Prehistoric Stone Tool Technology: Flint Use and its Physical Basis

Dr. Uduwila Uparathana

Bhiksu University of Sri Lanka, Sri Lanka

DOI: https://dx.doi.org/10.47772/IJRISS.2026.10100376

Received: 24 January 2026; Accepted: 30 January 2026; Published: 07 February 2026

ABSTRACT

This research paper examines the stone technology of prehistoric humans, especially the use of flint. The criteria for selecting raw materials in the production of prehistoric tools, the chemical composition of siliceous rocks, and their inherent physical properties are discussed here. The mechanism of 'conchoidal fracture', the basic basis of stone tool technology, is scientifically analyzed when a force is applied to a rock. Furthermore, the study describes methods for distinguishing between natural rock fractures and artificial fractures caused by human intervention, as well as basic shaping techniques such as quartering and flaking. Another aspect of this study is identifying the age of a tool through 'patina', the chemical changes that occur on the surface of rocks. Finally, this study emphasizes that archaeology makes a significant contribution to building robust typological models for interpreting past cultural dynamics by understanding these technological limitations and capabilities.

Keywords: Conchoidal Fracture, Flint Knapping, Lithic Technology, Patination, Prehistoric Archaeology

INTRODUCTION

Archaeology is not merely the excavation of objects hidden in the past or the conservation of ancient monuments. It is a formal scientific discipline striving to build predictive models and principles regarding the complex dynamics of human culture, social evolution, and human behavioral patterns. Its primary objective is to reconstruct the social relationships, economic patterns, environmental adaptations, and technological advancements of past humans based on physical evidence or 'material remains'. In other words, the role of modern archaeology is to scientifically establish not just *what* happened in the past, but *why* and *how* it happened.

Specifically, when studying prehistoric eras where no written evidence is found, the main challenge archaeologists face is building a larger picture based on limited evidence. Unlike organic matter that decays over time, 'stone tools' used and created by past humans become the strongest evidence that survives for a long period. These stone tools are not merely pieces of rock; they are a mirror revealing the brain development of early humans, the coordination between the hand and the eye, and the technical knowledge they possessed. Therefore, the study of stone tools is the primary methodology that illuminates the darkest eras of human history.

When scientifically analyzing any stone tool industry, it is a complex process that goes beyond merely looking at the shape of the stone. For this, archaeologists conduct their studies based on three main factors:

1. By studying the selection of suitable rock types for tool making, the locations where they were found, and how they were transported, the mobility patterns and geological knowledge of past humans are identified.
2. By analyzing the steps followed to prepare a tool from a stone block (preparing a core, flaking, shaping), their technical skills and traditions are understood.
3. By studying the shape of the finished tool and micro-wear patterns, it is decided for what function the tool was used (such as for hunting, tanning hides, or cutting wood).

Of these three, 'technology' is the aspect that can be most scientifically and physically reconstructed through experimentation. This is why modern experimental archaeology has made it possible to test ancient technologies today.

Looking at the human evolutionary history over four million years, it appears that early humans secured their existence by shaping the rock resources in their environment as needed. This journey from simple pebble tools to complex microlithic tools is not just a technological advancement, but also a mirror of human brain growth and cognitive ability. The ability to plan for the future and an understanding of three-dimensional space are essential to flake a stone and create a tool.

Figure 01. Pebble tools

(https://www.sciencephoto.com)

The primary focus of this article is on Flint technology. Flint is a silica-rich, very hard rock with glass-like properties. Its specific scientific importance lies in the way it fractures. This is known as a 'conchoidal fracture'. When this rock is struck at a specific angle, the way shock waves travel is subject to physical laws. Therefore, studying flint technology is not about understanding random events, but understanding the interaction between controlled force and the properties of matter. This article aims to discuss the scientific basis in depth.

Figure 02. Bubble marks

(https://www.google.com/search) Research Objectives

- To identify the criteria used by prehistoric humans to select raw materials for producing tools.
- To analyze the chemical and physical composition of flint and its behavioral patterns.
- To explain the process of 'conchoidal' fracture that occurs when force is applied to a stone.
- To describe the methodologies for distinguishing between natural and human-made fractures.

Research Problem

A major problem in the study of stone tools is how to distinguish between stones shaped by natural forces (e.g., being washed away in a river, animal trampling) and tools intentionally produced by humans among the stone fragments found. Furthermore, how changes in rock properties under different environmental conditions (e.g., heat, moisture) affect the technological process is discussed as a major problem here.

RESEARCH METHODOLOGY

This research primarily follows a formal experimental plan based on qualitative and observational data. Here, the stone tool production process and related technical methods are scientifically investigated using experimental archaeology and comparative study methodologies. This methodology operates primarily through observational procedures, analytical criteria, and research limitations.

Specific observational procedures were followed during the data collection process. To understand ancient lithic technology practically, experimental simulations of producing stone tools were conducted within a controlled environment. Here, steps from raw material selection to the final tool were closely observed, and the produced tools and removed flakes were examined using hand lenses and measuring instruments. Specifically, recording physical characteristics such as striking platforms and bulb characteristics, and conducting mineralogical analyses to test the fracture properties and hardness of selected rocks like quartz and chert were carried out.

Accepted academic and theoretical models have been used to analyze the collected data. Here, the standard technical parameters and classification catalog introduced by Dr. Siran Deraniyagala (Deraniyagala 1974) for classifying microlithic tools and geometric shapes of prehistoric humans, including the Balangoda Man of Sri Lanka, are used as a primary basis. Additionally, the theoretical classification regarding hand axes and chopping tools presented by Professor Hallam L. Movius (Movius et al. 1968) in analyzing lithic tool technology in the Asian region has also been utilized for comparative analysis purposes.

However, certain limitations that may affect this study have also been identified. A major limitation is that the skill level and physical input of a modern researcher creating stone tools may differ from the proficiency that existed within the instinctive lifestyle of ancient humans. Furthermore, subtle discrepancies may exist due to geochemical changes that may have occurred over time between current rock samples used for research and rocks used in the past, and the possibility of a certain subjective nature remaining in the results based on the observer's interpretations during qualitative data analysis can also be cited as limitations of this methodology.

RESULTS AND DISCUSSION

Raw Material Selection, Composition, and Comparative Analysis

Prehistoric humans paid close attention to several basic physical characteristics when selecting rocks for stone tool creation. As Bordaz points out, the hardness of the rock, the ease of flaking (Knappability), and the absence of specific cleavage planes that cause unnecessary breakage were critical factors in this selection process (Bordaz 1970: 9). Siliceous rocks were most suitable for meeting these requirements, and Flint/Chert is considered the optimal medium. However, a clear diversity among raw materials can be identified in comparative analyses conducted on the use of materials other than flint. According to Andrefsky's classification, while a much sharper edge than flint can be obtained using 'Obsidian' or volcanic glass, there is a tendency for those tools to break quickly due to its extremely brittle nature (Andrefsky 2005: 23). In contrast, although Quartz and Quartzite, which are abundant in countries like Sri Lanka, are very hard rock species, controlling flaking is complex due to their irregular crystal structure. Yet, Whittaker points out that these rocks are highly suitable for heavy-duty tasks (Whittaker 1994: 67). Additionally, the moisture content in the rock affects tool production; as Semenov states, the 1.5% moisture in fresh flint makes flaking very favorable, and it has been confirmed that dry stones can be soaked in water to regain plasticity (Semenov 1964: 57).

Figures 03.04. Raw materials selection

(https://en.wikipedia.org/wiki/Flint)

Patination and Thermal Alteration

The chemical and physical weathering process that occurs on the surface of a stone over time is called 'Patination'. As Hurst and Kelly emphasize, since the rate of patina deposition varies based on environmental temperature and the chemical composition of groundwater, its ability to be used directly for absolute dating of a tool is limited (Hurst and Kelly 1961: 255). Additionally, identifying thermal alteration in stones exposed to fire is archaeologically important. According to research conducted by Purdy, heating to a controlled temperature can improve the flaking properties of the stone, while overheating creates circular fractures known as 'potlids' and 'starch' fractures (Purdy 1975: 134). These features provide evidence regarding how ancient humans controlled fire and their heat treatment technology.

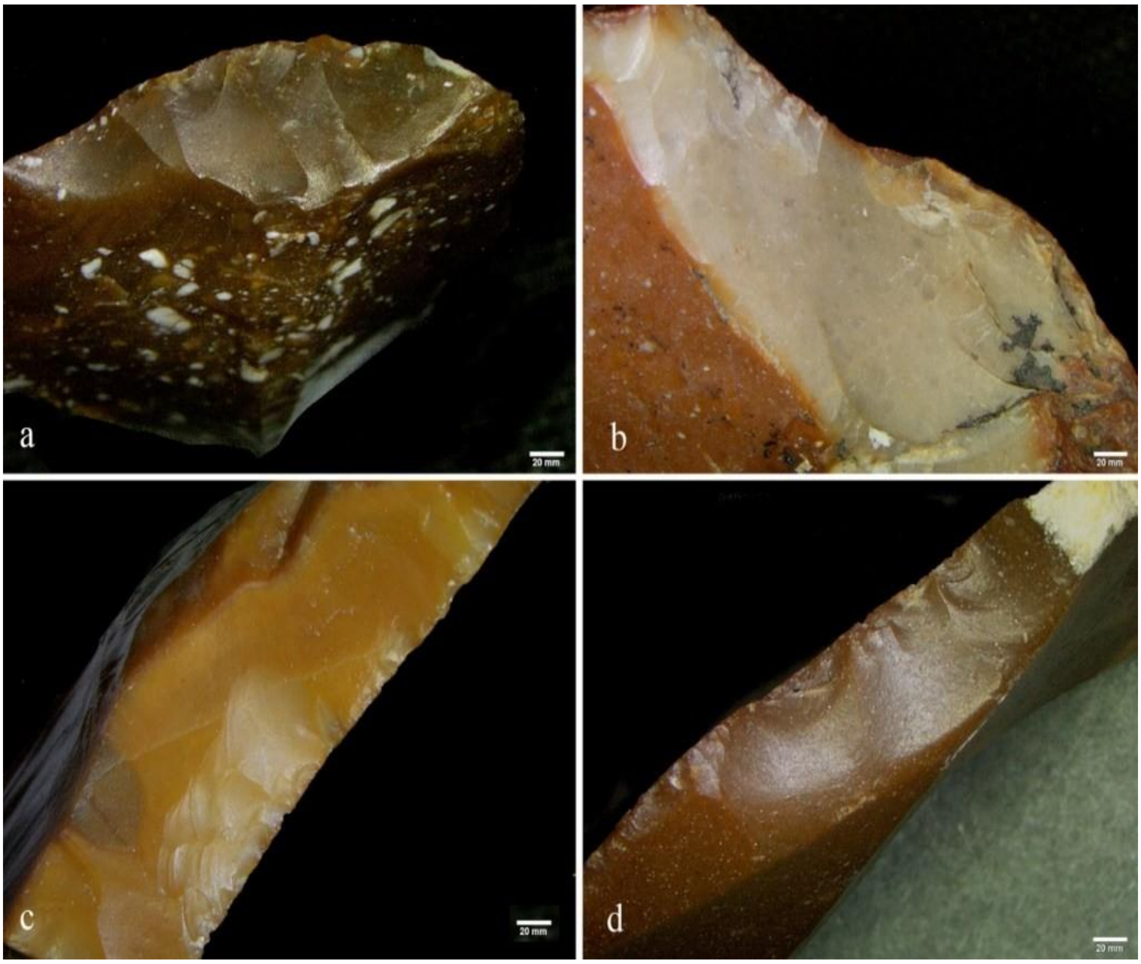


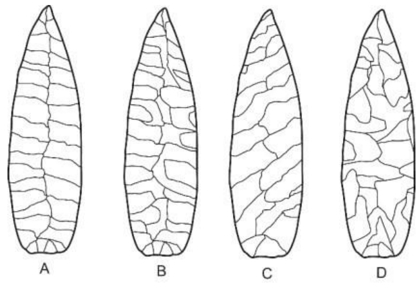
Figure 05. Function, Life Histories, And Biographies Of Lower Paleolithic Patinated Flint Tools

(https://www.nature.com/articles)

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue I January 2026

Fracture Mechanics and Techniques

The fundamental basis of stone tool technology is 'Conchoidal Fracture'. As Cotterell and Kamminga describe, when a blow is struck perpendicularly to the surface of a stone, that force travels into the material in the form of a cone (Cone of force) (Cotterell and Kamminga 1987: 685). Here, a striking platform is created at the point of impact, and a 'bulb of percussion' remains after the flake is detached. The skill of the toolmaker depends on controlling this force, and striking at the wrong angle can result in incomplete fractures such as 'hinge' or 'step' fractures (Coles and Higgs 1969). As Crabtree points out, naturally occurring fractures are irregular, but the uniformity in the flaking pattern of a human-made tool can confirm it is an intelligent creation (Crabtree 1972: 32). In this creation process, the direct percussion method, as well as the later developed pressure flaking method, were used. According to Pelegrin's studies, pressure technology allowed for the production of very thin and sharp-edged tools, representing a high stage of technological evolution (Pelegrin 1990: 118).

Figures 6. 07. Incorrect crackers (https://www.google.com/search)

Tool Use, Functionality, and Micro-wear Analysis

There is a strong interrelationship between the physical form of a tool and its function. As Odell points out, light projectile points were specialized for hunting, while scrapers with thick edges were specialized for tanning hides (Odell 2004: 45). Furthermore, the efficiency of tools was improved by mounting small microlithic tools onto a handle to use as composite tools. What these tools were actually used for is definitively identified through Microwear Analysis. According to the methodology introduced by Keeley, striation patterns and micropolish on the tool edge can be identified through microscopic examination (Keeley 1980: 22). For example, the bright polish formed when cutting wood and the rough polish formed when cleaning hides are different from each other. By comparing this data with a reference collection obtained through experimental archaeology, it has become possible to scientifically reconstruct the diet and technological practices of ancient humans.


ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue I January 2026

Figure 08: Hammering with Bone hammer **Figure 09. Hammering with a stone hammer**

Figures 10. 11. Pressure hammer with bone tools

CONCLUSION

According to the scientific investigation conducted through this research, it is confirmed that prehistoric stone tool technology is not merely a random process based on physical needs, but a complex amalgamation of human Cognitive Evolution and a deep understanding of environmental raw materials. The unique logic demonstrated by early humans in selecting rocks for tool creation well illustrates the primary form of geological and mineralogical knowledge they possessed. In particular, the selection of Flint or siliceous rocks based on properties such as hardness, homogeneous structure, and ease of flaking serves as strong evidence reflecting their advanced technical knowledge regarding raw material management.

Secondly, the most important physical basis emphasized by this study is the theory of ‘Conchoidal Fracture’ and ‘Controlled Force’. Realizing that a flake of a desired shape can be obtained by directing the force applied to the rock at a specific angle is a decisive turning point in human technological history. An understanding of this mechanism is essential for identifying the difference between naturally occurring irregular fractures and manmade tools. As confirmed through Experimental Archaeology, early humans were intelligent enough to improve technical efficiency by altering the internal properties of the rock through methods such as heat treatment.

Furthermore, analysis regarding patina and Use-wear analysis confirms that a stone tool is not merely a product but a document through which past human activities can be read. While patina provides data on time and environmental effects, wear patterns provide the opportunity to reconstruct past economic patterns and subsistence strategies. This acts as an essential tool for the modern archaeologist to reconstruct past social behaviors.

Finally, this research points out that the globally accepted principles of flint technology can be equally applied when analyzing other rock media found regionally, such as Quartz or Chert. This theoretical background is extremely important to understand the technical potential of the geometric microlithic tools created by the prehistoric humans of Sri Lanka (e.g., Balangoda Man). Therefore, it can be concluded that the study of stone tool technology is a reading of the ‘lithic memory’ of early humans, and it serves as the strongest foundation for scientifically interpreting the initial stage of human culture and technology.

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ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue I January 2026

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