14 Stratigraphy

An important aspect of post-excavation analysis is to order deposits and interfaces chronologically, by **stratigraphy**. Stratigraphy is the analytical process that the archaeologist or geologist carries out; **stratification** refers to the physical layering of deposits in a site.

As we already saw in chapter 12, it is useful to distinguish between lithostratigraphy, biostratigraphy, and archaeological or ethnostratigraphy. Lithostratigraphy, biostratigraphy, and archaeological stratigraphy share the assumption that we can recognize depositional events and events that remove material (erosion, pit-digging, etc.), but differ in the unit that consititutes that "event." For a geologist or biostratigrapher, the event might last thousands of years. Archaeologically interesting events may have lasted less than one day, or as much as two centuries. In this chapter we will concentrate on archaeological stratigraphy, but some discussion of lithostratigraphy and biostratigraphy is necessary. In fact, some authors (Farrand, 1984; Stein, 1992) argue that there is no need for a distinctly archaeological stratigraphy, and that lithostratigraphy is perfectly adequate for archaeological work. Although it is true that there are geological analogues for many of the processes that affect archaeological stratification, here we will follow principally the alternative view, espoused especially by Harris (1989), that the goals and shorter time scale of archaeologists, and the fact that cultural site-formation processes are sometimes quite different from geological ones, require some distinctly archaeological stratigraphic theory.

In spite of the debate between these two groups, they do agree on several points. Both adopt the three main principles of lithostratigraphy — the Principle of Superposition, the Principle of Original Horizontality, and the Principle of Original Continuity — for sedimentary deposits, although archaeological stratigraphers frequently have to deal with deposits and features created by nonsedimentary (especially cultural) processes.

The *Principle of Superposition* is that, for sedimentary deposits, deposits that were formed earliest were overlain by ones formed later, so that the ages of deposits tend to be ordered by their depth. Although deposits were laid down in that order, later events, such as earthquakes and landslides, can alter their physical ordering.

The *Principle of Original Horizontality* is that all sedimentary layers formed in bodies of water were originally deposited horizontally, as a result of gravity and other physical phenomena. Again, these layers can later become tilted and warped out of horizontal.

The *Principle of Original Continuity* is that each layer originally extended spatially as a whole, uninterupted sheet or lens, and that any discontinuities or edges that now exist are the result of erosion, faulting, and other processes that dislocate or remove portions of the layer.

One of the main differences between the two stratigraphic camps is in the importance they assign to the **interfaces** between deposits. An interface is simply a boundary between deposits, representing, for example, the surface that would have been exposed at the top of the deposit before it was covered by other deposits, or the concave surface exposed when someone excavates a pit into pre-existing deposits. Those in the lithostratigraphic camp, notably Stein (1987), argue that the deposit is the unit of importance for both archaeological stratigraphy and lithostratigraphy:

A deposit, like the "bed" of the geologists, is a three-dimensional "envelope" of sediment distinguishable from surrounding sediment on the basis of its physical properties because it was formed under a particular set of physical conditions (Stein, 1987:339). In Near Eastern archaeology, the deposit is often called a "locus" (Dever and Lance, 1978).

The other camp is just as emphatic that geological stratigraphy is inadequate for understanding deposits created by human activities (Harris et al., 1993). Rather than focus only on deposits, Harris submits that the analysis of archaeological site formation requires attention to *layers*, *features* and **interfaces**. These, he argues, are contextual units that archaeologists recognize repeatedly on all kinds of archaeological sites in all parts of the world.

Layers are essentially equivalent to deposits that geologists would recognize, if on a rather different scale. They are deposits whose horizontal dimensions are much greater than their vertical dimension, so that archaeological excavations can intersect them over some extent of an archaeological site. Layers have distinct sedimentary characteristics that allow them to be distinguished in the field, including particle shape, texture, color, pH, composition, and compaction.

Features have no close analogue in geology. They include such nonportable artifacts as hearths, pits, walls, and structures, with vertical dimensions often even greater than their horizontal dimensions, and are generally smaller than layers in horizontal extent. More importantly, although some features — a purposely built mound, for example — are equivalent to deposits, others, such as pits, are in fact defined by the *removal*, rather than deposit, of sediment. Later, of course, the pit can be filled with new sediment, constituting one or more deposits, but the pit fill represents one or more events quite distinct from, and later than, the event of digging the pit. In addition, some kinds of features, notably walls built from stone, mud, or brick, constitute what Harris calls *upstanding strata*. If we were to treat these as geological deposits, they would violate the principle of original horizontality because their largest dimension is often the vertical one. Each feature is always associated with at least one interface.

Finally, there is the **interface**. This is the most important point of disagreement between Harris and the geoarchaeologists, in spite of the fact that it actually does have an analogue in geology: the unconformity. Uncomformity is the term geologists use for the upper surfaces of sediments that have been truncated by erosion or lain for some time without any deposition occurring on them. For Harris (1989), the interface represents either the upper surface of nondepostion on a layer, on which human activities took place or other deposits were laid, or the boundaries created when pre-existing sediments are removed by erosion or excavation, or when features are constructed, renovated, or repaired. Intrusive interfaces are those created by digging, burrowing, gullying, or insertion of posts.

Harris refers to intrusive interfaces such as ditches, pits, and post-holes as *Vertical Feature Interfaces*, while *Horizontal Feature Interfaces* result from the destruction or levelling of upstanding strata, such as stone or brick walls, leaving truncated walls or foundations.

Stein's (1987:355-56) principal objection to Harris's classification of stratigraphic phenomena appears to be her doubt that archaeologists are competent to recognize them consistently in the field (Harris et al., 1993:14; Triggs, 1997:29). She criticizes him for failing to provide explicit, objective criteria for assigning stratigraphic phe-

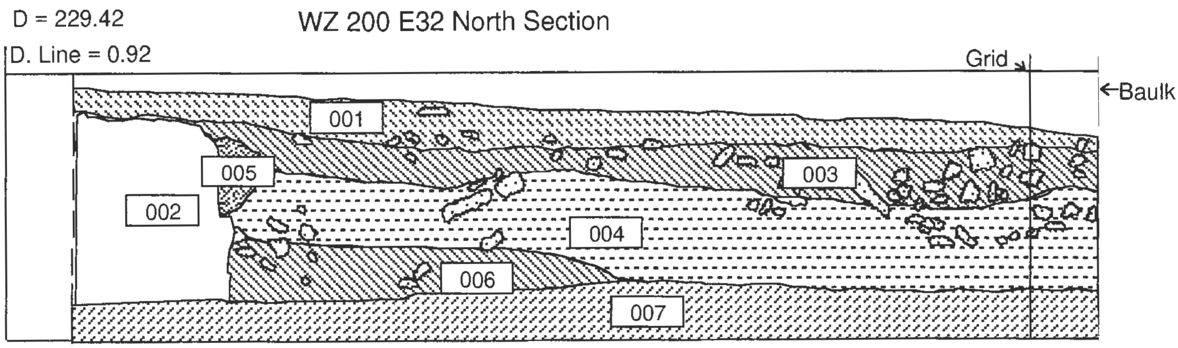

Figure 14.1. Example of a stratigraphic section drawing showing the vertical relationships between deposits that intersect the North edge of an excavated 4m x 4m square. Data from the Wadi Ziqlab Project, Jordan.

nomena to the classes he proposes.

Another point of contention is Harris's (1989) emphasis of the *single-context plan* over the stratigraphic section (figure 14.1). This is a map that depicts a complete plan of a particular stratigraphic unit (or the portion exposed by excavation) as viewed from above (figure 14.2). Harris prefers sets of these plans to stratigraphic sections because not all layers, features, and interfaces intersect the sections, and thus important stratigraphic information is omitted from the record in the sections (Harris et al., 1993:4). Consequently, archaeologists following Harris's methods, especially in the United Kingdom, tend to conduct open-area excavations rather than grid-and-baulk excavations. In the former method, the excavators remove deposits in the reverse order of their deposition, simultaneously over a wide area. The single-context plan and frequent topographic levels are their principal recording instruments, the stratigraphic units being treated much like superimposed sheets of paper (Triggs 1997: 34). In the grid-and-baulk method, excavations in different parts of a site can proceed at quite different paces because they are separated by **baulks** — strips of unexcavated sediment — and drawings of the vertical sections exposed on the sides of the baulks are their main stratigraphic recording instrument (figure 14.1).

Triggs (1997:34-35) argues for an archaeological stratigraphy that combines the interfacial views that Harris espouses with the vertical views visible in sections. He notes that the vertical section provides clues to the site-formation processes that created and transformed the deposit that are unlikely to be visible in plan view alone.

The Harris Matrix

The archaeological stratigraphy that Harris advocates depends especially on the abstract representation of stratigraphic relationships in what is now called the Harris-Winchester matrix or the **Harris matrix**. It is built from the record of all *unequivocal* relationships between layers, interfaces, and features, and is essentially like a wiring diagram, flow chart, or lattice, rather than a matrix in the mathematical sense (Orton, 1980).

In the Harris system, each layer, feature, and interface is represented by a labelled box and the nonredundant stratigraphic relationships between them by line segments (figure 14.3). It is important to note that the purpose of the resulting diagram is to show the sequence of deposits, features, and interfaces in time, not to show physical relationships (Harris, 1989:34-36).

The stratigraphic units in the labelled boxes are any deposits, features, or interfaces that represent a distinct moment of time, whatever its duration. The boxes are connected by vertical line segments by the *Law of Stratigraphic Succession*. According to this law, any stratigraphic unit is placed on the diagram "between the undermost (or earliest) of the units [that] lie above it and the uppermost (or latest) of all the

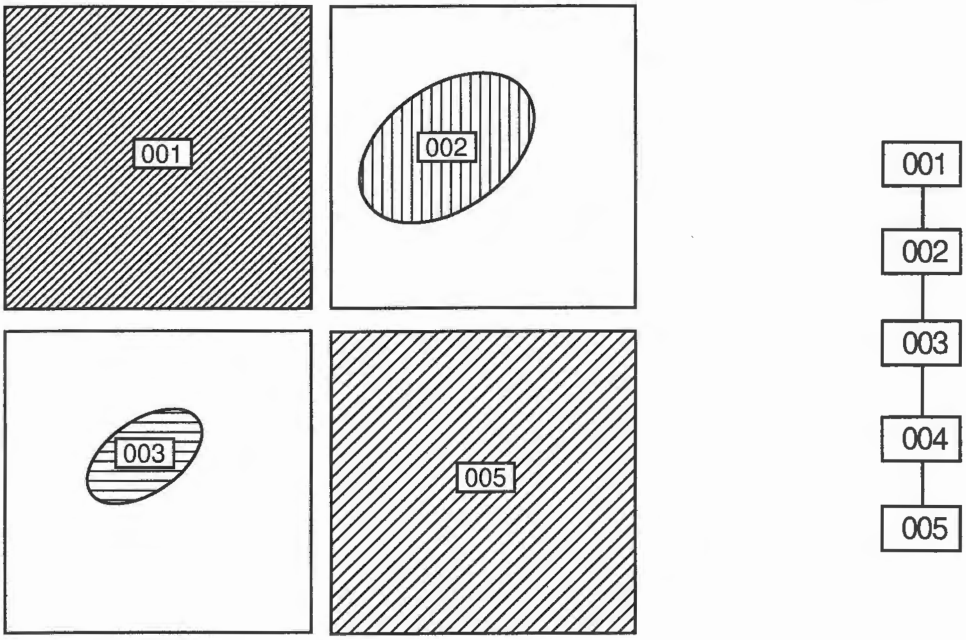

Figure 14.2. Single-context plans. Unit 005 is a layer into which a pit (interface 004) was cut, then filled by deposit 003, then 002, before the whole area was covered by layer 001. The single-context plan for interface 004 would look the same as that for pit fill 002, but with contour lines inside it.

units [that] lie below it and with which the unit has some physical contact, all other superpositional relationships being redundant" (Harris, 1989:157-58). These nonredundant superpositional relationships are indicated by the vertical line segments in such a way that the oldest unit is at the bottom of the diagram and the youngest units are at the top. It is not necessary to indicate the other physical relationships between units because they contribute nothing to our understanding of the stratigraphic sequence (figure 14.3).

This becomes clearer, perhaps, when we represent the relationships by a mathematical model. Here we might represent the stratigraphic relationships with the "> " sign, which we will take here to mean, "older than." If we make the statements,

Unit 1 > Unit 2, and

Unit 2 > Unit 3,

then we can conclude by deduction that Unit 1 > Unit 3, and that the full sequence is Unit 1 > Unit 2 > Unit 3. Consequently, we do not need to show the relationship, Unit 1 > Unit 3, as it would only tend to complicate the diagram without contributing any essential *chronological* information (figure 14.3). The Harris matrix that results from the gradual build-up of such relationships provides an extremely useful representation of all the stratigraphic units, including those that do not intersect any stratigraphic sections, along with the key chronological relationships between them.

However, it often happens that there are stratigraphic units whose relationships are uncertain because there is no physical contact between them. For example, in figure 14.4, we know that Unit 004 and Unit 005 are both older than Unit 001 and both are younger than Unit 008, but we have no stratigraphic information that would allow us to confirm or deny that Unit 004 > Unit 005. In mathematical form we would express this problem with the following statements.

Unit 008 > Unit 004 > Unit 001, and

Unit 008 > Unit 005 > Unit 001.

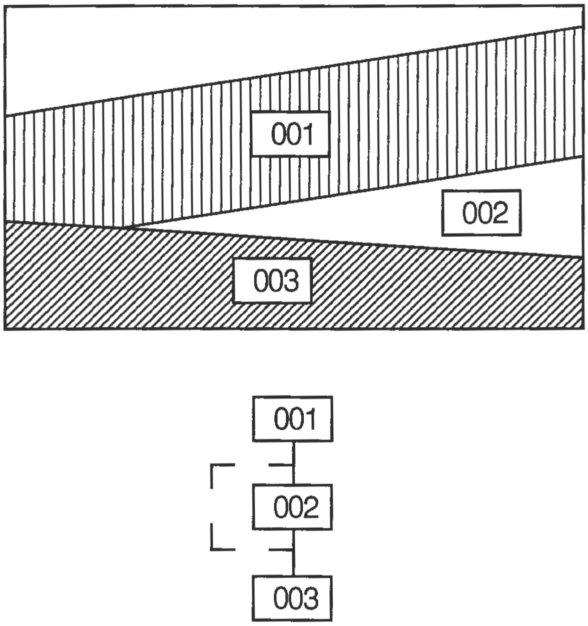

Figure 14.3. Schematic section drawing and simple Harris matrix for three superimposed deposits. The superposition of 001 over 003 is redundant (dashed lines) and so should not be included in the Harris matrix.

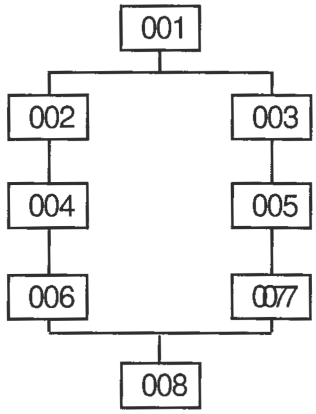

Figure 14.4. Multinlinearity in a stratigraphic sequence. Although we can follow the sequence confidently in each one of the two separate branches, we do not know the relationship between units on different branches except that they are all later than 008 and older than 001. Unit 008 could be a wall that separates two areas with somewhat different sedimentary histories.

From these statements we cannot deduce that Unit 004 > Unit 005, or that Unit 004 < Unit 005, or even that Unit 004 = Unit 005. We can only deduce that both date to some time between the two events represented by Units 008 and 001, and can only guess at their precise relationship unless additional information is available. When this happens we have what is called a *multilinear stratigraphic sequence*, and it is extremely common on sites that have substantial architecture because walls, ditches, and other constructed features commonly partition the site into a patchwork of regions with separate stratigraphic histories. In these cases we require nonstratigraphic information, such as reliable radiocarbon dates or evidence from the geoarchaeological characteristics, site-formation processes, or artifactual content of deposits, to help us sort out the most probable order of units in different strands of a multilinear sequence, much as geologists use fossil content, paleomagnetic reversals, and potassium-argon dates to work out the associations between noncontiguous lithological members.

Many archaeologists around the world have adopted Harris's matrix approach, but its acceptance is by no means universal and some archaeologists have modified it to suit their own purposes. In some cases the modifications result from misunderstanding Harris's purpose in omitting redundant relationships. In some cases they go so far as to try to represent many *physical* relationships rather than those relationships that have chronological importance (e.g., Paice, 1991). These may be useful attempts to represent site structure or illustrate certain site-formation processes, but they cloud the strictly chronological picture. Still others attempt to represent the relative lifespans of stratigraphic units by elongating some of the boxes or make the matrix easier to read by symbolically distinguishing layers, interfaces, and various kinds of features on the diagram (e.g., Bibby, 1993; Hammond, 1993).

Because constructing a Harris matrix for sites with numerous stratigraphic units can be a daunting task, even though the stratigraphic relationships themselves are mathematically simple, many archaeologists have turned to computer software to construct the diagrams. The Bonn Archaeological Program™ is a software package with routines designed for this purpose (Scollar et al., 1992). Here we simply enter all the individual stratigraphic relationships, such as Unit A > Unit B and Unit C = Unit D, and the computer works out all the sequences, eliminates redundant relationships, and draws a Harris diagram.

One of the chief advantages of such software is that it allows us to identify stratigraphic errors. Sometimes, for example, our first attempt to construct a Harris matrix from the set of stratigraphic relationships we have recorded in the field leads to such propositions as Unit A > Unit B > Unit C > Unit A. Clearly such a set of relationships is impossible, as no unit can be both above and below another unit. The Bonn program flags such logical inconsistencies so that we can return to the field notes and attempt to discover the recording errors that led to them. The final results of the analysis, once such errors have been corrected, can be very complex and exhibit considerable multilinearity (e.g., figure 14.5).

Grouping Stratigraphic Units

Once a Harris diagram has been completed for all the stratigraphic units on a site, typically archaeologists want to group them so that all units belonging to a fairly brief period (rather than moment) of time, and thought to be associated with a distinct human occupation of the site, are associated. This results in a larger unit that Old World archaeologists typically describe as a *phase* (not to be confused with Willey and Sabloff's [1956] usage of the term) or stratum and that New World archaeologists would usually call a *component*. Stein (1992) would call this an *ethnozone*. The phase, component, or ethnozone then becomes one of the building-blocks for comparison with other sites, creating regional sequences, and reconstructing the spatial extent of cultures or *complexes*.

Because of the common problem of multilinear sequences, phasing also tends to rely in part on nonstratigraphic information, such as the artifact content of deposits. Yet this is complicated by the fact that we cannot assume that all the artifacts and ecofacts found in a deposit or laying on an interface are of the same age as the deposit or interface itself. The presence of individual artifacts, and groups of artifacts, in layers and features is influenced both by natural disturbance processes (see chapter 12) and cultural site-formation processes, such as discard, recycling, and pit-digging (see Schiffer, 1987:47-140). Harris (1989) distinguishes three kinds of cultural remains on the basis of their chronological relationship to the deposit in which they were found: indigenous, residual, and infiltrated remains.

Indigenous remains are those artifacts and ecofacts that were created only shortly before the deposit in which they were found.

Residual remains are those artifacts or ecofacts that had been in existence for some time before they came to rest in the deposit in which archaeologists found them. In some cases they are *curated* artifacts, such as family heirlooms or coins, that were kept or circulated for many decades before they were eventually lost or intentionally buried. More commonly, they are remains that were removed from some other sediment through pit-digging, erosion, or some other destructive process and redeposited in a new resting place, such as an artificial fill or a colluvium.

Infiltrated remains are artifacts and ecofacts that were actually created *after* the deposit in which they were found, but that somehow worked their way into it, usually from above, without leaving any obvious trace of their infiltration. Among the processes that can cause younger objects to settle into older deposits are earthworm activity, frost heaving, and root penetration.

Associating Noncontiguous Stratigraphic Units

Geologists, prior to radiometric dating, depended heavily on "type fossils" or on spectra of animal remains or pollen to establish whether spatially separated deposits were probably contemporary, or one was later than the other. The

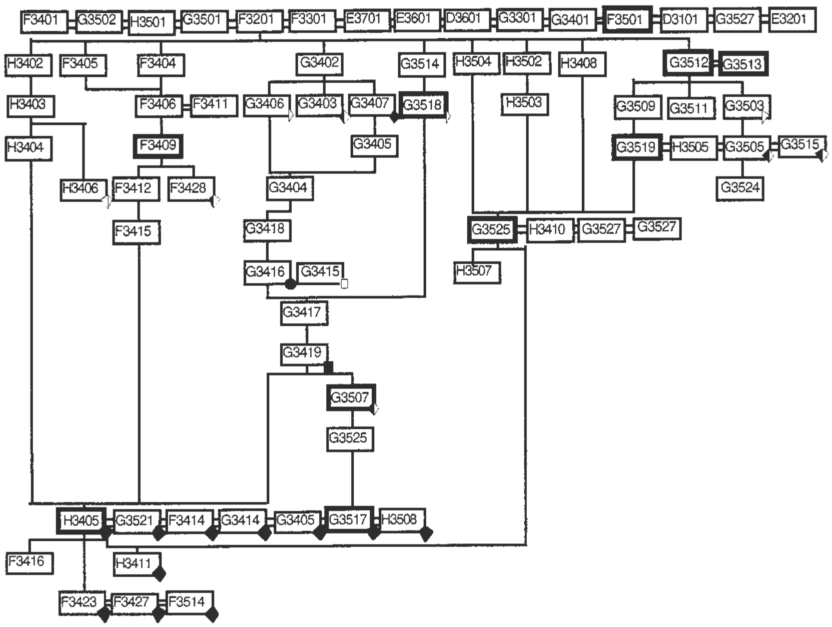

Figure 14.5. Example of part of a Harris matrix executed with the Bonn Archaeological Program™ (Blackham, 1994). Symbols on the matrix indicate walls, graves, etc.

geologists' problem was closely analogous to archaeologists' problem of multilinear sequences.

Today, archaeologists sometimes try to associate widely separated deposits on the same site or components at different sites by carrying out statistical analyses of the artifact distributions in deposits. Some of these analyses are based on seriation (see chapter 13) or clustering methods (chapter 3).

Here I will briefly mention a relatively new method based on set theory. The Unitary Association Method was developed to establish stratigraphic relationships for noncontiguous deposits on the basis of sets of fossils present in them (Guex, 1991; Savary and Guex, 1991), but Blackham (1998) has adapted it for use with archaeological assemblages. It uses the observed superpositions of artifact types in stratified series to identify the sequence of associated sets of artifacts as well as "virtual associations" that take into account the fact that any sampled deposit is unlikely to include all the artifact types that existed at the time it was deposited. A "local horizon" is the set of all associated artifact types in a layer, but those that are sub-sets of other local horizons are combined with them to create "maximal horizons." Other artifacts associated with the members of each maximal horizon are used to define "maximal cliques," which are ethnostratigraphic units representing unique associations of artifact types. Information on the superposition of artifacts that belong to these associations is used to put the maximal cliques into stratigraphic order. A software package called *Biograph*™ (Savary and Guex, 1991) resolves contradictions in this ordering and produces an ordered series of "unitary associations." Subsequently, the contents of each physical stratigraphic unit at each site must be a subset of one of the unitary associations, and so can be ordered relative to deposits with which it has no physical connection.

Conclusions

On stratified sites, our data on the ordering of events consist of observable evidence of stratigraphic superposition of deposits and features and cutting of interfaces into pre-existing deposits. Sometimes this evidence may be difficult to recognize in the field, and archaeologists spend years gaining experience in the detection of interfaces and features. Once they have entered such information into their field notes, however, we can use careful analysis of the individual observations, usually with the aid of

Harris matrices and computer software, to detect probable errors in the stratigraphic observations and to order deposits, interfaces, and features in time. Sites with complex stratigraphy, standing architecture, or many noncontiguous excavation areas are likely to produce multilinear sequences with many units of uncertain stratigraphic order. We must then turn to other methods, some of which are discussed in the following two chapters, to sort these out.

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