Lithic Technology and Ritualistic Use: Analysis of Cores at HOR-1 Pyre Cremation Assemblage

Cyrus Solhjou

ABSTRACT

The Hora Mountain site (HOR-1) in Malawi contains Africa's earliest known cremation, dated to 11-12 ka, providing a unique opportunity to examine the intersection of technology and ritual behavior in early Holocene hunter-gatherers. This study analyzed 142 quartz cores from excavated pyre deposits to investigate whether lithic technology varied systematically in relation to mortuary activity. Cores were measured for mass and dimensional attributes using digital calipers and precision scales, then categorized by stratigraphic context (above-ash, within-ash with remains, within-ash without remains, and below-ash). Analysis revealed patterning: miniaturized, exhausted cores concentrated within cremation deposits containing human remains, while substantially larger specimens occurred in above-ash contexts, with significant mass differences (15.81g vs. 0.58g). Consistent bipolar reduction techniques throughout the sequence indicate technological continuity across multiple cremation events. The deliberate placement of functional tools within mortuary contexts represents economic investment in ritual practice, as useful objects were removed from circulation. These findings challenge traditional interpretations of African hunter-gatherers as purely nomadic groups with simple social structures, instead demonstrating that Late Pleistocene communities created persistent ritual places where technological and symbolic behaviors converged. The HOR-1 assemblage provides empirical evidence that stone tool technology served dual practical and cultural functions, transforming everyday objects into vehicles for memory, identity, and meaning in early African societies.

INTRODUCTION

Understanding how early humans used technology to express meaning, memory, and identity has long challenged archaeologists. Stone tools are often treated as the most utilitarian artifacts of prehistory. Still, they detail social and symbolic choices that provide insight into the early humans' thoughts on what to make, where to make it, and why. In recent decades, studies of miniaturization and bipolar reduction have reframed how archaeologists interpret these technologies, suggesting that even small fragments of quartz can reveal complex adaptive and cultural behavior (Ambrose 2002; Wadley 2014). This study examines the lithic assemblage from the Hora Mountain cremation site (HOR-1) in Malawi, the earliest known cremation in Africa, dated to roughly 11–12 ka (Cerezo-Román et al., 2025). By analyzing quartz cores collected above, within, and below the pyre deposits, this project explores whether differences in lithic technology correspond to ritual activity, production continuity, or both.

Lithic miniaturization, or the production of small tools and exhausted cores from limited raw materials, has been recognized as a hallmark of technological flexibility in Late Pleistocene societies. Pargeter (2019) defines miniaturization as both a practical response to resource constraints and a cognitive adaptation that reflects planning depth and innovation. Ambrose (2002) similarly argued that microlithic production in sub-Saharan Africa represents not merely economic efficiency but symbolic complexity: "small things remembered" as markers of shared identity. Across southern Africa, miniaturized assemblages appear in contexts of changing mobility and climate, linking technological choices to broader patterns of behavioral modernity (Pargeter 2019; Wadley 2014).

Within this framework, bipolar reduction—placing a stone core on an anvil and striking it from above—emerges as one of the most economical and widespread lithic strategies. Binford and Quimby (1963) first characterized bipolar reduction in North American contexts, noting its distinctive crushing and splintering scars. Later, Barham (1987) replicated these patterns experimentally in southern Africa, confirming that bipolar knapping was deliberate and systematic, rather than merely the chaotic byproduct of poor material. Flenniken (1981) extended this argument through controlled experiments showing that flat bipolar cores can yield small, standardized flakes efficiently. Together, these studies redefined bipolar reduction as an intentional technological system rather than a primitive or wasteful technique.

Subsequent research has deepened that picture. Goodyear (1993) described bipolar reduction as a strategic response to raw-material scarcity, maximizing flake output when larger cores were unavailable. Driscoll (2010) analyzed quartz mechanics in early Irish assemblages and demonstrated how fracture unpredictability can be managed through bipolar methods, producing consistent results even on poor-quality raw material. Building on this foundation, de la Peña (2015) provided a qualitative guide for identifying bipolar traits, including crushing, opposed bulbs, and linear impact platforms, on both flint and quartz. These diagnostic criteria provide the methodological backbone for the present analysis of HOR-1 cores.

Experimental studies by Pargeter and de la Peña (2017) further connected bipolar reduction to lithic miniaturization, demonstrating through replication that milky-quartz nodules can be systematically reduced to extremely small sizes without sacrificing flake control. Their work also established measurable expectations, specifically defining scar morphologies and compression angles that serve as reference points for archaeological identification. Barham (1987) and Callahan (1987) both confirmed that bipolar reduction produces diagnostic traits even at small scales, allowing archaeologists to reconstruct sequences of reduction from highly fragmented cores such as those at HOR-1. Collectively, these experiments reveal a technological tradition grounded in adaptation and intentionality.

At the same time, research in African Middle and Later Stone Age contexts has shown that technological strategies often intersect with symbolic or ritual behavior. d'Errico, Backwell, and Wadley (2012) identified regional variability in bone technology at Sibudu Cave, interpreting repeated use of certain materials as evidence of social memory and ritual action. Mourre and Jarry (2011) demonstrated that splintered or "pièces esquillées"—the classic bipolar product—can serve both functional and symbolic roles, blurring the line between toolmaking and meaning-making. In this light, the small, exhausted quartz cores surrounding the HOR-1 cremation may represent more than discarded waste. Their presence within and above the pyre deposits could indicate acts of offering, site revisitation, or commemoration—behaviors reflecting cultural continuity and collective memory.

The HOR-1 cremation itself offers a rare glimpse into how early Holocene hunter-gatherers in Africa memorialized the dead. Excavations reveal multiple burn events and microlaminated ash layers, suggesting that the pyre was revisited over time. If the lithics associated with these deposits exhibit consistent technological signatures, such as repetitive bipolar reduction on locally sourced quartz, they may signal both practical knapping activity and symbolic reuse of the place. By quantifying morphological and dimensional differences in cores from distinct stratigraphic contexts (above-, within-, and below-ash layers), this study examines whether the assemblage reflects ordinary production debris or deliberate deposition associated with ritual practice.

This research situates HOR-1 within a long trajectory of lithic innovation and symbolic behavior. Drawing on experimental and ethnographic parallels (Pargeter 2019; de la Peña 2015; Ambrose 2002; Wadley 2014), it treats technology not merely as a survival strategy but as a cultural expression. The following analysis compares quantitative and qualitative attributes of cores to evaluate (1) whether technological variation corresponds with pyre stratigraphy, and (2) whether such variation can be interpreted as evidence of ritualized behavior. Through the integration of lithic analysis and contextual interpretation, the HOR-1 assemblage offers new insights into how early African societies linked the material and the metaphysical: how the making and breaking of stone became intertwined with the making and remembrance of human life.

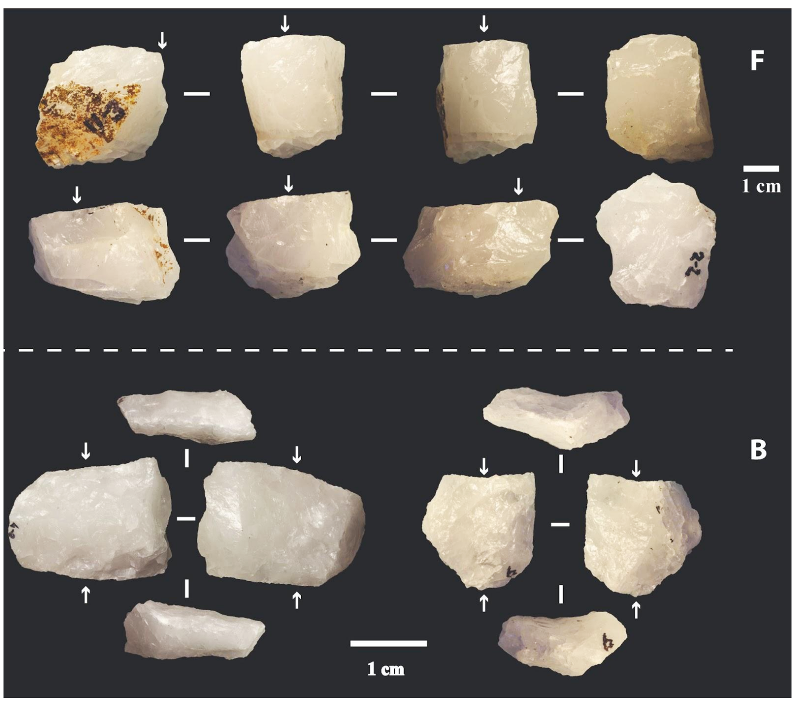

Figure 1: Milky quartz freehand cores (top) and bipolar cores (bottom). Photos and diagram created for the African Paleoscience Lab Quartz Sorting Guide using a photo editing and modeling app, 2024.

METHODS

The Hora Mountain (HOR-1) site is situated in northern Malawi's Kasitu Valley, a region characterized by granite hills and open miombo woodland. The rock shelter lies partway up the mountain's slope and has preserved multiple layers of human activity spanning the Late Pleistocene to the early Holocene. HOR-1 is best known as Africa's earliest confirmed cremation, dating to roughly 11,000–12,000 years ago (ka) (Cerezo-Román et al., 2025). A pyre cremation refers to a funerary feature in which a human body is intentionally burned on an open fire structure, often leaving behind ash, charcoal, and calcined bone intermixed with artifacts. Because organic material and heat-altered stone can remain stratified in such features, pyre contexts provide rare evidence of how early humans combined ritual and technology.

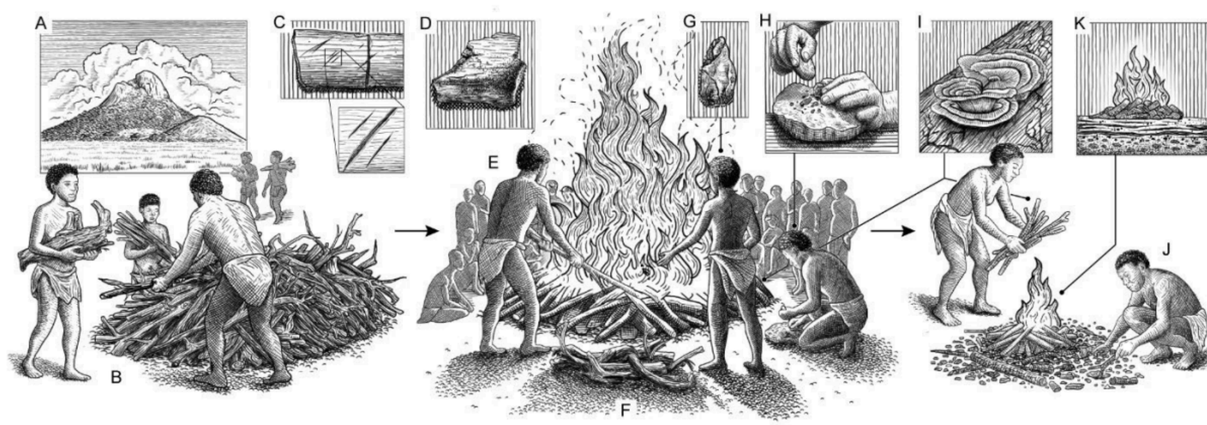

Figure 2: Sequence of events forming the HOR-1 cremation feature. (A) The site lies at the base of a granite inselberg. (B) Large amounts of wood were gathered to build the pyre, indicating communal labor. (C) Cut marks on bone show defleshing before burning. (D) Blackened, heat-fractured remains reflect intense fire exposure. (E) The pyre and body at Cluster 1 were disturbed, creating Cluster 2. (F) High temperatures were maintained by adding fuel. (G) Convergent points occur only within cremation deposits. (H) Bipolar reduction dominates the lithic assemblage. (I) Charred *Ganoderma* and termite tunnels indicate use of deadwood. (J) Missing cranial and dental remains suggest removal before or after cremation. (K) Fires were repeatedly rekindled at the same location, preserving ritual memory. Illustration created by Cerezo-Román et al. (2025), HOMER Consortium.

This study focuses specifically on the lithic material—stone artifacts—recovered from the HOR-1 cremation feature. In archaeology, a core is the piece of stone from which flakes are struck to make cutting tools. Examining cores allows researchers to reconstruct how people made and used tools. All cores in this study were made of locally available milky quartz, a raw material common across the Hora Mountain slopes.

Lithic material was analyzed to assess technological variation across the cremation deposit. Excavations at HOR-1 were conducted by the Malawi Ancient Lifeways and Peoples Project (MALAPP) between 2016 and 2022. Analysis took place during the 2025 summer session at the African Paleoscience Laboratory of New York University under the supervision of Pieper Grantham (Undergraduate Mentor), Keegan Martin (Undergraduate Mentor), and Dr. Justin Pargeter (Lab's Principal Investigator/Mentor).

During excavation, the pyre deposit was divided into one-meter-square units, each subdivided into four quadrants labeled A, B, C, and D. This study examined quadrants E11-a and E11-c, the two sections containing the densest concentration of burned material and lithic debris. Quadrant E11-a represents the portion of the pyre with a comparatively dense amount of human remains, with the most cores of the cremation, while E11-c contains fewer cores, in turn having more diffuse ash and sediment. Comparing these two areas helps determine whether activity patterns were consistent across the pyre surface.

Artifacts were recovered through two methods: plotted and screened collection. Larger artifacts recorded in three-dimensional space during excavation are known as Plotted Finds (PF), while 3 mm artifacts refer to smaller items recovered by sieving excavated sediment through a 3 mm mesh screen. This dual recovery method captures both large, intact objects and small, fragmented pieces that would otherwise be missed. The PF and 3 mm categories were further subdivided into "complete" and "broken" cores to evaluate fragmentation patterns that might reflect burning, trampling, or later sediment disturbance.

Each core was assigned a unique identification number and measured for a consistent set of variables. Digital calipers were used to record the maximum dimension, width, and thickness along orthogonal axes to the nearest 0.01 mm. Mass was measured using a digital balance to the nearest 0.01 g.

Technological traits were recorded in accordance with the quartz reduction criteria outlined by de la Peña (2015) and Pargeter (2019). Reduction type, bipolar or freehand, was determined by the presence of opposed crushing, splintered platforms, and compression scars, which are diagnostic of bipolar reduction (de la Peña, 2015). This involves placing the core on an anvil and striking from above to maximize flake output from small nodules. Freehand reduction describes striking flakes off a held core with a hammerstone. The intended product of each core (flake or blade) was noted, with blades defined as flakes at least twice as long as they are thick. Additional observations included the presence of cortex (the raw stone surface), degree of exhaustion, and completeness.

Stratigraphic context was determined by lot number and grouped into four main categories:

1. Above-ash (lots 99, 213, 214): deposits overlying the cremation feature, likely representing later or post-ritual activity.
2. Within-ash with remains (lots 128, 145, 146, 251, 254, 258, 746, 766, 774): ash layers directly containing human bone fragments.
3. Within-ash without remains (lots 100, 113, 119, 220, 247, 252, 765, 912): cremation layers lacking human remains but associated with ash and charcoal.
4. Below-ash (lots 915, 921): sterile layers underlying the pyre, potentially predating the cremation event.

RESULTS

A total of 142 quartz cores were analyzed from the HOR-1 pyre assemblage. Measurements of mass, dimensional attributes, and technological traits were used to examine reduction intensity (the degree to which a stone was worked) and depositional variation (the differences between cores within layers). Together, these patterns help reconstruct both the technological behavior and the ritual use of space at the site.

Recovery and Contextual Patterning

Artifacts from HOR-1 fall into two main recovery classes: 3 mm and PF (Plotted Find), representing different stages of preservation and excavation. The 3 mm fraction captures the smallest, most fragmented pieces of quartz, often representing the exhausted remains of cores broken by heat or extensive use. The PF material, by contrast, includes larger and more complete specimens recovered individually during excavation.

When compared statistically, these two categories reveal clear differences in size and weight. Complete 3 mm cores between quadrants E11-a and E11-c averaged 2.03 g per core (n=41), while broken 3 mm cores averaged 0.94 g (n=65). Combined, the 3 mm fraction averaged 1.37 g across 106 specimens.

By contrast, Plotted Find (PF) cores were substantially heavier: complete PF specimens averaged 9.62 g (n=21), and broken PF specimens averaged 2.71 g (n=11). Altogether, PF cores averaged 7.25 g across 32 specimens. These results confirm a clear recovery bias toward larger artifacts in plotted samples, a pattern commonly observed in mixed recovery assemblages (Pargeter 2019).

Within the 3 mm fraction, fragmentation corresponded strongly with mass. Broken cores consistently weighed less than complete examples, likely reflecting post-depositional processes such as trampling, sediment compaction, or burning within the pyre. Among PF specimens, the same relationship held true: complete cores were roughly three times heavier than broken ones, suggesting that breakage occurred after deposition rather than during the toolmaking process. Together, these comparisons confirm that physical damage is primarily driven by taphonomic forces rather than human action.

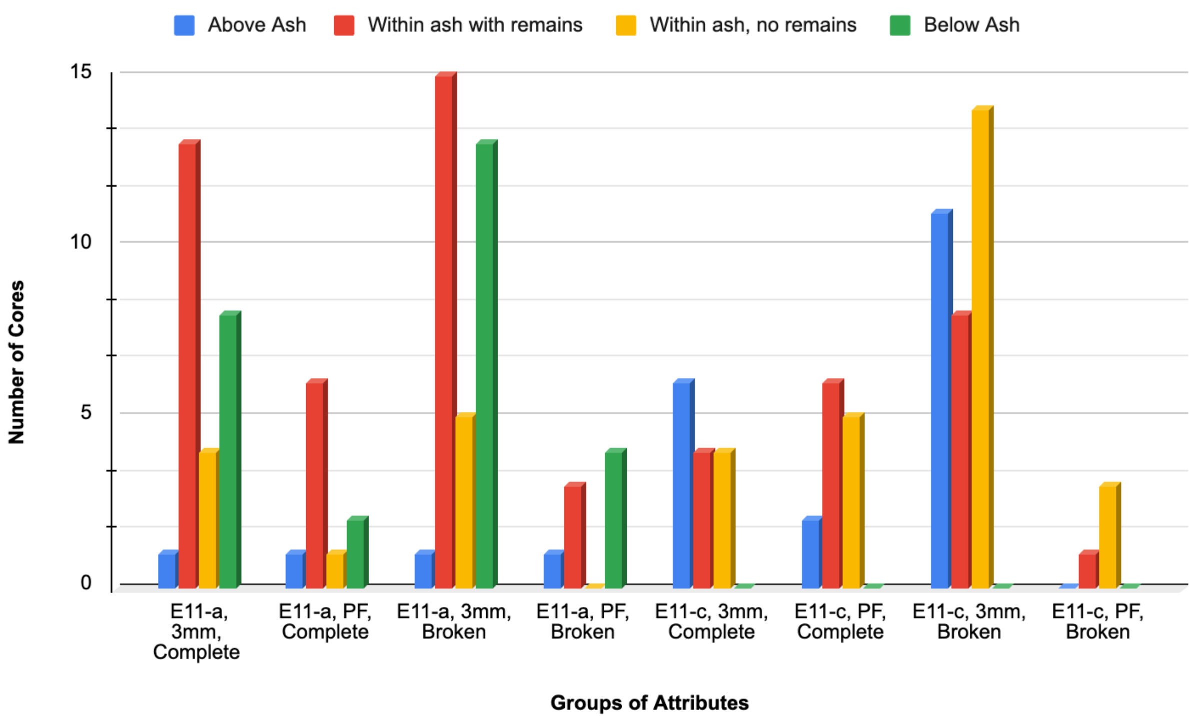

Figure 3: Number of quartz cores by recovery class, quadrant, completeness, and stratigraphic context. Most cores occur within ash deposits containing remains, with higher counts of broken 3 mm cores in E11-a and complete 3 mm cores in E11-c. Graph created by the student researcher using Google Sheets, 2025.

Spatial and Stratigraphic Distribution

Cores were unevenly distributed across stratigraphic contexts. Above-ash deposits (lots 99, 213, 214) contained 20 specimens, while within-ash contexts without remains contained 36, within-ash with remains contained 56, and below-ash contexts contained 27. The highest density occurred within cremation layers containing human bone, indicating that lithic material was most strongly associated with direct mortuary deposits (Cerezo-Román et al., 2025).

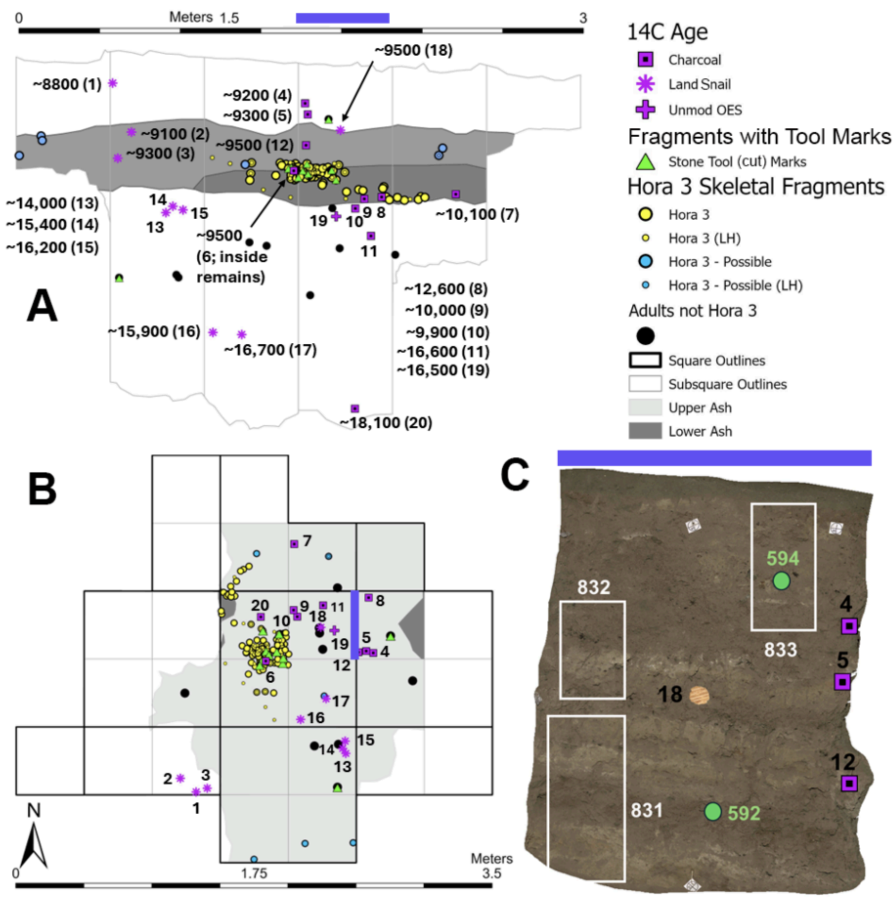

Figure 4: Profile (A) and plan (B) views of the HOR-1 cremation feature showing radiocarbon ages and the concentration of adult remains within the within-ash with remains layer. Bone fragments are often found among lithic materials and heated rocks, suggesting an intentional association during the burning process. (C) Locations of phytolith (green) and micromorphology (white) samples. The blue line links equivalent stratigraphic sections between views. Created in a stratigraphic tooling software by Cerezo-Román et al. (2025), HOMER Consortium.

Comparisons between quadrants reveal subtle but meaningful spatial differences. Quadrant E11-a, located toward the center of the pyre, contained both the largest and most diverse range of cores, including several heavy PF specimens over 10 g. Quadrant E11-c, slightly offset from the main pyre, produced fewer cores overall, dominated by small, fragmented 3 mm specimens averaging 1.5 g. This asymmetry suggests differential deposition, where E11-a may represent the central burning area and E11-c the peripheral spread of ash and residue.

Mass averages also varied by depth and context. Above-ash deposits yielded larger, heavier cores (mean ≈ 2.8 g), possibly redeposited from surface activities or later site reuse. Within-ash layers without remains averaged 3.5 g, while within-ash with remains showed the highest mean mass (≈ 4.1 g), consistent with larger, more intact artifacts being deposited alongside cremation materials. Below-ash layers contained the smallest and most reduced cores (mean ≈ 1.5 g), likely representing earlier background occupation before the pyre was constructed.

This vertical pattern—from small, exhausted cores at the bottom to larger, intact cores at the top—reflects the changing use of space over time. The presence of larger artifacts in upper layers may represent later, secondary deposition as the site was revisited. In contrast, the fine, heat-altered debris within the pyre layers reflects direct association with burning events.

Technological Traits

Both bipolar and freehand reduction techniques were identified across all contexts, with bipolar traits present in many small, exhausted cores and freehand features more common on larger specimens. The consistent presence of both methods across all stratigraphic levels suggests technological continuity rather than distinct occupational phases.

Smaller, exhausted 3 mm cores almost exclusively displayed bipolar characteristics, confirming that quartz miniaturization at HOR-1 was an intentional process rather than a byproduct of raw material limitations. Larger PF specimens included both freehand and bipolar examples, showing that knappers alternated between strategies depending on core size and shape. This combination aligns with experimental findings by Pargeter and de la Peña (2017), who demonstrated that bipolar reduction allows efficient use of small quartz nodules without sacrificing flake control.

Dimensional averages support this pattern. Across all contexts, complete cores measured between 14 and 27 mm in maximum dimension, while broken cores averaged 12 to 23 mm, confirming that breakage typically affected smaller specimens. The combination of small size, opposed impact scars, and high exhaustion levels points to a deliberate effort to reduce quartz nodules to exhaustion, a hallmark of Late Pleistocene miniaturization (Pargeter 2019).

Summary

The quantitative and qualitative results together paint a clear picture of structured, repetitive behavior at HOR-1. Larger, intact cores are often found above and within the cremation deposits, frequently spatially clustered with human remains. Smaller, exhausted cores dominate the ash matrix itself, consistent with debris produced during or after burning events. Reduction techniques remained constant across all layers, indicating that the same community or cultural group likely revisited the pyre site repeatedly, adhering to stable technological traditions.

The combination of technological continuity, stratigraphic concentration, and deliberate deposition within cremation layers indicates that the HOR-1 lithic assemblage was not random debris but part of an intentional mortuary practice.

DISCUSSION

The HOR-1 lithic assemblage reveals complex patterns that intersect technological, depositional, and potentially ritual dimensions of early Holocene behavior. The systematic differences observed across stratigraphic contexts, combined with the concentration of material within cremation deposits, suggest that lithic production and deposition at this site extended beyond purely utilitarian concerns.

The dramatic size differences between above-ash and within-ash contexts, particularly evident in the E11-a 3mm complete cores (15.81 g above vs. 0.58-1.42 g within/below), cannot be explained solely by recovery bias. These patterns suggest either selective deposition of larger cores in upper levels or differential reduction intensity across temporal phases of site use. The concentration of specimens within ash deposits containing human remains (n = 56) compared to other contexts suggests an intentional association between lithic material and mortuary activity. This pattern becomes more significant when considered alongside the site's evidence for repeated cremation events and ash microlamination, indicating multiple episodes of burning and deposition.

The prevalence of miniaturized cores throughout the assemblage aligns with broader Late Pleistocene patterns in southern Africa, where lithic miniaturization has been linked to both economic and symbolic behaviors (Pargeter 2019; Ambrose 2002). At HOR-1, the production of extremely small cores through bipolar reduction may have served dual purposes: maximizing raw material utility while creating objects suitable for ritual deposition. The fact that these miniaturized products concentrate within cremation deposits rather than dispersing across the site supports their potential symbolic significance.

The asymmetrical distribution of material between quadrants A and C, particularly the absence of quadrant C cores in below-ash contexts, suggests spatial structuring of activities at the site. This patterning could reflect designated areas for different stages of the cremation process, with lithic reduction and deposition following culturally prescribed spatial rules. Alternatively, it may indicate chronological differences in site use, with earlier phases (represented by below-ash deposits) showing more restricted spatial extent.

The consistent application of bipolar reduction throughout the sequence demonstrates technological continuity despite potential changes in site function. This continuity suggests that the same communities or closely related groups returned to HOR-1 repeatedly, maintaining consistent technical traditions while engaging in mortuary rituals. The combination of technological consistency and stratigraphic concentration within cremation deposits strengthens the interpretation of intentional, culturally meaningful deposition rather than incidental accumulation of knapping debris.

Comparisons with other African Later Stone Age sites reveal that the association of lithic material with mortuary contexts is not unique but remains relatively rare in the archaeological record. The HOR-1 assemblage thus provides valuable evidence for understanding how early Holocene hunter-gatherers integrated technological and ritual practices. The deliberate placement of exhausted cores within cremation deposits may have served to commemorate the deceased, mark territorial claims, or fulfill spiritual obligations related to death and renewal.

The evidence for post-depositional rather than intentional breakage, indicated by consistent mass differentials between complete and broken specimens across all contexts, suggests that the cores were deposited whole as part of mortuary rituals. Their subsequent fragmentation through taphonomic processes does not diminish their original symbolic intent. Indeed, the act of depositing functional tools in mortuary contexts represents a significant economic choice, removing useful objects from circulation to fulfill social or spiritual obligations.

CONCLUSION

This analysis of 142 quartz cores from the HOR-1 cremation site provides new insights into the intersection of technology and ritual in early Holocene Africa. The systematic variation in core attributes across stratigraphic contexts, combined with the concentration of lithic material within cremation deposits, supports the hypothesis that stone tool production and deposition at HOR-1 served both practical and symbolic functions.

Key findings include: (1) significant size variation between stratigraphic contexts, with above-ash deposits containing substantially larger cores; (2) concentration of lithic material within ash deposits containing human remains; (3) consistent use of bipolar reduction techniques throughout the sequence; (4) evidence for post-depositional rather than intentional fragmentation; and (5) asymmetrical spatial distribution suggesting structured use of site space.

These patterns, when considered alongside the site's evidence for repeated cremation events, indicate that HOR-1 functioned as an ongoing location where technological and ritual practices converged. The deposition of miniaturized cores within cremation contexts represents a materially costly behavior that prioritized social or spiritual values over economic utility. This practice links HOR-1 to broader patterns of symbolic behavior in Late Pleistocene Africa, while highlighting the unique ways in which local communities expressed their cultural identity through technology.

Future research should focus on expanding the sample size through analysis of additional quadrants, conducting detailed technological analysis, including refitting studies, and comparing the HOR-1 assemblage with contemporary sites in the region. Experimental replication of bipolar reduction on local quartz sources would help establish whether the observed size distributions result from raw material constraints or deliberate technological choices. Additionally, microscopic analysis of edge damage and residues could reveal whether cores were used prior to deposition or manufactured specifically for ritual purposes.

The HOR-1 lithic assemblage ultimately demonstrates that even the smallest, most fragmentary archaeological remains can illuminate complex past behaviors. Through careful analysis of technological attributes and depositional contexts, these miniaturized quartz cores reveal how early Holocene communities in Africa wove together the practical and the sacred, transforming simple stone tools into vehicles for memory, identity, and meaning. In doing so, they remind us that human technology has always been more than a mere survival strategy: it is, and has always been, a fundamental medium for cultural expression.

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