

Geochemistry and mineralogy of iron nodule bearing Siwalik paleosols of Kangra sub-basin, Northwest Himalaya, India

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The Siwalik group in the Himalayan foreland basin has one of the most extensive molasse sequences, extending around 6000 meters from the Miocene to the Pleistocene epoch. During the late Miocene to Pleistocene epoch, the Himalayas witnessed dramatic climatic and geological changes that affected their evolution. Siwalik sediments, especially paleosols, have a strong potential for understanding the floodplains in the context of prevailing climatic and tectonic circumstances in the evolution of the Himalayas. Chemical sediments, such as Fe-Mn nodules, are an important paleopedogenic feature of the paleosols. Our present study focuses on mineralogical and geochemical investigations of the nodule-bearing paleosols of Trilokpur village of the Kangra district of Himachal Pradesh, India, along the Brahal Khad river section. The petrographic and bulk mineralogy analysis using XRD revealed that quartz, plagioclase, and biotite are the primary minerals of the nodules and paleosols. Apart from that, nodules also contain hematite and goethite. The nodules show enrichment in Fe, Mn, P, V, As, Cd, Pb, and V compared to the host paleosols. The chondrite-normalized REE patterns show a similar trend for nodules as well as paleosols, implying that nodules and paleosols are related, and the REEs were supplied from the host sediments, without any fractionation. Therefore, it may be suggested that the weathering of mafic minerals has provided Fe, Mn, and other trace elements, including REE, for the nodules formed in the paleosols. In lower Siwalik paleosols, illite, kaolinite, and chlorite are common clay minerals indicating moderate weathering, whereas smectite is also found in the lower sub-horizons of middle Siwalik paleosols, suggesting periodic wet-dry conditions promoting the formation of swelling clays and supported nodule formation. The presence of different clay minerals in different stratigraphic levels suggests changing climatic conditions during 6-11 Ma.