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# EVOLUTION OF LAKES DURING QUATERNARY PERIOD- SANGLA, RAKCHHAM PALAEOLAKE - A CASE STUDY

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## ABSTRACT

The Himalaya has numerous lacustrine deposits and lakes most of which owe their evolution during the Quaternary period. Some of the lakes are remnants of depression of intermontane basins while others are the proglacial lakes formed as a result of retreating glaciers. The Gangbal, Nandkol and Lamayuru lakes in Ladakh district, J&K; lakes along Spiti valley, e.g. Chandra Tal, Suraj Tal etc in Lahaul and Spiti districts, Himachal Pradesh; Vasuki Tal, Garbayang and lakes in Arwa valley, Chamoli district, Uttaranchal are some of the examples of glacigenic lakes/ lacustrine deposits. The lacustrine deposits owe their origin to alluvial, fluvial or glacio-fluvial activity.

Majority of lakes and lacustrine deposits are glacigenic in origin. In the Sangla valley, Kinnaur district, Himachal Pradesh, Sangla and Rakchham palaeolakes were formed due to retreat of the Baspa trunk glacier. The palaeo-geomorphological study in the Baspa basin reveal four different stages of glaciation and the depletion in areal extent of glacierised area was from 1074 sq km to 244 sq km (present day). The deposits are mostly varve clay rhythmites with intercalated silt and sand. Marginal deposits have ferruginous bands whereas in the central part these are grey coloured. The lacustrine deposits were transgressed during the end phase by fluvial deposits of sand and gravel (diamictite).

**Key words:** Evolution, Lakes, Quaternany, Palaeolakes.

## INTRODUCTION

During the Quaternary period, larger areas of Himalaya were under ice cover. With the passage of time and the climate changes, the cryosphere regime of the Himalaya also weakened which reduced the ice cover. The present day scenario is the result of a retreating phase of the glaciers. The landscapes so developed have involved various processes and the materials therein. The various features developed were 'highs' and 'lows'/ depressions. The depressions in due course of time have resulted in the formation of lakes due to supply of meltwater from the glaciers.

The lakes in the Himalaya owe their origin mainly to either structural / tectonic causes or are a result of glaciation. The lakes formed due to structural/tectonic causes are fairly large in size as compared to the glacigenic lakes e.g. Pangong –Tso and Tso Morari in J&K. In the present time, lakes of glacial origin are far more numerous than all other types of lakes put together. Vishan Sar, Kishan Sar, Gangbal, Nand-Kol, Brahm Sar etc., in J&K, Chandra Tal in HP, Vasuki Tal, Gandhi Sagar and lakes in Arwa valley in Uttranchal are some of the examples of lakes of glacial origin. Lamayuru in J&K, lakes along Spiti river in HP, Sangla and Rakcham lake in HP and Garbyang in Uttranchal are some of the examples of palaeolakes.

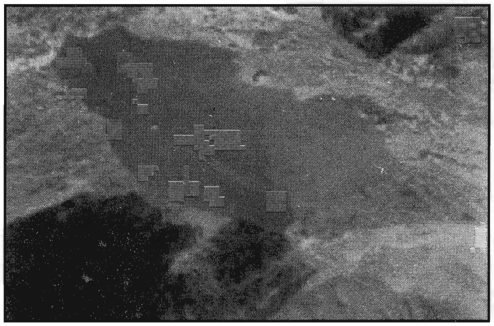

Fig. 1. Gandhi Sagar Lake, Uttaranchal

The glacier origin lakes and paleolakes are widespread along length and breadth of the Himalaya, which was once been covered by widespread glaciation. The Gangbal area in J&K is a typical example of existing glaciated lake (fig. 1) while Sangla-Rakchham area in HP is typical example of paleolakes.

## ORIGIN OF GLACIAL LAKES

These lakes may form and occupy

(i) Ice eroded hollows in areas of varied structure, rock basins in valleys or valley heads (Cirques e.g. Vasuki Tal) and rock basins in the deepened cols or passes of former watersheds with or without morainic fringes.

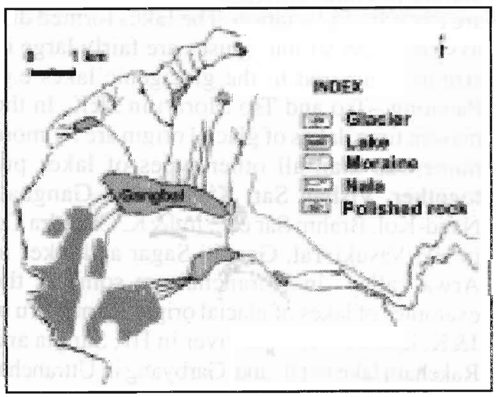


Fig. 2. Gangbal and Nandkol Lakes, J&K

(ii) Valley obstructed by morainic barriers (Gandhi Sagar lake, Uttaranchal (fig. 1), Gangbal lake, J&K (fig. 2).

(iii) Depression due to surface irregularities of glacial drift.

(iv) Kettle holes left by melting of masses of stagnant ice after burial or partial barrier by glacio-fluvial drift.

(v) Valleys obstructed by ice barrier (Lunana lake, Bhutan)

In the Himalaya some of the lake basins have been identified. Though their origin is due to other geological processes, their continuous existence is mainly due to recharge by meltwater from glaciers within the catchment of lake basin e.g. Kiagar Tso, etc.

The study of palaeolakes/ palaeo-lacustrine deposits enables in understanding the palaeo-environment of the region.

### Area of study

The geomorphological studies in Baspa basin have revealed the existence of paleolakes viz. Sangla and Rakchham and some other smaller lakes as observed near Barakhaldu, Rimdarang and Tumar Garang area.

The Sangla palaeolake was found to cover an area of 3.44 sq km extending from Kupa bridge over Baspa river to upstream of Batsari fan and extending laterally upto Rukti Khad. The apex and peripheral portion of the lake deposit near Batsari are found to be overlain by fluvial deposit. The maximum thickness of lacustrine deposit at the centre of the lake is around 350 m.

The Rakchham palaeolake extend from Rakchham to Mastrang. It covers an area of about 2 sq. km. Lacustrine deposits are exposed on both side of the valley. These deposits are transgressed by the fluvial deposits.

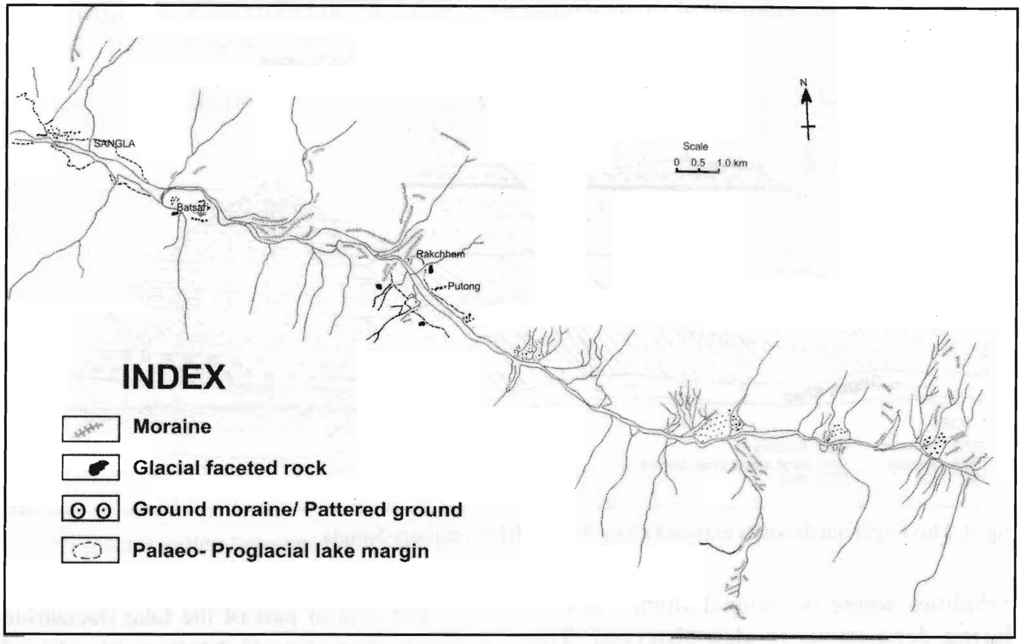

Fig. 3. Geomorphological map of Sangla-Rakcham area, Kinnaur district, H.P

## Formation of lakes

Based on geomorphological mapping from Chasu (downstream) to Tumar Garang (upstream), a palaeoglaciation history is reconstructed (fig.3). The lowest limit of glaciation is found to extend upto Saphni (2400 m asl, present day elevation) downstream of Raturang. The Baspa Trunk glacier was blocked by right lateral moraine of Anklang glacier flowing transversely from the left bank of Baspa. The right margin of the trunk glacier was blocked by moraines from Haran Ghatti near Raturang. These reworked moraines can be observed in the area. The Trunk glacier terminus degenerated, and the Sangla lake was formed. The blockade continued for a considerable period of time as is evident by a thick lacustrine deposit of more than 350 m. The evidences suggest that the water from the lake outflows from left and right margin of the lake cutting across the moraine.

Further retreat of trunk glacier between Khargola and Dungdensee formed a terminal moraine and the glacier remained stationary near Rakchham. The tributary valley glaciers viz. Khargola and Gor Garang had advanced due to the high gradient of the valley floor. The left lateral moraines and terminal moraine of the Gor Garang glacier have influenced the snout of the trunk glacier. At a later stage, the trunk glacier degenerated and paved the way for formation of yet another lake in Rakchham area Rakchham the lake. The water overflowed from the left margin of the lake, as evidenced by the presence of a palaeo-channel in the area. Smaller lakes are demarcated near Barakhaldu, Rimdarang and upstream of Tumar Garang.

## CHARACTERISTICS OF THE PROGLACIAL LACUSTRINE DEPOSITS

### *Sangla lacustrine deposits*

The Sangla lacustrine sediments are much finer, with laminated mud and massive mud. Mostly it is varve, clay with rhythmites and

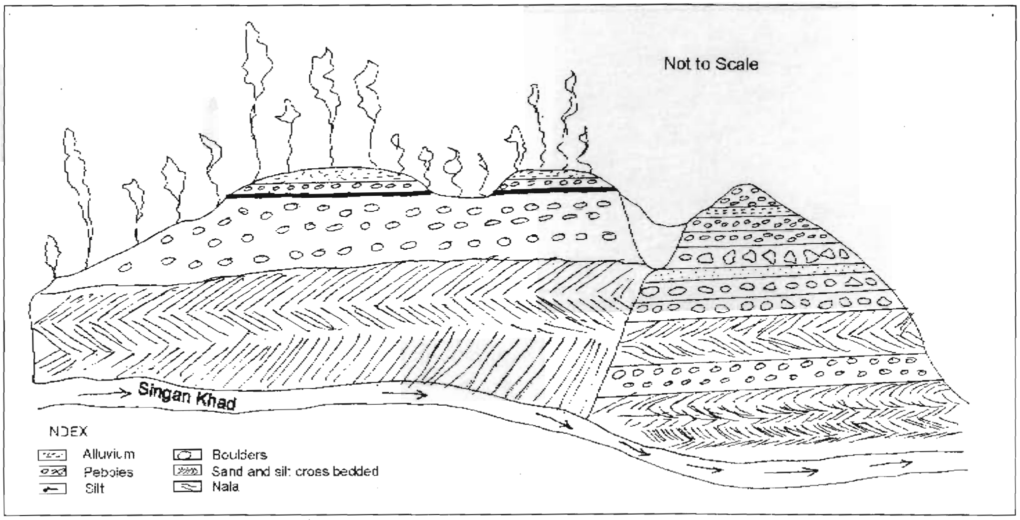


Fig. 4. Fluvio-glacial deposits exposed along Singan Khad, Batsari-Sangla

turbidities where occasional slump faulting during depositions is also observed. The lacustrine deposits were found to be transgressed in the end phase of fluvial deposits of sand and gravel (diamictite) (fig. 4). The lake margin deposit at higher elevation exhibits rhythmites of clay bands intercalated with ferruginous bands and minor silt and sand bands. The thickness of these deposits varies greatly. They are cross bedded with stratification disposed horizontally or at low angle towards the centre of the basin.

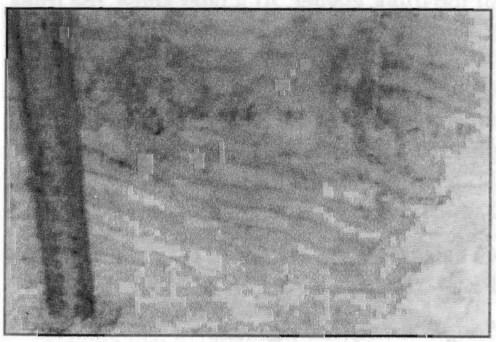

Fig. 5. Lacustrine sediments (rhythymites) showing gravity slumps.

The central part of the lake (lacustrine deposit) is not exposed due to overburden of the recent fluvial and reworked morainic sediments. However, section exposed during excavation for construction of a dam permitted the detailed study of the entire column of the deposit. The section exposes grey and pink coloured rhythmites, without ferruginous band, and contains carbonaceous matter in contrast to the upper horizons (fig. 5). Carbonaceous matter was also found towards the margin of the lake.

### *Rakchham lacustrine deposits*

The profiling for the dam axis of Baspa Hydel Project Stage I, 2 km upstream of Rakchham by geophysical methods and bore hole data have revealed that in Rakchham the lacustrine deposits which are 77-143 m thick, are overlain by 4-12 m fluvial and fluvio-glacial sediments deposited by the Baspa river along its course (fig. 6). However, the total thickness of lacustrine deposits in Rakchham has been estimated to be 200-225 m.

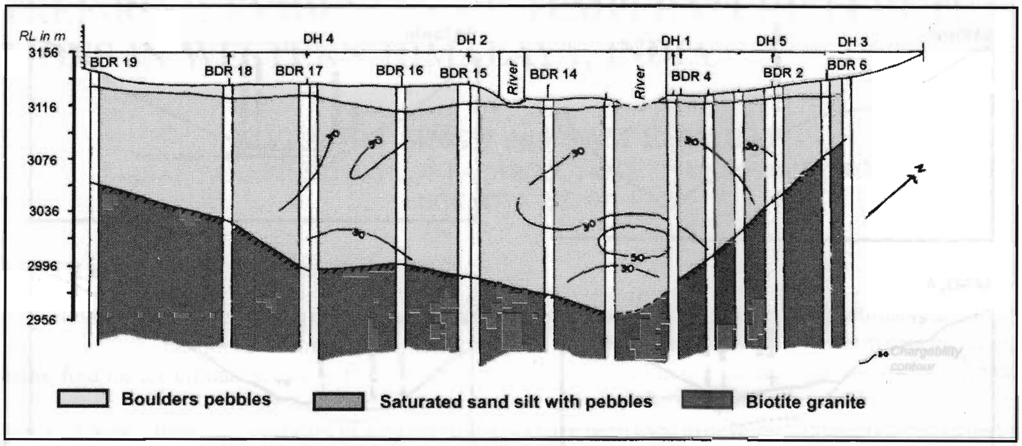


Fig. 6. Geophysical logs and borehole logs across Baspa river –Rakcham dam axis.

***Reconstruction of Palaeo-history***

Various glaciogeomorphic features were studied and mapped on 1:50,000 and 1:25,000 scale. The Baspa valley from head to Kupa bridge is broad U-shaped, and at present the Baspa river is flowing over sediments deposited during the past glaciation. The tributary valleys are mostly U-shaped with some valleys exhibiting a deep V-cut (fig. 7) in the lower reaches near the confluence with main trunk river Baspa e.g. Khargola Garang, Gor Garang, Khomsing garang, Mangsa Garang and Shushang nala. The deep cut in the valley is the result of their hanging valley characteristics during the past glaciation. Moreover, this profile is also attributed to rejuvenation of the terrain wherein the existing U-shaped valley has been modified. Glacier pavements have been observed on the right side of Baspa valley opposite the confluence of Jorya Garang and Badpa river, at a distance of 1.25 km southeast of Rakcham PWD Rest House and near Mangsa Garang.

Ground moraine deposited by the Baspa trunk glacier was observed near Tumar garang and Rimdarang nala. At places the moraines have been reworked due to fluvio-glacial action. The alpine permafrost conditions in the area have led to development of patterned ground between Mangsu garang and Mujilang. Interpretation of the cross sections across the valley had helped in paleo-geomorphological reinterpretations.

Based on the field data, a conceptual model has been developed wherein four stages of palaeoglaciation are envisaged, apart from the present day glacier at 4400 m asl. The stages are:-

| Stage | Nomenclature | Altitude (m a.s.l.) |
|---|---|---|
| V | Present day | 4400 |
| IV | Mujilang | 3520 |
| III | Rakchham | 3100 |
| II | Chasu (Sangla) | 2520 |
| I | Saphni | 2400 |

## CONCLUSIONS

The sedimentary sequences, as a matter of fact, constitute an expression of the changing depositional conditions in time and thus form the basis for conceptualising the model for its glacigenic deposition. The study

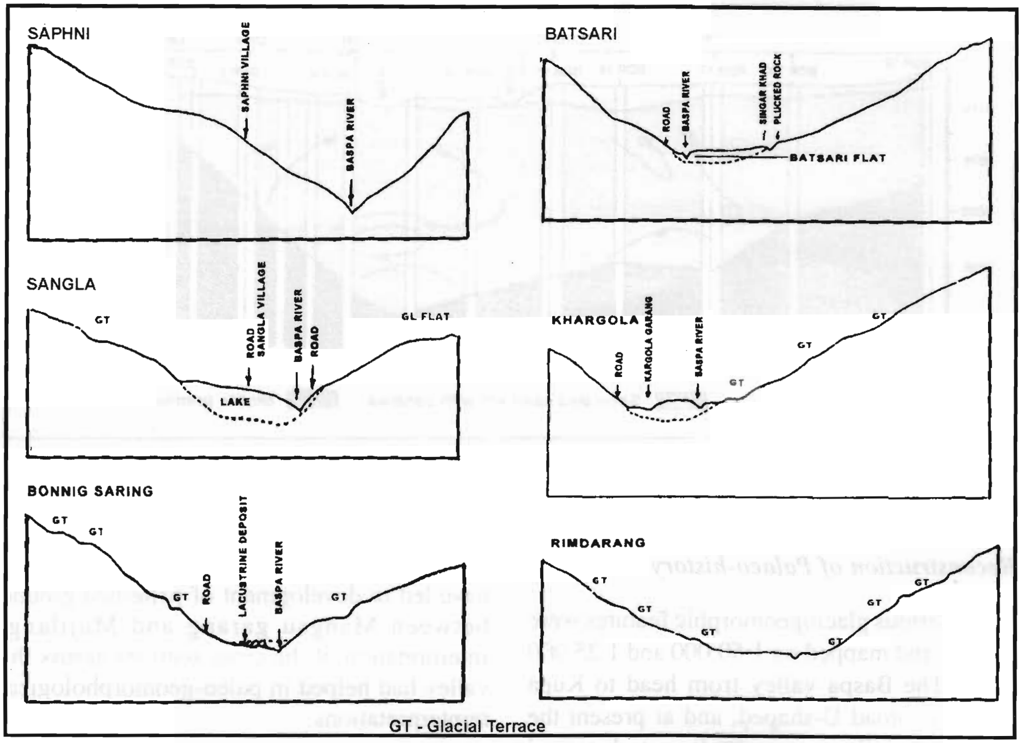


Fig. 7. Section across Baspa valley at different locations-GT—glacial terraces evidenced at different altitudes.

of palaeo-lakes, lacustrine deposits and the present-day lakes in the context of the Himalaya is dealt systematically to decipher the palaeo-environment and the impacts, thereby evolving the palaeo-history of the area. However, further studies on the laminated/varved sediments need to be undertaken in greater detail to decipher annual and decadal scale climatic variability. Laminated /varved sediments provide key resource for unraveling the range of climate variability and for understanding as to how the past climate variability may be affected by climate forces, unlike the present scenario.