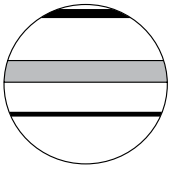

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Paleoenvironmental shifts spanning the last ~6000 years and recent anthropogenic controls inferred from a high-altitude temperate lake: Anchar Lake, NW Himalaya

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Abstract

Integrating multiproxy results (geochemistry, mineral magnetism, grain size, and C/N ratio variability supported by ^{14}C AMS dating), obtained from a 1.4-m sediment core retrieved from high-altitude Anchar Lake, Kashmir Valley, NW Himalaya, we present a 6000-years record of paleoenvironmental and paleolimnological shifts. Phase 1 (6000–4700 cal. yr BP) revealed a wetter climate with a significant terrestrial input corresponding to the gradual strengthening of the westerlies. Phase 2 (4700–3900 cal. yr BP) reflects an overall improved westerly precipitation and autochthonous sources of organic matter (OM). Magnetic parameters also indicate higher lake levels and reducing conditions during this phase. Phase 2 was followed by a gradual diminishing pattern of the westerlies as also represented by phase 3 (3900–2500 cal. yr BP) and phase 4 (2500–1600 cal. yr BP) indicating moderate precipitation conditions, catchment stability, and temperate and/or cold-dry climatic conditions. Phase 5 (1600–500 cal. yr BP) revealed the prevalence of moderately cold/dry and further subdued westerly precipitation. Phase 6 (500 cal. yr BP to present) is represented by reduced westerly precipitation, shrinking lake margins, and significant terrestrial/anthropogenic controls over the lake basin. Mineral magnetic parameters indicate reducing lake bottom water conditions and eutrophication during this phase due to anthropogenic activities. These paleoenvironmental shifts reveal near synchronous changes (within dating uncertainties) with other regional paleoclimate records close to the present Anchar Lake location and reflect the gradual late-Holocene diminishment of the amount of winter/early summer moisture provided by the mid-latitude westerlies.

Keywords

^{14}C AMS dating, Anchar Lake, Kashmir Himalayas, magnetic and geochemical analyses, OM and C/N ratio, paleoenvironmental shifts

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Introduction

Multiproxy investigation of lake core sediments is a prerequisite for reconstruction and a proper understanding of the high-resolution paleoclimate/paleoenvironmental variability (Ali et al., 2018; An et al., 2012a, 2012b; Hillman et al., 2018; Lauterbach et al., 2014; Lei et al., 2014; Ning et al., 2017; Sandeep et al., 2017; Schwarz et al., 2017), lacustrine regime shifts (Hembrow et al., 2018; Liiv et al., 2018; Liu et al., 2013), and human impacts (Gurjazkaite et al., 2018; Hillman et al., 2018; Niemann et al., 2013; Ohlendorf et al., 2003; Zhang et al., 2014) spanning the Holocene period (since ~11,700 yr BP). Variability in the proxy records of lake sediments is characterized by sudden and persistent responses to climate-induced environmental changes over the catchment areas, including precipitation and temperature changes, anthropogenic influences, and primary productivity among others (Hillman et al., 2018; Schwarz et al., 2017). The long stretch (~2400 km) of the rising Himalayan ranges exercises a dominant control over the meteorological and hydrological conditions bordering the NW and NE regions of the Indian subcontinent (Benn and Owen, 1998). Prevalence of diverse climatic conditions that are similar to those of the widely separated latitudinal belts, within a limited area, makes these high mountain ranges ideal sites for reconstructing the past climate variations (Pang et al., 2014). Even a slight variation in climate in the Himalayas has widespread socio-economic impacts over the Indian subcontinent as majority of the rivers derive significant portion of their discharge from the seasonal snowmelt and/or melting of the Himalayan glaciers (Bhutiyani et al., 2007; Joshi et al., 2017).

The Kashmir Valley, which is located in the NW Himalayan region between the Pir Panjal (SW) and Greater Himalayan (NE) ranges, preserves some of the dynamic records of past climate changes that occurred during the late Quaternary to Holocene period. These are archived in loess/paleosol sediments, freshwater lake and paleolake sediments, cave deposits, and tree ring cores (for last few hundred years) among others. For example,

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