

Clay Minerals as Climate Change Indicators—A Case Study

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ABSTRACT

The clay mineralogy of the Late Pliocene-Early Pleistocene Pinjor Formation of the type area, northwestern Himalaya, India has been investigated to understand the paleoclimatic conditions and paleotectonic regime prevailing in the frontal Himalayan terrain during 2.5 Ma to 1.7 Ma. The clay minerals were investigated by X-ray diffraction analysis and scanning electron microscope studies. Study of the oriented aggregates of 47 representative clay samples of the Pinjor Formation of the type area reveals that illite is the most dominant mineral followed by chlorite, kaolinite, vermiculite and mixed layer clay minerals. The distribution of the clay minerals in the three lithostratigraphic units of the Formation, namely the Kona Clay Member, the Tanda Bhagwanpur Wacke Member and the Chauki Nadah Pebbly Bed Member which are well exposed along the Berwala-Mandhana section, the Kona-Karaundanwala section and the Ghaggar River-Chauki Nadah section, is nearly uniform suggesting thereby the prevalence of similar sedimentation environments in the Himalayan foreland basin. The presence of illite and kaolinite suggests their derivation from crystalline rocks containing feldspar and mica as also from pre-existing soils and sedimentary rocks. Further, the paleoclimatic conditions were moderate. Presence of chlorite suggests the weathering of intermediate and basic crystalline rocks and low grade metamorphic rocks in the positive areas. The presence of kaolinite in the Pinjor Formation is mainly attributed to the weathering and subsequent leaching of the mineral from granitic and basic rocks in the hinterland. Vermiculite has been mainly formed by weathering and transformation of biotite. Warm and humid climatic conditions prevailed for a major part during the deposition of the detritus which favored weathering and transformation of minerals. During the terminal phase of sedimentation there was renewed tectonic activity which had a significant impact on climate as precipitation and mechanical weathering rates increased substantially. Post 1.7 Ma there was a marked shift in temperature patterns and subsequent cooling of the landmass, which resulted in a decreased vegetation cover and a subsequent decrease in animal population thriving on it.

Keywords: Clay Minerals; Climate; Pinjor; Siwalik; Himalaya; India

1. Introduction

Clay mineral assemblage of the Late Pliocene-Early Pleistocene Pinjor Formation of the type area in northwestern Himalaya is of significant importance in understanding the paleoclimatic and paleotectonic conditions prevailing in the positive and negative areas and their interrelationship; types of source rocks, modes of sediment transport, sedimentation environments and post-depositional changes experienced by the sediments.

The Himalayan orogenic belt is topographically divided into three major sub divisions, namely the southernmost frontal Himalaya comprising the low lying Siwalik Hills, the middle Lesser Himalaya and the northern Great Himalayan belt. The Siwalik Group of northwestern Himalaya in India is exposed in a linear fashion along the Himalayan foothills for a distance of about 2400 km, from near Jammu in the West to near Tripura in the East.

It represents a huge thickness of sediments ranging from 3300 m to 6300 m [1] which were deposited in a fore-deep. The Late Pliocene-Early Pleistocene Pinjor Formation (1.7 Ma - 2.5 Ma) of the Upper Siwalik Subgroup is very well exposed in the type area Pinjor and surrounding regions (Figure 1). The Formation attains a thickness of 703 m to 1800 m. It overlies the Tatrot Formation (2.5 Ma - 5.6 Ma) and is underlain by the Boulder Conglomerate Formation (0.7 Ma - 1.7 Ma). The Pinjor Formation has a conformable gradational contact with underlying and overlying formations. Lithologically, the Formation consists of poorly to moderately indurated light grey to pale brown, medium to coarse grained, pebbly sandstones and pale brown to chocolate brown sandy clays. Reference [1] observed that the Siwalik Group of the western Himalayan is a product of two coarsening up mega cycles. The first mega cycle is represented by the Lower Siwalik/Nahan Formation which is characterized

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Climate Change Adaptation, Risk Management and Sustainable Practices in the Himalaya Sanjeev Sharma, Jagdish Chandra Kuniyal, Pritam Chand, Pardeep Singh, 2023-03-10 This volume analyzes ecological and socio economic risks due to climate change in the Himalayan mountain ecosystems communities and proposes adaptation strategies and sustainability practices In order to better understand the potential actions required to improve natural resource conservation and the development of mountain people s livelihoods The authors discuss the current status of local knowledge system on various environmental aspects of conservation and sustainable use of mountain resources in the Himalaya The book addresses the institutional capacities gaps and priority areas of capacity building to strengthen policies and governance in regard to climate change landuse management biodiversity conservation and sustainable management in the Himalayan region The aim of this book is to enhance coordination building among policymakers planners mountain communities to foster collaboration between different stakeholders by understanding local perceptions of climate change as well as variability issues and establishing adaptation strategies to cope with these impacts The chapters incorporate theoretical and applied aspects and may serve as baseline information for the sustainability of mountain ecosystems through the contribution of multidisciplinary and interdisciplinary expertise from the Himalayan region The book will be useful for students teachers and researchers working in different areas pertaining to mountain ecosystems as well as policymakers and planners working on issues related to the sustainability of the mountain ecosystem

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Analytical methods Secondary carbonates in soils of different regions **Bibliography and Index of Geology** ,1992

Cratonic Basin Formation M. C. Daly,R. A. Fuck,J. Julià,D. I. M. Macdonald,A. B. Watts,2018-12-03 Cratonic basins are large distinctive features of the continental crust They are preferentially developed on thick continental lithosphere are typically sub circular in shape and subside over periods of hundreds of millions of years They are also endowed with significant resources However in spite of their location in continental interiors and often well known geology the subsidence driving mechanism and tectonic setting of these basins remains controversial This volume presents both lithospheric and basin scale datasets acquired specifically to interrogate the tectonic process of cratonic basin formation Focused on the Silurian to Triassic Parna ba cratonic basin of Brazil the papers discuss the results of a multidisciplinary basin analysis project comprising new geophysical geological and geochemical data This unique dataset enables the characterization of the lithospheric crust and mantle beneath the Parna ba Basin constrains the detailed evolution of the basin itself and enables comparisons with cratonic basins globally Several convergent themes emerge providing new and powerful constraints for models of the driving mechanisms of these enigmatic basins **Bibliography of Agriculture with Subject Index** ,1983-10

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