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DOWNSTREAM CHANGES IN LITHOLOGY AND SEDIMENT LOAD IN THE BASPA RIVER VALLEY , HIMACHAL PRADESH.

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ABSTRACT : Studies carried out on a 12 km stretch of Baspa river, Himachal Pradesh, on lithological (geological), sediment load and sedimentary features indicate a dominant role of abrasion in downstream fining of the clast/sand material. The bed lithology is mostly granite-gneiss-migmatite and schist which offer enough resistance and in conjunction with the corrasion result in considerable fining of the clasta.This phenomena is initiated at the head of the valley where glaciers bring down enormous sediment and pour them into the main channel at a high angle. Most of the features in the form of gravel bars and natural leavees' are present temporarily along the river banks and display a common role of these processes in sediment fining. Moreover, the upper reaches are of granite overlain by slate/phyllite - sand - stone - quartzite lithology. The increasing proportions of (granite > quartzite > sandstone > slate/ phyllite proportions in sediment downstream are indicative of the assertion.

INTRODUCTION :

Downstream fining of particles in rivers is ascribed to the process of sorting and abrasion. Most of the workers (Pettijohn, 1992; Mangelsdorf, et al., 1990 and Parker, 1991, a,b) have favoured this fact. However, the dominance of the above two factors has remained a matter of scientific speculation. Kodama (1994, a,b) has demonstrated the influence of abrasion in fining of clast/particles in the process of fluvial transport downstream. Abrasion includes splitting, crushing, chipping, superficial cracking and grinding (Keunen, 1956). The work carried out in favour of this process has been limited (Kodama, 1994). In the present case, as is evidenced this process appears to have established major domain over hydrologic sorting.

The present area of study is confined to a stretch of Baspa situated in the Kinnaur district of Himachal Pradesh, a glacifluvial valley, between Chitkul and Sangla (Fig. 1). Main relevant features of the valley as observed are as follows.Narrow glaci-fluvial valley in major antiforms, geologically occuring in the High Himalayan Crystallines composed of a prograde metamorphic crystalline sequence of schist, gneiss, migmatite and granite with occasional / phyllite, quartzites and sandstone. Intrusive granite of Miocene (Searle, et al., 1987) is exposed at high altitudes with fresh nature and very little foliation. Gravel bars (Fig. 2, Table 1) are observed at seven places in this stretch along with natural levees'. Lacustrine deposits are also seen at Rakcham and Sangla. The valley at present hosts 89 glaciers out of which 4 are major, 12 minor and others can be regarded as dead ice or niche glaciers.

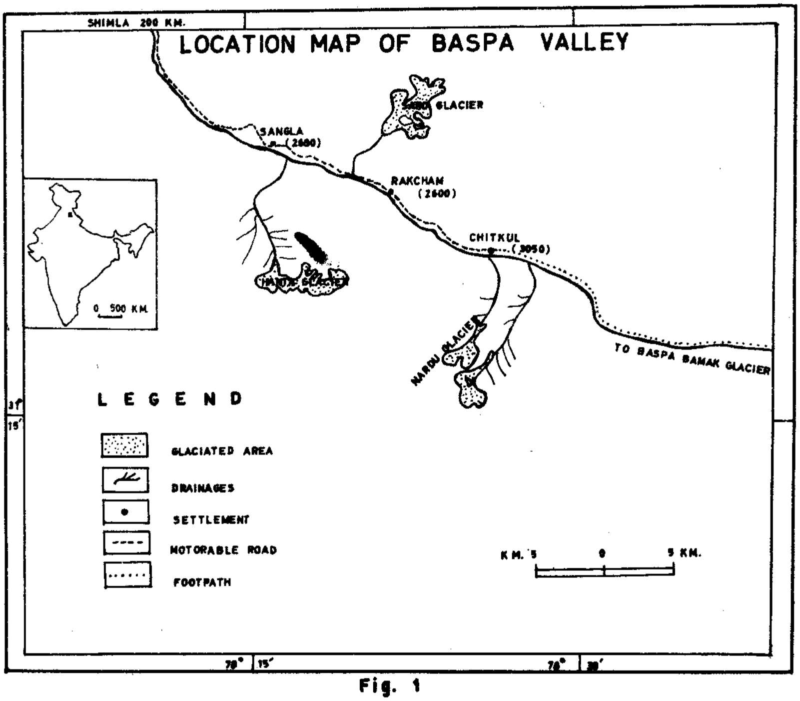

Fig.No. 1 : Location of the area of study

For most part of this stretch the river valley along its present course exposes hard rocks belonging to the above mentioned lithology. The river course as shown in Fig. 2 is a narrow one which has carved its way through the valley previously occupied by a large valley glacier. The glacial record is faithfully preserved in the form of end moraines present at Sangla and Rakcham which evidence the rapid melting phases of this glacier. The fulvial action during abrupt melting and consequent flooding is manifested at seven places along the course of the river. Moreover, the temporary daming of the river at different times at Sangla and Rakcham hav given rise to lacustrine deposits which are more prominent at Sangla. The discharge of the river is maximum during the peak melting season (July - Aug) and is dependent on the incipient temperature and solar radiation.

FLUVIAL SEDIMENT CHARACTERISTICS :

Major clast, boulder; and sand proportions present in the above mentioned fluvial deposit is shown in Fig. 3. There is a marked dominance of quartzite, granite and sandstone lithology,whereas the sand fraction includes a major chunk of feldspathic, micas and quartz granites of varied dimensions. Clays as is evident from the fig. are very less in these deposits being carried away by the water in suspension The dominance of this type of lithology is a direct indication of the fact that abrasion is a sole agent in reducing the sizes of clasts downstream. The abundance of sandstone and phyllite/slate clasts in glacial material and lack of proportionate clasts downstream sediments favour the assertion. Several classes of grain have been identified and are presented in Table - 1. A perusal of this table does not show the same weight ratio in different classes

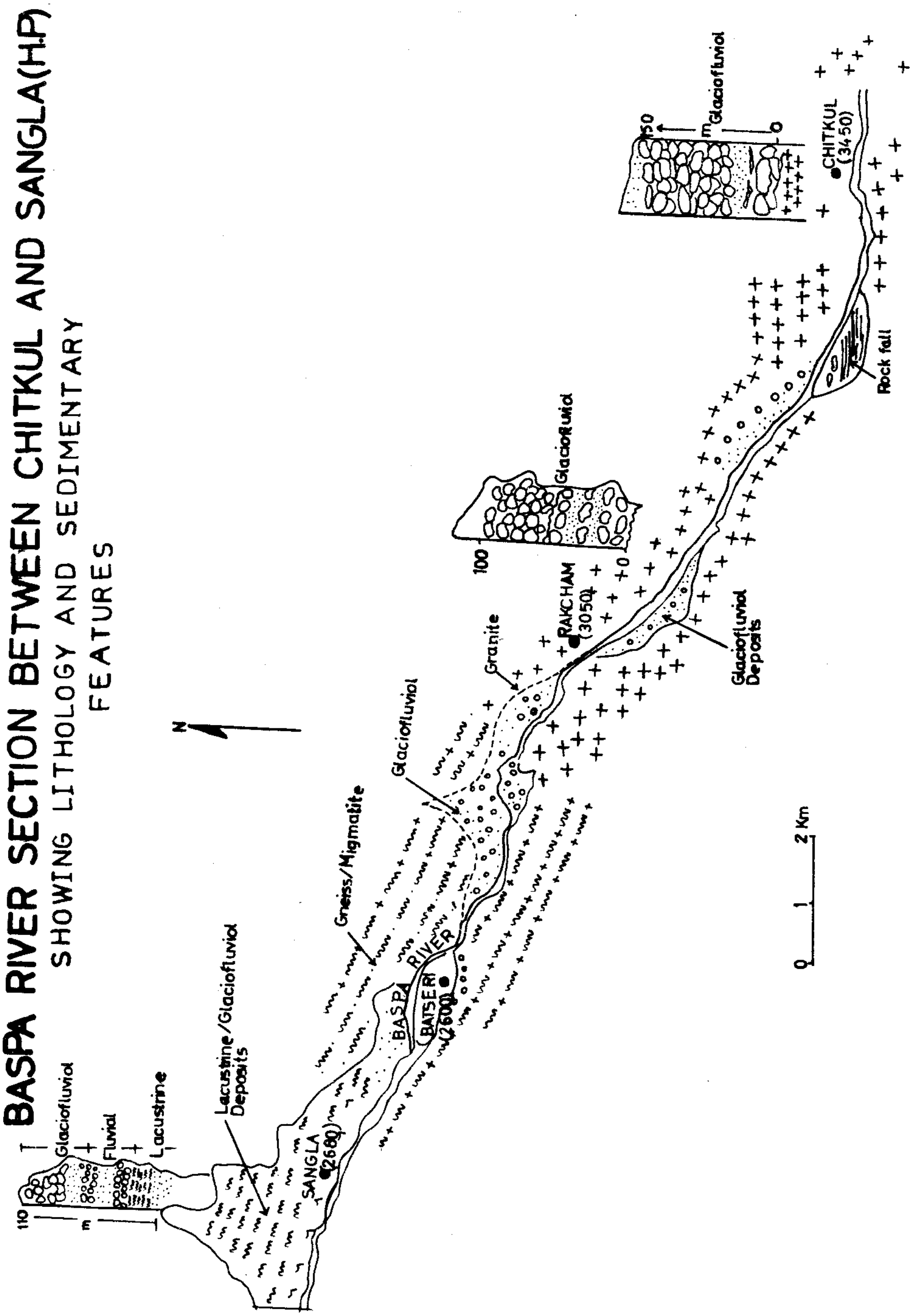

Fig : 2

Fig.No. 2 : Baspa river section between chitkul and sangla (H. P.) showing lithology and sedimentary features

which is typical of hydraulic sorting.Relative hardness of the groups appears to the major factor in their occurrence. Maximum variation in size is shown by the lithologies like sandstone and quartzite. Moreover, quartzites show lesser degree of angularity downstream.

PROCESSES :

Sediment in the valley, in bulk is supplied by the glaciers which have carved out enormous material by mechanical weathering. Rock falls, avalanches also contribute to this process. Chemical weathering is also responsible for release of smaller grains. This sediment is drained by small glacial melt water channels into the main channel. Since these confluence with a steep gradient, their flow is highly turbulent. The noise produced by their movement and abrading boulders is easily heard along the channels. A major degree of cracks and abrasion occurs in this portion of the channels which is easily decip hered by the abrasion marks and cracks on the rocks observed downstream. The turbulence of the streams is a function of the steep gradient. This in conjunction with the hard bedrock results in higher, competence and critical velocity of the channels. Break in slope at different places has a marked effect on the sediment, which gets deposited depending on the width of the valley. Such spots with comparatively wider valley have favoured deposition of gravel bars and making of natural levees' below Chitkul, Mastarang, above and below Rakcham and above Sangla. This explains the genetic relationship of various factors responsible for their production.

DISCUSSION :

Vertical exaggerations in the longitudinal profile of this stretch of the Baspa River reveals certain kinks and slope of the channel (Fig. 4). The lithology of the bed (Fig. 2) is varied in composition as shown above but is almost uniform as regards the resistance, which can be in turn regarded to be high. This could be a major cause of breaking and curshing of the rocks. Since the competence of the river is high, the inter-load attrition and abrasion is high in this zone. This is evident from the considerable reduction in the size of the boulders downstream. The process of mechanical breakdown of boulders is initiated right at the head of the valley, where glacial action plays a havoc with the lithologies giving rise to varying degree of size in the sediment (few mm to few meters in dia.) Furtheron, the process attains a different mode where meltwater from glaciers descends a steep slopes carrying with it maximum glacial debris. This zone is an exclusive zone of crushing of rock fragments by abrasion, attrition and saltation. Turbulence in upper reaches of these streams adds to this process. Hereafter, the confluence with the main channel induces abrading and rounding of the grains. Thus the river not only indulges in the erosive action but deposits heavy load wherever slope angle is less. Percussion marks are a conspicuous feature in the boulders lodged in bars and levees'. It has been established that such marks are evidences of breaking of rock fragments (Lamb and Johnson, 1963, Oya, 1981, and Kodama, 1990, 1992) by collision during floods. This assertion also favours the present assertion. Presence of asymmetrical large boulders, rough surface textures and tiny grooves or notches along bedding planes or joints are all evidences for the active role of this process (Kodama, 1993). The process of fining insitu is augmented by polishing due to small particles and their eddies.

Thus the rapid changes in lithology in the study area cannot be explained by sorting. If these changes were induced by sorting only, it is expected that every lithological group would show the same weight ratio in each grain size,class (Kodama, 1993) along the path.

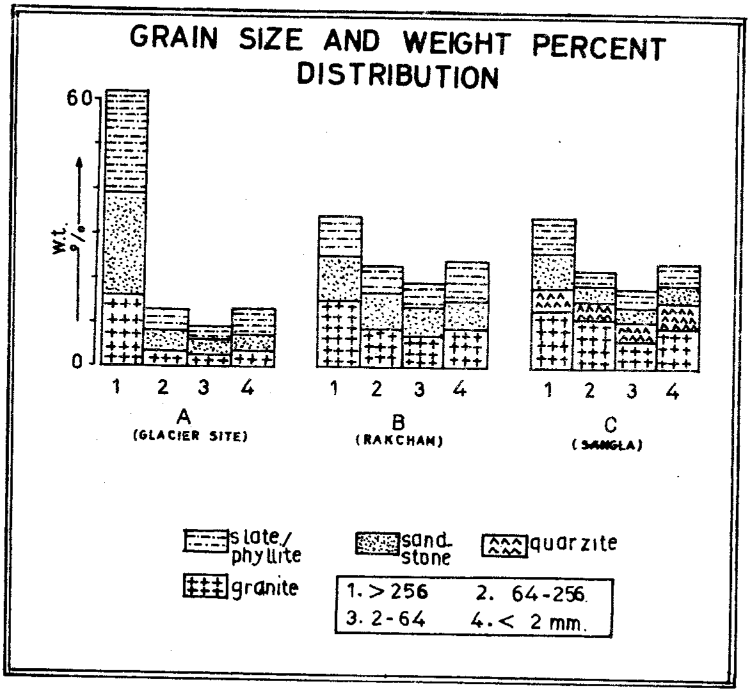

Fig.No.3 : Grain size distribution and weight percent analysis of sedpment at *A : Glacier site B : Rakcham C : Sangla*

Because the mobility of gravel depends mainly on its size, hydrologic sorting by lithology does not occur within the same class. The quartzite/sandstone, granite show significant changes in size within a distance of 15 km. More so, the angularity of the grains is expected to be more in quartzite for hydrologic sorting which is not the case in present study and hence it is concluded that abrasion has played a dominant role a fining of sediment downstream.

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