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# Beyond the Rohri Hills Plateau: A Comparative Technological Analysis of Palaeolithic Scraper Workshops at Veesar Valley and the Rohri Hills, Sindh, Pakistan

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**Abstract**
The Rohri Hills of Upper Sindh are one of South Asia's best-known chert-procurement and lithic-production landscapes, yet nearby Veesar Valley preserves a workshop record whose technological emphasis differs from the classic plateau model. This paper compares Veesar Valley with Palaeolithic workshop evidence from the Rohri Hills to evaluate how similar raw-material opportunities were translated into different reduction strategies, formal-tool outputs and landscape organizations. The Veesar dataset comprises 270 identifiable lithics from 98 mapped workshops. Ninety scrapers form 33.3% of identifiable lithics; side scrapers dominate the scraper class (n=76; 84.4%) and occur in 37 of 51 lithic-bearing workshops. Cortex values on 118 artifacts include low, intermediate and high categories in comparable frequencies, supporting multi-stage local reduction when integrated with cores, flakes, crested elements, blades, picks and hammerstones. Published Rohri Hills research documents a longer and technologically diverse sequence, including Acheulean workshops, Late/Upper Palaeolithic production and extensive Indus-period quarrying and blade manufacture. Field comparison records larger, more heavily weathered and more extensively decorticated artifacts in parts of the Rohri comparative sample, whereas Veesar preserves smaller artifacts, partial cortex and a conspicuous scraper component. These contrasts are treated as testable hypotheses rather than universal distinctions. The comparison shows that raw-material abundance alone did not determine technological organization. Veesar Valley is best interpreted as a scraper-rich, multi-stage workshop landscape within the wider Rohri–Thar chert province, while the Rohri Hills represent a long-duration extraction and production system. The study establishes a comparative framework for future stratified, metric and geoarchaeological testing.

**Keywords:** Veesar Valley; Rohri Hills; Palaeolithic; scraper technology; lithic reduction; chert procurement; technological organization.

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## 1. Introduction

Comparative lithic archaeology is most informative when it moves beyond the question of whether two assemblages contain the same formal tool types and instead asks how technological systems were organized in relation to raw material, mobility, reduction goals, tool maintenance and landscape structure. Technological-organization research has demonstrated that procurement, transport, core reduction, blank selection, retouch and discard form interdependent behavioural decisions rather than isolated analytical categories (Binford 1979, 1980; Bamforth 1986; Kelly 1988; Nelson 1991; Andrefsky 1994, 1998, 2009; Kuhn 1994, 1995; Odell 2004). The chaîne opératoire and reduction-sequence traditions similarly emphasize the sequence and transformation of technical actions, although they emerged from different intellectual histories (Leroi-Gourhan 1964; Tixier et al. 1980; Geneste 1985; Sellet 1993; Inizan et al. 1999; Shott 2003; Bar-Yosef and Van Peer 2009; Soressi and Geneste 2011).

These approaches are particularly relevant to quarry-workshop landscapes. Raw-material abundance creates technological possibilities, but it does not prescribe a single reduction strategy. High-quality stone may support expedient flake production, curated formal tools, large-scale blank manufacture, or several of these strategies at different times (Andrefsky 1994; Kuhn 1995). Therefore, two geographically related chert-rich landscapes can share geological opportunity while differing substantially in the organization and visibility of technological activities.

Scrapers offer a useful comparative lens because their formal morphology is influenced by blank shape, edge position and reduction history. Classic typologies remain indispensable descriptive tools (Bordes 1961; Débenath and Dibble 1994),

but experiments and archaeological studies show that repeated retouch and resharpening can alter scraper form, thickness relationships and typological classification (Dibble 1984, 1987, 1995; Kuhn 1990, 1992; Rolland and Dibble 1990; Clarkson 2002; Hiscock and Clarkson 2005; Eren et al. 2005; Brumm and McLaren 2011). Comparative studies must therefore distinguish the frequency of formal scraper categories from the technological processes that produced them.

The Rohri Hills of Upper Sindh provide one of the strongest South Asian settings in which to explore this problem. Their limestone formations contain abundant high-quality chert, and research has documented repeated exploitation from the Early Palaeolithic through later prehistoric periods (Allchin 1976; Biagi and Cremaschi 1988, 1991; Biagi et al. 1996, 1998–2000; Biagi 2008, 2017, 2022, 2024; Biagi and Nisbet 2011; Biagi and Starnini 2011, 2014; Kenoyer 1998; Vidale 2000; Law 2011). Veesar Valley, situated to the south within the Rohri–Thar transition, preserves another dense workshop system associated with chert-bearing limestone and dune-interdune environments.

The central problem of this paper is whether Veesar Valley should be interpreted merely as an extension of the Rohri Hills quarry-workshop tradition or as a technologically distinctive manifestation of chert exploitation. The comparison is especially timely because the expanded Veesar catalogue differs from earlier small-sample interpretations: the current dataset is overwhelmingly side-scraper-rich within the scraper class, whereas earlier Veesar research emphasized volumetric blade technology and a stronger end-scraper signal. This changing empirical picture makes explicit sampling history and analytical denominator control essential.

The paper asks five questions: (1) Which technological features are genuinely shared between Veesar Valley and the Rohri Hills? (2) Which contrasts are supported quantitatively at Veesar and by published evidence in the Rohri

Hills? (3) What is the significance of the strong side-scraper signal at Veesar? (4) How should field-observed differences in artifact size, cortex and patination be evaluated scientifically? (5) What does the comparison reveal about the relationship between raw-material abundance and technological organization in prehistoric Sindh?

## 2. Study areas and environmental setting

### 2.1. Rohri Hills

The Rohri Hills form an elongated limestone plateau system east of the Indus alluvial plain in Upper Sindh. Chert occurs in nodules and seams within the limestone and is also exposed through natural weathering. The hills have long been recognized as an important Palaeolithic and later prehistoric lithic-resource zone. Geomorphological research linked artifact distributions with plateau surfaces, erosional processes and raw-material availability, while archaeological survey and excavation demonstrated direct procurement and workshop activity (Biagi and Cremaschi 1988; Biagi et al. 1996).

The archaeological record is diachronically complex. Acheulean workshops, Late/Upper Palaeolithic production localities and major Indus-period quarry/mining systems all occur within the broader Rohri landscape. This long-term use makes the hills analytically valuable but also warns against treating "Rohri Hills technology" as a single homogeneous tradition (Biagi and Cremaschi 1991; Biagi et al. 1998–2000; Biagi and Starnini 2011; Biagi 2024).

### 2.2. Veesar Valley

Veesar Valley lies in the western Thar Desert–Rohri Hills transition. The project geography describes a mosaic of low limestone outcrops, dune surfaces, interdunal/alluvial valleys, seasonal drainage and nearby water-retaining depressions. Chert, including banded material, is locally available. The broader field report recorded 153 workshops across survey activity, whereas the

standardized catalogue/GIS analysis used here contains 98 mapped workshop localities with usable artifact associations. These totals refer to different documentation scopes and must not be conflated.

The wider Thar region has experienced major Quaternary environmental fluctuations. Palaeoenvironmental work in Rajasthan and the Thar documents changes in effective moisture, lakes and vegetation that altered the ecological possibilities of arid-zone landscapes (Singh et al. 1974; Allchin et al. 1978; Enzel et al. 1999; Blinkhorn et al. 2017). Procurement of stone in such settings can be embedded within movements directed toward water, plant and animal resources rather than occurring as a wholly separate economic activity (Binford 1980; Kelly 1988; Kuhn 1995).

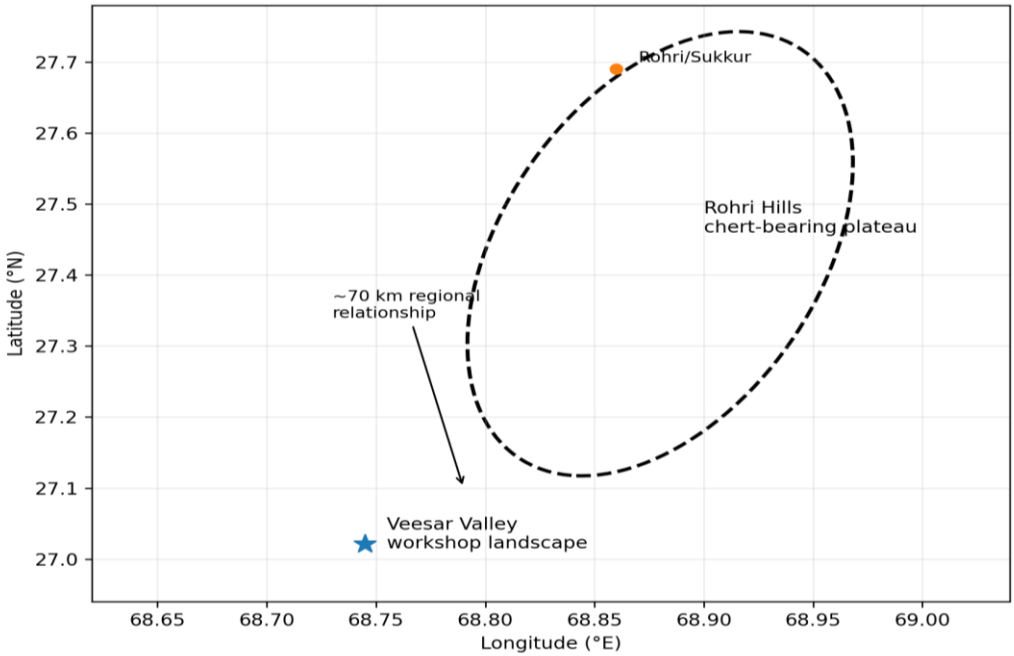



**Figure 1.** Schematic regional relationship of Veesar Valley and the Rohri Hills. The Rohri Hills corridor is shown for orientation and is not intended as a surveyed archaeological boundary.

## 3. Archaeological background of the comparison

### 3.1. Rohri Hills as a persistent lithic-resource landscape

The Rohri Hills sequence illustrates repeated technological reinvention of the same geological resource. Early Palaeolithic research identified Acheulean occurrences and emphasized their environmental context (Biagi and Cremaschi 1988). Ziarat Pir Shaban subsequently provided workshop evidence for bifacial manufacture and local raw-material exploitation (Biagi et al. 1996). These contexts establish that chert procurement structured technological behaviour long before the later prehistoric quarry systems.

Late/Upper Palaeolithic research at Ziarat Pir Shaban 2 and related localities documented cores, flakes, blade-like products, crested elements, hammerstones and picks, demonstrating organized production in another technological phase (Biagi et al. 1998–2000; Biagi 2008, 2017, 2022). Middle Palaeolithic discussion is more complicated: Levallois/Mousterian assemblages are present in Sindh, but classic Levallois-Mousterian signatures are not uniformly distributed across the Rohri Hills and should not be projected onto every scraper-bearing locality (Biagi and Starnini 2011, 2014).

The Indus-period record reveals the largest documented scale of exploitation. Harappan quarrying and flint working at the Rohri Hills included extraction features, precores, cores and specialized blade production associated with regional exchange and urban craft systems (Biagi and Cremaschi 1991; Kenoyer 1998; Vidale 2000; Law 2011; Biagi 2024). The technological objective of these later industries differs fundamentally from Palaeolithic scraper production, but their scale demonstrates the exceptional persistence of the resource landscape.

### 3.2. Veesar Valley research history

Veesar Valley was documented as an unusually dense workshop landscape outside the main Rohri plateau. Field descriptions recorded Lower Palaeolithic objects in

low frequency, a strong Middle/Upper Palaeolithic workshop component, occasional Mesolithic indicators and later Indus-related material. Earlier research also documented volumetric blade technology and argued for the significance of inter-dune factory localities. The present paper retains those observations as part of the research history but evaluates them against the expanded quantitative catalogue rather than assuming that the earlier sample and the current 98-workshop analytical system are equivalent.

**Figure 2.** Workshop-surface contrast from the Veesar/Rohri comparative field documentation: (A) small Palaeolithic workshop surface; (B) a high-density workshop surface. Source: project field documentation.

## 4. Comparative analytical framework

### 4.1. Why technological organization rather than typological matching?

Direct typological matching is insufficient for this comparison because the two regions preserve different chronological mixtures and different archaeological sampling histories. A scraper in a Middle Palaeolithic flake assemblage, a bifacial implement from an Acheulean workshop and a Harappan blade core all occur within the same broad chert province but belong to different technical systems. The comparative unit must therefore be the organization of procurement and reduction rather than simple co-occurrence of artifact names (Nelson 1991; Andrefsky 2009; Shea 2013).

This approach also helps separate technological inference from functional interpretation. Microwear studies show that scraper morphology alone cannot securely identify hide, wood or bone working without use-wear or residue evidence (Keeley 1980; Rots 2010). Experimental lithic studies likewise emphasize that morphology, reduction and functional damage must be tested through replicative and quantitative methods rather than assumed (Marreiros et al. 2020). Three-dimensional core analysis increasingly provides another route for evaluating platform geometry and reduction organization (Valletta et al. 2021).

### 4.2. Cortex and source-proximal reduction

Cortex is important because both Veesar and Rohri are source-oriented landscapes. Yet cortex percentage is not a simple clock measuring reduction stage. Cortex can vary with nodule geometry, removal position, blank transport and assemblage formation. Modern cortex studies therefore emphasize assemblage-level expectations and explicit measurement rather than rigid stage assignment (Dibble et al. 2005; Douglass et al. 2008; Douglass and Holdaway 2011; Lin et al. 2016; Middleton 2022). Surface contexts also require attention to discard and geomorphic redistribution (Holdaway et al. 2004; Holdaway and Wandsnider 2006; Fanning et al. 2008; Douglass et al. 2023).

### 4.3. Comparative evidence classes

The analysis distinguishes three kinds of evidence. First, quantitative Veesar evidence derives from the standardized catalogue. Second, Rohri Hills comparisons derive from published excavated or surveyed contexts. Third, several differences—especially relative artifact size, patination, degree of cortex removal and workshop concentration—derive from the project's field-comparison chapter. The third category is retained as a hypothesis-generating dataset, not presented as a statistically representative sample of the entire Rohri Hills.

### 4.4. Analytical comparability and inferential limits

Comparative quarry-workshop studies are vulnerable to a scale problem: frequencies calculated from a systematically catalogued assemblage can appear more precise than observations drawn from legacy surveys, selective collections or phase-specific published descriptions. The present study therefore separates numerical comparison from technological analogy. Veesar frequencies are treated as internally robust only for the standardized catalogue, whereas Rohri Hills evidence is used to define the range of documented technological behaviors rather than to generate artificial two-sample statistics. This distinction follows broader concerns in lithic archaeology about assemblage formation, time averaging and the non-equivalence of collections produced under different recovery protocols (Schiffer 1972, 1987; Shott 2003; Carr and Bradbury 2011).

The same caution applies to cortex. Percent cortex is informative at Veesar because it can be combined with artifact class, core presence and workshop provenience, but it cannot be converted directly into a universal sequence of reduction stages. Experimental and analytical work has shown that nodule size, original morphology, reduction direction, blank selection and transport can all alter the cortical signal (Dibble et al. 2005; Douglass et al. 2008; Lin et al. 2016). Accordingly, the comparative question is framed as whether Veesar preserves a broader or different representation of source-proximal reduction than the Rohri samples described in the literature and project observations, not whether a given cortex percentage has an invariant behavioral meaning.

A second comparability issue concerns spatial scale and collection design. A frequency calculated for a mapped workshop cannot be compared directly with a percentage reported for an entire quarry district unless the survey unit, collection intensity, artifact-size threshold, raw-material exposure and chronological attribution are equivalent. Quarry landscapes are especially susceptible to this

problem because dense production areas may contain millions of uncollected chips while published samples preferentially emphasize diagnostic cores and formal tools. For this reason, the present paper does not use absence from a published Rohri sample as evidence that a technological element was absent from the Rohri Hills. Instead, it asks whether particular organizational signatures are archaeologically prominent under the sampling regimes available. This distinction is consistent with formation-process and technological-organization approaches that separate the structure of the archaeological record from the structure of past behavior (Schiffer 1987; Nelson 1991; Shott 2003; Carr and Bradbury 2011).

**Table 1.** Comparative evidence classes and inferential status used in this study.

| **Evidence class** | **Veesar Valley** | **Rohri Hills** | **Interpretive status** |
|---|---|---|---|
| Quantitative catalogue | 270 identifiable lithics; 98 mapped workshops | No matched Rohri dataset in present project | Strong for internal Veesar frequencies; not a direct two-sample test |
| Published archaeology | Earlier Veesar presentation and field report | Acheulean, Late/Upper Palaeolithic and Harappan quarry/workshop studies | Strong regional contextual comparison |
| Field comparative observations | Size, partial cortex, workshop density, core reuse | Size, heavy patination, extensive decortication, smaller scatters in observed sample | Hypothesis-generating; requires matched sampling |
| Chronology | Mixed surface indicators | Long sequence with multiple excavated phases | Comparison must be phase-sensitive |

## 5. Materials and methods

### 5.1. Veesar Valley dataset control

The Veesar source catalogue contains 327 numbered records. Conservative cleaning excludes pottery, five entries described only as "Lower Palaeolithic Tools," and unresolved artifact-type rows that cannot be assigned consistently. The resulting analytical sample contains 270 identifiable lithics. Fifty-one workshops contain at least one identifiable lithic artifact. Cortex percentages are explicitly recorded on 118 identifiable artifacts; missing values are treated as missing rather than as zero cortex.

**Table 2.** Veesar Valley dataset control and analytical denominators.

| Measure | Value | Analytical denominator |
|---|---|---|
| Field-report workshop total | 153 | Broader field documentation |
| Mapped workshops | 98 | GIS/coordinate framework |
| Workshops with identifiable lithics | 51 | Workshop comparisons |
| Identifiable lithics | 270 | Artifact composition |
| Scrapers | 90 | Scraper composition |
| Side scrapers | 76 | Subtype frequency |
| End scrapers | 14 | Subtype frequency |
| Explicit cortex observations | 118 | Cortex analysis |

### 5.2. Artifact and scraper classification

Artifact types follow normalized catalogue terminology and established lithic descriptive principles (Bordes 1961; Débenath and Dibble 1994; Inizan et al. 1999; Andrefsky 1998; Odell 2004; Shea 2013). Scraper categories are treated as morphological descriptions. Their behavioural interpretation follows reduction-based research emphasizing blank form, retouch and resharpening (Dibble 1984, 1987, 1995; Kuhn 1990, 1992; Clarkson 2002; Hiscock and Clarkson 2005; Eren et al. 2005; Brumm and McLaren 2011).

### 5.3. Rohri Hills comparison protocol

Rohri comparison is literature-led and phase-sensitive. Acheulean workshop evidence is compared with Veesar only at the level of source-proximal

procurement, heavy percussion and technological investment, not scraper frequencies. Late/Upper Palaeolithic workshop evidence is more directly comparable in core, flake, crested and blade-related components. Harappan quarry evidence is used primarily to illustrate extraction scale, specialized blank production and the persistence of raw-material exploitation, not as a direct cultural analogue.

### 5.4. Field-observation comparison

The project comparison chapter records several contrasts: Rohri artifacts in the observed comparative sample are described as larger/heavier, heavily patinated or weathered, more frequently decorticated and associated with smaller/lower-density workshop scatters; Veesar artifacts are described as generally smaller, frequently partially cortical and concentrated in larger workshop scatters, with surface and field-reported sub-surface procurement and repeated conversion of cores into tools. Because no matched Rohri measurements accompany these observations, they are analyzed as explicit propositions for future testing rather than as statistically demonstrated regional differences.

### 5.5. Quantitative logic and reproducibility

All percentages reported for Veesar use explicit denominators. Scrapers are calculated against the 270 identifiable lithics; side- and end-scraper proportions are calculated against the 90-scraper subset; workshop frequencies use the 51 workshops with identifiable lithics; and cortex summaries use only the 118 artifacts with explicit cortex observations. Missing cortex values are treated as missing and are not recoded as zero. This denominator control is necessary because different archaeological questions require different analytical populations, and conflating them would overstate scraper abundance or artificially depress cortex values.

Spatial concentrations are descriptive rather than inferential. The reported peaks at W-75, W-32, W-3, W-43 and W-84 identify where scrapers are most frequent within the standardized catalogue, but they are not presented as statistically independent occupation events. Surface movement, repeated visits and unequal visibility can produce clustering that resembles activity specialization (Schiffer 1987; Holdaway and Wandsnider 2006; Fanning et al. 2008). The analysis therefore uses these concentrations to generate hypotheses about recurrent workshop use and activity differentiation, which require controlled density sampling and stratified testing before stronger behavioral claims are made.

No inferential statistic is calculated between Veesar and Rohri Hills because a matched Rohri artifact database collected under identical criteria is not available in the present project. Avoiding a pseudo-quantitative regional comparison is a methodological choice: the objective is to establish a reproducible baseline for Veesar and a phase-sensitive comparative model that can be tested by future equivalent-area sampling. This approach is consistent with technological-organization studies that prioritize the relationship among procurement, reduction, mobility and discard over simple cross-site type counts (Nelson 1991; Andrefsky 1994, 2009; Kuhn 1995).

For future replication, the comparison can be converted into a standardized protocol with variables recorded at artifact, workshop and landscape scales. Artifact-level variables should include maximum dimensions, mass, cortex proportion, blank type, platform attributes, dorsal-scar organization, retouch location and edge angle. Workshop-level variables should include sampled area, artifact density, frequencies by technological class and the proportion of cortex-bearing pieces. Landscape-level variables should include distance to chert exposures, geomorphic setting, slope, elevation, drainage and evidence for extraction features. Recording these variables under identical procedures in

selected Rohri and Veesar localities would permit multivariate comparison without conflating chronological and sampling differences. It would also allow the current qualitative contrasts—especially workshop density, artifact size, cortex removal and core reuse—to be evaluated as falsifiable hypotheses rather than descriptive impressions (Andrefsky 2009; Carr and Bradbury 2011; Valletta et al. 2021).

## 6. Results

### 6.1. Results: the Veesar Valley technological signature

#### 6.1.1. Assemblage composition and scraper prominence

The cleaned Veesar assemblage contains 76 side scrapers, 61 flakes, 38 picks, 27 cores, 16 crested flakes, 15 blades, 14 end scrapers, 11 crested blades, four hammerstones, three spalls, two nodules and three other individually represented forms. Scrapers therefore account for 90 of 270 identifiable lithics (33.3%). Side scrapers form 84.4% of the scraper class and 28.1% of the total identifiable assemblage. Scrapers occur in 40 of 51 lithic-bearing workshops; side scrapers occur in 37.

**Table 3.** Composition of the identifiable Veesar Valley lithic assemblage

| Artifact category | n | % of identifiable lithics |
|---|---|---|
| Side scraper | 76 | 28.1 |
| Flake | 61 | 22.6 |
| Pick | 38 | 14.1 |
| Core | 27 | 10.0 |
| Crested flake | 16 | 5.9 |
| Blade | 15 | 5.6 |
| End scraper | 14 | 5.2 |
| Crested blade | 11 | 4.1 |
| Hammerstone | 4 | 1.5 |
| Spall | 3 | 1.1 |
| Nodule | 2 | 0.7 |
| Other | 3 | 1.1 |

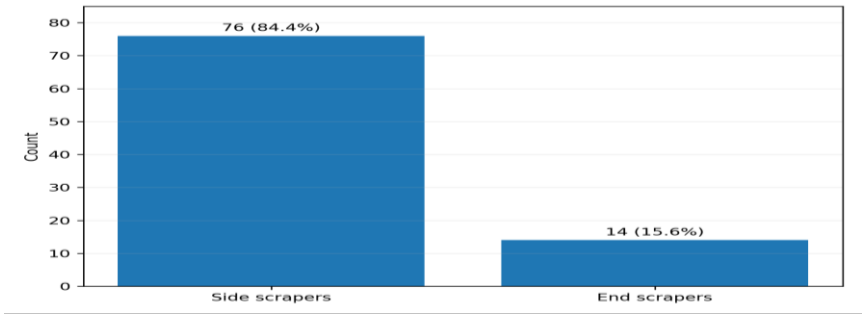



**Figure 3.** Composition of the Veesar Valley scraper assemblage. Side scrapers form 84.4% of scrapers, not 84.4% of the total lithic assemblage.

### 6.1.2. Cortex and reduction breadth

Cortex values range from 5% to 95%. The descriptive groups contain 43 low-cortex artifacts (5–20%), 42 intermediate-cortex artifacts (30–60%) and 33 high-cortex artifacts (70–95%). Their approximate balance is significant because it is consistent with multiple parts of the reduction continuum occurring within the same wider landscape. The interpretation is strengthened by the simultaneous presence of nodules, cores, cortical flakes, ordinary flakes, crested elements, blades and retouched tools; cortex alone would not establish the physical method of quarrying.

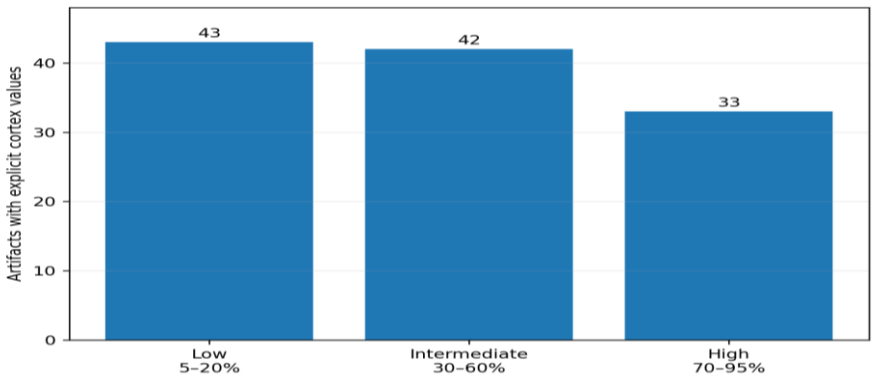



**Figure 4.** Distribution of explicit cortex classes in the Veesar Valley analytical sample (n = 118).

### 6.1.3. Spatial concentration

Scraper production is widespread but uneven. The strongest recorded concentrations occur at W-75 (8 scrapers), W-32 (7), W-3 (5), W-43 (4) and W-84 (4). These peaks may indicate repeated production at preferred localities, differences in access to workable chert, activity specialization or collection effects. They should not be interpreted automatically as intact knapping floors because Veesar is a surface landscape affected by aeolian and runoff processes.

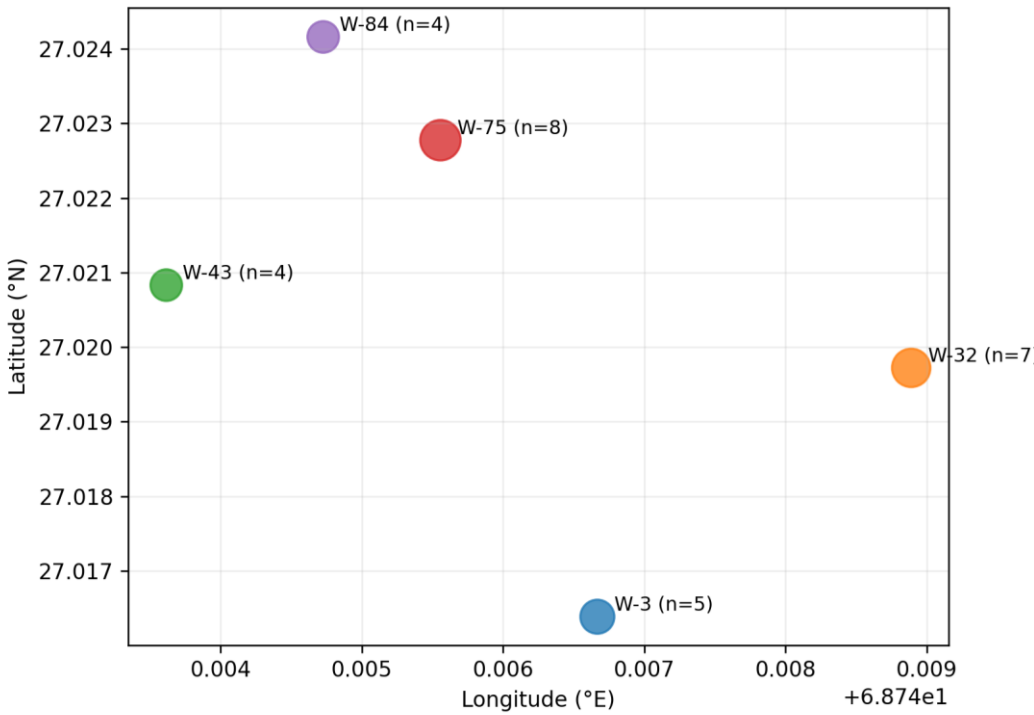



Figure 5. Principal scraper concentrations in the standardized Veesar catalogue. Symbol size scales with scraper count; coordinates are catalogue-derived.

## 6.2. Results: comparison with Rohri Hills

### 6.2.1. Raw-material procurement

Both regions clearly represent source-oriented lithic landscapes. Rohri Hills quarrying is supported by excavated extraction features, mining evidence, large

quantities of production debris and long-term workshop systems (Biagi and Cremaschi 1991; Biagi and Starnini 2011; Biagi 2024). Veesar likewise contains nodules, highly cortical artifacts, cores, picks and reduction debris, while project field observations report direct surface and sub-surface access to chert. The difference is evidential strength: Rohri quarrying is documented in excavated contexts, whereas the Veesar sub-surface extraction model requires fuller publication of geological profiles, feature plans and excavation records.

### 6.2.2. Workshop scale and archaeological visibility

The Rohri Hills operate archaeologically at a very large landscape scale, with quarry and workshop complexes spread across extensive plateau surfaces. Veesar also represents a landscape rather than a single workshop: 98 localities are mapped in the analytical system and the broader field report describes 153. However, the present Veesar sample has a conspicuous formal-tool signal, whereas many Rohri studies emphasize extraction, cores/precores, blank production and production waste. Thus, "scale" has two meanings: Rohri is the larger regional extraction system, while Veesar can be locally dense and scraper-rich within its surveyed valley.

### 6.2.3. Artifact size, cortex and surface alteration

The original field comparison describes Rohri artifacts as heavier and larger, more strongly patinated/weathered and more frequently decorticated than Veesar material. Veesar artifacts are described as smaller and more frequently partially cortical. These observations could reflect differences in reduction intensity, raw-material form, chronological composition, post-depositional exposure or sampling. Patination is particularly sensitive to weathering history and cannot serve as a simple chronological measure. Accordingly, the paper treats this contrast as a research hypothesis requiring matched measurements, raw-material controls and surface-weathering analysis.

### 6.2.4. Core management and blank production

The Rohri Hills sequence contains multiple core technologies. Acheulean workshops demonstrate bifacial objectives; Late/Upper Palaeolithic contexts contain cores, blade-like products and crested preparation; Harappan mining systems produced standardized cores and blades. Veesar also contains more than one reduction signal: flakes dominate the debitage/tool relationship in the present catalogue, but blades, crested blades and crested flakes are present, and earlier research documented volumetric blade-core technology. Therefore, the scientifically defensible contrast is not "flake versus blade." Rather, the current Veesar catalogue is scraper/flake-emphasized, while Rohri studies include phases in which extraction and standardized blade production are especially visible.

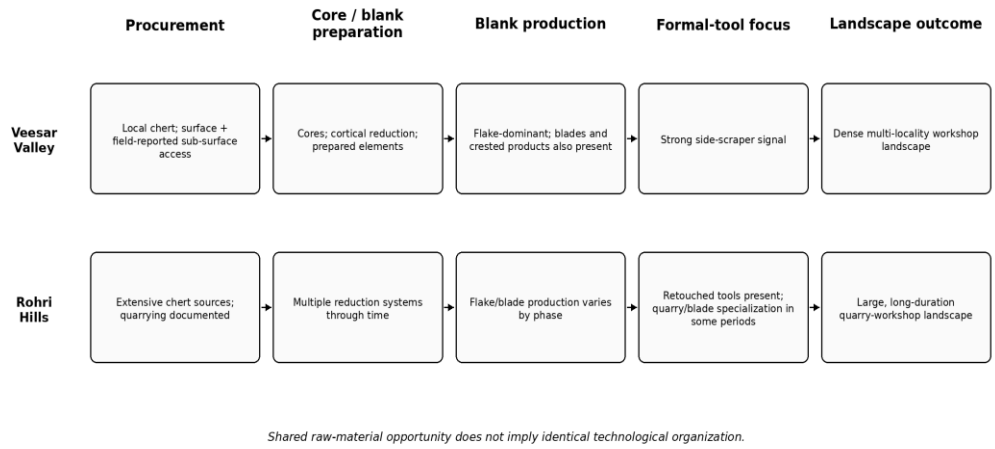



**Figure 6.** Comparative technological pathways. The figure summarizes published and catalogue-derived differences without converting qualitative evidence into invented numeric scores.

### 6.2.5. Scraper production as the clearest contrast

Scraper production provides the strongest quantitative distinction available from the present project. At Veesar, 90 scrapers form one-third of the identifiable lithics

and 76 side scrapers dominate the scraper class. Rohri Hills publications document scrapers and retouched pieces, but the best-known workshop studies are not defined by a comparable scraper-centered frequency signal. At Acheulean workshops the principal technological objective is bifacial production; at Late/Upper Palaeolithic localities core and blank production is prominent; at Harappan mines specialized blade production dominates. Veesar therefore stands out because formal scraper manufacture is unusually visible in the current dataset, not because scrapers are absent from Rohri.

### 6.2.6. Comparative Palaeolithic plates

The project's comparative plates visually reinforce two aspects of the analysis. First, the Lower Palaeolithic materials from Veesar and the Rohri Hills show that both landscapes preserve heavy-duty and early reduction traditions, but surface alteration and artifact morphology vary. Second, the Middle and Upper Palaeolithic plates demonstrate that both regions contain retouched and blade-related components, supporting a model of repeated technological use rather than a one-period contrast. These plates are illustrative rather than metric; formal comparison should be based on standardized measurements and technological attributes.

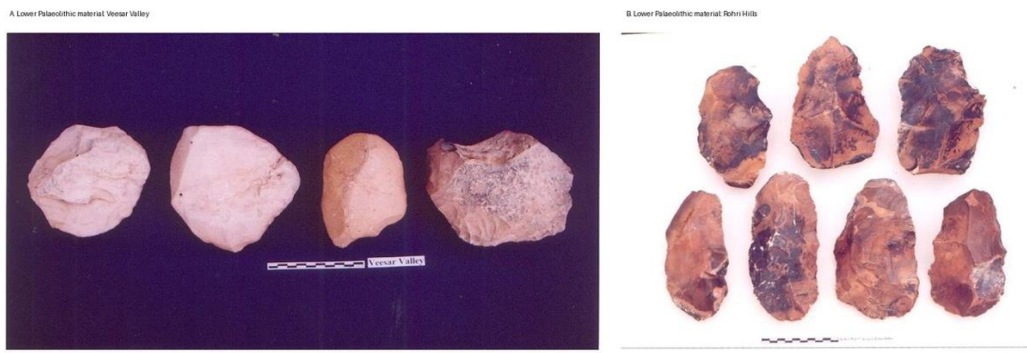
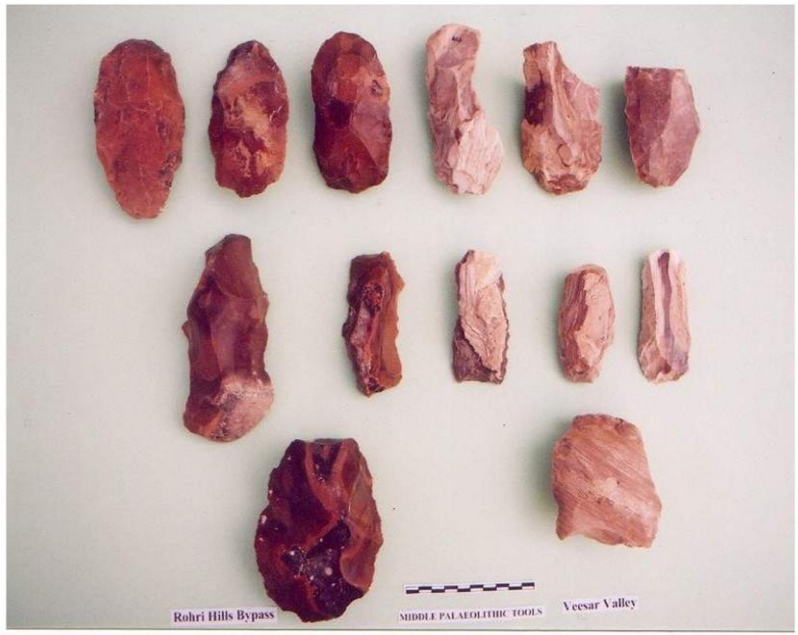



**Figure 7.** Lower Palaeolithic comparative plate from project documentation: (A) Veesar Valley; (B) Rohri Hills.

A Middle Palaeolithic comparative plate




B Upper Palaeolithic comparative plate

**Figure 8.** Middle and Upper Palaeolithic comparative plates from project documentation. Original labels have been preserved within the field photographs.

## 7. Discussion

### 7.1. Similar geology, different technological organization

The comparison demonstrates that lithic raw material is an enabling condition rather than a deterministic explanation of assemblage structure. Both Rohri and Veesar provide high-quality chert close to workshop activity, yet the visible outputs differ. This result is consistent with broader technological-organization models in which raw-material abundance interacts with mobility, task requirements, blank design and maintenance rather than producing a single predictable toolkit (Bamforth 1986; Kelly 1988; Andrefsky 1994; Kuhn 1994, 1995; Nelson 1991).

At Veesar, the strong side-scraper signal suggests repeated selection of flake blanks with suitable lateral edges. Side-scraper morphology may reflect both initial blank form and continued retouch (Dibble 1987, 1995; Kuhn 1990, 1992; Clarkson 2002; Hiscock and Clarkson 2005). The Veesar pattern is therefore best interpreted as recurrent lateral-edge production within a source-proximal reduction system, not as a simple cultural fossil.

### 7.2. Beyond the "Rohri plateau model"

The phrase "beyond the Rohri Hills plateau" is analytical rather than geographical rhetoric. It emphasizes that prehistoric exploitation of the northern Sindh chert province cannot be understood solely through the major plateau quarry systems. Veesar demonstrates that adjacent desert-margin and interdunal settings could host dense production landscapes with different formal-tool signatures. Similar resources were incorporated into distinct technological organizations, possibly by different groups, at different times, or for different task objectives.

This perspective also helps reconcile the long Rohri sequence. The same geological source supported Acheulean bifacial manufacture, later blade-related production and Indus-period mining. Such diachronic variation makes it unlikely

that raw-material availability alone explains technological form. Veesar adds another expression to this history: a surface workshop system in which scraper manufacture is especially prominent.

### 7.3. Middle Palaeolithic interpretation without typological overreach

Side scrapers are compatible with Middle Palaeolithic technological traditions, but they are not sufficient to assign every Veesar workshop to the Middle Palaeolithic. South Asian research demonstrates that Palaeolithic technological change is regionally variable and that prepared-core, flake, point and retouched-tool strategies appear in different combinations and chronologies (de Terra and Paterson 1939; Dennell et al. 1988; Rendell et al. 1989; Sankalia 1974; Misra 1989, 2001; James and Petraglia 2005; Chauhan 2009).

Recent dated sequences have made this variability clearer. Attirampakkam demonstrates both deep Acheulean occupation and an early transition toward Middle Palaeolithic technology (Pappu et al. 2011; Akhilesh et al. 2018). Jwalapuram provides evidence for Middle Palaeolithic occupation across the Toba event (Petraglia et al. 2007; Haslam et al. 2010, 2012). Katoati demonstrates Middle Palaeolithic occupation within the Thar Desert and provides an especially relevant arid-zone comparator (Blinkhorn et al. 2013, 2017). Veesar should therefore be evaluated as a local technological system within South Asian diversity rather than forced into a European Mousterian template.

### 7.4. Cortex, transport and workshop organization

The Veesar cortex distribution supports source-proximal multi-stage reduction, but it also exposes the limits of a simple quarry model. High-cortex pieces document early reduction, while intermediate and low-cortex materials—including retouched tools—indicate continued manufacture and discard. This combination is more consistent with a workshop landscape where several reduction stages were conducted than with a locality used only for testing raw

stone. Yet cortex proportions can also be altered by selective transport and reduction geometry, which is why future work should employ cortex-ratio and volume-based methods (Dibble et al. 2005; Douglass et al. 2008; Douglass and Holdaway 2011; Middleton 2022).

### 7.5. Formation processes and patination

The observed difference in patination between some Rohri and Veesar artifacts may be meaningful, but it is not a secure chronological test. Plateau exposure, dune burial, aeolian abrasion, runoff, sediment chemistry and exposure duration can create different surface histories. Surface archaeological theory demonstrates that repeated movement, exposure and discard can produce palimpsests whose spatial patterning is real but temporally compressed (Schiffer 1972, 1987; Holdaway et al. 2004; Holdaway and Wandsnider 2006; Fanning et al. 2008; Douglass et al. 2023). The comparative article therefore uses patination as a taphonomic variable to be measured, not as a stand-alone cultural discriminator.

A stronger taphonomic program would record patination and weathering independently from typology and then compare them with geomorphic position. Artifacts from exposed limestone surfaces, dune margins, interdunal depressions and runoff zones should not be assumed to have experienced equivalent post-depositional histories. Replicated ordinal scoring, surface microscopy and spatial association with sedimentary units could help determine whether visually distinct patinas correspond to different exposure histories or merely to local microenvironments. This is particularly important in a long-lived lithic province where the same raw-material source was revisited over many millennia. If patination classes correlate with technological systems only after geomorphic setting is controlled, they may contribute to relative sequencing; if they correlate primarily with surface context, they should be treated as formation-process indicators. Such separation is essential before surface alteration is used to support

chronological arguments (Schiffer 1987; Holdaway and Wandsnider 2006; Fanning et al. 2008).

### 7.6. Raw-material abundance, curation and technological flexibility

The Veesar–Rohri comparison also contributes to a wider question in technological organization: how abundant high-quality stone affects decisions about curation and reduction. Raw-material abundance can reduce the cost of replacement, but it does not eliminate planning, blank selection or maintenance (Andrefsky 1994; Bamforth 1986; Kuhn 1994, 1995). At Veesar, local chert occurs together with a substantial formal scraper component. This combination suggests that direct access to stone and investment in retouched edges were not mutually exclusive. Instead, local abundance may have allowed knappers to select blanks flexibly while still maintaining suitable working edges when an artifact continued to be useful.

The apparent transformation of some cores into scraper- or pick-like implements, if confirmed by detailed scar-sequence analysis, would be particularly informative. Such reuse would indicate that technological economy cannot be reduced to a contrast between curated tools and expedient source-area waste. Lithic systems often combine different degrees of investment within the same landscape, depending on immediate task requirements and the properties of available blanks (Binford 1979; Nelson 1991; Odell 2004). For Veesar, this model is preferable to assuming either unrestricted waste because stone was abundant or intensive conservation because retouched tools are common.

Rohri Hills evidence provides the long-term comparative perspective. Acheulean bifacial production, later core-and-blank systems and Indus-period quarry industries demonstrate that the same geological province supported very different technological organizations at different times (Biagi and Cremaschi 1988, 1991; Biagi et al. 1996; Biagi 2008, 2024). Veesar is therefore best

interpreted within a resource-landscape framework in which geology structured recurrent access while social and technological choices structured what was made, how intensively it was reduced and which products were transported or discarded.

### 7.7. A testable comparative model

The strongest outcome of the comparison is a set of testable predictions. These predictions distinguish what the current data demonstrate from what future matched sampling must establish.

**Table 4.** Testable hypotheses generated by the Veesar–Rohri comparison.

| Hypothesis | Prediction | Required test |
|---|---|---|
| Veesar is more scraper-focused than comparable Rohri Palaeolithic workshops | Higher proportion of formal scrapers under matched collection protocols | Equivalent-area systematic sampling and identical typological criteria |
| Veesar artifacts are generally smaller | Lower median length/width/mass within matched technological phases | Metric comparison controlling for artifact class and chronology |
| Veesar retains more cortex | Higher cortex ratios after controlling for nodule size and class | Cortex-ratio or surface-area/volume analysis |
| Rohri artifacts are more heavily patinated | Higher standardized weathering/patina scores | Blind surface-alteration scoring and petrographic control |

| | | |
|---|---|---|
| Veesar workshops are locally denser | Higher artifact density per $m^2$ in comparable surveyed units | Controlled transects/quadrats and total debitage counts |
| Core reuse is more visible at Veesar | Higher frequency of cores transformed into retouched/heavy-duty tools | Scar-sequence analysis and refit/attribute study |

### 7.8. Chronological complexity and repeated landscape use

Both comparison areas are chronologically persistent, but the evidential resolution differs. Rohri Hills research includes excavated and phase-specific contexts ranging from Acheulean workshops to Harappan mines. Veesar currently relies heavily on surface distributions containing scraper-rich flake technology together with blades, crested pieces, field-assigned Lower Palaeolithic material, limited Mesolithic annotations and an Indus-related blade. This combination is best treated as a multi-period palimpsest until stratified excavation separates components.

The change between earlier Veesar interpretation and the expanded catalogue is itself evidence for the importance of sampling. Earlier work emphasized end scrapers and volumetric blade technology; the current catalogue contains 76 side scrapers and only 14 end scrapers. Rather than choosing one description as "correct," the manuscript interprets them as records of different sampling scales, localities or stages of documentation. Future publication should retain collection provenance so that technological components can be evaluated spatially and chronologically.

### 7.9. Implications for South Asian lithic archaeology

The Veesar–Rohri comparison contributes to three broader debates. First, it strengthens the argument that South Asian Palaeolithic technology is regionally diverse and cannot be reduced to a single sequence of European-derived types

(Sankalia 1974; Misra 1989, 2001; James and Petraglia 2005; Chauhan 2009). Second, it shows how source-rich landscapes can be repeatedly reorganized technologically through time, a pattern also visible in the transition from Palaeolithic exploitation to Indus-period specialized quarrying in the Rohri Hills. Third, it demonstrates the analytical value of integrating surface archaeology with technological organization rather than dismissing workshop scatters as undifferentiated palimpsests.

Internationally, the Veesar assemblage is relevant because scraper morphology can be examined in direct association with raw-material procurement. Theoretical and experimental studies of unifacial reduction (Dibble 1995; Kuhn 1990; Eren et al. 2005) can therefore be tested in a South Asian quarry-workshop context rather than only in cave or residential assemblages. Likewise, modern analytical methods—including controlled experiments, use-wear and 3-D core modelling—offer a pathway from descriptive comparison to falsifiable technological reconstruction (Keeley 1980; Rots 2010; Marreiros et al. 2020; Valletta et al. 2021).

**7.10. International significance and research agenda**

The international relevance of the comparison lies in its capacity to connect a well-known South Asian raw-material province with questions that have often been developed from European, Levantine or Australian lithic sequences. Scraper reduction, cortex representation and source-proximal production are not regionally specific processes; they are analytical problems concerning how archaeologists infer behavior from incomplete material residues (Dibble 1995; Kuhn 1990; Sellet 1993; Soressi and Geneste 2011). Veesar provides a valuable case because raw material, production debris and formal scrapers occur within the same mapped landscape, allowing these relationships to be tested directly rather than inferred from transported toolkits alone.

The next comparative step should be explicitly symmetrical. Equivalent-area survey units in Veesar and selected phase-controlled Rohri localities should record artifact density, complete metric distributions, cortex using reproducible surface-area or ratio methods, platform and dorsal-scar attributes, raw-material characteristics, patination scores and core transformation. Where stratified sediments survive, absolute dating should be linked to the technological samples. Such a design would convert the hypotheses developed here into a regional experiment on how prehistoric groups organized stone procurement and tool production across the Rohri–Thar chert province. It would also provide a stronger basis for evaluating connections with dated Middle Palaeolithic records elsewhere in South Asia, including Katoati, Jwalapuram and Attirampakkam (Petraglia et al. 2007; Blinkhorn et al. 2013, 2017; Akhilesh et al. 2018).

Such a program would also make the Veesar–Rohri comparison relevant to broader questions of technological convergence and regional diversity. Similar raw-material opportunities do not necessarily generate equivalent technological systems, and apparent similarity in formal tools does not necessarily imply identical mobility, provisioning or reduction histories. Dated South Asian sequences already show that prepared-core, flake, point, blade and retouched-tool strategies appeared in different combinations across regions and periods (Petraglia et al. 2007; Haslam et al. 2010; Blinkhorn et al. 2013; Akhilesh et al. 2018). A phase-controlled Rohri–Veesar dataset could therefore test whether scraper-rich production represents a local response to source-proximal conditions, a recurrent technological tradition, or one component within a wider mosaic of Palaeolithic land use. That question is more informative internationally than attempting to force Veesar into a single externally derived typological category.

## 8. Conclusions

Veesar Valley and the Rohri Hills are closely related components of the same broad northern Sindh chert province, but the available evidence indicates that they should not be treated as identical workshop systems. Both preserve direct engagement with high-quality lithic raw material, source-proximal reduction and repeated landscape use. Their archaeological signatures, however, differ in emphasis and scale.

The Rohri Hills represent a long-duration extraction and production landscape whose documented sequence includes Acheulean workshops, later Palaeolithic core-and-blank production and extraordinary Indus-period quarrying and blade manufacture. Veesar Valley is also technologically diverse, but the current standardized dataset is especially notable for formal scraper manufacture. Ninety scrapers form 33.3% of identifiable lithics; 76 side scrapers account for 84.4% of the scraper class and are widely distributed among lithic-bearing workshops.

Cortex, cores, flakes, crested elements, blades, picks and hammerstones demonstrate that Veesar cannot be reduced to a finished-tool discard locality. Multiple stages of production occurred within the valley. The most defensible comparative interpretation is therefore that Veesar represents a scraper-rich, multi-stage workshop landscape nested within a wider regional tradition of chert exploitation, while Rohri provides the larger and more chronologically diverse plateau-scale extraction system.

The field-observed contrasts in artifact size, cortex removal, patination, workshop density and core reuse are archaeologically promising but remain hypotheses until matched samples are measured. Framing them in this way strengthens rather than weakens the comparison: it converts descriptive field observations into a research programme capable of testing whether different

technological organizations emerged despite access to related raw-material resources.

The broader conclusion is that geology structured opportunity but did not dictate technological outcome. Prehistoric groups repeatedly returned to the Rohri–Thar chert landscape, but they organized procurement, reduction and formal-tool production in different ways. Veesar Valley therefore deserves recognition not simply as "another Rohri workshop," but as a distinctive archaeological expression of long-term technological engagement with the lithic landscapes of Sindh.

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