

Soils of the Past

An introduction to paleopedology

Gregory J. Retallack

University of Oregon

Eugene

USA

SECOND EDITION

b

**Blackwell
Science**

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An introduction to paleopedology

Dedicated to Ken and Wendy Retallack, for letting me be

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Contents

Preface to the second edition, vii

Preface to the first edition, ix

Acknowledgments, xi

Part 1: Soils and paleosols

- 1 **Paleopedology, 3**
- 2 **Soils on and under the landscape, 7**
 - Soils and paleosols on the landscape, 7
 - Quaternary paleosols, 9
 - Paleosols at major unconformities, 10
 - Paleosols in sedimentary and volcanic sequences, 11
- 3 **Features of fossil soils, 13**
 - Root traces, 13
 - Soil horizons, 19
 - Soil structure, 24
- 4 **Soil-forming processes, 37**
 - Indicators of physical weathering, 37
 - Indicators of chemical weathering, 41
 - Indicators of biological weathering, 50
 - Common soil-forming processes, 57
- 5 **Soil classification, 63**
 - FAO world map, 63
 - US soil taxonomy, 64
 - A word of caution, 76
- 6 **Mapping and naming paleosols, 77**
 - Paleoenvironmental studies, 77
 - Stratigraphic studies, 83
 - Deeply weathered rocks, 86
- 7 **Alteration of paleosols after burial, 87**
 - Burial decomposition of organic matter, 89
 - Burial gleization of organic matter, 90
 - Burial reddening of iron oxides and hydroxides, 90
 - Cementation of primary porosity, 91
 - Compaction by overburden, 93
 - Illitization of smectite, 95

Zeolitization and celadonitization of volcanic rocks, 97

Coalification of peat, 97

Kerogen maturation and cracking, 98

Neomorphism of carbonate, 99

Metamorphism, 100

Common patterns of alteration, 100

Part 2: Factors in soil formation

- 8 **Models of soil formation, 105**
- 9 **Climate, 108**
 - Classification of climate, 109
 - Indicators of precipitation, 112
 - Indicators of temperature, 118
 - Indicators of seasonality, 120
 - Indicators of greenhouse atmospheres, 125
- 10 **Organisms, 128**
 - Traces of organisms, 129
 - Traces of ecosystems, 145
 - Fossil preservation in paleosols, 153
- 11 **Topographic relief as a factor, 160**
 - Indicators of past geomorphological setting, 160
 - Indicators of past water table, 164
 - Interpreting paleocatenae, 166
- 12 **Parent material as a factor, 171**
 - General properties of parent materials, 172
 - Some common parent materials, 176
 - A base line for soil formation, 179
- 13 **Time as a factor, 183**
 - Indicators of paleosol development, 185
 - Accumulation of paleosol sequences, 194

Part 3: Fossil record of soils

- 14 A long-term natural experiment in pedogenesis, 207**
- 15 Soils of other worlds, 209**
 - Soils of the Moon, 209
 - Soils of Venus, 213
 - Soils of Mars, 216
 - Meteorites, 220
 - Relevance to early Earth, 225
- 16 Earth's earliest landscapes, 227**
 - Oxygenation of the Earth's atmosphere, 231
 - Differentiation of continental crust, 239
 - Precambrian scenery, 242
- 17 Early life on land, 246**
 - Did life originate in soil? 248
 - Evidence for early life in paleosols, 256
 - Mother Earth or heart of darkness? 260
- 18 Large plants and animals on land, 263**
 - Evidence of multicellular organisms in paleosols, 265

How did multicellular land organisms arise? 272
Biological innovation or environmental regulation? 275

- 19 Afforestation of the land, 280**
 - Early forest soils, 282
 - A diversifying landscape, 285
 - A finer web of life on land, 291
 - The shape of evolution, 298
- 20 Grasses in dry continental interiors, 300**
 - Early grassland soils, 303
 - How did grasslands arise? 312
 - Evolutionary processes, 314
- 21 Human impact on landscapes, 317**
 - Human origins, 320
 - Early human ecology, 324
 - A tamed landscape, 328

Glossary, 334

References, 352

Index, 395

Preface to the second edition

In the years since first publication of this book, paleopedology has grown from a long childhood into gawky adolescence. Paleopedology's infancy was well captured on the opening page of Vladimir Nabokov's (1955) *Lolita*, in which it is offered as the epitome of an obscure scientific interest of Humbert. Now, it is no longer a surprise to find a paleosol or a paleopedologist. Emphasis now is on interpretation of large suites of paleosols, for example, tracking past fluctuations in atmospheric carbon dioxide from the isotopic composition of carbonate nodules in paleosols. Such isotopic studies of paleosols demonstrate that they really were soils of the past. Their message about former environments and ecosystems goes beyond their surface appearance. The study of these remarkable rocks is now in a phase limited mainly by human ingenuity. Isotopy, cathodoluminescence, magnetic susceptibility, X-radiography and microtomography are opening new vistas into the formerly hidden world of paleosols.

The first edition of this book was mainly ideas and questions. This edition is devoted more to procedures

and answers. The way of paleopedology is currently being mapped out on several fronts. Global change, coevolution, mass extinctions and comparative planetary geology are some of the currently important topics informed by paleosols. In pursuit of these broader objectives, procedures for recognition and study of paleosols are becoming routine. Much of the first edition outlining such procedures has now been consigned to tables. I have also written another book (Retallack 1997a) as a source book of terminology and procedures for professionals. Here, however, emphasis remains on what paleosols can tell us of the way the world works. The theory and issues of paleopedology continue to grow in the quirky, sometimes upsetting and sometimes inspiring, manner of adolescence. In another 10 years, perhaps the field will have settled into comfortable middle age. For the moment, however, as the Chinese proverb has it, we live in interesting times.

Gregory J. Retallack
Eugene, Oregon, 2000

Preface to the first edition

Landscapes viewed from afar have a timeless quality that is soothing to the human spirit. Yet a tranquil wilderness scene is but a snapshot in the stream of surficial change. Wind, water and human activities constantly reshape the landscape by means of catastrophic and usually irreversible events. Much of this change destroys past landscapes, but at some times and places, landscapes are buried in the rock record. This work is dedicated to the discovery of past landscapes and their life through the fossil record of soils. A long history of surficial changes extending back almost to the origin of our planet can be deciphered from the study of these buried soils or paleosols. Some rudiments of this history, and our place in it, are outlined in a final section of this book. But first it is necessary to learn something of the language of soils, of what happens to them when buried in the rock record, and which of the forces of nature can be confidently reconstructed from their remains. Much of this preliminary material is borrowed from soil science, but throughout emphasis is laid on features that provide most reliable evidence of landscapes during the distant geological past.

This book has evolved primarily as a text for senior level university courses in paleopedology: the study of fossil soils. It is not the usual view of this subject from the perspectives of soil science, Quaternary research or land use planning. It is rather the view of an Earth historian and paleontologist. Compared with the elegant outlines

of a fossil skull or the intricate venation on a fossil leaf, fossil soils may at first appear unprepossessing subjects for scientific investigation. These massive, clayey and weathered zones are fossils in their own way. Their identification within a classification of modern soils presupposes particular past conditions, in the same way as the lifestyle that can be inferred from modern relatives of a fossil species of skull or leaf. Particular features of paleosols also may reflect factors in their formation in the same way as ancient diet can be inferred from the shape of fossil teeth, or former climate from the marginal outline of a fossil leaf. This book is an exploration of the idea that paleosols are trace fossils of ecosystems.

Examples in this book are drawn largely from my own work on fossil soils, some of it not yet published elsewhere. Theoretical concepts have been borrowed more widely from allied areas of science including geomorphology, coal petrography, plant ecology, astronomy and soil science, to name a few. The fossil record of soils is a new focus for integrating existing knowledge about land surfaces and their biota. Paleopedology remains an infant discipline, hungry for theory and data of the most elementary kinds. This book is one attempt to partially quell the growing pains.

Gregory J. Retallack
Eugene, Oregon, 1989

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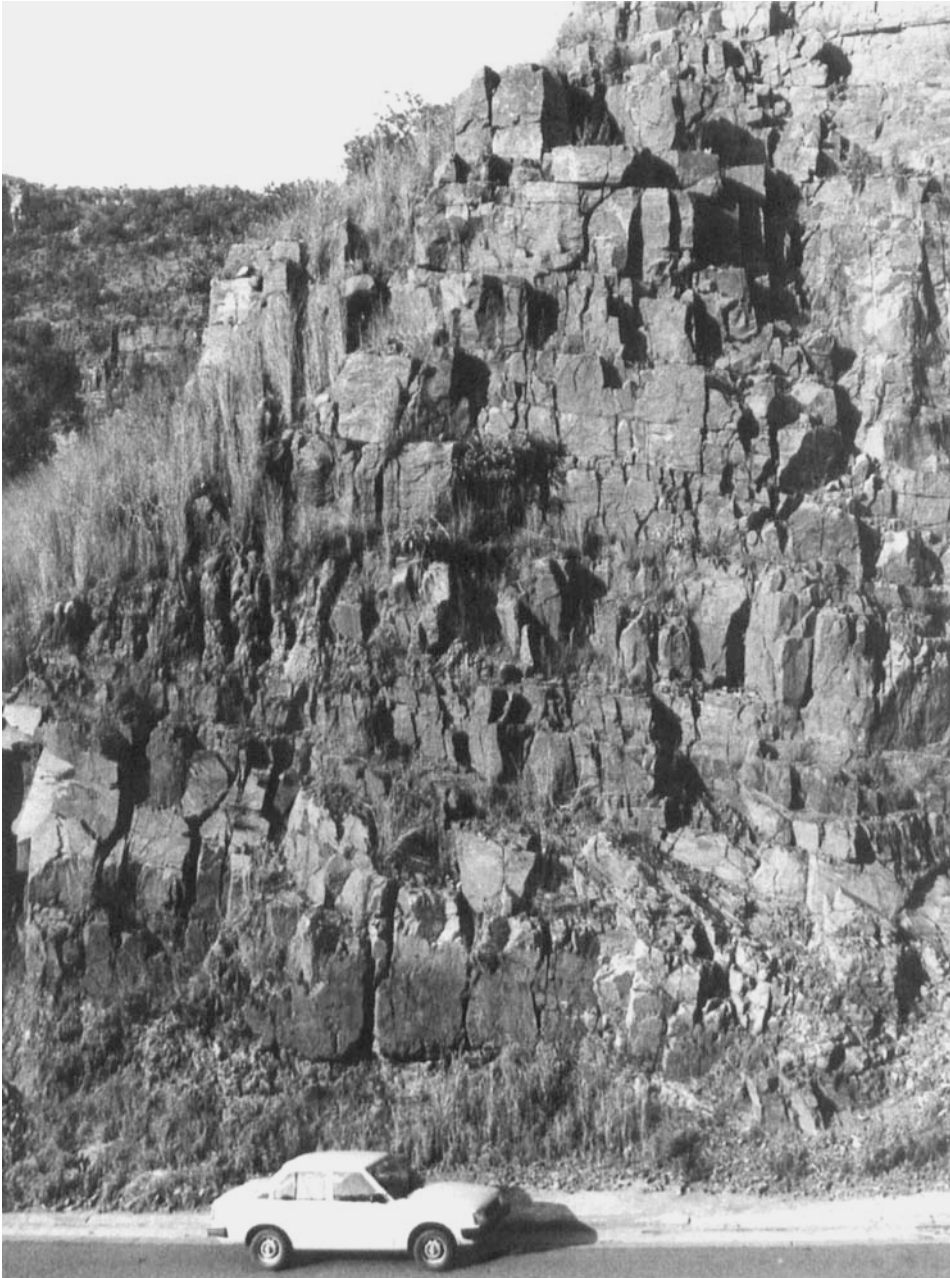
This book on paleosols would be slender indeed without extensive borrowing of facts, experiments, ideas and inspiration from allied areas of science. I have been fortunate to be able to draw upon the wise counsel of prominent sedimentologists (J.R.L. Allen, A. Basu, D.R. Lowe, R.M.H. Smith, E.F. McBride and L.J. Suttner), paleontologists (R. Beerbower, A.K. Knoll, J.W. Schopf and P. Shipman), geochemists (G.G. Goles, J.M. Hayes, H.D. Holland, W.T. Holser and T.E. Cerling) and soil scientists (P.W. Birkeland, S.W. Buol, L.D. McFadden, P.F. McDowell, L.R. Follmer, D.L. Johnson and A.J. Busacca). Among the emerging cadre of paleopedologists concerned with rocks older than Quaternary it is a pleasure to acknowledge stimulating discussions with D.E. Fastovsky, M.J. Kraus, W.R. Sigleo, V.P. Wright and S.G. Driese. Last and certainly not least, many of my ideas

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Part 1

Soils and paleosols



2200 million year old paleosol (light colored zone) near Waterval Onder, South Africa.