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Laterites of the Bengal Basin Characterization, Geochronology and Evolution

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Sandipan Ghosh
Department of Geography
Chandrapur College
Burdwan, West Bengal, India

Sanat Kumar Guchhait
Department of Geography
University of Burdwan
Burdwan, West Bengal, India

ISSN 2211-4165

ISSN 2211-4173 (electronic)

SpringerBriefs in Geography

ISBN 978-3-030-22936-8

ISBN 978-3-030-22937-5 (eBook)

<https://doi.org/10.1007/978-3-030-22937-5>

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Cover image by Sonja Weber, München

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The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Foreword

It takes a brave man to write about laterite today. The material is very widespread in the world and is extensively used in buildings and roads, yet in many ways it remains a puzzle. There are arguments about what it is, and dictionaries and glossaries use definitions that are far from agreed. Laterite has been referred to as a soil type, a rock type, a complete weathering profile—such a range that it has led to calls for the term to be abandoned altogether. This won't happen because the material that looks like the Indian laterite occurs abundantly worldwide, and the term is so widespread among ordinary people, even if the meaning is unclear. It must be remembered that the first accounts of laterite, including that of Buchanan who coined the word, described a material, not a profile or a process.

The origins of laterite are permanently under debate, and there are numerous conflicting hypotheses. Perhaps several processes are involved that produce similar looking end products. The arguments have been going on for a very long time, almost since the first descriptions of laterite in India going back three hundred years. This is much longer than most scientific controversies.

Because of this conflict, occasional summaries are produced, which provide a basis for the next round of discussion, and this book is such a contribution. Some attempted summaries try to cover the whole world, and others are based on limited areas. The present book attempts to give a world overview at the beginning, but then describes the laterites of a specific area, the Bengal Basin, in detail.

Local studies are particularly valuable as they provide fine detail to illustrate the reality of the situation, and contrast with the often arm-waving generalizations of global debate. Each region where this is attempted has its own unique location, geology, and landscape history that can provide special opportunities, and also some limitations, on what conclusions can usefully be drawn.

In the study area presented in this book, we find a range of laterites, some formed on old bedrock and some on younger sediments of Cenozoic age, some containing fossils. To this, the authors have added results from optically stimulated luminescence (OSL) dating, which provides further constraints on age. These features make this area especially suited for studying the laterites of different ages, especially the younger ones.

Alas, the details presented here will not stop controversies, but the book presents a new step on the ladder leading to better understanding. They go all the way from definitions of terms, to detailed profile descriptions, presented in clear diagrams that provide a factual basis to inform our future arguments.

Armidale, Australia
April 2019

Cliff Ollier
Emeritus Professor
University of New England

Preface

The present work, entitled *Laterites of Bengal Basin: Characterization, Geochronology and Evolution*, is a comprehensive attempt to explore, analyse, discuss, and elucidate various dimensions of laterites and related ferruginous materials on the basis of detailed geomorphic, geological, and palaeogeographic characteristics (*viz.* lithology, structure, weathering profile, regolith geology, terrain morphology, Quaternary geomorphology, palaeoclimatology) of the Bengal Basin obtained from various sources such as maps, reports, books, research papers, as well as extensive field survey and profile analysis.

The studies were restricted in the western shelf zone of the Bengal Basin or western geomorphic unit of Ganga–Brahmaputra–Meghna Delta where the glimpses of Late Tertiary–Quaternary laterites cover the western districts of West Bengal (Birbhum, Paschim and Purba Bardhaman, Bankura, and Paschim Medinipur). The lateritic unit of this region is renowned as the *Rarh Plain* (*Rarh* means the land of red soil) which is dissected by the dense network of rills and gullies to develop badlands. The exhaustive field studies include reconnaissance traverses, detailed profiling or litho-log preparation of the important sections, characterization of individual sections and its relationship with the underlying and overlying lithologies, and age determination through dating techniques. More than twenty-seven sections of different laterites spread over the *Rarh Plain* had been studied and analysed to unearth the palaeogenesis of variable ferruginous facies in this part of the Bengal Basin.

Geomorphologically, the laterites are generally concentrated in the upland areas of dry deciduous forests or interfluves which are dissected by major west to east flowing peninsular rivers and their tributaries (*viz.* Dwarka, Mayurakshi, Kopai, Ajay, Kunur, Damodar, Dwarakeswar, Silai, Kangsabati, Subarnarekha rivers). The eastern part of the laterite occurrences in West Bengal shows a sharp contact with the Gangetic alluvium to the east. Small laterite hillocks on Rajmahal Basalt Traps represent butte-type structures. But all of the laterites are restricted within very low levels from 40 m to 100 m from mean sea level. The most interesting fact is that the

laterites occur over a wide variety of rocks including basalts, granite–gneiss, Gondwana sandstones, dolerite dyke, and unconsolidated sediments of Late Tertiary and Early Quaternary age.

The laterites belong to two types: (1) *in situ* primary laterites and (2) *ex situ* secondary or reworked laterites. The primary laterites may be genetically related to four types of parent rocks, viz. (a) Rajmahal Basalt Trap, (b) dolerite in gneissic country, (c) Gondwana sequence, and (d) gneiss. The secondary laterites do not have direct genetic relation with the underlying rocks or sediments. The study reveals that the *in situ* lateritization on basalt is characterized by well-developed laterite profile (8 to 10 m thick) starting from top hardcrust/duricrust, mottled zone, lithomargic clay, and saprolite, followed by parent basalt at the bottom of these sections. The *ex situ* laterite developed over Tertiary or Quaternary sediments involved ferruginization of lower conglomerate–pebble horizon–sandstone unit but not the upper *Sijua* and *Panskura* alluvium sediments. The pisolitic hardcrust is appeared as primary type in the laterite profile, but the vermicular hardcrust with tubular fluid passage channels are very poorly developed and absence of lithomargic clay or pallid zone is the feature of secondary type. So, for apposite understanding of lateritization and genesis of laterite lithosections in the western part of Bengal Basin, the present monograph has systematically presented the fundamental details, discussion, analysis, and conclusion in ten chapters.

In Chap. 1, an attempt has been made to present clearly the statement of research problem, its regional and global issues, major conceptual aspects of regolith geology, imperative ideas, and definitions of laterite and important terms related to laterite study. In Chap. 2 it tries to focus on the literature review, the identification of research gaps in the study of Indian laterites, and methodological outlook of the study. Next, in Chap. 3 it tries to unearth the tectono-geomorphic evolution of the Bengal Basin and its geological structure which are essential and fundamental part of the study. Additionally, the climate, soils, and natural vegetation of study area are discussed here. The effect of tropical weathering on the gneiss, basic dyke, Gondwana group of rocks, and Rajmahal Basalt Traps is minutely discussed in Chap. 4. Chapter 5 minutely has analysed the profiles of low-level or *ex situ* laterites which separate the lithological formations of Archaean, Gondwana, and Tertiary gravels from the *Sijua* and *Chuchura* Formations (Quaternary Alluvium). The various chemical properties of laterite samples, lateritization processes, and applicable theory of lateritization are discussed in Chap. 6 to get ideas about the genesis of ferruginous layers in the weathering profiles. In Chap. 7, the age determination, span of lateritization event, and dating data analysis are included to draw significant information about the geochronology of laterites. It tries to unearth the palaeogenesis, palaeoclimatic implication, and palaeogeomorphic evolution of laterites in the shelf zone of the Bengal Basin in Chap. 8. In Chap. 9, the economic significance of laterites, productivity of latosols, potentiality of geotourism, and soil erosion issue are discussed to get few inferences on the significance of laterite to human society. Chapter 10 is the epilogue part which summarizes and concludes

the extensive field and laboratory studies of the important profile sections of western districts (viz. Birbhum, Paschim Bardhaman, Bankura, and West Medinipur) of West Bengal.

Burdwan, India

Sandipan Ghosh
Sanat Kumar Guchhait

Acknowledgements

The authors take the opportunity to express their deep sense of gratitude to Dr. Cliff Ollier (Emeritus Professor, University of New England, Australia) for providing his invaluable research papers and critical ideas about the regolith geology of tropics and the laterites of India. Professor Ollier has given new concepts, ideas, and research findings to understand the evolution of laterites in the Bengal Basin.

The authors like to extend their thanks to Prof. Dr. Mike Widdowson (Lecturer, Department of Geography and Geology, University of Hull, England) who has provided many valuable articles, chapters, and valuable ideas to carry out the fieldwork of laterite study.

The authors like to express their deep sense of gratitude to Dr. Suvendu Roy (Assistant Professor, Kalipada Ghosh Tarai Mahavidyalaya, Darjeeling), Subhankar Bera (Junior Research Fellow, Department of Geography, University of Kalyani), Rahaman Ashique Ilahi (Project Assistant, National Research Centre for Orchids, ICAR, Sikkim), Subhamay Ghosh (Research Scholar, CSRD, Jawaharlal Nehru University, New Delhi), Sukanta Mandal (Assistant Teacher), and Ankita Saha (Assistant Teacher) for their rigorous help, support, and cooperation in completing the fieldwork and data analysis.

The authors like to extend their thanks to all the organizations from which data, reports, and relevant maps have been collected, *viz.* National Bureau of Soil Survey and Land Use Planning (Kolkata), Geological Survey of India (Kolkata), Survey of India (Kolkata), National Atlas Thematic Mapping Organization (Kolkata), and National Remote Sensing Agency (Hyderabad).

The authors finally like to express their thanks and gratitude to all the faculty members of the Department of Geography, The University of Burdwan (Dr. Giyasuddin Siddique, Dr. Gopa Samanta, Dr. Narayan Chandra Jana, Dr. Biplab Biswas, Dr. Namita Chakma, Dr. Biswaranjan Mistri, Dr. Deb Prakash Pahari, Dr. Somasis Sengupta, Dr. Subodh Chandra Pal, Dr. Tapas Mistri, and

Dr. Sumana Sarkar) for their valuable suggestions from time to time, particularly for their constructive criticism and showing interest with regard to the present work and thought-provoking enquiry.

Sandipan Ghosh
Sanat Kumar Guchhait

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