain and adjoining low land area of present day course of channel and associated geomorphic features, point bar, sand bar, channel braids etc.	Channel and Flood plain environment
	VI	Berhi Ganga terraces 1_Phase of Aggradation / Degradation=	**BRT_1**
	V	Madhmeshwar Ganga terraces 2_Phases of Aggradation / Degradation =	**MDT_1 to MDT_2**
	IV	Bal Ganga terraces 3_Phases of Aggradation / Degradation	**BLT1- BLT3**
		Mandakini terraces 3_Phases of Aggradation / Degradation =	**MT_1 to MT_3**
		Pindar terraces 3_Phases of Aggradation / Degradation =	**PT_1 to PT_3**
		Dhauli Ganga terraces 3_Phases of Aggradation / Degradation	**DGT_1 to DGT_3**
	III	Bhilanga terraces 4_Phases of Aggradation / Degradation =	**BHT_1 to BHT_4**
	III	Nandakini terraces 4_Phases of Aggradation / Degradation=	**NT_1 to NT_4**
	II	Bhagirathi terraces 5_Phases of Aggradation / Degradation =	**BGT_1 to BGT_5**
	I	Alaknanda terraces 6_Phases of Aggradation / Degradation	**AT_1 to AT6**

The area genetically comprised of terraces of three domains, viz. Glacial, Fluvio-glacia and Fluvial which represent distinct environment of sedimentation of Pleistocene, late Pleistocene and Holocene time during Quaternary period. The Glacial terraces are identified at an average elevation of 1150 m above MSL, the fluvio-glacial terraces at an average elevation of 975m above MSL and fluvial terraces at an average elevation between 650 to 900 m above m.s.l, type area is attempted in to understand the nature of Quaternary sedimentation in these valleys in increasing antiquity.

The statistical parameters of sediment of fluvial terraces of Alaknanda revealed that the average mean size for AT1 is 1.550 Ø (medium sand) and it varies from -0.3240 Ø to 2.250Ø (coarse sand to fine sand), for AT2 average mean size is -0.5350Ø (coarse sand) and it ranges from -1.742Ø to 1.565Ø (very coarse to medium sand),AT3 the average value is 1.760Ø whereas it ranges between -0248 to 2,650 Ø The average and range values of means size of Alaknanda terraces (ATo to AT3) predominantly consist of both coarser and finer sediments, whereas younger terraces (ATo to AT1) primarily consist of very fine sand.The mean size of sediment in sequence of terraces except in AT2 has strong tendency to decrease in decreasing antiquity i.e. from AT3 to AT1 towards the younger terraces.

The progressive increase of finer sediments towards younger terrace revealed the constant and steady decrease in load carrying capacity of Alaknanda from early to late history of river sedimentation. The anomalous values of mean size in the terrace AT3 indicate sudden reactivation in energy condition of the channel system during sedimentation perhaps due to tectonic dislocation in watershed region of Alaknanda which is also manifested in disposition of sediment in vertical column of AT3 terrace in the valley.

The average value of standard deviation for terrace AT0 is 0.3740 Ø (well sorted), whereas it varies from 0.2530 to 0.4665Ø (well sorted). The average value for AT1 is. 0.3.320Ø it ranges from 0.255 Ø to 0.440 Ø, average value for AT2 – AT6 is 0.3.35 Ø and it varies from 0.348 to 0.555 Ø . The average value for terrace AT3 is 0.6120Ø (moderately sorted) and it varies from 0.540 Ø to 0.710Ø (moderately sorted). The average and range value of (S) indicate that sediments are poorly sorted to very well sorted.

The sorting index of sediments appears to be related with size of sediments. The correlation between these two parameters revealed that the higher terraces AT2, AT-3 contrastingly consist of coarser clastic and are mostly moderately sorted, as compared to AT1 to AT2, AT3, AT3 which comprised of medium to fine, sediments and show significant improvement in sorting. The size distribution curve indicates variable unimodel to bimodal nature of sediments.

The probability plots indicate that the sediments load of AT2 to AT3 consist of traction (average 82%) and little of suspension whereas AT1 to A2 both of traction and suspension (average 55% and 45% respectively). This variation from AT1 to AT3 revealed strong fluctuation in the current velocity of the channel and steady decrease in the kinetics of river from early to late history of sedimentation (Khan1975). The average value of standard deviation (S) from AT3 to AT1 shows sharp progressive improvement in sorting of sediments which may be due to (i) due to repeated reworking of sediments (ii) due to increase load in mean size of sediments, (iii) progressive static environments of sedimentation towards later phases, perhaps due to low energy condition of channel during sedimentation.

The average value of skewness is + 0.123Ø positive skewed), for skewness AT1 skewness is (positive skewed), where it varies from -0.626 to 0.225 Ø (negative skewed to very negative skewed), for AT2 AT3, AT3, AT4) the average is +0.385 (positive skewed) and varies from 0.440 to -0.975 Ø (very negative skewed) and varies from 0.145 to -0.328 (negative skewed to positive skewed).

The average value of skewness revealed that the sediments of older terraces are strongly negative skewed, whereas the sediments of younger terraces are positive skewed. The negative skewness is considered to be the resultant of high energy environment and the winnowing action of the sand, whereas the positive is the reversal of former. The relative skewness range of the sediments from negative skewed to positive skewed from older to younger terrace revealed the steady decrease in the load carrying capacity of channel and current velocity towards the late history of river sedimentation in the Narmada valley.

The average value of Kurtosis for terrace AT1 is 0.385 Ø (very platykurtic) it varies from 0.285 Ø to 0.370 Ø i.e. (very platykurtic), for terrace AT2 the average value is 0.385 Ø (very platykurtic) and it varies from 0.3600 Ø to 0.4560 Ø (very platykurtic), for terrace AT2 , AT3, AT4) the average value is 0.5240 Ø (very platykurtic) and varies from 0.385 Ø to 0.681 Ø (platykurtic to very platykurtic) for terrace AT3, the average value is 0.639 Ø (very platykurtic), and varies from 0.6325 Ø to 0.755 Ø (platykurtic to very platykurtic). The younger terraces ATo to AT1 show the lower values of Kurtosis whereas the older AT2 to AT1 the higher values. The values decrease from older to younger terraces which suggest that the sediments from older to younger terraces become mesokurtic to very platykurtic. The relatively lower values of Kurtosis towards younger terraces indicate that the sediments were derived from more than one source

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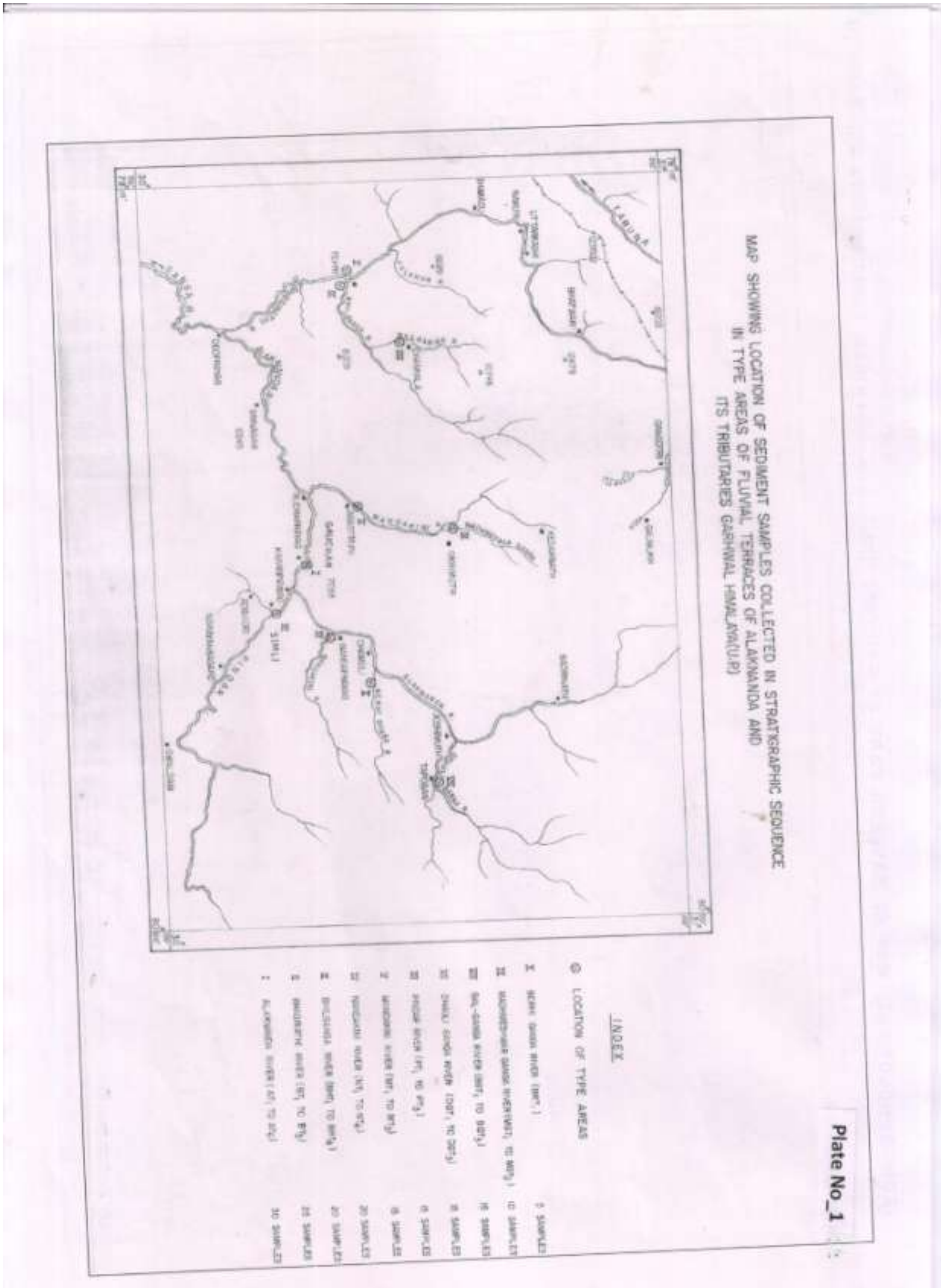
AND ITS TRIBUTARIES, GARHWAL HIMALAYA, U.P. (UTTARKHAND STATE) INDIA Table No 1 SEQUENCE OF VALLEY DEVELOPMENT & QUATERNARY SEDIMENTATION EVOLUTION IN ALAKNANDA

Age	Environ ments	Possible Cause	Quaternary Sedimentation &Phase of Aggradations / Degradation	Alaknanda	Bhagirathi	Bhilangna	Nandakini	Mandakini	Pindar	Dhauli Ganga
------------------ Holocene ------------------	---- Fluvial Environment ---	Tectonic / Climatic / Eustatic Changes	Aggradation / Degradation	AT_0	BT_0	BHT_0	NT_0	MT_0	PT_0	DHT_0
				Simultaneous processes of erosional / depositional in progress						
			Aggradation / Degradation	AT_1	BT_1	BHT_1	NT_1	MT_1	PT_1	DHT_1
				Riverine depositional processes in progress						
			Aggradation / Degradation	AT_2	BT_2	BHT_2	NT_2	MT_2	PT_2	DHT_2
				Riverine depositional processes in progress						
			Aggradation / Degradation	AT_3	BT_3	BHT_3	NT_3	MT_3	PT_3	DHT_3
				Riverine depositional processes in progress						
			Aggradation / Degradation	AT_4	BT_4	BHT_4	NT_4			
				Riverine depositional processes in progress						
			Aggradation / Degradation	AT_5	BT_5					
				Riverine depositional processes in progress						
			Aggradation / Degradation	AT_6						
				Riverine depositional processes in progress						

Table 2:- sequence of valley development of alaknanda & its tributaries alaknanda and its tributaries, garhwal himalaya, u.p. (uttarkhand state) india.

Age	Stages of valley development	Terraces	Environment of sedimentation
Recent to Holo-cene		Flood Plain and adjoining low land area of present day course of channel and associated geomorphic features, point bar, sand bar, channel braids etc.	Channel and Flood plain environment
	VI	Berhi Ganga terraces	**BRT_1**
	V	Madhmeshwar Ganga terraces	**MDT_1 to MDT_2**
	IV	Bal Ganga terraces	**BLT1- BLT3**
		Mandakini terraces	**MT_1 to MT_3**
		Pindar terraces	**PT_1 to PT_3**
		Dhauli Ganga terraces	**DGT_1 to DGT_3**
	III	Bhilanga terraces	**BHT_1 to BHT_4**
	III	Nandakini terraces	**NT_1 to NT_4**
	II	Bhagirathi terraces	**BGT_1 to BGT_5**
	I	Alaknanda terraces	**AT_1 to AT6**


MAP SHOWING LOCATION OF SEDIMENT SAMPLES COLLECTED IN STRATIGRAPHIC SEQUENCE
IN TYPE AREAS OF FLUVIAL TERRACES OF ALAKNANDA AND
ITS TRIBUTARIES GARHWAL HIMALAYA(U.P)
INDEX
LOCATION OF TYPE AREAS
Plate No_1

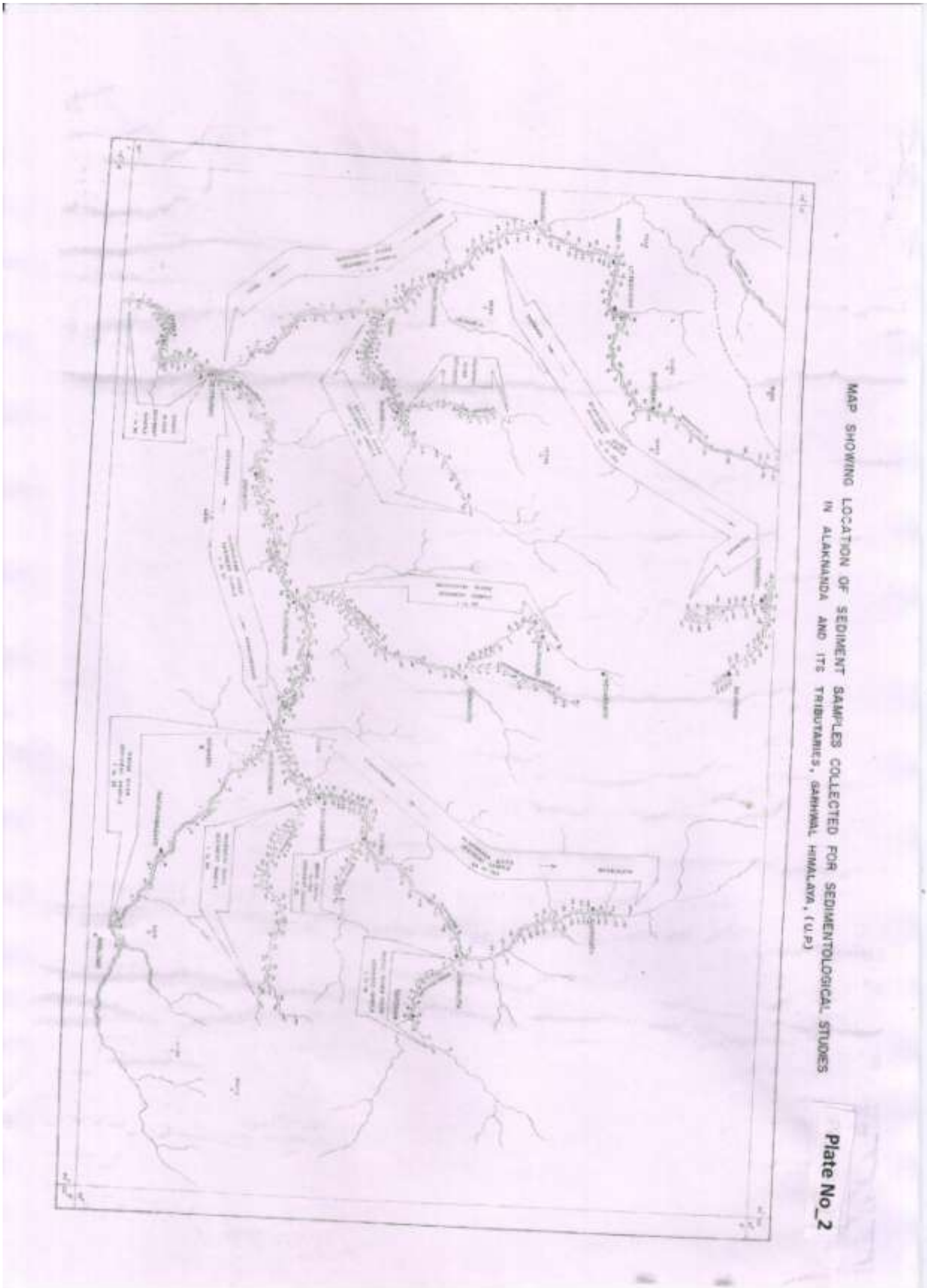

MAP SHOWING LOCATION OF SEDIMENT SAMPLES COLLECTED FOR SEDIMENTOLOGICAL STUDIES
IN ALAKNANDA AND ITS TRIBUTARIES, GARHWAL HIMALAYA, (U.P.)

Plate No_2

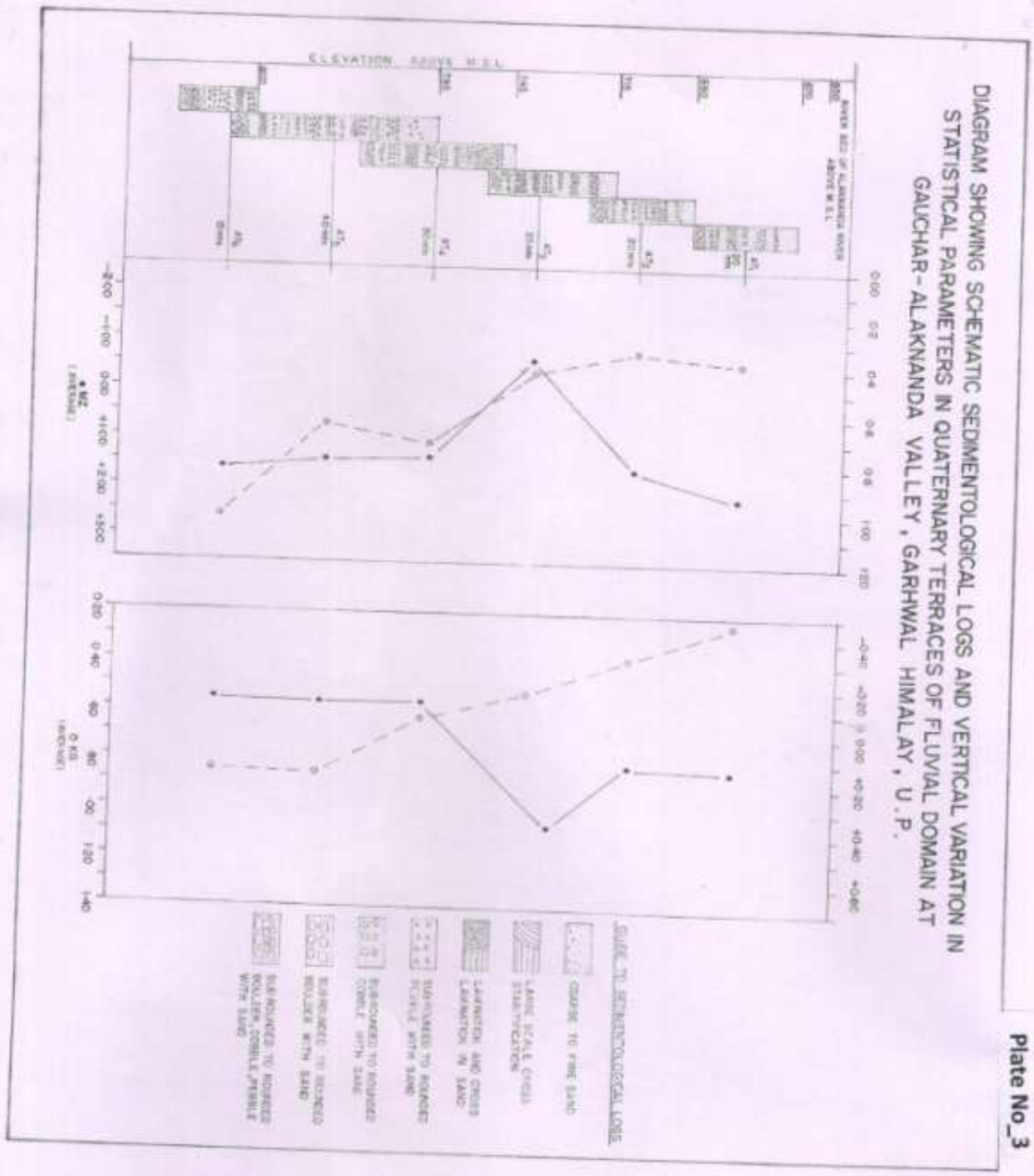


DIAGRAM SHOWING SCHEMATIC SEDIMENTOLOGICAL LOGS AND VERTICAL VARIATION IN
STATISTICAL PARAMETERS IN QUATERNARY TERRACES OF FLUVIAL DOMAIN AT
GAUCHAR-ALAKNANDA VALLEY, GARHWAL HIMALAY, U.P.
ELEVATION ABOVE M.S.L.
GUIDE TO SEDIMENTOLOGICAL LOGS
Plate No_3

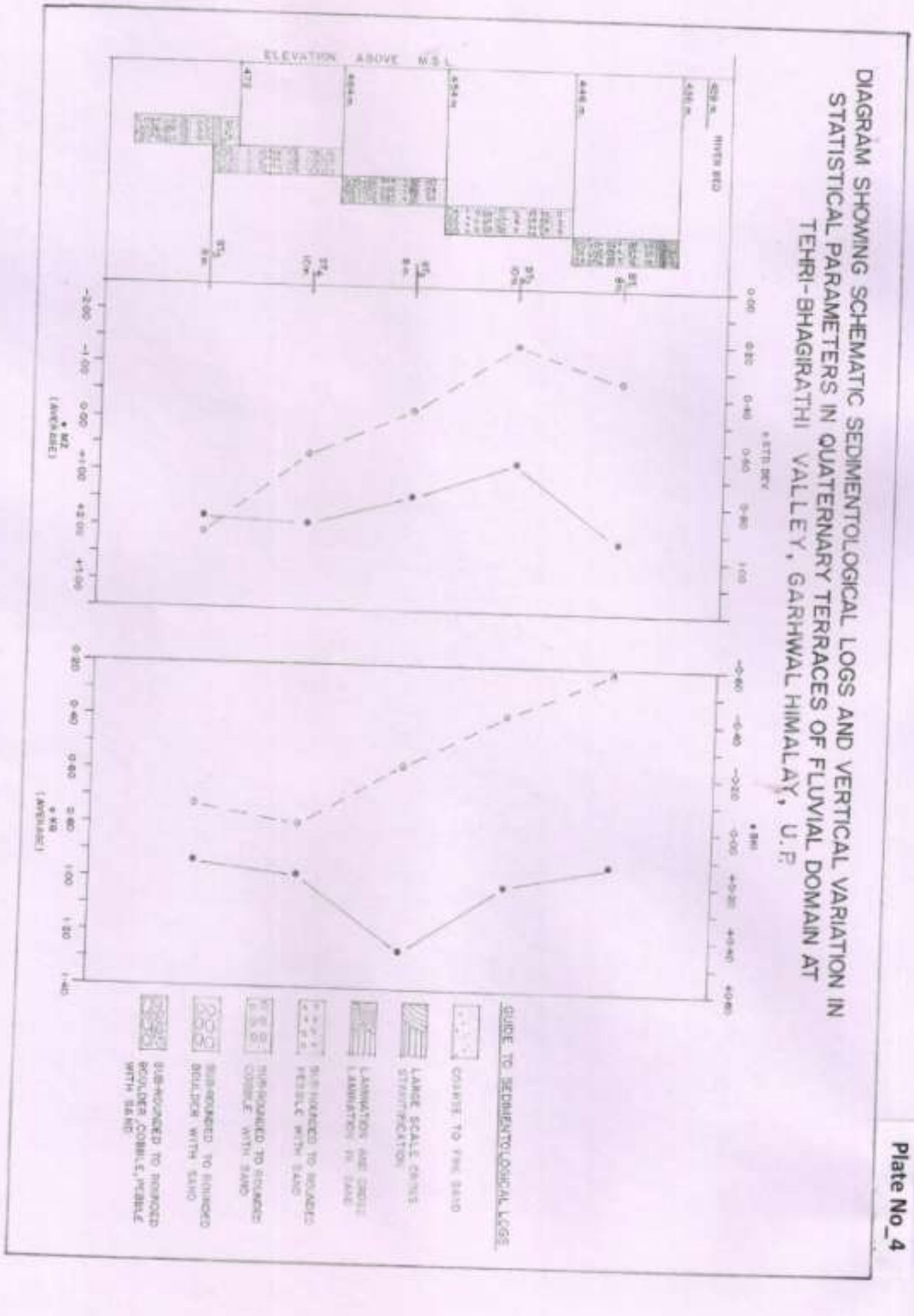
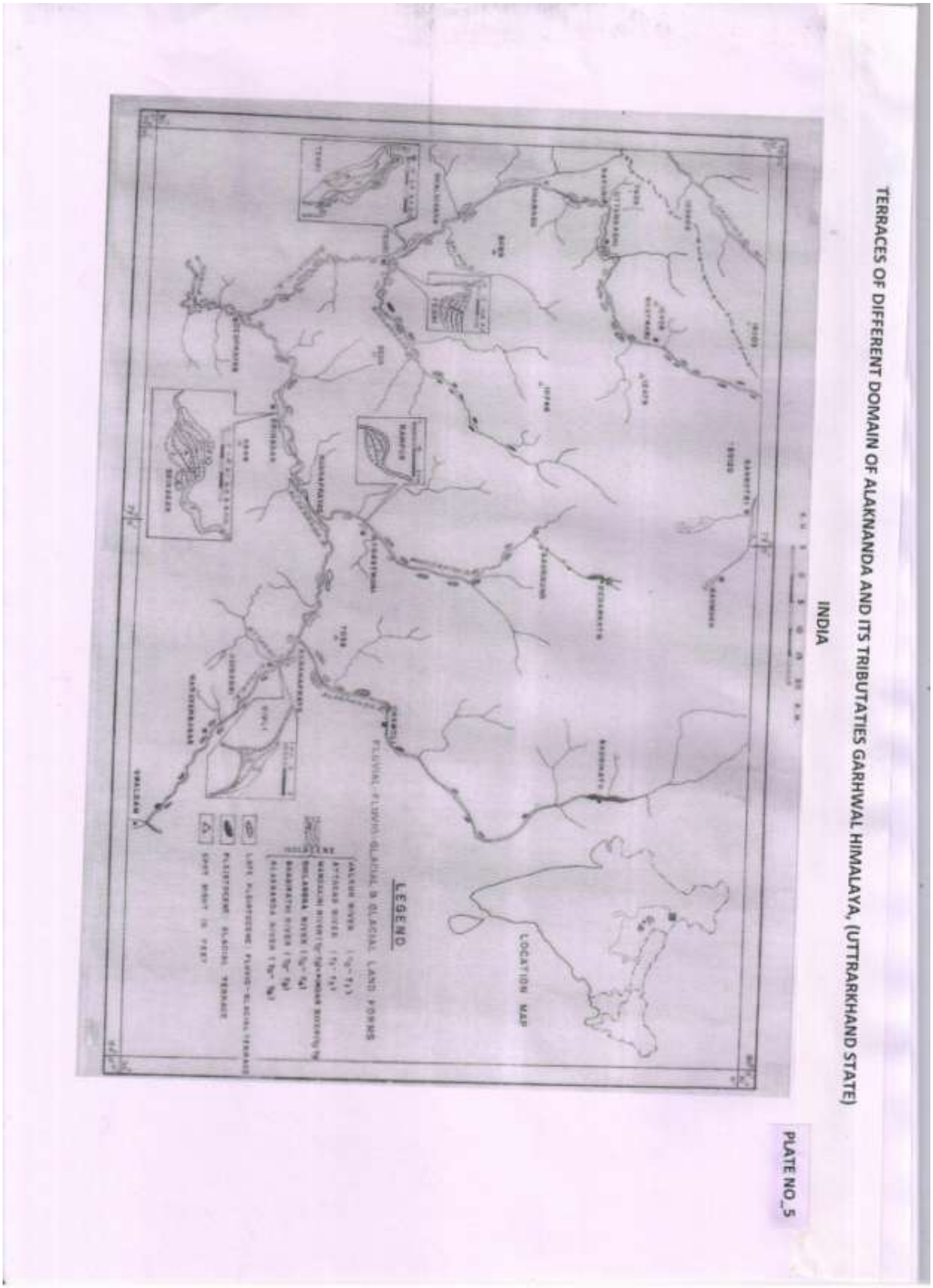


DIAGRAM SHOWING SCHEMATIC SEDIMENTOLOGICAL LOGS AND VERTICAL VARIATION IN STATISTICAL PARAMETERS IN QUATERNARY TERRACES OF FLUVIAL DOMAIN AT TEHRI-BHAGIRATHI VALLEY, GARHWAL HIMALAY, U.P
ELEVATION ABOVE M.S.L
GUIDE TO SEDIMENTOLOGICAL LOGS

Plate No_4


TERRACES OF DIFFERENT DOMAIN OF ALAKNANDA AND ITS TRIBUTATIES GARHWAL HIMALAYA, (UTTRARKHAND STATE)
INDIA
LOCATION MAP
LEGEND
PLATE NO_5