

Pankaj Srivastava  
Dilip K. Pal

# Micromorphology of Soils and Paleosols of India

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***Authors dedicate this book to the following  
scientists and teachers who pioneered  
micromorphological research in India***

*Late Mr. K.R. Venugopal, ICAR-NBSS&LUP*

*Dr. A.R. Kalbande, ICAR-NBSS&LUP*

*Late Dr. J.L. Sehgal, ICAR-NBSS&LUP*

*Dr. S. B. Deshpande, ICAR-NBSS&LUP*

*Late Prof. B. Parkash, IIT, Roorkee*

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## Preface

The surface soils provide the most formidable foundation of life on Earth and are also known to be the most complex and important biomaterials regulating the ecosystem and its sustainability. The soils of low latitudes especially in the tropics are uniquely placed with extreme climatic and weathering conditions than other soils. Although much valuable work has been done throughout the tropics, it has been always difficult to manage these soils to sustain their productivity and it is more so when comprehensive knowledge of their formation remained incomplete for a long time. Therefore, soil care needs to be a constant research endeavor in the Indian tropical environment as a new soil knowledge base becomes critical when attempts are made to fill the gap between food production and future population growth. During the last few decades, research work undertaken by the pedologists and geologists of well-known institutions, especially by those in the ICAR-NBSS&LUP (Indian Council of Agricultural Research-National Bureau of Soil Survey and Land Use Planning), Department of Earth Sciences of the erstwhile University of Roorkee (presently known as Indian Institute of Technology, Roorkee), and Department of Geology, University of Delhi, is worth mentioning as this has expanded the basic knowledge on the development of Indian and tropical soils.

The ancient soils or paleosols occurring in fluvial sequences of the Indian Geological record, especially in the Himalayan foreland basin, are potentially useful for paleoenvironmental reconstructions because their formation in response to direct interaction of the lithosphere, atmosphere, and hydrosphere during the Himalayan orogeny. However, these pre-Quaternary paleosols preserved in the thick fluvial sequences pose an important challenge to unravel the ancient soil-forming process due to burial or diagenetic overprinting. These challenges have been overcome by the detailed micromorphological analysis of these paleosols that helped to characterize the key paleopedofeatures, distinguish them from diagenetic overprinting, and to interpret the ancient soil-forming processes in the tropics.

This publication is an attempt to highlight the unique usefulness of micromorphology in resolving many important but enigmatic pedological and paleopedological issues (clay illuviation, formation of pedogenic and non-pedogenic  $\text{CaCO}_3$ , modification of plasmic fabric, contemporary and relict pedogenic processes, polygenesis of soils, recognition of paleosols, diagenetic overprinting of paleopedofeatures, alluvial cyclicity of fluvial succession) in

Alfisols, Mollisols, Ultisols, Vertisols, Inceptisols, and paleosols of tropical Indian environments and paleoenvironments. Although the micromorphological facility is not easily available to most of the national soil and geoscience laboratories, this technique is of tremendous value in pedological and geological research for precise and unambiguous definitions of soil taxa to build the national soil information and the stratigraphy of terrestrial sediments. Consequently, it awaits inclusion in the course curricula of soil and geoscience disciplines at national academic institutions.

The students of pedology and geomorphology often come across extreme difficulties in relating to examples applying the principles of soil science from textbooks devoted almost exclusively to soils of the temperate climate of the erstwhile Soviet Union, Europe, and the USA. Therefore, the format of this publication is arranged for a process-oriented treatise on micromorphology of the tropical soils and paleosols as a reference for pedologists, earth scientists, MSc and PhD students, and also for land resource managers who are engaged in enhancing the productivity of such tropical soils in India and elsewhere.

The authors will remain ever grateful to their respected teachers of soil and geology for drawing them to pedology and paleopedology which offered more than a lifetime of fascinating problems to unravel. This state-of-the-art information on micromorphology is primarily based on significant research contributions made by the authors, their esteemed colleagues at the Division of Soil Research Studies, ICAR-NBSS&LUP, Nagpur, many MSc and PhD students both at ICAR-NBSS&LUP and Department of Geology, Delhi University. Unstinted technical support and assistance received from Messrs. Late S.L. Durge, G.K. Kamble, and L.M. Kharbikar of ICAR-NBSS&LUP helped the authors enormously in bringing the task to successful fruition.

The thoughts presented in this publication have evolved over years in discussion among the authors and their graduate students and several prominent soil scientists. Special mention is due to the late Dr R.P. Dhir, ICAR-CAZRI; late Dr H. Eswaran, SCS, USDA; and late Prof. Don H. Yaalon, Hebrew University, Israel.

The authors duly acknowledge the sources of the diagrams that have been adapted mostly from their publications. The authors are grateful to dear members of their families for their patience, understanding, encouragement, and above all unstinted moral support.

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