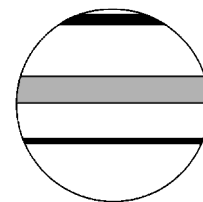


Holocene book reviews on environments and palaeoclimate



Interhemispheric climate linkages

Edited by Vera Markgraf, San Diego: Academic Press, 2001, 454 pp., \$99.95, hardback. ISBN: 0-12-472670-4

Over the last few decades, palaeoclimate studies have produced a large increase in the amount of proxy data. Only recently, however, has the data base been sufficiently large to merit a comprehensive summary of climate linkages. To this end, a 1999 gathering of climatologists and palaeoclimatologists in Mérida, Venezuela, contributed papers to *Interhemispheric climate linkages*, edited by Vera Markgraf of the Institute of Arctic and Alpine Research at the University of Colorado. This book provides a 'progress report' of studies along the Pole-Equator-Pole 1 (PEP 1) transect, spanning the Americas from Tierra del Fuego to Alaska. The book's intended audience is scientists from many disciplines of the natural, social and historical sciences. The book has a strong international component; the 67 authors represent 13 countries, and the abstracts are in English and Spanish.

The book is organized in three parts: 'Present day climates'; 'Human dimensions: the last millennium of climate change'; and 'Long-term climate variability'. Part One begins with three papers on modern climatic variability and interhemispheric linkages. The first two chapters, by Dettinger *et al.* and Enfield and Mestas-Núñez, provide an analysis of modern climate and oceanographic conditions that produce interannual to multidecadal El Niño/Southern Oscillation (ENSO)-like variability in the Americas. Marengo and Rogers in the third chapter summarize evidence that polar air-mass incursions into low latitudes are both frequent and severe enough to affect climate in the tropics. In the fourth chapter, Evans *et al.* use a creative statistical analysis of tree-ring data to reconstruct the leading modes of climate variability in the Pacific Basin.

Part Two explores climatic change over the last millennium and related human dimensions. Chapters 5 and 9 analyse the archaeological and tree-ring records, respectively, for influence of volcanic eruptions. Chapter 9, by Boninsegna and Hughes, finds a weak correlation between climate and volcanic eruptions in tree-ring records from North and South America. Chapter 5, by Payson Sheets, presents a fascinating analysis of how simple and complex societies respond to explosive volcanic events. Complex societies appear less able to adapt to sudden volcanic events and, by implication, climatic stresses – an important warning to modern societies in the face of potential rapid future climatic change. Further support for the effect of climate on civilization is presented in Chapter 6, by Brenner *et al.*, showing that rapid pre-Columbian cultural collapse was associated with droughts in northern Central America (Yucatan Peninsula) and the Bolivian Altiplano. Similarly, Chapter 7, by Núñez *et al.*, correlates wet periods with human occupation of the now dry and sparsely populated Atacama basin of Chile. Luckman and Villalba (Chapter 8) analyse glacier fluctuations in the Americas during the 'Little Ice Age' (thirteenth to twentieth centuries). Their review of glacial and dendrochronological records from across the PEP 1 transect shows a broad synchrony in glacial fluctuations on centennial timescales. At a higher time resolution, Villalba *et al.* show in Chapter 10 that tree-ring records reveal decadal-scale climate variability along the west coast of the Americas.

Part Three examines the geomorphic, lacustrine and vegetation evidence for long-term climatic variability. Clapperton and Seltzer (Chapter 11) provide a summary of glacier advances during Marine Isotope Stage 2 in the American Cordilleras, and provide compelling evidence for a broad synchrony in glacial expansions, supported by the related aeolian landforms discussed by Muhs and Zárata in Chapter 12. On a smaller scale, Pajón *et al.* present speleogenetic evidence from Cuba for changing climate (Chapter 13). Their paper identifies the importance of karst regions as being relatively underutilized repositories of palaeoclimatic data. The following three papers present lacustrine evidence of climatic change from seismic and sediment core data. An excellent example of the comprehensive data synthesis available in this book is Figure 22 of Bradbury *et al.*'s

review, which summarizes lacustrine changes in 20 lakes since the full glacial period along the PEP 1 transect. Chapter 17, by Bush *et al.*, tackles two controversial topics in palaeoclimate during the Last Glacial Maximum: how much cooler and how much drier were the tropics? Their analysis of palaeoecological and noble gas data suggests that tropical lowlands were $\sim 5^{\circ}\text{C}$ cooler than today, and that the lower atmosphere was probably saturated. This last point, they suggest, means that the glacial lapse rate must have been similar to today's at between 5 and $7^{\circ}\text{C}/\text{km}$. Chapters 18–20 summarize a large number of pollen records from the Americas and their palaeoclimatic significance, while Chapter 21 summarizes palaeoclimatic changes in the mid-latitudes of both hemispheres. In the penultimate chapter, Peteet provides an overview of general circulation model results for the Americas based on both the time slice and sensitivity approaches. Finally, the last chapter, by Markgraf and Seltzer, summarizes the state of knowledge about interhemispheric climate linkages, based on a summary of papers in this book and in the primary literature.

The chapters of this book provide a comprehensive review of late-Quaternary palaeoclimatic changes in the Americas, and contain references to virtually all the important studies. The most difficult task facing the authors is assigning specific climate forcings to inferred proxy-derived palaeoclimatic changes. However, while interpretations of data from each site may have a non-unique solution, evaluation of the hundreds of sites in this book permits a narrowing of possible climate scenarios. Further research will surely resolve some of the finer details of palaeoclimate in the Americas. The research community will expectantly await similar compilations for the other PEP transects in Europe and Asia. This book should form one of the cornerstones of palaeoclimate science and direct future research in sensitive areas. It is highly recommended for all palaeo-scientists.

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The two-mile time machine: ice cores, abrupt climate change, and our future

Richard B. Alley, Princeton, NJ: Princeton University Press, 2000, 229 pp., \$24.95/£17.95, hardback. ISBN 0-691-00493-5

The two-mile time machine is an artfully written and engaging summary of palaeoclimatology in general, and the Greenland Ice Sheet Project (GISP2) in particular. Richard Alley has found the delicate balance needed to make this book both readable and relevant to the lay reader, while also providing an entertaining and fascinating account of the ice-core process and climate records for those of us working in the field of palaeoclimatology.

The text is organized in five parts comprising 18 chapters. Part I introduces the reader to the relevance of climate to society, and to natural archives that can provide some proxy record of climatic change. Part II is a primer on ice coring from both a logistical and scientific perspective. Beginning with a brief history of ice coring, Alley then delves into the mechanics and personalities involved in GISP2. The remainder of this section is devoted to ice flow, dating ice cores, palaeothermometry using isotopes and borehole temperatures, and aerosols and gases trapped in ice cores. Part III is a big-picture look at climatic change on scales from deep time to late Quaternary Dansgaard-Oeschger oscillations. In this section, Alley reviews the orbital forcings that drive glacial-interglacial cycles and concludes with a discussion of the evidence for the bizarre climatic instability of the last glacial hemicycle. In Part IV (entitled 'Why the weirdness?') Alley addresses the possible cause of abrupt climatic change, and here he focuses on thermohaline circulation in the North Atlantic Ocean. The final part ('Coming craziness?') addresses the potential for

abrupt climatic change in our lifetimes as a result of anthropogenically induced global warming. This section includes useful discussions of the scientific consensus regarding global warming, the role that the press plays in promoting the view that there remain significant scientific doubts about global warming, and the need to consider non-traditional economic discount rates when calculating the cost of responding to global warming. The book also includes appendices of the principal cast of characters who made GISP2 a success, and a useful annotated bibliography of sources and related information.

The real strength of this text comes as much from Alley's writing style as it does from his thorough discussion of a broad range of palaeoclimatic methods and data. His use of analogies to explain and illustrate complex time-series is both effective and entertaining. For example, the concept of nested frequencies of late-Quaternary climatic change is presented in terms of a 'roller coaster riding the orbital rails, with Heinrich-Bond bungee-jumping off the roller coaster while playing with a Dansgaard-Oeschger yo-yo' (p. 126). Similarly, borehole temperature records are explained in terms of the temperature profile imparted on a frozen dinner placed in an oven, then in a freezer, and then in an oven again. These and numerous other analogies make this text eminently readable and will ensure that it contributes greatly to informing the public about the basis for understanding climatic change both in the past and in the future.

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An environmental history of Great Britain: from 10,000 years ago to the present

I.G. Simmons, Edinburgh: Edinburgh University Press, 2001, 419 pp., £59.50, hardback, £19.99, paperback. ISBN 0-7486-1284-X (hardback), 0-7486-1283-1 (paperback)

From my viewpoint as a palaeoecologist on first flicking through the contents and looking at the balance of this book – 68 pages for 6000 BP to AD 550 but 272 pages for the remaining one-and-a-half millennia – I felt somewhat let down; here was one of our foremost palaeoecologists seemingly underplaying the importance of the prehistoric period for understanding the landscapes of Great Britain. This was then compounded by reading on the back cover that another eminent palaeoecologist considered the book to be 'magisterial, insightful, readable. . .' However, on completing the final chapter I felt that both had got it right. The book is accessible, entertaining, tremendously well exemplified throughout, and a very thorough overview of British environmental history. The balance is correct and makes for a much better read than a concentration on the prehistorical evidence would have done. This is not, as Simmons is quick to point out, a landscape history but an *environmental* history, concentrating on change and the dynamism of the British environment in contrast to landscape histories which tend to be more to do with reconstructing snapshots of landscape.

In the Introduction, Simmons also emphasizes that the book is positioned between objective scientific history and what he defines as 'moral' history, or 'cultural construction'. By the final chapter he argues that this approach should be seen as detached in a real attempt 'to extract regularity from the messiness of change' (p. 325). Objective it may be, but at best Simmons achieves a semi-detached approach from which the book benefits, especially as illustrated by the clear positions he takes on several issues, most noticeably on the failings and shortsightedness of the establishment, economic imperatives and governments, particularly of a right-wing predisposition, when dealing with fragile environments and the recognition of any responsibility for passing on an environment at least as healthy as, and preferably healthier than, the one we inherited. This approach is best seen in the final sentences to sections such as that on 'Heaths in the eighteenth century': 'On the sandy periphery of London, Hounslow Heath on the Bath Road, a favourite with highwaymen, has now been replaced with Heathrow Airport where European airlines also practise extortion' (p. 132); and also (perhaps lost to a non-British audience) when talking about 'Sacred space between 1914–1950': 'The conjunction of sacred and secular space in this period is perhaps to be seen as Lords and Old Trafford: the saying goes that the English (*sic*) are not a spiritual people, so cricket was invented to give them an idea of what eternity might be like.'

In the Preface, we are offered two ways to read this book, either as a

whole or by dipping in and out to follow themes, such as woodland, wetlands or heaths. Students using the book will no doubt do the latter, but the best way to follow the discussion, to see the environment evolve and detect the 'regularities', is to do as the author suggests and read it as a text. From the title, many teachers in higher education may see the book as a godsend – all environmental history is here or referenced within – but undergraduates may have some difficulty with it. There is a lot here and the references to disciplines such as art, literature, poetry and social history could well prove elusive to a generation for whom *Friends* is a cultural high spot. It would be disappointing if undergraduates could not get involved with the themes that are explored, as this is a book that all self-respecting geography undergraduates should read, as should a range of social scientists and historians. The essence of the book, encompassed in the distinction drawn between the terms environmental and landscape history, is the importance of continuous change and the complexity of influences on the environment, requiring appreciation of the interests and involvement of an ever-widening range of disciplines to develop a worthwhile understanding of such an environmental history.

The 10 000 years of the title are dealt with in a straightforward chronological order from 'Hunter-gatherers and fisherfolk 10,000 to 5,500 B.C.' to 'A post-modern world, 1950 to the present', concluding with a chapter on 'Experience and meaning'. Within each chapter, recurrent environmental niches and themes are examined at a depth reflecting their importance within the time period under review. Every section is extremely well illustrated with wide-ranging examples, all of which reinforce the central arguments. Much of what Simmons calls 'the scholarly apparatus' is 'tucked away' in footnotes, but these cover 36 pages and are an enjoyable read in themselves. The major strength of the book lies in its readability (where else would you be able to describe soils as having 'seasonal quagginess'?), clarity of expression and breadth of detail (he reports Queen Mary as commenting 'So *that's* what hay looks like' when evacuated to Badminton as illustrative of establishment attitudes to the countryside at the time – and you feel that such asides only scratch the surface of fundamental issues regarding environmental history, especially related to conservation and environmental awareness, which have not yet been addressed by those working in the field).

The core text is supplemented by a series of aerial photographs with commentaries, one for each chapter, used to summarize the essence of the period, and there is also a glossary and a set of brief biographies. The book is generally well illustrated, but some of the photographs have not reproduced well; for example, in Plate 2.5 the flints and hearth cannot be seen, and in Plate 6.4 the environmental disintegration at Beamish is lost in the poor quality of the image. Such very minor gripes apart, this is an idiosyncratic and (yes!) magisterial overview of a complex and fascinating topic. In these times of R.A.E. domination by peer-reviewed international journal output, it provides a salutary reminder of the importance of books for revitalizing our thinking on fundamental issues not only within narrow disciplines but also at a much broader scale.

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Tectonic geomorphology

Douglas W. Burbank and Robert S. Anderson, Oxford: Blackwell Scientific, 2001, 274 pp., £52.50, paperback. ISBN 0-632-04386-5

The interaction between sediment transport processes and tectonic processes is at the absolute heart of a contemporary understanding of landforms and their development, and increasingly so at coarser time and space scales. Geomorphologists have been more concerned with fine scales and Earth scientists with coarse scales, and it is only in the last decade that there has been appreciable convergence between these points of view, which is only now beginning to surface in textbooks. Summerfield's (1991) book was a notable pioneer, but Burbank and Anderson's book brings the discussion up to date in a rapidly developing field, and is therefore timely. I hope that there will soon be other books that explore this field of tectonic geomorphology from various viewpoints.

The approach taken is very strongly geological, in the sense that arguments are made primarily from analysis of the landforms towards inference of processes, rather than from an analysis of process towards the forms which they produce. Although processes and process rates are explicitly discussed, both in the context of erosion and uplift rates (Chapter

7) and of numerical modelling (Chapter 11), there is very little detail about sediment-transport processes, in marked contrast with other recent geomorphology texts, such as Allen (1997).

Tectonic geomorphology is introduced through a simplified view of the approaches of Davis, Penck and Hack, with their implicit assumptions about the relationships between uplift and erosion (Chapter 1). It examines geomorphic markers (Chapter 2), particularly coastal and river terraces, and provides an excellent summary of current dating methods which are essential to their interpretation (Chapter 3). There is a clear discussion of the morphology of faults and folds, together with the distinctions between co-seismic deformation and inter-seismic adjustments due to immediate changes in loading and subsequent changes due to erosion and deposition (Chapter 4).

Methods for directly determining tectonic movements and their effects on landscape morphology are grouped by time and space scale. Short-term (10-year) deformation can be monitored using survey and interferometer methods, where individual earthquake events are involved (Chapter 5). For longer periods (Chapter 6), displacement of strata, formation of terraces, disturbance of tree growth shown in tree-rings, and lichen dates of rockfall episodes are among the methods which show the aggregate effect of movement on a fault or fold. For longer periods of 10^4 – 10^8 years, the co-seismic tectonic movements must be linked to erosion rates and isostatic compensation to interpret long-term fluvial sediment yields and isostatic and other estimates of exhumation rates (Chapter 7).

The response of landscape morphology can best be seen in fluvial terraces and migrating plan-form geometry in the short term ($\sim 10^4$ years) and for moderate areas (Chapter 8); in flights of marine terraces and channel gradients in the medium term ($\sim 10^6$ years, Chapter 9); and in the long term (10^8 years, Chapter 10), in drainage-basin evolution, again examining the strong interactions between tectonics, erosion and isostatic/flexural compensation to understand landscape morphology.

The final chapter (Chapter 11) is on numerical modelling of landscapes, with a relatively cursory discussion of sediment-transport processes and the application of slope models to the degradation of fault scarps. This is followed by a fuller discussion of orogen-scale models for which the interaction between erosion and tectonics is strongest. Although there is reference to some of the more sophisticated integrations of surface and tectonic processes (e.g., Kooi and Beaumont, 1996), the level of discussion here is one of the weaker sections of the book.

Although the most significant interactions between geomorphology and tectonics are seen at continental scales and over periods of millions of years, the Holocene is a long enough period for important interactions to be seen. Although this book does not provide a detailed manual of all the techniques which bear on environmental change, it does give a valuable introduction, and, more importantly, places this in the context of the longer-term interactions. As a textbook of geomorphology, the emphasis on landforms and tectonics is a useful counterweight to the more normal concentration on sediment transport and on process rather than form, and will therefore provide most valuable supplementary reading within physical geography, and Earth and environmental science courses, but, in my view, it provides only one of the important perspectives needed for a broad understanding of landforms and their development.

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The Cenozoic of southern Africa

Edited by T.C. Partridge and R.R. Maud, New York: Oxford University Press, 2000, 406 pp., \$80/£55, hardback. ISBN 0-19-512530-4

Southern Africa has an old, eroded surface with few Cenozoic deposits. Nevertheless, a substantial amount of work has been done on these Cenozoic deposits and this book provides an extremely useful review. The

emphasis is on late-Cenozoic deposits ranging from the Neogene to the present with a particular emphasis on Quaternary deposits. Southern Africa, along with East Africa, contains valuable fossil sites of early humans, and late-Cenozoic deposits provide important environmental information related to hominid evolution. There is a total of 23 chapters covering a broad spectrum of topics on the geology, geomorphology, palaeontology and palaeoclimate of southern Africa. Topics covered in the first 16 chapters include: geomorphic evolution; coastal deposits of the southeast, south and west coasts of South Africa and Namibia; interior cave deposits related to important fossil sites; aeolian deposits of the Namib Sand Sea and Kalahari; and lacustrine, pan, estuarine, wetland and fluvial environments. Also included are chapters on palaeosols and duricrusts, periglacial features, colluvial deposits and stable-isotope studies.

The following five chapters present summaries of the fossil records of hominids, mammals, micro-mammals, pollen and plants. The last two chapters are on the Quaternary archaeological record and palaeoclimatic evolution. There is also a chapter on Cenozoic volcanism that seems out of place in this volume because it is the only chapter on igneous rocks and because, regrettably for dating purposes, volcanism only extended into the earliest Cenozoic and therefore these volcanic rocks do not overlap at all with the other deposits discussed in this volume. The other oddity of the volume is that there is no chapter covering the marine record. Some chapters do extend their reach to include adjacent shelf areas, but it is unfortunate that a chapter dedicated to marine deposits was not included because of the advances that have been made in marine studies and the value of linking marine and terrestrial deposits, particularly for improved chronostratigraphic control. In fact, a central theme throughout the book is the lack of accurate chronostratigraphic control. Luminescence dates, as well as some magnetostratigraphy, have greatly improved the chronostratigraphy, but the lack of volcanic deposits, the paucity of fossil material (that is often reworked) and post-depositional alteration such as calcrete and silcrete formation, combine to make the dating of Cenozoic deposits a major challenge in many areas of southern Africa. There needs to be a greater effort into the correlation of those deposits that occur on land with the often more complete and better-preserved successions offshore on the shelf and upper slope.

The chapters are written by well-seasoned experts and their quality is generally good. Most of the figures (all black-and-white) are well done but some of the photographs are poorly reproduced. Typographical errors are generally few, but include the spelling of comprise and incise with a 'z', perhaps an exaggerated hangover from the conversion of British to American spelling styles. An index is included but, most vexingly, the titles of references in the bibliography are omitted. The price, although certainly in line with other books, is unfortunately out of reach of many southern African postgraduates who would perhaps benefit most from the book.

In summary, this book presents an excellent review of a broad spectrum of topics that would be very useful to anyone interested in the late-Cenozoic deposits, evolution and processes of southern Africa.

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World savannas: ecology and human use

Jayalaxshmi Mistry, Harlow: Prentice-Hall, 2000, 344 pp., £19.99, paperback. ISBN 0-582-35659-8

The need to address the misconception that savannas are only found in Africa is the rationale given for this new volume on *World savannas*. Thus the book describes the ecology and human use of savannas not just in Africa, but across Asia, Australia and South America. The first chapter suggests a conceptual framework with which to study savannas. The relationship between plant-available moisture (PAM) and plant-available nutrients (PAN) and, to a lesser extent, herbivory and fire, are used as the main determinants. These themes are used in the subsequent chapters to structure the description of each of the savanna ecosystems. Chapters 2 to 9 outline the characteristics of the savannas of Brazil, Venezuela/Colombia, central Africa, West Africa, East Africa, southern Africa, Southeast Asia and Australia. The final chapter concludes and discusses the main issues and challenges facing savannas in the next century. In addition to this, the book contains a short appendix of related internet sites and a brief glossary of terms.

The impressive amount of information in the book is backed by a lengthy bibliography of 65 pages. It therefore represents a much-needed, substantial contemporary work on the ecological functioning of the world's savannas. The specific content is a reflection of the author's particular background and expertise on vegetation and the importance of fire in ecological functioning. There are detailed sections on vegetation characteristics in each of the savanna areas, but only scant detail on soils, climate and degradation issues. Unfortunately, the book adopts a descriptive 'regional geography' approach that restricts the opportunity for development of conceptual ideas and limits comparisons and contrasts between areas. For example, the problems of grass invasion in the Cerrado of Brazil are described, but the obvious links to bush encroachment and deforestation issues in southern Africa and elsewhere are not mentioned. There are also numerous examples where information seems to be provided with little obvious reason, such as Table 7.5 (p. 179), which lists the number of cattle and goats in Namibia, Botswana and South Africa in 1998. The descriptive narrative also appears to generalize and oversimplify in places and there is little evaluation or interpretation of research.

In southern Africa, one of the key sources of information on the functioning of the savanna ecosystem has been the long-term study at Nylsvley (Scholes and Walker, 1993). Although this is liberally referenced throughout Chapter 7, it is not given explicit recognition and its location on a map of southern Africa is inaccurate by 600 km. There are other examples of apparent oversights such as Figure 6.8 showing the effect of boreholes on soil and vegetation. Perkins and Thomas (1993) developed this 'Piosphere' model in the Kalahari; however, it is described in the section on East Africa and receives no mention in the southern Africa chapter.

Although the book contains a wealth of information on each of the major savanna ecosystems, there are only brief accounts of some of the current research issues. Recent Australian work on erosion, soil crusts and nutrient cycling is not mentioned. There is some discussion of recent developments in integrating indigenous and scientific knowledge of soil degradation to provide informed management solutions. However, for a book on ecology and human use it is surprising that this theme does not recur through several chapters. The use of remote sensing as a tool for estimating the extent and properties of large areas of savanna is another important current research area that only receives a brief mention.

In attempting to provide information on all the world's savannas, the author has taken on a huge task. In certain aspects she has succeeded, providing an interesting account of fire ecology in particular. However, the necessarily broad coverage has led to a book with few insights into the workings of the savanna and an unbalanced description of savanna ecosystems. Students should find the wealth of detail included in the book, especially on fire and vegetation, of some use, as there are few such texts covering these areas. However, a more interpretive book with a wider scope would have been preferable.

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Soils of the past: an introduction to palaeopedology (second edition)

Gregory J. Retallack, Oxford: Blackwell Science, 2001, 404 pp., £37.50, paperback. ISBN 0-632-05376-3

'The first edition... was mainly ideas and questions. This edition is devoted more to procedures and answers.' So writes the author in the preface to this second edition of *Soils of the past*. This is a book that expounds traditional pedological views but with an intriguing focus on the time factor. Most soil science books pay lip service to time as a factor in soil formation. This book takes time as its central theme and attempts in Part I (the first seven chapters) to rewrite topics such as soil features, soil formation and soil classification against a geological timescale.

Whereas most texts would discuss weathering processes, this book extends the concept into post-depositional change. For example, the decomposition of organic matter is related to the formation of coal; soil colour is discussed in terms not only of pedogenesis but also of diagenetic alteration. Part 2 of the book is a systematic exposition of the five classic factors of soil formation, but again with the refreshing angle of *changes* in these factors – climatic change, vegetation succession, landscape evolution and so on.

Part 3 is the most interesting and challenging section of the book. It opens with a discussion of soils of other worlds, as an introduction to speculation about the early stages of the Earth. Logically, it then charts the probable sequence of soil formation and change throughout Earth history, from the emergence of life onto land through to the impact of the evolution of humans. For such a developing branch of geoscience, to suggest these are answers is a little risky, but certainly this book provides a reasoned and well-researched synthesis of present knowledge.

Forty pages of references bear witness to a comprehensive review of the topic. This is certainly not a book to sit down and read from cover to cover, but one is immediately fascinated by some sections, and I did find it difficult to put down. For readers of *The Holocene*, this book may well be of only peripheral interest; only the last few pages relate to glacial and post-glacial changes. However, the central theme of the book is the use of fossil soils to reconstruct past environments, and the principles are almost equally applicable to Holocene soils. This is certainly a book for the library shelves of any Earth science or geography department, and certainly a thought-provoking read for any student of Earth history or environmental change.

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Geoarchaeology: exploration, environments and resources

Edited by A.M. Pollard, London: The Geological Society, Special Publication 165, 1999, 180 pp., £65, hardback. ISBN 1-86239-053-3

The papers in this Special Publication of The Geological Society, edited by A.M. Pollard, are a promptly published subset of those presented at the Geoarchaeology session of the Geosciences '98 conference at Keele University in April 1998. They represent a valuable source of well-researched case studies in geoarchaeology. Each peer-reviewed paper includes clear discussion and evaluation of the archaeological, historical and geological research questions, the techniques selected, and the results, interpretations and directions for future research. They are grouped under the subheadings of 'Exploration', 'Environments' and 'Resources'. In the introduction, Pollard discusses the significance of these research areas, and highlights the value of each case study, not only to specific research questions, but to wider interdisciplinary issues and current concerns. He also discusses the nature and development of the interaction between geology and archaeology from the mid-nineteenth century, when the application of the principles of geological stratigraphy contributed to establishing the antiquity of humankind. He reviews changes in the definition and focus of geoarchaeology, and, like the editors of the journal *Geoarchaeology*, adopts a non-prescriptive view of geoarchaeology, which includes the application of a wide spectrum of geoscience techniques, including geophysics and archaeometry, to problems in archaeology.

The three papers on 'Exploration' focus on exploration geophysics, which, together with other remote-sensing techniques, has led to significant scientific advances in archaeology, and permitted the rapid location, identification and assessment of buried features prior to (sometimes without) excavation or scheduling of monuments. They illustrate recent advances in geophysical techniques and applications based on research on medieval sites in Yorkshire, a Romano-British villa in Wroxeter, and Napoleonic-period tunnels in Liverpool. Vernon *et al.* show that fluxgate gradiometry and magnetic susceptibility can detect strong magnetic anomalies associated with sites of iron smelting, and to a lesser extent lead smelting, in slag-covered industrial areas, particularly when combined with controlled experiment and analysis of features and residues from different processes. Murdie *et al.* apply Euler deconvolution on magnetic gradiometry readings to obtain information on the depth and stratigraphical relationships of buried features in comparison to analyses using georadar techniques. Cuss and Styles demonstrate how high-resolution microgravity techniques can be used in complex urban environments with substantial

noise signals that would otherwise impede the use of resistivity- and magnetometry-based techniques, to detect air-, rubble- or water-filled cavities.

In the first of three papers on 'Environments', Latham *et al.* survey the stratigraphy of a sedimentary sequence in a South African cave. Their re-examination of a flowstone with australopithecine fossils dated by magnetostratigraphy suggests that they have been disturbed by hyaena denning rather than floodwaters. Tipping *et al.* examine the nature and duration of particle incorporation and pedogenic processes in the formation of a podzol by analysing exotic pollen, spheroidal carbonaceous particles, ^{137}Cs and soil micromorphology from an arboretum in Scotland founded in 1840. Their results indicate rapid and prolonged mixing in the uppermost organic horizons and suggest that the temporal resolution of pollen stratigraphies in podzol profiles is even coarser than formerly suspected. Thorndycraft *et al.* identify enhanced tin concentrations in the fine fraction of river sediments downstream from known areas of tin streaming, and date them to the mediaeval period in Dartmoor.

Of the six papers grouped under the heading of 'Resources', three relate to metallurgy. Young and Thomas examine the provenance of iron ore from a mediaeval boat in the Bristol Channel. The cargo appears to derive a single ore deposit, probably in Glamorgan, but may have been *en route* to large-scale smelting works near the Forest of Dean, acquired by the Lordship of Glamorgan through territorial expansion. Budd *et al.* explore zinc isotope fractionation in liquid brass, with implications for distinguishing among high-temperature industrial processes, manufactured products and natural mineral sources, and for environmental geochemical monitoring. Thomas and Young illustrate the need to consider furnace lining chemistry and fuel sources in assessing the correlation between slag and ore fragments in ancient iron-working sites. They show how careful sampling strategies, study of a wider range of elements and geochemical modelling can help to elucidate the behaviour of particular elements in high-temperature processes.

In the first of the remaining papers on 'Resources', Lazareth and Mercier analyse the geochemistry and provenance of granitic rocks brought as ballast to ports, and used in local, often dateable, buildings. They suggest that there was direct mediaeval trade between Brittany and Cornwall and Ireland. Millard examines the alum industry, one of Britain's first geochemical industries. He highlights the importance of studying waste materials and conducting experimental archaeology to understand the extraction processes and to generate comparative reference materials for the various stages of production. Zaykov *et al.* discuss the wide range of geoarchaeological research undertaken in the southern Urals from 1991 to 1998, initiated by the creation of the Arkaim Cultural Reserve, including: the provenance, selection and manufacture of lithic tools; the composition of copper and bronze ores and artifacts, and lead and gold artifacts; and corrosion processes and products.

Although aspects of some of these case studies have already been published, many present succinct and critical overviews, with key data and excellent explanatory tables and illustrations. Used in conjunction with geoarchaeological textbooks, this volume would prove a useful sourcebook for the examination of specific case studies in geoarchaeology and archaeological science courses for third-year undergraduate and masters students. I would like to conclude this review with a quotation from the closing summary by the editor: 'The papers presented here exemplify the many and varied ways in which the geosciences and archaeology have come to mutually support each other. . . . The benefits to archaeology will be the vast technical expertise in the geosciences. For geoscientists, the benefit will be the input of a knowledge of past human behaviour, which is of increasing importance through the Quaternary. The future agenda of geosciences undoubtedly requires an improved understanding of the two-way relationship between humans and the environment.'

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