CHAPTER

5

Methods of Excavation

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There are many reasons for carrying out archaeological excavations and many ways to determine the appropriate techniques to use. In contemporary archaeology, the emphasis is on area (or block) excavation, as this provides an excellent way to examine behavioral and contextual relationships. In this chapter a wide range of other excavation methods are reviewed. Some are largely outdated and have become part of archaeology's history. But, in certain cases, variations of these techniques may be applied in modern field research. Flexibility remains a key consideration and the archaeologist should be aware of all approaches to excavation. Although consistency in field techniques is desirable, the ability to adapt methods to newly developing field problems should be paramount. As Sir Mortimer Wheeler (1956:81) said "The experienced excavator, **who thinks before he digs,** succeeds in reaching his objective in a majority of cases."

TOOLS AND EQUIPMENT FOR FIELD ARCHAEOLOGY

The number and variety of implements used in archaeological investigation throughout the world are practically limitless. So many special or unusual conditions are likely to be met in the course of excavation that even a bare minimum of equipment must necessarily include an assortment of tools. Subject to the limitations imposed by money, convenience of transportation, and storage in the field, the more the better is a sound general rule.

There are now some companies that offer tools specialized for the archaeologist (see Appendix B). Individual, prepackaged "dig kits" can be purchased, a real boon to the student preparing for a field school! The "complete archaeologist" can obtain rubber kneepads (or leather/felt ones if you prefer), a leather belt-pouch for your trowel, and the "archaeologist's work vest" with pockets and clips and a backpack pouch to hold the pencils, small tools, and other items that are always needed in the field.

Large Tools

Large or expensive tools and special equipment are usually supplied by the institution sponsoring the dig or by organizations that rent or lend them. For example, field vehicles (vans, Suburbans, pickups, and jeeps) will vary depending on the size of the project crew, the nature of the terrain, and the ability of the project to support them (see Dillon 1982). Boats are sometimes used for surveys and for transporting crews and supplies to excavation locales (Meighan and Dillon 1982). For clearing the site for excavation, several kinds of tools may be needed, including weed-hooks, rakes, hoes, and machetes. A chain saw and gasoline-powered "weed-eater" will speed the process. Screening equipment, also generally supplied by the sponsoring institution, is discussed later (see "Screening Excavated Deposits").

In the last analysis, excavation consists of moving earth; hence, the shovel is the trademark of archaeology and perhaps its most indispensable tool. Long-handled, round-point standard No. 2 excavating shovels are recommended as basic. Square-point shovels are useful in excavating sandy deposits, and many archaeologists find them valuable for cleaning excavation unit floors in the search for post molds, rodent burrows, and other features. Spades are very useful for cutting sod, especially when working in lawn-covered areas where the sod has to be replaced after excavation (this is quite common in historic archaeology); scoops can be useful in removing fill from narrow trenches, and they can come in handy for backfilling. Long, narrow-bladed sharpshooter shovels are useful for digging shovel tests.

Ordinarily, enough shovels should be provided so that every member of the digging crew has one. Shovel handles should be sandpapered occasionally and treated with linseed oil. Conditions and methods for using shovels and other tools are discussed in greater detail below.

Heavy, sharp, stout-handled "railroad" picks are often used, though lighter-weight miner's picks or short-handled pick-mattocks are easier to handle and are preferred by some archaeologists. Because picks can cause considerable damage to artifacts, they are generally used only to loosen calcareous, highly compact, or stony deposits too hard for shovels to penetrate. They are nevertheless essential where such deposits occur. A heavy pick swung with both hands represents considerable force, and workers should be cautioned not to strike themselves in the foot and not to hit other workers who may be nearby, particularly behind them. Where paid labor crews are used, workers usually specialize in the use of pick, shovel, wheelbarrow, or the like, often becoming very skillful and efficient with their chosen tool.

Hand Tools

Certain smaller implements are also considered essential (Figure 5.1). Excavators may have to furnish themselves with one of each because the sponsoring organization may not supply these tools.

Trowels are used for careful excavation, especially to uncover and excavate in the immediate vicinity of artifacts or features and wherever larger tools might damage or displace materials. A 4.5- to 5-inch Marshalltown or Goldblatt brand pointing trowel is by far the best. Both brands are made of excellent steel, with the blade and stem of one piece. They are expensive but worth the investment. Cheap trowels will bend and break, and more-flexible mason's trowels and garden trowels are inconvenient. Some excavators find a rectangular-bladed margin trowel (such as the 5-×-2-inch Marshalltown variety) to be a useful adjunct to the common pointing trowel. A rigid, fine-point, wood-handled **ice pick** is also useful, for exceptionally delicate excavation in exposing features, recovering artifacts from hard deposits, dealing with fragile materials, and such. Sharpened and honed **splints** of bamboo or wood are also valuable tools in cleaning burials and features, and some archaeologists also include **dental picks** and **tweezers** in their tool kits. **Root clippers** are needed to trim the floor and walls of units.

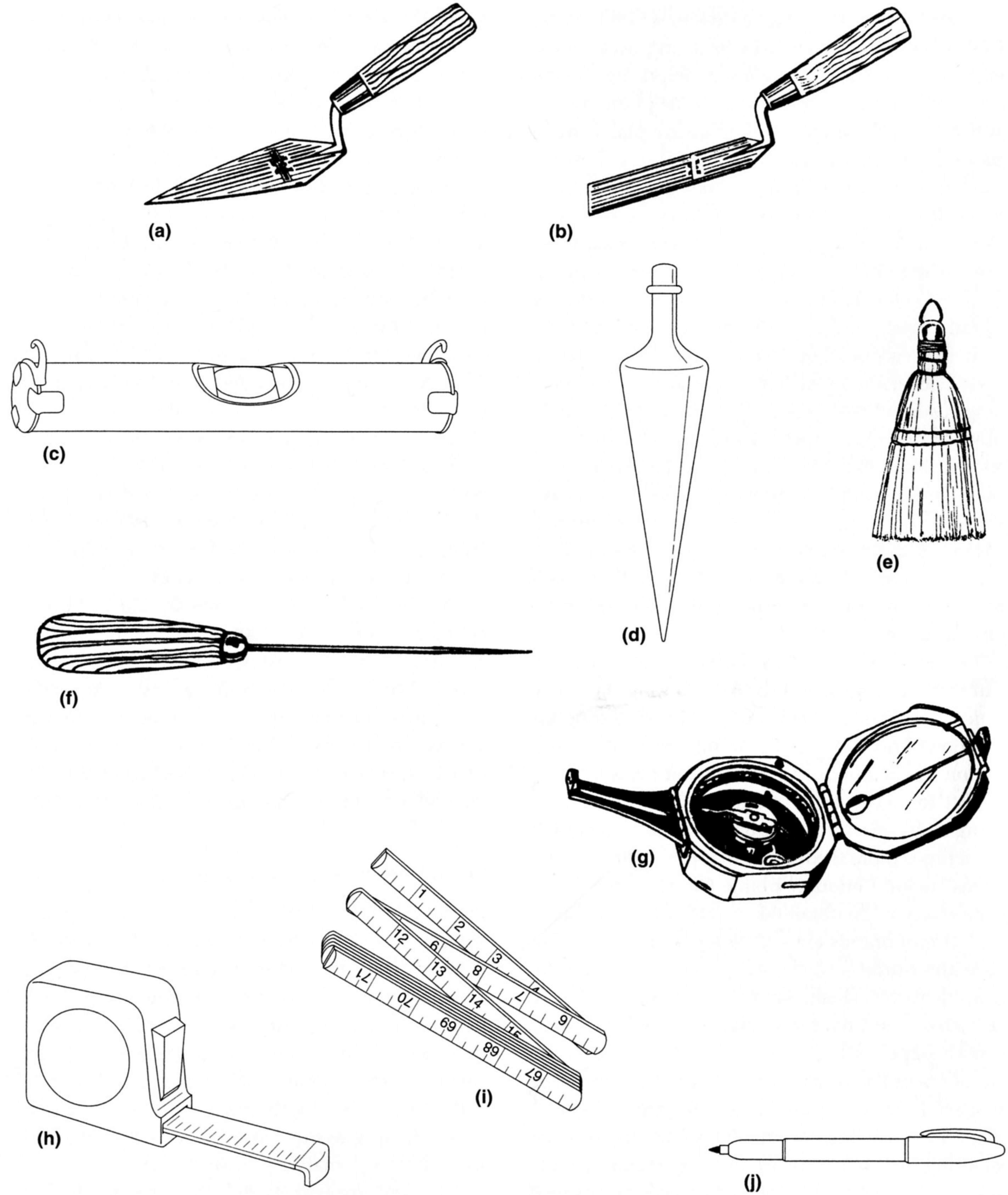


Figure 5.1 Selected hand tools used in archaeological excavations: (*a*) pointing trowel, (*b*) margin trowel, (*c*) line level, (*d*) plumb bob, (*e*) whisk broom, (*f*) ice pick, (*g*) Brunton compass, (*h*) tape measure, (*i*) folding wood rule, (*j*) Sharpie marking pen.

Paint brushes 2 inches or less in width are very useful. They are helpful in brushing away loose earth in delicate work, such as exposing burials and features and preparing them for photography. A heavy brush and a metal or sturdy plastic **dustpan** can be used to collect dirt at intervals when careful exposure is being done. Occasionally, a whisk broom may be more convenient than a paint brush for removing loose earth. **Measuring tapes** are indispensable during the excavation process, as well as for laying out grids and test pits during the initial phases of the fieldwork. A 2- or 3-m hand tape that can be clipped on your belt or stuck in your pocket is a must. Tapes that are 30 or 50 m in length should also be included in any field project. Steel or fiberglass tapes are superior to cloth ones, though more expensive, and must be cared for by oiling and cleaning. Whitefaced tapes are the easiest to see and thus are the least likely to be misread. Metric **folding wooden rules** are also handy during excavation. **Plumb bobs** and **string line levels** are crucial for plotting artifact locations and measuring depths.

Compasses are indispensable in site surveying, but they are also useful for determining the orientation of burials and features and for recording the location of nonpermanent datum points once excavation has begun. A Brunton **pocket transit** is very useful for most archaeological purposes. A Silva Ranger compass or a Suunto KB-14 compass is sometimes more flexible for mapping. Other useful items include enough **blank forms** to record all data likely to be obtained: a field notebook (some waterproof brands are available), artifact slips, feature and burial records, site survey sheets, photographic record sheets (and the necessary cameras, of course; see Chapter 8), and field catalog sheets. Graph paper will be needed for mapping. Large numbers of bags—cloth, strong paper, and plastic (especially the "zippered" type)—are indispensable. Metal-rim **tags** or linen tags with copper-wire or string ties are handy for labeling or closing cloth bags and for labeling cataloged objects. **Felt-tipped pens** are excellent for marking paper bags because the lettering is bold and permanent. Artifacts and other materials recovered are generally kept in small sacks during the course of excavation; large bags are used for burials and features. Plastic **vials** and kraft **boxes** of various sizes are useful for storing small artifacts. Whenever possible, cardboard **cartons** are used to store materials and to protect them during transport by automobile; all freight shipments should be in wooden boxes.

Stakes (or sections of lightweight concrete reinforcing bar ["rebar"]), are needed for laying out the site grid before excavation and as local datum points in measuring thereafter. Wooden stakes can often be made at the site, but it is safer to take them along, if there is room. They should be at least a foot long, and stakes 1-×-2-×-24 inches (or even 30 inches) are recommended (some archaeologists use long, 100-penny nails or galvanized spikes). Usually, a small **sledgehammer** is needed to drive in the stakes. Metal-rim tags with tie strings should be included for marking the stakes according to their coordinate location; they can, alternatively, be labeled with a broad-tipped marking pen. Last, plenty of **pencils** should be on hand.

The items described above should be considered a minimum equipment list; a number of additional implements, described below, will often be useful. With a little ingenuity, a great many other implements can be improvised in the field to meet special conditions. Additional equipment necessary in surveying, mapping, preservation of material, and other tasks is discussed in Chapters 7 and 9.

Other Handy Implements

Before photographing a feature, a stratigraphic profile, or a skeleton from a burial, the archaeologist will want to remove any residual loose earth and dust. A **bellows** or a **bicycle tire pump** may be very useful for this purpose; use an **ear syringe** on delicate specimens. The advantage of such instruments, if properly handled, is that they will not disturb fragile or lightweight objects. A **pocket magnifying glass** or "loop" (7X to 20X) is handy for examining small objects on the spot.

A **hand sprayer** of the type commonly used to spread solutions on garden plants may be used to spray water on a wall or cleared flat surface to bring out color distinctions that are otherwise faint or invisible. Light spraying of this sort can be done immediately before photographs are taken to achieve greater contrast (Bruce-Mitford 1956:236; Hole and Heizer 1973:Figure 45).

Thin **plastic sheeting** can be used to shelter an excavation and the excavators from the rain (Borden 1950) and to cover the units overnight. In many areas, the sheeting can help hold moisture in, keeping the units from drying out and thus making excavation easier the next morning. Santure (1990:11) reports the use of straw, as mulch, covered by polyethylene sheeting to keep deposits from freezing during the excavations at the Norris Farms 36 cemetery site in Illinois.

When working in dry caves or rockshelters (or in dusty crawl spaces), a **respirator** or filtered dust mask is essential.

Field recording is enhanced with a **permanent-ink pen,** especially those of the Sharpie brand. **Flagging tape** in various colors also comes in handy to mark corners of units, datum stakes, or survey instrument locations.

If constituents from the excavation, such as burned rocks, are to be quantified before discarding, a **spring scale** with an aluminum pan that can be suspended from a tree limb is very useful.

First aid kits should be at every excavation, along with **"freeze kits"** for snakebites or, more likely, wasp and bee stings. Insect sprays and ant poison are often needed at sites; be cautious in using these materials because some of these substances can be toxic. **Hats** or caps should be worn by all, along with **sunscreen;** overexposure to the sun can cause health hazards, such as basal cell carcinomas. **Gloves** should also be used, especially by students new to the rigors (and blisters) of fieldwork.

APPROACHES TO EXCAVATION

Once a site has been selected for excavation, the major problem confronting the archaeologist about to begin work is precisely where to dig. In the past, this crucial question was often answered by intuition or by selecting an area that "looked rich." More recently, various random and systematic techniques have been devised for sampling a site to see which areas seem to merit further exploration. The particular technique used depends upon the research design of the excavation project (see Chapter 3). These techniques are not without their problems (such as "blank spots" not covered by random sampling), but they do undeniably eliminate subjective bias in deciding where to dig.

Many contemporary excavation projects are preceded by geomorphological studies so that ancient landscapes can be better understood and site formation processes determined. Remote sensing (see Chapter 4) can also play an important role at some sites. Martin et al. (1991) used a magnetometer and an electronic conductivity sensor at sites in north-central Texas. Although both were able to detect buried features of fire-cracked rocks, the magnetometer provided more information, such as the nature of the disturbance and episodes of repeated use, that the feature had undergone (see Scollar et al. 1990 for more detail on this type of remote sensing).

In addition to these techniques, archaeologists have more-traditional approaches for locating an area within the site with the most potential for excavation, and thus deciding precisely where to concentrate their efforts. Unless sufficient advance information is available about the contents of the site (e.g., from the techniques noted above or from looting, damage from construction, or deep erosional cuts), exploratory or test excavations are usually carried out. These often take the form of shovel tests, test pits (*sondage,* Struever 1968b; or "telephone booths," Flannery, ed. 1976), or narrow trenches (Skinner 1971:167). Whether their location is chosen by a computer or by the excavator, at random, by intuition, by logical reasoning from survey evidence, or by a combination of the five, such preliminary excavations can provide information on the composition and stratification (and culture history) of a site, locate areas of activity or concentrated deposits within it, and thus serve as a guide for later, more-extensive excavation.

Most archaeologists will be interested in learning more about the nature and depositional history of the soils in the site area. For such purposes, Deetz (1967:13–14) has suggested digging a "control pit" in a spot away from the area containing cultural remains, although under some circumstances on- and off-site soil samples can be collected with a hand auger (Cook and Heizer 1965:29). In some sites, geomorphological studies require the excavation of long backhoe trenches for comprehensive studies.

Sir Mortimer Wheeler (1954:84–85) says of the test pit (his "control pit") system:

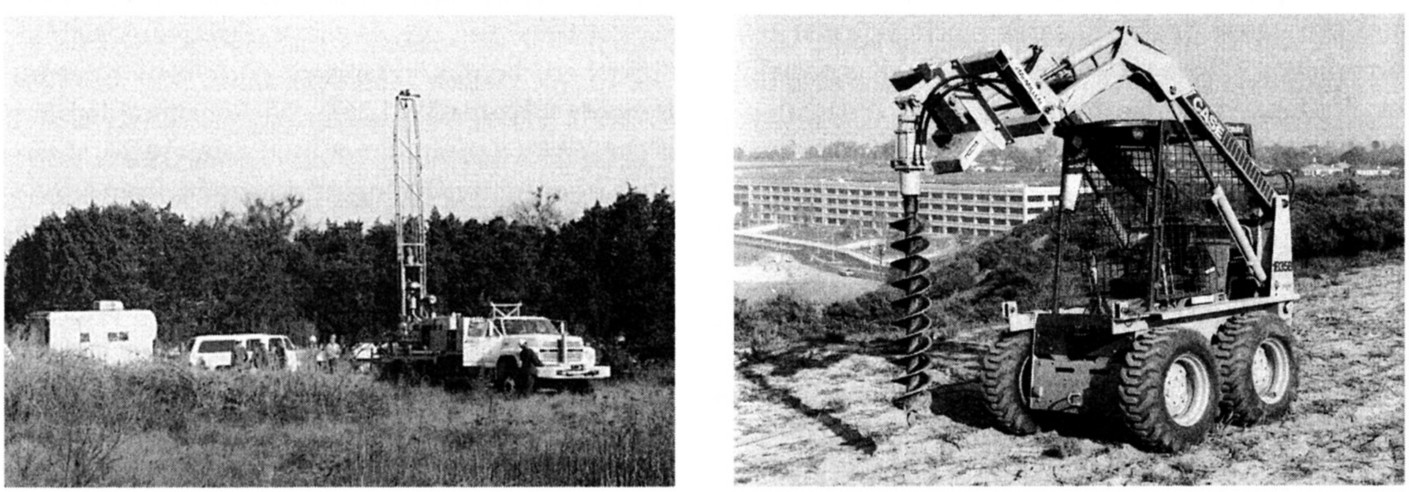
> This is the supervisor's own special charge, and upon it the accuracy of the general digging in large measure depends. . . . Its purpose is to enable the supervisor, with a minimum disturbance of the strata, to anticipate the nature and probable vertical extent of the layers which are being cleared by his main gang. It is a glimpse into the future.

Although archaeologists once shunned the use of machines and heavy equipment, these have become commonplace, especially when a site is doomed for destruction. The archaeologist must decide where excavations should be focused and what the stratigraphy and geomorphology of various parts of the site—which cannot be hand-excavated—will look like. Backhoes, "ditch-witches" (Odell 1992), and other trenching machines have proved invaluable in this regard, giving the archaeologist an early glance at the characteristics of a site and thus guiding the development of the best excavation plan possible (e.g., Black and McGraw 1985; Condon and Egan 1984).

Mechanical earth augers can also be used to get a view of the nature of site deposits (Assad and Potter 1979; Percy 1976; Stockton 1974). Portable, handheld mechanical augers can penetrate only to about 3 ft. However, Whalen (1994:31) reports the use of a bucket auger to define buried features before excavation at the Turquoise Ridge site in western Texas. Howell (1993) used a similar auger at sites in Veracruz, Mexico, and found them to be very useful in areas where thick vegetation prevented surface collections of sherds, as well as for indicating the stratigraphy and depth of dense occupational deposits.

Hydraulic coring of archaeological sites (Figure 5.2a,b) has become a commonly used technique for geomorphological studies, as well as for tracking stratigraphic units across deeply buried sites and gauging the vertical extent of occupational debris in such sites. Stein (1986, 1992) has written on the advantages of coring, noting that continuous stratigraphic samples can be taken with a core. Schuldenrein (1991) advocates the use of coring as a means of rapidly detecting sites in culture resourcement management studies, and Hoffman (1993) has used close-interval coring to determine internal site structure and artifact density.

One must be very careful in the use of heavy machinery, but there are many instances where spe-



(a) (b)

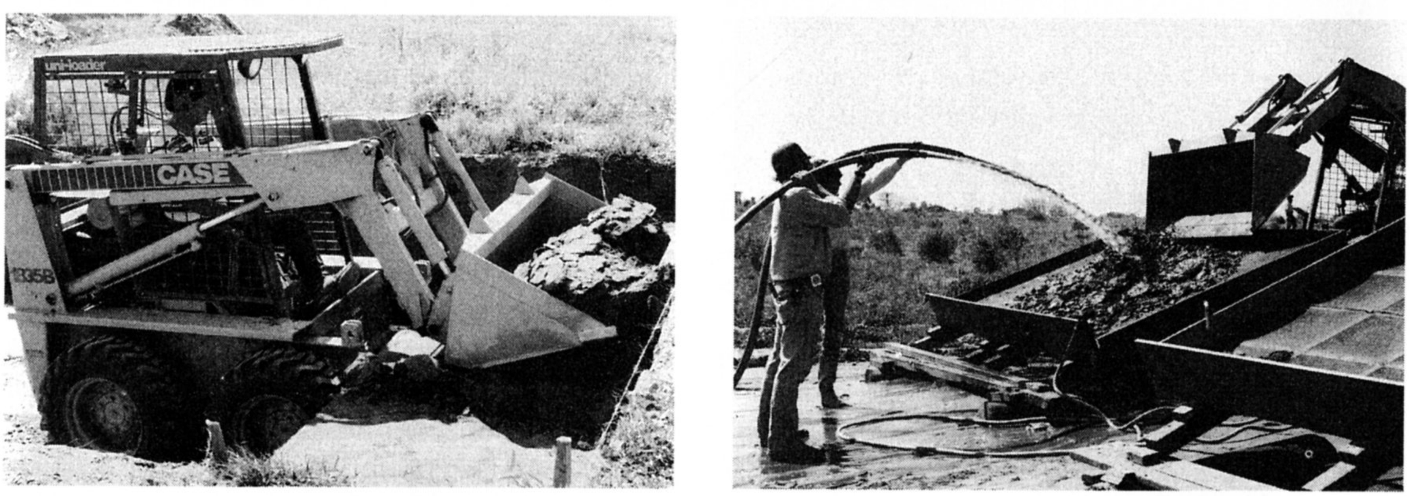
Figure 5.2 Coring at archaeological sites: (*a*) deep-coring with truck-mounted core; (*b*) auger-coring.

cial circumstances require such equipment (as in testing terrace deposits for buried occupations) or where machinery is an integral part of the research design (e.g., removing sterile overburden to allow broad horizontal excavations). Van Horn et al. (1986) and Van Horn (1988) have described their use of such equipment at two California sites. At site LAn-59, a Case 1835B Uni-loader with a backhoe and bucket loader was used to excavate the remains of this doomed site (Figure 5.3a). This was done after a 10 percent hand-excavated sample had been obtained. Excavation was by stratigraphic levels, although absolute depths of artifacts could not, of course, be recorded. Deposits were placed by the tractor into 6-×-10-ft screens (Figure 5.3b) where the soil was water screened. At site LAn-61, it was determined that a 10 percent hand-excavated sample would be too costly. Thus, an excavation program was worked out in which the site was dug in 10-cm arbitrary levels—9 percent by machine, 1 percent by hand. A John Deere tractor with a backhoe and loader was able to remove a single 10-cm layer at a time, but the excavators switched to a smaller Case 1835B Uni-loader because it was more maneuverable. Again, large screens and water screening were used to process the excavated deposits: ⅛-inch screen maximized recovery. Van Horn et al. (1986) believe that the use of this machine in the sandy matrix of this site was in many ways superior to hand excavation, and they noted both the accuracy and speed with which the excavation proceeded. The Uni-loader could remove 15 m^3 of deposit per day (all put through ⅛-inch screen), whereas hand excavation removed 2.5 m^3 per day. "Hard" features such as hearths survived machine excavation and could be recorded in place; "soft" features were usually damaged or destroyed.

Condon and Egan (1984) used a D8 bulldozer at a site to blade an area in order to expose and record feature data that would otherwise have been destroyed. Similarly, Brown et al. (1982) were able to use a small bulldozer to gradually blade away deposits between two areas of hand-excavated hearths at Texas site 41LK67. In this intervening area, the blading of six strips disclosed 30 additional rock cluster features.

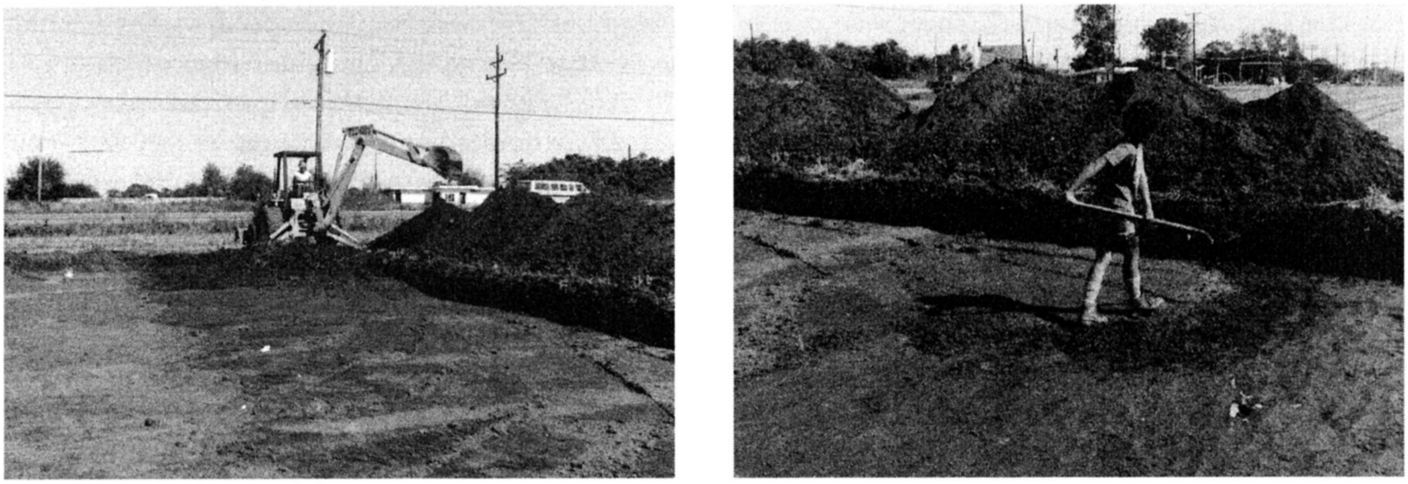
Esarey and Pauketat (1992) illustrate the use of a backhoe (with a toothless bucket) to open a large area at the Lohmann site in Illinois (Figure 5.4a,b). After mechanical stripping, shovel scraping was then used. The shovel scraping allowed "100% identification of subsurface features" within the excavation blocks (Esarey and Pauketat 1992:15). Similarly, in a CRM salvage excavation in Illinois, Esarey and Santure (1990) combined road-grader scraping and shovel scraping to expose large portions of agricultural villages along an Illinois highway right-of-way.

Thoms (1994) used a front-end loader to scrape or blade a site surface "in order to locate and



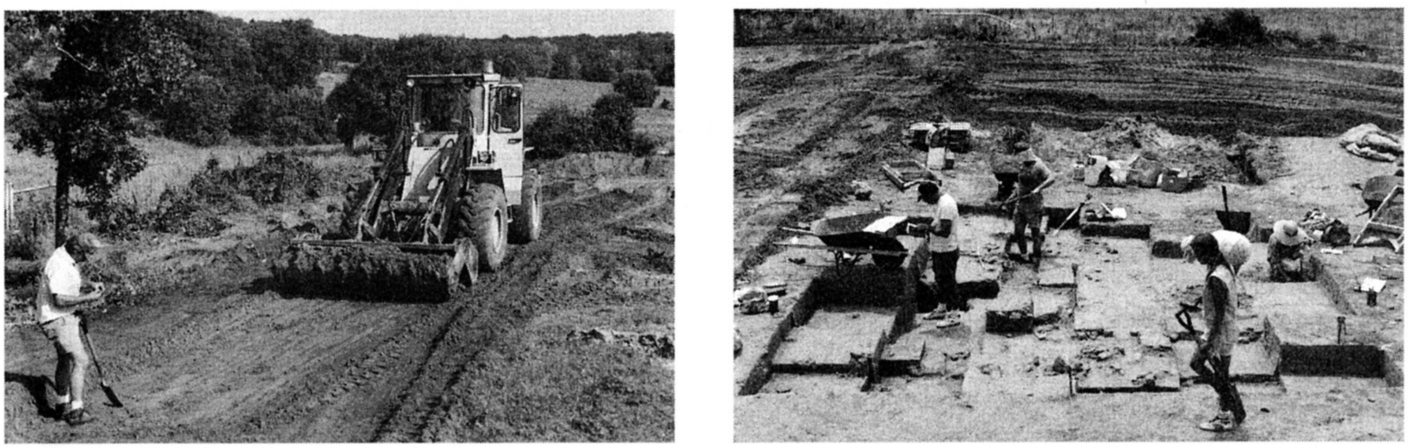
(a) (b)

Figure 5.3 Mechanically aided excavation at site LAn-59, California: (*a*) removing the deposits with a front-end loader; (*b*) water-screening.



(a) (b)

Figure 5.4 Exposure of subsurface at the Lohmann site, Illinois by (*a*) mechanical stripping with a backhoe and (*b*) shovel scraping.

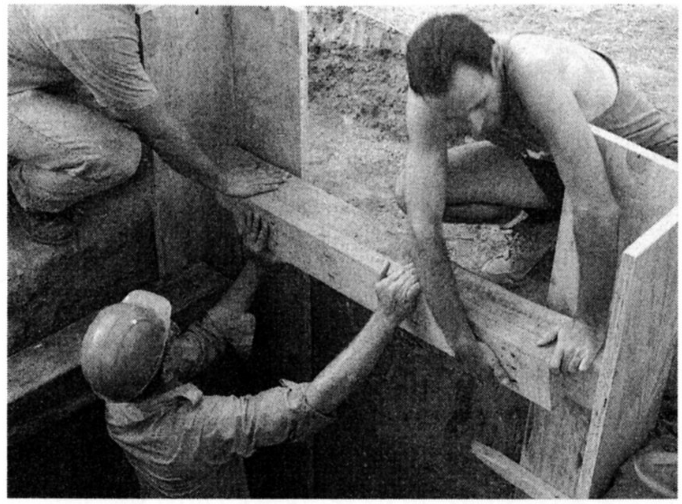


(a) (b)

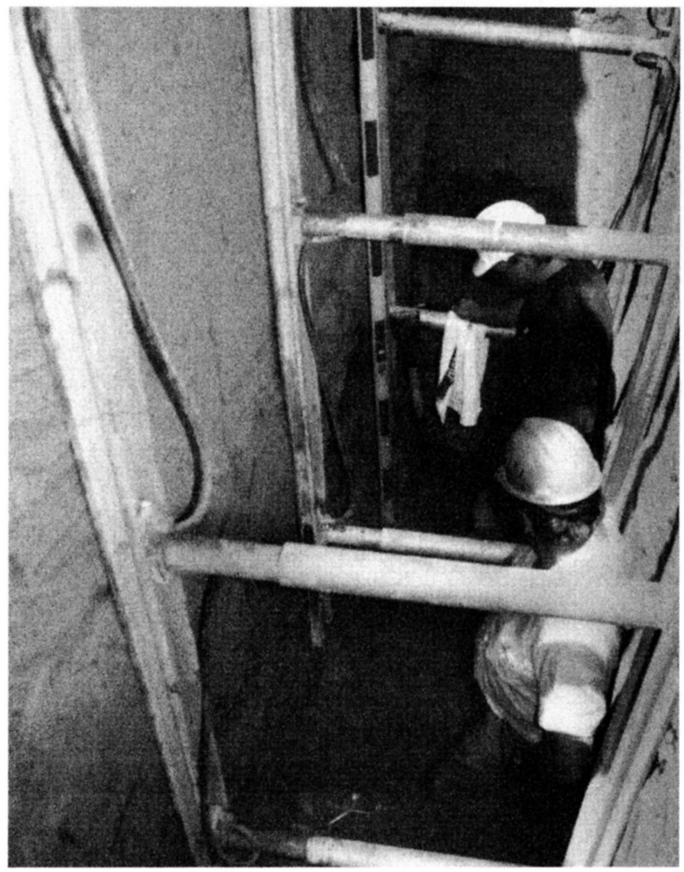
Figure 5.5 Blading a site surface before excavation: (*a*) very shallow scraping or blading with a front-end loader to expose feature locations; (*b*) hand-excavated block exposing features found through blading.

recover possible features and artifacts." Hand excavation was also done, and was accelerated by the blading process (Figure 5.5a,b). The use of this approach was part of a detailed research design; before blading, the site was first surveyed at 1-m intervals with a proton magnetometer and each anomaly found was scanned with a metal detector, then probed to detect rock concentrations. Next, 13 backhoe trenches were excavated and profiled, and data from these were used to select a location for the combined blading/hand-excavation episode (Thoms 1994:54).

Special planning in the use of mechanized techniques has to be done for very deeply buried sites. For example, the Zilker Park site (41TV1364) in Austin, Texas, was to be cut by a massive trench for a wastewater line. The site deposits were estimated to be at least 6 m deep and to date back perhaps 11,000 years. The use of a backhoe to sample a site of this depth was not possible—it just could not dig deep enough. So, the excavators (Ricklis et al. 1991) used a large trackhoe that could reach depths up to 6 m. They excavated the trench in 40-cm trench-long horizontal levels and screened 30 full hand-shovel loads through ¼-inch mesh; 5 hand-shovel loads were put through ⅛-inch mesh. This allowed vertical sampling throughout the 6 m of cultural and ecological (e.g., snails) remains. The trackhoe trench profiles were used to study the depositional processes at the site, to record archaeological lenses, and to obtain sediment samples for radiocarbon dating (see Chapter 14). Such an approach provided a controlled sample and made possible a realistic evaluation of this site for planning purposes by city engineers. Of course, trenches or any other deep excavations must be shored according to engineering standards to ensure crew safety (Figure 5.6a,b).



(a)



(b)

Figure 5.6 Shoring of trench so that it can be safely excavated and profiled: (*a*) wooden shoring installed; (*b*) iron bars add reinforcement at bottom of trench.

SITE EXCAVATION TECHNIQUES

Once an area of a site has been chosen for excavation, the archaeologist must choose the appropriate excavating method. The choice depends on the type of site being investigated and on the specific goals of the expedition. For example, Thomas (1983) began work at Gatecliff shelter, Nevada, using "vertical" techniques—test pits and trenches—to obtain a stratigraphic sequence. He next moved to a "horizontal excavation strategy" to excavate and record short-term, intact occupational surfaces within the deposit; deep, open-area excavation was used to explore the remainder of the deposits (Figure 5.7a–d).

Many methods of excavation are available and can be used in combination as well as singly: trenching; the strip method; quartering; architectural units; area and large-area, or block, excavation; and stripping, to name only some of the standard methods we discuss here. Selection of any of these techniques depends on the research design and the nature of the site deposits.

Trenching

Trenching has been used to obtain cross sections of sites and is particularly important in stratigraphic interpretation because it provides a single, long vertical profile. In addition, trenches can expose buildings buried under later structures (Figure 5.8).

Sometimes, as reported by Flannery (ed. 1976), long profiles can be recorded from fortuitous "transects" or trenches cut through mounds, as in the case of vertical cutbanks created by the removal of earth for adobe brick at sites in Oaxaca. At San José Mogote, a stratigraphic "transect sample" was made possible by cleaning the profiles of an adobe-brick maker's cutbank over 99 m long (later this

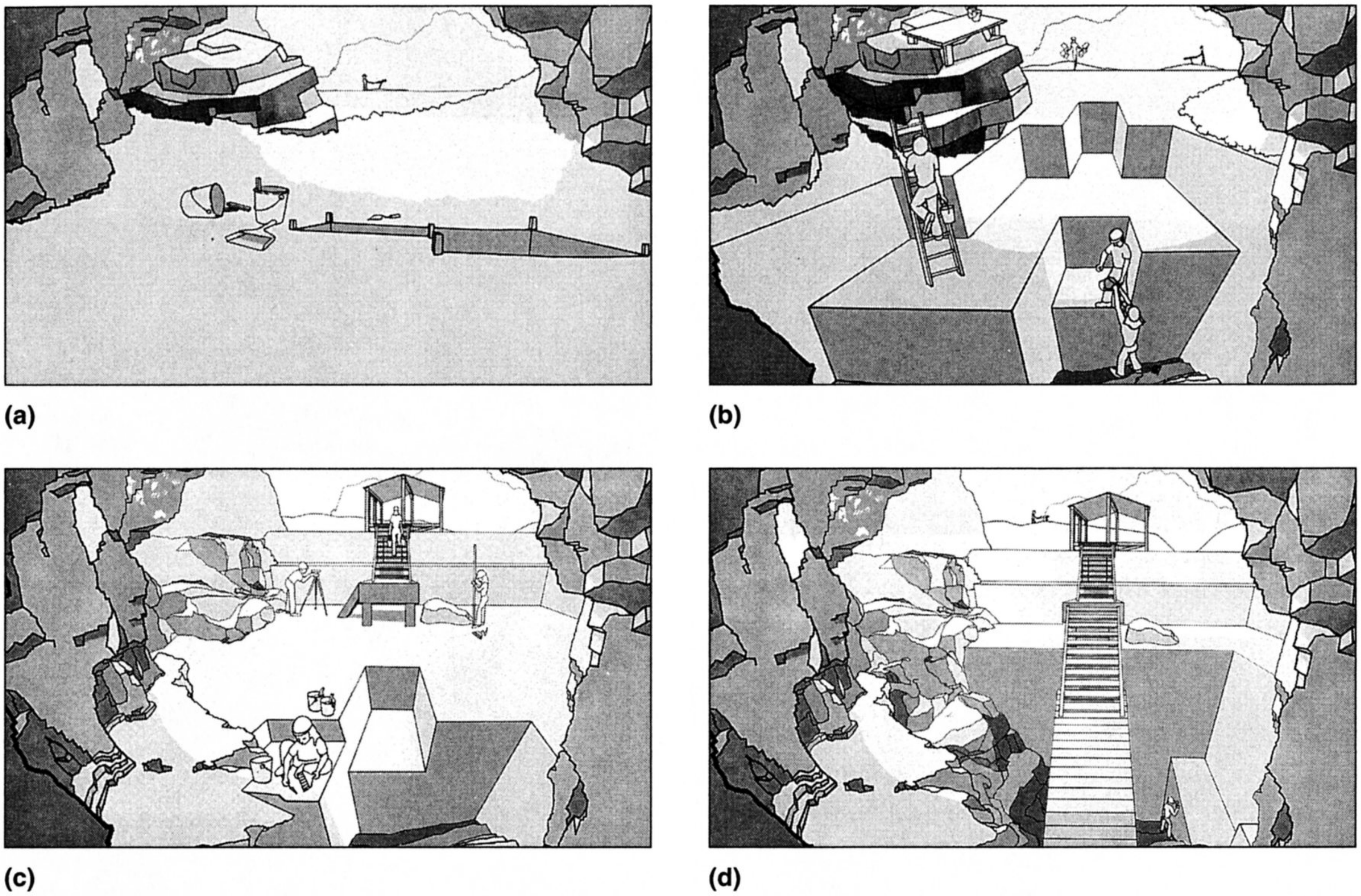


Figure 5.7 Approaches to the excavation of Gatecliff shelter, Nevada: (*a*) initial test pits; (*b*) area excavations opened from initial testing; (*c*) excavation across all deposits after removal of large roof-fall blocks; (*d*) deep excavation at the site, terraced for safety.

was connected with another adobe cutbank, creating a "continuous cross section of the village some 192.5 m long . . . [containing] more than a dozen house lenses with floors, and many associated middens, pits and burials" (Flannery, ed. 1976:72)).

Excavation of trenches can be accomplished in a variety of ways. Most common is a linear interconnected series of pits, usually excavated in arbitrary or stratigraphic levels. The term *trench* can also be applied to variously shaped rectangular test pits dug in a site. Trenching can be done by power machinery if sterile overburden is being removed to expose buried cultural remains. As indicated earlier, narrow trenching may be used as a sampling technique in the search for houses, cemeteries, or activity areas to be exposed by area excavation. John E. Clark (personal communication 1996) used a lengthy, hand-dug trench in Chiapas, Mexico, to identify a Formative era ball court.

At certain historic sites where only the approximate area occupied by a fort or mission building is known, the excavator may decide to dig a series of narrow exploratory trial trenches in the hope of encountering foundations, bases of walls, a stockade line, or the like. Once something is known of the location of certain features (identifiable perhaps from illustrations of the original structures) and the extent of the site area, excavation of that area can begin.

In sites where extensive features such as structures are encountered, excavation by trench alone will not give a sufficiently extensive view of the situation. For example, Haury's (1937) sectioning of the great canal at Snaketown yielded the desired information on the size of the canal and its history of use over a long period of time. But in the large ball courts at the same Snaketown site, a trench, though revealing a cross section of the court at one

Figure 5.8 Use of a trench to explore a mound. This trench cuts east-west through the center of Operation 2012 at Colha, Belize. It has exposed stratigraphy related to construction in Late Preclassic times, overlying a plaster-surfaced Middle Preclassic building (seen at the bottom rear of the trench). Note the 2-m stadia rod scale.

point, failed to provide all the data needed on the structure.

Strip and Quartering

In another excavation approach called the **strip method,** often used in mound and barrow excavation, digging begins at the edge of the area to be excavated, and work continues straight through the site in strips—that is, the face of the deposit is exposed in successive parallel cuttings usually 5 ft wide. If a feature is encountered lying partly in one strip or section and partly in the next, it is left on a pedestal while the one strip is excavated and not fully exposed until the excavation advances to the other strip. Then, as the feature is brought into full view, it is noted and removed and the pedestal of earth on which it rested is excavated (see Perino 1968:Figure 30). As each section of the mound is exposed, a stratigraphic profile is drawn so that the construction of the entire deposit can later be determined. Illustrations of this excavation approach are presented by Atkinson (1953:Figure 10), Cole (1951:59, Plate 5A), Perino (1968), and Wheeler (1954:94–95, Figures 18, 19).

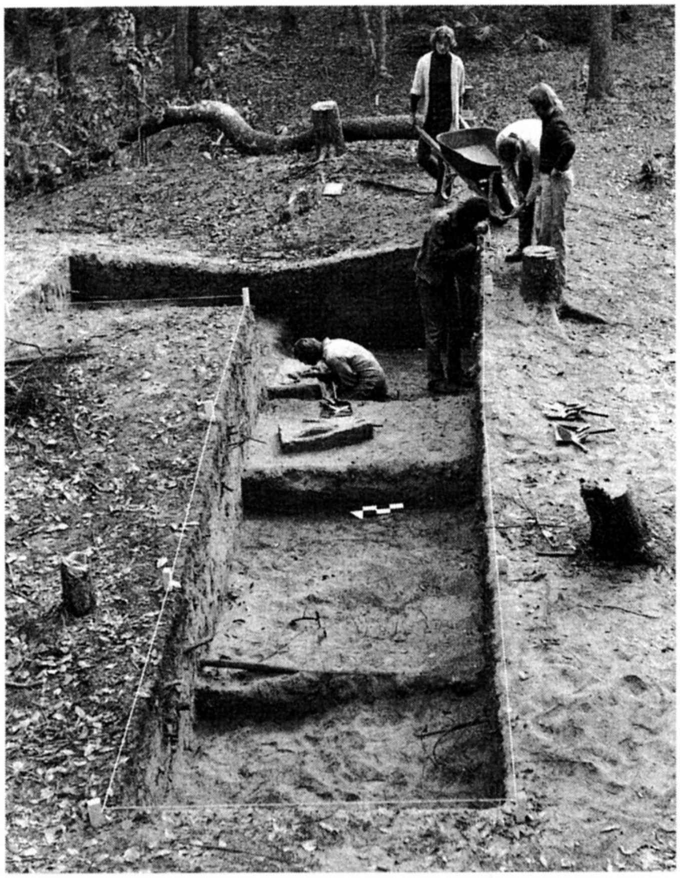
An alternative technique is **quartering,** or the **quadrant method,** where the mound is laid out into four quadrants by balks 3 or more ft wide. Excavation of each quadrant proceeds systematically, and the coordinate balks preserve the contour and stratification of the deposit. (For further details see Atkinson 1953:59; Clark 1947:97; Kenyon 1961: Plate 7; and Wheeler 1954:95.)

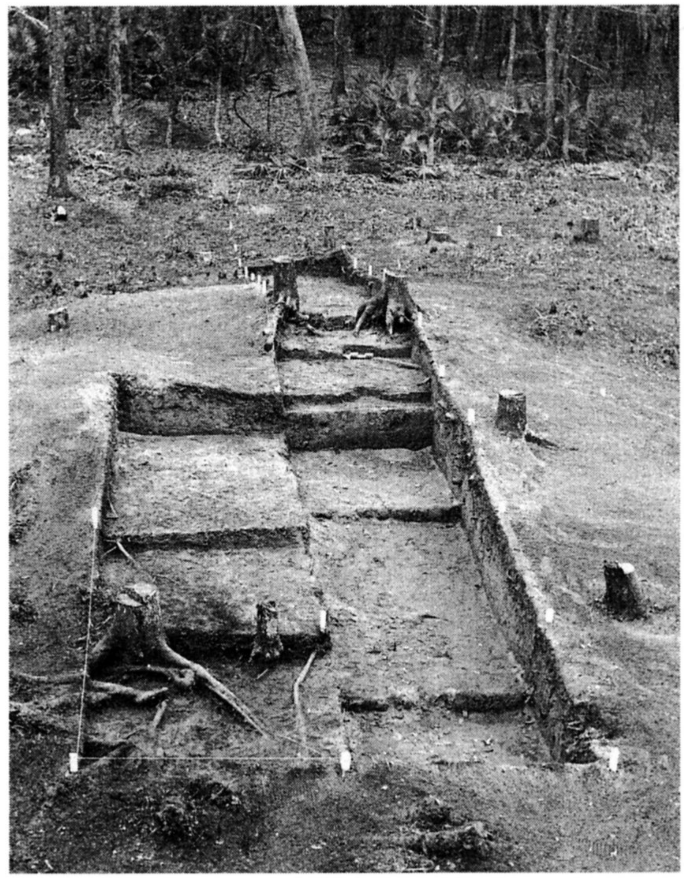
Jelks and Tunnell (1959:8) describe the quadrant excavation of a mound in eastern Texas:

> A stake was placed near the center of the mound and a grid of 5-foot squares was established which tied in with the centrally located stake. Then each quadrant of the mound was excavated separately. Beginning at the top of the mound, an entire quadrant was taken down by regular vertical intervals, usually of 0.5 feet each. The floor of the excavation was cleaned and examined after each level was removed, and measured drawings were prepared to record any zoning or occupational features that were observed in the excavation floor. The four profiles radiating in the cardinal directions from the central stake were always left intact until measured drawings had been prepared.

Architectural-unit Excavation

In digging mounds on Santa Catalina Island, Georgia, Thomas (1989) first cleared the mounds of all vegetation. The crew then laid out a metric grid system (2-×-2-m units) with the baselines placed along cardinal directions. A permanent datum point (a brass marker in a concrete base) was placed on the perimeter of the site, away from the mound. Next, a contour, or topographic, map was made of the mound. Photographs were taken before excavations commenced. Thomas's first objective was to determine mound stratigraphy and to sample the deposits for artifacts and organic materials for radiocarbon dating. Thus, the first excavation (Figure 5.9) was a trench of four contiguous 2-m-square units, begun at the end of the mound and cutting to the center (two units were dug carefully with trowels). This test trench was dug down to sterile sand. Once the results of the testing were analyzed, a crew returned to the





(a) (b)

Figure 5.9 Excavations at McLoed Mound, Santa Catalina Island, Georgia: (*a*) initial test trench; (*b*) opening up the excavations from the initial exploration.

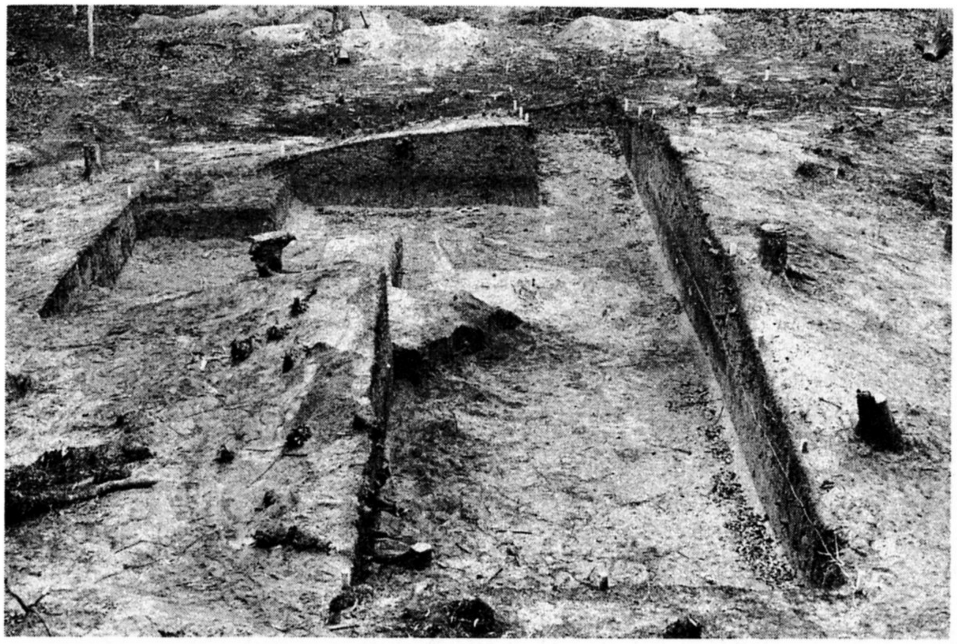
mound. Digging resumed in the form of large blocks of contiguous units (Figure 5.10), mapping in all cultural materials for a better horizontal perspective. In the case of each mound excavated by Thomas, at least 50 percent was left undug.

Observable **architectural units** or features such as house depressions, pithouses, or rooms in Southwestern American ruins (cf. Deetz 1967:17; Fitting 1973; Shafer 1982) may be used as excavation units. Even so, however, it is wise to establish systematic horizontal and vertical controls in excavating them. Also, if many rooms or other architectural features are present at a site, there must usually be some process for selecting the rooms to be excavated. Hill (1967) used probability sampling in such a situation at Broken K pueblo, Arizona.

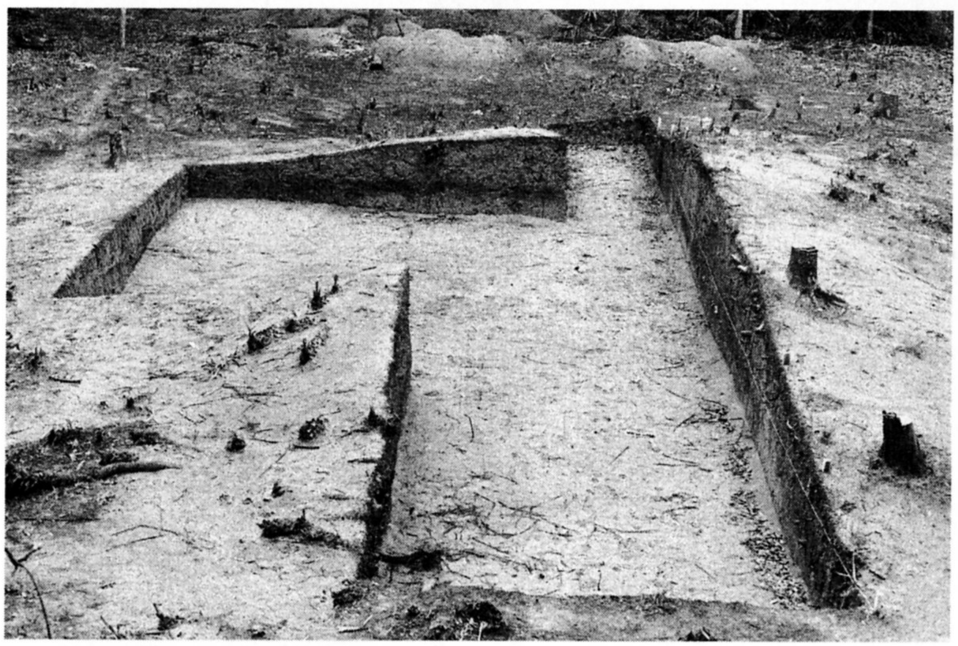
Area Excavation

Area excavation, by which is meant the orderly exploration of a sizable expanse of a site, allows the archaeologist to obtain a larger (and more meaningful) sample of artifacts, features, activity areas, and other buried remains than trenching or other less-extensive methods. Area excavation is usually *but not always* done within a grid system (Figure 5.11). The grid system (see Chapter 9) allows each unit to be excavated so that a wall or balk can be left between adjoining squares. The balk preserves, until the very end of excavation, the stratigraphic profile on all sides of the excavation unit (Figure 5.12a,b). (The careful preservation of balks is shown in the excavations of Atkinson 1953:42–43; Bruce-Mitford 1956:Plate 8A; Goodwin 1953: Figure 8; Kenyon 1961:Plate 8; and Wheeler 1954.)

"Horizontal" information is vital to modern anthropological archaeology, providing data on site structure, behavioral units, patterning related to social phenonema, and artifact concentrations. Archaeologists should work for broad exposure of buried cultural remains, using **large-area excavation,** or as some have called it, **block excavation.**



(a)



(b)

Figure 5.10 Excavations at McLoed Mound, Santa Catalina Island, Georgia: (*a*) continued expansion of the excavations, exposing a central tomb (light area near center); (*b*) completed excavations.

Block excavation may be undertaken as one phase of an overall excavation plan. For example, at the Deshazo site, a Caddoan village in east Texas, Story (1982) used backhoe trenches, test pits, and ultimately block excavations in her field strategy. The continuing horizontal exposure of Unit 1 at the site provided evidence of three overlapping house outlines (Figure 5.13a,b).

Another example is reported from the Pumpkin site, South Carolina (Charles 1995). An area 22-×-90 m was stripped down to the red clay subsoil. This led to the exposure of more than 500 features, including post molds and pits. Features were marked with flagging pins until they could be carefully exposed, mapped, and sampled (Charles 1995:8).

In rescuing the Norris Farms 36 site, a prehistoric Native American cemetery in Illinois, Santure (1990) describes the use of a metric grid placed over the entire site, with excavation then proceeding

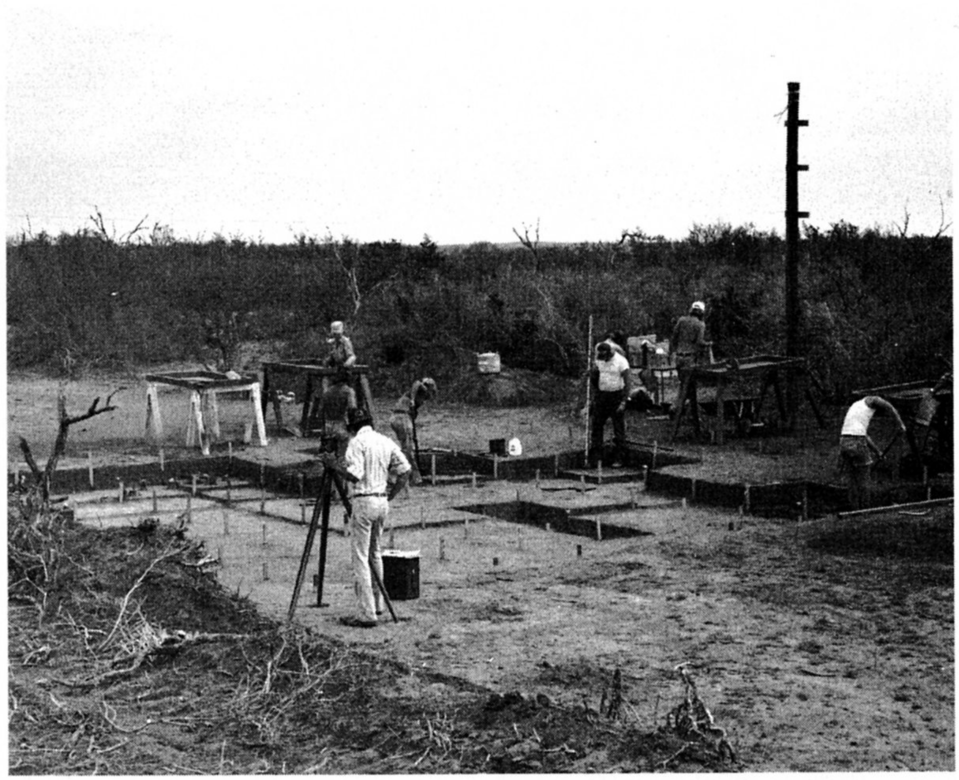
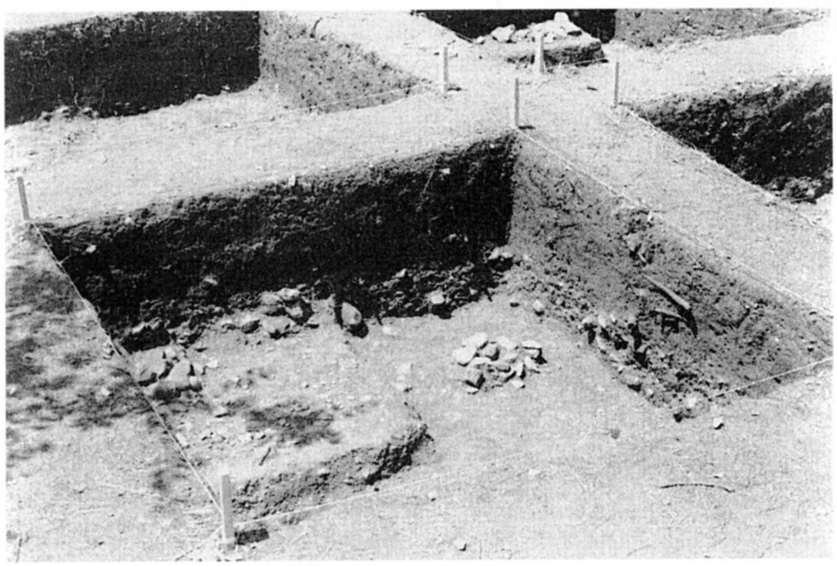
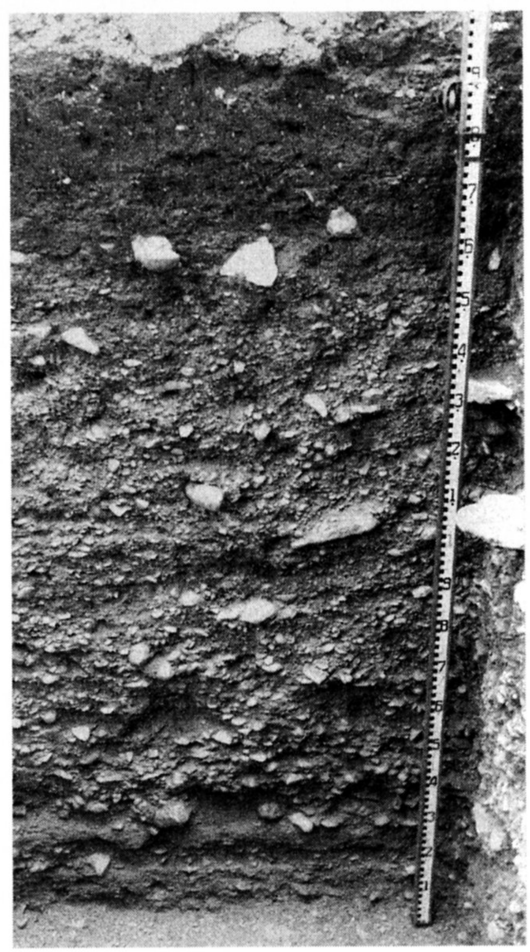


Figure 5.11 Area excavation using a grid system as exposure of deposits is expanded by shallow machine stripping (upper part of photo), site 41LK67, southern Texas.



(a)



(b)

Figure 5.12 Area excavation utilizing balks, which are left in place to help record both (*a*) cultural features (shown in the profiles) and (*b*) natural stratigraphy.

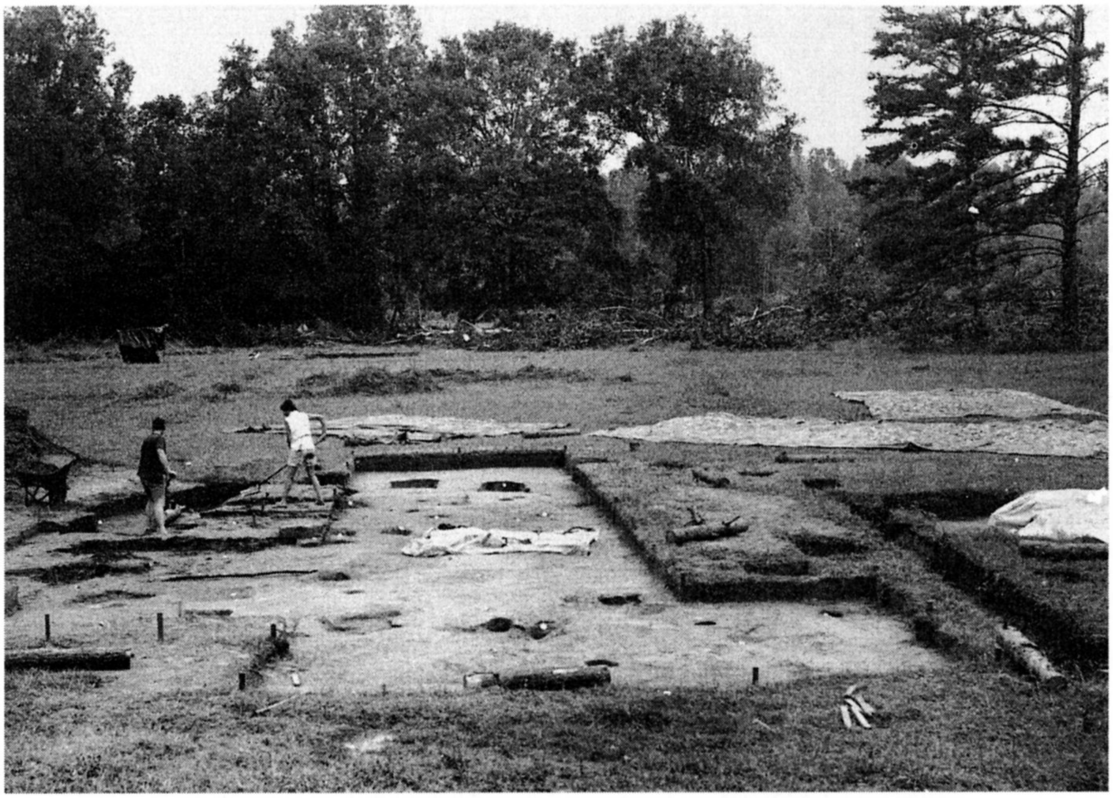


Figure 5.13a Area excavation exposing a Caddoan house floor at the Deshazo site in eastern Texas.

in 3-x-3-m units, further subdivided into 1-x-1-m squares. Balks (30 cm wide) were preserved around each 3-x-3-m unit to map sediment deposits revealed in the profiles. Shovel scraping was used to expose features and burial pit outlines and to remove sediment in the gravel fill above the burials; the excavators switched to trowels just before the human remains were encountered. With this combination of approaches, an area of 2,078 m^2 was exposed (Esarey and Santure 1990:9, Figure 3.5). Because the site had to be dug during the winter, a portable fiberglass-covered frame building, heated by the sun and a kerosene heater, was used.

As noted above, area excavation may or may not involve a grid layout, and balks may or may not be preserved. At the Wilson-Leonard site, a deep, stratified site in central Texas, Michael B. Collins (personal communication 1996) worked from a preexisting grid but developed a large, open area excavation to sample Paleoindian occupation surfaces near the bottom of the site (Figure 5.14). The chief value of large-area, or block, excavation, according to Struever (1968b), is that it "provides a broad expanse of living surface enabling recovery of the total population of cultural items resulting from activities carried on in that particular precinct" (Figure 5.15). Black et al. (1993) have excavated the Higgins site in central Texas using an area approach, but rather than recording by grid coordinates, they used an EDM (electronic distance measurement; see Chapter 9) with an attached small recording computer with keyboard. Locational data were entered, and at the end of the day, the disk was downloaded into field laptop computers and backed up on a floppy disk. This system, called a Total Data Station, is flexible enough to record the finds being made by a crew of 8–10 people.

Biddle and Kjolbye-Biddle (1969:211–213) report the use of what they call "open-area" horizontal excavation at Winchester, England, covering in detail the techniques and problems of this kind of excavation. The advantage of this approach, according to the authors, is that "an overall view of the horizontal is always obtainable"; the disadvantage is that it is difficult and "requires . . . great site discipline and well-trained workers." Another aspect of block, large-area, or open-area excavations is that they require a lot of time and money.

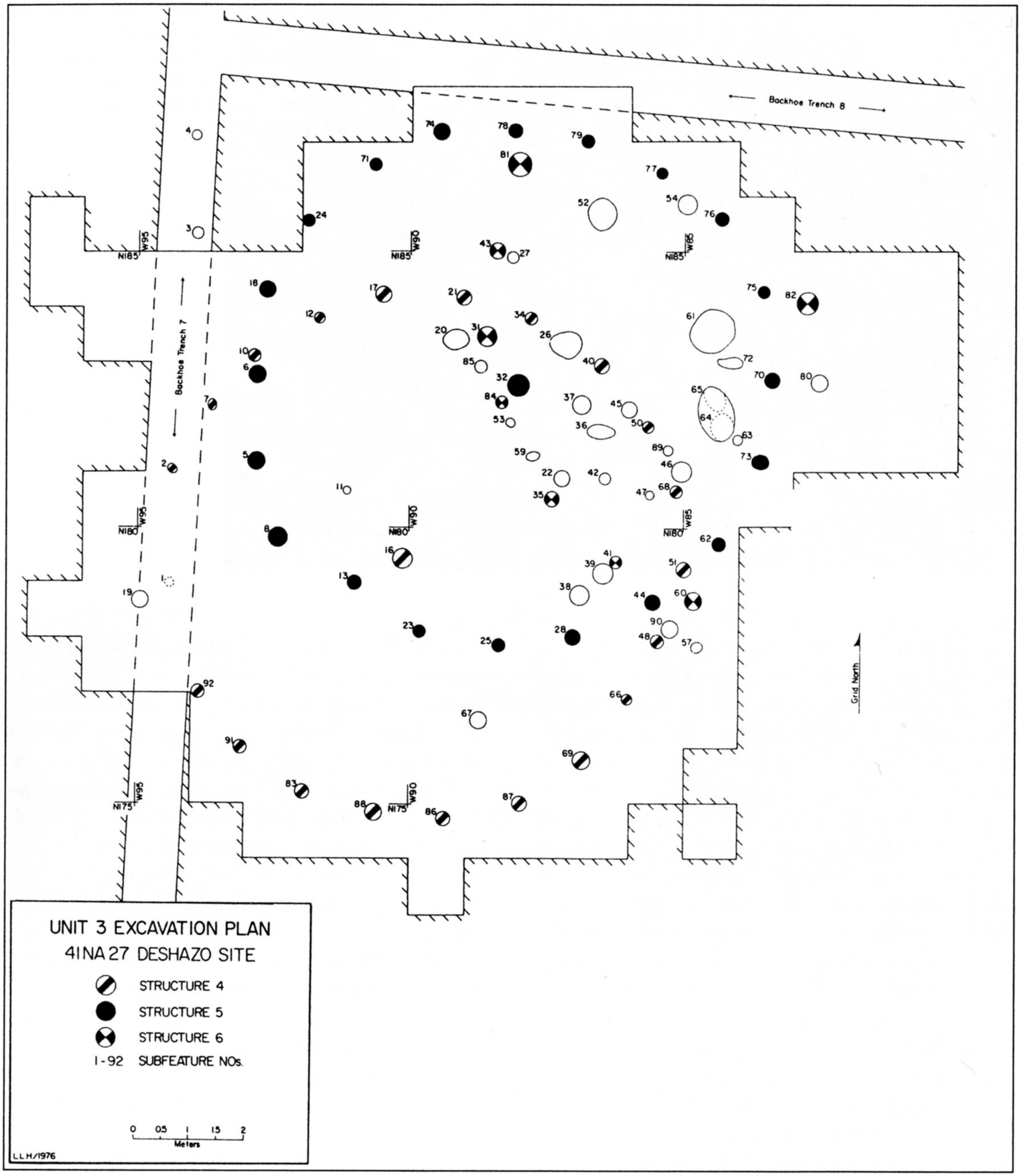


Figure 5.13b Plan showing overlapping house phases at the Deshazo site.

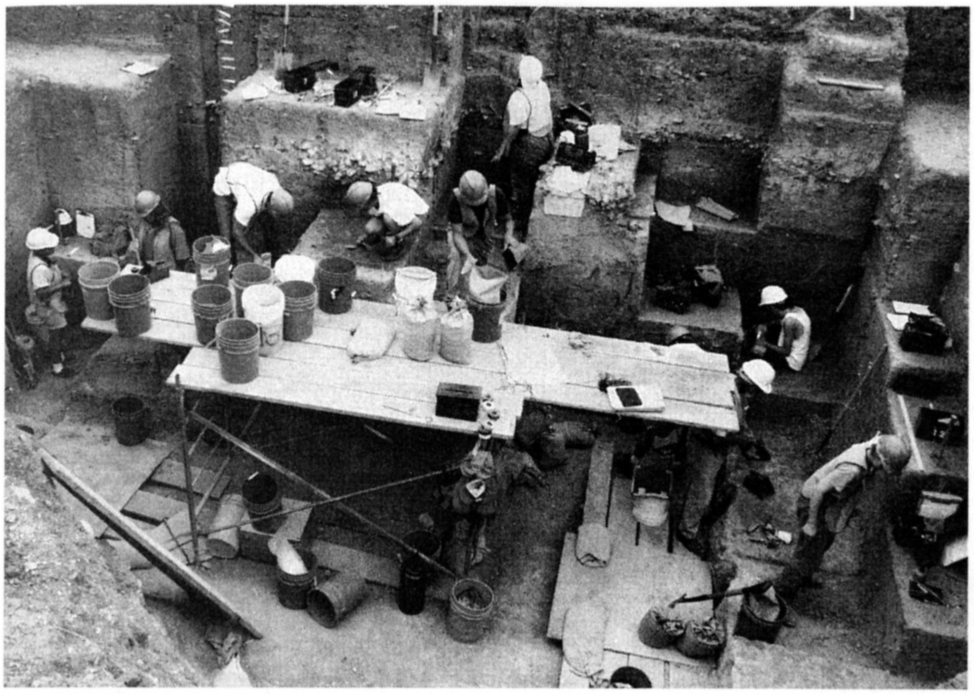


Figure 5.14 Area excavation at the Wilson-Leonard site, central Texas.

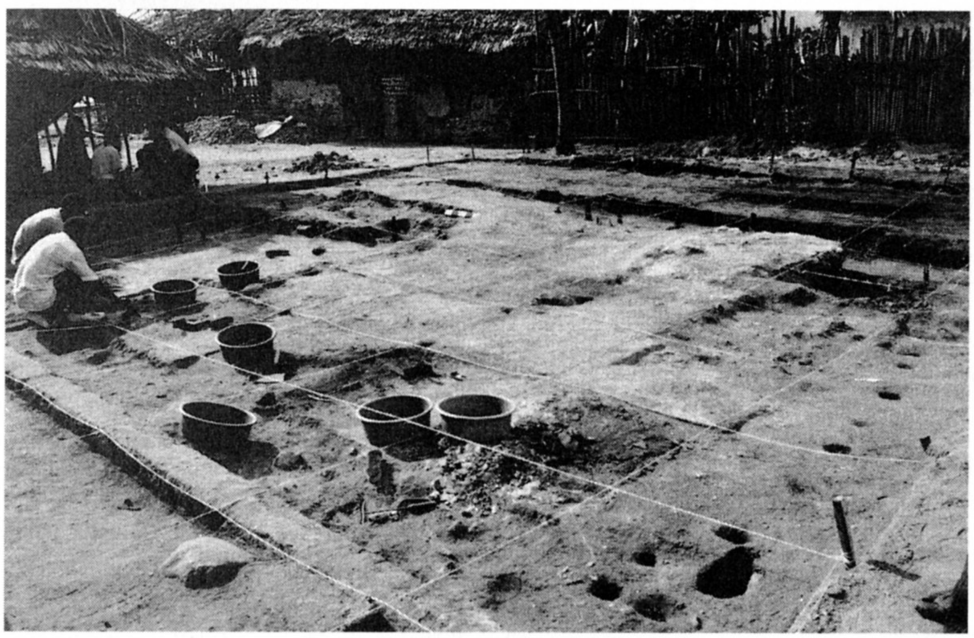


Figure 5.15 Area excavation, exposing features and in situ cultural materials at Lamu, Kenya.

Stripping

Stripping excavations have been used to remove large areas of overburden to expose stable land surfaces bearing living floors, houses, or other cultural features (see Binford et al. 1970). This kind of excavation may be the third phase in the excavation of a site, the first phase being test pitting and the second phase being "block" excavation (Binford 1964). Stripping can be costly, because it usually involves power machinery. However, it is a most valuable excavation technique, permitting archaeologists to examine very large areas and to sample a greater number of phenomena within a site (see Brown et al. 1982) (Figure 5.16). Shovel stripping can also be used to trace features that are buried at shallow depths. Some archaeologists feel that shovel stripping is abused when plow zones are stripped without screening the excavated deposits.

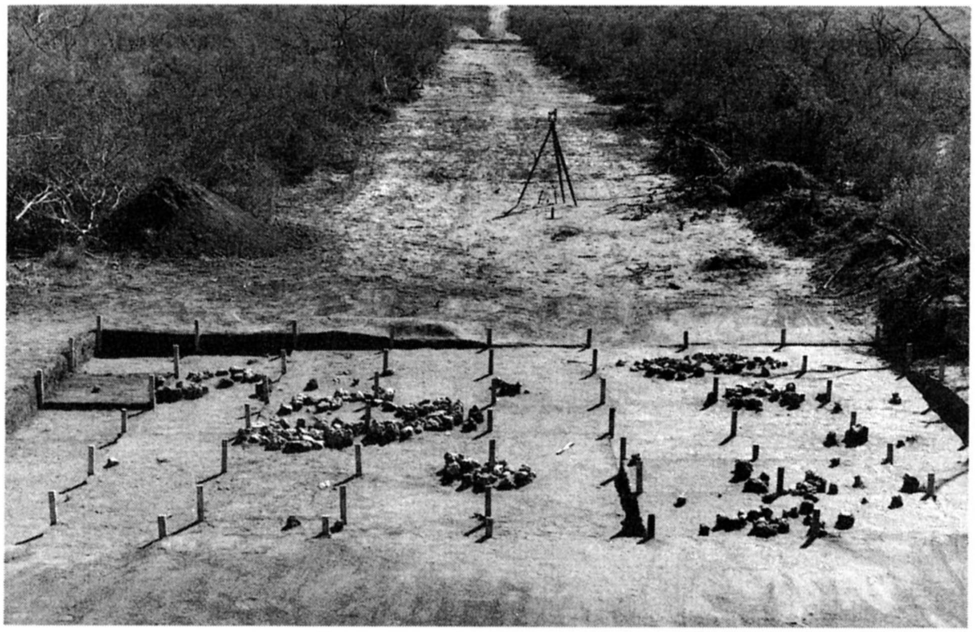
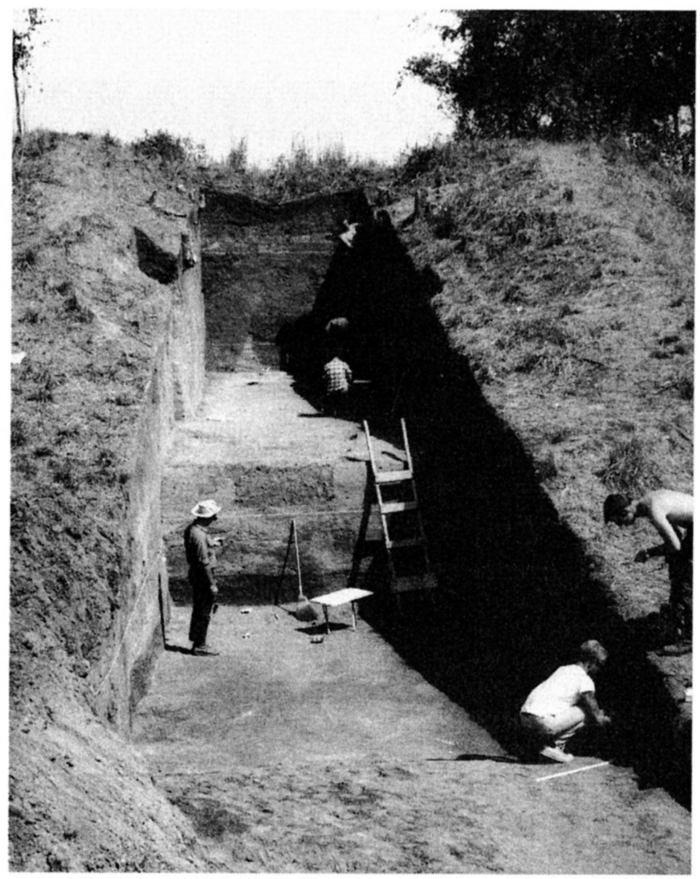


Figure 5.16 Area excavation, exposing shallow hearths. Grid stakes left in place. Site 41LK67, southern Texas.

(a)



(b)

Figure 5.17 Excavations at Mound C, George C. Davis site, eastern Texas: (*a*) view of mound before excavation; (*b*) clearing of treasure-hunter's trench, exposing undisturbed mound fill and burial pits.

What we have provided here is but a brief review of certain major approaches to excavation. So many considerations can affect the plan of an excavation that archaeologists rarely use exactly the same system twice. The best approach to the excavation of a site is a flexible one, allowing the excavator to take advantage of the techniques that will best elucidate the problems under investigation. Adapting techniques to the site at hand is up to the individual in charge of the excavation. As an example of modifying excavation techniques to fit the situation, Figure 5.17 shows excavations in Mound C, a large Caddoan burial mound at the George C. Davis site in eastern Texas. A huge trench had been cut into the mound early in the twentieth century by treasure hunters. The excavator, Dee Ann Story (University of Texas at Austin), used power machinery to clear most of this trench, then a crew with shovels and trowels to locate the edges of the disturbed area. In the process of recording the stratigraphy exposed by the treasure-hunter's trench, Story recognized and excavated large burial pits.

EXCAVATION METHODS

The process of actual digging, like the process of deciding on the location of excavations, varies with the character and content of the site and the research objectives of the excavator. Here again a number of alternative systems are available. The critical factor, no matter what method is selected, is that horizontal and vertical control be carefully maintained. And, as always, flexibility is critical to good excavation.

Vertical-face Methods

Occasionally a unit or a contiguous series of units is dug entirely as a **single vertical face.** This is equivalent to the "slicing" procedure once used for excavating in the Mississippi Valley and other parts of the eastern United States (see Ford 1963:9, Plate 1). One clear disadvantage with this method is that materials may fall out unseen, and if they do, their location is lost forever. This kind of excavation also makes it exceedingly difficult, if not impossible, to trace horizontal relationships of artifacts and features.

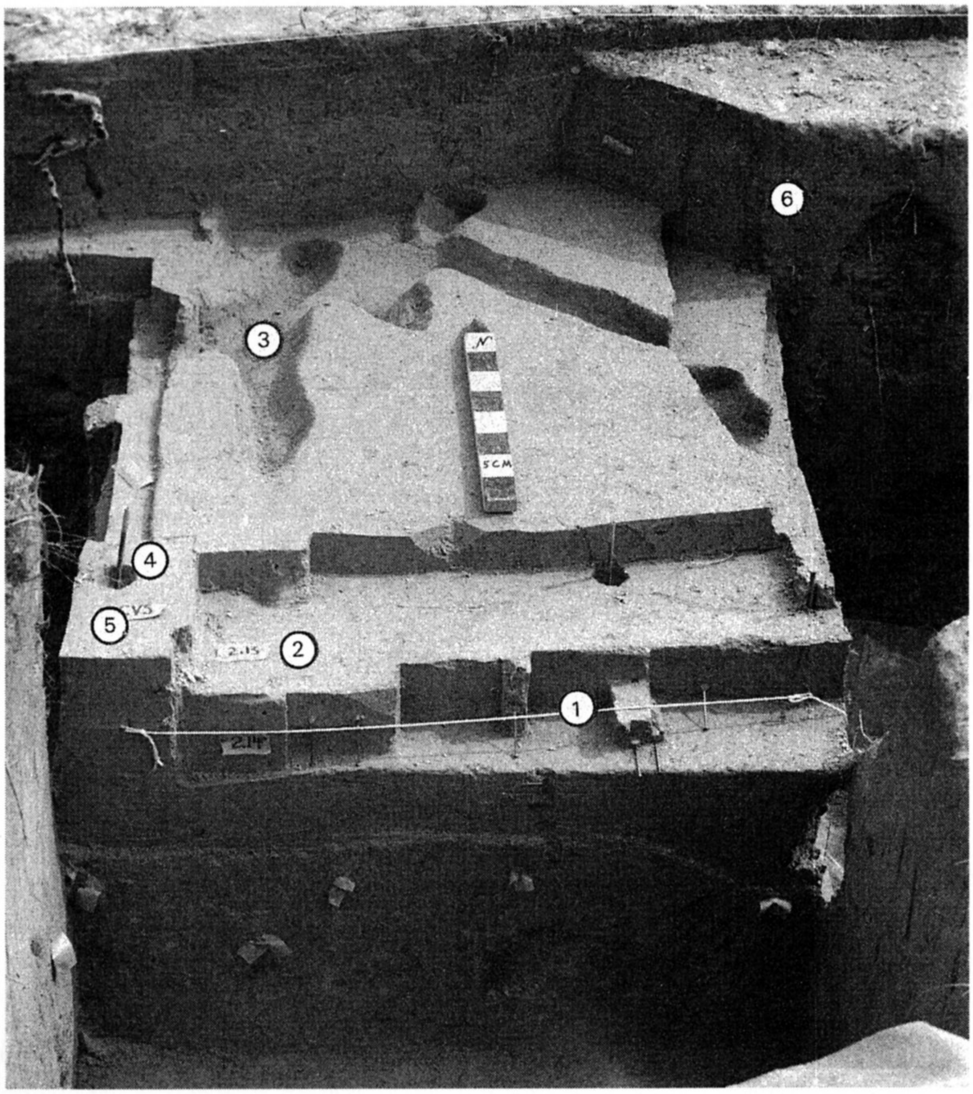
Gunn and Brown (1982:59–61) have modified this approach, developing a technique they term the **control face** (Figure 5.18):

> This most basic concept literally dictates trowel movements in the hands of the excavators. All excavation, whether it be following a strata contact, an occupation floor, or removing a rodent disturbance, is done against a vertical control face. . . . A control face . . . is composed of a vertical *cut,* the material being removed; a horizontal *surface,* the material being left; and the *contact,* the perpendicular juncture between the cut and the surface. An excavator normally works against a two-to-five-centimeter deep control face, which extends across his square. Moving his trowel conformant with the strata, the excavator slices off a defined amount of the control face with each pass, systematically moving across the meter unit. Each slice moves the contact back a few millimeters exposing more of the surface and removing more of the cut. In addition to giving the excavator a clear perception of the materials to be removed and those to be left, the control face allows the supervisors to readily check the accuracy of the excavator's efforts.

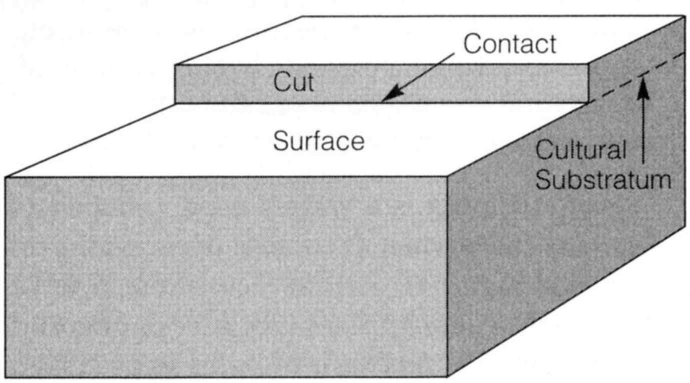
Gunn and Brown (1982:59) used the control face technique as a part of a **control front:**

> As with the trowel, the movement of the crew needs to be coordinated in a systematic manner. A control front is composed of a line of control faces crosscutting adjoining excavation units. Excavators aligned in this manner are encouraged to pay close and constant attention of the progress of excavation by their flanking comrades. The spirit of cooperation engendered by the excavators on the control front not only spurs efficiency but leads to constant communication on matters of density of artifacts, vertical locations of artifacts, facies changes in lithology and pedogenic development, and field analysis of interesting distribution patterns. Such discussions insure cross-referencing of unit excavation notes and avoid problems of correlating occupation floors and lithologic contacts from square to square after the fact.

Level-stripping is a widely used variation of the vertical-face system. It consists of excavation in a staggered series of vertical faces, from 6 to 12 inches or more in height, at successive depths and looks in cross section like a flight of steps (Lloyd 1963:Plate 2; Martin et al. 1947:Figure 1). The result is that levels, rather than coordinate squares, are excavated as discrete units by the workers assigned to them. This method, perhaps better termed **step-trenching,** is particularly useful in digging large mounds. For example, Lamberg-Karlovsky (1974) describes and illustrates step-trenching as used at Tepe Yahya.



(a)



(b)

Figure 5.18 Control column (photo) and control face excavation techniques: (*a*) Circled numbers in the photo identify (1) a line of chert flakes, (2) a defined substratum, (3) rodent disturbance, (4) insect dung deposits, (5) constant volume sample area, and (6) crayfish disturbance. (*b*) A control face is composed of a vertical *cut*, the material being removed; a horizontal *surface*, the material being left; and the *contact*, the perpendicular juncture between the cut and the surface.

Unit-level Method

The **unit-level method** is undoubtedly the most common method of excavating sites that show little stratigraphic variation (Figure 5.19). Here the technique is to dig each pit, defined by the lines of the grid system, vertically as a discrete unit, always completing one before beginning another. The digging is done in a succession of separate arbitrary levels, each 5, 10, or 20 cm (or 3, 6, or 12 inches) deep; the excavation of each level is also completed before the next is begun. The thickness of the arbi-

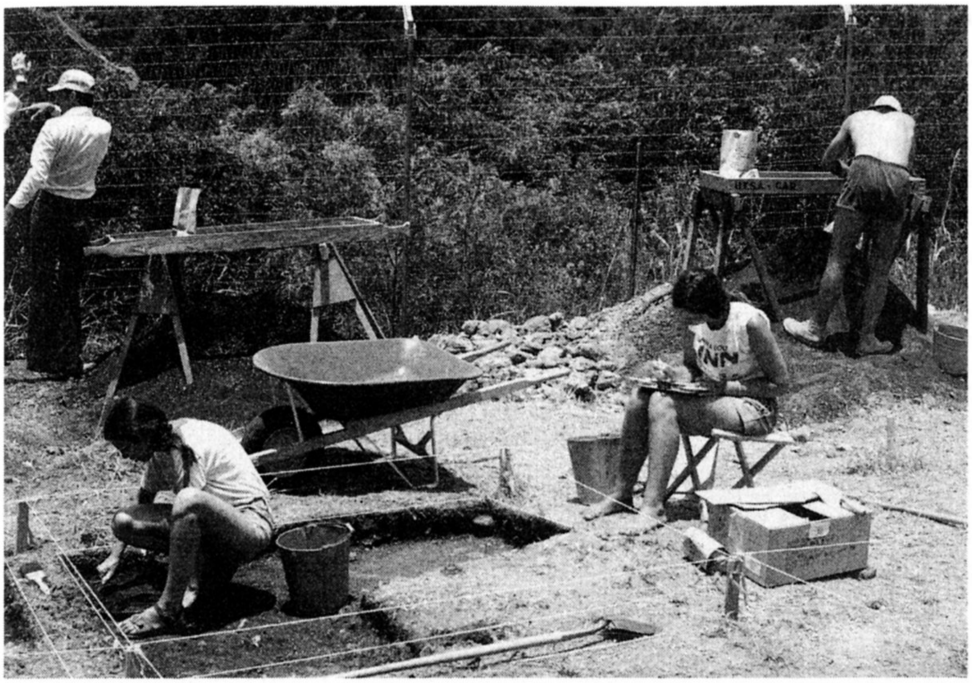


Figure 5.19 Beginning an excavation unit using arbitrary levels. Upper level of 10-cm thickness is being removed from unit and screened.

trary level depends on the research design and the character of the deposits at the site. Unless there are extenuating circumstances, level thickness should be consistent across the site. Deposits from each unit level are screened to recover chipped stone artifacts, potsherds, animal bones, mollusk shells, debitage, and other items that were not collected or recorded at the moment of discovery.

The unit-level technique is best employed in sites with no visible stratification and in projects emphasizing chronology or culture history. There are many such sites in North America. For example, in California shell middens, there are lenses of mollusk shells interspersed with layers of earth, but these are usually very localized occurrences that run for a span and then disappear. The nature of these small lenses in such sites is clearly shown in illustrations published by Schenck (1926:Plates 36, 37).

In North American sites like these shell middens, workers have become accustomed to digging in arbitrary levels within the unit-level system. The British archaeologist Sir Mortimer Wheeler (1954:53) bemoaned the use of this "outworn system, with its mechanical unit levels," and Pallis (1956:326) also objected to excavation by arbitrary levels or merely recording depth of finds from a datum-line as "substitutes for actual stratification." No archaeologist will disagree with Wheeler's or Pallis's insistence on visible stratification as the surest means of accurate and meaningful recovery (and subsequent interpretation) of data. In fact, Stein (1992) reports her efforts in using natural stratigraphy in shell midden excavations. But the fact remains that there are many instances where the archaeologist must deal with a deposit that does not contain such stratification, and in these situations, the excavator must turn to a mechanical method of vertical control.

For example, see the cave deposit without visible stratigraphy in Iran illustrated in Hole and Heizer (1965:Figure 10). Or note the remarks of MacNeish (1958:33), who writes: "The deposits [of Nogales Cave, Mexico] contained no definable strata, and all the material from the surface to the bottom of the excavation was one stratum of grey powdery ash and refuse. Occasionally a short lens of white ash or charcoal could be discerned, but none was extensive enough to define as zones." Evans and Meggers (1959:8) have shown why some Amazonian sites lack evidence of clear-cut stratigraphy, as the result of heavy precipitation and leaching.

Indeed, not all of Wheeler's British colleagues decry the method of "metrical stratigraphy," as witnessed by this statement by Burkitt (1956:235): "Where there is no obvious stratigraphy but more than one industry is present . . . uniform layers of 6 to 9 cm thick [are] removed." An example of the history of the controversy over the use of "metrical" versus "natural" stratigraphy can be found in an extended discussion by Phillips et al. (1951:240–241) in which they call attention to the problem of finding cultural differences in unstratified deposits and distinguish between the terms *stratigraphy* and *stratification* (for the latter, see Chapter 10).

Archaeologists continue to have strong feelings about the use of arbitrary levels. One reviewer of the draft for this book wrote, in 1993, that he/she had never used arbitrary levels in test pits or other excavations. Another reviewer that year took just the opposite approach, commending the discussion of arbitrary levels and wondering if we were not being too defensive! After all, most archaeologists use both approaches. The comments of Praetzellis (1993:85) are perhaps most appropriate: "Arbitrary excavation will continue to be a valuable tool when it is used with an understanding of site structure and not as part of an inflexible archaeological orthodoxy."

In practicing metrical stratigraphy, accurate depth recordings of finds are obviously essential. Where the occupation deposit is thin, very small differences in the depth at which objects lie may have meaning. Indeed, in a deposit without visible stratification, these minute distinctions may be the only means whereby the worker can recognize and separate successive occupations (see Bruce-Mitford 1956:273). It is also important when excavating by arbitrary levels to watch for evidence of disturbance. For instance, intrusive pits and rodent burrows will contain fill that ordinarily dates from a more-recent time than the level into which the pits and burrows penetrate, though rodents can also pull up fill from earlier strata (see Phillips et al. 1951:290–291; see also Bruce-Mitford 1956:Figure 43 for graphic, and classic, illustrations of much-disturbed stratification; in addition, Bocek 1992 has noted the lateral displacement of cultural materials by rodent burrowing).

The use of arbitrary levels and stratigraphic excavation can be combined. For example, in digging rockshelter deposits in which natural stratigraphy would be expected, it is sometimes useful to subdivide the units on an arbitrary basis (e.g., in 10-cm levels; see Flannery et al. 1986; Thomas 1983) to ensure tighter vertical control over excavated materials. Hester and Heizer used 15-cm levels to remove thick Early Archaic strata at Baker Cave in southwest Texas (Chadderdon 1983).

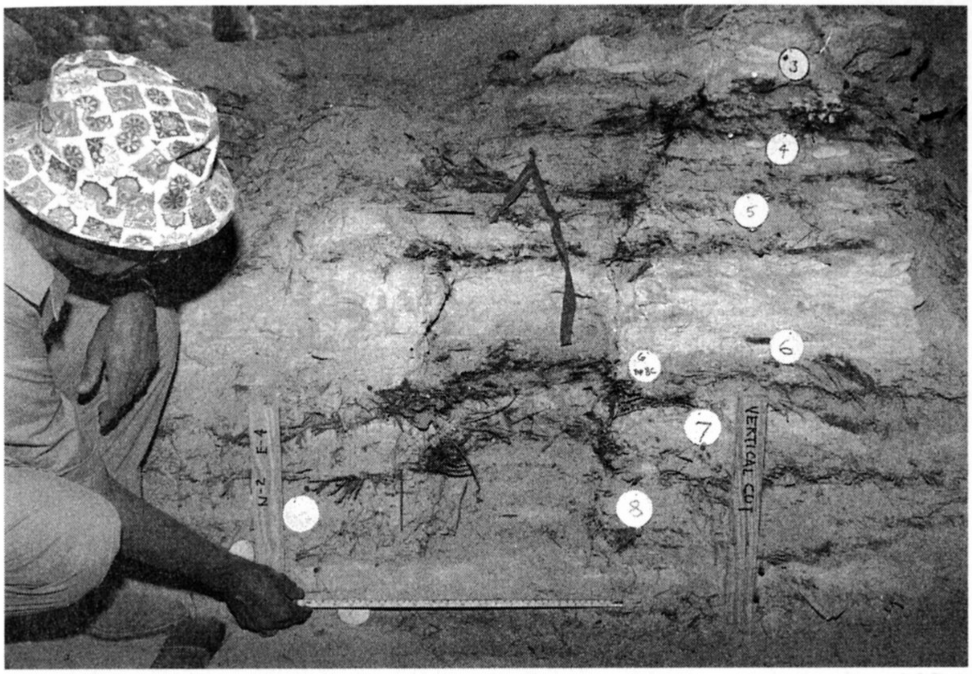
Natural-stratigraphic-level Method

Excavation by **natural stratigraphic levels** involves peeling off the visible strata in a site deposit. We illustrate this technique by reference to several published reports. Keller (1973) began his excavations at Montague Cave, South Africa, by making some preliminary cuts, the profiles of which indicated stratigraphy so complex that arbitrary levels would have been unsuitable. One 6-inch level in one of the test cuts yielded microliths from one side of the square and much older hand-axes from the other. Obviously the strata dipped so that a single-level cut into different zones would have caused mixing of the artifacts of different occupations. Thus, the major excavations were done by "natural" units, but with one further provision, as Keller (1973:8) states:

> However, within these "natural" units we encountered concentrations of artifacts that appeared to represent material deposited during a single occupation and so were called occupation horizons or surfaces. The occupation horizons were termed "cultural" units until it became apparent that the layer containing them was equally as cultural in its formation as the horizons themselves.

Keller also provides a useful discussion regarding the differentiation between "natural" and "cultural" depositions at a site. (For further comments on natural stratigraphy, see Chapter 10.)

Other examples of excavation by visible stratigraphic levels at cave and rockshelter sites can be found in monographs by Aikens (1970; Hogup Cave, Utah), Alexander (1970; Parida Cave, Texas), and Jennings (1980; Cowboy Cave, Utah). At Parida Cave and similar sheltered sites along the Rio Grande in Texas, the cultural deposits are extremely complex, but if carefully excavated, they can yield much anthropological information (see Chadderdon 1983; Collins 1969:2–4; Word and Douglas 1970:8, Figure 5) (Figure 5.20). Determined efforts by T. R. Hester and K. M. Brown to use stratigraphic levels in a section of Baker Cave, Texas, proved extremely confusing, until the excavation profiles revealed that strata had been interrupted, contorted, and even reversed by a pre-



(a)

(b)

Figure 5.20 Excavating by stratigraphic (natural) levels, Baker Cave, southwest Texas, 1976: (*a*) profile view showing stratigraphy; (*b*) excavation proceeding by natural levels; a fiber layer is being exposed.

historic pit-hearth sequence going back, in one spot, several thousand years.

Many open sites are also amenable to excavation by natural stratigraphic layers. The **isolated block** method is sometimes used when stratigraphy is visible. The method entails digging a square trench to isolate a block or pillar of deposit; the stratification thus exposed on all four sides of the block is carefully recorded, and the block is then peeled layer by layer. Classic examples of this technique are provided by Bird (1943:253–257), Chadderdon (1983), Schmidt (1928:258–259), Smith (1955:13–14, Figures 82 and 83), and Webb and DeJarnette (1942:95–98, Figure 27, Plate 142). At times, the block can be "isolated" on three sides, allowing stratigraphic levels to be excavated (Figure 5.21).

(a)

(b)

Figure 5.21 Excavations at Baker Cave, southwest Texas, 1985: (*a*) isolated block shows stratigraphic profile, (*b*) levels are peeled away by stratigraphic layers.

Although open sites in the southeastern United States have usually been excavated by arbitrary levels, Morse (1973) excavated the Brand site (a Dalton "butchering station" in Arkansas) by natural stratigraphy. By peeling off the visible stratigraphic layers, Morse was able to expose in situ working floors at the site (see Morse 1973:24, Figure 2). At the Belcher Mound in Louisiana, Webb (1959) recognized in his preliminary investigations that the mound was stratified, with at least four habitation levels. Abandoning the traditional "vertical cake-slicing technique," Webb proceeded to excavate each habitation level as a natural unit.

Bison-kill sites in North America provide other instances of excavation by natural zones. Kehoe (1967) exposed the stratigraphy of the Boarding School Bison Drive (Montana) in test excavations in 1952. Later, in 1958, excavation was done by "layer stripping rather than by arbitrary levels" (Kehoe 1967:13), using the profiles of the 1952 test cut as a guide. Dibble (in Dibble and Lorrain 1968:19) relates the excavation technique used at Bonfire Shelter, Texas:

> The nature of the deposits at this site . . . provided an opportunity for prime reliance on a "natural level" excavation technique. After preliminary exploratory test had made gross outlines of the deposits . . . reasonably clear, further excavation by arbitrary levels was abandoned. Proceeding in descending order of stratigraphic occurrence, four culture-bearing deposits were excavated primarily as vertical units.

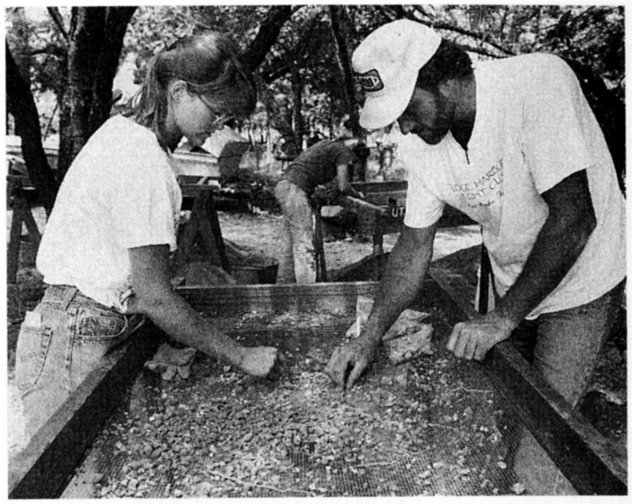
Whether the excavator uses arbitrary levels or natural strata will of course depend on the internal structure of the site and the problems being investigated. As mentioned earlier, it may at times be advisable to combine the two methods (for example, a thick natural zone can itself be excavated in arbitrary levels), use other techniques, or even devise new ones. In the notes and ultimate publication of any excavation, excavation methods should be carefully recorded so that future workers will know how the materials were recovered.

SCREENING EXCAVATED DEPOSITS

Sifting excavated earth through screens (Figure 5.22a,b) enables the archaeologist to recover many materials that might otherwise be overlooked (leading to considerable bias in the sample obtained from a site). Each digging crew may have a number of sizes and grades of screens for use under varying circumstances. Screens of ¼-inch mesh have commonly been used, but these can often allow tiny flint flakes, animal bones (Shaffer 1992b), and other minute forms of archaeological evidence to be lost. Thus, fine-screening (with ⅛- or 1⁄16-inch mesh) has become a part of most modern excavations (e.g., Gordon 1993; Shaffer and Sanchez 1994; Thomas, 1983, 1985; Whalen 1994).

In sites where preservation of plant and animal remains is particularly good, a ¼-inch screen can be set over an ⅛-inch screen (Figure 5.22b). The larger items can be collected rather quickly from the top screen, and then small bones, seeds, and other tiny items can be collected from the ⅛-inch mesh (Chadderdon 1983; Flannery et al. 1986). The residue on the lower screen can also be scooped up for later sieving through graduated geological sieves and subsequent careful picking back at the lab.

Aten (1971:15) combined fine screening with "water screening" in processing deposits from coastal middens of mucky (or hard, when dry) clay, using a small gasoline-operated pump to wash deposits through 1⁄16-inch mesh screen. This technique provided excellent recovery without damaging or destroying such materials as the bones of small animals, as can sometimes happen with dry screening. Indeed, water screening has become a common technique in many excavations (Figure 5.23). Van Horn and Murray (1982) used a water-screening system that employed a sodium bicarbonate solution to get 100 percent recovery from clayey soils. They warn, however, that the effects of this process on radiocarbon samples (i.e., charcoal or other organics in the deposits) are not known. Other examples of water screening may be seen in Diamant (1979:210–217), Highley (1986:Figure 25b), and Shutler et al. (1980:Figure 1.8). Some water-screening systems use nested screens, involving



(a)

(b)

Figure 5.22 Screening: (*a*) at an archaeological site using ¼-inch mesh screen on sawhorse screen stands; (*b*) at Baker Cave, Texas, 1976, using ¼-inch mesh set over ⅛-inch mesh below.

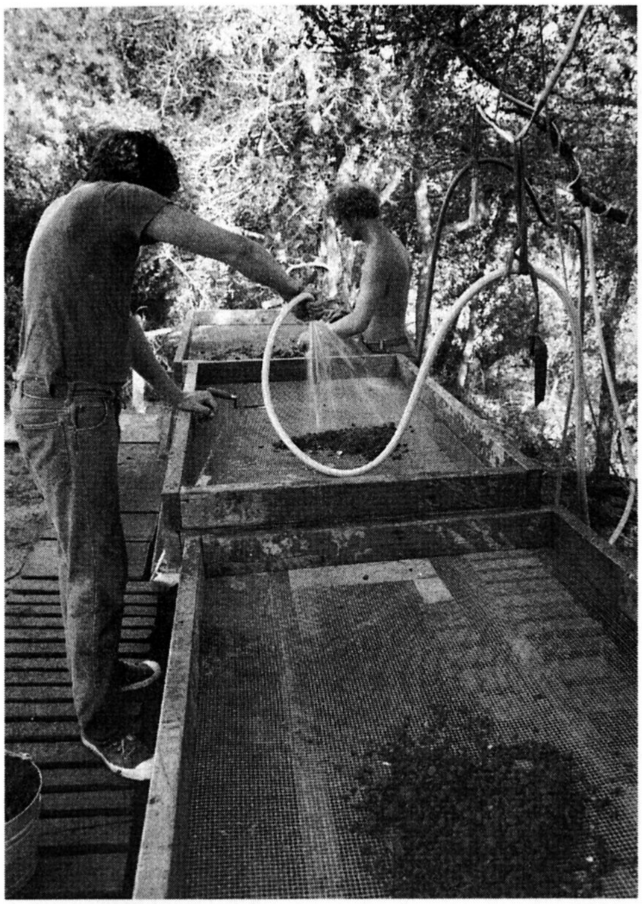


Figure 5.23 Screening of archaeological deposits using low-pressure water screening through ⅛-inch mesh.

¼-, ⅛-, and 1/16-inch screens. However, in some situations, water screening can be destructive, harming fragile bones and plant remains. Ingbar (1985) has provided a comparison of the fine-screening of soil samples to obtain seeds and other plant remains for paleobotanical research at Gatecliff shelter, Nevada. He experimented, using geologic sieves, with dry-screening, flotation, and wet-screening. He found dry-screening the most effective, wet-screening less so, and flotation a distant third. However, he warned that these results may be specific to his project and the nature of the Gatecliff shelter deposits.

At the British Camp shell midden, Stein et al. (1992) washed the excavated sediments through four nested screens. They were, from top to bottom, 1-, ½-, ¼-, and ⅛-inch (Stein et al. 1992:Figure 3). Materials from the upper two screens were field-sorted, and those from the smaller mesh screens were taken to the laboratory. They reported that 90–95 percent of the fish bone in the shell midden was removed from the ⅛-inch (3-mm) screen.

Archaeologists have also used screening to determine the quantitative composition of an archaeological deposit. Beginning in 1945, workers at the University of California (Berkeley) carried out a program of screening large samples of refuse deposits, sorted the screenings into components (such as bone, shell, obsidian, rock), measured the relative amounts of each, and used the quantitative data to gain insight into the economic and industrial activities of prehistoric hunter-gatherers. These studies resulted in a considerable literature, summarized in Heizer (1960:95–96).

If a limited amount of screening is planned, small hand screens with cross-braced legs are most convenient (Figure 5.24). These may be made up in several sizes so they will nest together for more convenient transportation. Larger screens (often 3-×-5 ft) resting on sawhorses permit a greater volume of earth to be processed, yet are easy to move as excavation progresses. In some large-scale excavations, screens are mounted in metal frames supported by flexible steel bands that allow vigorous shaking. Screens can also be suspended from tripods, where vigorous shaking will quickly process the excavated soil. "Shaker screens" that are rocked by a motor on a carriage have been found to be useful (Bird and Ford 1956; Diamant 1979; Story 1982: Figure 12), and other forms of mechanized screening have been proposed (e.g., Bird 1968; Guerreschi 1973; Michie 1969). Junius Bird devised a "dump sifter" at Gatecliff shelter (Thomas 1983:22–23) to speed the processing of sterile deposits. Earth was dumped down a ramp covered with ½-inch screen, and any soil that did not pass through the screen was examined on a sorting table at the end of the ramp. Perino (1981:Figure 9) has illustrated a "rocking screen" situated in a frame on ball bearings; it is said to be three times faster than conventional screening. Hunt and Brandon (1990) report the use of agricultural grain cleaners for mechanical screening of site deposits. These screening drums (Figure 5.25) process the soil rapidly, and the tumbling does not damage artifacts during the process.

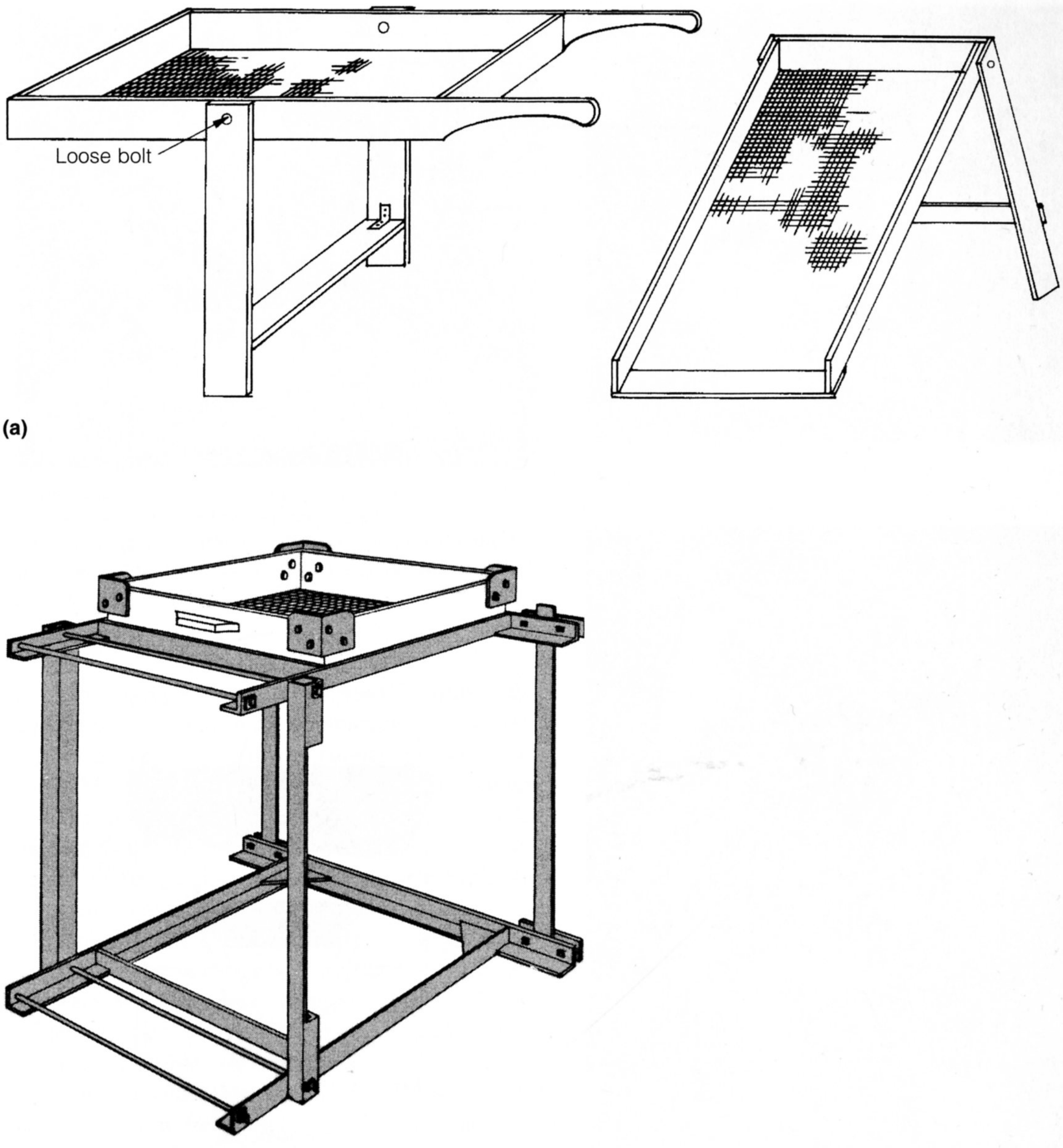


Figure 5.24 Various screening devices: (*a*) hand screens; (*b*) MacBurney shaker sieve.

The number and kinds of screens provided for an excavation depends on the character of the site and the goals of the research project, but two or three hand screens (¼-inch and ⅛-inch) would probably be a minimum for any site. One example of adapting the screening process to site-specific situations involves the use of a "sorting board" at Colha, Belize. In Maya lithic workshops comprised wholly of debitage and tools broken in manufacture, the density of the debitage is so great (up to 5 million pieces per cubic meter; Hester and Shafer 1992), the usual ¼-inch screen is impractical. Thus,

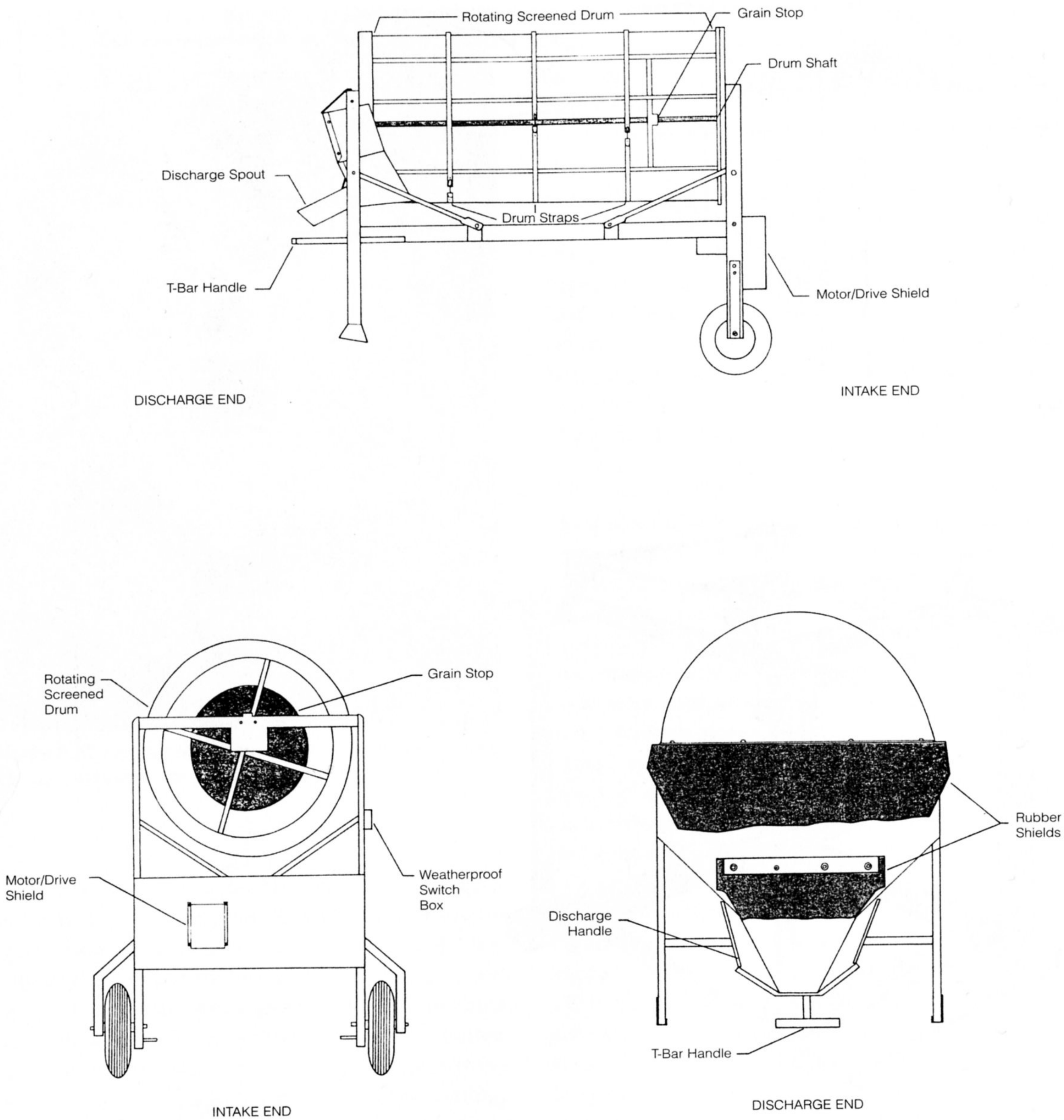


Figure 5.25 Use of a mechanical grain-sieving device as an archaeological screen.

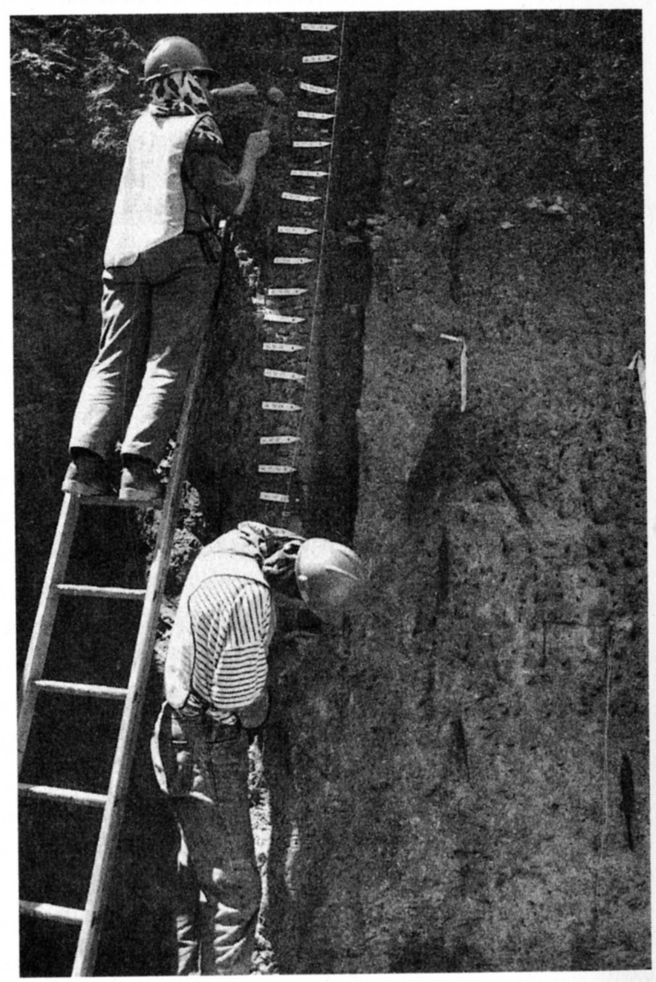
we used a sorting board built much like the traditional screen to examine the flake debris and extract broken formal tools (to study and quantify the debitage, we used column samples removed from the profiles). A modification of the sorting-board technique (Figure 5.26) involves covering half of the screening frame with ⅛-inch mesh. Thus, in digging Early Postclassic midden deposits, the large sherds and lithics could be picked up off the sorting-board portion, and the rest of the deposit screened at the other end to collect faunal remains.

Figure 5.26 Use of a sorting-board/screen. Part of the 3-x-5-ft frame is a wooden sorting board from which large objects can be removed; then, the soil is pushed onto the ⅛-inch mesh that covers the other half for screening.

Moving the excavated dirt from the unit to the screen usually requires wheelbarrows or buckets (either galvanized or heavy rubber buckets work well). The buckets are also useful as water containers if very hard and dry deposits have to be "softened up" or if features must be cleaned and carefully prepared for recording and photography (or if units have to be bailed out after a rain!).

Finally, it should be emphasized that most contemporary archaeologists collect matrix samples, sometimes as column samples (Figure 5.27a), sometimes as constant volume samples (e.g., Thomas 1985:74), or sometimes as microstratigraphic samples (Figure 5.27b). These are not screened in the field but are taken to the lab for a variety of analyses, including fine-screening for faunal and botanical remains, flotation, constituent analysis, and micromorphological studies. At Baker Cave, Texas, the entire fill of a 9,000-year-old hearth was bagged and transported to the lab (Hester 1983). Fine-screening with geologic sieves produced an amazing array of tiny animal bones (including those of 16 species of snakes!), charred seeds, flint chips, and more. More than half the sample was saved for analysis in the future.

(a)



(b)

Figure 5.27 Taking samples from an excavation: (*a*) removing column samples from a profile; (*b*) extracting microstratigraphic samples.

EXCAVATING A "TYPICAL" UNIT

The earlier discussions of excavation techniques have been fairly general. To give a clearer picture of practical application of these techniques in the course of ordinary excavation, we think it worthwhile to describe the steps in the process of digging a "typical" excavation unit (Flannery et al. 1986 provide a readable and detailed account of the excavation process, as used at Guila Naquitz Cave, Oaxaca). The proper or customary use of the tools mentioned earlier in the chapter is also addressed further here.

A "typical" unit means one that shares all or most of the characteristics commonly found in excavation in an area. In the real world, such a unit is rarely encountered; most will exhibit at least one special or unique feature. This typical excavation unit, let us say, is 2 m square, and its limits are defined by the intersecting lines of the coordinate system. Its four corners are marked by stakes, each bearing a label (tag, flagging tape, or writing on the stake) giving its coordinate location. The sides of the unit are marked with taut string tied to each corner stake.

Important Considerations

Three considerations should be kept in mind at the beginning of every excavation: cave-in prevention, recording accuracy, and corner-stake preservation. The danger of cave-ins is a real problem in very soft, unconsolidated, or wet site soils. Shoring of units and trenches must sometimes be done, both for crew safety and to comply with federal OSHA requirements (see Figure 5.6). Cave or rockshelter deposits, often loose and relatively uncompacted, have a tendency to slump, and there are recorded instances of archaeologists being killed by the collapsing walls of deep trenches. As a general rule, in any excavation likely to be carried to a depth where there is danger of slumping, the walls of the pit or trench should be sloped inward, or battered, to ensure their stability. Sampson (1975) used stepped walls to protect against collapse of a large unit dug into the "living clay" of the Caddington site in England (see also Thomas 1983 for an example from a Nevada rockshelter). The dangers of cave-in are evident when you consider that a 10-ft-deep trench (with backdirt on one side) will dump 10 tons of dirt into the unit in the event of a collapse.

Because of the wall slopes—or other wall modifications designed to ensure safety—not all of the deposit contained within a unit as defined on the surface will actually be excavated. The earth lying between the theoretical and actual limits of the unit may, however, be removed when an adjoining unit is excavated. In such cases, care should be taken that materials recovered within this remainder are located, for the record, within their correct unit, according to the site map. Be sure to record in the field notes both the surface and base dimensions of grid (or pit or trench) units that have been excavated with sloping, or battered, walls. You or the reader of your report may want to calculate the cubic content of the deposit excavated, and these measurements will be essential. The depth to which excavation will be carried in any unit can often be determined in advance from its position on the site and indications from nearby excavations. Keep in mind that a decreasing volume of earth is removed as you go deeper (in a unit with sloped walls); this can create problems in comparing and interpreting artifact densities—and in making comparisons between levels across the site.

Remember that the stakes marking the corners of excavation units must be used to record the position of all materials subsequently recovered; their location must therefore be carefully preserved. One way of doing this is to leave the stakes standing on top of substantial columns of earth, which are not to be excavated until the stakes can have no possible further utility. Again, because these columns will lie partially within four separate units, the location of materials eventually recovered from them should be carefully determined. Columns that obstruct the excavation of a burial or some other feature whose exposure is required will, of course, have to be removed.

Obviously, the excavation of any unit must begin with a careful examination of the surface.

The presence of surface finds is a signal that all deposits within the unit, from the surface down, must be examined. Where sterility has been absolutely determined (in earlier test cuts), the surface layer can be dug off with a shovel and thrown aside without examination. It should be remembered, however, that even though a surface layer is "sterile" in that it does not contain cultural material, it is still an important element in the depositional history of the deposit. The same, of course, is true for buried sterile layers separating cultural deposits.

Before excavation begins, you should photograph or make a plan drawing of the unit surface. You should also certainly have the surface contours plotted on your overall site map.

The Excavation Itself

When all sterile matter, if any, has been removed from the top of a unit, the business of actual archaeological excavation begins. In our "typical" excavation unit, this is done with a combination of trowel and shovel. Depending on the goals of your excavation, you may want to carefully scrape down the deposits, using the shovel to move the loose dirt into buckets and then to a screen. When using arbitrary levels, some excavators like to cut a narrow trench along one wall, perhaps to a depth of 10 cm, and then systematically work across the unit with trowels and shovels. This makes it easier to maintain the bottom of the arbitrary level. If an artifact or other object to be recorded is revealed, its location should be plotted immediately, before excavation is resumed.

During the course of excavation, the loose, excavated earth is removed from the unit at fairly frequent intervals and is processed through a screen (see "Screening Excavated Deposits" earlier). Although the earth from the excavation can be thrown directly into a screen, it may also be carried by buckets or in a wheelbarrow to the screen for sieving. As each level, natural or arbitrary, is completed, the floor of the unit should be scraped clean and carefully inspected for evidence of cultural features or natural disturbances such as tree roots or rodent burrows. The walls (profiles) of the unit should be inspected for evidence of disturbance, pits, soil changes, and so on. Because of this, unit walls should be kept as vertical as the soil deposits will allow (remembering the safety warnings about cave-ins). Neat, vertical walls are important in the process of careful excavation and recording.

Much excavation in North America is conducted in the manner just outlined, in which each unit is dug downward in successive natural or arbitrary levels to the base of the site. However, features such as hearths, pits, and post molds that require refinements or modifications of technique are often encountered in the course of excavation. Some of the special techniques employed in recovering various types of features are discussed in Chapter 7. If a feature or an object cannot be exposed without further large-scale excavation, it should be carefully protected while that excavation is in progress. Trained excavators develop, before long, a "touch" or "feel" so sensitive that the slightest contact with an object is often sufficient for them to release pressure and avoid breaking it. Many experienced workers can tell, from contact, whether they have struck bone, burned clay, or stone.

As noted earlier, the trowel is usually used in combination with shovels or other excavation tools. Trowels should be employed to work through site deposits that contain an abundance of artifactual materials (flint, potsherds, etc.), and shovels are then used only to remove the soil already examined. At those excavations where every attempt is made to leave artifacts in place until they can be plotted (Figures 5.28 and 5.29), work is done almost entirely with trowels. When artifacts are encountered, they are carefully exposed and their in situ positions are plotted on a plan of the unit. This approach permits a precise examination of the spatial relationships among artifacts, debris such as burned rocks, features, and other buried evidence.

In some areas, where the average land contour is near sea level or the water table is very near the surface, groundwater may be encountered during excavation of a unit. Alluvial deposition may have elevated the surface of the ground, and a corresponding elevation of the groundwater level may immerse portions of the site deposit. Gasoline-

Figure 5.28 Excavating a grid unit. Here, at site 41LK201 in southern Texas, students are excavating in 1-m square units; note the string outlining the units and the use of trowels and dental picks to expose bison bone in situ; note labeled unit bag at upper right.

powered pumps can be used to remove the water as it seeps in. A simple hand pump of the diaphragm type (costing about $300) can remove 40 gallons of water per minute; we have used this type of pump successfully in swamp-margin excavation units in Belize.

In his classic study of field methods, Wheeler (1954:56) describes how, at Arikamedu, India, he excavated to a depth of 11 ft below the water table by keeping the water out of the pit with pumps. During excavations in 1991 at the Gault site in central Texas, high water tables and seep springs combined to inundate the excavations unless two water pumps were running at all times. A deep part of a backhoe trench, cut for stratigraphic and geomorphological studies, served as a "sump." One pump pulled water from this sump for use in water-screening the gummy matrix.

Figure 5.29 Excavating a grid unit. Here, at site 41LK201, a recording grid is placed over the unit for accurate and fast plotting of in situ cultural materials.

Whenever possible, units are excavated down to the base of the site or, in other words, to sterile subsoil. (The difference between midden deposit, usually relatively dark in color, and subsoil, normally lighter, is often quite distinctive.) However, such lower deposits cannot safely be presumed sterile until examined with care (i.e., until they are found to be wholly lacking in any evidence of human utilization—no flakes, sherds, burned rock fragments, etc.). To ensure that the bottom of site deposits has been reached, the excavator should take one quadrant of the unit deep into the presumed sterile stratum or use an auger to probe even more deeply.

EXCAVATING SPECIAL SITE TYPES

Certain types of sites demand special considerations and techniques. They include water-saturated sites, caves and rockshelters, and structural remains.

Water-saturated Sites

The excavation of water-saturated sites, such as Ozette and Hoko River, Washington (Croes and Blinman 1980) and Hontoon Island, Florida (Purdy and Newsom 1985), requires a wholly different approach to archaeology. At Hoko River, excavators first used "on-shore coring" to determine the depth and remaining extent of the site. Next, excavation was done via "hydraulic techniques"—with carefully adjusted hose nozzle pressure. Using a grid pattern of units, individual squares were cautiously exposed; artifacts were mapped via three-dimensional coordinates, tagged, and recorded in otherwise traditional fashion, although the preserved vegetal materials, basketry, wooden artifacts, and fishing lines had to be delicately bagged for prompt removal to a field laboratory for treatment (at Ozette) with polyethylene glycol to force out the water (see Chapter 7).

Caves and Rockshelters

The excavation of cave and rockshelter sites involves a great many special considerations not applicable to open sites and thus requires specialized techniques. Limited space, lack of light, the distinctive character of the deposits, the problem of dust, and especially the far better preservation of perishable cultural materials in dry caves are all factors that profoundly affect methods of excavation. Cave excavation can be hazardous. Bats can carry rabies, loose sections of ceiling can be dislodged and fall, and dust can cause serious respiratory difficulties. An exhaust fan run by either a gasoline engine or an electrical generator, dust-filter masks, artificial lighting (Heizer and Napton 1970:Plates 8–11), and timber cribwork to prevent cave-ins (Harrington 1933) may be necessary. At Hidden Cave, Nevada, Thomas (1985:70) had his crew wear surgical masks (Figure 5.30) to keep from inhaling large amounts of dust particles (he had wisely had the deposits checked for the presence or absence of valley fever [*Coccidioidomycosis*], whose spores can be spread through dusty excavations). Excavators also used wood plank walkways through the cave to keep from stirring up the dust. But the dust was so bad that a specially built ventilation system eventually had to be installed. Hidden Cave was also very dark, and the generators that operated the ventilation system did double duty by also supplying power for a lighting system. Other gear and specialized techniques may be necessary if exploration is part of a cave investigation (see Steele and Hissong 1984).

Caves containing evidence of human occupancy occur in many areas. In drier regions, these sites may yield normally perishable materials such as plant leaves and other plant parts, wood, leather, coprolites, and the like (their preservation in the field is often a problem; see Chapter 7). Good discussions of rockshelter excavation strategies are provided by Flannery et al. (1986), MacNeish (1975, 1978), and Thomas (1983, 1985). For example, MacNeish's work in the Tehuacan Valley of Mexico

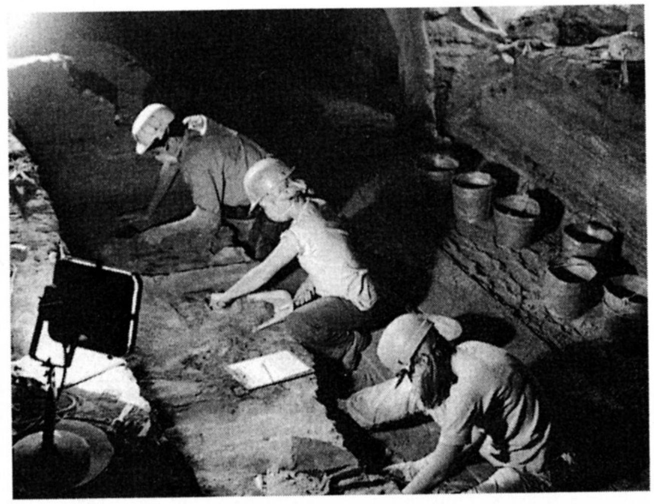
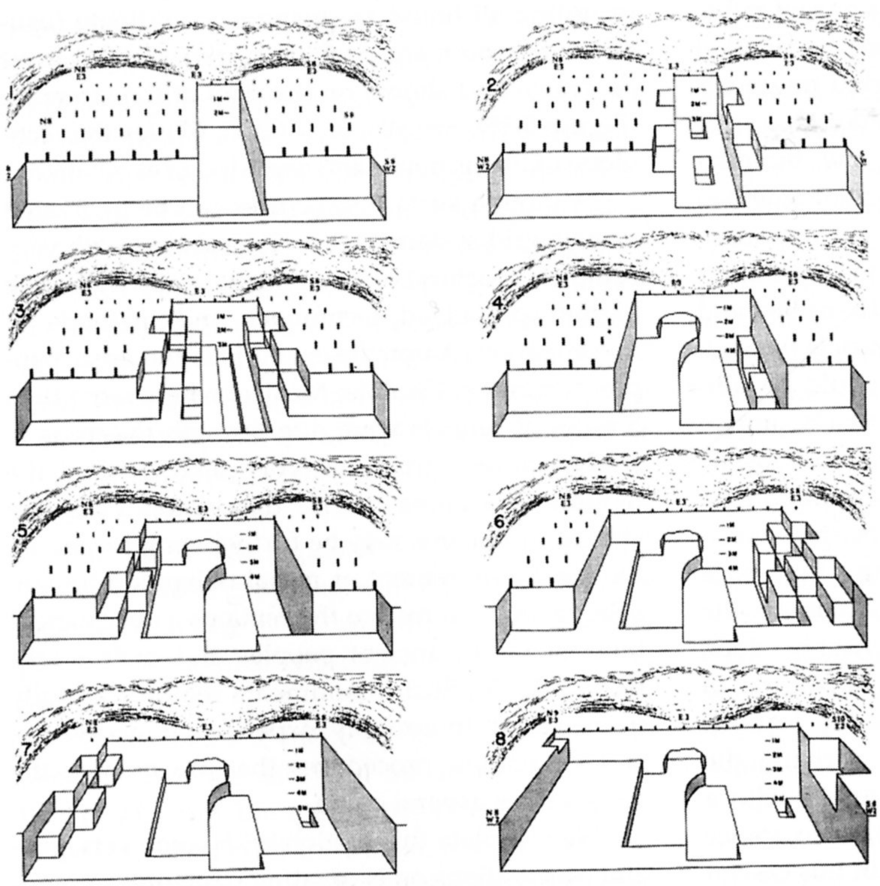


Figure 5.30 Excavating cave deposits, wearing surgical masks to minimize dust hazards, at Hidden Cave, Nevada, 1979.

first utilized a "blitz crew" to put test pits in rockshelter sites. Test pits could then be connected as a trench, as he did at Purron Cave (MacNeish 1975:69). This trench provided a profile from which 17 different stratigraphic zones could be identified. The rockshelter floor was then staked out in grid fashion and cross-trenches of connected 1-m-square units were dug. These provided profiles from which adjacent squares could then be dug by natural levels, stripping away the defined stratigraphic zones. When natural levels were impractical, 20-cm arbitrary levels were used. Excavations proceeded by "alternate squares" (Figure 5.31), which permitted MacNeish (1975:73) "great control of the stratigraphy." A critique of MacNeish's excavation approach in the Tehuacan Valley has been written by Kowalewski (1976), and it is useful to compare the differing views on the excavation strategies that were used.

Archaeologists and students planning rockshelter and cave excavations could usefully consult the following references, which contain further information on the methods and problems involved: Aikens (1970), Chadderdon (1983), Collins (1969), Cressman (1942), Cressman et al. (1940), Flannery (1986), Heizer and Krieger (1956), Heizer and Napton (1970), Jennings (1980), Lehmer (1960), Logan (1952), Loud and Harrington (1929), Movius (1974), Shafer and Bryant (1977), Steward (1937),

(a)



(b)

Figure 5.31 Excavating Purron Cave, Mexico, using the alternate-square method. As shown in the photograph (*a*) and the isometric drawing (*b*), the cave was dug first by cutting a trench through the deepest deposits. Next, 1-m squares were excavated in an alternating fashion (thus leaving 1-m balks to help trace stratigraphy). These began at the trench walls and moved away from it while following horizontal strata exposed in the deposits.

Thomas (1983, 1985), Word and Douglas (1970), and Zingg (1940).

Structural Remains

Structural remains found at sites (such as those standing structures at many Mesoamerican sites) and those discovered during excavation are of great interest and significance. Simple structures constructed largely of perishable materials may leave only minimal traces, usually post molds, behind. Excavators must therefore be constantly alert for these traces—postholes, wall trenches, hearths, and packed earthen floors.

Once recognized, such remains rarely present problems that cannot be dealt with adequately by standard field procedures, if these are perceptively applied; the remains will usually be treated and recorded with the same care and in the same detail as smaller features of special importance. Particular attention should be given during the clearing of the floor to any evidence of wall or roof materials. Often, sizable fragments of the walls or roof fall to the floor and are preserved by one or another agency. If the structure burned, charred fragments carefully excavated and recorded may go a long way toward reconstructing what the building looked like. Such remains should be photographed and drawn in situ. Postholes, wall trenches, possible entranceways, evidence of hearths, and other items of importance must be carefully studied and recorded. Cache and storage pits, burials beneath the floors, and subfloor deposits should be diligently sought. The location of all artifacts, animal bones, and other objects found on the floor must be precisely recorded because their distribution may help locate various activities within the structure.

The best procedure for excavating a floor once it has been discovered is usually to remove the overburden to within a few centimeters of the floor, where structural materials begin to appear or, in any case, before floor-level artifacts and features appear. The deposit immediately overlying the floor can then be excavated meticulously with a trowel. If the structure is a pithouse, its existence may be apparent before excavation. In this case, it may be desirable to dig a unit off center until the floor is located. From this unit, a trench or trenches can be dug to locate the walls, which can then be outlined. Overburden may be removed next, and the floor surface deposit finally dissected by careful horizontal digging. If pithouses are suspected but are not evident from the surface, it may be necessary to dig a test pit outside the site area to test the depth and character of the undisturbed subsoil. Test pits can then be dug in a grid to determine where disturbed deposits continue below the expected natural level. This may indicate pithouse fill to be excavated in the manner described. Sometimes a soil auger can locate floors and save digging pits.

In a site occupied over a long period of time, later house pits may cut through earlier ones (Figure 5.32). Such complex situations require the greatest care in the recording of details and a perceptive overall handling of the excavation. Because pits were sometimes dug for clay or other materials and then filled with trash, care must be exercised not to confuse such features with pithouses. In recording all house excavations, coordinate (usually north-south and east-west) cross sections must be drawn and shown on the plan of the structure (Figure 5.33). See Wood (1969:65, 67) for the technique of Plains house and earth-lodge excavation.

Although surface structures can be excavated using a grid system, archaeological sites with very complex structural or monumental remains require highly specialized techniques and methods of investigation. A notable example is the great temple-pyramid at Cholula, Mexico, where more than 5 miles of tunnels were dug through the mass to study earlier structures concealed within the mound (Marquina 1951). Excavating elaborate structural remains may be further complicated by the legal requirement or moral obligation to consolidate or even restore the remains as permanent monuments of ancient peoples and their works (Bernal 1963). Such monuments require carefully trained and thoroughly experienced excavators and excavation procedures that are outside the scope of this general guide.

We complete this section with some very general observations on excavating structures of moderate structural complexity. The presence of such

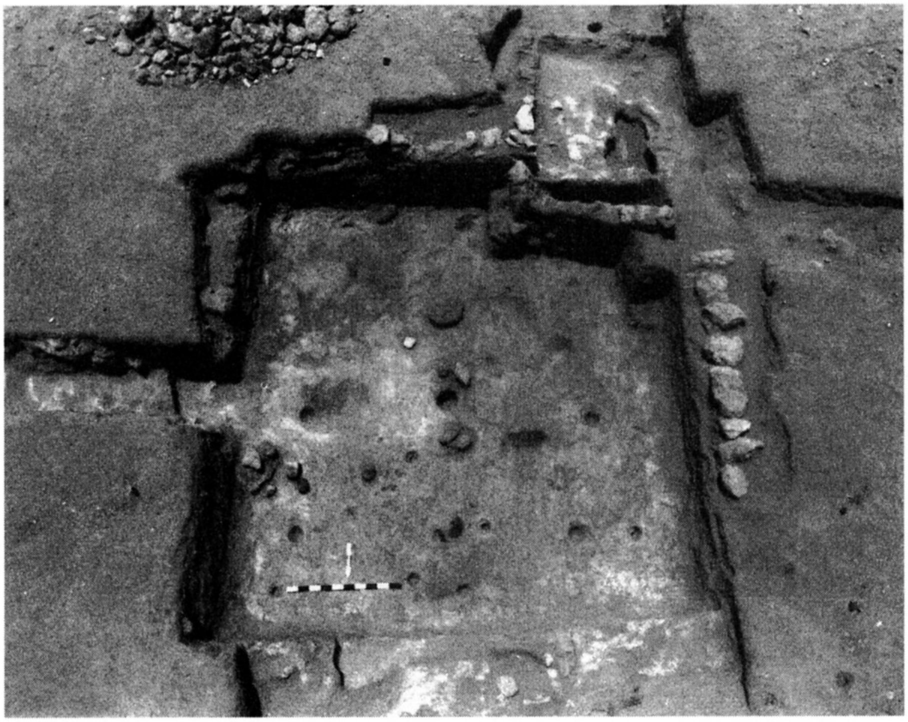


Figure 5.32 A Mimbres pithouse excavated at the Old Town site in New Mexico. A later surface room was built over the upper right corner after the pithouse was abandoned. Scale is 1 m.

remains is generally indicated by the mounding that results from the collapse of a roof, upper wall, or other superior portions of the structure and the subsequent erosion of the debris. Confronted with a mounded feature, the archaeologist's immediate task is to determine whether it is architectural in nature. Structures built of stone are sometimes obvious from building stones present in the debris of the mound, but features of earthen construction are seldom so evident. Similarly, rubbish heaps form mounds. These will usually turn out to be formless, but because rubbish was often used as construction fill for platforms and foundations, the issue may remain clouded until actual excavation is undertaken. The regularity of the mound form, its alignment or grouping with other mounds, the presence of a nearby borrow pit, and construction patterns in the area will usually provide clues to identification.

The excavation methods to be applied will depend upon the nature of the structure and the way it was built, the specific objectives of the excavators, and the limiting factors of resources at hand versus the magnitude and complexity of the structure. In general, the basic principle in excavating stone or adobe structures is "work from the known to the unknown." Thus a pit, perhaps 2-m square, is usually dug some distance outside the mound periphery to locate a plaza or court floor, an old ground surface, or an occupational level and to determine the nature of the subsoil deposits. The pit is then expanded into a trench dug into the side of the mound, penetrating first the surface soil and humus of the present mound, then the collapsed and eroded debris from the upper portions of the structure, and finally the base of the structure's exterior wall.

Once this element of the structure has been discovered and exposed by the archaeologist, side trenches may be opened to follow the wall to the left and right. Where construction is not well preserved, the trench should not turn a corner at an especially poorly preserved section of the wall but should continue well beyond the corner before making the turn. From the amount of fallen wall stone and the preserved height and contour of the mound, it may be possible to determine approximately the original wall height. In clearing the walls, any fallen ornamental or decorative features should be noted and carefully recorded. Evidence

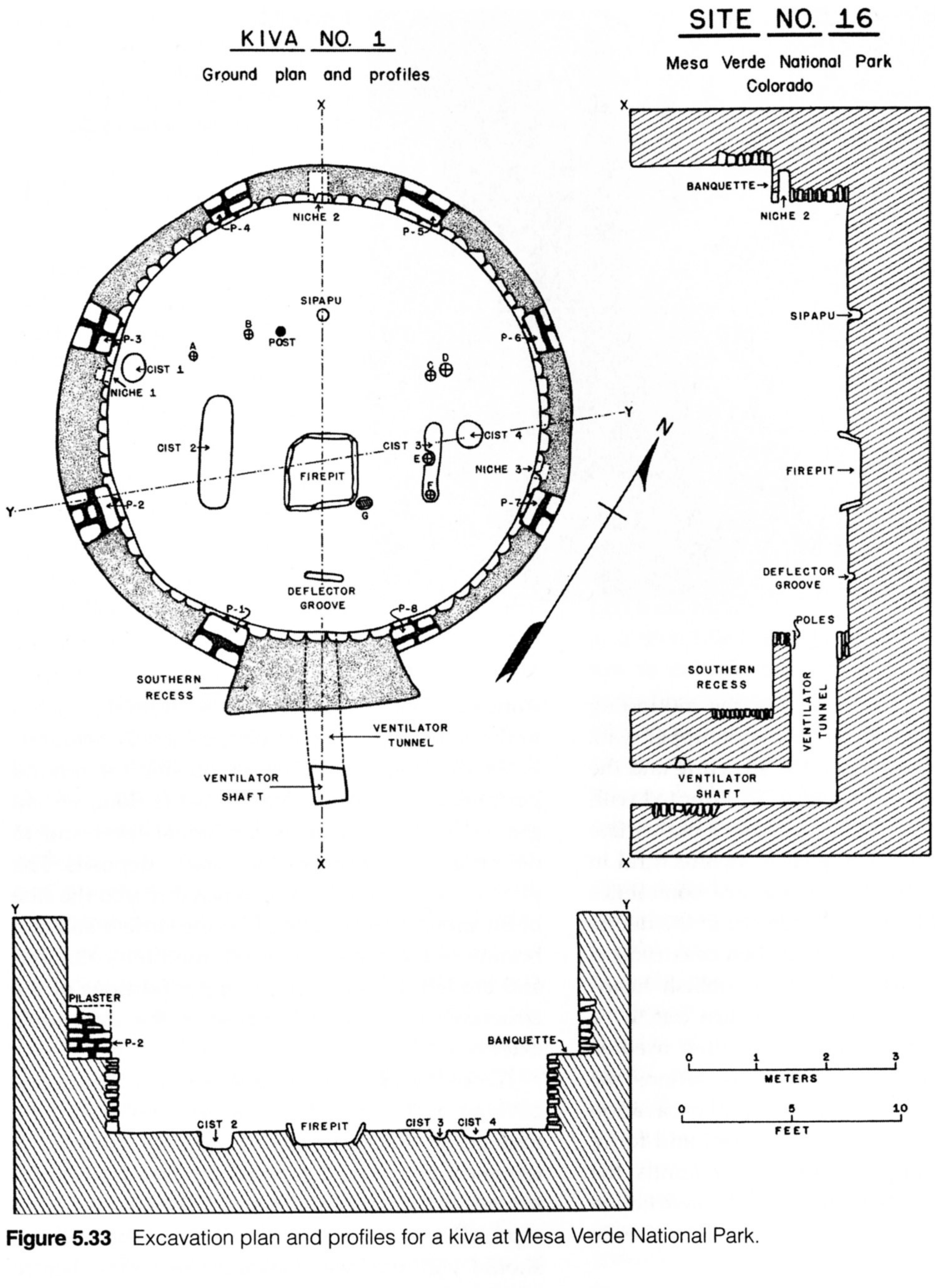
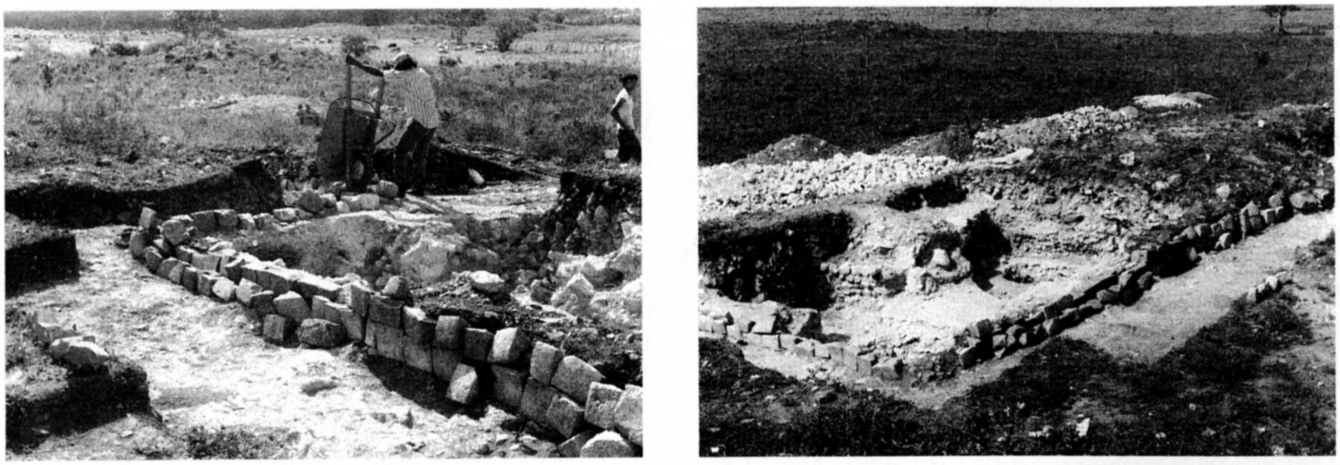


Figure 5.33 Excavation plan and profiles for a kiva at Mesa Verde National Park.

of the original wall facing or surface treatment may be preserved at the base of the wall.

If the exterior walls enclose rooms, these may be excavated next. As discussed earlier, overburden is usually removed to within a few inches of the floor, with the floor zone then carefully exposed by trowel excavation. If the walls are part of a substructural platform, excavation must then turn to the upper terraces or superstructure. These walls are located as before, by trenching in from



(a) (b)

Figure 5.34 Excavation of a Maya house mound at Colha, Belize: (*a*) using the subop method, the lower wall foundations are found at Operation 2008; (*b*) the perimeter of the house is exposed, and portions of the interior are excavated.

the side of the mound where the upper floor level should be located. If a foundation platform is present, it is usually desirable to sample its fill and to investigate the possibility of earlier construction or an enclosed tomb. Although this is sometimes done by pit excavation from above, the greatest control is maintained when a trench can be excavated in from the side along the base level. In this way, features are exposed where they should be best preserved, and the chance of missing or damaging features is minimized. In excavating foundation fill, the investigator must be careful not to mistake temporary retaining walls and makeshift stairways used in building up the fill for earlier interior construction. Indeed, these construction techniques used in building up the fill should be noted, as Ford and Webb (1956:37–38) and Morris et al. (1931:1:146–148, 204–206) have done.

In carrying out these kinds of excavations, a grid system is often not feasible. There are several other systems that archaeologists have used to keep track of horizontal and vertical proveniences during excavation of structural remains. At the site of Colha, Belize, a system of "operations" (a mound or other major structure has a sequential operation number) and "suboperations" (trenches and other excavation units numbered sequentially) was utilized with great success (see Stock 1980; see also Sharer and Ashmore 1987). The "subops" exposed architectural features, leading to exposure of the entire building outline (Figure 5.34a,b).

Where construction is of adobe, distinguishing the walls and other structural features from debris composed of the same material can often be painfully difficult. Kidder, who excavated an adobe platform structure at Kaminaljuyu, Guatemala, reports that it was sometimes impossible to see the juncture or separation lines between buildings approached in cross section in a penetration trench. The problem was resolved by having workers use the pointed end of a hand pick for all advance or exploratory work. Because fill did not bond or fuse with the adobe walls it covered, the pick was used to rip dirt loose and pull it forward, causing material to fall away at the cleavage line between fill and wall and exposing the wall (Kidder et al. 1946:27–28, 90, 92). Braidwood and Howe (1960: 40–41) discuss a similar problem in the excavation of touf (loaded-mud) walls.

Although building plans and reconstructions generally seem clear-cut and obvious in published reports, students will find the situation in the field is often quite the opposite: they will constantly face difficult interpretative and procedural decisions of the greatest importance. Even recognizing and interpreting such basic architectural features as walls and floors can be difficult. Where alterations occurred in ancient times, the remains will often

Figure 5.37 Area excavation of Maya structures and related remains. At Operation 2031 at the site of Colha, Belize, a complicated pattern of house floors, retaining walls, burials, fire pits, caches, and middens from the Middle and Late Preclassic periods was exposed.

in than undisturbed earth, are often used as fill for platforms and foundations. Such rubbish may be scattered about and subsequently incorporated into other deposits or into structures at some distance from where it originally lay. Such disturbed deposits require perceptive ordering through correct interpretation of the structural events; careful and constant attention together with precise recording are required to work out these events and their correlations.

BACKDIRT AND BACKFILLING

Almost invariably, the archaeologist excavates a site under an agreement to restore the land surface. Also, open pits are hazards to ranch and farm animals, as well as to people, wild game, and other creatures, and often may have to be fenced during excavation. In most cases, when the digging is completed, all excavated earth must be replaced in the trenches and pits and the surface left level and smooth.

Backfilling is one of the unavoidable consequences of archaeology, and its ultimate necessity should be borne in mind at all times in the course of excavation. In CRM archaeology, the fieldworker may escape the drudgery of backfilling, because the construction project may involve massive earth-moving after the excavations are done.

A little foresight in the distribution of backdirt may save a great deal of trouble in backfilling. In exploratory excavation, excavated earth is generally piled as compactly as possible on the surface at one side of the unit. Do not see how far you can throw the excavated earth, because it must all be returned to the hole from which it came! To ensure sufficient earth to fill all excavations at the end of the dig, any area on which backdirt is to be thrown should be completely cleared of vegetation or other cover. Otherwise, a considerable amount of dirt may settle and become packed among plants or other matter and be very difficult to move.

Excavated earth should not be put where it covers the surface of units that are likely to be excavated later. Very large piles should be avoided; they are difficult to handle and may necessitate moving the dirt a considerable distance when it is replaced. The main point is to keep a pattern for backfilling in mind at all times during the excavation so that at the end, every pit or trench can be refilled with loose earth piles as near at hand as possible.

The backfill should be packed in so that it will not settle too much during subsequent rains. As the hole is being filled, the earth should occasionally be tramped on and tamped and probed with digging bars and shovels to pack it firmly. Backfilling almost always takes longer than you think. Be sure to allow enough time for it when setting up an excavation schedule, especially if you have a deadline. On the average, for instance, it takes one worker with a shovel a couple of hours to completely refill one 1-×-1-m unit that has been excavated to a depth of 1 m.

A digging crew can sometimes borrow a Fresno scraper from a local rancher (Fitting 1973:7). Hooked to a jeep or a pickup truck, this will fill a site more easily and rapidly than workers with shovels. Large excavations—where the time required for labor to clear, remove overburden, or refill pits and trenches is prohibitive—can often be cleared or filled with a bulldozer or backhoe with a front-end loader secured on hire or loan. A good (and thrifty!) excavator will keep this in mind and, during the course of digging, try to make arrangements to secure such machinery on loan from someone whose interest in the excavation has been cultivated.

Archaeologists often throw bottles and other nonperishable camp debris into the bottom of excavation units prior to backfilling. These serve as markers to any later excavator who might happen to dig in the same spot. Even pothunters sometimes have the forethought to mark their plunderings by placing some modern object in their pits. McKern (1930:443), during his excavations at the Kletzien mound group (Wisconsin), came across a bottle containing a slip of paper bearing the date "Oct. 11, [18]'96," apparently a record of some early relic-collector's explorations.

SOME HAZARDS IN FIELDWORK

Although it is not our intention to end this chapter on a negative note, it is important to remind students that field investigation can be dangerous. Ordinary city life also has its hazards, as we all know, but they do not prepare anyone for the unfamiliar dangers an excavation offers. Although most archaeologists will not face the perils of an Indiana Jones, there are sometimes problems with guerrillas, smugglers, and most commonly, the climate and foods of a foreign land.

Outside the continental Unites States, there is always the risk of contracting a local disease that, if left undiagnosed or if incorrectly treated, may cause severe health problems. Several diseases can be contracted from eating food prepared in an unsanitary manner. "Traveler's diarrhea" is a common plague and sometimes best countered by large doses of Pepto-Bismol! Water is often contaminated and should always be boiled or otherwise purified if this is known or suspected to be the case (good portable drinking water purifiers are available for under $30, but larger systems are needed to meet the demands of a big field camp). A well-trained local doctor usually can recognize infections and knows how to treat them.

Various prescription drugs and immunizations are often necessary for work in foreign countries. Antimalarial drugs should be carefully considered, in close consultation with a physician. Chloroquine is often recommended, though other strains of malaria (such as Falciparm) require different drugs. Diphtheria-tetanus boosters are recommended every 10 years. A broad-spectrum antibiotic such as tetracycline should be part of your medical kit if the field camp is some distance from medical facilities. Indeed, it is a very good idea to work with a physician to plan the medical aspects of any foreign or remote archaeological project. A member of the field team should be designated to develop and maintain a camp first-aid kit. Staff with CPR training and first-aid skills should be identified. Based on our experience, we would also highly recommend that every crew member have health insurance, either personal or inexpensive group insurance that can be purchased for the duration of the project.

Our comments have focused on fieldwork in other countries, but there are plenty of hazards in doing fieldwork in North America. First of all, whether abroad or in the rural United States, you should behave in a manner that will not offend the local population. This may involve the way you talk or dress; it is best to observe local standards, customs, and courtesies. When digging sites in rural areas, you need to be concerned about potential hazards—rattlesnakes (and other venomous snakes), range cattle, bulls, and rabid wild animals. Snake leggings and snake-bite first-aid kits may be wise investments for certain projects.

Ticks have always been bothersome pests for field archaeologists, and Rocky Mountain spotted fever, spread by the dog tick, has long been a hazard. However, in North America today there is the threat of Lyme disease, which is transmitted by the deer tick and is very common in parts of the United States in the spring and summer seasons. Early symptoms of Lyme disease include a red, circular rash appearing within 2–30 days, fatigue, mild headaches, muscle or joint pain and stiffness, fever, and swollen glands. If you develop such symptoms during or after fieldwork, consult a doctor immediately so that effective treatment can be started.

Valley fever is an endemic disease contracted by breathing dust from soil containing the fungus *Coccidioides immitis* (see Thomas 1985:67). It consists of an unpleasant, though rarely fatal, lung infection (Werner 1974; Werner et al. 1972). The range of this fungus is in a belt from northern California southeast through southern Nevada, Arizona, southern New Mexico, and Texas to the Gulf Coast. Also, cave bats are under suspicion as carriers of rabies. According to Bat Conservation International (July 8, 1996; http: //www.batcon.org), there is no direct evidence linking the transmission of rabies to bat urine or feces. However, histoplasmosis (a respiratory infection caused by the fungus *Histoplasma capsulatum,* which may exist in warm, humid bat habitats) is a concern. Fieldwork in such conditions resquires the use of a respirator that filters out particles as small as 2 microns (Brass 1994; Constantine 1988).

The appearance of hanta virus spread by mice is another concern for archaeological crews. At this time, the virus is found mostly in the American Southwest, but it has spread to moist climes to the East.

Working in dry and dusty caves may lead to serious problems of lung congestion. The Harvard archaeologist S. J. Guernsey reportedly died as a result of such exposure. Fungal spores in caves or sealed cavities (such as burials) can also be harmful. The "Pharaoh's curse" associated with Tutankamen's tomb in 1922 may have been a reaction to severe allergies to mold, fungi, or organic dust in the tomb. It has been suggested that some people associated with that project contracted allergic alveolitis and died of pulmonary insufficiency (C. Stenger-Phillips; Ph.D. thesis, Strausburg University Medical School). Fibrous dust found at some locales can cause pleural mesothelioma, a dangerous disease that could be, although it is not yet known to be, a hazard to archaeologists (Rohl et al. 1982). Camp dangers are common—tripping over tent ropes, eating tainted food, drinking contaminated water, preparing food in dirty field kitchens, falling into the campfire, and the like. Pressure gas lanterns are known to release toxic fumes from the beryllium in the incandescent mantle (Griggs 1973).

As we have already suggested, cave-ins of deep trenches or pits can occur in all kinds of sites, but especially in caves. Several archaeologists have died in cave-ins. Two relic collectors suffocated as a result of a tunnel collapse while digging into a Caddoan shaft tomb (Perino 1981:4). People have had their skulls damaged by heavy double-ended picks wielded by careless co-workers. Unskilled use of axes and machetes has also claimed its share of victims. Guns should also be prohibited in all field camps unless they are needed to defend the camp against dangerous animals or to shoot game for food. Indeed, the director of any excavation has the responsibility to be aware of any illnesses or injuries among crew members that require medical attention as well as to provide and maintain an adequate and clean camp, to insist on good hygiene, and to provide a good diet.

Archaeologists, as a result of the demands of CRM archaeology, have begun to develop excavation safety checklists (e.g., at the Office of the State Archaeologist, University of Iowa). OSHA standards originally led to such plans, but with the ever-increasing number of students in field schools and non-CRM activities, it is incumbent on the field director to ensure crew safety (such concerns include depth of excavations, stability of excavation walls, keeping heavy tools away from edges of units where they might fall into a pit, placement of backdirt, etc.). And the university archaeologist starting his or her first field school should be sure to check with the university's legal staff regarding the existence of, or preparation of, a liability release form.

GUIDE TO FURTHER READING

Barker 1982; Dancey 1981; Dever and Lance 1978; Dillon 1989; Fladmark 1978; Haag 1986; Joukowsky 1980; McIntosh 1986; Sharer and Ashmore 1993; Thomas 1989; Wheeler 1954