New Approaches to Old Stones

Approaches to Anthropological Archaeology

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New Approaches to Old Stones

Recent Studies of Ground Stone Artifacts

edited by

Yorke M. Rowan and Jennie R. Ebeling

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Introduction: The Potential of Ground Stone Studies

Yorke M. Rowan and Jennie R. Ebeling

Why Study Ground Stone?

Archaeology is unique among the social sciences because it requires that we study all material remains—from unique works of art to common household tools—to better understand past human behavior, particularly the basic subsistence activities that occupied the lives of most ancient people. Researchers have created sophisticated technical and typological approaches to the analyses of certain categories of material culture, particularly pottery and flaked stone; however, not all material culture receives equal attention, and in many areas of the world, selective reporting from the field limits the potential of any artifact class. Ground stone artifacts, long recognized as part of the essential domestic tool kit for food processing as well as other activities, are the most visible artifacts that provide information about a number of daily activities necessary for human survival. With notable exceptions, these artifacts have received only sporadic methodical attention in the archaeological community until recently. Whether researchers are interested in hunter-gatherers or food producers, ground stone artifacts are frequently a key component to understanding such diverse phenomena as subsistence patterns, sexual division of labor, social organization of craft production, and activities related to cultic and mortuary practices in past societies. These and other issues are investigated by the authors of the chapters in this volume, which is one of the first to bring together studies of ground stone artifacts from diverse sites and regions in order to demonstrate how this often overlooked class of material culture can be used to address a variety of research questions (but see Procopiou and Treuil 2002). Our intent is also to introduce archaeologists working around the world to the rich possibilities of ground stone studies, and promote awareness of the analytical potential of these tools. It is our hope that archaeologists would then treat excavated ground stone tools with the same analytical attention as other categories of material culture, which would allow for greater strides in ground stone research in the future.

What is Ground Stone?

As many scholars have noted, the phrase 'ground stone' when used to describe artifacts such as those collected in the studies of this volume is a broad, general term that does not always accurately reflect the expansive category of material culture (Adams 2002:1; Runnels 1981:218; Schneider 1993:5; Wright 1991:4). The broad assumption underpinning the term ground stone requires two observations about the general class of artifacts. First, many artifacts in this category are made using a variety of techniques that include flaking, pounding, abrading, polishing, pecking and drilling. Traditional categorical distinctions between flaked and ground stone artifact classes do not reflect the common inference that many ground stone tools are initially flaked from a larger nodule or boulder and subsequently shaped using a variety of techniques, while some chipped stone artifacts involve platform grinding for effective flaking or grinding to complete the final tool. At the same time, some tools produced primarily through flaking may be ground, whether intentionally, or unintentionally, through use (Crabtree 1974). Second, ground stone can refer to the way a tool was used. Indeed, many classes of artifacts may be used as grinding equipment, but others are manufactured using similar techniques and produce artifacts that have little or nothing to do with reducing plant or other materials. Such objects include vessels, digging stick weights, axes, spindle whorls, hoes, etc.

For these reasons, definitional boundaries of such a study are problematic and ground stone is probably a less cohesive category than other common classes of material culture. Ground stone artifacts are generally thought of as utilitarian tools such as grinding slabs, handstones, mortars, and pestles, but they also include a multitude of poorly defined and amorphous groupings of artifacts. In addition, a number of object types that fall into this category were considered luxury items intended for elite classes and royalty, not quotidian subsistence tools for the reduction of grains and other substances. Perhaps the definition of such a category could be narrowly defined as those tools in the grinding process for the reduction of materials, commonly grains but including other substances such as salt, meat, bone, shell, pottery, pigments, ore and other materials (Cushing 1920; Hayden 1987; Kraybill 1977; Woodbury 1954). Clearly there is a continuum from the most basic forms of stone used for processing materials to those primarily used to hold precious liquids, for display, or for ritual purposes. For the present volume, we have chosen the broader, more inclusive perspective. Material culture classes such as building stone, decorative items, statuary and semi-precious stone were excluded as best reserved for other specific studies.

Neglect of Ground Stone in Site Reports

Studies of ground stone would, at first glance, appear to be simply one more component of material culture, much like chipped stone or pottery. However, as a number of authors in this volume note, ground stone studies more frequently fall under the category of 'other' in site reports, outside the main material culture categories of ceramics and chipped stone (Schneider 1993). In many regions, such studies are frequently limited to a short descriptive chapter or an appendix, rarely integrated into the synthetic understanding of a site. Similar situations are noted in Mesoamerica, the Aegean and the Near East.

There are a number of reasons for this neglect of ground stone assemblages in different parts of the world. The commonly observed slow change in basic grinding implements such as grinding slabs and handstones means that their potential as chronological indicators is much less than that of ceramics or flint projectile points. In some areas where ceramic vessels or projectile points are found, either category may be more common than ground stone artifacts, which tend to be very durable. Thus, the low typological variability and low quantity render them less analytically attractive for some studies. In addition, even though ground stone tools were used in a variety of activities unrelated to food production, archaeologists still associate them closely with the mundane, usually female, tasks of food preparation and often assume that their uses are self-evident or, worse, uninteresting. And, admittedly, these artifacts can be large and cumbersome, which makes collection, transport, and permanent curation challenges that many are unwilling to face. It is the sad reality that large stone artifacts are still abandoned in the field at too many sites, never to be properly studied or published. Contributors to this volume note other reasons why ground stone has been neglected in their research areas.

Ground stone studies are much more developed in some regions than in others. In general, archaeologists working in the New World and Australia seem to have dedicated much more analytical attention to ground stone artifacts than those working in much of the Old World, especially those who focus on the historic periods. This might be explained by the availability of ethnographic data on those continents—archaeologists have had the benefit of a long tradition of ethnographic observations since colonization in determining the use of certain stone artifacts. It may also be a result of the emphasis on chronology that is still characteristic of some Old World projects, such as in the southern Levant. Although chronology is a fundamental concern to archaeologists, the amount of research effort placed on resolving chronological issues varies greatly. Research in New World archaeology appears less focused on chronological issues and more successful at exploring the context, both culturally and technologically, of ground stone to study other topics, such as diachronic changes in subsistence patterns. From the perspective of those working primarily in the eastern Mediterranean, scholars of New World archaeology appear to have developed more sophisticated approaches to utilizing ground stone assemblages. This reflects, in part, a positive aspect of the greater impact processual models had upon anthropologically oriented archaeology in the New World, with the emphasis on quantified methodology to answer questions centered on subsistence, production, and environmental questions. In some areas of the Old World the influence of processual models came much later, if at all, and traditional culture historical approaches remain predominant.

Early Ground Stone Studies

The assumption in the late nineteenth century was that the earliest tools of 'uncivilized peoples' would be chipped stone tools, and that later, as agriculture developed and became the foundation on which civilizations were built, ground stone tools were developed (McGuire 1893). However, recent studies suggest that the earliest stone tools associated with hominid remains were probably made from blocks and cobbles, many of them unshaped, and used as 'pitted anvils' (de Beaune 2004; Leakey 1971; Leakey 1976; Leakey 1994). Similar tools have been discovered at the Lower Paleolithic Acheulean (ca. 0.78 Ma) site of Gesher Benot Ya'aqov, Israel located in the Dead Sea Rift (Goren-Inbar *et al.* 2002).

Early archaeological approaches to the study of ground stone artifacts were often part of general studies of stone tool manufacture by aboriginal or recent descendants of indigenous groups who still had knowledge of ancient ways. One of the pioneers of collecting ethnographic observations, both firsthand and from other ethnographers, was William Henry Holmes. In *Handbook of Aboriginal American Antiquities, Part I*, Holmes compiled an exhaustive reference work, the principal purpose of which was 'to assemble and present the antiquities of the continent in such a manner and order as to make them readily available to the student who shall undertake to present a comprehensive view of the evolution of the culture among men' (Holmes 1919:xiii). Holmes recognized a larger research goal beyond description. He had already published his comparative study of raw stone material, manufacturing waste distribution, and tools in the tidewater country around Washington, DC, which was an effort to establish the distribution of chipped stone tools and debris and their origins. Holmes recorded the rejected, incomplete tools in quarries, disproving the then-current claim that the tools were Paleolithic in age. Documenting his investigation of a soapstone quarry within the District of Columbia a few years prior, he included quarrying tools used in the vessel manufacturing process (Holmes 1890:fig.6). His other investigations in the area identified steatite quarry areas at Piney Branch and Rose Hill, including study of the trenches, quarrying tools, shaping of vessels and rejects that included 'cut, pecked, ground and polished implements … quarried in hundreds of places along the eastern border of the highland' (Holmes 1893:9) such as mortars, pestles, axes, picks, hammerstones and a variety of other implements.

Despite these auspicious beginnings, interest in ground stone apparently waned. Already in the early part of the twentieth century, the lack of interest among researchers of the American southwest was noted, despite the initial descriptive documentation of the nineteenth century (Bartlett 1933). A similar trend is evident in the Near East, where early observers provided detailed reports of daily life that included grinding implements (Dalman 1933). With the adoption of modern technology and domination of industrial technology, traditional manufacturing and subsistence practices were abandoned in many regions and ethnography came to be viewed as less relevant to understanding the archaeological past, with some notable exceptions (Kramer 1979).

The resurgence of interest in understanding the origins of domesticated plants meant that ground stone tools sometimes featured prominently in studies of early agriculture in many parts of the world. Many earlier archaeologists worked on the assumption that the transition from reliance on wild plants to domesticated species was marked by changes in food-processing technology, particularly ground stone artifacts. Such a premise is entirely reasonable but has proven difficult to demonstrate, and variable according to region. Regardless of region, analytical studies that incorporate ground stone assemblages seem to typically build upon a similar assumption that artifact morphology directly reflects the function of an object. For instance, studies of hunter-gatherer transitions to sedentary populations frequently assume that mortars were used for nut and acorn processing, and that grinding slabs or *metates* reflect a tool dedicated to reduction of cereals (Schneider 1993). In California, for example, mortars and pestles are generally associated with acorn processing, one of the fundamental staples of indigenous populations. For this reason, research focused on the distribution of the mortar and pestle as an indicator of acorn subsistence, although it is unclear that this is a reliable indicator of initial acorn exploitation (Jones 1996). In addition, ethnographic accounts do not support the exclusive use of mortars and pestles for acorn processing, although intensified subsistence is likely (Basgall 1987).

In the Near East, the long-held belief was that mortars were tools for the reduction of wild, gathered foods such as acorns and nuts, while grinding slabs were used for processing domesticated cereals. Using both experimental data and ethnography, Wright effectively challenged this assumption. She notes that tool morphology is not a dependable gauge of specific function or diet (Wright 1994). The identification of starches representing wild barley (*Hordeum*) processing on a grinding slab at the Epipaleolithic (19,500 ^{14}C yr BP) site of Ohalo II, on the shore of the Sea of Galilee, Israel (Piperno *et al.* 2004) further supports the lack of simple correspondence to a single material. A correlation between tool morphology and the shift to increased dependence on agricultural products was also a presumption of archaeologists in the US southwest. In some areas, basin and slab *metates* were considered corollaries to wild plant processing and trough *metates* to agricultural production (Adams 1999); in other areas, ecological models that rely on the assumption that millingstones must equal plants was challenged (Sutton 1993). Similar assumptions are fundamental to interpretations in the Orinoco Valley, Venezuela and greater Amazonia, where some artifact assemblages are considered evidence for the processing of bitter manioc, while others, such as *manos* and *metates*, are deemed indicative of maize processing (Perry 2004).

Numerous studies, particularly ethnographic and ethnoarchaeological, provide cautionary tales, underscoring the need to avoid oversimplification of grinding implement function (David 1998; Gould 1971; Roux 1985). These and other ethnographic observations clearly demonstrate that tool use is often more complicated than scholars commonly assumed, and that many tools are multi-functional.

Constraints and Problems in the Nature of the Artifacts

Particular drawbacks to the study of ground stone assemblages include the expedient nature of many stone artifacts, confirmed by ethnographic observations which indicate that people will frequently use a cobble for a variety of pounding and grinding activities (Gould 1971), or use a grinding slab or mortar to process a variety of substances (Cane 1989; Smith 1988; Smith 1989). In addition to demonstrating possible multi-functionality, ethnoarchaeological studies underscore the further complicating factor that people will re-use ancient stone tools where available, particularly if sources for manufacturing new implements are not immediately accessible to the habitation or work area (Roux 1985). Recently abandoned sites were also useful sources for the procurement of artifacts, whether fragmentary or complete (Huckell 1986, cited in Schlanger 1991), either as tools or in secondary contexts such as building materials or hearths (Camilli *et al.* 1988, as cited in Schlanger 1991); implements broken during rejuvenating processes may be discarded, or they may be used for a related function. Ground stone tools commonly remain on sites, and we would expect to find greater investment in tool design where people intended to return to a site (Nelson and Lippmeier 1993). That possibility may have far-reaching implications because any observed trend toward increasing numbers of ground stone implements at a single locus may not be an accurate reflection of increased ground stone use, but may be evidence for recycling of earlier implements by later occupants and their subsequent deposit in the later occupation contexts (Simms 1983).

Constraints and Problems Related to Classification and Typology

The profusion of terminologies and overlapping types was noted decades ago (Hole *et al.* 1969:170) and continues, varying according to region, sub-disciplinary tradition and, apparently, individual preference. In part, this reflects our lack of ability to identify the functions of tool types. However, there is a trend toward some consensus on some of the major tool types, although these trends may be more pronounced and cohesive in the New World than the Old. This is evident in the terminology used by the authors of the papers in this volume; the reader will note the variety of terms used to describe similar tool types.

The lack of agreed-upon typological classifications certainly frustrates attempts to begin comparative regional inter-site studies and impedes even the effective utility of descriptive reporting of single site artifact assemblages, but this drawback may have a hidden advantage. In many other material culture assemblages, the opposite problem manifests itself: where material culture and chronological frameworks are so fundamentally intertwined neither can serve as an independent control on the other—as is the case in the southern Levant, for example, where the chronology of the historic periods is founded on ceramic typologies developed a century ago. Nevertheless, the lack of typological agreement sometimes hampers efforts to undertake comparative, quantified regional analyses. However, this book contains contributions by scholars specializing in a variety of regions and time periods, and editorial insistence on standardized terminology could increase a loss of information. As a result, the editors provided authors with general guidelines for preferred terminology to facilitate comparisons, but deferred to a contributor's expertise for specific terminology. We suggest, at least for broad classes of artifacts, a general terminology could be adopted that allows a common lexicon for researchers. Despite these constraints, most archaeologists would agree that many stone artifacts form the primary tool kit for food and other manufacturing processes, and are thus essential to understanding past daily activities. Thus, ground stone tools offer potentially fresh insights into a range of diverse social processes, as the papers in this volume attest.

Research Trends and Stone Artifacts

Stone tools are well-suited to the application of a variety of experimental and analytical techniques. Although still in their infancy, these approaches provide one of the fundamental directions in which studies of ground stone tool function will go to provide fresh perspective. The final form in which archaeologists discover an artifact is the product of a variety of processes, including intentional design, use modification, re-use and post-depositional alteration. Much of the research on ground stone focuses on determination of function, and this has begun to refine our understanding of how grinding implements were used. A variety of approaches attempt to tackle this problem by establishing new ways in which to interpret function independent of tool morphology. The results of these studies will eventually correct interpretations based on the assumption that artifact form equals function.

Experimental Approaches

An early proponent of experimental work, Joseph D. McGuire discussed experimental work aimed at understanding the potential functions of ancient tools (McGuire 1891; McGuire 1892). McGuire (McGuire 1893:311) argued that, contrary to popular opinion of the time, the 'art of grinding and battering stone must have preceded that of chipping'. However, little experimental work focused on ground stone artifacts until much more recently. Replication and use wear analyses that build upon the seminal work of Semenov (1973) and Keeley (1980) are now widely applied to understand the function of chipped stone tools but only a few similar studies have been applied to ground stone artifacts, despite early insights that included ground stone examples (Semenov 1973:134–42). These approaches are increasingly used in conjunction with other techniques, in particular analytical identification of residues and microbotanical traces.

Replicative Studies and Use-wear

Ground stone artifacts are typically described and classified according to similarities based on morphology. Very often, function is inferred based on the morphological form of a stone artifact and raw material used. As noted above, tool morphology is a poor indicator of stone tool functions, and morphology of grinding and pounding tools may be an unreliable indicator for materials processed. There are several ways to move beyond the inferred understanding of function based on form. Ethnographic observations are commonly investigated in order to make analogous inferences about the function of an archaeological artifact based on the observed use of similar artifacts. Experimental work focuses upon the use of replicated tools based on ancient examples in order to observe wear, rates of wear, polish development, and kinetic patterns. In order to understand chipped stone tool function, increasingly sophisticated techniques of replication and use-wear (Ahler 1979; Bamforth 1988; Hayden 1979; Hayden and Kamminga 1979; Nance 1971; Tringham *et al.* 1974; Unger-Hamilton 1989; Vaughn 1985) have established the potential of this approach for understanding tool function, but application of similar studies to ground stone artifacts remain few. The most exhaustive sequence of investigations was conducted by Adams in a series of essays (Adams 1988; Adams 1989a; Adams 1989b; Adams 1993a; Adams 1993b) and further explored in *Ground Stone Analysis: A Technological Approach* (Adams 2002). Other experimental efforts in ground stone include replication and use-wear studies of handstones, grinding slabs, mortars and pestles (Dubreuil 2004), analysis of hammerstones and the debitage from their production (Pritchard-Parker 1998), grinding slab rejuvenation (Pritchard-Parker 1993), wear rates (Wright 1993), and combinations of experimental and ethnohistoric work to understand the relationship of *mano* surface area to changes in *metate* form (Mauldin 1993). The logistical difficulty of microscopic examination of large ground stone tools remains a major obstacle to analysis. In addition, superior results are documented for microscopic use-wear of finer flints over coarser materials; many ground stone tool classes are chosen for the coarseness of the material. This will render microscopic use-wear analyses more difficult in many cases, although this may enhance preservation of residues and microbotanical remains.

Residue and Trace Analyses

Chemical residue and microbotanical analyses of grinding implements have begun to produce reliable data on the natural resources and technologies involved in the grinding and pounding process. Methods developed include plant tissue identification such as cellular structure, starch grains, phytoliths and resins, as well as other approaches involving biochemical and genetic techniques. Under this broad heading a number of different analytical techniques are included, some still controversial or in experimental stages. For instance, initial claims for the identification of blood residues using a crystallographic method for hemoglobin identification (Loy 1983) were effectively challenged (Cattaneo *et al.* 1993; Eisele *et al.* 1995; Garling 1998; Smith and Wilson 1990; 1992). More accurately termed protein residues (Newman *et al.* 1997), such analyses now use other techniques such as crossover immuno-electrophoresis (CIEP) and enzyme-linked immunoabsorbent assay (ELISA) primarily applied to a variety of stone tools, typically chipped stone. Results of these techniques have been sharply criticized (Fiedel 1996) and defended (Newman *et al.* 1997) but the application shows potential (Hyland *et al.* 1990; Kooyman *et al.* 1992). Most applications have focused on chipped stone tools, in particular those from North American contexts (e.g. Bruier 1976; Loy 1992; Loy and Dixon 1994) although an early innovative application specifically focused on ground stone assemblages from southern California (Yohe *et al.* 1991).

Lipid (fats and oils) extraction and analysis using gas chromatography (GC) and gas chromatography/mass spectrometry are typically applied to ceramic vessels. Applications to ground stone artifacts, largely limited to New World assemblages, have not been widely tested. Fatty acids, the major constituent of lipids, are typically abundant and insoluble in water, which makes them good candidates for residue analysis. Nevertheless, there are complications in identification and understanding decomposition rates, requiring experimental work to determine fatty acid composition and possible degradation through comparison to modern samples subjected to cooking (Quigg *et al.* 2001). Other experimental studies further suggest that comparison of natural lipid concentrations of rocks should be made in order to establish a baseline distinguishing culturally introduced lipids from those occurring naturally (Buonasera 2005). Nevertheless, the long duration of ground stone tools in food preparation suggests that lipid analyses will prove an important avenue of future study.

Starch analyses on prehistoric stone tools also show great promise, although most applications concentrate on understanding the role of tuberous plant remains in the shift to cultivation in the New World (Piperno and Holst 1998, and references therein) and Australia (for discussion, see Fullagar 1998). Studies focused on grinding implements ('edge ground cobbles', possibly used for tuber processing) rather than chipped flint tools provide evidence that starch grains can be isolated and identified, with rough use surfaces providing the best surface for retention and preservation of starch grains (Piperno and Holst 1998:772), although their presence on polished, chipped stone tools is also documented (Loy 1994). Study of the ground stone tools in the Neotropical forest demonstrated that the tools were used not only to process tubers, but a variety of other plants, such as palms, legumes and small-seeded varieties of maize as well (Piperno and Holst 1998:773). Analyses of starches recovered from ground stone and flake tools from the Orinoco Valley, Venezuela disproved the commonly held assumption that *manos* and *metates* are indicative of maize processing, while other tools are functionally related to manioc processing (Perry 2004). Pollen analyses would also seem relevant (Pritchard-Parker 1996), although in combination with other techniques as a control against the problem of airborne contamination.

Integrative approaches combining use-wear, residue and lithic technology seem the most promising. Various combinations have been applied, generally to chipped stone tools (Brass 1998; Kealhofer 1999) but are appropriate for ground stone (Field 1998; and Fullagar *et al.*, this volume).

Other laboratory techniques, such as DNA residues, remain untried on ground stone tools to our knowledge, but have shown promise through application to ancient chipped stone tools (e.g. Shanks *et al.* 2004; Shanks *et al.* 2005). Multiple tests could become necessary where tools may have been used for a variety of materials (Babot and Apella 2003).

Provenience Studies

Investigating the origins of materials used by ancient people is a well-established and vast avenue of study within archaeology, although application to stone typically focuses on luxury goods and exotic artifacts. A vast array of characterization techniques are employed to establish the origin of materials and their distribution from their geological sources, but interpretation of this evidence requires other techniques of spatial analysis, often modeled on ethnographic analysis (Renfrew and Bahn 2001:359). Larger stone grinding tools are less frequently subjected to these analyses because of the common perception that the lack of portability and general availability of the raw materials precluded the exchange of these materials (Biskowski 2003). Yet, to take an example from the Near East, Natufian (12,500–10,200 BP) populations exploited more distant basalt sources rather than those available closer to home, presumably because of the superior qualities of the distant flows (Weinstein-Evron *et al.* 1995, 1999, 2001). By the Roman period, basalt was traded for large milling implements across the Eastern Mediterranean (Williams-Thorpe and Thorpe 1993; Williams-Thorpe *et al.* 1991; Xenophontos *et al.* 1988), the Adriatic (Antonelli 2004) as well as southern Europe and North Africa (Peacock 1980). The assumption that stone would be sought and exchanged over large distances only if a semi-precious or ore-based material should be reevaluated.

Organization of this Volume

Several of the papers in this volume began as presentations at the Annual Meetings of the American Schools of Oriental Research (2001–2003) in sessions devoted to the presentation of ground stone studies from sites in the ancient Near East chaired by the editors. The interest in these sessions and the contacts made among the relatively few ground stone specialists working in this region led to this volume of papers devoted to ground stone studies. Ground stone specialists working around the world were also solicited for papers in order to expand the volume, and we were overwhelmed by the response. It is clear from the interest and enthusiasm expressed by the contributors in this volume and other ground stone specialists who could not contribute that such a volume is long overdue.

The papers are organized into three thematic sections, although overlap between papers in these sections is frequent. Jane Peterson's incisive contribution (Part IV) provides a detailed discussion of themes presented in each paper; therefore, an introduction to the papers will be brief.

Part I: Production and Exchange

Part I includes eight papers that deal with issues of production and exchange of ground stone artifacts. These processes are essential to understanding not only the utilization of resources and distribution of items, but also the information necessary to infer patterns of socio-economic organization, social interaction and communication at the inter- and intra-regional levels.

Two studies report on the identification of quarry and production sites. Drawing on their previous fieldwork at quarrying and production sites in western North America, Schneider and LaPorta use geoarchaeological field techniques to identify basalt vessel and implement extraction and production sites in the southern Levant. Harrell and Brown present their discovery of six Islamic-era quarries for steatite cooking vessels in Egypt's southern Eastern Desert and revise the view that Arabia was the principal source for steatite vessels in the Middle East during this period.

Carter and Rassmann focus on the use of ground stone implements in the production of specialized stone objects. Through an examination of the stone implements made of non-local amphibolite that were used to carve stone vases used for feasting activities in Late Bronze Age Crete, Carter investigates the social context of production of these elite vessels. Rassmann suggests that handstones were used to carve the unusual sandstone rings found in quantity at the Pre-Pottery Neolithic site of Ba'ja in Jordan, thus demonstrating that these tools, which are usually identified as food processors, could have other uses as well.

Early Bronze Age production and exchange networks in the southern Levant are the subject of two studies in Part I. Abadi and Rosen reconstruct the ground stone production and distribution system in the Negev Desert in Israel during the Early Bronze Age through the examination of waste products and finished implements from three recently surveyed or excavated sites. Milevski discusses the exchange of ground stone tools and vessels during this period using a variety of sources of evidence, and concludes that ground stone was integrated with dispersal networks for other commodities, including metals and pottery.

Two papers consider the production and exchange of ground stone artifacts in more general discussions of this equipment in disparate regions. Using diverse assemblages excavated from several Neolithic sites in Western Asia, Wright considers a number of issues related to tool production and use, including the use of ground stone tools in several craft traditions that emerged during this period. Biskowski presents a discussion of prehispanic maize-grinding tools in central Mexico and, applying insights gleaned from artifact attribute analyses and source analyses, suggests that specialized tortilla production arose at the cities' margins in response to increased fuel consumption and costs.

Part II: Interpreting Function, Primary vs. Secondary Use

Seven papers confront a variety of subjects relating to the assessment of the physical context of artifact use and discard; these give insights into not only the function of these artifacts, but also the social context of their use. Ethnographic studies in both the New and Old Worlds indicate that archaeological sites are desirable sources of grinding implements. Without understanding the effects of ground stone reuse, our estimation of diachronic changes in ground stone assemblages may be inaccurate. A consideration of the physical evidence for artifact use and reuse is most appropriate for understanding the long and complex life-histories of these uniquely durable objects.

Four papers reconstruct ground stone artifact use and reuse through a variety of approaches. Fullagar, Field and Kealhofer identify the remains of *Poaceae* starch grains, phytoliths and fern and lily starch on a ca. 27,000-year-old grinding slab from southeastern Australia; this physical evidence for grass seed processing challenges the notion that social and technological change was restricted to the Holocene in this region. Valado reports the results of a series of pottery-polishing stone replication experiments and explores the implications for interpreting archaeological specimens from the Mogollon Rim in East-Central Arizona and their role in craft production during the Pueblo III-Pueblo IV transition. Liebowitz combines textual and iconographic sources with insights gleaned from ethnographic observations to interpret wear patterns on handstones used to grind grain excavated at the Bronze-Iron Age site of Tel Yin'am, Israel. Basgall, through an assessment of the use, reuse, and discard patterns of a large assemblage of handstones and grinding slabs, investigates the variation in the organization of hunter-gatherer milling technologies in the northern Mojave Desert in North America.

Three authors consider discard patterns of stone artifacts and their use in reconstructing prehistoric behavior in diverse contexts. Adams discusses the widespread phenomenon of the purposeful destruction of ground stone artifacts and, using ethnographic analogy from the US Southwest, builds a framework for evaluating broken objects found deposited in intentional deposits for insights into ritual behavior. Kadowaki reconstructs the life-histories of residential buildings in Neolithic Ayn Abu Nukhayla, Jordan, through the spatial analysis and site formation processes of ground stone tools and other refuse of domestic activities. In a paper that reviews the important role that ground stone artifacts play in modern research in the US Great Basin, Kolvet discusses such issues as the reconstruction of women's space and the social aspects of grinding, and the reuse of grinding equipment by Paleoindian and Paleoarchaic peoples.

Part III: Symbols of Luxury and Ritual Equipment

Part III includes five papers that explore the use of ground stone artifacts as symbols of luxury and ritual equipment. Ground stone artifacts are primarily considered food production tools, but they frequently serve as equipment for ritual processes occurring in temples, sacred precincts and mortuary rites. In addition, stone artifacts may serve as prestige goods conferring or reaffirming the status of the owner. Investigation into the ritual and symbolic associations of the artifacts permits us fresh glimpses into the cognitive realms. Specialized production is frequently related to ritual events, including both mortuary and non-mortuary ceremonies.

Two authors consider the function of specialized stone vessels as funerary objects. Schaub focuses on the corpus of well-carved basalt bowls excavated in shaft tombs at Bab edh-Dhra', Jordan, and reconstructs an estimate of their symbolic and material value for this Early Bronze Age society. Roosevelt considers the funerary use of stone *alabastra* in western Anatolia during the sixth–fourth centuries BC and suggests that these vessels were made popular through their associations with Lydian and Persian royalty and their very orientality.

Two studies focus generally on the ritual associations of stone vessels found in very different contexts. Luke's interdisciplinary study of three styles of Late Classic vases from Mesoamerica concludes that marble, alabaster, and travertine vases represent true luxury goods reserved exclusively for royalty. Amit, Seligman, and Silberbod report on the excavation of two man-made caves in Jerusalem that functioned as a quarry and workshop for limestone vessels and ossuaries produced during the Second Temple (Roman) Period, the former in accordance with the requirements of Jewish purity laws.

In an effort to gain a more complete understanding of the value of these artifacts in past social systems, Rutter and Philip build upon the results of recent geochemical analyses of ground stone artifacts in the southern Levant. Although specific basalt vessel manufacturing localities have yet to be identified during late prehistory, Rutter and Philip use the growing database of geochemical analyses of basalt artifacts and flows to posit that social factors could be as, or more important than, a rock type's physical properties.

Concluding Remarks

Ground stone tools are embedded in a broad collection of activities ranging from highly mobile hunter-gatherers to fully sedentary inhabitants of urban settlements, and as such are relevant to an enormous pool of potential research questions. As Peterson notes in the concluding paper, the diversity of material culture and analytical approaches is matched by the range of theoretical perspectives engaged by authors in this volume, reflecting trends and debates across the discipline. These studies indicate that despite a continued interest in the quotidian realm—commonly assumed to be the extent of ground stone tools—the role of stone objects in ritual activities, gendered activities, elite exchange and burial or social emulation also engage these researchers.

While recognizing the importance of the innovative approaches in this volume, descriptive and classificatory reports remain an essential component to advancing studies of ground stone analyses; without them, we would lack the future possibility of using quantification and comparison of assemblages to investigate the relationship between artifact morphology, manufacturing, and reuse, regional and spatial variability, and the socio-economic context in which these objects were produced, exchanged and abandoned. It is essential, then, to continue to move past poor collection, curation and reporting habits of ground stone assemblages if we are to establish the utility of ground stone artifact analysis to broader research questions.The studies collected in this volume indicate that scholars are moving in the right direction in establishing new innovative parameters for analysis beyond description and classification.

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