Chronology of the Late Quaternary glaciation around Badrinath (Upper Alaknanda Basin): Preliminary observations

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Reconstruction based on the presence of lateral moraines and other relict periglacial features in Upper Alaknanda basin indicates three phases of glaciation during the Late Quaternary. From oldest to youngest, they are named as Alaknanda (Stage-I), Alkapuri (Stage-II) and Satopanth (Stage-III) glacial advances. The oldest Stage-I was the most extensive glaciation in the basin that reached south of Badrinath (2604 m asl). Compared to this, the other two glaciations were terminated around 3550 and 3700 m asl respectively, in the N–S trending Upper Alaknanda basin. Preliminary estimate based on limited optical dating suggests the Stage-I predates the Last Glacial Maximum (LGM). An indirect age estimate based on the chronology of recessional moraine dated to 12 ka suggests that Stage-II was deposited during the LGM whereas Stage-III is dated to 4.5 ka. Conical heaps in the vicinity of the present-day snout are attributed to the recent recession probably associated with the Little Ice Age.

Keywords: Late Quaternary glaciations, optical dating, periglacial features, Satopanth and Bhagirath Kharak glaciers.

The seasonal distribution of precipitation in Himalayan glaciers is of summer accumulation-type, i.e. maximum accumulation and ablation occurs during summer. Towards the growth of the glaciers, the Indian Summer Monsoon (ISM) is a major source of moisture. Hence changes in the extent of valley glaciers can be used to reconstruct the past precipitation and temperature conditions. These changes are manifested in the pattern of distribution of the glacial sediments, particularly the lateral moraines. In a valley glacier, the highest point of lateral moraines coincides with the Equilibrium Line Altitude and terminates at the snout.

In the Trans-Himalayan region, evidence for past glaciations is preserved in the form of well-developed moraines and valley fills that exceed several tens of metres in thickness. According to Owen et al., the extent of valley glaciations varied considerably throughout the Late Quaternary. Although most studies indicate multiple events of glaciation in the Himalaya, quantitative estimate on their timing is lacking due to scarcity of organic material that precludes the use of standard radiocarbon-dating techniques. Recent advancement in luminescence dating has opened up the possibility of proving the timing of the Late Quaternary in the region. There exists some estimate on the timing of various glacial advancement from the Central Himalaya, which provides insight into the fluctuations in ISM during the Late Quaternary. This study is a contribution towards understanding the magnitude and variability in the Late Quaternary glaciation in the Upper Alaknanda basin, in which an attempt has been made to reconstruct the pattern of glaciation. Lateral moraines associated with three glacial advances are well preserved in the Upper Alaknanda basin. These are named as Alaknanda (Stage-I), Alkapuri (Stage-II) and Satopanth (Stage-III) glacial advances. In order to reconstruct the stratigraphy of various glacial advancements and related glaciogenic features, field mapping was carried out at 1:50,000 scale supported by Total Station (TS) survey. It was found that Stage-I glaciation was the most extensive that reached south of Badrinath (3000 m asl), whereas the successive glacial advances, viz. Stages-II and III were restricted around 3550 and 3700 m asl respectively. Further, in order to ascertain the timing of various glacial stages, a preliminary chronology using the Optical Stimulated Luminescence dating techniques on lateral moraine and glacio-fluvial sediments has been attempted.

Lithology of the area is dominated by calc-silicate, biotite gneiss, schist and granite (pegmatite–apatite veins) belonging to the Pindari Formation. A regionally extensive Pindari Thrust that passes through Hanuman Chatti is a major structural feature that differentiates two distinct basins, the wide U-shaped Badrinath basin from the narrow V-shaped Pandukeshwar basin.


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