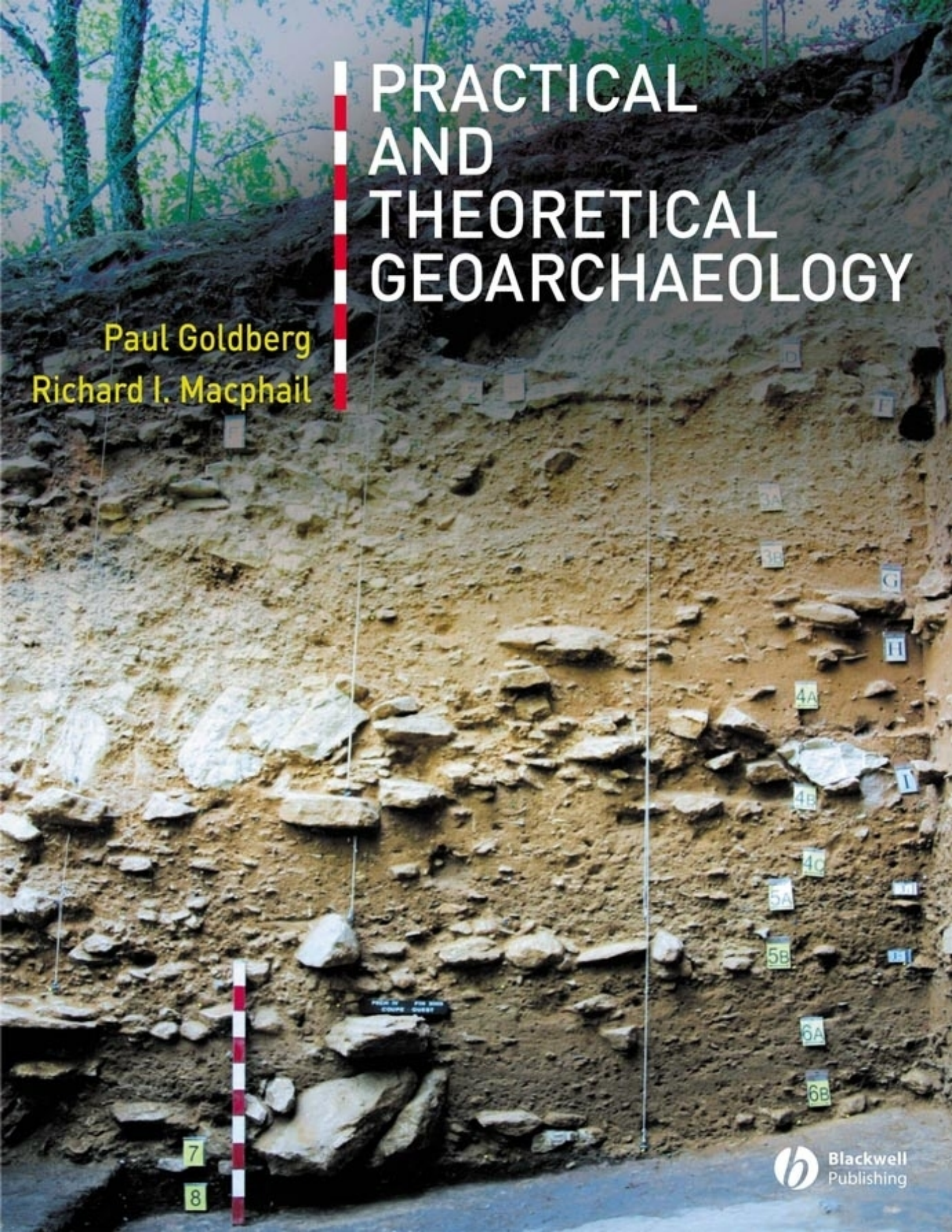
PRACTICAL
AND
THEORETICAL
GEOARCHAEOLOGY
Paul Goldberg
Richard I. Macphail
Blackwell
Publishing

Contents

Practical and Theoretical Geoarchaeology

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Blackwell
Publishing

Dedicated by RIM to the late Peter Reynolds (Butser Ancient Farm, United Kingdom) and Roger Engelmark (University of Umeå, Sweden): pioneers of experimental farms (see Chapter 12)

From RIM: to Mum, Jill, and Flora

From PG: to my folks for sending me away to summer camp

BLACKWELL PUBLISHING

350 Main Street, Malden, MA 02148-5020, USA

9600 Garsington Road, Oxford OX4 2DQ, UK

550 Swanston Street, Carlton, Victoria 3053, Australia

First published 2006 by Blackwell Science Ltd

1 2006

Library of Congress Cataloging-in-Publication Data

Goldberg, Paul.

Practical and theoretical geoarchaeology/Paul Goldberg and Richard I. Macphail.

p. cm.

Includes bibliographical references and index.

ISBN 0-632-06044-1 (pbk. : alk. paper) 1. Archaeological geology. I. Macphail, Richard. II. Title.

CC77.5.G65 2006

930.1’028–dc22

200

5018433

A catalogue record for this title is available from the British Library.

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Preface

Geoarchaeology within the past two decades has become a fundamental discipline whose value is recognized by everyone interested in past human history. First, archaeologists have become increasingly sensitive to the fact that sediments and stratigraphy provide the ultimate context for the artifacts and features that they excavate. Understanding this sedimentary context and its implications is a requisite for carrying out modern archaeology and for interpreting the archaeological record fully and accurately. Environmentalists (e.g. paleoecologists, soil scientists, sedimentologists, geologists, biologists, and climatologists) on the other hand, have turned to archaeology, because it provides a long-term view of human–environment interactions that have shaped both Quaternary and Holocene landscapes. Such knowledge can have a critical bearing on the future, for example, through identifying areas of sustainable landuse. Interpretation of such ecological information depends upon detailed understanding of the pedosedimentary and geomorphological context, as in archaeology. Geoarchaeology is an important discipline, because as shown recently, it increases our understanding of human impacts on the landscape through the study of ancient soils and occupation deposits. These investigations can provide detailed histories of human endeavors up to the present.

Although geoarchaeology – though not defined as such – had its roots at least in the eighteenth century (Rapp and Hill, 1998) it never came together as a subdiscipline until the appearance of the edited volume *“Geoarchaeology: Earth Science and the Past”* by Davidson and Shackley (1976). At this time Renfrew (1976) coined the term

“geoarchaeology” in his Preface. Since then, a number of texts have appeared, the earliest ones (e.g. Rapp and Gifford, 1985) again were collections of papers, which were followed by single authored volumes (e.g. Waters, 1992; Rapp and Hill, 1998). In most cases however, the archaeological and human element as geoarchaeology was often underexplored in favor of landscape studies. This present volume, *Practical and Theoretical Geoarchaeology,* attempts to address this deficiency by providing what we feel is a more balanced view of the discipline by including detailed investigations of human activities as revealed by geoarchaeology. Potentially fruitful avenues of expansion of the discipline are highlighted, for example, in chapters on caves, experiments, occupation deposits, and forensic applications.

This book aims to be both an educational and practical tool, describing how geoarchaeology is carried out across a wide range of environments and periods, employing examples from many countries. It endeavors to teach readers both how to approach geoarchaeological problems theoretically and how to deal with them in practice. The topics covered range from regional-scale studies down to smaller, open area excavations and strata in past and present urban areas, such as Roman and Medieval London. The book presents numerous field and laboratory techniques, exposing readers to approaches suitable to a variety of site situations. Instructive guidelines and protocols are given to show the reader how to create integrated reports that include field evaluations, laboratory assessments, and archive and publication reports.

The book is designed primarily for undergraduate students in Archaeology and those Environmental and Geoscientists, who wish either to train in geoarchaeology or gain a background in this applied science. It is intended to serve as a basic text and an intermediary course in geoarchaeology.

It also serves as a necessary text for advanced undergraduates and postgraduate students requiring access to geoarchaeological skills. In addition, it should act as a valuable resource for professionals in order to help develop their awareness of both field and laboratory methods and to identify the full potential of geoarchaeological investigations either for research or mitigation archaeology. Beginners in the subject may benefit from reading Chapters 1 to 3 first, which provide introductions to stratigraphy, sediments, and soils.

Acknowledgements

Those who know us are keenly aware how long it has taken us to get this book together. We thank them here at the outset for their patience and any grief we might have inflicted. There are too many people to thank individually, but a number of folks helped us considerably in writing the book.

Early discussions with Wendy Matthews were very stimulating and helped frame the focus of the book. Similarly, before we were too far along, David Sanger provided some fundamental insights about geoarchaeology and its practitioners. He reminded us that most geoarchaeology books are not written by archaeologists. Again, we hope that this helped us steer a more equitable course on the subject. Along the way we benefited from extensive and intensive collaboration and picked up valuable insights from Ofer Bar-Yosef, Steve Weiner, Takis Karkanas, Trina Arpin, Sarah Sherwood, Carolina Mallol, Arlene Rosen, Harold Dibble, Shannon McPherron, Steve Kuhn, Mary Stiner, Susan Mentzer, Lauren Sullivan, as well as Mike Allen, John Crowther, Gill Cruise, Johan Linderholm, the late Peter Reynolds, and Pat Wiltshire.

The staff at Blackwell has been exemplary, especially in light of the experiences that the authors have had with publishers. Delia Sandford and Rosie Hayden provided congenial help with a great deal of enthusiasm: a sheer pleasure. They also supplied a good deal of forgiveness and support along with Ian Francis, our editor. It was his questionable idea to contact us in the first place, and we are grateful for the opportunity to capitalize on it.

Students at Hebrew University, Boston University, the University of Tours, and the Institute of Archaeology, and

members of the Archaeological Soil Micromorphology Working Group served as test subjects for various parts of this book over the years. Colleagues at HU (Na'ama Goren-Inbar, Nigel Goring-Morris, Anna Belfer-Cohen, and Erella Hovers) offered immense opportunities to observe exciting real-time geoarchaeology. Nigel Goring-Morris, simply one of the best field archaeologists around, furnished several examples of key sites that really helped build a geoarchaeological story. Colleagues at Texas (Mike Collins, Tom Hester, Britt Bousman, Lee Nordt, Charles Frederick) provided a different outlook and a growing experience, in spite of the accent. The years of field work at Dust Cave with Boyce Driskell revealed that anthropogenic deposits exist even for hunters and gatherers in the New World.

Over the years, the interaction with many geoarchaeologists similarly shaped our thinking. At the outset, the late Henri Laville served as an inspiration for cave sediments, along with Prof. F. Bordes. Marie-Agnès Courty has carried on this tradition of scholarship and friendship and has set the bar for geoarchaeological standards. Our first collaboration with her was invigorating and subsequent geoarchaeological interactions have helped us all develop and profit. We continue to be indebted to her.

Reid Ferring and PG were graduate students working in the Negev in the early 1970s and the latter has gained lots of insights into New World and Old World, geology, archaeology, and geoarchaeology, particularly in the field, waiting for things to happen. Rolfe Mandel and Vance Holliday, are among the foremost geoarchaeology practitioners, and they were instrumental in providing support, knowledge, and insights over the years. Much of this was sharpened by sharing the editorial helm with Rolfe at *Geoarchaeology*. Many hours were spent talking about the state of the discipline and the people who practice it. Vance Holliday in particular, devoted a lot of his time to

furnish us with timely, constructive comments that significantly improved our message and how we should get it across. Not only are all these folks helpful, but they are simply nice people and made collaboration a pleasure. We also specifically would like to thank our other reviewer (from the United Kingdom), and Gill Cruise who played the devil's advocate with parts of the text. Duncan FitzGerald provided valuable advice on several chapters.

Over the years, we have been encouraged by many other people and organizations who also supplied us with help, support, and information: Bud Albee, Nick Barton, Nick Bateman, Martin Bell, Francesco Berna, Sandra Bond, Mike Bridges, Barbara Brown, Brian Byrd, Dana Challinor, Nick Conard, Jane Corcoran, Andy Currant, John Darlymple, Roger Engelmark, John G. Evans, Nick Fedoroff, Charly French, Henri Galinié, Anne Gebhardt, Daffyd Griffiths, Ole Grøn, Simon Groom, Joachim Henning, John Hoffecker, Bruce Larson, Tom Levy, Elisabeth Lorans, Stephen Macphail, Curtis Marean, Roberto Maggi, Dominic Powlesland, Kevin Reeves, Mark Roberts, Thilo Rehren, Philippe Rentzell, Pete Rowsome, Tim Sara, Solveig Schiegl, Joe Schuldenrein, Astrid Schweizer, Christine Shaw, Jane Sidell, Michela Spataro, Julie Stein, Chris Stringer, Kathryn Stubbs, Ken Thomas, Peter Ucko, Brigitte Vliet-Lanöe, Steve Weiner, Alasdair Whittle, Tim Williams, Liz Wilson, Jamie Woodward, Elizabeth Zadora-Rio, the Universities of Frankfurt and Tours, the Institute of Archaeology (UCL), The Alexander von Humboldt Foundation, University of Tübingen, Albion Archaeology, Butser Ancient Farm, Corporation of London, English Heritage, Framework Archaeology, Museum of Londan Archaeology Service Norfolk Archaeological Unit, Suffolk Archaeological Unit, Oxford Archaeology, and Wessex Archaeology. We are grateful to all of you.

Introduction

Geoarchaeology has become highly prominent these days, and geoarchaeological themes appear in journal articles, monographs, and reports, either within a specific section of an article or as a stand-alone publication. Journals embrace not only mainstream "geoarchaeological" type of publications, such as *Geoarchaeology* or the *Journal of Archaeological Science,* but also other journals that touch on more mainstream archaeological, anthropological, or geological subjects: *Journal of Human Evolution, American Antiquity, Journal of Sedimentary Research,* and *Antiquity.* In the United States, annual meetings of both the Geological Society of America (GSA) and the Society for American Archaeology (SAA), generally have at least one session or poster session, in addition to society-sponsored symposia on the subject. The GSA has an Archaeological Geology Division, and the SAA has the Geoarchaeology Interest Group. The Association of American Geographers (AAG) commonly has geoarchaeology sessions at their annual meetings.

Moreover, the most exciting archaeological sites that one reads about today – either in the popular press or professional literature – commonly have a substantial geoarchaeological component. The reader has only to be reminded about the significance of the geoarchaeological aspect of sites that are concerned with major issues relating to human development and culture. Some high profile issues and sites include: the use and evidence of the controlled use of fire (Zhoukoudian, China); the sedimentary context and the origin of early hominins (Dmanisi, Republic of Georgia; Boxgrove, United Kingdom; Mediterranean and South African caves – Gorham's Cave, Gibraltar; Kebara

Cave, Israel; Blombos Cave, South Africa); peopling of the New World (Meadowcroft Rockshelter United States; Monte Verde, Chile); Near Eastern urban cultures (Çatal Höyük, Turkey; Abu Salabikh and Tel Leilan, Syria), and early management of domestic animals (Arene Candide, Italy). Even previously excavated localities, such as the Folsom site, are being reinvestigated from a more sophisticated geoarchaeological perspective.

These well-known landmark sites have really drawn attention to the contribution that geoarchaeology can make to, and its necessity in, modern archaeological studies. This situation was not the case a few decades ago when only a handful of archaeological projects utilized the skills of the geoarchaeologist; one of the authors (PG) could enumerate the sparse number of geoarchaeological studies at the time he was a graduate student in the late 1960s. Still, the best results have come from highly focused geoarchaeological investigations that have employed the appropriate techniques, and that have been intimately linked to multidisciplinary studies that provide consensus interpretations.

This book is about how to approach geoarchaeology and use it effectively in the study of archaeological sites and contexts. We shall not enter into any detailed discussion of the origins and etymology of "Geoarchaeology" versus "Archaeological Geology." (Full discussions of this irrelevant debate can be found in Butzer, 1982; Courty *et al.,* 1989; Rapp, 1975; Rapp and Hill, 1998; Waters, 1992.) In a prescient, no-frills view of the subject Renfrew (1976: 2) summed it up concisely and provided these insights into the nature of geoarchaeology:

> *This discipline employs the skills of the geological scientist, using his concern for soils, sediments and land-forms to focus these upon the archaeological "site," and to investigate the circumstances which governed its*

location, its formation as a deposit and its subsequent preservation and life history. This new discipline of geoarchaeology is primarily concerned with the context in which archaeological remains are found. And since archaeology, or at least prehistoric archaeology, recovers almost all its basic data by excavation, every archaeological problem starts as a problem in geoarchaeology.

These issues of context, and what today would be called "Site Formation Processes" in its broadest sense, can and should be integrated regionally to assess concerns of site locations and distributions, and geomorphic filters that might have controlled them.

In this book – as will be seen throughout the volume – we take a decidedly pragmatic and functional approach. We do not see any need to differentiate between the two and consider geoarchaeology, archaeological geology, and geological archaeology to fall under the same rubric: any issue or subject that straddles the interface between archaeology and the earth sciences. Classifications – and in this case the distinctions between geoarchaeology and archaeological geology – are of value only if they are ultimately useful. Does it *really* matter how we categorize research that is aimed at studying postdepositional dissolution of bones at a site? According to the above this research would fall into both camps, but does it help us to know if we are doing geoarchaeology or geological archaeology or archaeological geology? For the sake of brevity, we employ the simple term, *Geoarchaeology.*

Geoarchaeology is practiced at different scales (Stein and Linse, 1993). Furthermore, its use and practice vary according to the training of the people involved and the goal of their study. For example, geologists and geographers may well emphasize the mapping of large-scale geological and geomorphological features – such as where a site may be

situated within a drainage system – or other regional landscape features. This is a regional perspective scale that exists in three dimensions, with relative relief possibly being measured in thousands of meters, especially if working in the Alps and Andes. Much of the geoarchaeological research carried out in North America is focused at this landscape scale. Geologists would also be interested in the overall *stratigraphy* of site deposits and how these might interrelate to major landforms, such as stream terraces, glacial landforms, and loess plateaus. Pedologists, on the other hand, would be more concentrated on the parent materials, the surfaces upon which soils were formed, and how both have evolved in conjunction with the landscape; such materials can be buried by subsequent deposition or can be found on the present-day surface. In either case, pedologists' focus tends to be on the scale of the soil pit, that is, on the order of meters. Archaeologists themselves may want to focus geoarchaeological attention upon microscale, centimeter-thick occupation deposits: what they are, and how they reflect specific or generalized past human activities. In the case of rescue/mitigation archaeology – commonly termed Cultural Resource Management (CRM) in the United States – geoarchaeology is tailored to the nature of the "job specifications" proscribed by the developer under the guidelines of salvage operations. Finally, the geoarchaeologist may well be just one member of an environmental team whose task is to reconstruct the full biotic/geomorphic/pedologic character of a site and its setting, and how these environments interacted with past human occupations. All these approaches can be relevant depending on the research questions involved, and holistically they could be subsumed under the term, "site formation processes" (Schiffer, 1987).

Archaeologists come from a variety of backgrounds. As stated above, in North America, archaeology is taught

predominantly in anthropology programs, although some universities (e.g. Boston University, United States, and Simon Fraser University in Canada) actually have archaeology departments; Classical and Near Eastern Archaeology programs are not rare, and these tend to emphasize written sources over excavation. In Europe, archaeology is included within programs, or in departments and institutes, and not necessarily as an extension of anthropology.

Although in the United Kingdom, geoarchaeology is taught in a number of archaeological departments, this is not always the case in Europe as a whole. In France, for example, this subject may only be taught to prehistorians and not to classical or medieval archaeologists. Commonly, even in the United Kingdom and elsewhere in the world, geoarchaeology is more likely to be seen as an *ad hoc* offshoot of geology and geography. In North America, it is not anchored in any particular department and may be cross-listed among Anthropology, Archaeology, Geology, and Geography. In spite of good intentions and good training, many geoscientists tend to be naïve in their approach to solving archaeological problems, and as a consequence they effectively reduce their potential in advancing this application of their science. This often diminishes or even negates their contributions to interdisciplinary projects. The opposite situation can be found, where an archaeologist does not even know what questions to ask (Goldberg, 1988; Thorson, 1990).

Thus, as Renfrew (1976) so cogently demonstrated, geoarchaeology provides the ultimate context for all aspects of archaeology from understanding the position of a site in a landscape setting to a comprehension of the context of individual finds and features. Without such knowledge, even the most sophisticated isotope study has limited meaning and interpretability. As banal as it might sound, the adage,

“garbage-in, garbage-out” is wholly pertinent if the geoarchaeological aspects of a site are ignored.

In the past, geoarchaeology was carried out very much by individual innovators. In North America, the names Claude Albritton Jr., Kirk Bryan, E. Antevs, E.H. Sellards, and C. Vance Haynes immediately come to mind as the early and prominent leaders in incorporating the geosciences into the framework of archaeology (see Holliday, 1997 and Mandel, 2000a for details). In fact, Mandel aptly points out that for the Great Plains, geoarchaeology – or at least geological collaboration – locally constituted an active part of archaeological survey for several areas, although it was patchy in space and time. Much of the emphasis was focused on evaluating the context of Paleoindian sites and how these occurrences figured into the peopling of the New World (Mandel, 2000).

In Europe, during the period from the 1930s to the 1950s, Zeuner (1946, 1953, 1959) at the Institute of Archaeology (now part of University College London), developed worldwide expertise in the study of the geological settings of numerous Quaternary and Holocene sites that ranged from India to Gibraltar. After Kubiëna (1938, 1953, 1970) called the world’s attention to soil micromorphology, Cornwall (1958) also at the Institute of Archaeology, applied this technique to archaeology for the first time (see below). At the same time, Dimbleby (1962) developed the link between archaeology and environmental studies, and produced one of the first detailed investigations of past vegetation and monument-buried soils for Bronze Age England Dimbleby (1962). Duchaufour (1982) in France also systematically studied environmental change and pedogenesis. In mainland Europe, the legendary French prehistorian François Bordes (1954) – whose doctorate in geology dealt with the study of loess, paleosols, and archaeological sites, principally in Northern France – placed

the French Palaeolithic within its geomorphologic setting. Vita-Finzi (1969), working in the Mediterranean Basin, used archaeological sites to suggest the chronology of Mediterranean valley fills, which he related to both climatic and anthropogenic factors. Cremaschi (1987) investigated paleosols and prehistoric archaeology in Italy.

Although some geoarchaeological research is funded by granting agencies (NSF, NGS, NERC, CNRS), much, if not most, of modern geoarchaeological work – in both the New and Old Worlds – is fostered and sponsored by CRM projects, ultimately related to human development throughout the world. Approaches and job specifications vary according to whether investigations are at one end of the spectrum, short-term one-off studies, or long-term research projects at the other. Geoarchaeological work can be done by single private contractors or by huge international teams, which may well include specialists who also act as private contractors. Nowadays, local authorities, government agencies (e.g. State Departments of Transportation in the United States) and national research funding agencies (e.g. NSF in the United States, AHRB and English Heritage in the United Kingdom, AFAN and the CNRS in France, and Nara National Institute in Japan) may all be involved in commissioning geoarchaeological investigations. It is currently a very flexible field. It is also one where there is an increasing need for formal training, but where relatively few practitioners have been in receipt of one.

Geoarchaeological work is now often broken up into several phases, with desktop investigations, fieldwork survey, excavation, sample assessment, and laboratory study, all being likely precursors to full analysis and final publication. This is all part of modern funding and operational procedures.

Single-job or site-specific studies may be as straightforward as finding out “What is this fill?” whereas

problem-based research could involve the gathering of geoarchaeological data on the possible first controlled use of fire, as at Zhoukoudian, China (Goldberg *et al.*, 2001; Weiner, 1998). Sites are investigated at different scales and sometimes, for very different reasons. At one time “dark earth” – the dark colored Roman-medieval urban deposits found in urban sites across northern Europe – engaged the particular interest of geoarchaeologists because these enigmatic deposits commonly span the “Dark Ages,” and human activities at this time were poorly understood (Macphail, 1994; Macphail *et al.*, 2003). Analysis of “dark earth” therefore, became a research-funded topic for urban development sites (CRM projects in urban areas) across Belgium, France, and the United Kingdom, for example. On the other hand, attention can be focused on individual middens and midden formation because they provide a wealth of material remains, particularly organic, that are normally poorly preserved and complex to understand and interpret (Stein, 1992). Regional studies of the intertidal zone, for example, may include the investigation of middens as one single component. The recent study of the intertidal deposits of the River Severn around Goldcliff, Wales, for example, involved analysis of sediment and drowned soils in order to investigate sea level changes and their effects on the populations living in the coastal zone during the Mesolithic through Iron Age periods (Bell *et al.*, 2000). Equally, studies of alluvial deposits and associated flood-plains (Brown, 1997; French, 2003) have involved the search for buried sites, within the overall realm of evaluating the distribution of archaeological sites. The Po plain of Italy (Cremaschi, 1987) and the Yellow River of China (Jing *et al.*, 1995) both feature a series of late prehistoric settlements. Many of the most significant Paleoindian and Archaic sites in the United States are situated within alluvial sequences (Ferring, 1992, 1995; Mandel, 1995, 2000a).

Dead Sea
Deansway, Worcester, UK
Die Kelders Cave, South Africa
Dmanisi, Republic of Georgia
Dry Creek site, central Alaska
Dust Cave, Alabama
Ecsegfalva, Hungary
El Castillo, Spain
Er Grah, France
Et-Tabun Cave, Israel
Finley site, Wyoming
Fishbourne, UK
Geißenklösterle, Germany
Gesher Benot Ya’akov, Israel
Goldcliff, UK
Gorham’s Cave, Gibraltar
Gough’s Cave, Cheddar Gorge, UK
Grand Erg Oriental, North Africa
Great Lakes, USA
Great Salt Lake
Hamifgash area, Western Negev of Israel
Hampton Court, UK
Hayonim Cave, Israel
Hazleton, UK
Hell Gap, Wyoming, USA
Hohle Fels, Germany
Hopeton Earthworks site, Ohio
Hungary
Jordan
Jordan Valley
Kebara Cave, Israel
Kharga Oasis, Egypt
Killpecker Dune Field, Wyoming, USA

Koobi Fora, Kenya
Lake Lisan, Jordan Valley
Lake Mungo, Australia
Lascaux, France
London (Guildhall) amphitheatre, UK
London basilica, UK
Magdeburg, Germany
Maiden Castle, UK
Meadowcroft Rockshelter, PA
Mississippi River
Monte Verde, Chile
Nabta Playa, Southern Egypt
Nahal Besor, Israel
Nahal Sekher, Israel
Nahal Zin, Israel
Namib Desert; Sahara; Arabia
Negev, Israel
Nizzana, Israel
Oakley, UK
Ohalo II, Israel
Olduvai Gorge, Tanzania
Overton Down, UK
Pevensey Castle, UK
Pincevent, France
Po plain, Italy
Pompeii, Italy
Poultry, London, UK
Potterne, UK
Qafzeh Cave, Israel
Qseima/Qadesh Barnea, Sinai
Raunds, Northamptonshire, UK
Rose Theatre, London, UK
St. Julien, Tours, France

Schöningen, Germany
Scladina Cave, Belgium
Scole, UK
Sea of Galilee (Lake Kinneret)
Shiqmim, Israel
Simpson Desert, Australia
Sinai
Southern Plains, USA: Texas, Oklahoma
Spitalfields, London, UK
Stonehenge, UK
Stratton, UK
Underdown Lane, UK
Umeå, Sweden
Tajikistan
Tarquinia, Italy
Tel Leilan, Syria
Three Ways Wharf, Uxbridge
Tilleda, Germany
Tonto Basin, Arizona
Tower of London
‘Ubeidiya, Israel
Uzbekistan
Uxbridge, UK
Vanguard Cave, Gibraltar
Vässingstugan, Sweden
Vesuvius, Italy
Wadi Mushabi, Sinai
Wareham, UK
Warren Villas, UK
Westbury Cave, UK
West Heath, UK
West Heslerton, UK
West Stow, UK

Whitewater Draw, Arizona
Willendorf, Austria
Wilson-Leonard site, Texas
Yellow River, China
Zhoukoudian, China

Archaeological, Geological and Chronological Periods and Cultures

Allerød
Altithermal
Anglian Period (Pleistocene)
Anglo-Saxon Period
Archaic, USA
Aterian
Atlantic Period
Aurignacian
Beaker Period
Boreal Period
Bronze Age
Brunhes/Matuyama boundary
Byzantine
Chalcolithic (Copper Age)
Clovis
Dryas
Epi-Gravettian
Epi-Palaeolithic
Flandrian
Geometric Kebaran
Gravettian