CHAPTER 27

GEOLOGY

Doctoral Theses

01. YADAV (Pooja)
Paleosols in Overbank Sediments of the Kotla-Brail Section, Siwalik Group, Nw Himalaya: A Record of Late Miocene Weathering, Provenance, Climate, and Paleovegetation.
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Abstract

This study presents high-resolution paleopedological data from the Siwalik Group of the Himalayan Foreland Basin spanning the Late Miocene (ca. 11.0–6 Ma). A continuous 1.85 km thick stratigraphic succession exposed along the Kotla–Brail section in the Kangra sub-basin was systematically investigated to elucidate the interactions among chemical weathering, paleopedogenesis, climatic variability, and tectonic processes. A total of 74 paleosol profiles, including 22 from the Lower Siwalik (LS) and 52 from the Middle Siwalik (MS), were analyzed using an integrated approach comprising field observations, micromorphology, clay mineralogy, bulk geochemistry, and stable isotope geochemistry. Field-based characterization of paleosols developed within overbank deposits enabled the identification of different pedofeatures and distinct paleosol types. The paleosols are characterized by 2.5YR–5YR hues in the LS and 5YR–7.5YR hues in the MS, with Bw, Bt, Bk, and Bss horizons typically ranging from 0.5 to 2 m in thickness. Micromorphological analyses indicate variable degrees of pedogenic development, as evidenced by blocky and wedge-shaped peds, clay coatings, bioturbation features, and accumulations of pedogenic CaCO3 within Bw, Bt, and Btk horizons. These field and micromorphological attributes were used to define pedofacies. The LS succession is dominated by moderately to well-developed paleosols (Type-A and Type-B), whereas the MS succession is characterized by weakly to moderately developed profiles (Type-B and Type-C), indicating a relative decline in pedogenic intensity. Clay mineralogical assemblages indicate variability in source lithology and weathering intensity, while bulk geochemical proxies further constrain the degree of chemical weathering. Stable isotope compositions of pedogenic carbonate nodules suggest the predominance of C3 vegetation throughout the study interval and indicate a notable increase in precipitation intensity at ~8 Ma, likely corresponding to a strengthening of the Indian Summer Monsoon. Integration of the multi-proxy dataset enables reconstruction of paleoweathering regimes, pedogenic processes, paleoclimatic evolution, and tectonic dynamics. Four distinct phases of paleopedogenesis controlled by climate change and tectonics are identified: (1) 10.49–9.72 Ma, characterized by semiarid to subhumid climate, weak pedogenesis, feldspar-rich provenance, high sedimentation rates, and intensified tectonic activity; (2) 9.72–8.77 Ma, reflecting subhumid to semiarid conditions, weak to moderate pedogenesis, tectonic quiescence, and reduced exhumation; (3) 8.77–7.56 Ma, marked by increased humidity, intensified chemical weathering, well-developed paleosols, and low exhumation rates; and (4) 7.56–6.16 Ma, indicating subhumid to humid climate, moderate pedogenesis, tectonic quiescence, feldspar-rich sources, and rapid exhumation of the Higher Himalayan Crystalline (HHC).

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