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Reconstruction of landscape and climate of the largest drainage basin in the Ladakh Range, NW Trans Himalaya during the last 7000 years

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ABSTRACT

Landform geomorphology and glacial lake deposits in the largest drainage basin of the Ladakh Range i.e. Chang La-Tangtse basin were studied to infer their palaeoclimatic significance. The grain size, mineral magnetism, percentage loss on ignition (%LOI) and organic carbon stable isotope ($\delta^{13}C$) data in combination with total organic carbon (TOC) supported by AMS ^{14}C (calibrated) dates of a 190 cm long section from the Chang La-Tsoltak palaeolake provides a climatic record since the last ~ 7075 cal yr BP. The χlf, χARM, and SIRM values suggest that the catchment-derived palaeolake sediments predominantly contain magnetically "soft" minerals like magnetite and maghemite. The $\delta^{13}C$ values range between −21 and −24 ‰ with an average of –22 ‰ which suggests a mixed C3-C4 plant signature and water stressed ecosystem. The relatively small variations in the $\delta^{13}C$ values of organic matter in the entire lake profile suggest a stable climatic condition. The prominent effect of westerlies is seen between 7075 and 6040 cal yr BP with huge detrital influx at the lake bottom indicating a glacial advancement in the region. The affect of Mid-Holocene warm period is evident at 6040 cal yr BP with the advent of ISM. Paradigm shifts in the proxy values are observed at 5710, 4890, 3435, and 2800 cal yr BP. The influence of westerlies gradually reduces at 2800 cal yr BP. The landscape evolution and the climatic variations in the Trans-Himalaya are primarily governed by westerlies and do not correspond to the Indian monsoon variability records, particularly during the Mid-Holocene Thermal Maxima. Several other regions of the Ladakh Range also record similar climatic variations, indicating that the palaeolake sediments also reflect regional climate variations.

1. Introduction

The Himalayan Range and the Tibetan Plateau collectively referred to as the 'third-pole', host the largest cryosphere cover outside the Polar Regions (Pant et al., 2018), strongly influenced by the South Asian Monsoon in the east and the mid-latitude westerlies in the west. The third pole comprising more than 46,000 glaciers covers approximately 100,000 km^2 of the total glacial area (Yao et al., 2012; Pfeffer et al., 2014), which ensures fresh water supply to a large population. Changes in glacial discharge may substantially impact sea level conditions, consequently altering the biota and local climate (Hagen et al., 2003). During the last glacial period, only the highly elevated areas including the Himalaya and the Tibetan Plateau provided favourable conditions for the formation of large glaciers and ice caps (Seltzer, 2001). Despite occupying 116 × 10^5 km^2 glacial covered area it is not very well documented in terms of grave concerns of today, that is climate change and the forcing behind the impact whether global, regional, or local level, and the impact and intensity of ISM versus mid-latitude westerlies. Hence to hit all these concerns the glacial lakes and their deposits from the Ladakh range, NW Trans Himalaya, were aimed at. Glaciers and glacial lakes are sensitive indicators of recent climate change (Phartiyal et al., 2020). Recent trends and investigations suggest that the total area of glaciers will continue to shrink while the area of glacial lakes and their number will likely continue to increase. The pro-glacial and glacial lakes in the region have attracted much attention because of the negative mass balance in recent decades. These lakes are very sensitive to

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