

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 Kora Clay Member, the Tanda Bhagwanpur Wacke Member and the Chanda Nallah Pebbly Bed Member which are well exposed along the Barwah-Mandhana section, the Kora-Kamandawala section and the Ghaggar River-Chanda Nallah 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 paleo-climatic 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 paleo-climatic and paleotectonic conditions prevailing in the positive and negative areas and their inter-relationship; 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 700 m to 1500 m. It overlies the Tattai 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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Clay Minerals As Climate Change Indicators A Case Study:

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 **Handbook of Green Concept** Ms.

Kity Maurya and Dr. Aneeta Sen, This book mainly focuses on Green concept i e Green Chemistry Green Economy Green Finance and various environmental issues This book makes the Green concept crystal clear in different disciplines It is beneficial for individuals of Science Commerce as well as Arts streams Thus it is a web of various fields coming together woven in a better way to understand the Environment and the requirement of understanding its different corners The green concept is not very new concept but still its difficult to understand in regarding to its various fields This Handbook is written in language which could be easily understood which makes the targeted concept clear in a better way Various diagrams tables and examples have been included which makes the book more attractive for the readers Chemical, Mineralogical

and Isotopic Studies of Diagenesis of Carbonate and Clastic Sediments Ihsan Al-Aasm, Howri Mansurbeg, 2021-06-10

Diagenesis of carbonates and clastic sediments encompasses the biochemical mechanical and chemical changes that occur in sediments subsequent to deposition and prior to low grade metamorphism These parameters which to a large extent control diagenesis in carbonates and clastic sediments include primary composition of the sediments depositional facies pore water chemistry burial thermal and tectonic evolution of the basin and paleo climatic conditions Diagenetic processes involve widespread chemical mineralogical and isotopic modifications affected by the original mineralogy of carbonate and clastic sediments These diagenetic alterations will impose a major control on porosity and permeability and hence on hydrocarbon

reservoirs water aquifers and the presence of other important economic minerals In this Special Issue we have submissions focusing on understanding the interplay between the mineralogical and chemical changes in carbonates and clastic sediments and the diagenetic processes fluid flow tectonics and mineral reactions at variable scales and environments from a variety of sedimentary basins Quantitative analyses of diagenetic reactions in these sediments using a variety of techniques are essential for understanding the pathways of these reactions in different diagenetic environments Global Climate Change and Pedogenic Carbonates R. Lal,1999-09-28 Basic concepts Analytical methods Secondary carbonates in soils of different regions Philosophical Transactions ,2002-04 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 and Index of Geology ,1992 Principles of Sequence Stratigraphy Octavian Catuneanu,2022-07-22 Principles of Sequence Stratigraphy Second Edition presents principles to practical workflow that guide applications in a consistent manner that is independent of model geological setting and the types and resolution of the data available The book explains the points of agreement and difference between the various approaches to sequence stratigraphy while also defining the common ground that affords the standard application of the method This enables the practitioner to avoid nomenclatural and methodological confusions and apply sequence stratigraphy The text is richly illustrated with hundreds of full color diagrams and examples of outcrop borehole and seismic data The book s balanced approach helps students and professionals acquire a sound understanding of the concepts and methodology It will appeal to geologists geophysicists and engineers with interest in basin analysis stratigraphy and sedimentology as well as in all economic applications that concern the exploration and production of natural resources including water hydrocarbons coal and sediment hosted mineral deposits Updates the award winning first edition in all aspects of sequence stratigraphy from the underlying theory to the practical applications Presents the standard approach to sequence stratigraphic methodology nomenclature and classification the role of modeling in sequence stratigraphy and the difference between modeling and methodology Discusses the roles of scale and

stratigraphic resolution in sequence stratigraphy and the workflow that affords a consistent application of the method irrespective of the types of data available Describes the three dimensional nature of the stratigraphic architecture and the variability of stratigraphic sequences with the tectonic setting depositional setting and the climatic regime Illustrates all concepts with high quality full color diagrams outcrop photographs and subsurface well data and seismic images **The Antarctic Paleoenvironment** James P. Kennett, Detlef A. Warnke, 1992-04-08 Papers based on work presented at a conference held at the University of California Santa Barbara August 28 31 1991 entitled The Role of the Southern Ocean and Antarctica in Global Change an Ocean Drilling Perspective Papers deal with paleoenvironmental data from the Antarctic including geology climate fossils sediments and the eustatic record Petroleum Abstracts ,1993 The American Journal of Science Mrs. Gambold,2005 **Geoscience Abstracts** ,1965 *Bibliography on Cold Regions Science and Technology* ,1996 *Journal of Sedimentary Petrology* ,1991 Oceanic Abstracts ,1997 *International Aerospace Abstracts* ,1993 Bibliography of Agriculture with Subject Index ,1976-07 Cretaceous Oceanic Red Beds Xiumian Hu,2009 *Initial Reports of the Deep Sea Drilling Project* Scripps Institution of Oceanography,1969 Bibliography of Agriculture ,1998

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