

**Archaeology as human ecology:  
Method and theory for a  
contextual approach**

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**Cambridge University Press**

*Cambridge*

*London New York New Rochelle*

*Melbourne Sydney*

## Site modification

### Archaeological residues

ever size and complexity, are functions of cultural agencies, during occupation as regional and local geomorphic subsystem; and contributes to the blend of cultural that affect a site during its use and subse- tion or destruction. The degree to which ide a representative time slice of human ossilized, as it were) is only in part con- servation on a stable surface, or dispersal f cultural variables is another part of the ng, and after the final phases of human r surface.

transformations has been outlined by Schiff- of systemic versus archaeological context. ch commendable for sociocultural inter- ses of excavation strategy the factors in- e considered from three perspectives:

on. During the original utilization of an archaeological materials are progressively areas), lost, or deliberately aggregated in During abandonment, higher proportions t behind in areas of manufacture, use, and tive the aggregate of abandoned materials ill depend on whether abandonment wan er or not the objects were easy to replace. re conveniently portable in terms of avail- ravel distance. Structures, burials, etc., are ey are fixed.

ion. Discarded or abandoned archaeologi-

cal materials can be reutilized by their original owners, by other mem- bers of the same social unit, or by another group of people occupying the same site. The time interval here can range from minutes to millen- nia. For example, a stone tool can be sharpened or modified by retouch- or renewed flaking—during the course of a single animal-butcher- ing event, during repeated use of an ephemeral site, during a switch from one activity to another on a multiple-activity surface, or during reutil- ization of that surface years or centuries later. Activity shifts and site reutilization, even by the same sociocultural group, serve to smudge the record of specific human activities; they may instead create atypical spatial distributions of various aggregates that incorrectly suggest real functional associations.

Reutilization of a site, such as a damp cave, can lead to trampling and serious disturbance of the top 10 cm or so of an earlier occupation level, with partial or even complete incorporation into a new deposi- tional matrix (see Chapter 6); if diagnostic artifacts are absent from the reworked product, the mixture probably will go undetected, and the resulting artifactual statistics will be skewed and meaningless. Even in open-air sites, penecontemporaneous trampling can help disperse the artifactual material from a single occupation through as much as 50 cm of uncompacted sediment, possibly simulating multiple levels, when, in fact, "refitting" of lithic artifacts and debitage will indicate only one level (Cahen et al., 1979). In town sites, on the other hand, large-scale public construction commonly involves the razing and clearing of older structures, infilling of new level surfaces with old rubble or refuse, and so forth (Wilk and Schiffer, 1979) (see Chapter 6), possibly introducing diagnostic objects into much younger contexts that may lack contempo- rary artifacts. These examples illustrate the hazards of site reutilization and caution against the simplistic assumption that archaeological resi- dues unaffected by nonhuman disturbance represent discrete and pri- mary activity patterning.

3. *Cultural disturbance.* Human activities that rearrange or remove archaeological materials in a nonfunctional site include grave robbing, "pot hunting" and "picking over" for select artifacts, excavation, plow- ing, and various latter-day construction activities. Particularly insidious are the processes of picking over and plowing of surface sites, as well as selective excavation strategies that skew retrieval in favor of larger, diagnostic, or finished artifacts.

These three categories of cultural transformation suggest formidable, often insurmountable, problems in the interpretation of sociocultural

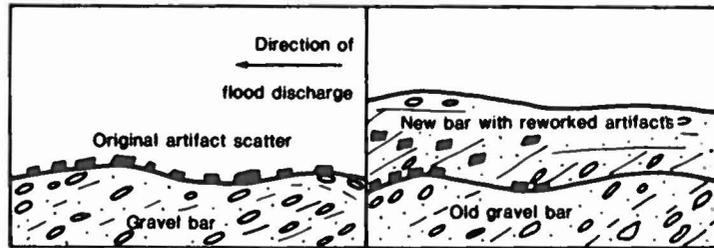


Figure 7-1. Dispersal and secondary bedding of gravel-bar workshop site.

context. But they represent only one side of the coin in the matter of what exactly is primary. These processes are complemented by a host of noncultural transformations that include preburial dispersal, post-depositional disturbance, and geobiochemical modification, as well as site destruction and related artifact dispersal. A conceptual framework for ancient sites has been provided by Fedele (1976), and a methodology for examination of such sites in their landscape is also available (Butzer 1981a).

### Preburial dispersal

Dispersal can be defined as a primarily horizontal movement of surface aggregates that affects particles of different mass and shape at different rates and leads to distortion or elimination of original microspatial relationships. In the case of distortion, we can speak of partial dispersal; in the case of destruction of such interrelationships, we speak of effective dispersal.

Prior to their burial in and under sediment, portable archaeological materials are prone to mobilization in response to geomorphic processes. For residues buried immediately or soon after abandonment, moving water is the primary potential agency of dispersal. For residues that have never been sealed in sediment, the forces of gravity, frost, and wind can also contribute to dispersal over longer periods of time.

The greatest dispersal hazard generally coincides in time with site burial and tends to be a function of the net energy crossing the site surface. Moving water can exert its force in the form of turbulent channel discharge, which might scatter lithic artifacts that had been abandoned on a gravel bar or sandbar during the low-water season (Figure 7-1). Or its energy might be expended as a surge of water breaking through a low point on a channel levee to form a sand splay on the interior margin of a floodplain, or the gentle spreading of muddy

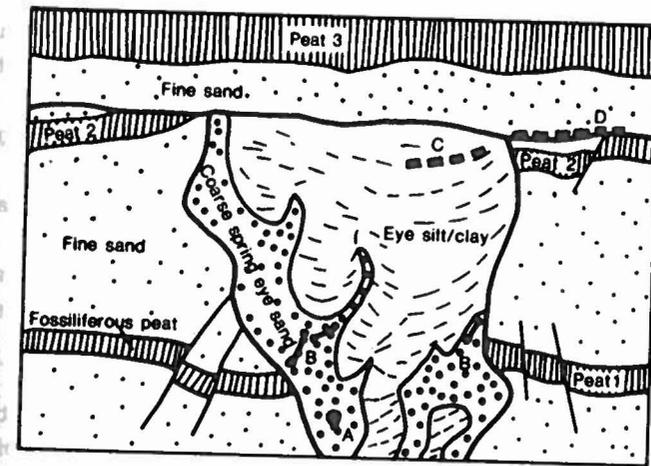


Figure 7-2. Disruption and dispersal of fossils and bones by eruption of artesian spring vent. A: Human fossil brought up from unexposed basal bed. B: Fossils reworked from peat 1 by eruption. C: Surface artifacts from top of peat 2 redeposited in spring-eye silts. D: Surface artifacts on peat 2 dispersed by flushing.

waters over a wide floodplain, leaving an increment of silt or clay. Particularly ideal are the low-energy conditions in floodplain backswamps and lakes. Springs usually provide low-energy sedimentation opportunities, but some deep-seated aquifers are prone to periodic explosions of energy as spring vents erupt and create havoc in related beds, leading to redeposition and dispersal (Figure 7-2) (Butzer, 1973a). Running water on slopes can also effect dispersal or burial or both. Surface runoff can range from a thin film of water moving through a grassy turf to a surge of water racing across a surface or being channeled into multiple rills. Very intensive rains, particularly in semiarid environments, can also lead to entrainment of large masses of silty material in mudflows that contain more sediment than water and that can mobilize even large rocks. Finally, seashores and lakeshores witness another potent form of aqueous energy.

The dispersal of artifacts can be illustrated by a test plot at Alexanderfontein, near Kimberley, South Africa, where Middle Stone Age lithics have been repeatedly moved by running water and incorporated into successive generations of colluvial sediments. Modern erosion, primarily by sheetwash, is undermining such surficial sediments, which form flat grassy surfaces that terminate abruptly 15 to 50 cm above bare spots with inclines of 1° to 5° that in turn run 5 m a more

origin but were the result of soil-frost sorting: On slopes of  $2^\circ$  to  $5^\circ$ , such rings were circular, with internal diameters increasing with the size of the stones; at inclinations of  $5^\circ$  to  $10^\circ$ , the rings were stretched into ellipsoidal garlands or rock caused by downslope movement; on gradients steeper than  $10^\circ$ , the garlands were torn apart by solifluction into stone stripes (perpendicular to the contours) or scatters in which individual pebbles either pointed downhill or were parallel to the contours (Figure 7-4). As a result of soil frost, the archaeological materials of this particular level were rearranged, although still in basic association (partial dispersal), on  $2^\circ$  to  $5^\circ$  grades, but they were effectively dispersed on slopes steeper than  $8^\circ$ .

Eolian influences on dispersal are particularly noticeable in blowouts (i.e., saucer-shaped depressions deflated in older sands). Artifacts exposed by removal of underlying sand are commonly perched on the slopes of such blowouts, at  $5^\circ$  to  $15^\circ$ , where they are highly susceptible to rainwash. Eventually, a once-dispersed scatter of artifacts can become concentrated on the floor of the blowout, simulating a primary cluster (Figure 7-5).

The geomorphic agents most relevant for dispersal have been described in Chapter 4 and elsewhere (Butzer, 1976a).

#### Postdepositional disturbance

*Sealed sites* can be described as archaeological materials within a sediment matrix (i.e., geologically in situ). Such occurrences contrast with surface sites, in which cultural residues are exposed on the surface (because of lack of sediment) due to matrix erosion from sealed materials or to exposure of sealed materials by disturbance processes. Many sites within the A horizon of a soil should be regarded as surface sites (Lewarch and O'Brien, 1981) when they have been downmixed into the soil by plowing or earthworm activity.

Disturbance is a concept useful to describe the rearrangement of sealed sites in place. Disturbance is here defined as a primarily vertical movement of buried aggregates, variably affecting particles of different mass, shape, and material, leading to changes in inclination, orientation, and vertical or horizontal position that distort or eliminate the original three-dimensional relationships. Such disturbance can be partial or complete, and it can be physiogenic, due to mechanical processes, or biogenic, due to biological processes.

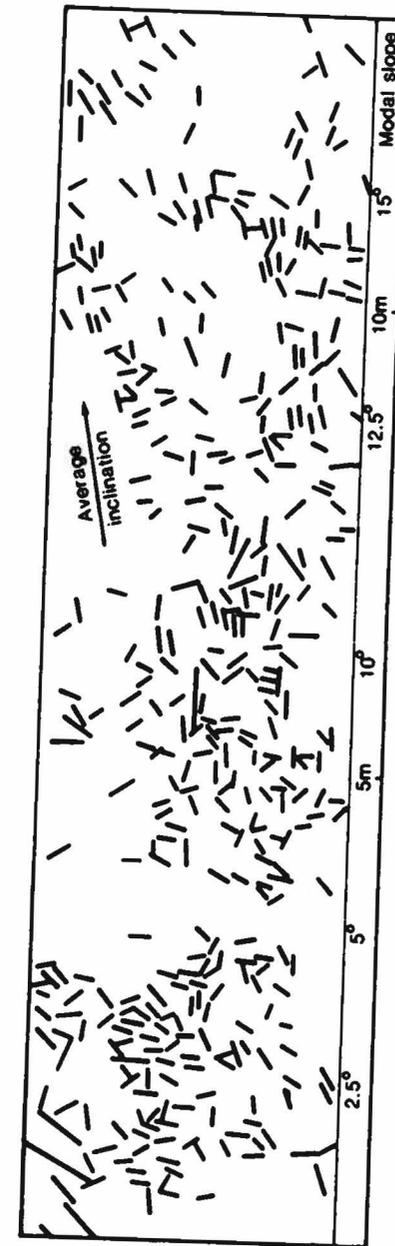


Figure 7-4. Orientation of rocks (> 10 cm major axis) according to slope. Plan view of the lowest archaeological levels, Acheulian site of Torralba, Spain (1,100 m) (composite, not to scale, and generalized). Mid-Pleistocene soil frosts arranged stones into rings on level ground and garlands on intermediate slopes, with diffuse downslope orientation on steeper gradients.

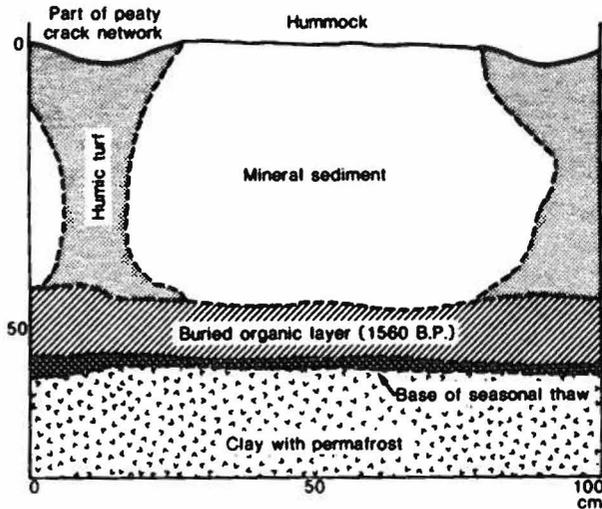


Figure 7-7. Substrate at the Engigstciak site, Yukon Territory, Canada. Artifacts and bones are found in the buried soil and in the peaty crack networks. They are probably derived from convectional movements related to seasonal freezing and thawing, as well as a rolling-under movement whereby slow solifluction on gentle slopes allowed segments of surface soil to slip between and under blocks of frost-segregated mineral sediment. Modified from Mackay et al. (1961:Figure 5).

slopes or through frost-favored viscous soil sludging (solifluction). Creep and solifluction in temperate environments integrate with colluvial processes to produce slope wash, with "dry" downslope shifting of cliff-base rubble and with "wet" viscous mass movements such as mudflows, earthflows, and landslips (see Chapter 4). The sum total of such processes can lead to partial or complete disturbance in the horizontal dimension and, near the bases of hillsides, can produce multiple colluvial horizons that may even superpose archaeological materials in reversed vertical sequence (Figure 7-8).

**Clay and salt dynamics.** In warm environments with alternating wet and dry seasons, abundant expandable clays (montmorillonite or smectite) can produce effects as dramatic as those of frost. Such clays swell when wet and contract when dry, with the result that rocks and artifacts are mixed laterally and pushed upward by selective swelling adjacent to solid objects. Eventually, one or more subsurface archaeological horizons can be rearranged and ultimately transported up to the surface, where they will simulate a surface site. During the dry season, de-

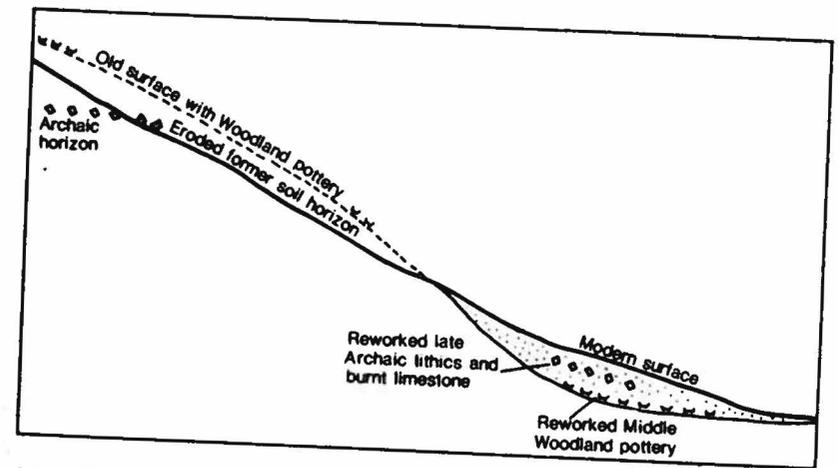


Figure 7-8. Hypothetical erosion of Archaic site, leading to downslope superpositioning of older Archaic occupation materials over younger Woodland pottery.

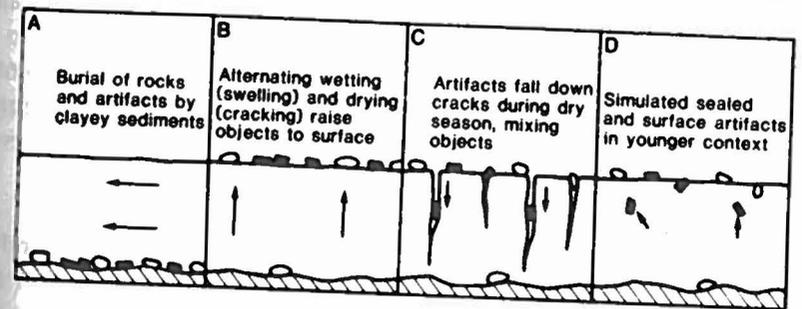


Figure 7-9. Artifact mobility in expandable clays.

hydration cracks commonly form in such soils, and artifacts at the surface can tumble 10 cm to 1.5 m down such fissures, providing a potent mixing mechanism (Figure 7-9). In very arid environments, the top 20 to 50 cm of relatively fine soil also respond to occasional wetting by expelling air from voids as they fill with water; this tends, together with swelling of any expandable clays, to push up larger aggregates, which gradually accumulate at the surface. Two horizons can be created out of what was originally one subsoil horizon (Figure 7-10) (Butzer and Hansen, 1968:179). The wetting and drying of soil salts can produce similar effects in deserts, because the salts crystallize and expand while drying out. Wetting of clayey soils also facilitates human trampling, and Stockton (1973) has shown that under such conditions in a cave, small objects can move upward while larger ones move



and phosphate values will eventually be changed, distorted, or otherwise rendered meaningless. For example, organic matter, potassium and nitrogen are gradually destroyed or flushed out of the horizon, whereas phosphates may switch from soluble to fixed forms or may migrate down into lower subsoil horizons. Consequently, the preservation of such key indicators in a warm and wet, but aerated, microenvironment is time-dependent, and their values may be reduced to the level of background readings after several millennia. Similarly, anomalously high phosphate values at 50 to 100 cm in the subsoil may record a surface occupation (Eidt, 1973, 1977), possibly destroyed by plowing, rather than occupation levels at depth, because phosphorus is readily leached into lower horizons. Alternating cycles of solution, mobilization, and precipitation of soil compounds also allow for possible mineral replacement or accretion, a critical factor in fossilization of bone and botanical remains (see Chapters 10 and 11).

*Mineralizing solutions.* The presence of lime, soluble iron, mobile (colloidal) silica, and available phosphates favors concentration of such compounds, or combinations thereof, in soil waters. This is particularly true in subsoil environments prone to alternate wetting and drying or alternate oxidizing and anaerobic conditions. Calcareous, ferruginous, siliceous, and apatite cements may form in the process, either in preexisting voids or as replacements for dissolved minerals. Such mineralization leads to compact mineral products of high density and great durability.

*Sodium salts.* Sodium chloride (halite) as well as various other salts and alkalies (pH of about 9 or more) are inimical to the preservation of organic components in oxidizing environments. Bone and botanical remains are corroded, broken apart, and eventually decomposed, whereas organomineral compounds are destroyed or broken up and regrouped as new minerals.

The actual course of events in organic preservation is difficult to predict, and presence or absence of organic materials generally is interpreted with the benefit of hindsight. However, such considerations are useful in devising excavation strategies and are particularly important in evaluating the possibilities of selective preservation. An appreciation of the chemical processes that affect organic residues is equally important during the course of excavation, because horizons often are identified ad hoc according to organic coloration, and decisions regarding e-mesh sieving and flotation for organic matter are made on the

basis of the macroscopic residues encountered. Apparent deformations within a stratified sequence may be the result of oxidation and disappearance of organic materials, which can constitute almost 100% of some original bulk residues, generally characterized by limited compaction and exceptionally low densities. White mineral ash must be distinguished from partly combusted carbonized material, and from oxidized and partly vitrified reddish fire-contact laminae, in the process of distinguishing true hearth complexes from amorphous organic residues (see Chapter 6). Finally, chemical alteration, oxidation or humification, and related structural changes may be linked to soil or other weathering horizons that terminate or interrupt an occupation sequence (Dimbleby and Bradley, 1975; Liebowitz and Folk, 1980). These points serve to draw attention to no more than a selection of possible avenues for interpretation of the geobiochemical features of abandoned sites.

Particularly informative examples of chemical and other analyses of organic residues have been provided by Cook and Treganza (1950), Cook and Heizer (1965), Davidson (1973), Hassan and Lubell (1975), and Hall and Kenward (1980). A broader systematic framework within which to use chemical data as indicators of microspatial patterning activities has been outlined by Sjöberg (1982).

#### Site destruction and artifact dispersal

The history of an abandoned site is a function of human, biogenic, and physiogenic agencies acting directly on or within the site, as well as peripheral geomorphic processes that condition or accelerate its attrition. For example, suppose a lithic workshop on a riverine gravel bar is partly dispersed by a surge of torrential discharge, and its remnants are buried under thick gravels and sands; the abandoned irrigation canal is clogged with silt and obscured by drifting sands; the pillaged villa is burned to the ground and gradually covered with a spread of hillwash.

More complex is the metamorphosis of a prominent village mound not submerged under the sprawling foundations of one or more later cities. The interactions of the potential forces that work to level abandoned occupation mounds (see Chapter 6) can be outlined as follows (Figure 7-15):

1. *Compaction and weathering.* Gravity compaction and filling of the remaining voids, by microcollapse and small-scale subsoil water transport, will increase bulk density at the price of reduction in relief.

is also influenced by mound relief and by the type and effectiveness of vertical mixing agents. These findings, both deductive and inductive have profound implications for surface prospecting and archaeological testing on mounds. They also suggest a need for caution in predicting subsurface distributions from surface occurrences (Redman and Watson, 1970; Binford, 1972).

**Environmental modification of archaeological residues**

"The archaeological record at a site is a static, three-dimensional structure of materials existing in the present. The remains in this site have undergone successive transformations from the time they once participated in a behavioral system to the time they are observed by the archaeologist" (Schiffer 1975:838). As argued by Schiffer and as explicated here, two different sets of processes are involved in these transformations: (a) cultural activities that remove the residual materials from their original behavioral context into archaeological context and (b) environmental factors that modify these cultural residues through erosion or burial, destruction or selective preservation, and vertical or horizontal disturbance. Schiffer considered the latter "n-transforms" (i.e., noncultural transformations) to be a set of experimental "laws" that explain and predict the interactions between culturally deposited materials and environmental variables. These n-transforms derive their systematic content from the natural sciences, but Schiffer argued that they should be studied and formulated by archaeologists.

Although I am sympathetic with this implicit plea that archaeologists begin to pay attention to such n-transforms, the issues of dispersal, disturbance, and chemical modification are evidently too complex to be diagnosed or appreciated by untrained excavators. This is the purview of the geo-archaeologist, and it can be argued that site formation and modification are the why and wherefore of archaeosedimentology.

Building on the content of this chapter, it is now possible to systematize the environmental transformation of archaeological residues by means of two graphic subsystems, one devoted to dispersal, burial, and disturbance (Figure 7-16, top), the second devoted to preservation of organic residues (Figure 7-16, bottom).

In the case of the mobilization flow diagram, various conditions of dispersal, burial, and/or disturbance produce surface or sealed sites that can be primary, semiprimary, or secondary. These terms require specific definition from an environmental perspective: A *primary site*

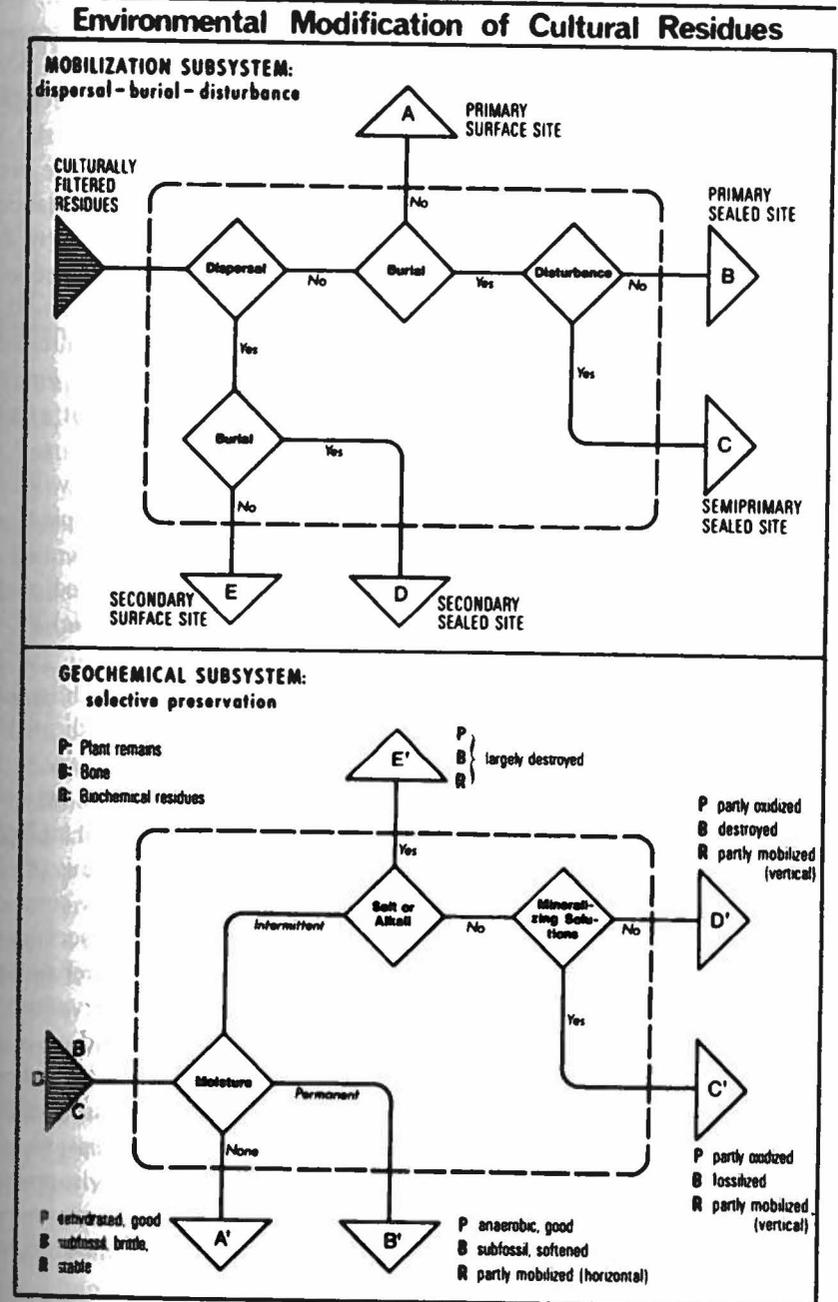


Figure 7-16. Systemic representation for environmental modification of archaeological residues. For key to symbols, see Figure 2-1.