Book Reviews

Boxgrove: A Middle Pleistocene Hominid Site at Eartham Quarry, Boxgrove, West Sussex. M. B. Roberts and S. A. Parfitt, with contributors, 1999, English Heritage (P. O. Box 229, Northampton NN6 9RY, U.K.), Archaeological Report 17, London, xxiv + 456 pp., $128.00.

The county of West Sussex in the South of England, long notorious in anthropological circles for the Piltdown forgery, has now produced at Boxgrove not only a superbly preserved Middle Pleistocene archaeological and paleontological record, but also at last a legitimate homind fossil. The region has long been known to be fossiliferous, and the local raised beach succession was initially described by Prestwich (1859). Boxgrove itself is the site of a commercial sand and gravel quarry, and the project described here began work in 1983 as a rescue operation. The pace of research accelerated in the late 1980s with the commencement of larger scale quarrying. Happily, this coincided with the more active involvement of English Heritage, and the authors are able to report that large portions of the site complex have been declared a site of special scientific interest (SSSI) and are no longer under threat.

The present volume reports work carried out from 1983 to 1992, although it includes a few details concerning the Boxgrove hominid tibia (Roberts et al., 1994; Stringer, 1996), discovered in 1993. The aim of the volume is to provide the geological and paleoenvironmental framework, and to resolve issues of context for the fossil and artifactual finds. This it does through a series of 37 specialized reports and three appendices, contributed by Roberts, Parfitt, and 32 additional specialists. Reports are grouped into six chapters devoted to background, geology, nonmammalian paleontology, mammalian paleontology, dating attempts, and archaeology.

The Boxgrove sediments are described here as the Slindon and Eartham Formations, exposed in a narrow outcrop trending E–W for a length of about 10 km, east of the town of Chichester and about 12 km north of the present-day shore of the English Channel. Both formations appear to have accumulated at the base of an ancient chalk cliff whose now-buried outlines have been revealed through resistivity (Lewis and Roberts, Chapter 2.2). The Slindon Formation, unconformably overlying Cretaceous Upper Chalk, comprises a marine fining-upward sequence, and is divided into a lowermost gravel member (numbered units 1 and 2), a sand member (unit 3), and an uppermost silt member (units 4 and 5). The overlying Eartham Formation (units 6–11) is terrestrial in origin, its sediments derived primarily from the decomposition of the chalk cliff. The lower sediments appear to represent a temperate marine environment, and three marine cycles are recognized by Collcutt (Chapter 2.3) in the sands of unit 3 alone. The upper deposits seem to have been laid down under colder conditions at the onset of the "Anglian" glaciation. From the evidence of pollen and plant trace fossils (cf. Roberts, 1986), local vegetation appears to have been comprised primarily of grasses, with woodland probably existing at higher elevations on the nearby chalk downlands.

Artifacts and fossils are found in relatively small numbers in the sands of the middle Slindon Formation and the chalk gravel of the Eartham Formation. The major artifact and fossil bearing deposits are the silts and marls (units 4a and 4b) of the upper Slindon Formation, representing an intertidal environment, and unit 4c, a paleosol developed upon them. Examination of sediment micromorphology and estimates of sediment "ripening" lead MacPhail and Goldberg (Chapter 2.6) to estimate a lifespan for the landsurface represented by this paleosol at < 100 years. Fauna occurs in concentrations associated with flint knapping debris in units 4a and 4b; on the 4c paleosol bones are more dispersed and show more extensive signs of weathering, trampling, and carnivore ravaging. Bones are best preserved in the northern exposures near the ancient chalk cliff, where they have been less affected by decalcification than elsewhere in the site complex.

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The Middle Pleistocene fauna would conventionally be described as "Cromerian" *sensu lato*, and one project aim, reasonably enough, is to provide a more precise age estimate. The authors are resourceful in the application of current dating techniques and even-handed in evaluating the results. The disappointing outcome reflects the current state of play in the discipline, and the exasperating limits of the methods available for this important time period. Application of AAG (amino acid geochronology, Bowen and Sykes, Chapter 5.6) and DRM (depositional remnant magnetism, David and Lindford, Chapter 5.7) produced no usable results. U-series (Rae, Chapter 5.2), IRSL (infra-red stimulated luminescence, Parks and Rendell, Chapter 5.3) , OSL (optically stimulated luminescence, Rhodes, Chapter 5.4), and ESR (electron spin resonance, Grün, Chapter 5.5) yielded estimates ranging from 175 ka to $>$ 350 ka. Biostratigraphic correlation on the basis of calcareous nannoplanktons (Gard, Chapter 5.8) indicates that the Boxgrove sediments may have been deposited during OIS (oxgen isotope stage) 11 (423–362 ka). In the end, Roberts and Parfitt opt for the age indicated by the "Cromerian" mammalian fossil fauna, that is, OIS 13, or 524–478 ka. If this assessment is accurate, Boxgrove is roughly contemporary with sites such as High Lodge (Ashton et al., 1992) and Kent's Cavern (Campbell and Sampson, 1971) and, with them, represents the earliest occupation of Britain (Roebrooks, 1994; Roebrooks and van Kolfschoten, 1994; Roberts et al., 1995).

As a paleontological site alone, Boxgrove is remarkable. The vertebrate assemblage represents a minimum of 88 species, including numerous birds (Harrison and Stewart, Chapter 3.6), reptiles (Holman, Chapter 3.5), and fish (Parfitt and Irving, Chapter 3.4). The mammalian fauna (Parfitt, Chapter 4) includes 50 species, 11 of which are extinct. Rodents, lagomorphs, bats, and insectivores are abundant. The most common large carnivore is the wolf, though cave bear, spotted hyena, and lion are also present, together with an unidentified elephant and the extinct rhinoceros, *Stephanorhinus hundsheimensis*. Among the artiodactyls, the cervids are abundant and diverse, and include red, roe, and fallow deer, as well as the extinct giant deer, *Megaloceros* cf *verticornis*.

Detailed archaeological excavations were carried out in "Quarry 1" and "Quarry 2," about 600 m to the east, both as lateral exposures of fairly large areas (30–100 m^2) and in exploratory test pits. Although Roberts shies away from use of the term "Acheulian," Middle Pleistocene flint knapping at Boxgrove seems to have been directed almost exclusively toward the production of smallish ovate handaxes. There are few other retouched tools and, surprisingly, no cores unrelated to biface manufacture. Raw material is thought to be flint cobbles from the nearby chalk cliff (Roberts, 1986), and large numbers of unfinished roughouts have been found in this area of the site complex. Replication experiments (Wenban-Smith, Chapter 6.4) indicate that hard percussors, in some cases including flint nodules retaining their cortex, were used for the initial shaping, whereas final thinning was sometimes accomplished with a soft organic percussor, such as wood, bone, or antler. Extensive exposure of paleosol unit 4c shows a dispersed pattern of artifact distribution in area A of Quarry 1, where not all products of the reduction sequence are present. In area B of Quarry 1, however, overlapping refitting artifact scatters reveal three distinct episodes of handaxe shaping and resharpening.

For units 4a and 4b, artifact refitting and microdebitage analysis (Austin, Bergman, Roberts, and Wilhelmsen, Chapter 6.2) strongly support a sometimes startling degree of site integrity. At Quarry 1 area A, for example, a flake scatter was found in unit 4b together with quantities of tiny flake fragments and flint dust; 51% of the individual flakes were found to refit, and earlier flake removals were found to lie below later removals, suggesting they lay as they fell. At site GTP 17 in Quarry 2, refitting in one scatter in unit 4b had a remarkable success rate of 60%. This refitting resulted in a single nodule with 70% of its surface covered by cortex, and a void in the middle conforming to the shape of an ovate handaxe roughout.

At GTP 17, six or more nodules of flint derived from the chalk cliff 40 m to the north appear to have been transported to this spot on the mudflats. Reduction of the nodules resulted in the production of $>$ 1800 pieces of lithic debris $>$ 20 mm in size. Some of the artifacts were apparently used to butcher a large horse (*Equus ferus*) and to smash up the bones for marrow extraction. From analysis of cutmarks and other traces of bone modification, both macroscopic and microscopic, the authors (Austin et al., Chapter 6.2; Parfitt and Roberts, Chapter 6.5) argue for early hominid access to carcasses. The fact that carnivore toothmarks are never found to underlie hominid cutmarks at Boxgrove is a particulary com-

pelling bit of evidence in their favor. More controversial will be the semicircular "wound" in a horse scapula from site GTP 17, interpreted by Roberts (Chapter 6.2) as the result of a puncture from a projectile.

Clearly, the hominids whose occupational residues are represented at Boxgrove were capable of a good degree of foresight, as raw materials and partially finished artifacts were transported for distances of several hundred meters, most likely for the purposes of dismembering and processing large mammal carcasses. However, chimpanzees hunt and transport stone (Boesch and Boesch, 1983, 1984, 1989; Boesch-Achermann and Boesch, 1994), and even the earliest archaeological sites are best regarded as artifact input-output systems (e.g., Bunn et al., 1980). At Boxgrove, cutmarks and other signs of modification are found most frequently on the bones of deer, horse, rhino, and wolf, and the authors recognize traces of skinning, disarticulation, filleting, and marrow extraction, although more details are needed to substantiate this. It is particularly interesting that they claim to be able to distinguish between cutmarks made by flakes and those made by bifaces, and that a particular form of "bipolar" impact damage seems strongly to indicate that bones were rested upon stone anvils when smashed open for marrow.

At the close of this volume, after a useful review of the Middle Pleistocene hominid fossil record (Stringer, Chapter 6.6), Stringer and Trinkaus (Chapter 6.7) discuss the Boxgrove hominid tibial fragment and its implications. What is chiefly notable about this specimen is its size and degree of robusticity. While neither epiphysis is present, the large transverse and circumferential dimensions of the diaphysis place the Boxgrove tibia at or beyond the limit of the ranges for a comparative sample. Stringer and Trinkaus suggest a stature estimate of 1.77–1.82 m, which exceeds all previously known estimates for Lower and Middle Pleistocene hominids outside the tropics. The body weight estimate of 80 kg provided by Roberts et al. (1994) is probably not excessive, and thus the Boxgrove homind confirms the impression of very large body mass for Middle Pleistocene hominids at both high and low latitudes (cf. Ruff, 1993; Grine et al., 1995; Ruff et al., 1997; Kappelman, 1997).

This is a volume by specialists for specialists. Although a two-page glossary is provided at the beginning of the volume, much of the professional vocabulary employed here (e.g., "diamicts," p. 304) is not found in the glossary and is unlikely to be familiar to amateurs. The many well-produced photos and site plans provide an exceptionally detailed source of information, and the reconstructions of Boxgrove during the different phases of its depositional history (Figures 87–89) are particularly well suited to adaptation for a museum exhibit or popular account. The index is far from exhaustive, lacking entries for such common terms as "raw material" and "microwear," and this reader found it difficult at times to integrate information from the separate geological, paleontological, and archaeological sections of the book. But these are minor quibbles with a very elegant presentation of a massive amount of data. The authors are to be congratulated for a fine achievement, and for their restraint in not attempting to paper over discrepancies among the different lines of evidence that are bound to emerge in a project of this scope. The work continues (Roberts et al., 1997), and an anticipated additional monograph in this series (Roberts et al., in preparation) will address further aspects of hominid behavior at Boxgrove.

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Geoarchaeology: Exploration, Environments, Resources. A.M. Pollard (Editor), 1999, The Geological Society, London, Geological Society Special Publication 165, 180 pp., $104.00 (hardbound).

This collection of papers edited by Professor Mark Pollard (University of Bradford, UK) is the result of a session on geoarchaeology convened at the "Geosciences 98" conference organized by The Geological Society. The speed of publication in little over a year is commendable and a credit to the editor, contributors, and publishing house staff.

In the Introduction to the volume, Pollard clearly states that it is not the purpose of this book to discuss the semantics of the term "geoarchaeology" or the range of geosciences that it encompasses. Instead, a broad definition is adopted to include chemical analysis and geophysics, as well as the more

traditional subset of geosciences including geomorphology, sedimentology, pedology, and stratigraphy that are usually associated with the subject. The resulting collection of 12 papers is therefore diverse, and, to provide structure, the papers have been grouped under the themes of Exploration, Environments, and Resources.

The three papers assembled under the theme of Exploration are all concerned with development and testing of ground-based remote sensing techniques modified from methodologies used in exploration geophysics. In the opening paper, Vernon et al. show the potential of fluxgate gradiometry and magnetic susceptibility to identify processing structures on iron and lead smelting sites in North Yorkshire (UK). In the second paper, Cuss and Styles deal with the problems of using geophysics in urban areas, particularly related to "noise" and demonstrate the application of high resolution microgravity measurements to locate 19th century tunnels built beneath the Edge Hill district of Liverpool (UK). In the final paper, Murdie et al. produce vertical profiles of buried features at the Roman-British site of Wroxeter (UK) using Euler deconvolution on magnetic gradiometry data and compare them with those produced by GPR survey over the same area. All three papers show the potential of ground-based remote sensing techniques and are commendable critical of their approaches, illustrating that these techniques are of most value when used as part of multidisciplinary studies. For example, Vernon et al. stress the need for further information on smelting processes to interpret fully the results of their surveys and should also be congratulated for including examples of geophysical survey that have produced inconclusive results. Cuss and Styles admit that success was only possible because of an initial comprehensive desktop study of documentary records and preliminary field survey that allowed assessment of the likely depths and conditions of impassable tunnels and enabled appropriate techniques and survey parameters to be established. The quality of illustrations in this section is generally high and, in the case of the geophysical plots, allow the reader to assess fully the interpretations discussed in the text. The only exceptions are Figures 3, 5, and 6 in the paper by Cuss and Styles, which should have been reproduced to a larger size.

Three papers covering widely differing topics and timescales are grouped under the second theme of Environment. The opening paper by Latham et al. reconsiders the interpretation of cave sediment stratigraphy in Makapansgat Cave, South Africa, the site of important Australopithecine discoveries. This paper provides more questions than answers, but illustrates the spirit of geoarchaeology, in that a full understanding of this site will only be achieved through parallel investigations by a multidisciplinary team including both archaeologists and geologists. Importantly, it illustrates that there are considerable problems of interpretation at well-researched "classic" sites. Despite scientific advances, too often classic localities are ignored on the basis that they will yield no new information or because it is assumed that interpretations are beyond doubt. Changing timescales considerably, the second paper by Tipping et al. considers the palynological content of a free draining ferric podzol soil profile in southern Scotland, dated by three known age inputs since ca. 1840 A.D. (non-native tree pollen, spheroidal carbonaceous particles and ^{137}Cs). Pollen in soils buried beneath archaeological sites is often used to provide palaeoecological information, but this study shows that even over a short period of time, the pollen is thoroughly mixed and in this context, is of little palaeoecological value. The final paper, in this section by Thorncroft et al., assesses the potential of geochemical analysis of fluvial sediments to provide evidence of prehistoric tin mining on Dartmoor (UK) and a possible source for the rapid demand in bronze that occurred around 4000 years ago. To date, no surface or subsurface archaeological evidence of prehistoric mining activity has been recorded, possibly as a consequence of destruction of sites during later phases of mining. However, the earliest evidence of the enrichment of fluvial sediments with tin dates to after 1280 $\pm$ 45 A.D., corresponding with documentary evidence. Therefore, the search for evidence of prehistoric mining must continue. In all three papers in this section, the quality of the illustrations is high.

Six papers are grouped under the third and final theme of Resources. The first two consider the provenance of raw materials moved by boat and the implications for medieval and post-medieval trade routes. The first paper by Young and Thomas provides an assessment of regional Iron Ore trade around the Bristol Channel Orefield (UK) through detailed petrological and textural analysis of iron ore recovered from a foundered boat. The second paper by Lazareth and Mercier provides evidence of trade at a European scale from the analysis of the petrology, geochemistry, and K/Ar dating of selected granite

ballast boulders found on archaeological sites in La Rochelle and Brouage (France). Although petrology and geochemistry proved helpful in this latter study for provenancing the granites to particular regions, this work showed that dating control was critical for provenancing boulders to particular intrusive bodies in the United Kingdom and Ireland. Although the standard of illustration in both these papers is high, the inclusion of petrological thin sections as color plates may have aided presentation. The third paper in this theme highlights the significance of the Alum industry in North Yorkshire (UK) as a source of raw material for textile dyeing during the 17th and 18th centuries A.D. The paper provides interesting initial results, but is let down by the lack of illustrations (for example, a map showing localities mentioned in the text). The next two papers provide details of chemical processes. Budd et al. consider the chemical processes involved in the manufacture of brass, and Thomas and Young attempt to model the chemical interaction between ores, furnace lining, and fuel ash in an iron furnace. This latter study aims to improve our ability to provenance slag found on archaeological sites and is validated using smelting slags, furnace lining, and roasted ore fragments from a Roman iron-making town in Herefordshire (UK). While I appreciate that Thomas and Young's previous chapter in the book detailed the local ore industry of the study region, this paper may well be read in isolation from the others in the book and therefore some location and geological maps of the study area would have proved useful. The final paper of the section and book provides a synthesis of archaeological studies, which have taken place in the Southern Urals of the Former Soviet Union since 1991. In particular, it focuses on the exploitation of gold, copper, and lead, as well as the trade in lithic material between Bronze Age settlements of the region.

The papers collected in this volume are diverse and illustrate the range of research being undertaken in the broad field of geoarchaeology. A book of this type is always going to be dependent on the range of conference presentations offered, and it's a pity that examples of research using other developing techniques such as Ground Penetrating Radar, Airborne Multi-Spectral Remote Sensing, and landscape modeling using GIS were not offered. However, despite a few grumbles regarding illustrations, the standard of research is high, and many of the papers are topical and very applied. Aspects of this book should undoubtedly be required reading for undergraduates, postgraduates, academic researchers, and geoarchaeologists working in the commercial sector. Significantly, from a UK perspective, its publication by The Geological Society certainly indicates that (in the UK) geoarchaeology is finally being considered as a mainstream subject.

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Paleoenvironmental Reconstruction in Arid Lands. A.K. Singhvi and E. Derbyshire (Editors), 1999, A.A. Balkema, Rotterdam, ix + 326 pp., $85.00 (hardbound).

Drylands, broadly conceived, comprise about 35% of the world's land surface. These arid and semiarid regions are sensitive to regional or global climatic variations, and throughout prehistory the size and aridity of drylands have waxed and waned in response to climate change, with dramatic consequences for people who lived there. The record of environmental change in drylands is of fundamental importance to understanding many problems in the evolution of human societies. This volume brings together a diversified array of approaches that illustrate how paleoenvironmental history of dryland environments can be reconstructed.

The volume is a product of the International Geological Correlation Programme's Project 349, dealing with "Desert Margins and Palaeomonsoons of the Old World: 135,000 Years to the Present," which ran from 1993–1997. Part of Project 349 was a series of training workshops on methods of paleoenvironmental reconstruction, and the 11 chapters included here are based on those courses. They cover a wide range of disciplines with an emphasis on the earth sciences, including geomorphology, pedology, remote sensing, speleothems, plant geography, archaeobotany, and radiocarbon dating. The chapters generally examine the major principles of interpretation, methods used in the field, lab, and in analysis, drawbacks and cautionary notes about the various methods, and case studies showing how they were successfully used. Examples are usually (though not exclusively) drawn from Old World drylands, but the disciplines are clearly applicable to studying drylands worldwide.

E. Derbyshire begins the volume with a consideration of "climatic geomorphology," how landforms may (or may not) be useful for understanding past climatic regimes and changes. His broad ranging chapter makes a good introductory setup for the volume as a whole. Derbyshire examines global climatic changes, likely local geomorphic effects, threshold effects, and the difficulties of linking all of these from a process standpoint in local settings. He stresses that the relationship between landform change and climate change is complex indeed, and many generalizations about process relationships have proven difficult to sustain. Issues of equifinality often make the assignment of certain landform features to correspond to certain climatic patterns difficult or impossible. As Derbyshire (p. 21) puts it, "information on palaeogeomorphological responses to climate change are sparse . . . [because of] the inherent complexity of the multifactorial relationship between landforms and climate." Yet he finds that landforms can provide correlative information on climate, in conjunction with other data sets including solid stratigraphic or sedimentological records. Derbyshire uses examples from Africa, Australia, and western China to show linkages between fluvial system landforms and climate change, and discusses aeolian system change in the context of his own work on the Loess Plateau in China.

Derbyshire's introduction is followed by K. White's brief primer on remote sensing technology and its application in geomorphological mapping of drylands. Remote sensing has been an essential tool for geomorphological and geoarchaeological interpretation for quite some time now. White covers basic system designs and principles of spectral recognition and discrimination, and then explores some applications for aeolian and fluvial systems.

At the other extreme from remote sensing is the "intimate sensing" approach to soil micromorphology described by R. Kemp—the microscopic study of thin sections to identify a soil's fabrics and features. Under the microscope, a soil's fabric can reveal different phases of soil development such as alternating wet or dry climatic cycles, that differentially translocate clay fillings around larger mineral grains. Kemp begins with details of soil sampling, thin section preparation, and data presentation and interpretation. He then discusses main features of dryland soil micromorphology and the major factors affecting their presence in a soil. Kemp notes that soil micromorphology has not been used extensively in studies of arid lands, but the rewards of such studies seem compelling. Such studies should be equally rewarding at archaeological sites, where human activities have distinct and interpretable impacts on soils.

The soil science theme is expanded in the next chapter by N. Fedoroff and M. Courty, who give a detailed discussion of soil forming processes under conditions of increasing aridity. Dryland soils respond to increasing aridity as well as increasing moisture. Aridity affects the translocation of soil articles through the column, the development of surface crusts, proneness to flooding events, shrinking and swelling cycles, chemical weathering processes, and the accretion of carbonates and salts. Effects of these processes can in turn be recognized in both soils and paleosols in drylands. Fedoroff and Courty note that the lithified ancient soils sometimes found preserved in drylands sometimes allow a longer time range for paleoenvironmental interpretation than is customary in geomorphic or palynologic records. The authors call for greater interaction with archaeologists in working out the chronology of "pedo-sedimentary" sequences, particularly for the Holocene.

Continuing along this theme, S. Tandon and S. Kumar delve deeply into the soil deposits known generically as calcretes. Calcretes typically form in seasonal climates with 400–600 mm annual precipitation and net moisture deficit. Though they are a nightmare to dig through, calcretes can be very useful for paleoenvironmental interpretation. Isotopes of carbon and oxygen have proven especially valuable.

Dating of calcretes have been attempted using radiocarbon, luminescence, uranium series, and electron spin resonance, but this has proven quite difficult, as calcretes remain a somewhat open system.

K. Glennie's enjoyable discussion of dunes as indicators of climate change begins with some basics of dune formation in response to wind direction and intensity. Then it jumps to a review of global atmospheric dynamics in glacial and interglacial times, with effects on the distribution of deserts, sea surface, and global wind regimes. This forms the backdrop for an examination of superimposed dune systems in the Arabian Peninsula, and what they can tell us about changing climates.

G. Nanson and S. Tooth turn to fluvial systems in drylands, and how they can indicate climate change. River systems in arid zones have been less well studied than those in more humid climes, and arid-land fluvial sequences have proven difficult to date. Advances in luminescence dating of fluvial sediments lead Nanson and Tooth to suspect that, in the future, fluvial systems may become the main source of evidence for precipitation change in drylands. After discussing major factors affecting flow regimes, the authors point to problems associated with using fluvial systems as paleoclimatic indicators. Equifinality is one well-known issue; another is the strong response to flashy episodic floods and the related result that many arid-zone rivers are nonequilibrium systems. Nanson and Tooth use four well-described case studies (from the American Southwest, Australia, and the Nile River Valley) to emphasize the important scale-dependent responses of different fluvial systems to climate change. Small headwater systems are responsive to minor climate changes, but have a short-term alluvial record. Larger systems may be less responsive to short-term climatic events, but contain a more detailed record of longer-term trends. Even larger basins, such as the Nile, integrate climate over large regional or global scales.

Speleothems are an often overlooked source of paleoenvironmental information in drylands, but, as G. Brooks's chapter shows, they shouldn't be. The detailed and often high-resolution stratigraphic records preserved in stalactites, stalagmites, and flowstone sheets can indicate episodes of increased moisture, decreased moisture (e.g., if speleothems are now submerged), and changing atmospheric conditions. Most promising is the use of carbon, oxygen, and hydrogen isotopes to reconstruct paleotemperatures or air mass dominance. Speleothems may encase and preserve pollen in areas where fossil pollen is otherwise scarce. Brooks details the sampling and dating of speleothems, describes the use of isotopic signatures, and illustrates how speleothems can provide extremely high-resolution terrestrial records rivaling tree-ring series or varves. As Brooks notes, the future is bright for speleothem studies in the 21st century.

A more traditional approach to paleoclimatic reconstruction is provided by S. Ghazanfar, who describes how plant geography—floristic similarities among regions, patterns of endemism, and distribution of relict plant taxa—can be used to learn how past patterns of climate affected the development of modern vegetation. Ghazanfar examines the flora of Arabia and surrounding regions in this light, seeing connections to the floras of northeastern Africa, Oman, Baluchistan, and southern Iran, and concluding that a period of enhanced humidity prevailed sometime during the past which allowed plant species to migrate and intermingle. Although this method is coarse-grained, and not greatly amenable to refined dating or assessing the magnitude of climatic change, plant geography remains a useful corroborative tool.

Additional evidence of vegetation change is obtained from fossil plant remains, of course, including those from archaeological sites. H. Barakat and C. Rolando provide a good example by using charcoal analysis (anthracology) to record past shifts in the margins of the Sahara Desert. They describe the utility, methods, and pitfalls of charcoal analysis, and then use charcoal identifications from several Neolithic sites in the southern Sahara to document aridification fluxes during the middle to late Holocene.

Finally, M. Head discusses radiocarbon dating of various materials common to arid regions, and the problems attendant therein. The author briefly but lucidly describes the radiocarbon method, how dates are calculated, and how to collect and prepare samples. He then considers use of specific materials in more detail: fossil wood, charcoal, plant macrofossils, pollen and peat, phytoliths, sediments and soils, carbonates, shells, and bone. Though these discussions can get a bit "cookbooky" on the lab methods, they contain valuable cautions about problems potentially associated with many samples. They serve

to give the reader a deeper sense of the complexities involved in this mainstay of archaeological and paleoenvironmental dating.

Altogether, this volume is an eclectic look at a range of (mostly) earth science approaches to paleoenvironmental reconstruction in drylands. The papers are all informative, although they vary in the level of technical information presented; some are accessible as introductory reviews, while others are larded with enough technical jargon to warrant a geological dictionary close at hand. The quality of the illustrations, including color photographs of soil thin sections, is generally quite good and to the point. Chapter references, while not comprehensive, are useful starting points for deeper investigations of the relevant literature. One can think of various topics of importance in dryland paleoenvironmental reconstruction that were left out (e.g., paleolake histories, pollen analysis, faunal accumulations, sedimentology, surface ages, paleomonsoons), but some of these are touched on tangentially, and a single book cannot do everything. Examples of archaeological applications are relatively few in this volume, but geoarchaeologists working in arid lands will no doubt find many applications of the methods described in this book useful in their own studies.

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Seriation, Stratigraphy, and Index Fossils: The Backbone of Archaeological Dating. Michael J. O'Brien and R. Lee Lyman, 1999, Kluwer/Plenum, xi + 253 pp., $59.95 (hardbound).

In this volume O'Brien and Lyman explore the principles, uses, and historical development of archaeology's traditional relative dating techniques: seriation, stratigraphic excavation, and cross-dating. The authors believe that these important tools for keeping track of time are routinely underappreciated and misrepresented in modern archaeological practice, and they seek to rectify this situation by accomplishing two primary goals. The first is to describe in detail how each dating method works, the second to explain these techniques in the context of their historical development in (primarily) North American archaeology. In so doing, O'Brien and Lyman have set out to produce a work that will be of use to all archaeologists, from graduate students to established professionals.

Anyone familiar with developments in North America has touched base with recent articles and volumes by O'Brien and Lyman, advocating the development of evolutionary theory for archaeology. The authors' concern for relative dating techniques is no isolated indulgence, but stems directly from challenges posed by evolutionary archaeology, especially the definition of analytical units and the assessment of historical relationships among archaeological units. It is no accident that they devote half the book to artifact types and seriation.

Chapter 1 sets the stage by spelling out terminological distinctions between relative and absolute concepts of time, continuous and discontinuous time, direct and indirect dating, measurement scales (e.g., nominal, ordinal), and ideational versus empirical units of study. Thus, regarding the latter one learns that time is real (empirical), but units used to measure it are ideational. O'Brien and Lyman also promise to set straight some common misconceptions. By page 7, for example, one is told to anticipate learning that, contrary to conventional wisdom, a "stratigraphic revolution" in the early 1900s was not responsible for an emerging interest in measuring time (rather the key change was in how artifacts were studied); that seriation was not a European invention (frequency seriation was an American invention); and that archaeology's efforts to become scientific did not originate with the processual movement of the 1960s (it began in the early 1900s, with the measurement of time).

Most of Chapter 2 is devoted to exploring the contributions of James A. Ford and James B. Griffin, whose work with prehistoric ceramics from the Mississippi Valley in the early to mid-1900s brought the conceptual issues surrounding chronological artifact types to the forefront of archaeological discussion. For Ford especially, ceramic types were conceptual tools created by archaeologists, useful to the extent that they monitored the passage of time. Types were thus ideational units, but trial-and-error rather than explicit theory was the standard guide, with one charting the waxing and waning of types through time. O'Brien and Lyman detail the confusion that resulted when some archaeologists, most notably Albert C. Spaulding, could not accommodate the apparent arbitrariness of types so conceived, and proposed instead quantitative techniques for discovering "real" types in individual assemblages. The ensuing debates have been well chronicled by others, but O'Brien and Lyman's important contribution is framing them in a clear theoretical context: Ford and other culture historians could not explain rigorously *why* chronological types behaved over time as they did. Phrased differently, the demonstrably successful units used to measure time (chronological types) were ideational, but the theory governing their success remained unknown.

Enter seriation, to which O'Brien and Lyman devote Chapters 3 and 4. Seriation as a relative dating technique is based on the simple procedure of placing objects or sets of objects in an order based on their degree of formal similarity. As explained by the authors, the successful extraction of temporal information in this way depends on two assumptions: *historical continuity* (similarity in form denotes proximity in time), and *heritable continuity* (similarity in form denotes relatedness). Demonstrating that an artifact series exhibits historical continuity requires independent data, for example, documenting the proposed sequence from stratigraphically superposed deposits. Assuming that step, one can move to the trickier task of assessing heritable continuity, that is, whether the sequence is actually a lineage.

At this juncture the authors consider how the challenge of resolving heritable continuity is undertaken by paleobiologists seeking to establish phylogenetic sequences among nonhuman organisms. Through 12 pages of Chapter 3, one encounters basic contents of the paleobiological toolkit, including the important distinction between homologous and analogous similarities, shared primitive (symplesiomorphic) versus shared derived (synapomorphic) traits, chronospecies versus biological species, principles of cladistic analysis, and so on. The relevance of this conceptual arsenal resides in the presumed comparability between genetically mediated inheritance among nonhuman organisms and nongenetic inheritance among humans. Thus, O'Brien and Lyman refer to a "geneticlike" (p. 65) connection between ancestral and descendent phenomena, and hold the common denominator between organisms and artifacts to be "replication" involving "transmission" (p. 73). They go on to conclude that "heritable continuity is, by definition, phylogenetic, regardless of the mechanisms of transmission and regardless of what is transmitted" (p. 101).

In view of the standard complaint that genetic and cultural processes are not the same, however, O'Brien and Lyman have (narrowly) missed the bull's-eye in specifying the crucial sense in which those processes are the same. The property shared by genetic and cultural systems that is responsible for heritable continuity resides, in fact, squarely in the unanswered question of what is transmitted in both cases. The answer is, *information that affects the expression of an organism's phenotype.* Thus, homologous similarities reflect *continuity of information flow*, and in this crucial sense one can speak equivalently of trilobite and pottery vessel lineages. This is not different from anything said by O'Brien and Lyman, but is, I believe, a clearer way of saying it. And why should we worry about a small measure of added clarity? As O'Brien and Lyman (p. 22) insist, "Science is one sense-making system that requires precision; we cannot leave terms undefined . . . ."

Importantly, in the case of cultural information flow, seriation requires, or at least works best, when it tracks trait expressions that do not propagate according to directional processes such as natural selection. As appreciated in common-sense terms by Ford and other culture historians, and now formally modeled by evolutionary archaeologists, seriation works when applied to adaptively neutral traits that show stochastic patterns over time. Some evolutionary archaeologists define such traits as *stylistic*, a use of the term "style" that other archaeologists have found problematical. Regardless of terminological disputes, establishing the theoretical warrant behind seriation, and expanding its traditional use to the rigorous measurement of interaction and lineage relationships, is a major accomplishment of evolutionary archaeology.

There are of course different kinds of seriation. As O'Brien and Lyman explain, *phyletic seriation* charts historical continuity within a lineage of forms of a given kind of artifact. This approach is exemplified by the pioneering work of W. M. Flinders Petrie, who studied temporal changes in ceramic vessels from Egyptian predynastic burials. In North America, A. V. Kidder's classic work with pottery from Pecos Pueblo in New Mexico is another early example of phyletic seriation. In contrast, *frequency seriation*, which tracks the relative frequencies of shared types across assemblages, was invented by A. L. Kroeber, and dominated the work of North American scholars in the early 1900s. *Occurrence seriation*, a simpler derivative of frequency seriation, measures only the co-occurrence of types across assemblages. Most of Chapter 4 is devoted to a detailed discussion of the assumptions, operating procedures, and results of frequency/occurrence seriation techniques. One ends this strong presentation better prepared to accommodate the authors' opening argument that a change in how artifacts were studied, rather than a "stratigraphic revolution," underlay the discipline's emerging interest in measuring time.

Chapters 5 and 6 are devoted to the topics of superposition, stratigraphy, and cross-dating through index fossils. Much of this discussion explores the work of early pioneers such as Nelson, Spier, Kidder, Vaillant, and Ford, with one goal being to drive home the point that there was no "stratigraphic revolution" in the early 1900s, but more of a "historical-type revolution" (p. 171). Any stratigraphic revolution was in the mid-1900s, when seriation was used less and less because archaeologists were increasingly using stratigraphic excavation to construct chronologies rather than to confirm them. This trend, integral to modern archaeological practice, was reinforced by the invention of radiocarbon dating, and the subtitle to Chapter 5, "Measuring Time Discontinuously," captures O'Brien and Lyman's argument that this trend was not a particularly healthy development. Seriation alone among archaeological dating techniques measures time *continuously*. As units of *cultural* analysis, stratigraphic units carve up time as discrete chunks, and when expanded through correlations with cross-dated artifact types, culture change can only be seen as a series of sudden transformations from one state to the next. Such a view is antithetical to historical science, an important point that warrants careful reflection by all archaeologists.

In the end, O'Brien and Lyman's work converges on two important points. First, relative dating techniques are just as useful and scientific as more commonly used techniques, and we will benefit by rediscovering and using relative techniques to augment other techniques. Secondly, and of equal importance, the formally modeled principles that make seriation work constitute a rare example of rigorous archaeological theory, founded in broader evolutionary theory, and with analytical uses that extend far beyond the measurement of time. In my view, O'Brien and Lyman underscore the first point more strongly than the second, due partly to a closing chapter that seems like a brief afterthought. I think they wind up this volume where it should have started: An introduction to the clash of two metaphysics (essentialism, materialism), and the implications thereof for the history of archaeological practice, as explained in subsequent chapters. But other writings among evolutionary archaeologists have developed the second point, and O'Brien and Lyman have performed a valuable service in making the first point clearly.

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It's About Time: A History of Archaeological Dating in North America. Stephen E. Nash (Editor), 2000, University of Utah Press, viii + 296 pp., $45.00 (cloth-bound).

Stephen Nash has filled a real void in Americanist archaeology by gathering together experts in diverse aspects of chronometry and asking them to write chapters on their expertise that anyone with a general background in archaeology can read and understand. Writing for the uninitiated is not something that most of us are good at, and it is the sign of an excellent editor—as opposed to simply an assembler or compiler—that he or she can sand the rough spots, fill in the low spots, and produce a readable, and enjoyable, edited book. Nash was able to reach the same level of accessibility in his recent single-authored volume, *Time, Trees, and Prehistory* (Nash, 1999), so we should not be surprised over his success with *It's About Time.* Undoubtedly credit also goes to the editorial staff at the University of Utah Press, which over the past decade or so has become a major player in publishing books on North American archaeology—a position gained through the solid content and professional look of the volumes the press publishes. Nash's book is no exception.

The volume is organized into five parts and 11 chapters, each of which I list below, with authors, to give readers a sense of what is included in the book. For the most part, however, my remarks are directed at the first two papers. This in no way is meant to demean the content of the other chapters or the ways in which the information is presented. Rather, the first two chapters emphasize topics I view as fundamental to understanding not only the history of Americanist archaeology but also the trajectory it took during the first half of the twentieth century. The topics treated in those chapters form the basis for understanding the history of sophisticated chronological methods that were developed after about 1950 and which are well covered in later chapters.

Part I, Introduction, contains a single chapter, "The Surprisingly Deficient History of Archaeochronology," by Nash and Jeffrey S. Dean. Part II, Layers, Styles, and Rings: Early Approaches to Archaeological Dating, contains three papers: "Stratigraphy and Archaeological Dating" by Julie K. Stein, "The Foundations, Practice, and Limitations of Ceramic Dating in the American Southwest" by Eric Blinman, and "Seven Decades of Archaeological Tree-Ring Dating" by Nash. In large part Nash's chapter on tree-ring dating is an abstract of his recent book on the topic (Nash, 1999), which anyone with an interest in the subject should read thoroughly. However, if you want only the highlights, read the shorter version.

Part III, Radiation, Magnetism, Water, and Light: Later Approaches," contains four papers: "The Introduction of Radiocarbon Dating" by R. E. Taylor, "Thirty Years of Archaeomagnetic Dating" by Jeffrey L. Eighmy, "Obsidian Hydration Dating, Past and Present" by Charlotte Beck and George T. Jones, and "Luminescence Dating and Why It Deserves Wider Application" by James K. Feathers. I suspect that the authors of these four chapters had a difficult time deciding what to include and not to include when they outlined their papers. I say this for the simple fact that they know too much, each being a leading expert with respect to the chronological methods he (and she) covers. I believe they chose the correct path, given the potential readership, by going light on the intricacies of the methods and sticking with history and applications. If readers are interested in the mechanics, there are numerous references that will point them in the appropriate directions.

Part IV, Historical Records and Narrative, contains two papers: "Dendrochronology and Historical Records: Concordance and Conflict in Navajo Archaeology" by Ronald H. Towner and "Narrating Archaeology: A Historiography and Notes toward a Sociology of Archaeological Knowledge" by Jennifer L. Croissant. Towner's contribution points out that there can be disparity in results produced by different chronological methods—a cautionary tale that needs to be retold every so often. Croissant, a sociologist, examines the rise of dating methods from an outsider's view, and, although she makes some interesting observations, her perspective on the history of the discipline is, in my opinion, slightly naive. Part V, Conclusion, contains a single chapter: "Just a Matter of Time? North American Archaeological Dating in the Twenty-First Century" by Nash.

Anyone who attempts to write or edit a book on time is faced with the difficult decision of how best to introduce the subject. If the book is to be an edited volume, one not only has to write abstracts of the papers to be included but also has to provide a common thread that unites the papers. Nash and

Dean accomplish the latter by examining the rise of chronology in Americanist archaeology during the second decade of the 20th century and then focusing briefly on four topics of utmost importance in any chronological endeavor: absolute versus relative dating methods (they use the word "techniques"); independent versus intrinsic dating techniques; dated events versus target events; and accuracy, precision, and resolution. Any discussion of dating methods must address these fundamental issues, and Nash and Dean do an excellent job of presenting them in concise language. They also present a brief account of the dawning of interest in chronological matters in Americanist archaeology, noting that archaeologists prior to 1914 focused on artifact classification, description, and typology; as they gained control over these realms, "they began to experiment with stratigraphic . . . and seriation . . . analyses developed by their European contemporaries" (p. 3). Nash and Dean then go on to suggest that the impetus for chronological investigation came from anthropological as opposed to archaeological quarters.

There are a few problems with the manner in which Nash and Dean handle this early period in Americanist archaeology, and they stem from how one chooses to examine the period prior to about 1914. Stein makes the same mistake in her chapter that Nash and Dean do in theirs. The issue basically revolves around when Americanists began to excavate stratigraphically. Both Stein and Nash and Dean believe that stratigraphic excavation in North America began around 1914 with Nels Nelson's work in the Galisteo Basin of New Mexico, followed shortly thereafter by A. V. Kidder's work at Pecos Pueblo, a few kilometers east of where Nelson was working. Here Stein and Nash and Dean are following received wisdom (e.g., Browman and Givens, 1996; Willey and Sabloff, 1993) that a "stratigraphic revolution" occurred in New Mexico—a belief that perhaps has its roots in Clark Wissler's (1917) statement that Nelson's work ushered in a "new archaeology." It was a new archaeology all right, but it had little or nothing to do with stratigraphic excavation. Rather, the revolution was in how Nelson charted the passage of time: by plotting frequencies of pottery types against geologically vertical space (O'Brien and Lyman, 1999).

Received wisdom has it that earlier excavations by Americanists—William Henry Dall, Fred Sterns, Mark Harrington, Charles Peabody, and even Nelson in his work along San Francisco Bay—were not stratigraphic excavations. Rather, they were simply cuts designed to facilitate post hoc stratigraphic observations. Stein (p. 15) is explicit in the distinction: "Stratigraphic excavation is a method of recording the arrangements of artifacts as excavation proceeds, separating artifacts of one layer from artifacts of stratigraphically different layers. Stratigraphic observation after excavation is a method of recording the superpositional relationship of artifacts in the sidewalls of trenches; artifacts are not separated during or (necessarily) after excavation." This seems to me to be a logical distinction, but then Stein (p. 15) states, "both methods employ stratigraphic dating." Stein is correct: Regardless of whether one keeps artifacts segregated by level as one excavates down through an archaeological deposit or simply plows through the deposit in order to expose a face from which to derive pottery (or other) samples by level, the end result is *exactly* the same: using superposed artifacts to measure the passage of time. If the end result is the same, who cares *how* the samples are generated? Why do we still hear references to a "stratigraphic revolution?"

The truth is, Americanists had long known that superposed artifacts could be used for chronological purposes. This was not something they happened to pick up from their European colleagues, although in some cases what Americanists saw in terms of *technique* when they visited European excavations—for example, Nelson's visit to St. Acheul, France, and Castillo Cave, Spain, in 1913 (Nelson, 1921)—was transported to North America. If we are to believe received wisdom, then we are forced to view archaeologists such as Nelson and Kidder as pretty naive individuals, fumbling around in northeastern New Mexico until they suddenly "discovered" that stratigraphic excavation led to a chronological method. But they were anything but naive. They might not have held to the view of Frederic Ward Putnam that there were perhaps ten millennia or more of prehistory waiting to be found in North America, but they knew that superposition held the key to whatever time depth there was. Thus by the time that anthropologist Berthold Laufer made his often cited remark in 1913 that "Chronology is . . . the nerve electrifying the dead body of history," keeping track of time through superposition was part and parcel of what Americanists routinely did.

Further evidence of just what a red herring the so-called "stratigraphic revolution" is can be found in

Laufer's next sentence, which Nash and Dean quote: "It should be incumbent upon the American archaeologist to establish a chronological basis of the pre-Columbian cultures, and the American ethnologist should make it a point to bring chronology into the life and history of the pre-Columbian Indians" (Laufer, 1913:577). Laufer was responding to remarks made by archaeologist Roland B. Dixon in his 1913 presidential address before the American Anthropological Association. In it Dixon, without using the term, laid out the basis for what later would be known as the direct historical approach. For his part Laufer wasn't trying to interest archaeologists in chronological matters—a "call to arms" is how Nash and Dean (p. 3) refer to the remarks. He *knew* archaeologists were interested in time. All he was saying was that ethnologists should work backward in time to link ethnohistorically and ethnographically documented groups with archaeological sequences.

Another topic on which I disagree with Stein and Nash and Dean is seriation and the role it played in early Americanist archaeology. Part of the problem, I suspect, is that the word remains undefined. Blinman comes close in his chapter, but even there it is not clearly defined. The absence of a definition is fairly typical of the discipline at large: Almost no one does seriation anymore (but see Blinman's chapter), and what usually passes for seriation really isn't. John Howland Rowe's (1961:326) definition is precise: "[T]he arrangement of archaeological materials in a presumed chronological order on the basis of some logical principle other than superposition. . . . . The logical order on which seriation is based is found in the combinations of features of style or inventory which characterize the units, rather than in the external relationships of the units themselves." What normally passes as "seriation" is percentage stratigraphy—plotting the relative frequencies of artifact types against vertical space. This is what Kidder did at Pecos Pueblo (Nelson used absolute frequencies) and what archaeologists have been doing ever since.

Stein (p. 28) states that "Seriation ushered in the 'stratigraphic revolution' . . . into North American archaeology." Nash and Dean (p. 3) state that Americanists in the second decade of the 20th century inherited the seriation method from their European colleagues. Both statements are incorrect. Taking them in reverse order, it is patently clear that "Americanist" seriation, primarily frequency seriation, has no traceable roots to Europe. Rather, it was invented de novo by A. L. Kroeber while walking across the countryside around Zuni Pueblo, New Mexico, in 1915 (Kroeber 1916). This is an undeniable fact, but what has happened over the years is a mysterious linkage between what Kroeber did and what Europeans such as John Evans, A. L.-F. Pitt Rivers, and W. M. Flinders Petrie did. They certainly performed sequence dating, but this had no visible bearing on what Kroeber later did. It is interesting that Stein views seriation as the trigger for the "stratigraphic revolution," given that Nelson began working in the Galisteo Basin in 1911, 4 years before Kroeber made his surface collections from sites around Zuni.

Stein makes an excellent point when she notes that stratigraphic excavation is used by different disciplines for different reasons: Geoscientists use it for determining relations between strata in space and succession in time, whereas archaeologists use it almost exclusively for establishing temporal relations. She also provides a concise and interesting overview of the use of stratigraphy by archaeologists and geoscientists interested in the Paleoindian period, but she badly muddles things in her discussion of the Lower Mississippi Alluvial Valley Survey undertaken by Philip Phillips, James A. Ford, and James B. Griffin in the 1940s. I don't disagree with her discussion of their excavation strategies, nor of their lack of sophistication relative to stratigraphic nomenclature, and I certainly agree that the project "greatly influenced American archaeology" (p. 30). But I cannot agree at all that out of the project came the terms "component," "phase," "horizon," and "tradition" (p. 30). Rather, "phase" and "component" were terms W. C. McKern employed (and defined) in the Midwestern Taxonomic Method, which was formulated in the early to mid-1930s, and it was Gordon Willey (1945), not Phillips, Ford, and Griffin, who first gave "horizon" and "tradition" formal definitions. With respect to names that crop up in Stein's chapter, I point out that Phillips's first name was Philip, not John; Ford's first name was James, not Jack; and Manuel Gamio's name is spelled with an *e*, not an *a*.

Anyone who reviews a book as broadly concerned with a topic as Nash's book is will (or should) find points of disagreement. Time, especially the history of the measurement of it by Americanist archaeologists, happens to be a subject of personal interest, and I have taken the liberty of highlighting some areas of disagreement. I reiterate that this in no way lessens the importance I place on the book. I

recommend it as a text at both the undergraduate and graduate levels, especially in classes that focus on archaeological method, and as a book that should be read from time to time by all archaeologists. As Nash and Dean cleverly state in their introduction (p. 2), "This book is about time because it offers critical histories of the development and application of the most important dating techniques relevant to North American archaeology." I agree.

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