In the early 1970s, two University of Arizona graduate students and a University of Arizona junior faculty member founded “behavioral archaeology.” Behavioral archaeology was formulated as a new approach to investigating people-material interactions in all times and places (Reid 1995; Reid et al. 1974; Reid et al. 1975; Schiffer 1975, 1999). Since that time, behavioral archaeologists have made important advances in the study of prehistory, history, social change, technology, and communication (LaMotta 2001; LaMotta and Schiffer 2001; Reid and Whittlesey 1987 1997, 1999; Schiffer 1988, 1996, 2002; Schiffer and Miller 1999; Schiffer and Skibo 1987, 1997; Walker 1999; Walker et al. 2000; Zedeño and Stoffle 2003; Zedeño 2000). One major focus of behavioral archaeology has been the study of formation processes (Binford 1979; Reid 1985; Schiffer 1983, 1987; Shott 1998, 2006). As an essential component of behavioral archaeology—not its totality—the conceptual place of formation processes in landscape archaeology is the focus of this chapter.

As a result of an emphasis on formation processes and the success of behavioral approaches, behavioral archaeology is sometimes inaccurately equated with the study of formation processes (see Shaw and Jameson 1999: 113). A recent compilation of important contributions to formation theory can be found in Shott (2006). As formulated by behavioral archaeologists, the study of formation processes includes investigation of both environmental and cultural formation processes. Cultural formation processes include reuse, discard, reclamation, and cultural disturbance. Examples of specific cultural formation processes are lateral cycling, secondary refuse disposal, scavenging, and trampling. Environmental formation processes include deterioration, decay, environmental disturbance processes, and earth surface processes, such as patination, fungal decay, cryoturbation, and volcanism (Schiffer 1987).

A misconception in archaeology is the use of “taphonomy” as a synonym for “formation processes.” Taphonomy is “the study of the processes . . . that affect animal and plant remains as they become fossilized” (Merriam Webster’s Collegiate Dictionary, 10th edition). When used appropriately, “taphonomy” is not a synonym for “formation processes” but a small subset of formation processes having to do specifically with the transformation of organisms from the biosphere to the lithosphere.

**Formation Processes of the Archaeological Record**

In *Formation Processes of the Archaeological Record*, Schiffer (1987) presented a behavioral
framework for understanding the formation of artifacts, deposits, and sites and brought together in one volume much of what was known about how the archaeological record is formed. Formation Processes was a contribution relevant at every level of archaeological investigation, from the design of surveys to the collection, analysis, interpretation, and modeling of data. Schiffer is careful to point out, however, that Formation Processes was only an introduction to the study and urged the reader to consult other sources. Most important, Schiffer stressed that archaeologists need to incorporate understandings of formation processes at every level of archaeological inference. The study of formation processes involves not only the identification of potential transformations of the archaeological record but also continuous evaluation of potential relationships to systemic behaviors and the effects of formation processes on specific artifacts, deposits, and sites.

Since Formation Processes was published, investigations of formation processes have contributed to many different kinds of archaeological inquiry. Formation processes are fundamental to the building of middle-range theory and the construction of behaviorally and archaeologically meaningful inference. By informing on how the archaeological record is formed, formation process studies are crucial to learning about people-material interactions. As Schiffer (1987: xviii) puts it, “the cultural past is knowable, but only when the nature of the evidence is understood.”

Formation Processes in Landscape Archaeology

Formation processes have traditionally been investigated at the level of artifacts, deposits, sites, and regions. Although investigation of formation processes at the level of landscapes is rare (Bintliff and Snodgrass 1988; Stafford 1995; Stafford and Hajic 1992), development of frameworks for modeling landscape formation processes is essential to the implementation of a scientific landscape archaeology. Recently, Heilen (2005) formulated a behavioral approach to landscape archaeology. Heilen’s (2005) framework is founded on one of the most fundamental distinctions in archaeology, the distinction between systemic context and archaeological context. Elements (people, tools, facilities, places) participating in a behavioral system are in systemic context. Artifactual materials no longer participating in systemic context, such as those recovered during the course of archaeological fieldwork, are in archaeological context.

in archaeological context to be reincorporated into systemic context (Schiffer 1972).

From a behavioral perspective, there are two kinds of landscapes: (1) archaeological landscapes and (2) systemic landscapes (Figure 58.1). Archaeological landscapes are arrays of archaeological materials—artifacts, features, deposits, and sites. Systemic landscapes are networks of people, places, materials, and activities connected through the exchange of matter, energy, and information (cf. Basso 1996; Bentley 2003; Bentley and Maschner 2003; Binford 1982; Buchanan 2002; Heilen 2005; Newman 2003; Schlanger 1992; Strogatz 2001; Thomas 2001; Tilley 1994; Watts 1999; Watts and Strogatz 1998; Whittlesey 1997; Wilkinson 2003; Zedeño 2000).

From a transformation perspective, archaeological landscapes and systemic landscapes are related but are not isomorphic structures. In the course of fieldwork and analysis, archaeologists routinely measure and record attributes of archaeological landscapes. The properties of systemic landscapes can only be inferred from the properties of archaeological landscapes through careful development and application of middle-range theory. Middle-range theory is a set of deductively or inductively established principles, corollaries, and material correlates that can be used to specify relationships between systemic processes and archaeological patterns. Middle-range theory includes principles of formation processes, such as c-transforms and n-transforms. All too often, archaeologists attempt to “read” systemic landscapes directly from archaeological landscapes (Heilen 2005).

Landscape Formation Processes and Scale

The issue of scale should be considered a central focus of landscape archaeology. In landscape

![Figure 58.1 A schematic diagram of relationships between discard, loss, abandonment, and reuse/recycling/reclamation in systemic and archaeological landscapes](image-url)
archaeology, scale can be understood in terms of spatial, temporal, and behavioral dimensions. In the analysis of archaeological landscapes, the most behaviorally meaningful scales are those that match the inferred scales of systemic landscapes under investigation.

**Spatial Scale**

Spatial scale can be defined by *extent* and *grain*. *Extent* refers to the absolute size of a study area or landscape. *Grain* refers to the absolute size of the smallest analytical spatial unit. Changes in grain or extent can cause changes in landscape metrics, some of which are predictable according to scaling relations (Figure 58.2). Incompatibilities and disagreements between landscape studies can result from incongruent spatial scales. Results of landscape studies conducted at incongruent spatial scales can be rendered comparable through the application of empirically or theoretically derived scaling relations (Ebert 1992; O’Neill et al. 1989; Turner and Gardner 1991; Turner et al. 2001; Wiens 1989; Wu 2004; Wu and Qi 2000).

Spatial scaling is an important component of landscape archaeology that has bearing on how landscapes form and how they are analyzed. Drawing upon ecological and ethnographic frames of reference, Heilen (2005) argues that the extent and grain of systemic landscapes depends on how organisms exchange matter, energy, and information with their environments (Chust et al. 2004; Ritchie 1998). The spatial scaling of human systemic landscapes is related to the specific ways in which human groups perceive and interact with their environments and can vary along economic, technological, and ecological dimensions (Heilen 2005; Heilen and Reid In press).

**Temporal Scale**

Temporal scale can be understood in terms of *span* and *interval*. Here, *span* refers to the absolute time frame in which relevant events or processes are understood to have occurred. *Interval* refers to the smallest resolvable temporal unit. The time depth of individual temporal units, such as a geological layer or archaeological feature deposit, can be highly variable. An archaeological interval often depends on processes that are independent of behavioral processes of archaeological interest (Dean 1978; McPherron et al. 2005; Ramsey 2003). An interval can be a geological layer or a deposit, depth range within a deposit, or a combination of temporal markers such as diagnostic artifacts, sedimentary facies, or chronometric age determinations that constrain the time dimension of archaeological manifestations. Understanding the relationships between time, archaeological pattern formation, and behavior is a central problem in archaeology and will continue to be so in landscape archaeology. For instance, despite compelling and informative ethnoarchaeological studies of land use and site formation, few observations on living landscape behaviors come anywhere close to approximating the interval of many archaeological deposits. Since many archaeological landscapes at least partly consist of surface archaeology, and many intervals are incongruous or ambiguous, controlling for time in landscape archaeology is a vexing problem. Establishing the sequencing or contemporaneity of events and processes especially, the temporal scale at which events or processes can be ascertained, is essential to assessing relationships among components of archaeological landscapes.


Figure 58.2 Examples of potential relationships between landscape metrics, such as diversity or fragmentation, and changes in grain or extent.
Behavioral Scale

Behavioral scale can be understood in terms of interactions, activities, and behavioral systems. Low-level behavioral scales are hierarchically nested within higher-level behavioral scales. Interaction scale refers to discrete mechanical, thermal, chemical, acoustic, or visual interactions between people and materials. Activity scale refers to discrete activities performed by individuals, households, and task groups. Activities consist of a finite number of interactions. Systemic scale refers to one or more behavioral systems. Behavioral systems are networks of activities (LaMotta and Schiffer 2001; Schiffer 1987).

A major focus of behavioral landscape archaeology is to investigate the topological structure of complex landscape networks. To understand landscape networks, we need to develop archaeologically relevant quantities that can be used to model networked exchanges, perhaps by simulating the interplay between simple interactions and activities. In this way, complex network structures and their resulting archaeological consequences can be modeled as the outcome of specific performances, strategies, and recipes for action (Heilen 2005).

Discussion

The archaeological record is the residual consequence of an enormous array of interacting natural and cultural processes occurring across a broad range of spatial, temporal, and behavioral scales. The archaeological record is created by behavior, refracted, or distorted by postdepositional processes. Major questions in the study of landscape formation processes include the following.

- How are we to understand the relationships among landscape patterns, formation processes, and behavior? Can we use broadly scaled environmental characteristics to understand broadly scaled archaeological patterns?

- How are we to understand the relationships between archaeological landscape patterns and landscape-level formation processes? Major questions in the study of landscape formation processes include the following.

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- How are we to understand the relationships among landscape patterns, formation processes, and behavior? Can we use broadly scaled environmental characteristics to understand broadly scaled archaeological patterns?
Do archaeological landscape patterns result from top-down or bottom-up processes? What are the relevant quantities for investigating archaeological landscape patterns and systemic landscape processes? How do these quantities relate to each other? What results from interactions between bottom-up and top-down landscape formation processes? (Brown and Witschey 2003; Brown et al. 2005; Corning 1998; Lansing 2003; Layton 2003; Turcotte and Rundle 2002; West et al. 1999).

Heilen (2005) advances the concept of landscape hierarchy in the study of landscape formation processes. Hierarchy theory specifies that higher-level landscape properties or processes guide or constrain lower-level properties or processes (Kotliar and Wiens 1990; O’Neill et al. 1989). Some broadly scaled archaeological landscape patterns may result from broadly scaled environmental or cultural processes (Binford 1979 and Snodgrass 1988). For instance, the availability of raw materials or the size and shape of major landscape features may exert high-level hierarchical controls over lower-level phenomena, such as the behavior of individuals or the distribution of species (Milewski and Diamond 2000). There are many earth surface processes that transform and distort patterning in archaeological deposits or even create distinct patterns independent of artifact depositing behaviors (Schiffer 1987). Consequently, fundamental properties of archaeological landscapes—such as the characteristics of artifact-bearing deposits—may be partly organized or biased according to broadly scaled environmental regimes or attributes.

Conversely, bottom-up processes involving the interplay of many simple interactions and activities could result in complex, broad-scale patterns. Simulation modeling is one potential approach to identifying kinds of archaeological patterns that could be generated through the repeated interplay of simple interactions and activities. An important task in landscape archaeology will be discovering how systemic processes and archaeological patterns are related across a wide range of scales.

Ultimately, investigation of landscape formation processes is crucial to understanding relationships between archaeological and systemic landscapes. After all, identifying important sources of variation in the archaeological record is key to inferring past behavior. Landscape formation processes must be investigated according to a framework that actively incorporates the multiple spatial, temporal, and behavioral scales involved in the formation of the archaeological record. We suggest that a behavioral framework is the most appropriate to understanding human landscape behavior in all times and places. In doing so, archaeologists are able to draw robust conclusions about landscapes of the past, present, and future.

References


Conclusions

Behavioral archaeologists have established that archaeological patterns are the product of numerous interacting formation processes. However, it is impossible to control for (or even identify) them all. Instead, archaeologists can only hope to focus their attention on formation processes that are...


