Catena 245 (2024) 108318

Contents lists available at ScienceDirect

Catena

journal homepage: www.elsevier.com/locate/catena

Phytolith based paleoecological reconstruction from a loess-paleosol sequence in the Kashmir Himalaya, India

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ARTICLE INFO

Keywords:
Phytolith
Proxy
Paleovegetation
Paleoclimate
Heinrich Events
Kashmir Himalaya

ABSTRACT

The temporal vegetation development provides vital information for understanding past climatic changes. In this study, we reconstruct vegetation dynamics from the last glacial period using phytoliths as a proxy from the Wanihama loess-paleosol sequence (LPS) near Srinagar in Kashmir Himalaya, India. Different phytolith assemblages and indices (Ic and Iw) revealed a series of warm and cold events documented in the LPS. The data indicate the predominance of broad-leaved and sparse conifer vegetation from ca. 42 ka to 39 ka, suggesting a comparatively warm and humid climate. After ca. 39 ka, conifers and grasses increased, indicating a transition to a cold climate. The cold climate, intervened by a short stadial, continued until ca. 31 ka with the predominance of conifers, grasses, and sedges. Subsequently, three other cold events were noted until ca. 14 ka, which resulted in vegetation disappearance and a substantial decrease in phytolith count. These cold events roughly coincide with the climatic instability in the Atlantic Ocean that caused severe cooling at high northern latitudes and likely impacted the Asian climate. Phytolith assemblages showed an overall increasing proportion of C4 grasses towards the top of the LPS, suggesting warm and dry climatic conditions. We also correlated the phytolith-based vegetation reconstruction with other paleoenvironmental proxies recorded from the same section, as well as with the last glacial climatic changes documented in different regions, to determine the reliability of phytoliths in LPSs as a proxy for past vegetation and climate reconstruction in the Kashmir Himalaya.

1. Introduction

Phytoliths are microscopic, amorphous silica structures formed through the deposition and bio-mineralization of silica inside and between the cells of many living plants (Rashid et al., 2019; Wani et al., 2023; Rehman and Rashid, 2023). Following the death and decay of plants, phytoliths become incorporated into soil and sediments (Strömberg et al., 2018; Qader et al., 2023a,b). The resistance of phytoliths leads to excellent preservation in soils and other sediments, enabling researchers to reconstruct past vegetation by identifying different diagnostic phytolith morphotypes (McCune et al., 2013; Das et al., 2013; Gao et al., 2023). Because of their distinctive characteristics, phytolith analysis allows for the differentiation of C3 and C4 vegetation as well as the reconstruction of former forest or grassland ecosystems (Contreras et al., 2019; Ghosh et al., 2011; Biswas et al., 2021). Phytoliths have been used to reconstruct vegetation shifts and climatic variability in various regions, including the African savannah (Novello et al., 2015), the Pampas of South America (Fernandez Honaine et al., 2006; Osterrieth et al., 2016), the Great Plains of North America (Strömberg and McInerney, 2011; Woodburn et al., 2017), and the monsoon regions of China (Lu et al., 2007; Gao et al., 2018).

Phytolith assemblages have been extensively used in the Loess Plateau of China for quantitative reconstruction of paleovegetation dynamics (Lü et al., 1999; Yang et al., 2023), paleoenvironment (Lü et al., 2006; Lü et al., 2007), rice exploitation (Zuo et al., 2021), and fire history (Gu et al., 2008), etc. From India, several studies have been carried out on various paleoclimate archives, like archeological deposits, and lacustrine sediments to demonstrate the potential of phytolith studies for reconstructing past vegetation, past climate changes, and prehistoric farming (Thapar, 1967; Bisht, 1976; Chauhan, 1994; Kajale and Eksambekar, 2001; Saxena et al., 2005; Eksambekar, 2009; Prasad et al., 2011; Saxena et al., 2013; Biswas et al., 2016; Nogué et al., 2017;

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https://doi.org/10.1016/j.catena.2024.108318
Received 5 April 2023; Received in revised form 22 July 2024; Accepted 12 August 2024
Available online 17 August 2024
0341-8162/