GEO-ARCHAEOLOGY IN PRACTICE

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Richard L. Hay. *Geology of the Olduvai Gorge: A Study of Sedimentation in a Semiarid Basin.* Berkeley and Los Angeles: University of California Press, 1976. 300 pp. Illustrations, figures, and index. $22.50 cloth.

Charles B. Hunt. *Death Valley: Geology, Ecology and Archaeology.* Berkeley and Los Angeles: University of California Press, 1975. 246 pp. Illustrations, figures, and index. $14.95 cloth, $6.95 paper.

The preservation of evidence at an archaeological site older than a few millennia is seldom ideal, while the quality and comprehensiveness of research projects are rarely appropriate for an optimal exploitation of all the potential information available even at an average site. The result is that most archaeological research produces indifferent information: material objects that are additive, but which provide little new information for our cumulative understanding of past human activities. Classification of artifactual remains becomes increasingly complex and often increasingly arbitrary. And, there is a big step between the study of such objects and their correct interpretation in terms of economic subsistence, let alone culture. Similarly, hominid sites mainly yield fragmentary bones that are difficult to reconstruct as a single individual, let alone as representative of a prehistoric group. As a result, genetic variability is poorly understood and much of the taxonomic discussion generated is correspondingly controversial, if not querulous and trivial.

The preoccupation with classification of objects in prehistoric research is understandable on account of the indirect and fragmentary nature of the evidence. But it has produced interpretations of prehistory that are focused on objects, instead of on dynamic people living in groups. Fortunately, during the last several decades, there has been increasing effort by a number of prehistorians (I use the word deliberately so as to include digging archaeologists, paleo-anthropologists, and "applied" scientists) with diverse specializations to study prehistoric man in his context, i.e., where and how he lived. With such an approach it is necessary to excavate archaeological sites with special care and detail, and to record and analyze horizontal and vertical associations. The investigation must further relate the hunting encampment, house, or whatever, to a particular local and regional setting (Butzer 1971: 401-03), by virtue of the fact that the archaeological horizon is normally contained in a geological medium and that it may include diagnostic biological components.

This is then an interdisciplinary effort, in which different specializations contribute towards a single goal. No single category of information merits a disproportionate share of attention. All must be studied with equal thoroughness in order to recreate the activities of a prehistoric group in time and space. It is an approach that is ecological, focused on relationships between humans and their physical environments, between humans and animals, between humans and plants, and among different human groups. Ecologically oriented prehistorians are still a long way from being able to write such living prehistory, since the number of properly studied sites is so small. But their perspectives, emphasizing the fundamental role of the interrelationships between nature and culture, can contribute greatly towards elucidating the evolution of humankind.

One vital facet in such an ecological approach to prehistory is adequate geo-archaeological study (Butzer, in press; Gladfelter, in press). Geo-archaeology contributes far more than stratigraphic information. In the ideal case it is basic for the identification of micro-environments (i.e., depositional environments such as lacustrine, littoral, deltaic, riverine, spring, eolian, slope, volcanic, cave, abri, fissure), meso-environments (i.e., topographic setting and relief, providing a partial definition of the biotope), and macro-environments (i.e., zonal types such as periglacial, arid, or humid tropical, essential to the identification of biomes). When the practitioner is sufficiently attuned to and allowed to participate in excavation strategy and implementation, geo-archaeology can resolve further aspects at the research interface: burial, preservation, and contextual factors critical to the recognition of primary, semi-primary, or secondary sites. It can further be argued that a functional classification

of Stone Age sites into categories such as quarry/workshop, kill/butchery, or camp/living can only be properly made with the close collaboration of a geo-archaeologist. Finally, the geo-archaeologist can probably contribute significant information on the availability and limitations of environmental resources, or help generate higher-level interpretations such as cultural adaptations or adaptive radiation.

Unfortunately there is an acute shortage of effective geo-archaeologists, for reasons that I have outlined elsewhere (Butzer 1975). There are, of course, numerous technical appendices to site reports or short papers of such a nature in the literature, but the selection of comprehensive studies remains small. Monographic works that purport to or succeed in implementing geo-archaeology are therefore of considerable interest, in terms of both their methodology and content. Two such volumes have recently appeared, both laudably published by the University of California Press. Both are by geologists: R. L. Hay is a professor of geology at Berkeley, and C. B. Hunt long served with the U.S. Geological Survey and was a professor of geography at John Hopkins for several years prior to his retirement.

Death Valley is a distillation of three professional papers of the U. S. Geological Survey (published in 1966 and now out of print) of which Hunt was senior author, while the archaeology was originally presented by Alice Hunt in the Anthropological Papers of the University of Utah (No. 47, 1960). In its present format the book aims "to reach a broader audience by presenting the essence of all four reports in as nontechnical language as possible."

Following a brief introduction to the major components of the natural environment, the first substantive chapters treat the hydro-geology; the salt minerals found in the basin, including analysis of a range of patterned-ground varieties due in part to desiccation or salt or both; and the surficial sediments (mainly gravel fans). The second part of the book inventories igneous, metamorphic, and sedimentary rocks (Precambrian to Cenozoic) exposed, and then outlines the tectonic history and the mineral resources. The archaeological sections outline four phases of Indian occupation, possibly beginning with the Pleistocene/Holocene transition, and give interesting observations on old trails, tin cans, and bottle glass younger than 1849. The concluding section presents a useful account of the vegetation communities and a summary of the animal world.

For Southwestern desert rats this will undoubtedly be a fine guidebook, illustrated as it is with a wealth of good photos (mainly due to John R. Stacy) and diagrams. For professionals without a regional interest in Death Valley, the book will prove disappointing. The basic problem is

that it is wholly descriptive and uneven in its detail. Some geological discussions, such as those of the older rocks and tectonic evolution, are fairly rigorous and far from "nontechnical," while treatment of the Cenozoic sediments is next to useless. There is, incredibly, no systematic information on environmental changes: no usable description of shorelines (including no appropriate sections or maps), no tabular presentation of Quaternary episodes, no radiocarbon dates. Bits of data on expanded Holocene lakes (mainly 3000 to 0 B. C.) are found scattered in several chapters, but I found it impossible to reconstruct even the rudiments of the Pleistocene-to-Holocene record without consulting the original reports (which are not listed in the bibliography but in the preface). The Indian archaeology is presented much like a park brochure, i.e., in next-to-meaningless generalizations. Lacking numerical data or proper technical descriptions, the artifacts illustrated are barely sufficient to allow the reader to guess at the extra-regional relationships of the four culture phases labelled Death Valley I, II, III, and IV, and must accept their dating on faith. And at no point are the categories "geology," "ecology" or "archaeology" integrated.

Overall, *Death Valley* is an attractive but superficial description of a region that would have been of great interest to both amateur archaeologists and professionals. It fails because it underestimates the sophistication of its potential audience. The key to communicating with interdisciplinary readers is well-organized data, presented in a palatable form, subtly demonstrating cause-and-effect or interrelationships with a limited but accurate vocabulary. Gutting the contents is no solution. And as far as geo-archaeology is concerned, *Death Valley* is a classic example of how it should *not* be done.

Geology of the Olduvai Gorge is based on quite different premises, as the subtitle *A Study of Sedimentation in a Semiarid Basin* might suggest. It gives the results of fourteen years of research in a small basin in comprehensive fashion, superseding a number of partial, preliminary reports. This presentation is uncompromisingly rigorous but, as an explicit concession to the nongeologist, Hay provides a glossary of geological terms, a discussion of the principles and methods of environmental interpretation, and a nontechnical overview of the stratigraphy. An explicit goal is to show how modern laboratory analysis of sediments can provide a wealth of information about paleo-environments. At the same time, *Olduvai Gorge* "aims to provide the archaeologist and anthropologist with the stratigraphic position, age, and paleogeographic setting of the many hominid remains and archaeologic sites" as well as to give a preliminary assessment "of man's selectivity and transport of stone used for tools."

The volume begins with an appreciation of the earlier geological work of Hans Reck (since 1911), E. J. Wayland, and R. Pickering, followed by an explanation of the original nomenclature (including Beds I to VI) and its modifications, as well as a description of the regional geological setting. The bulk of the book consists of detailed, unit-by-unit descriptions, analyses, and interpretations of Bed I (up to 60 m thick, 1.2-2.7 million B.P.), Bed II (up to 30 m, 1.7-1.15 million B.P.), Bed III (up to 11 m, 1.15-0.8 million B.P.), Bed IV (up to 10 m, 0.8-0.6 million B.P.), the Masek Beds (to 15 m, 0.6-0.4 million B.P.), the Ndutu Beds (up to 14 m, spanning much of the period 400,000-32,000 B.P.), the Naisiusiu Beds (maximum 10 m, ca. 22-15,000 B.P.), and minor Holocene sediments (pertaining to the last 9000 years). These sections are profusely documented with sections, maps, lithofacies descriptions, geochemical and mineralogical data (often tabular), and any chronometric or paleomagnetic information.

The brief concluding chapters bring in the geomorphic evolution of the basin, summarize the depositional environments linked to fossil or artifactual sites, indicate the sources of lithic raw materials, and include a brief postscript on recent work in the Laetolil Beds of the adjacent Eyasi basin. All radiocarbon dates are listed in Appendix A, and archaeological sites from Beds I and II are inventoried in Appendix B, including numbers, a brief description of contents, stratigraphy, facies, and references, where available.

The age brackets assigned to the different stratigraphic units at Olduvai should not indicate continuous and conformable sedimentation over some 2 million years. There have been repeated episodes of deformation, during which the relief and configuration of this "sediment sump" on the western periphery of the Eastern Rift were significantly changed. As a result, the locus of primary accumulation progressively shifted a total of some 25 km eastward, firstly midway in Bed II, then following Bed II, Bed III, and Bed IV, and a last time after deposition of the Masek Beds. The sediment facies exhibit complex horizontal and vertical shifts or abrupt changes with three principal components: lacustrine (including chemical precipitates), fluvial (dominated by reworked volcanic products), and eolian (chiefly various size-grades of wind-borne volcanic ejecta). Apart from basal lavas, the overall horizontal arrangement of facies is a radial one, where peripheral coarser alluvial deposits are interdigited with the fine sediments of a central lake or evaporation pan. Vertically, the sequence is characterized by facies shifts that reflect ongoing hydrologic changes (in part due to protracted deformation of the basin or changes in the topography of the line of volcanic peaks to the east; in part related to primary changes of climate) and by more abrupt alternations of fine and

coarse-grade deposits reflecting episodic eruptions or tectonic discontinuities.

Resolving all these details, interpreting the macro-patterning, and relating the stratigraphic facts and meso-environmental inferences to a plethora of sites excavated over many decades clearly represents a mammoth task. Hay is both a sensitive, applied scientist and a highly specialized, "hard-core" geologist, who masters a range of technological expertise rivalled by that of next to no other applied geologist. The result is the most detailed and authoritative study of a sedimentary basin that I have yet seen, as well as the most comprehensive geo-archaeological study of a large site complex attempted.

Situations providing research opportunities and financial resources comparable to those of Olduvai always will be uncommon, so that the principal interest for a wider audience of paleo-anthropologists and prehistorians will probably lie in the applied results. No attempt will be made here to summarize the unique value of the paleo-environmental data for those interested in the late Cenozoic of East Africa. But some of the geo-archaeological conclusions deserve mention. So, for example, Bed I hominid activity was highly concentrated on the eastern margin of the Olduvai lake; sites of lower Bed II are still largely confined to lake-margin deposits, but dispersed over a larger area; initially, in upper Bed II, sites were again highly concentrated near the southeastern lakeshore, but thereafter were more widespread although primarily located in or adjacent to stream channels, a preference evident in Beds III-IV and in the Masek unit. Interestingly, Hay raises the question of whether the contrasting distribution of Acheulean sites (as defined by biface percentages) along stream channels and away from the lake, and of Oldowan sites on or next to the lakeshore, may represent nothing more than two toolkits used in different contexts by the same hominids. The raw material data indicate that most assemblages of lithic artifacts include a small but significant proportion of rock from distances of at least 8 km away; these proportions increase during the time span represented by Beds I and II, suggesting an increasing degree of hominid mobility. Hay proposes that rare artifacts from more distant sources may have been obtained indirectly, from other hominid groups.

Those who are familiar with the overall history of research at Olduvai will readily appreciate just how crucial Hay's work has been in terms of sweeping revisions of the stratigraphy, for relation of the chronometric dates (initially rather controversial) to specific geological subunits, and above all for contextual interpretation of the hominid and archaeological sites. In fact, much of the impact of the late Louis Leakey's hominid

discoveries and of Mary Leakey's untiring, exemplary archaeological work would be diminished, if not open to controversy, without this firm geo-archaeological anchoring. I would earnestly hope that Hay's study will be examined by all who question the relevance of rigorous geo-archaeological field *and* laboratory research for prehistory and early hominid research. One peer-group reviewer (for the NSF Anthropology Program) recently questioned how sediment analysis can contribute to stratigraphic correlation and environmental interpretation, or how pedogenic processes can be detected through laboratory analysis. In my view, *Olduvai Gorge* provides sufficient methodology-by-example to answer these implicit objections.

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