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Climatic Conditions in the Central Part of the Kashmir Valley During the Pleistocene–Holocene Transition: Insights from Lithostratigraphy, Geochemical Analyses, and Radiocarbon Chronology of Palaeosol Sequences

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Abstract: The Kashmir Valley, characterized by its rich loess–palaeosol sequences (LPSs), provides a unique geo-archive for reconstructing Late Quaternary climate dynamics. This study presents an extensive multi-proxy study, integrating high-resolution lithostratigraphy, geochemical analyses, stable isotope analysis of soil organic matter (δ^{13}C-VPDB), and radiocarbon (^{14}C) chronology of a sediment sequence approximately 200 cm thick, to unravel the complex interplay of climatic, pedogenic and environmental processes shaping the region spanning the Pleistocene–Holocene transition. The results establish a precise chronology of the sediment sequence between 13.4 ka and 7.2 ka, covering the transition from the Pleistocene to the Holocene Epoch. The results reveal distinct climatic and environmental conditions during this Epoch. The study reveals substantial loess deposition during the cold and dry glacial climate towards the end of the Pleistocene, followed by a shift to a warmer and wetter interglacial climate at the onset of the Holocene Epoch. This climatic shift led to the development of soil units with pronounced fluvial characteristics around 10 ka, eventually transitioning to fluvial deposition. Geochemical indices such as Ca/Ti, Al/Ti, Si/Ti, and K/Ti indicate low weathering intensity prior to 11 ka, followed by a noticeable increase around 11 ka, possibly driven by enhanced precipitation. δ^{13}C values, ranging from −26.2‰ to −22.5‰, suggest C_3-dominated vegetation during the Late Pleistocene, indicating wetter climatic conditions. This study provides valuable insights into the intricate interactions between climate, soil development, and vegetation dynamics during the critical Late Pleistocene–Holocene transition in the Kashmir Valley.

Keywords: Pleistocene; Holocene; ^{14}C AMS dating; Kashmir Valley; palaeoclimate; stable isotope

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1. Introduction

Palaeosols serve as one of the important records of past landscape dynamics and have been extensively studied throughout the globe [1–6]. These sedimentary archives provide a unique window into the past, offering valuable insights into climatic, ecological, and geomorphic changes that have shaped our planet over the millennia [7–9]. Among the crucial