

Magnitude, Direction, and Interpretation: Formation Factors of Archaeological Assemblages

By

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### **Abstract**

Historically, archaeology has worked under the assumption that buried deposits are more valuable for archaeological inquiry, as they retain more of their original context. While better techniques have developed for dealing effectively with so called “lithic scatter” and other surface materials, large-scale changes have not occurred in the way that these materials are treated by the discipline as a whole. This is in part because the methodology concerning these materials is self-reinforcing; a differential valuation creates differential results, which in turn justify future differential valuations. Some basic concepts of physics, applied properly, demonstrate an effective way in which surface materials may be treated. But new techniques alone are inadequate; here, a critique of terminology and attitudes is presented as a motivation for change. Ultimately, such investigations must implicitly recognize the basic idea that the forces that act on artifacts, from the quarry to the trowel, are not destructive as much as they are formative.

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## **Chapter 1: The Surficial Record**

### ***Introduction***

A study of relevant archaeological literature shows that focus on, and application of, site formation processes is not necessarily done in an equitable manner, and that buried materials receive the bulk of the analytical attention. Surface sites, or so-called scatter, are often assumed to be simply disturbed materials. This attitude ignores the fact that nearly all archaeological materials are disturbed, as the definition applies, and that the differential potential of surface versus buried materials is the result of differential attention by archaeologists in the past and present.

A series of field collections in western Kansas provides a handy example. In 2004, a University of Kansas archaeological field school performed a surface collection of materials from the Smoky Folsom site in Eastern Colorado. No subsurface excavations were performed, and materials from the surface were collected from a plowzone context. Limited spatial data were recorded with collection areas defined by topography and landmarks in the field. These data were subsequently lost because of mixing during initial laboratory processing before analysis began.

Analysis of the Smoky Folsom materials began in 2005. Each artifact was catalogued and measured for size, material type was recorded, existence of a platform was noted, and the amount of dorsal surface cortex was recorded. A KU field school in 2006 revisited the Smoky Folsom site and performed a survey in the same location. This time, a total station was set up, and the spatial data for all of the collected materials were recorded.

The actual materials collected and their spatial data are not as important to this particular discussion as are the research questions that were raised during the course of the planning,

collection, and analysis of the materials. Of primary interest was the difference between the 2004 and 2006 Smokey Folsom surveys, namely the spatial data. The economics of work and time dictate that the collection of such data can be expensive. What set of standards and/or assumptions were at work in those differing years; and perhaps more importantly, since, in terms of the spatial data, the surveys took nearly opposite strategies, was either one of the surveys working against some accepted norm?

Those questions are partially discussed below, but as time passed a particular line of reasoning seemed to become more important. Archaeological fieldwork does not proceed from an unlimited source of funds or labor, and so prioritization is a fact of reality. Surveys and their components have a price attached and efficiency, the costs compared to the results, is important.

In the case of surface materials, was the 2004 survey at Smokey Folsom just practicing good economics?

This and related questions are discussed below, and the answer is “yes and no.” Yes, because a simple review of the history of surface materials shows that the cost/benefit ratio is quite low. No, because that valuation isn’t necessarily accurate.

This study contends that in the right context, with the right conceptual tools, surface materials can be treated in a way that greatly enhances their value to researchers in the field. This is achieved in large part by neutralizing agents that work against the perceived value of surface materials. Surface materials suffer from a historical bias, and that bias is reflexive. Certain analytical concepts, field strategies, and terminology serve to reinforce the idea that surface materials have inherently low value, and that low value serves as justification for what has been a historical bias.

### ***Surface Sites***

Surface sites and so-called artifact scatters are pervasive, and their presence is documented across the globe, either near excavated sites or localities, or as sites themselves. Their study, however, tends to be marginalized (Sullivan 1987; Runnels et al. 2003). This seems reasonable when one considers the lack of control available at a surface site, and the quality of information that can be gained from subsurface assemblages, especially if they are well separated or otherwise minimally disturbed. Activity that occurs on the surface, both environmental and cultural, has a greater capacity for disturbing surface artifact integrity than what occurs beneath it.

Still, archaeological sites begin as surface sites, and recorded surface sites outnumber subsurface sites worldwide (Ripley, 1998). They are also more at risk of immediate and continued disruption. If relevant information of adequate quality can be obtained from such scatter, if they are worth studying, then they should be studied. If unique information, or information that can be compared to subsurface assemblages can be obtained, then they definitely merit investigation.

### ***History and Thoughts about the Archaeological Record***

In 1863, in a letter to the Anthropological Society of Paris, Broca (1863:308-309) espouses the need for a solid understanding of site formation processes in establishing “irrefutable proofs of the antiquity of man.” As the antiquity of man was in some general question at the time, Broca not only points to a site where human bones were found in the same context as Pleistocene animals, but also attempts to explain the processes that might have shaped how that concurrence

came to be, effectively dismissing ways in which modern humans bones could have come to be located at the site.

In order to remove these prejudices it was not sufficient to show that human remains are frequently intermixed with the bones of so-called antediluvian animals; for it was objected that man might have entered the osseous caverns long after the extinction of these animals; that ferocious beasts, subterranean currents might subsequently have imported fragments of his skeleton, or that they might have been introduced by crevices; and when it was shown that, applied to some special cases, all these interpretations were false, there remained yet that intangible objection, that some unknown cause may have disturbed the soil of the caverns. A question thus put could only be solved by a different mode of investigation. It was now requisite to search for the traces of man no longer in caverns, of which the evidence was rejected, nor in the osseous breccia, but in the quaternary formations, in situ, in beds which neither were nor could have been disturbed, since they have preserved their relations with the superficial and lower strata.

It was immediately essential to the field of archaeology to identify how agents of change and disturbance patterned the archaeological record into present configurations. Indeed, spatial patterning observations of one sort or another were employed in the field consistently. To use a few examples, Fowke (1892:74) used the arrangement of stones over a burial site to infer which Native American tribe the burials belonged to. Gilder (1909:78-79) recognized an antler as a percussion-flaking instrument because of its proximity to “[a] scattered...peck of small flint flakes and chips.” McCown (1941:207), discussing the antiquity of man once again, this time in the Americas, pointed out several problems and inconsistencies with human remains that appeared to be positioned in context with Pleistocene-age geologic features. Reliance on, and dedication to, high quality spatial information and interpretation has continued into the present day. Binford and other processual archaeologists succeeded in transforming the study of site formation processes into a far more rigorous discipline through the 1960s and 1970s, and the growth of geoarchaeology in the 1980s and 1990s intensified this trend. Some specific avenues site formation process studies have taken are discussed in Chapter 4.

Perhaps it is this cognizance of site formation that lead to the comparatively late start for materials found strictly on the surface, as the lack of modern statistical controls and investigative technologies and methods could have made surface materials seem truly randomized. Early archaeological excavation reports often did not mention any materials that were not excavated (Miller 1886). Discussion of objects on the surface was constrained to topography reports and macro and semi-permanent features, such as standing walls, grave markers, etc. (Brown 1886). The economical nature of collecting surface materials, both because they are relatively easy to map and collect, and because they may serve as markers for subsurface deposits, was increasingly recognized through the 1960s and 1970s (Fish 1978; Mayer-Oaks 1966; Redman & Watson 1970). Investigations of surface materials for their own sake did not become prominent or robust until the 1980s and 1990s, and it is probably not coincidental that this is the time period in which geoarchaeology, ethnoarchaeology, and taphonomic studies started to gain similar prominence and in which scientifically rigid studies of debitage began to appear and multiply (Hassan 1979; Sullivan and Rozen 1985; Yellen 1977).

Although the formal practice of archaeology is not more than a couple hundred years old, the informal practice of procuring cultural materials goes back much further. Loewen (1995: 91) provides journal entries of an early 17<sup>th</sup> Century Massachusetts colonist.

The next morning, we found a place like a grave. We decided to dig it up. We found first a mat, and under that a fine bow... We also found bowls, trays, dishes, and things like that. We took several of the prettiest things to carry away with us, and covered the body up again.

Federal protection of antiquities began in earnest in 1906, with the passage of the American Antiquities Act, and the evolution of the legalities of archaeology in America roughly mirrors the

increasing focus of archaeology itself on the need for rigidly scientific investigation, good control over data, and cultural ownership of archaeological materials.

...any person who shall appropriate, excavate, injure, or destroy any historic or prehistoric ruin or monument, or any object of antiquity, situated on lands owned or controlled by the Government of the United States, without the permission of the Secretary of the Department of the Government having jurisdiction over the lands on which said antiquities are situated, shall, upon conviction, be fined in a sum of not more than five hundred dollars or be imprisoned for a period of not more than ninety days, or shall suffer both fine and imprisonment...

This is the act's main provision, according to the National Park Service (NPS 2005). The act also establishes the issuance of permits for excavation of archaeological materials.

The Historic Sites Act of 1935 had potentially larger implications, as it established national policy toward the preservation of "...significant historic or prehistoric sites for the inspiration and benefit of the people of the United States" (MNSU 2003). The National Park Service, under the Department of the Interior, was charged with gathering information on likely sites, as well as preparing a survey of existing sites of this nature. The department was given authority to actually reconstruct sites for purposes of preservation (Renfrew and Bahn 2004:560).

The next major piece of legislation was the National Historic Preservation Act of 1966. This act took the national policy of the Historic Sites act one step further, stating, "...the spirit and direction of the Nation are founded upon and reflected in its historic heritage" (NPS 2005). The act established a National Register of Historic places, and provided assistance for state and local governments, Indian tribes, and Native Hawaiian organizations in their own preservation programs (Renfrew and Bahn 2004:560). As a complement to this act, the Department of Transportation Act of 1966 stated that the Secretary of Transportation could approve no project that would use land on the National Register of Historic Places, with a few minor exceptions (Renfrew and Bahn 2004:560). The Archaeological and Historic Preservation Act of 1974

authorized federal agencies to provide funds for the preservation and recovery of archaeological or historic resources when endangered by federal projects (Renfrew and Bahn 2004: 561). The Archaeological Resources Protection Act of 1979 gave additional protection to sites located on federal and Native American lands (Renfrew and Bahn 2004:561)

Finally, the Native American Graves Protection and Repatriation Act, passed in 1990, provided a process for museums and Federal agencies to return Native American cultural materials, specifically human remains, funerary objects, sacred objects, and objects of cultural patrimony, to lineal descendants, culturally affiliated Indian tribes, and Native Hawaiian organizations (Renfrew and Bahn 2004:561). Any material of this type, which can be traced to any of the parties described, is to be repatriated to that party. In addition to the Federal law, lower levels of government have been moved to enact legislation protecting local archaeological materials (King 1968).

The main limitation of all of these acts is that they provide no protection for materials located on privately owned land (Renfrew and Bahn 2004:561). A main advantage is that these pieces of legislation provide the potential for archaeological site study preservation, and the interpretation of what sites and kinds of sites are significant is generally depended on the archaeologists.

In a general study of the history of archaeology, the placement of different assemblages or the details of particular sites might not be critical, but the more specific histories of surface assemblages and subsurface excavations clearly diverge. Shott (1995: 475) succinctly states “All archaeologists know that the material record is the complex product of many depositional and post-depositional processes. As the discipline has lost its methodological innocence in the past 30 years, we have begun to grapple with the complexities in ways that can be unsettling.” As will be discussed below, part of that loss of methodological innocence included differential treatment

and, perhaps, valuation of surface versus subsurface materials, as the dirt sitting above an artifact became a measure of the amount of statistical control available that could be maintained when investigating its history.

Although progress concerning surface and subsurface sites may have diverged, it is often the case that research or progress made is applicable to both (even if part of that divergence concerns actually applying it). Concerning site formation processes, Wood and Johnson (1978) give a comprehensive description of fanalturbation, aquaturbation, crystalurbation, aeroturbation, pedoturbation, cryoturbation, graviturbation, and several otherurbation processes, and discuss the degree to which naturally created intrasite patterning may contribute to archaeological interpretation of cultural materials. Aside from general site formation processes, the study of surface materials in and of themselves does not appear to become a prominent feature until the 1980s, and truly begins to expand in the 1990s.

### ***Looking For Scatter***

Ammerman and Feldman (1978:734) write, “The surface of a site is the one part of a site that the archaeologist has direct and also economical access to.” *Direct* and *economical* generally are two qualities highly conducive to investigation. The surface of a site is also the first part of a site to be disturbed by virtually any human activity, including excavation. Moreover, there has long been a strong suspicion of a correlation between surface and subsurface artifacts, with some amount of testing to assess this relationship (Redman and Watson 1970; Ammerman and Feldman 1978; Baker 1978; Whalen 1990; Downum and Brown 1998; Simmons 1998).

Because artifact provenience on the surface can be destroyed by excavation, and since nothing else can be done but leave them for further disturbance, it seems important for the study

of surface scatters that effective survey and collection be done. This essentially involves actually documenting as many surface artifacts as possible in the time allotted. The literature (Baker 1978; Wandsnider and Camilli 1992) indicates that artifact size is the largest variable determining what gets picked up and what doesn't, though Baker and Wandsnider give differing interpretations as to why.

After investigations at four sites in different topographies, Baker identifies a "size effect," where there is a statistically significant difference between the frequencies of large artifacts collected versus the frequency of small artifacts collected. He surmises that at sites where sediment deposition and burial of artifacts is not swift, subsequent human occupants may find and utilize the large artifacts that remain partially buried and visible, but not notice the smaller, buried lithics. In this way, larger artifacts preferentially remain at a higher level in the profile. Baker also hypothesizes that, where populations were mobile and/or settlements temporary, portability of items may have been important. Large artifacts would have been left behind in favor of smaller, lighter pieces.

While Baker's research does show a correlation to size, Wandsnider and Camilli may give a more supportable hypothesis on the matter (Baker also acknowledges the need for further research). While the authors do note that size is the largest factor, they include size with other variables under the umbrella term "obtrusiveness." The authors conducted surveys (two different groups passing each area) of several sites in Wyoming, and additionally conducted seeding experiments, where a number of "artifacts" (colored nails and washers) were planted in sites prior to survey. Wandsnider and Camilli came to the conclusion that among small artifacts, ground cover, the color of the artifacts in comparison to the surrounding sediment, and the actual pace (ground speed) of the surveyor were significant variables in the frequency of collection.

Only when artifact size was large did these factors become insignificant. In other words, the “size effect” can be explained simply by noting that large artifacts are easy to see, and small artifacts are not. It was also determined that among surface sites of high density, the majority of the artifacts were found on the second pass. Furthermore, at a transect spacing of 15 meters, the average surveyor can expect to *intersect* only 6-13% of the artifacts in a given area, regardless of whether he or she notices them, assuming a random distribution.

The authors note, “Clearly, the perception that the archaeological record consists of rare ‘hot spots’ in high artifact density and just a few dispersed artifacts is heavily reinforced by traditional discovery techniques” (Wandsnider & Camilli 1992:182). It seems that bias might weigh heavily on research of surface artifacts, but this is not to say that no other processes play a significant role.

### ***Disturbing the Record***

Human activity plays a large role in what happens to exposed artifacts. Often times, our only knowledge of archaeological sites comes from materials that were not only exposed, but turned over, moved, or otherwise turbated. But the disturbance of materials can often be quantified to determine its effect. Investigation of plow zone artifacts, for instance, suggests that plowing does not necessarily laterally displace artifacts as severely as one might think (Roper 1976) (Odell and Cowan 1987). Similar research was done concerning human trampling, which yielded evidence of predictable distributions. (Gifford-Gonzalez et al. 1995). Collectors can also impact the record, though it is theoretically possible to account for their activity (Downum and Brown 1998).

As lithics tend to be out of human possession longer than they are in it, environmental processes are a likely culprit to effect significant post-depositional change in the record. Butzer (1980:418) calls the environment a “dynamic factor in the analysis of archaeological context.” Animal burrowing, water infiltration, and other turbation processes can all affect the record before it is uncovered. Once uncovered, the same processes that drive sediment erosion and deposition are free to work on artifacts. Once on the surface, vertical spatial information is severely compromised, if not eliminated. At multi-component surface sites, examining the soil profile is potentially not an option. However, lithic assemblages that were uncovered and reburied in a more shallow context by natural processes have been documented, and subsequent vertical displacement after that reburial provided evidence, in one case, of what and how many different components were present at the site (Surovell et al. 2005). Hill slope gradient strongly correlates with lateral displacement of artifacts in arid conditions (Fanning and Holdaway 2001). It is apparently not the primary agent in subarctic conditions, being secondary to cryo-action and wind (Bowers et al. 1983). In the latter case, some artifacts were observed to move upslope. Hilton (2003: 168, 170), who references Bowers, et al. (1983), notes the effect of wind on surface deposits and also credits solifluction.

What might be surprising is the difference between environmental disturbance on surface versus subsurface artifacts. While surface artifacts are exposed to the elements, they are not necessarily displaced or disturbed more than their subsurface counterparts. In an investigation of Hohokam sites in the American Southwest, qualities such as artifact inclination (and paint on ceramic sherds) were preserved on the surface (Downum and Brown 1998). An investigation of surface artifacts in Wyoming, including core samples and utilizing geoarchaeological methods, was able to reconstruct the Paleoenvironmental changes that occurred at Glacial Lake Yahara

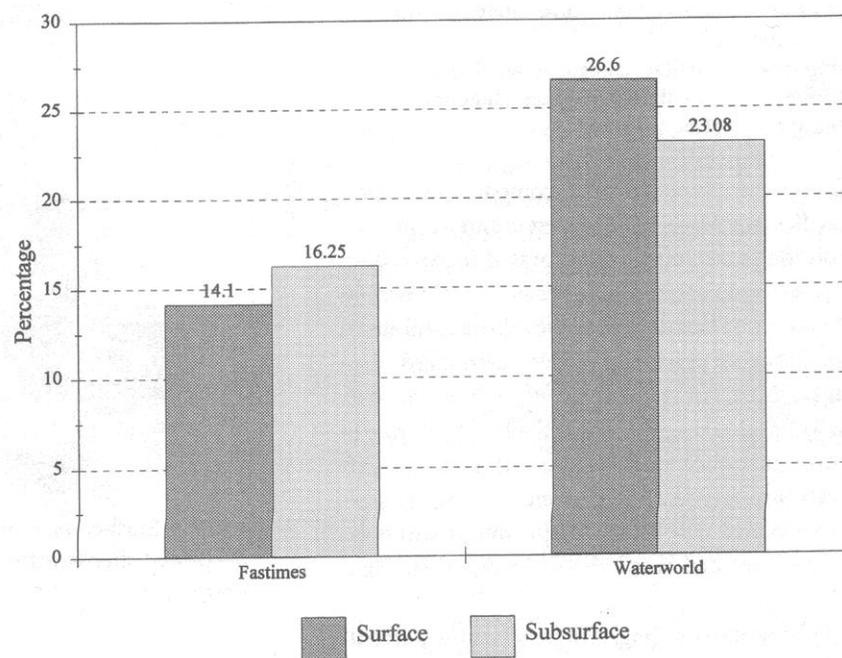
over the course of the Holocene (Ripley 1998). Surface artifacts were used as “semi-quantitative age indicators,” and they agreed well enough with the geomorphic evidence gathered. In this case, slope angles were low, and so evidence for lateral displacement of the artifacts was also low.

Wood and Johnson (1978:369) conclude.

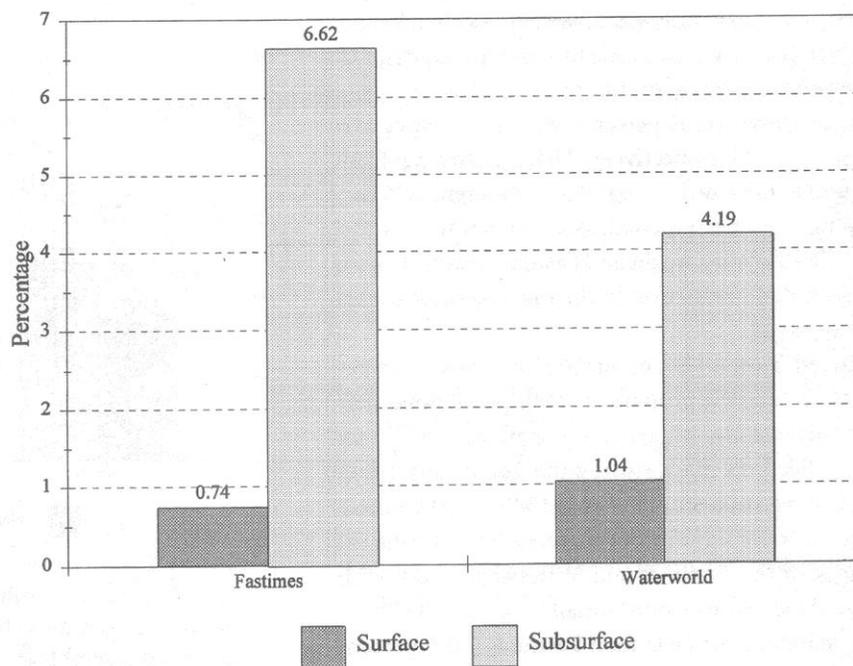
Soils are not static bodies – they are dynamic, open systems in which numerous processes operate to pedoturbate profiles, and to move objects vertically and horizontally within them. These processes may operate singly or in combination in additive or subtractive fashion, in all environments and at all latitudes... Cultural materials, then, may sink into the soil, may be concentrated into layers at depth, may be reoriented within the soil, may be thrust to the surface, or may be moved horizontally on a plane or downslope. Various processual permutations can be envisioned. The result can be a spurious association of artifacts, with concomitant distortion in interpretation. Before we proceed to make interpretations that depend on artifacts being in their original position, we must demonstrate that they were not moved by one or another form of soil mixing, or qualify our interpretations according to the types of soil mixing possible in a given soil. In sum, we must pay more attention to the dynamic nature of the medium in which we dig.

### ***Recovery and Interpretation***

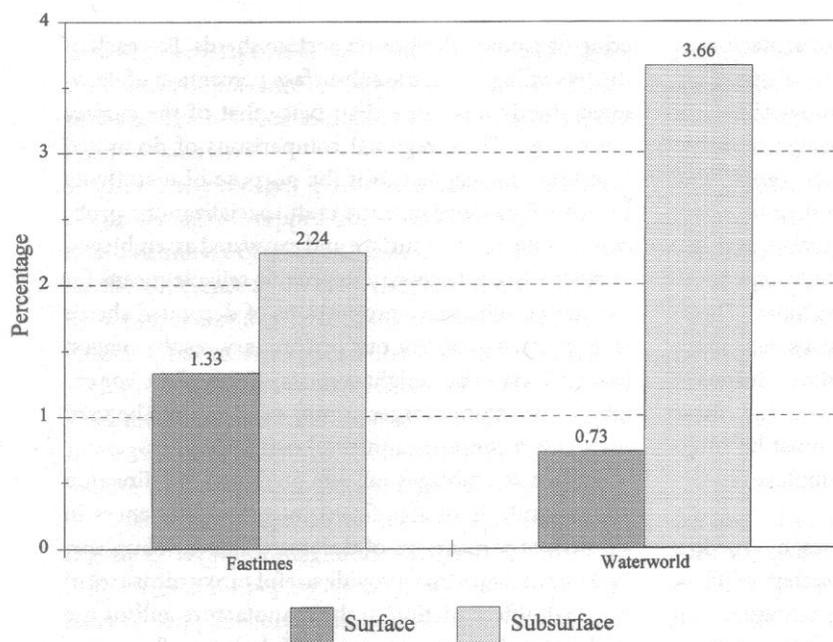
As stated, one main focus of research concerning lithic scatters concerns determining if a correlation exists between artifacts on the surface and those beneath it. Similarly, researchers usually need to know if the surface collection is truly representative of the assemblage diversity. These issues lose some importance in light of other questions when a site consists of only surface artifacts. Downum and Brown (1998) attempted to quantify potential surface to subsurface correlations among particular types of artifacts. Looking at two different Hohokam sites in Arizona, they compared percentages of chipped stone artifacts, formal tools, and ground stone artifacts.



**Figure 1: Surface vs. subsurface percentages of chipped stone artifacts within total artifact assemblage (modified from Downum and Brown 1998: Figure 7.8)**



**Figure 2: Surface vs. subsurface percentages of formal chipped-stone tools, within total assemblage of chipped stone artifacts (modified from Downum and Brown 1998: Figure 7.9)**



**Figure 3: Surface vs. subsurface percentages of ground stone artifacts within assemblage of all stone artifacts (modified from Downum and Brown 1998: Figure 7.10)**

A correlation emerges from figures 1, 2 and 3 concerning chipped stone in general, which indicates that this class of surface artifact is a good indicator of what lies beneath the surface. Formal tools and ground stone artifacts differed significantly. While these results appear to contradict the aforementioned matter of obtrusiveness, the surface collection procedures at the Hohokam sites were relatively intense, and focused on a pre-determined area for study and excavation. Instead, these results potentially highlight the activity of collectors visiting these sites and preferentially selecting formal tools over other artifacts. Alternatively, they possibly indicate the distribution of different activity areas at these sites, as much of the material came from midden contexts, where more debitage might be expected.

Simmons (1998) highlights several cases in which the surface record was not indicative of the subsurface record and offers a warning. "...Small sites can perhaps be the most deceptive when interpreting surface remains." Moreover, Simmons contends that study of surface data should not be overlooked, but belongs more suitably in the realm of "coarse grained" explanation. To be fair, the three examples Simmons uses involve instances where the subsurface assemblage was exceedingly useful while the surface assemblage was either very faint or nonexistent. He does not appear to offer analyses of sites where a strong surface assemblage either matches or does not match the subsurface assemblage. Still, sites do exist where there is only a subsurface signal. Similarly, sites exist where there is only evidence on the surface.

Tainter (1979) remarks, "...in many areas the majority of archaeological remains consist of light, ephemeral scatters of non-architectural debris." Such sites, if they are to be evaluated, must be evaluated on their own merits. They may also provide our only archaeological record in some localities.

### ***Conclusions***

Two thoughts stand out when reviewing the literature concerning surface artifacts. Runnels et al. (2003: 135) write, "While it has long been recognized that some sites may be strictly confined to the present surface with no relationship to a stratified deposit, such sites are often dismissed as of relatively little value for interpreting the past."

In analyses of post-depositional processes, it seems that pre-depositional processes do not always come to the forefront of discussion. In comparative terms, buried artifacts are assumed to retain more of their original context. In more absolute terms, is the difference always significant? Seemingly mundane details, such as whether or not the original knapper was standing or sitting,

can potentially affect distribution patterns of artifacts (Newcomer and Sieveking 1980). As stated earlier, artifacts that are currently buried have not necessarily remained buried since their initial deposition. Nearly every paper on the matter of surface scatter reviewed here, from the mid-1970s to the present, begins with the remark that these sites are often ignored, and ends with the remark that this reality is unwarranted.

Even in plow zones, surface artifacts can retain enough integrity to pique the interests of collectors and surveyors alike. In other regions, surface scatters can yield information about settlement patterns, activity areas, and the paleoenvironment. Still, Butzer (1980:417-418) warns, “Perhaps the environment is taken for granted. Certainly the environment is specified as a variable in most processual equations, but in all too many cases the equation is then resolved by treating that variable as a constant.”

Fanning and Holdaway (2001: 667) write, “It is now almost two decades since Dunnell and Dancey (1983) made the observation that all archaeological sites now buried were once surface scatters.” Dunnell (1990: 592) himself writes, “...it is disturbing that [the authors] draw upon the old saw that surface artifacts are valuable because they correlate with subsurface distributions to justify the value of the plow-zone record. There is no *necessary* relation between the two...the value of the plow-zone record is in no way dependent on such a relation...employing it in a context of justification only tends to reinforce the notion that the plowed record is redundant with the subsurface record.”

## Chapter 2: The Superficial Record

Before this study can proceed, another discussion is needed, one that deals with nomenclature and how it affects an understanding of the surficial archaeological record. This discussion refers to Chapter One, in that “scatter” is the focus. Additionally, the meaning of what constitutes a “disturbed” context is relevant. Also, a brief examination of “randomness” is appropriate as well.

This section is not just about definitions, or about standardizing use of terms. How these terms and concepts are used reflects bias that exists in how the archaeological record is studied, recorded, and analyzed; more than that, it introduces similar bias. When an archaeological assemblage is referred to as “surface scatter,” that is a value-laden description, one that implies (or states flatly) the value of an assemblage that may or may not have been analyzed.

The definition of the word “scatter,” for as much as it is used in the literature, does not appear in some places a reader might expect. It does not appear in *Archaeology* by Renfrew and Bahn (2004). It is not stated in “Making Sense of Lithic Flake Scatters” (Cowan 1999). Wikipedia does not have an entry on scatter that relates to archaeology; it does not have an entry on “surface scatter.” It does mention “worked flint scatters can survive untouched for many centuries,” in the entry on “Landscape Archaeology,” but the article does not credit such a claim to any specific source citation.

This situation is likely (despite an effort to keep speculation to a minimum) because “scatter” already has a perfectly serviceable definition. The 2010 Random House Dictionary defines “scatter” in several relevant ways. First, it defines the word as a verb:

–*verb (used with object)*

1. to throw loosely about; distribute at irregular intervals: *to scatter seeds*.
2. to separate and drive off in various directions; disperse: *to scatter a crowd*.

–*verb (used without object)*

4. to separate and disperse; go in different directions.

The dictionary then defines the word as a noun, and “scatter” is used most often in the archaeological literature as a noun.

–*noun*

5. the act of scattering.
6. something that is scattered.

Additionally, the etymology of “scatter” appears to be a Middle English word that means “to burst out laughing.”

While “scatter” seems to be an elusive target in the archaeological literature, “surface scatter” does appear in *The Concise Oxford Dictionary of Archaeology* (2003).

In America, surface scatters are sites that have geological or geographical context but no archaeological associations. This includes material incorporated in secondary contexts such as river gravels or colluvium. In Britain, surface scatters are spreads of humanly worked material...**(1)** material brought into the topsoil by cultivation and derived from disturbed archaeological features of some kind...**(2)** material remains of activities which only have a topsoil dimension in the sense that the material was originally dropped or placed or abandoned on the ground surface and over the course of time it has become incorporated into the topsoil...

For some perspective, *Oxford* also lists definitions for “flint scatter” and “surface survey.” Their entries appear below, respectively.

A general term applied to collections of worked flint, stone, debitage, and associated raw material gathered up from the surface of ploughed fields or disturbed ground...As such they do not represent distinct kinds of archaeological site but rather the archaeological manifestation of many different kinds of activity; their unity is a product of the way material has been recovered rather than the processes by which it was created in the first place...

The collection of archaeological finds from disturbed ground surfaces (e.g. cultivated fields)...

Before further discussion, it should be noted that the word “disturbed” has appeared, and this is a word that appears frequently in the literature. This word isn’t defined in any of the sources above aside from the Random House Dictionary, and neither is “disturbed context,” a phrase that seems equally likely to occur. To begin, here is the 2010 Random House Dictionary definition for “disturbed.”

*–verb (used with object)*

1. to interrupt the quiet, rest, peace, or order of; unsettle.
2. to interfere with; interrupt; hinder: Please do not disturb me when I'm working.
3. to interfere with the arrangement, order, or harmony of; disarrange: to disturb the papers on her desk.
4. to perplex; trouble: to be disturbed by strange behavior.

*–verb (used without object)*

5. to cause disturbance to someone's sleep, rest, etc.: Do not disturb.

Several things become apparent. First, the dictionary definition of “scatter” specifically refers to material that has been spread out irregularly, without care, or in an otherwise random way. The essence of this definition appears to be preserved as far as

archaeology is concerned, except that “scatter” is not explicitly defined in the absence of the word “surface.” A “surface survey” is apparently something that is carried out on disturbed ground surfaces exclusively, and the word “disturbed,” while used commonly in the literature, is not defined in the literature. Its definition is consistent with that of scatter; that is, materials that have been disturbed may often accurately be called scatter. “Secondary context,” which appears to be a more value-neutral term that carries the same definition of “disturbed” appears frequently in the literature, but not everyone uses it.

The point here is not to dispute any particular definition. As stated before, these words have serviceable definitions, and they are used correctly in the literature. The point is that these words are potentially being misapplied, and potentially being misapplied very, very often. These words might be appropriate on a surface that is a truly uncontrolled, unknown, even unknowable environment, and they might be appropriate if a set of artifacts on the surface can truly be said to have been moved around randomly or carelessly. Unfortunately, as the previous chapter details, this sort of evaluation is often assumed or not performed, partially because studies on surface assemblages are rare enough that such an assumption appears prudent, even after the fact.

Furthermore, the language that is used in describing surface materials reveals the nature of that assumption, and it has to do with randomness. An assemblage that is said to have no control is one in which there is no apparent progression from previous configurations as they have lead to the present one. Previous configurations may be infinitely assumed, of course, but they are not in evidence.

The definition of “random” is consistent across several sources. The 2010 Random House Dictionary entry is as follows.

–*adjective*

1. proceeding, made, or occurring without definite aim, reason, or pattern: the random selection of numbers.
2. Statistics . of or characterizing a process of selection in which each item of a set has an equal probability of being chosen.

The 2009 Collins English Dictionary entry for “random” reads

– *adj*

1. lacking any definite plan or prearranged order; haphazard: *a random selection*
2. *statistics*
  - a. having a value which cannot be determined but only described probabilistically:  
*a random variable*
  - b. chosen without regard to any characteristics of the individual members of the population so that each has an equal chance of being selected: *random sampling*
3. *informal* (of a person) unknown: *some random guy waiting for a bus*

– *n*

4. **at random** in a purposeless fashion; not following any prearranged order

The 2002 American Heritage Science Dictionary reads

Relating to an event in which all outcomes are equally likely, as in the testing of a blood sample for the presence of a substance

The 1997 American Heritage College Dictionary reads

– *adj.*

1. Having no specific pattern purpose, or objective
2. *Statistics.* Of or relating to equal chances of probability of occurrence for each member of a group

Statistics by Johnson and Bhattacharyya (2006:396) contains a discussion on

“Randomization and its role in inference,” and has this explanation.

Suppose that a comparative experiment is to be run with  $N$  experimental units, of which  $n_1$  units are to be assigned to treatment 1 and the remaining  $n_2 = N - n_1$  units are to be assigned to treatment 2. The principle of randomization tells us that  $n_1$  units for treatment 1 must be chosen at random from the available collection of  $N$  units – that is, in a manner such that all  $(N - n_1)$  possible choices are equally likely to be selected.

Archaeology by Renfrew and Bahn (2004) contains a brief discussion on the uses of random sampling techniques, although it leaves the actual definition and detailed process of random sampling up to other works. They similarly do not specifically discuss randomness or randomization. Archaeology, The Basics by Gamble (2001:48-52) discusses sampling techniques, but doesn't mention random sampling. In fact, the literature in general mainly talks about randomness as it pertains to statistical sampling techniques and survey design. Except for The Practical Archaeologist by Jane McIntosh (1999: 83), where the image of a properly filled out Site Recording Sheet has “random” as its first word, describing the materials that sit (along with some “occasional flints”) on top of the Roman Tiles that are at the site.

Mueller (1975: 26-27) remarks how *random*, as it applied to statistics is commonly misunderstood or misapplied.

The first two meanings of the term *random sampling* are accepted, but confused, usages in statistical theory...Random connotes that the supposedly unbiased (in the long run) laws of chance, rather than the biased archaeologist, determine which spatial unit is selected for investigation. *Random* in this sense is synonymous with probability theory...The probabilistic approach is operationalized by selecting one (or a combination of) specific schemes from many alternatives including simple random, systematic, stratified, and cluster sampling...The term *random sampling* is not used in a statistical sense at all when it refers to the non-probabilistic approach...any haphazard selection of units of units is thought to be a random sample. Such haphazard selection produces heavily biased results...Neither the archaeological nor statistical literature, to the best of my knowledge, offers a solution to this terminological abuse.

“Random” is not a term often used as a descriptor for arrangements of materials, but “disturbed” and “scatter” are used very frequently, and both words are at least close relatives of “random.” Looking at the entries above, it’s a very short step to infer that materials that have been scattered end up in something like a random configuration, and materials that have been disturbed might as well be. In the context at hand, they are all practically synonyms.

But they are not completely equivalent. “Scatter” implies qualitative disorder, while “random” implies quantitative disorder. Randomness can be accounted for; there are things that are random, and things that are not. Scatter is subjective, and it is used subjectively in the literature, because while there are methods to determine whether or not a configuration is disturbed or has been randomized in some way, such materials wouldn’t be called scatter if it were determined how they had been disturbed (ideally, they would be “in a secondary context,” or “bioturbated,” etc.), and materials that have already been designated as scatter (say, materials on the surface, or on “disturbed

ground”) aren’t likely to be subjected to those methods. Calling materials “scatter,” whether they have been analyzed or not, reflexively reinforces the notion that such materials are the one thing on which this discussion really hinges: they are presumably of limited or no archaeological value.

For many sites and assemblages of archaeological materials, the idea of the palimpsest might seem more appropriate than something that has been disturbed or disarranged outright. The Random House 2013 definition of “palimpsest” read as follows.

– *noun*

1. a parchment or the like from which writing has been partially or completely erased to make room for another text.

Bailey (2007:203) writes, “The term palimpsest has a long usage in archaeology...In this literature, the emphasis is on the interplay between erasure and inscription, often with cross-reference to archaeological data between the text and the material medium through which it is expressed...In common usage, a palimpsest usually refers to a superimposition of successive activities, the material traces of which are partially destroyed or reworked because of the process of superimposition...”

Looked at one way, a palimpsestic view of site formation processes, that is, viewing an arrangement of archaeological materials as something like a function of previous arrangements, and as a contributing factor to future arrangements (or at least not viewing present configurations as disconnected to configurations of past arrangements)

can provide an optimistic, pragmatic view of how those arrangements can change over time, and how they may be analyzed.

### ***The Other Side of the Floor***

None of what has been said previously should imply that there is an implicit assumption of good contextual integrity for buried materials. Archaeologists have spent long decades figuring out good techniques and methods for making sense of buried materials.

But the quality of such work on subsurface contexts is the point, here. The great efforts that have been made over the years to make sense of subsurface cultural materials appears to spread a little cognitive dissonance around, when the discussion of definitions and terms above is kept in mind. If a mental image of what an archaeologist might see as “scatter” wasn’t forthcoming before, it should be now.

For materials that lie below the surface, intrasite patterning can be used to determine activity areas of a site. Earthworm activity can be accounted for in a subsurface assemblage by, among other things, testing the pH of the soil and observing worm castings (Stein 1983). Gophers (Erlandson 1984), trampling (Gifford-Gonzalez 1985), coprolites (Shaffer 1992), rodents (Bocek 1984), moles (Ohel 1987), carnivores and butchery (Hill and Behrensmeyer 1985), plowing (Roper 1976), gravity (Rick 1976), children and novice flint knappers (Högburg 2008, Ferguson 2008), and reversed stratigraphy (Hawley 1937), to name a few, have all been analytically wrangled with for the purpose of gaining better control over subsurface materials.

For perhaps a more comprehensive view of how living things affect the archaeological record, the concept of the biomantle aggregates them all nicely. Johnson (1990:84) writes that the biomantle “as it appears in the literature, indicates one or more differentiated layers of soil produced largely by bioturbation – soil mixing by animals and plants.” Darwin (1881:176) wrote extensively about the biomantle without using the term, noting “archaeologists are probably not aware how much they owe worms for the preservation of many ancient objects.”

Formations of biomantles can be extensive. In some areas falling trees can disturb “total soil surface” within a few thousand years under optimal conditions, and such treefalls can displace “huge boulders,” as well as repurpose archaeological materials into literal projectiles when they occur (Johnson and Watson-Stegner 1990:584). Burrowing insects, such as ants and termites, can generate multi-layered soils simply by dislocating buried soils with their natural activities, and in some areas of the world, these faunal-generated biomantles are considered the characteristic soils of the region (Johnson 1990:90).

Villa (1982) documents conjoined pieces at the Terra Amata site that were separated up to 45 cm apart, vertically, most of them in the 20-30 cm range, some of them across apparently undisturbed strata boundaries. In fact, the spread of the entire assemblage was in the range of 50 cm vertically, while Villa described the horizontal distribution as “very limited.” Villa uses her analysis of the assemblage to ultimately reject previous assessments of the site as intact, and, interestingly, expresses very restrained frustration that many of these artifacts had not been given a vertical coordinate when the site had been originally excavated. Time constraints in the field very nearly

erased evidence of the complicated nature of the site, and only careful analysis some time later cast light on the situation.

To contrast, Surovell, et al (2005) describe a site containing artifacts that been exposed on the surface by deflation over 9,000 years ago, were reburied by natural processes at some time in the following 2,000 years, were nearly uncovered again several thousand years later, remained buried until the present day, and were finally carefully excavated and examined so that all of this could be determined.

In discussing this topic, comparing how surface and subsurface materials are treated, or should be treated, or when considering the significance of surface assemblages, their relative value should not be argued by attempting to diminish the value of subsurface materials. There is no benefit to portraying this comparison as a zero-sum situation, even if the pool of resources for such research may be somewhat shallow. All sites and materials, surface or subsurface, should be evaluated for their own merit and historical potential (Dunneil 1990:592).

In truth, the effort that has gone into investigating buried materials only highlights the tenacity of researchers in this field. Buried materials are assigned such value, and put under such scrutiny, that relevant, significant information can be gleaned from even very sparse deposits. What truly becomes highlighted, is the significantly lesser effort invested in materials on the surface.

This is not to say that no quality work has been done on surface assemblages, or even that not enough has been done. This is really just to pose a tentative question. If the careful archaeologist can document the formation history of something as complicated as what Surovell, et al. (2005) followed, if a buried-unburied-reburied deposit can be

analyzed with optimism, might it be just a little presumptuous to dismissively employ a word like “scatter” in reference to surficial archaeological evidence?

## Chapter 3 The Simple Sandpile

### *The sandpile*

The example of an object on a planar surface is perhaps the simplest that can be used when demonstrating mechanics. The object, free from the constraints of the real world, can move in any direction, at any speed, forever. It can spin on a single point, change direction from one instant to the next, and come to a halt without even a screech to mark it. The forces that act on such a naked object are obtrusive; they can be clearly analyzed and quantified.

Such a simplistic situation is considered ideal, and it can also be conceptually useful. In fact, many models and concepts in the physical sciences are both taught and described as they ramp up in complexity from a single, ideal situation. The ideal example provides an archetype, a readily available framework from which future examples and analogies can be drawn when real world situations become laboriously complex. A motorcycle driving on Route 66 doesn't behave exactly like a perfect sphere rolling along a smooth surface, but they are similar enough that "whole cloth" descriptions are not needed exclusively for both.

Similarly, a fragment of chipped stone lying on the ground doesn't behave exactly like a motorcycle on Route 66, but the proper way to describe their respective motions comes from the same physical and mechanical source material. In fact, the ideal situation bridges an analytical gap between the two: the vehicle and the stone are merely extended examples of the original sphere on a surface. The only real difference is the variables that are used, and those can be reduced to simple numerical values.

A second analytical gap must be bridged if real world interactions are to be modeled in relevant terms. It becomes apparent when multiple objects begin interacting that not only the

complexity of the description increases, which we might logically expect, but the properties and concepts involved can also change wholesale. Aggregate behavior emerges from the sand pile. An immediate example would be the difference between one pool ball on a table versus fifteen pool balls on the same table. As Mehta (2007, 1) notes about granular media, perhaps most significantly, "...granular flow is strongly non-Newtonian."

Studies of granular media constitute a separate endeavor from other topics in physics, as granular media exhibit their own behavior. "Granular media are neither completely solid-like nor completely liquid-like in their behavior – they pack like solid, but flow like liquids." (Mehta 2007, 1). Granular media work according to their own rules, but they are actually made up of smaller pieces. While much of the work concerning granular media has focused on powders, the sand pile is the basic analogy for the study.

The sand pile can serve as a useful corollary to the surface assemblage, and the concepts associated with it serve as a good introduction into the physics of archaeological assemblages. A pile of sand is a simple concept in itself, and it is something that is easy to create, but a close inspection of one reveals a deep complexity in both form and dynamics. The best example of a sand pile in nature, the sand dune, is primarily formed by eolian processes, and as such entire dunes can be moved by relatively low energy processes. In fact, one of the major factors in the formation of sand dunes is simply the amount of sand present (Partellim & Herrman 2003: 554-555). Dune formation processes seem to follow such extrinsic factors (to the sand particles) that dune formation on different planets has been observed to be fairly consistent (Bourke, Lancaster, et al 2010).

A pile of sand exists within a metastable configuration; in other words, it is stable under varying conditions, and actually exhibits what is known as *bistability*. What is more, the form that a sand pile takes reveals information about how it was formed, and so it is said that a sand pile retains a memory of its past configurations. A sand pile's aggregate behavior is vastly different than that of its component grains; indeed, its behavior is much more complex.

### ***Bistability***

Surrounding the notion of bistability is the simple idea of the *angle of repose*. A sand pile is essentially a graded surface in itself, and it does not move as a whole. The angle of repose for a sand pile is the grade at which the pile becomes unstable and will adjust itself to a more stable configuration. This essentially means that a sand pile that is too steep will experience avalanches on its surface until its grade is low enough that it becomes stable. This is where the notion of bistability enters, because a sand pile does not have a simple angle of repose; it has a range of them. Below this range of angles, a sand pile is stable, and it will not spontaneously rearrange itself. Above this range, avalanches will occur. Within this range, *bistability* occurs, and the sand pile may or may not experience avalanches or instability. (Mehta 1994: 3; Mehta 2007: 1)

It is important to note that a sand pile is considered *athermal*. In an aggregate with particles of sufficiently low mass, the particles respond to changes in heat and temperature in varying levels of agreement with the Ideal Gas Law (Wilson and Buffa 1997, 332). As a consequence, the nature of the aggregate itself can change. When water boils, the individual water molecules are excited until they have enough energy to reach a gaseous state, and the water turns to vapor. Grains of sand have relatively large masses, and as such they are well

above the threshold where Brownian motion might occur. A sand pile will not spontaneously rearrange itself in the absence of external disturbances (Mehta 1994: 4).

When external disturbances do occur, a sand pile exhibits further complexity, as it reacts differently to different magnitudes of force. When a sand pile experiences vibration of different intensities, different results occur. Anita Mehta (1994, 5) states “The claim is that for high intensities of vibration, the dominant process is independent-particle relaxation at the surface, leading to avalanches down the slope, whereas collective relaxation dominates at low intensities.” In other words, a sand pile can be “eased” into a more stable state with low intensity vibrations, while higher level vibrations will cause it to readjust its grade on the surface with avalanches. This is one indication that the space between individual grains might be an important factor, as how that space is filled during readjustment of the sand pile is influenced by the force acting on the pile. In a mixed sand pile that consists of both large and small grains, differing magnitudes of the vibration acting on the sand pile creates different sorting patterns.

### ***Surface Assemblages***

Much space has been given above to a discussion of the potential value of surface artifacts, and some existing research concerning them. For a raw physical description of how a surface assemblage can behave, a potential corollary is the sand pile. Sand piles and surface assemblages show several important similarities.

- 1) They can be viewed as aggregates of smaller particles
- 2) They do not spontaneously rearrange themselves in the absence of external disturbances
- 3) Their behavior in the presence of external disturbances is non-random, and varies according the direction, magnitude, and duration of the force present in the disturbance

- 4) When affected by external disturbances, they will readjust to a more stable configuration, relative to the disturbance that caused them to readjust in the first place

These similarities are sufficient that sand piles and surface assemblages may be considered conceptually analogous to each other under certain conditions

### ***Force and Energy***

While archaeologists typically write about forces that disturb artifacts in terms of what caused the disturbance (trampling, burrowing, flooding), a disturbance to an artifact or assemblage is merely the transfer of momentum, and the nature of such a transfer is a simple concept. Wilson and Buffa (1997, 98) say, “A force is something capable of changing an object’s state of motion...force is a vector quantity, with both magnitude and direction.”

The manner in which a force is transferred is well understood, as is the way one propagates through various media. What may be less apparent is how a force might propagate through an aggregate, when the transfer of force occurs not between one object and another, or through a continuous medium, but through many different objects in sequence.

So as an example, while the propagation of force through a hunk of chert as it is struck by a hammerstone is simple and fairly well understood, how a force might propagate through the debitage arrangement that results is more complex. The dynamics involved in this example lie at the heart of archaeology itself, as it is generally recognized that all archaeological materials undergo some amount of post-depositional disturbance. It also seems reasonable to note that nearly all archaeological materials were surface assemblages prior to being buried, and that many of them end up once again or remain as surface assemblages prior to collection.

It is often the case that archaeological inquiry focuses on the specific sources of disturbance (animals, wind, water, etc.); it might ultimately be more useful to focus on how forces acting on artifacts can be classified. A review of the literature shows a clear progression of discovery or recognition of “new” known sources of disturbance, and it seems reasonable to assume that there are still sources of disturbance that have as yet not been identified.

Recognizing what can happen to an assemblage in a value-minimum context has a clear advantage, in that there are many fewer unknowns when it comes to simple classifications of forces.

### ***The Behavior of Archaeological Assemblages***

First, an assemblage cannot be disturbed unless affected by an outside agent, whatever that agent may be. They do not spontaneously rearrange themselves, and so something – be it gravity, or wind, or water, or collector – is responsible for all changes. Forces have magnitude and direction, and it is the direction which becomes important first.

When one object imparts momentum to another object, that momentum is conserved, meaning that no new momentum is created, and none is lost. However, because of the force of friction, some of the kinetic energy is always lost. Some goes to moving air molecules (to make noise), to generating heat, or is lost to friction (Wilson and Buffa 1997: 182). Keeping this in mind, consider that a surface assemblage is, in one sense, nothing more than a series of objects with space between them.

The simplest example of this might be a pool table, with pool balls scattered on its surface. When the cue ball collides with another ball, it transfers its momentum to that ball. That ball then begins to move, all the while being slowed by the force of friction. When that ball

collides with another ball, its momentum is transferred to the new ball, and this continues until friction has drained away all of the momentum available and everything comes to rest. It is very easy to see, from a top-down view, how momentum is transferred from one ball to potentially many, and how the accumulation of those interactions, along with the force of friction, eventually bleeds away all the energy from the system.

In a system where the pieces are very close together, that energy can not only be drained away very quickly by the many interactions that take place in a very short time, but it is also dispersed throughout the system, so that more particles, and more interactions, become involved with time. Experiments with impacts into powder media have shown this effect can be very powerful. In an assemblage with many pieces, it essentially becomes a problem of division. The magnitude of the force becomes important in determining how far into the aggregate the force might travel.

This works well for an example involving a very discrete event like an impact, but a less discrete event might be a different situation. What if, for instance, water was flowing through a surface assemblage? The example of water can be discussed later, but the effect of a continuous force acting on an assemblage is certainly important. While it may seem like a very different situation, the fact is that it is really just a matter of duration. The force, continuous or not, will still have magnitude and direction, and one part of the assemblage will be affected before the others.

## Chapter 4: The Analogical Gap

The behavior of real sand piles is very complicated and has not been entirely accounted for mathematically or conceptually, but the concepts put forth in the previous chapter are more than enough to make some assumptions and draw some reasonable conclusions relevant to archaeological inquiry. Specifically, this allows intrasite patterning of artifacts to be approached in a more value-neutral context, where such patterning can be seen as a process that plays by certain rules, instead of as the decay of a once-intact assemblage that has been potentially exposed to a multitude of disturbances. Four conclusions of relevance are summarized here.

### *1. They can be viewed as aggregates of smaller particles.*

In a very basic sense, there is no real significance of the actual location of an object when considering its motion. Whether on a table top, falling through the air, or floating in space, the same rules of gravity, friction, and other forces apply. It follows that an object, say, a grain of sand, should be as theoretically unrestrained. It presumably should not matter that the grain of sand happens to be sitting in close proximity to hundreds or thousands of other grains of sand. The same might be said of a piece of chipped stone sitting on the surface as part of an assemblage. A paper by Bowers, Bonnicksen, and Hoch (1983) demonstrates why this is not the case.

Bowers et al. perform “flake dispersal experiments” of two different types, the second involving computer assisted modeling of assemblage behavior over time. Beginning with a Cartesian plot of an actual flake dispersion created as Bowers knapped a biface, the authors wrote a simple program to track and dictate the movements of those flakes over time. The

criteria were simple: “(1) flake movement was defined as four linear centimeters per year; (2) this movement was in a completely random direction; and (3) these movement occurred at one year intervals. Thus, each individual flake was assumed to move four cm in a randomly assigned linear direction for one year; at the conclusion of this interval, a new direction was randomly chosen and another four cm of linear movement was recorded.” (Bowers et al, 1983).

While the original distribution was an identifiable dispersal around a clearly defined locus of knapping, the simulated flake scatter patterns after 100 and 1000 years both appeared to be more or less random distributions, slightly off center in favor of the original direction of flake projection during the knapping. More informally, they both appeared to be mostly random distributions; indeed, this is what they were designed to be by the program, or at least what they were coming closer to with each successive programmed year.

There are two primary flaws with this experiment, and the purpose of pointing them out here is not to criticize the experiment. These two flaws merely point out the main reasons why a piece of stone in an assemblage no longer plays strictly by its previous rules; why, as Mehta (2007) put it, “granular flow is strongly non-Newtonian.”

Both flaws have to do with the random direction factor directed into the program. The first might not be obvious when tracking objects with a computer program, but probably becomes so when viewing actual objects on a surface. Objects in a group like this can't go in a random direction, because their options for movement are limited by the objects around them. Movement in a direction that causes the object to make contact with another will alter the motion of one or both of the objects.

In a group, in a granular medium, these interactions become emergent. An object cannot move without interacting with another object, which in turn can interact with the objects around

it, creating cascading interactions throughout the body of the aggregate that are more than the sum of, and, more importantly, not dictated by the rules governing, the interactions of any two of the individual objects. *The behavior of the assemblage supersedes that of the objects.*

The second flaw is the assumption of randomness itself. Assuming that interactions between objects were not a problem, and each stone was free to move in any direction, applying a random direction for each object is not necessarily justified. Bowers et al. (1983) demonstrate this point earlier in their paper while investigating frost action as an agent of flake dispersal.

2. *They do not spontaneously rearrange themselves in the absence of external disturbances.*

The statement above is redundant, yet true and important to keep in mind. While it may be important in the course of an investigation to separate the cultural from the non-cultural site formation processes, artifacts do not move on their own. Mehta (2007, 2) "...true thermal agitation in granular media takes place on an atomic rather than a particulate scale; therefore it is external vibration or shear that initiates and maintains the motion of grains."

This relative stability is a function of the *hysteresis* of a sand pile; that is, the sand pile carries with it a "memory" of its previous conditions. That is, within the sand pile, the shapes and masses of the grains that make it up, as well as the nature of the space between those grains, are significant in determining the properties of that sand pile. How that sand pile reacts to a disturbance depends on how it has reacted in the past, as each new configuration both persists until and contributes to the next change and is itself a function of the previous changes.

An especially clear illustration of this point comes from a survey of historic sheepherder camps by Hofman (1982). The study focused on intrasite patterning and intersite assemblage variation within and among the camps. The information from the nine camps surveyed retained

strong spatial patterning, to the point that “drop” and “throw” zones were designated within the sites. At one of the sites, cans in the throw zone were matched to their corresponding pull tabs in the drop zone. When non-cultural formation processes were noted as well, the evidence showed that the assemblages from different sites displayed a wide variation in composition and patterning. Hofman identified six reasons as to why this might be the case, only one acknowledging the effect of random chance.

While it may seem simplistic to just point at these sites and remark that none of the artifacts got up and walked away by themselves, they didn't. While this very obvious, basic fact may be a starting point for archaeological inquiry that researchers can (and should) take completely for granted, it can be demonstrated that this same obvious, basic fact can easily become an endpoint for archaeological inquiry, when, for example, buried sites are treated preferentially over surface sites because of a perceived lack of data control. Perhaps to this train of thought, Hofman (1982: 109) ends the paper by writing, “Surface sites are often considered less important or less valuable resources than buried ones. But, all archaeological deposits were at one time surface remains...we must be able to account for the surface stage of site development and disturbance processes in order to adequately interpret buried sites.”

### *3. Their behavior in the presence of external disturbances is non-random.*

Not only is an object in an aggregate constrained in which direction it may physically move, but it may only react to a given force that is acting on it. While there is recognized disorder in an aggregate, from the shapes of the individual particles, for instance, its behavior is not random. As a sand pile retains “memories” of earlier configurations, and its changes can be

viewed in one light as a series of relatively stable configurations over time, the nature of the force acting on a granular medium is clearly significant.

Instead of discussing the randomness of granular flow or artifact dispersal, it is more appropriate to talk about the randomness of the forces acting on them. As it seems that one major goal of archaeology is to demonstrate that the relationship between culture and material artifacts is not random, physical forces of cultural origin might be left out, but naturally occurring, or non-cultural forces, have been a focus of study for decades. The level of understanding varies, but many are well understood.

Bowers et al. (1983) demonstrated effectively that in arctic conditions, formation of ice spikes on the windward sides of artifacts was a significant agent of motion, to the point that artifacts were observed to move upslope. Turner (1986), discussing the role of rainfall in soil erosion (and subsequent artifact recovery), noted that the majority of a raindrop's mass, and as such momentum, splashes downhill on a slope, indicating that artifact displacement favors downslope movement in the rain (aside from the fact that the rainwater, once on the ground, will flow downslope on its own, and also aside from the discussion about differentials between small impact force from rain drops and continuous force from flowing water). Lee and Tchakerian (1995) show that on the Southern High Plains vegetation cover is the main factor determining the levels of soil that are eroded by wind (so much so that soil and vegetation conservation programs have significantly reduced the amount of observed dust in the air), and also that large and small events, but not moderate events, are responsible for the bulk of soil erosion.

*4. When affected by external disturbances, they will readjust to a more stable configuration, relative to the disturbance that caused them to readjust in the first place.*

Friction is defined by Wilson and Buffa (1997: 117) as “the ever-present resistance to motion that occurs whenever two materials, or media, are in contact with each other.” The *coefficient of friction* represents the effect friction has on the motion of an object and the forces acting on it. Friction comes in two major varieties, static and kinetic. Static friction is the force of friction that exists between two bodies while they are at rest relative to each other, while kinetic friction represents that force while they are in motion relative to each other (Wilson and Buffa 1997: 118). The coefficient of static friction is generally greater than the corresponding coefficient of kinetic friction (Wilson and Buffa 1997: 119), and this reality can have a variety of real-world consequences.

At a basic level, this means that it takes more force to get an object moving than it does to keep it moving. As far as a sand pile goes, friction is what holds it together. Without the force of friction, gravity would reign and the pile would scatter to cover whatever surface it happened to be sitting on. A sand pile’s configuration stores potential energy, and once the angle of repose has been breached, or when bistability flips one way within that pile’s range of angles, the force of friction is overcome and the pile is reconfigured. Specifically, it is reconfigured to a state in which it lies below its previous angle of repose, or it is still within its range of angles of repose while bistability remains flipped in favor of stability. Of course, in reality the angle of repose might not have been changed to an angle that was too high. This situation is just as likely if a force acts on the sand pile that makes the current angle of repose untenable, shifting it down into the bistability range or below it completely. In either case, the sand pile shifts into a configuration that is more stable, relative to the force that caused it to reconfigure itself in the first place.

In terms of single objects, or smaller numbers of objects, things get a little simpler. If an object is under the influence of a force that is causing it to move, and that object comes into an environment in which that force is no longer sufficient to overcome the force of kinetic friction (the surface on which the object is moving changes, for instance), that object will stop, and if that happens the force will no longer be able to move that object because the force of static friction now holds sway. The object is now in a stable position at rest until that force of static friction is overcome. Not only is the force acting on the object insufficient to overcome the kinetic friction of the surface, but the static friction is even greater.

The average midden is a good example of a stable feature that human behavior can produce at a site, but non-cultural activities produce noticeably stable features as well. Downslope movement (often with the assistance of water) can create artifact concentrations (Hofman 1982; Rick 1976) at the bottom of slopes. Additionally, Rick (1976: 133) notes the effect that since-vanished architectural features, like walls, can have on intrasite patterning, and goes so far as to criticize fully behavioral interpretations of artifact clusters in sites where walls may have at one time existed.

### ***The Surface Assemblage as a Sand Pile***

Stability is a single state; there are not varying degrees of it (bistability notwithstanding), and it largely exists as how the observer chooses to define it. An object in motion can be said to be stable, if the net force acting on it happens to be zero. But an aggregate is best served here by describing its stable state as “at rest.” It might be very difficult to sell a shifting sandpile as a stable configuration, and not terribly useful to offer constant reconfiguration as a stable state, either. But a sandpile or sand dune at rest is hardly resting, as its internal structure

counterbalances the potential energy of each of the grains that make it up. A pile of sand, sitting still on a flat surface, is stable in the same way that a house of cards is stable: it's merely waiting for an excuse to collapse. It is more of a collapse that has been paused in progress than it is a single, stable object. Consider Binford's statement (1981: 196) as another level of analogy, "Ascher's arguments regarding formation processes were extremely insightful. He argued that the archaeological record is some combination of interruptions in an entropy-linked process..."

The sand pile works well as an analogy primarily because it is simple. Although the "real," quantified behavior of a sand pile is something that is not completely understood, the observed, qualified behavior is something that seems relatively simple. Shake a sand pile, kick a sand pile, change the angle of the surface it sits on, or pile on more sand, and the visual of what will happen next is forthcoming. The primary force that shapes the reconfiguration of a sand pile is gravity, while at the same time gravity is responsible for the friction that holds the whole pile together. Whatever else happens to it, the sand pile is saved from the pull of gravity by its internal structure and friction. The phenomenon of bistability shows how tenuous this can be, and how much of a balance it is. When this balance is disturbed in some way, when an outside force acts on the pile, stability becomes instability, and gravity takes over. A sand pile will ultimately succumb to the forces that act on it. Its grains will scatter out across whatever surface it was sitting on, and the sand pile becomes a sand scatter (or a beach).

While a sand pile is a three-dimensional structure, the same forces that hold it together and keep it stable do not necessarily have to work vertically. Once a pile has collapsed completely, the grains are still not free to go just anywhere. Interactions are still to be expected. The internal structure of the sand layer will still be significant. This should be true of any surface

aggregate, where one object cannot move without considering its neighbors, and directional forces must affect some objects before others.

While a surface assemblage of artifacts does not visually resemble a sand pile, they are conceptually similar; they are analogous. The basic similarities are the strongest. The individual components of an assemblage may or may not be in contact with each other, but friction and gravity are the forces that hold them in place (all the better if they *are* touching each other), and even if they aren't touching, the behavior of an assemblage depends on the idea that they do interact with each other. While gravity itself does not necessarily affect a surface assemblage (except where a slope is involved), the direction of a particular disturbing force is important, and so both sand piles and assemblages are reconfigured by directional forces. Furthermore, their reconfiguration is influenced by their own internal structures. While a sand pile has stable features (bridges) and unstable features (gaps), at the very least an assemblage has the same sort of stability when one of its components is unable to move in a particular direction because another object is in its way.

## **Chapter 5: *Conclusions***

Inevitably limited resources place an inherent value on each action taken, each item collected, each page published, in the progression of archaeological inquiry. Simple pragmatics dictate efficiency and at least a general cognizance of the differential valuation that exists, but of course that valuation is influenced by a variety of factors. As far as archaeology is concerned, the more information contained in a particular object, deposit, or feature, the better, and a long standing consensus appears to be that objects that have been buried (under certain conditions) retain more useable information, which is a justified point of view for a variety of reasons. The logical consequence of that point of view, that unburied materials have lost some unknown amount of their original context, has been challenged in the discussion above. This point of view has not been tested to its fullest extent, and while work has been done on surface materials in past decades, there still exist new techniques and concepts, such as those mentioned above, for effectively dealing with them.

When examining traditional, or even common modern, views on site formation processes, it appears that surface deposits come up against a Catch-22, one that has to do with the energy of the processes involved. An assemblage that is found on the surface carries with it an assumption that it has been open and vulnerable to natural forces that operate on everything else that sits on the surface of the Earth, meaning that surface or unburied deposits are, most politely, referred to as existing in a secondary context. On the other hand, subsurface deposits are protected from those same surficial forces by the earth that covers them.

The disconnect here is twofold. First, there is a long record of literature detailing the fact that subsurface deposits are not protected from all forms of disturbance; in fact, there are many

forms of disturbance that only occur below the surface. This same record of literature also contains the body of knowledge necessary for dealing with and accounting for such forms of disturbance, something that exists in a much “thinner” form for surface assemblages. Second, any subsurface deposit that was not buried (probably intentionally) at the time of its creation spent some time as a surface assemblage, and so surficial processes are relevant to its interpretation. What’s more, those same forces that are responsible for disturbing things that are found on the surface were probably responsible for burying the materials. So where items on the surface may have been subject to natural forces, buried items have been subject to those same forces, but forces of sufficient magnitude to cover them up.

Schiffer (1983: 676-678) speaks substance to this current discussion:

[Ascher] suggested that “time’s arrow” progressively reduced the quantity and quality of evidence surviving in the archaeological record...[This] entropy view implies that our potential knowledge of the past is directly related to the state of preservation, which is conditioned by the time elapsed since cultural deposition. In deposits laid down recently, more can be learned about the past than can be learned much later when fewer artifacts – and those probably disturbed – are left. Although this position is unassailable as a statistical generalization, it has three important general exceptions.

- 1) Because degradation is caused by specific processes...deposits must be evaluated for the information potential (or limitations) on a case-by-case basis.
- 2) Even in badly degraded deposits some inferences – often very significant inferences – can be made confidently...present day adherents of the entropy view, especially those in cultural resource management studies...sometimes “write off” heavily disturbed sites.
- 3) ...artifacts, accumulate in the archaeological record through natural processes; such items serve as evidence for paleoenvironmental reconstruction...Thus, some information of archaeological interest accumulates through time...

In concluding this discussion of the transformation view, I note that it is at odds with the entropy conception in one important respect: *formation processes do not just degrade artifacts, they can introduce patterning of their own* [italics added]...To note that a formation process has a biasing effect is also to acknowledge that it has predictable consequences – which can be described by laws.”

Besides the weight brought from Schiffer's discussion (perhaps unintentionally, perhaps not) for including *all* archaeological materials as subject to formation processes, his note that some archaeological information accumulates over time brings a matter of equivalency to the topic. Simply put (Brown 1997: 40), artifact densities and spatial patterning are retained most strongly when a site is buried quickly and subsequently becomes subject to minimal disturbance.

Parsing this line of reasoning is a very important second step, because Schiffer provides relevant context. The initial patterning of an artifact assemblage at the time of initial deposition is itself subject to any number of parameters. The earlier forms of those artifacts (be they from a quarry, a riverbed, a cache, etc.) are not retained once the high energy processes of human culture are applied to them, yet it would not be considered logical to claim a wholesale loss of patterning, or even loss of significant information about their original context. Palimpsests are quite literally existing reminders of this idea (LaMotta and Schiffer 1999:27). The long history of experimental flint knapping (Spurrell 1874; Burton 1878; Mason, Holmes, et al 1891; Bixby 1945; Johnson, Behm, et al 1978) helped to bridge that particular gap by literally illustrating the processes involved. Wear-use analysis experiments of various types extend back to the 19<sup>th</sup> Century (Ascher 1961: 63).

Such investigation must implicitly recognize the basic idea that the forces that act on artifacts, from the quarry to the trowel, are not destructive as much as they are formative. In terms of site formation processes in general, Wood and Johnson (1978), who present an exhaustive list of turbative processes, end with an optimistic reminder.

At this point the reader may conclude that we are doomsday prophets for archaeology...On the contrary...At least six pedoturbative processes operate or have operated at [The Dry Creek Site in Alaska]: graviturbation, seismiturbation, faunalturbation, floralturbation, cryoturbation, and crystalurbation. Yet, in spite of the complex pedoturbatory processes that have occurred, the site still retains

enough contextual and stratified integrity that meaningful interpretations... can be made.

As stated above, archaeology has directed much time and effort into understanding and classifying the transformations that take place between initial deposition and excavation. As put by Hilton (2003: 166), “There is a general consensus that the processes responsible for the formation and subsequent transformation of archaeological deposits must be adequately evaluated before one can formulate meaningful interpretations of spatial patterning.” As demonstrated above, the disparate treatment of surface assemblages versus subsurface assemblages has, over time, resulted in a positively-reinforced notion that surface materials have less to offer because less has been gleaned from them.

This study has also outlined some of the ways in which the transformative process for surface materials may be understood; although that process is rooted in complex mathematics, its basic application as a framework is simple. Aggregates do not follow strictly logical rules as they apply to particles; rather, aggregates conform to their own sorts of emergent behavior. As a phrase borrowed from Foley (1981: 28) puts it, “...the first point that should be stressed is that the particulate structure of the archaeological site is illusory.”

Entropy displays a clear picture of the ultimate fate of all relevant deposits. If not more quickly, they are at least taken away by attrition. Before that, however, aggregates of artifacts conform to the forces that act on them in predictable ways. It is a chain of events, discrete periods defined by the increasing magnitude of their stability. Looked at in this way, *all* archaeological materials might be viewed as palimpsests; all are in a state of transition from one form to another, with information from the past contributing and being carried on through time.

In this way, it may become clear that use of a word like “scatter” has more than one applicable meaning in the field; first as a noun to describe materials of a certain perceived value, second as a verb to describe how a potential analysis was sent skittering to the wind.

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