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Assessing phytolith preservation in a Late Quaternary loess-paleosol sequence from the Kashmir Valley, Northwest Himalaya, India

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ABSTRACT

Phytolith content and its preservation in soils form a robust tool for paleoecological reconstruction. Post-depositional processes, however, influence the preservation of phytolith assemblages in soils thus making the paleoecological inferences biased. Here we evaluated the preservation of phytoliths in a Late Quaternary loess-paleosol sequence (LPS) from Kashmir Valley, northwest Himalaya. The soil micromorphological study, physicochemical parameters, phytolith morphometry, and phytolith translocation rates were employed to assess phytolith preservation and absence (not recorded) in the various litho-units of the Wanihama LPS. The comparison of phytolith content and soil physio-chemical parameters including pH, electrical conductivity, available N, P, K, organic carbon, extractable Fe, Zn, Mn and Cu do not show any significant correlation. This suggests that soil physicochemical parameters have a minor role in regulating the preservation of phytoliths in the LPS. The depth distribution of phytoliths exhibits an inconsistent pattern and phytolith content doesn't decrease systematically with depth. The phytolith content usually follows the loess-paleosol stratigraphy, with low concentrations in loess units and high concentrations in paleosols indicating that phytolith assemblages in the LPS have not been altered or translocated as a result of pedogenic processes. The micromorphological observations suggest weak pedogenesis and the sequence does not seem to be significantly mixed by bioturbation activities. This is augmented by the low translocation rate of <18%, and phytolith morphometry suggesting well-preserved phytoliths with minimum morphological alterations along the depth. The absence of phytoliths at certain stratigraphic units in the LPS thus suggests that climatic conditions rather than physicochemical parameters determine the phytolith preservation and their content in the Kashmir LPS.

1. Introduction

Phytoliths are microscopic amorphous silica structures ($SiO_2 \cdot nH_2O$) precipitated within plant cells (Piperno, 2006; Rashid et al., 2019), that are usually deposited directly into the topmost layer of soil after plant death and/or decay (Madella and Lancelotti, 2012). Their accumulation in soils and other sediments occurs when the turnover rate is greater than the losses by Si dissolution (Song et al., 2016). The durability and composition allow phytoliths to be preserved for millions of years in different soils and sediments, making them important paleoenvironmental proxies (Osterrieth et al., 2009). However, the distribution of phytolith assemblages in soils and sediments is influenced by various geomorphic (Esteban et al., 2017; Qader et al., 2023a), dissolution and taphonomic processes (Fishkis et al., 2010a; Osterrieth et al., 2009). Moreover, water availability, alkalinity, mechanical abrasion, and breakage of relatively dissolved phytoliths likely affect their potential for paleoclimatic studies (Cabanes et al., 2011; Madella and Lancelotti, 2012). Besides, vertical translocation due to bioturbation and leaching in soils (Alexandré et al., 1997; Fishkis et al., 2009, 2010a), surface translocation (Conley, 2002; Farmer et al., 2005), phytolith occluded organic matter (OM), ionic strength, presence of cations in solution, soil pH, EC, OM, grain size, ambient temperature and redox conditions also play an important role in phytolith preservation (Dove and Crerar, 1990; Parr and Sullivan, 2005; Fraysse et al., 2006; Loucaides et al., 2010; Nguyen et al., 2014). These processes can dissolve silica and result in the diminution of phytolith pool in soils. Integrating phytolith studies with soil micromorphology and physiochemical analysis is a potential technique for understanding soil formation processes, taphonomy and the

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