

NOTES

IS THE GANGOTRI GLACIER RECEDING AT AN ALARMING RATE?

Glaciers are the consequence of the ice ages. Present glacier cover of the Himalayas is the consequence of the Quaternary Ice age, and we have reasons to believe that the ice limit may have, once, extended beyond the southern limits of the Outer Himalayas. Since the last glacial cycle of the Quaternary ice age — about 10,000 years back, practically every glacier has shown degeneration in mass and volume. Same is true of the Gangotri glacier also.

Gangotri glacier, *sensu stricto*, is a glacier system with a glacierised area of about 300 km² (Fig.1). It is situated in the Bhagirathi valley of the Uttarakhand Himalayas, and comprises a cluster of more than seven glaciers, most of which merge or flow in to the main trunk — known as Gangotri glacier. The latter, flowing in northwesterly direction, is about 30 km long with a glacierised basin of 150 km², ranging in elevation from 4000 m.a.s.l. to 7,000 m.a.s.l.

RETREAT OF THE GANGOTRI GLACIER

Behaviour of this glacier, since the last glacial activity, can be better illustrated by referring to three distinct observational parameters:

Geomorphologic Evidences

Glaciers, wherever they exist or existed, leave a distinct

signature in the form of glacier landforms. These landforms can be the consequence of the glacier erosion or deposition. A survey of the Bhagirathi valley, downstream of the Gangotri temple, has revealed the existence of numerous characteristic glacier land-forms like: glacier pavements, saw cut trenches, link cavity system and till deposits almost up to Jangla, a linear distance of 47 km from the present snout position. Presence of so many characteristic glacier land forms leaves no doubt in one's mind that, at one time in the past — most likely during the last phase of glacial activity 10,000 years back- Bhagirathi valley must have been more glacierised than at present; and the Gangotri glacier must have extended at least up to Jangla.

Medieval Evidences – References from the Classic Literature

The word Gangotri stands for Ganga+Utri i.e. Ganga's descent. The glacier has become a part of the legend that speaks of the descent of the Ganga from the heavens, and can take pride of place, though indirectly, of being the earliest explored glacier, in the human history, by Bhagirath about 5,500 odd years back. In *Skanda Purana*, Bhagirath is quoted to have said, "Then came down from the sky, Ganga the daughter of the snowy mountains, and Mahadev (Shiva) received it (Ganga) on his own head".

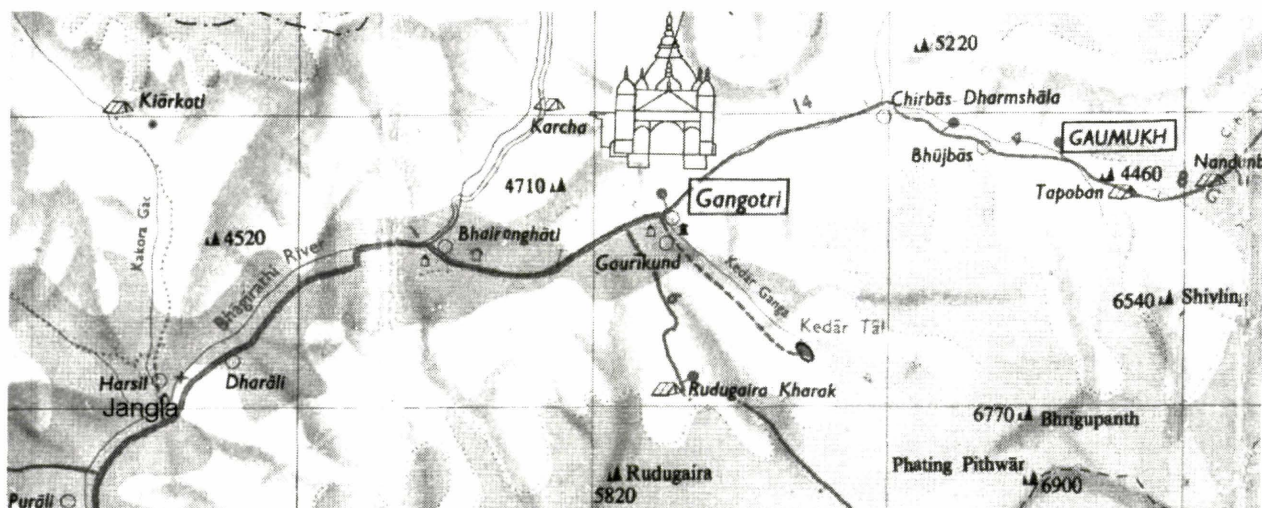


Fig.1. :Sketch map showing the relative position of Gaumukh, Gangotri and Jangla.

Rather than be involved in mythology, let it be presumed and rightly so that Bhagirath was an explorer who did the journey/penance to trace the source of this mighty river. What Bhagirath may in fact have stated, when he had the view of the entire glacier from a look out point up in the mountains, could be, "Ganga coming from the skies has frozen around the shoulders of a mighty peak (6540) that looks like the Shivling-personification of the Lord Shiva". Bhagirath visualised that if the whole glacier would melt all at once, the waters so released would cause havoc down below. In fact it would be disastrous. And he apparently stated it as such. That, in due course, became the legend that Lord Shiva held the river back in his locks lest Ganga cause the havoc. Legend further tells us that, "Ganga, when it finally managed to come out of the intricate dark locks (moraine ridges) of Shiva which are as fearsome and large as the Himalayas itself, was still so powerful that it went down to *Patal* before coming on the surface. The word *Patal* is obvious reference to the waterfall (*Patalganga*) at Gangotri.

Be that as it may, Bhagirath's indirect reference of the Shivling peak, moraine ridges and the water fall at Gangotri clearly indicates that, at the time of Bhagirath's visit, the snout of the Gangotri glacier must have been at and around Gangotri town. Obviously there was no ice cave, as no mention of Gaumukh has been made, and the glacier apparently must have been in active phase.

Taking the three possible snout positions, in different period of time into consideration: Jangla (10,000 years back), Gangotri (about 5,500 years back, based on secular retreat) and the present position at Gaumukh, it can be concluded that the glacier has vacated a total linear distance of 47 km in about 10,000 years - an average secular retreat of 4.7 metres per year.

Jangla	— 25 km —	Gangotri	— 22 km —	Gaumukh
8,000 BC		3,500 (?) BC		2004 AD
————— Retreat @ 4.7 m per year —————				

MODERN SCIENTIFIC OBSERVATIONS

Dating

Birbal Sahni Institute, Lucknow, has dated the trees that are growing over the old terminal moraines at Bhujbas, about 12 km downstream of the present Gaumukh (Fig.2) to be about 415 years old. This would mean that the terminal moraines at Bhujbas would be about 500 years old, as some time gap must have occurred between the vacation by the glacier and growth of vegetation. Taking that as the base,

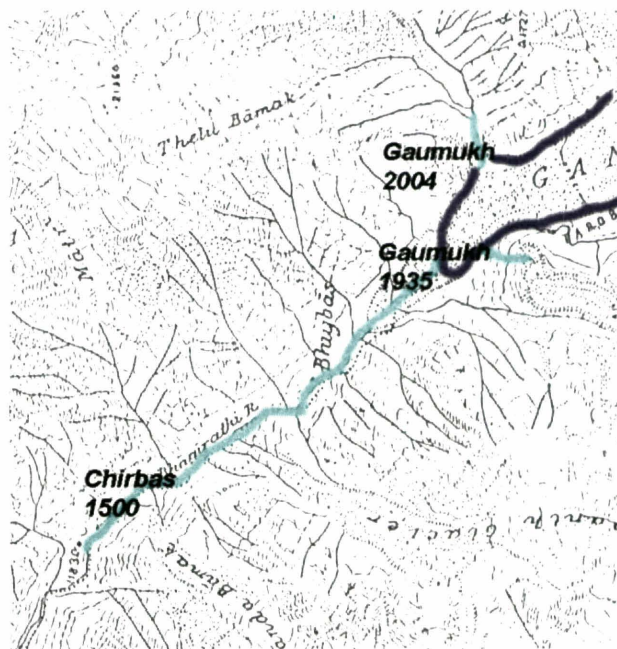


Fig.2. Map showing relative position of Bhujbas; Gaumukh in 1935 AD and in 2004 AD (red line).

the glacier would appear to have shown an average secular retreat of 27.5 m per year, during the last 500 years.

Chirbas	————— 12km —————	Gaumukh
500AD		2004AD
————— Retreat @ 27.5 metres per year —————		

Photographic Evidences

Snout of the Gangotri glacier marked by a prominent ice cave that is renowned under the name of Gaumukh – meaning mouth of the cow - has been the connoisseur of the explorers and the pilgrims over the centuries, for it is where the Ganga-Ganges-originate. Earliest photograph of the snout is that of Samuel Bourne published in 1866. Yet another picture of the snout-Gaumukh- was published in 1870. Both these photographs are now in The Oriental and India Office collections in London.

Griesbach of the Geological Survey of India visited the glacier snout in 1889 and made a sketch of the snout front showing the Gaumukh located on the western side of the snout. Dr. Auden of the Geological Survey mapped and photographed the glacier snout in 1935 and has, since, been followed by a number of teams from GSI and some other institutes in recent years. A comparative study of the photographs of the snout taken, from time to time, shows that the position of the Gaumukh has been shifting from the western limits to the eastern limits of the snout expanse.

Mapping of the Snout

Geological Survey of India teams have, more or less, regularly since 1935, been monitoring the snout of this glacier and, as a part of the monitoring activity, map of the snout front has been prepared (Fig.3) at various times. Comparison of the snout positions between 1935 and 1996 has revealed that the glacier front, especially the position of

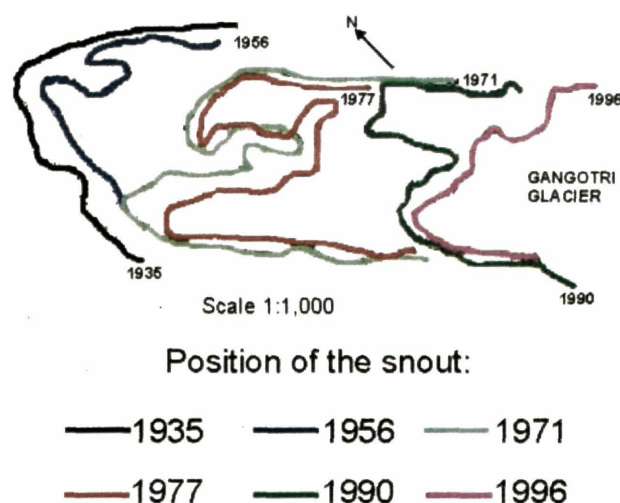


Fig.3. Relative position of the snout of the Gangotri glacier from 1935 AD to 1996 AD.

the ice cave Gaumukh, has been constantly changing and the glacier has retreated by about 1,100 metres during the period of 61 years (1935 to 1996), i.e. an average secular retreat of 18 metres a year.

A recent study, with the help of satellite imageries has revealed:

1. Position of the Gaumukh along the eastern limits has

further retreated at an average of about 15 metres per year in 2001AD and 2002AD.

2. Raktvaran *nala* (melt water stream from the Raktvaran group of glaciers) that had been flowing sub glacially till up to 2002AD has eroded away the glacier ice on the eastern side and has now started flowing along the valley wall by passing the eroded glacier ice.

Life Span of the Gangotri Glacier

Spate of recent publications, especially on the internet, have come out with frightening prospect of this glacier vanishing from the surface of earth in immediate future. One publication has gone to the extent of giving 2035 as the last date. Field data does not, however, indicate any such catastrophe. Retreat of 15 to 18 metres or so per year is indeed thought provoking, but definitely not alarming. Let us not forget that some of the glaciers in Columbia and even in Alaska have recently shown an annual retreat of more than 200 metres.

This glacier is going to end one day and here I would, once again, like to refer to ancient classics, and the words of Bhagirath: "Ganga, one day shall be recalled to the heavens". Reading between the lines, it connotes the fact that even Bhagirath realised, thousands of years ago, that this glacier/river having come from the skies (heaven) shall one day retreat to the skies. If we assume that this glacier will continue to retreat, say at the rate of 15 to 18 metres a year, as it is doing at present, even then it will take almost 2,000 to 1,600 years for the glacier, so to say, to go back to the skies.

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THE RISE AND FALL OF THE VENDIAN BIOTA: IGCP - 493

The two-day Workshop on IGCP Project - 493 on Rise and Fall of the Vendian Biota was convened by Patricia Vickers-Rich, James Gehling and Mikhail Fedonkin (Project Leaders) in Monash University Centre at Prato, Italy from 30-31 August, soon after the 32 IGC held at Florence. The workshop was attended by the National Working Group members from Australia, USA, Canada, UK, Russia, Spain, Germany, Poland, Italy, Japan, South Africa, Namibia, India and Iran. Topics related to Ediacaran/Vendian biota were

discussed including systematics, palaeoecology, taphonomy, stratigraphic and palaeogeographic distribution, palaeomagnetic calibration, radiometric dating and palaeoclimatic effects.

The International Union of Geological Sciences (IUGS) has ratified the new Ediacaran Period in 2004. The Ediacaran Period has been defined by an event recorded in a single section of rock outcropping termed the Global Stratotype Section and Point (GSSP). The IUGS ratified initial GSSP