Geological Society of America
Centennial Special Volume 4
1990

Chapter 29

Archaeological stratigraphy

Julie K. Stein
Department of Anthropology DH-05, University of Washington, Seattle, Washington 98195

INTRODUCTION

Archaeologists have utilized stratigraphy to represent temporal relations for over a century, but not until Gasche and Tunca (1983) published their *Guide to Archaeostratigraphic Classification and Terminology* was attention drawn to the fact that archaeologists were not rigorous in the systematization of archaeological strata. Geologists compiled stratigraphic guides during the last century in response to the need ". . . for uniform standard and common procedures in defining and classifying formal rock bodies, their fossils, and the time spans represented by them" (NACOSN, 1983, p. 847). In these guides the language used to denote rock units and their spatial and temporal relations is formalized.

Gasche and Tunca (1983) and other archaeologists believe that the terminology of archaeological stratigraphy used in describing archaeological sediments and their spatial and temporal relations also needs to be formalized. They argue that stratigraphic descriptions of archaeological sites are imprecise, and that descriptions are confused with interpretations. Following the example of geologists, these archaeologists propose a clarifying set of rules for terminology and classification for archaeological stratigraphy. The purpose of the Gasche and Tunca's guide is to ". . . facilitate and even to stimulate the exchange and correlation of all information produced from archaeological sites . . . and to establish a cross-referencing system, which would be as objective as possible . . . and that would eliminate the ambiguities brought about by an arbitrary language." (Gasche and Tunca, 1983, p. 325). They presented their guide as a proposal to the archaeological community for consideration.

In early geological stratigraphic guides, subdivisions of sequences of rocks are based on lithology (lithostratigraphic units), on fossil content (biostratigraphic units), and on the time periods in which rocks were deposited (chronostratigraphic units). The archaeostratigraphic guide is modeled on these efforts, most notably on the *International Stratigraphic Guide* (Hedberg, 1976). Gasche and Tunca propose three stratigraphic units for dividing archaeological sediments: on the basis of lithology (Lithologic Units), on artifactual content (Ethnostratigraphic Units), and on time periods (Chronostratigraphic Units). I examine each of the proposed units to determine its relevance to archaeology and to stratigraphy in general and conclude that an entirely new archaeostratigraphic guide is not warranted. Archaeostratigraphy can be accommodated by two additions to existing geologic stratigraphic guides and codes: (1) a new, lower-ranking Lithostratigraphic Unit (the Layer), to include strata subdivisions useful for archaeology and microstratigraphy, and (2) new Ethnostratigraphic Units (the Zone, Supra-Zone, and Sub-Zone) that divide sequences of rocks according to their artifactual content.

HISTORY OF THE ARCHAEOLOGICAL STRATIGRAPHIC GUIDE

The archaeostratigraphic guide proposed by Gasch and Tunca is one result of the 1977 UNESCO International Geological Correlation Program (IGCP), Project 146 ("River Flood and Lake Level Changes"). After the guide appeared, archaeological stratigraphers broke formal ties with the IGCP, and organized to draft an expanded guide on the model of the *International Stratigraphic Guide* (ISG) (Hedberg, 1976), produced by the International Subcommission on Stratigraphic Classification. The proposed archaeostratigraphic guide was then published in the *Journal of Field Archaeology* in 1983, along with a questionnaire that solicited comments from all members of the archaeological community. Examples of responses are Farrand (1984a, b).

At a roundtable discussion at the University of Ghent in 1983, the "Workshop for Archaeostratigraphic Classification and Terminology" (A.C.T. workshop) was formed, and publication of a new journal *Stratigraphica Archaeologica* was proposed (Gasche and Tunca, 1984; Tunca and Gasche, 1984). Committees were formed, which were responsible for producing sections of the proposed guide. Two issues of *Stratigraphica Archaeologica*, edited by L. De Meyer, appeared (1984, 1987). The journal is similar in many respects to the *Circulars* of both the International Subcommission on Stratigraphic Terminology and the International Subcommission on Stratigraphic Classification as well as the *Newsletters on Stratigraphy*, (Leiden), in which comments concerning the *International Stratigraphic Guide* (ISG) are circulated.

Stein, J. K., 1990, Archaeological stratigraphy, *in* Lasca, N. P., and Donahue, J., eds., Archaeological geology of North America: Boulder, Colorado, Geological Society of America, Centennial Special Volume 4.

The archaeostratigraphic guide of 1983 was not the first classification system proposed for archaeological strata. Harris (1977, 1979) made a significant contribution when he proposed a modest classification system, with special emphasis on how to record stratigraphy. Schiffer (1972, 1976, 1983, and 1987) proposed a classification scheme for the archaeological record based on objects found within deposits rather than on the physical characteristics of the deposits themselves. Shaw (1970) discussed the use of the archaeological term "culture" (referring to assemblages of artifacts) as a possible stratigraphic unit. Gasche and Tunca (1983), however, were the first to model their classification on geological guides and to propose three separate formal units for archaeological strata based on lithology, artifactual content, and time periods.

LITHOLOGIC UNITS

According to Gasche and Tunca, a lithologic unit is a "three-dimensional body characterized by the general presence of a . . . (dominant) . . . lithologic type, or by the combination of two or more of these types, or even by the presence of other particularities that confer on the unit a homogeneous character. . . . Among other particularities, detailed attention should be paid to the lithologic content, the structure, texture, and color of the content, and the degree of erosion or denudation and their geometry" (1983, p. 328, 329). Note that in the archaeostratigraphic guide the lithologic unit is equivalent to the lithostratigraphic unit in other geological stratigraphic guides and codes. Lithologic units are termed "Layers" (the basic unit used in stratigraphic correlations), "Sub-Layers" (lithologic units that form part of a Layer), and "Inclusions" (smaller units that are part of a Layer or Sub-layer).

Although Gasche and Tunca (1983) were the first in archaeology to define a lithologic unit comprehensively, Fedele (1976, 1984) suggested a similar unit earlier. Fedele defines an elemental sediment unit (ESU) as "a unit constituting the smallest geologically homogeneous entity as perceived in excavation . . . (and) contained between two consecutive recognizable discontinuities" (Fedele, 1976, p. 34). An ESU could be a stratigraphic division, a lateral (facies) differentiation, or a pedological horizon. In 1984, Fedele expanded his discussion of ESU and proposed a new unit called an operational unit, or cut. A cut is a ". . . geometric unit of dissection or digging" (1984, p. 9) that is the ". . . minimum volume of deposit that we are willing to cut as a single whole" (1984, p. 11). Cuts are based not solely on lithology, but also on convenience during excavation. Arbitrary 5-cm-thick layers excavated in exceptionally thick deposits are examples of cuts. After excavation is complete, cuts are grouped into elemental sediment units on the basis of the structure of the deposit. Thus, a cut is arbitrary, but an ESU is a ". . . formally named fact in the structure of a given site, whose mappable distribution can eventually be used as a marker" (1984, p. 11).

Discussion of lithologic units

Although Gasche and Tunca's proposal of a lithologic unit led to much discussion and some favorable reviews (Colcutt, 1987; Fedele and Franken, 1987; Farrand, 1984b; Le Tensorer, 1984; Stein, 1987), I suggest that a completely new unit is not necessary. Others have suggested that the new unit is needed because of: (1) problems of scale, (2) disagreement as to the importance and nature of discontinuities in archaeological lithologic units, in contrast to the importance and nature of discontinuities in geological lithostratigraphic units, and (3) the need to describe archaeological sediments with attention to characteristics that are appropriate for archaeological stratigraphic inquiry. After considering all these points, I suggest that there is not sufficient reason to propose a new type of lithostratigraphic unit, with three rankings of "Layer," "Sub-Layer," and "Inclusion." There is, however, valid argument for proposing a new rank of lithostratigraphic unit, one smaller than the existing unit of lowest rank (the Bed).

The scale of the "Layer." The first and most obvious dissimilarity between an archaeostratigraphic "Layer" and other lithostratigraphic units is in scale. The primary lithostratigraphic unit for geologists is the formation. Its spatial characteristics are purposely vague. The authors of the *International Stratigraphic Guide* say that "the thickness of units of formation rank follows no standard and may range from less than a meter to several thousand meters . . . [and that the] practicability of mapping and of delineation on cross sections is an important consideration in the establishment of formations" (Hedberg, 1976, p. 32). The authors of the *North American Stratigraphic Code* state that "thickness is not a determining parameter in dividing a rock succession into formations; the thickness of a formation may range from a feather edge at its depositional or erosional limit to thousands of meters elsewhere. . . .No formation is considered valid that cannot be delineated at the scale of geologic mapping practiced in the region where the formation is proposed" (NACOSN, 1983, p. 858). Mappability is a crucial determinant in these two definitions.

In archaeology, strata are differentiated in much the same way as in geology (that is, on the basis of physical characteristics), but on the scale of centimeters rather than meters. In modern excavations, strata are rarely more than 10 cm thick. The specific thickness is selected to record contexts. But as noted by Fedele (1984), because of lithologic similarities, smaller units are sometimes grouped into larger ones, which rarely exceed 50 cm. These dimensions are also convenient for mapping at a scale appropriate for an archaeological site, but not for a geologic region.

The difference in scale and the suggestion of a new term in the archaeostratigraphic guide stem from the underlying purposes of defining "formations" in geology, and "layers" in archaeology. Geologists trace bodies of rock laterally over large geographic regions. As noted by Ager (1981, p. 14), the strata worthy of the rank of formation were deposited in particular types of sedimen-

tary environments that covered vast areas (for example, ocean basins and continental shelves) and are useful for stratigraphic correlations over large areas. In archaeology, layers do not usually cover vast areas of the Earth's surface. Layers usually are not traceable beyond a few meters (for example, from inside to outside a dwelling or pit). A site may have a common sequence of strata everywhere in the site, which can be considered by the excavator as the "type stratigraphic sequence" of the whole site (similar to the stratotypes of the *International Stratigraphic Guide*). The strata in such a sequence are used as referents in discussion of the cultural and depositional history of the site (for example, the divisions of the middle and upper Paleolithic layers in cave deposits of southern France; Laville and others, 1980, p. 108).

Layers that terminate laterally over short distances are common in archaeological sites (Tunca, 1987; Meyer, 1984), and often they cannot be condensed into one general sequence (Cordy, 1987a). Correlations in stratigraphically complex archaeological sites frequently depend on the order of deposition of small disparate layers (discerned by recording overlapping edges) rather than on major stratigraphic units extending over the whole site. Thus, archaeologists do not expect to use "layers" in the same manner as geologists use "formations."

The difference in scale between "Layer," defined as the lithologic unit in the archaeological guide, and the variously ranked lithostratigraphic units in the geological codes is great enough to justify a new rank of lithostratigraphic unit. In the *North American Stratigraphic Code,* the units are formation (the largest unit), member, and bed (the smallest unit). The term "bed" (NACOSN 1983, p. 858) is sometimes used to designate certain particularly useful bodies of rock (coal beds, oil sands, etc.; Campbell, 1967). The term "Layer" designates a smaller unit than does "bed."

"Layer" is not proposed for archaeological use alone. Microstratigraphers examine subdivisions of rock that are very small. The term "Layer" refers to parts of larger bodies of rock (beds, members, or formations) and would be useful in other stratigraphic codes. That "Layer" can be easily incorporated into previously established codes illustrates the commonality of geological and archaeological research. Thus, I do not support the creation of a new archaeostratigraphic code, with a new lithologic unit, but rather a modification of existing geologic guides and codes to include a new smallest unit, the "Layer," which will promote unambiguous communication in all disciplines concerned with stratigraphy.

Nature of discontinuities. Controversy over the importance and nature of discontinuities centers on a reference in the archaeostratigraphic guide to stratigraphic "ruptures" in archaeological sites (a term referring to discontinuities in excavated areas), and how they are different from and more numerous than geologic discontinuities (Gasche and Tunca, 1983, p. 329). Although others have agreed with the statement (Franken, 1984; Le Tensorer, 1984), Fedele expresses the view most clearly when he writes that, "the importance of man and human society as users and producers of discontinuities constitutes perhaps the single main area of divergence between cultural and entirely natural systems, between archaeological and geological stratigraphies" (1984, p. 13). Fedele suggests the term "cladostratigraphy" to refer to stratigraphic inquiries pertaining to sedimentary discontinuities (1984, p. 8).

By no means does everyone agree that a difference exists between discontinuities in archaeological and in geological stratigraphy. Colcutt (1987, p. 13), argues that "man is just as much a destroyer of discontinuities as he is a user or producer, and in this he is not markedly different from earthworms, rabbits, trees, wind or running water." I agree with Colcutt and suggest that the nature of discontinuities is not sufficiently different in geology and archaeology to warrant a new lithologic unit. As is the case for geologic discontinuities, archaeological discontinuities should be described using a descriptive classification system (for example, abrupt conformities, angular unconformities, disconformities, etc.) I discussed (1987, p. 354), and Harris (1979) made an initial attempt at such a classification. But the fact that prehistoric people frequently dug holes does not support the proposal of a new lithologic unit.

Describing archaeological sediments. Fedele (1984) and Gasche and Tunca (1983) addressed the question of the appropriateness of applying geological (sedimentological) descriptions to archaeological deposits. They propose that lithologic units be described in descriptive terms similar to those used by sedimentologists. Such terms as grain size, grain shape, mineral composition, and sedimentary structure are traditionally used to describe geologic sediments (Blatt and others, 1972; Reineck and Singh, 1980) and to interpret depositional processes. Archaeologists (Franken, 1984) have not yet determined if the same descriptive terms are relevant for interpretation of archaeological depositional regimes, or if different descriptive terms must be designated.

Recently, archaeologists began to examine distinctive attributes of cultural deposition to see if they are different from traditional sedimentological analyses. Schiffer (1987) says that in addition to traditional sedimentological descriptions, certain attributes of artifacts are distinctive and diagnostic in the interpretation of cultural deposition (for example, roundness of sherd edges). Although such attributes are not yet adequately studied, they should be considered when developing stratigraphic nomenclature. Stein and Teltser (1989) state that grain-size distributions of separate compositional types of artifacts (for example, ceramics, lithics, bone) provide a basis for interpretations of archaeological deposition. This conclusion is an extension of microartifact analysis originally proposed by Fladmark (1982), discussed by Dunnell and Stein (1989), and utilized by Rosen (1986) and Hull (1987).

Whether use of nongeological or cultural attributes are necessary for archaeological descriptions of sediment, a standardized, descriptive (nongenetic) terminology is necessary for the description of archaeological (and geological) stratigraphic relations. Sedimentologists use a standardized descriptive terminology that

is more than adequate for archaeological purposes. Therefore, until it is demonstrated that specific archaeological attributes are necessary, I propose that the sedimentological terminology be followed.

ETHNOSTRATIGRAPHIC UNITS

Gasche and Tunca (1983, p. 331) propose the term "Ethnostratigraphic Unit" for deposits identified on the basis of their anthropic content (that is, artifacts). The terms: "Zone" (the basic unit), "Supra-Zone" (contains one or more Zones), and "Sub-Zone" (subdivision of a Zone) are subdivisions of ethnostratigraphic units. Like the fossils definitive of biostratigraphic units, the artifacts of ethnostratigraphic units must be only those artifacts whose age of manufacture or use is contemporaneous with the age of deposition of the strata. The artifacts must be products of cultural activities taking place contemporaneously with the deposition.

Discussion of ethnostratigraphic units

To determine that an object was made or used concurrently with deposition requires that the observer determine the artifact's age and compare that with the age of the depositional event. Obviously, the identification of an object as contemporaneous with deposition is an interpretation. Thus, because the goal of stratigraphy is to provide a descriptive system, selection of artifacts whose age of manufacture is contemporaneous with deposition is problematic. Gasche and Tunca advise that "prudence, however, is necessary in evaluating, given the wide range of possible interference, the length of usage of certain objects observable in any archaeological context, and also the limitations of our methods of excavation" (1983, p. 331). They acknowledge that correct interpretation of an artifact assemblage as "contemporary with deposition" depends on the training of the person examining the artifacts.

In addition to the similarity of biostratigraphic units and ethnostratigraphic units in that they both require fossils or artifacts to be contemporaneous with the deposition, Gob (1987) argues that artifacts are really fossils, and do not require a new stratigraphic unit. They can be used to subdivide biostratigraphic units.

Artifacts as opposed to fossils. The question of the justification of the ethnostratigraphic unit is linked to the issue of whether artifacts should be considered as separate and distinct from fossils (that is, cultural as opposed to natural). Are artifacts really special? Or are they another kind of fossil that we incorrectly believe to be special, only because we think we are so different from other animals? In their interpretations of human ancestors, archaeologists are guilty of just such ethnocentric opinions of the difference between people and animals. In the past, archaeological interpretations of the remains of australopithecines and *Homo erectus* and their artifacts (Binford, 1981; Brain, 1981) were based on cultural rather than on animal analogies. When these fossils and the artifacts associated with them were discovered, physical anthropologists and archaeologists proposed models of their existence based on images of hominids hunting large animals and living as families in home bases (Isaac, 1971, 1978; Leakey, 1971). After further research, investigators now interpret the same hominids as roving animal scavengers who frequently became the prey of carnivores (Brain, 1981). Their bones are often incorporated into the record after they were eaten by leopards. At Zhoukoudian, China, the smashed skulls found in approximately 350,000-year-old deposits were not the result of ritual cannibalism, but rather the result of carnivores consuming the brains of the hominids that were part of their food supply (Binford, 1981; Binford and Stone, 1986). We must be careful to insure that the proposal of an ethnostratigraphic unit is not just another example of our inclination to treat objects associated with human beings as separate and distinct from the rest of nature.

The proposition that artifacts are actually fossils, and therefore constitute appropriate contents of biostratigraphic units and not of ethnostratigraphic units (see discussion in Gob, 1987), parallels a discussion that occurred during the drafting of the *International Stratigraphic Guide* (Erben, 1970, 1972; Hedberg, 1973; Laffitte and others, 1972). Erben argued that a threefold division of strata (litho-, bio-, and chrono-), is not necessary: lithostratigraphy is enough. Fossils are only one of many types of lithologic particles that compose a formation and are no different from the particles of zircon, hematite, charcoal, or ash that are used to determine the ages of strata. Designation of chronostratigraphic units is the goal of all stratigraphy. They are interpreted from lithostratigraphy. Erben argued that all deposits are basically lithostratigraphic units and that only the particles selected for dating change as the stratigraphic unit changes. According to Erben, stratigraphy has been subdivided by more and more specialists in recent decades. The process begins when specialists note that certain particles within the formation do not fall within the purview of lithostratigraphy; a new stratigraphic unit is then proposed. Thus, archaeology is just the most recent discipline to subdivide stratigraphy.

Erben's arguments were rejected by the International Subcommission on Stratigraphic Classification (Hedberg, 1974). The *International Stratigraphic Guide* appeared with three stratigraphic units (lithostratigraphic, biostratigraphic, and chronostratigraphic). Following the tradition of separating units according to the data used to divide the rock sequence, the *North American Stratigraphic Code* contains even more subdivisions, including stratigraphic units based on magnetic, pedologic, and diachronic data. Dividing strata on the basis of artifactual data seems to be an extension of this trend.

Artifacts are not fossils, and artifacts are not classified on the same principles used to classify fossils. Fossils are classified according to Linnean biological taxonomy and evolutionary theory (Hancock, 1977). Trace fossils are classified in broad categories (for example, burrows, tracks, trails) and are tied to the body of the biological organism that made them. Artifacts, on the other

hand, are classified according to their morphology, manufacture technology, function, and style (Dunnell, 1971; Spaulding, 1960). Certainly a paleontologist would never suggest that paleontological training is preparation sufficient for classifying prehistoric artifacts, nor is archaeological training sufficient for classifying fossils. An artifact is only in a remote sense a kind of trace fossil. Our interest in their cultural implications goes far beyond their presence as traces, and requires a typological system and theoretical perspective distinct from those used for fossils. Thus, for stratigraphic purposes, artifacts must be considered separately from fossils.

Even though many artifacts are lithologic and many are fossils, generally speaking (for example, the bones of animals used for subsistence), archaeological stratigraphers are justified in following the example of the *International Guide* and the *North American Stratigraphic Code* by insisting that divisions of strata containing artifacts be considered as distinct stratigraphic units on a level with lithostratigraphic and biostratigraphic units (Cordy, 1987a, 1987b; Gasche and Tunca, 1983; Le Tensorer, 1984; van der Plas, 1987). Biostratigraphy is recognized as a legitimate way of subdividing a sequence of rocks, because the subdivision is based on data different from lithostratigraphy. Lithostratigraphic units are subdivisions of rock bodies based on lithologic attributes. Attributes accepted as relevant to lithostratigraphic description derive from mineralogical, petrological, and sedimentological theory. Biostratigraphic units are subdivisions based on paleontologic attributes: fossils accepted as being relevant to biostratigraphic divisions derive from biological taxonomy and evolutionary theory. Ethnostratigraphic units are subdivisions of primarily unconsolidated rock based on artifactual attributes: artifacts accepted as being relevant to ethnostratigraphic description derive from artifact typology and archaeological theory. Lithostratigraphy and biostratigraphy are ways to subdivide rocks, and they require specialists trained in the theoretical concerns of a specific discipline. Ethnostratigraphy is also a useful way to subdivide rocks and requires specialists trained in the theoretical concerns of archaeology. All three disciplines constitute legitimate stratigraphic practice.

Descriptions of ethnostratigraphic units. Gasche and Tunca (1983, p. 331) suggest that descriptions of ethnostratigraphic units be based on artifact classes. Lithologic units are characterized by the classes of artifacts they contain, and then are regrouped such that all layers with the same classes of artifacts form one ethnostratigraphic unit. Gasche and Tunca do not discuss necessary conditions for defining a class of artifacts. Cordy (1987a, 1987b, p. 31) suggests that the artifact content of units is not the material on which ethnostratigraphy should be described. He suggests that culture (*entité palethnologique*) is the appropriate basis for definition. Cultures are interpreted from artifact assemblages.

Gasche and Tunca's, and Cordy's suggestions have aroused some discussion (Gob, 1987) about problems of archaeological classification, and of separating description from interpretation. Gasche and Tunca regrouped the layers on the basis of artifact classes. The classes referred to are not standardized in a way that makes correlation from site to site possible. Different archaeologists with different research objectives might describe artifacts in grossly different ways and would certainly argue over the appropriateness of any given class, making stratigraphic correlations across regions impossible. As with biostratigraphy and lithostratigraphy, archaeology needs a formal description of artifacts (separate from the concept of types and classes) that is routinely made at every site. The descriptions would be available for archaeostratigraphers interested in regional correlations, but would not be the only descriptions made. Each excavator could go beyond the basic description to measure whatever attributes are necessary to address a variety of research questions, and to create as many classes or types as are necessary for the problems being addressed.

According to Cordy, culture would have to be interpreted from artifacts in the strata, after which the cultures would be grouped into ethnostratigraphic units. Archaeologists, however, do not agree whether culture can be interpreted from artifacts (Binford, 1983; Clarke, 1968; Dunnell, 1982; Watson and others, 1984; Willey and Phillips, 1958), and no single interpretation of the culture is necessarily the correct one. Cordy suggests using the term "culture" (*entité palethnologique*) as it is used to describe periods within the Paleolithic chronology of France (Bordes, 1961). Assemblages of tools that are found repeatedly across space are referred to as cultural traditions (for example, Mousterian), and are said to represent a prehistoric culture (*entité palethnologique*). The original classification of Bordes (1961) is based on morphological and technological attributes of artifacts found in distinct stratigraphic layers (couches). Layers are divided according to the artifact assemblages they contain; assemblages are divided by the kinds and frequencies of certain artifact types (this is a process similar to that described by Gasche and Tunca). The descriptions and groupings of artifacts lead to interpretations about the "life styles" of each prehistoric culture. The interpretations are combined with the description of the artifact types in such a way that they are now difficult to separate; for example, the Mousterian tradition implies both certain artifact types (and descriptions) and certain life styles. Although the original types are based on empirically derived descriptions of artifacts, the artifact types and the interpretations made by Bordes are more speculative, and their validity has been challenged (Binford and Binford, 1966; Binford, 1973; Bordes, and others, 1972; Bordes and Sonneville-Bordes, 1970).

Stratigraphic units are supposed to be identified not on the classification of fossils, rocks, or artifacts, but rather on noting the *presence* of certain taxa in the rock. At least conceptually, interpretation is not part of stratigraphic classification. Instead, stratigraphic classification follows from description of the presence or abundance of artifacts, fossils, or sediments. Of course rocks, fossils, and artifacts must be neutrally described at some level with classification systems that do not involve interpretation. The purpose of stratigraphy is to describe the way strata are found in the field in the most objective way possible. Only after the strati-

graphic framework is neutrally described can the sedimentary, biological, and cultural sequences be interpreted. Ethnostratigraphic units cannot be divided using interpretations of culture or interpretation of classes. We need to note the presence/absence/abundance of artifacts, differentiated on the basis of morphological or compositional attributes (descriptions). The problem in archaeology, as indicated by disagreements over appropriate classification systems, is that without a standardized scheme of describing artifacts (separate from placing them in classes or types), which is at least as standard as the Linnean system (even with its tremendous problems for paleontological applications), ethnostratigraphic units will be very difficult to use for regional correlation.

A basic set of descriptive attributes on which all archaeologists would agree would be difficult to select. For the last 50 years, archaeologists have been arguing about classification and about whether or not there is a natural order within artifacts that is discoverable (Krieger, 1944; Spaulding, 1953), or if all classifications are based on artificial orders imposed by the classifiers (Ford, 1954). In regions such as southern France and southwestern United States, there is some consensus as to what artifact attributes are standard and useful for historic correlations. They are such things as describing the length, width, and shape of lithics, and the temper, paste, surface decorations, and shape of ceramics. At this initial stage, no type designations are involved, only descriptions of attributes. In these regions then, after the descriptions are made, sequences of rocks can be divided on the basis of the presence/absence/abundance of artifacts with certain attributes.

Cultural historians started the process of analysis (Daniel, 1976; Dunnell, 1986; Willey and Sabloff, 1980). They noted that stylistic attributes change over time and that they can be used for regional correlation and for subdividing time. One of the primary purposes of stratigraphy is regional correlation. Perhaps subdivisions of rocks should be based on the presence of artifacts with historically relevant attributes (Krieger, 1944). Subdivisions can be made on the basis of the presence, absence, abundance, and variations of distinctive artifacts. Note that divisions are to be determined on the basis of the presence of artifacts with certain attributes, not by the presence of types. The designation of a type is an interpretation. Obviously this is not a simple matter, and selecting attributes that are historically relevant may be difficult. But it is a good place to start.

According to the archaeostratigraphic guide, ethnostratigraphic units are defined by the presence of classes of artifacts that they contain. The decision about which classes are to be used is problematic, but is best decided by someone trained in the theory and methodology of archaeology. As long as stratigraphers recognize that a body of rock can be subdivided by various schemes of classification, each independent of one another and developed for specific needs, etnhostratigraphic units should be considered as valid stratigraphic units separate from lithostratigraphic or biostratigraphic units. Ethnostratigraphy is a legitimiate subfield of stratigraphy.

CHRONOSTRATIGRAPHIC UNITS

Gasche and Tunca (1983) suggested that archaeological time-stratigraphic units that are characterized by their duration and by their temporal relations should be called "chronostratigraphic units." Chronostratigraphic units include one or several strata whose sedimentation took place during a specific time interval. They proposed the term "Phase" as the basic time unit. A phase is a grouping of adjacent strata of anthropic origins with a separate grouping of adjacent strata for those of natural origins. A "Set" is a group of phases, and a "Subphase" is a subdivision of a phase (1983, p. 330).

The archaeostratigraphic guide specifies only one type of chronostratigraphic unit, correlated most closely with the chronostratigraphic unit of other geologic stratigraphic codes, that is, a unit for all rocks formed during the same span of time. In the geological guides (Hedberg, 1976; NACOSN, 1983), there are two categories of geologic-time units: those that are material standards or referents representing a certain period of time (specific rock sequences or bodies); and those that are periods of time, represented in the material referents. Chronostratigraphic units are the material referents of a certain time (rock units). Geochronologic units (and geochronometric units in the *North American Stratigraphic Code*) are time units, based on formally defined chronostratigraphic units. Gasche and Tunca did not indicate whether archaeological chronostratigraphic units are meant to be the deposits that accumulated during a certain time or the time during which those deposits accumulated.

Discussion of chronostratigraphic units

Gasche and Tunca (1983) only minimally discussed the chronostratigraphic unit, and provided no valid arguments for accepting it as something different from geological chronostratigraphic units. Obviously, Gasche and Tunca considered the phase to be a subdivision of archaeological sediment that was deposited during a certain period of time, but they did not emphasize the difference (if any) between these sediments and geologic sediments. Rather than elaborate on the purpose of these units and how they differ from geological stratigraphy, Gasche and Tunca elaborated on the "constitution of chronostratigraphic units" (1983, p. 330). They detailed the manner in which a phase is to be grouped. They emphasized the need to separate deposits that have natural origins from those that have cultural origins, and the need to distinguish from natural deposits those ". . . anthropic deposits whose sedimentation is caused by positive occupation by man (occupation of living floors) or negative occupation by man (filling, raising, etc.)" (p. 330). These preoccupations with natural versus cultural origins are another way of saying that they are subdividing the rocks by their artifact content, or as ethnostratigraphic units. This perspective is an ethnocentric view of sedimentation, appropriate for creating ethnostratigraphic units. But it has nothing to do with chronostratigraphic units.

Gashe and Tunca discussed the constitution of chronostratigraphic units in terms of occupation, because in archaeological

excavation where architectural structures are present occupation or living floors are important material referents, the content of which is used to interpret spatial, behavioral, and chronological matter. Yet, within the bounds of stratigraphy, especially chronostratigraphy, there is no reason to differentiate strata interpreted as living floors from strata interpreted as roof fall. Living floors are merely thin strata bounded by synchronous surfaces (to use terms of NACOSN 1983, p. 849). Roof falls are strata bounded by synchronous or diachronous surfaces. Living floors and roof falls are interpretations of lithostratigraphic units, and may be different chronostratigraphic units (for example, people do not usually live in houses where the roofs are collapsing and accumulating within the structure), but depending on the time scale of interest the two lithologically different strata may be defined as one chronostratigraphic unit.

Stratigraphy and the appropriate fundamental unit. Perhaps Gasche and Tunca's emphasis on strata of anthropic origin and living floors stemed from the different fundamental units used for stratigraphy in archaeology and geology. Geological stratigraphy is based on such fundamental units as the Formation, the System, and the Period. Recognizing that any rock sequence can be subdivided in many ways depending on the focus of the stratigrapher, geologists are aware of the variety of fundamental units and their uses. Prior to the last few decades, archaeologists focused almost exclusively on the artifact as its fundamental unit for stratigraphic correlation. Because archaeological strata cannot be traced over entire sites or regions, interpretations of chronology were based on objects and the technological sophistication of those objects. In the nineteenth century, objects discovered in stratified deposits (primarily caves) were used to establish Stone Age, Bronze Age, and Iron Age units (see the discussion in Grayson, 1983).

The use of artifacts, as opposed to deposits, to establish stratigraphic sequences in archaeology permits interpretations of reversed stratigraphy, and primary and secondary deposits. Archaeologists occasionally record reversed stratigraphy within their sequence of layers, which refers usually to a reversal in the artifactual contents of a pile of backdirt that was dumped adjacent to the opening of a pit dug by the inhabitants of the site. Because the uppermost layer of the surface is dumped first, and then followed by more deeply buried layers, the stratigraphy of the pile (and the age of the artifacts within the layers) is reversed compared with the stratigraphy exposed in the sides of the pit. When labeling this sequence as reversed, archaeologists are referring to the temporal order of the age of manufacture for objects contained in the deposit. The stratigraphic order of the layers is not reversed with regard to superposition. The order in which the layers were deposited is still oldest on the bottom and youngest on the top. Reference to reversed stratigraphy reflects a confusion of the fundamental unit to which superposition applies. Archaeologists are calling the stratigraphy reversed because they are focusing on the age of tool manufacture. The fundamental unit to which superposition applies is the layer, not the age of the artifacts.

This confusion in archaeology as to the appropriate fundamental unit for stratigraphic and sedimentologic observations is also reflected in the use of the terms "primary" and "secondary" deposits. In archaeology, these terms describe the history of individual objects within the deposit, rather than the deposit itself. Geologically and archaeologically, a deposit is laid down only once. When its contents are eroded and then deposited a second time, a new deposit is created with a new depositional history (new sources, transport agents, etc.). For example, when a river erodes quartz grains from a Paleozoic sandstone formation, the quartz in the alluvium is part of a new deposit that cannot be thought of as geologically secondary. The concept of secondary deposit in archaeology actually refers to the source of the individual artifacts within the deposit. A deposit is considered secondary when at least one of the artifacts within it has been transported from another location where it had been part of a primary deposit. The primary deposit is found at the location where the artifact was dropped (intentionally or unintentionally) by its original user/manufacturer. By noting primary and secondary deposits, archaeologists have focused analyses only on the artifacts in the deposit, and by using attributes such as rounding of edges and surface features they have inferred that the artifacts were transported (Shackley, 1974). The inferences may be true for the artifacts, but they are false for the deposits.

Paleontologists face a similar problem when interpreting a fossil bed as representative of a life assemblage (Behrensmeyer and Hill, 1980; Gifford, 1981). Taphonomists have demonstrated the need to consider how biological organisms are incorporated into the geologic record, and the difference between life and death assemblages (primary and secondary deposits). The difference between taphonomy and archaeology lies in the focus on remains of biological organisms by taphnomists rather than on the objects manufactured and used by those organisms. A hand axe does not have a life position, as opposed to the death position.

During the last decade, archaeologists focused less on the artifact as a fundamental unit, and thus recognized the confusion in their attributions of reversed stratigraphy and primary and secondary deposits. In part, this shift occurred because interest turned toward new paths of inquiry such as interpretation of depositional events (Butzer, 1982; Davidson and Shackley, 1976; Hassan, 1978; Stein, 1987; Stein and Farrand, 1985), identification of attributes of artifacts that reflect cultural deposition (Binford, 1983; Hodder, 1986; Schiffer, 1983, 1987; Stein, 1985), investigation of the hypothesis that artifacts are deposited by agents other than people (Binford, 1981; Brain, 1981; Gifford, 1981), realization that artifacts are transformed and transported within the archaeological record (Stein, 1983; Villa and Courtin, 1983; Wood and Johnson, 1978), and most importantly, increased awareness of stratigraphic principles (Harris, 1977, 1979; Gasche and Tunca, 1983; Stein, 1987). Results of this work are making archaeologists aware that the fundamental units of archaeology are very close to those of geology.

Geologic time versus archaeological time. In both geology and archaeology, stratigraphers order strata in temporal se-

quences. In geology the temporal scale is often larger than in archaeology, but the difference is not sufficiently great to warrant proposing a new time-stratigraphic unit. Lower-ranking time-stratigraphic units appropriate for archaeological stratigraphy are already inherent in the geologic stratigraphic codes. Both disciplines depend on superposition and isotopic dating to order strata, and both have problems with strata representing deposition that transgresses time (Watson and Wright, 1980).

When geologic time scales were initially developed, geologists had few opportunities to use numerical dating methods and were forced to rely on relative means of dating strata. Formations and their relative positions were correlated across great distances and assigned to chronostratigraphic units, which usually represented long periods of time. The time during which those formations were deposited was labeled with respect to geochronologic units (Ager, 1981; Laffitte and others, 1972). The use of absolute dating methods for geological chronology in recent decades has resulted in the discovery of more gaps in the record (Gould and Eldredge, 1977; Ager, 1981), perhaps because of a logical error in the procedure for defining chronostratigraphic units (Watson, 1983; Lucas, 1985). Although correlations using relative-dating methods have been successful, it is now apparent that these correlations are in need of revision (Ager, 1984; Menner, 1984; Obradovish, 1984; Odin, 1982a) and that numerical ages (where available) improve the accuracy of relative ages for stratigraphic correlation (Odin, 1982b).

In archaeology, the introduction of numerical dating methods also resulted in refined chronologies (representing shorter intervals of times), which were defined using cultural historical methods. During the last few decades, archaeologists relied on isotopic dating to correlate artifact assemblages and to establish direct divisions of time (expressed in years). Before numerical dating, archaeological cultures, phases, and stages were conceived using a method similar to biostratigraphy, not by correlating deposits across space, but rather by correlating their artifactual content. The informal divisions of time were based on assemblages of artifacts that changed through time. Culture historians were able to order assemblages by noting the relative frequencies of artifacts with certain stylistic attributes. With the advent of isotopic dating, gaps in the chronologies were discovered. Nonetheless, each chronology can be thought of as a division of geologic time, similar to the geologic time units defined by biostratigraphic data. Archaeologists are concerned with only the most recent periods of the time scale, and with dividing sequences into smaller intervals of time. But the concept of archaeological time is the same as that of geologic time.

As in geology, the use of more accurate dating techniques to refine archaeological chronologies made the time-transgressive nature of prehistoric periods obvious and thus presented problems for chronostratigraphic correlations. For example, Neolithic artifacts are found in much earlier contexts in southwest Asia than they are in western Europe. Because "the Neolithic" is not indicative of time, but rather of technological innovations, age determinations of strata containing Neolithic artifacts are time transgressive. In the *North American Stratigraphic Code* a new "Diachronic Unit" is recognized (NACOSN 1983, p. 870–872), which is relevant to the time-transgression problems in archaeological periods. Diachronic units are defined as comprising unequal spans of time represented either by a specific lithostratigraphic, allostratigraphic, biostratigraphic, or pedostratigraphic unit, or by an assemblage of such units. Formal zones of time-transgressive artifacts (ethnostratigraphic units) could be identified, then used to establish formal diachronic units at appropriate levels (ranks). Diachronic units are successfully applied to Pleistocene glacial stratigraphy (Watson and Wright, 1980) and have a great deal of potential for archaeology.

Nothing in the definition of a chronostratigraphic, geochronometric, or diachronic unit, as appears in published geologic stratigraphic codes, prohibits their use in archaeological stratigraphy. On the other hand, there are many problems with the proposal of the new chronostratigraphic unit suggested by Gasche and Tunca (1983, p. 329–330). Rather than reinventing chronostratigraphy, I suggest that archaeologists adopt the use of the terms as they are defined in various geological stratigraphic codes. Archaeologists are more likely to arrive at reasonable correlations by applying in a rigorous manner the rules of chronostratigraphy developed in geology than they are by proposing a new definition for an already accepted term.

CONCLUSIONS

Archaeologists recognize the need to minimize ambiguity and clarify the distinctions among different kinds of stratigraphic units. To this end, Gasche and Tunca (1983) proposed an archaeostratigraphic guide, which introduced three stratigraphic units: Lithologic, Ethnostratigraphic, and Chronostratigraphic. For each unit, the application of subunits for archaeostratigraphy was described.

Gasche and Tunca stated that the "Lithologic Unit" is similar to the lithostratigraphic units of geologic stratigraphic codes and guides, but is subdivided into subunits with a ranking of "Layer," "Sub-Layer," and "Inclusion." Although archaeologists have suggested that archaeological discontinuities and descriptions of archaeological sediments require stratigraphic units unique to archaeology, the only characteristic of the "Layer," "Sub-Layer," and "Inclusion" that is different from previously proposed geologic lithostratigraphic units is the inferred difference in scale. I argue that, rather than proposing an entirely new lithologic unit with three ranks, archaeologists should support the proposal of a new, smaller-ranking unit of geological lithostratigraphic units, and that its name should be "Layer." Archaeologists should use the geological codes, and geologists should alter those codes slightly to accommodate the special concerns of archaeologists. In this way archaeologists need not reinvent lithostratigraphic units, but need only express their need for a unit of smaller scale with which they can practice stratigraphy.

The "Chronostratigraphic Unit" discussed in the proposed archaeostratigraphic guide is not sufficiently different from geo-

logic chronostratigraphic units to be justified. For purposes of archaeology, the chronostratigraphic and geochronologic units proposed in the various geological stratigraphic codes are more than adequate. Chronology is important in both archaeology and geology, and although the intervals of time on which each discipline focuses vary, the differences do not warrant creating a new chronostratigraphic unit for use in archaeology.

The "Ethnostratigraphic Unit," on the other hand, is clearly a valid and needed unit, in which stratigraphic classifications of strata are based on their artifactual content. As with biostratigraphic units, divisions of ethnostratigraphic units are based on their content. The ethnostratigraphic unit requires a separate name because it involves separate theoretical and taxonomic principles. Although archaeologists may not yet agree as to the standardized description of artifact classes, the division of rock sequences according to the presence of various artifacts is a valid stratigraphic practice, and deserves to be recognized.

One of the most important contributions of Gasche and Tunca is their discussion of whether strata containing artifacts warrant designation as separate ethnostratigraphic units. If each type of material on which division of strata is based is a legitimate, separate means of dividing strata, then biostratigraphic units, magnetostratigraphic units, pedostratigraphic units, and ethnostratigraphic units are all legitimate. The proposal of ethnostratigraphic units is based on the specific needs of archaeologists. Although artifacts have been described as fossils, they are not. They are objects produced by people, and require a separate methodology and theoretical perspective for their description and interpretation.

In the context of stratigraphy, with its emphasis on chronology, archaeology is closely related to geology. Stratigraphy in archaeology does not require a complete revision of geological stratigraphic codes. All that is required is that geologists recognize archaeology as a discipline concerned with stratigraphy, and in need of special considerations in the geologic stratigraphic guide. Under these premises, the new guide proposed by Gasche and Tunca is not particularly useful in its entirety, but their suggestion of a newly defined ethnostratigraphic unit that meshes with classic stratigraphic principles and that adds to the study of chronology is useful. Archaeostratigraphers do not require a new theoretical and methodological premise on which to base stratigraphy, but rather a new ethnostratigraphic unit on which to base new divisions of rock sequences. Archaeology is sufficiently different from geology and paleontology to warrant its own separate stratigraphic unit. But archaeology is not sufficiently different to warrant inventing a new stratigraphic code. If geologists will consider the needs of archaeologists and revise the stratigraphic guides and codes accordingly, then we can again, as we did in the nineteenth century, practice stratigraphy together. For further discussion of stratigraphic units see Thorson, Chapter 22, this volume.

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MANUSCRIPT ACCEPTED BY THE SOCIETY AUGUST 31, 1989

ACKNOWLEDGMENTS

For their assistance in the preparation of this manuscript I thank: Elizabeth D. Benchley, Paul Buck, Carol Carr, Robert C. Dunnell, William R. Farrand, Paul S. Goldberg, Donald K. Grayson, Angela R. Linse, Gregg Sullivan, Patrice A. Teltser, and Richard A. Watson. Special acknowledgment goes to W. Hilton Johnson, Herbert E. Wright, Jr., and Stanley E. Chernicoff for their insights concerning stratigraphy.