An Overview of the Siwalik Acheulian & Reconsidering Its Chronological Relationship with the Soanian – A Theoretical Perspective

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Introduction

The Acheulian lithic tradition was probably the most unique technological phenomenon of the Lower Palaeolithic. Its innovation, maturation, and longevity as a toolkit for the evolutionary and migratory success of Pleistocene*Homo* are unrivalled. The earliest Acheulian sites are found in East Africa at approximately 1.6 to 1.4 Myr for example at Konso-Gardula in Ethiopia and Peninj and Olduvai Gorge in Tanzania (Larick and Ciochon 1996). The industry is represented by a suite of attributes that have been progressively standardised over time. For example, the selection of raw materials, preparation of cores, and bifacial flaking techniques are all hallmark characters of the Acheulian tradition. From Africa, the Acheulian gradually spread throughout the Old World until it reached its eastern-most geographical domain, the Indian subcontinent. Acheulian assemblages are found in abundance throughout the subcontinent in varying geological, temporal, and technological modes. The earliest known Acheulian localities from South Asia have been securely dated to ~500 kyr and continued to persist in peninsular India until ~125 kyr (possibly longer), before yielding to Middle Palaeolithic flake-dominated assemblages (Mishra 1995; Rendell and Dennell 1985).

Although numerous localities in South Asia yield *in situ* palaeolithic material, many sub-regions generally consist of sediments heavily disturbed through natural and anthropogenic processes. One such region is the Siwalik range of hills, varying in elevation and lateral extent from Pakistan to Bhutan in northern South Asia. The Lower Palaeolithic record in the Siwalik region is essentially represented by open-air sites belonging to the Acheulian or the Soanian, a non-biface tradition. Soanian artefacts were primarily manufactured on quartzite pebbles, cobbles, and occasionally on boulders. The assemblages generally comprise varieties of choppers, discoids, scrapers, cores, and numerous flake types, all occurring in varying typo-technological frequencies at individual sites (see Paterson and Drummond 1962).

The Siwalik Acheulian facies sporadically occurs in exclusive context as well as in surface association with Soanian assemblages (Corvinus 1990; de Terra and Paterson 1939; Mohapatra 1981). The majority of these localities are from surface contexts, and dating them on an absolute scale has proved to be impossible. Therefore, all surface Acheulian sites in the region have been chronologically ordered (by previous workers) on the basis of their 'morpho-typological' attributes (de Terra and Paterson 1939), associated terrace sequences (de Terra and Paterson 1939; Lal 1956), and Siwalik frontal slope stability (Mohapatra 1981). Thus, the status of the Acheulian facies here continues to be highly ambiguous in terms of its temporal and technological relationship with the Soanian, the latter yet to be adequately defined. This paper focuses on the Siwalik Acheulian and Soanian sites and tool types will not be discussed in detail. However, general observations have been made to elucidate raw-material size, knapping strategies, and chronological relationships for comparative purposes. The Siwalik Acheulian facies is hypothesised to be chronologically older than the Soanian, rather than being contemporary with and/or including it [Footnote 1]. This conception is projected at an exploratory level through a range of geoarchaeological data such as: (1) geographic-geological contexts of sites; (2) raw-material size and availability; (3) artefact density at inter-and intra-site levels; and (4) newly available optically stimulated luminescence (OSL) dates that may be applicable to certain Soanian sites.

The Siwalik Hills

The Siwalik deposits are one of the most comprehensively studied fluvial sequences in the world. They comprise mudstones, sandstones, and coarsely bedded conglomerates laid down when the region was a vast basin during Middle Miocene, to Upper Pleistocene times. The sediments were deposited by rivers flowing southwards from the Greater Himalayas, resulting in extensive multi-ordered drainage systems. Following this deposition, the sediments were uplifted through intense tectonic regimes (commencing in Upper Miocene times), subsequently resulting in a unique topographical entity - the Siwalik hills. Establishing the timing, duration, and frequency of this upliftment history has great implications for our understanding of hominid land-use patterns, relative site chronologies, and natural site-formation processes. The Siwalik hills are located within the political boundaries of Pakistan, India, Nepal, and Bhutan, and range between 6 to 90 km in width (Acharyya 1994) (Figure 1). They gradually become steeper and narrower in relief and width respectively, from northern Pakistan to Bhutan (over 2000 km in length). The Siwaliks are divided stratigraphically into three major Subgroups - Lower, Middle, and Upper (Table 1). These Subgroups are further divided into individual Formations that are all laterally and vertically exposed today in varying linear and random patterns.

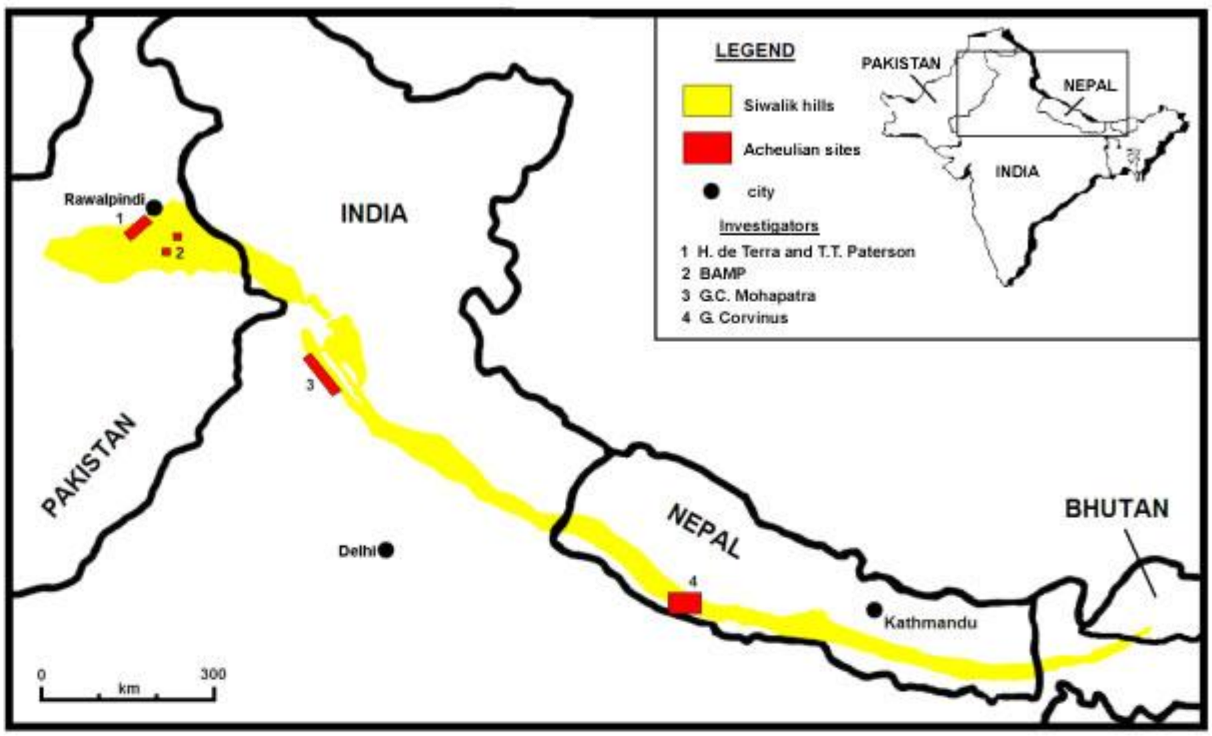

Figure 1. Distribution of Siwalik sediments and associated Acheulian sites.

SUB-GROUP	FORMATION	Corvinus & Rimal, 2001 (ma ago)	Prasad, 2001 (ma ago)
Upper Siwaliks	Upper Boulder Conglomerate	5.9 - ?	0.9 - 0.2
	Lower Boulder Conglomerate		
	Pinjore		2.4 - 0.9
	Tatrot		5.1 - 2.4
Middle Siwaliks	Dhok Pathan	7.9 - 5.9	10.8 - 5.1
	Nagri	10.1 - 7.9	
	Chinji	13.1- 10.1	
Lower Siwaliks	Kamlial	--	18.3 - 10.8

Table 1. Chrono-stratigraphical division of Siwalik sediments.

Often, palaeolithic sites located on Siwalik slopes are situated (in surface contexts) on or above hill sediments belonging to all Formations. However, we are primarily concerned with the Formations of the Upper Siwalik Subgroup (and younger sediments), of whose ages are concurrent with Pleistocene hominid dispersal and occupation throughout West Asia, South Asia, and Southeast Asia. In fact, in some rare (and highly criticised) cases, Lower Palaeolithic artefacts have been reported to be in association with Upper Siwalik strata (Sharma 1977; Verma 1975). The Upper Siwaliks are further subdivided into three Formations- Tatrot, Pinjore, and the Boulder Conglomerate, from oldest to youngest in age respectively. The majority of sites, however, are located in ‘post-Siwalik’ situations. Here, the term ‘post-Siwalik’ refers to sediments which have accumulated after the deposition of the Boulder Conglomerate, the youngest Siwalik Formation (Mohapatra 1976; Mohapatra and Singh 1979; Stiles 1978). In short, post-Siwalik deposits signify sediments which are younger in age than the Boulder Conglomerate. These comparatively younger sediments are dispersed in intermontane valleys, on Siwalik hill slopes, and in association with Middle to Upper Pleistocene river/stream terrace systems.

Ongoing erosion and tectonic activity has greatly affected the topography of the Siwaliks. Their present-day morphology is comprised of hogback ridges, consequent, subsequent, obsequent, and resquent valleys of various orders, gullies, choes (seasonal streams), earth-pillars, rilled earth buttresses of conglomerate formations, semi-circular choe-divides, talus cones, colluvial cones, watergaps, and choe terraces (Mukerji 1976). Associated badlands features include the lack of vegetation, steep slopes, high drainage density, and rapid erosion rates (Howard 1994). To the south of the Siwaliks are the Indo-Gangetic plains and in the north, they are bordered by the Lesser Himalayas.

The Duns

Intermittently located between the Siwaliks and the Lesser Himalayas (exclusively in India and Nepal) are *duns*, flat-bottomed longitudinal structural valleys with their own drainage systems (Nakata 1972). These essentially comprise several large Himalayan piedmont alluvial fans and terraces, which formed as a result of tectonic episodes in the flanking Siwaliks. The *duns* also consist of lacustrine, fluvial, aeolian and swamp-environment deposits, and range from Middle Pleistocene to Holocene in age. During their formative stage, most of the *duns* were slightly narrower and have gradually expanded over time through the erosion of the adjacent Siwalik sediments (a continuing process). In Nepal, these *duns* were often naturally filled with alluvial sediments of lacustrine and fluvial deposits, thus burying palaeolithic sites that were later exposed through erosion (Corvinus 1995). The monsoon rains temporarily supply seasonal streams (locally known as choes, khads, or nalas) located both within the Siwalik hills and the adjacent *duns*. These stream banks and their terraces yield sizeable numbers of lithic artefacts, owing to the shared location for both water and raw material.

The presence of numerous palaeolithic sites in the *duns* and the recent dating of specific *dun* sedimentary features (in India) combine to suggest a much younger terminal age for the Soanian than previously estimated (see below). For example, the abundant presence of Soanian artefacts and the complete absence of Acheulian bifaces in the Indian *dun* sediments are significant determinants in assigning broad comparative chronologies to *dun* formation and associated assemblages. Furthermore, Acheulian bifaces recovered from Nepali Siwaliks indicate that the *duns* there may have formed earlier than in India. In the Pakistani Siwaliks, *dun* sediments and associated geological features are absent.

The significance of the Boulder Conglomerate Formation

The abundance of conglomerates in the Upper Siwaliks establishes that the Himalayas to the north (where the conglomeratic material originates) reached their maximum height during the Pleistocene upheaval of the region. The Boulder Conglomerate Formation is essentially divided into Upper and Lower conglomerates, both being noticeably distinct units. They both comprise quartzite pebbles, cobbles, and boulders of varying size, type, density, and orientation. Although the matrix contains smaller nodules of other rock types, the quartzite was the most suitable raw material available to (and selected by) the hominid occupants of the region at the time. In addition to being located within the Boulder Conglomerate Formation, the rounded quartzite clasts also occur in streambeds, major riverbeds, and in the terrace sections in the *duns*. Recent field observations by the author have also revealed an additional source of quartzite clasts – in fragmented patches of small, uplifted palaeo-channels that are occasionally found within the fine-grained Siwalik strata.

The Boulder Conglomerate Formation of the Upper Siwalik Subgroup marks the onset of a dramatic change in climatic conditions, i.e. a pluvial phase perhaps accompanied by gradual uplift of the neighbouring Himalayas (Chopra 1979). This had strong repercussions on subsequent climatic fluctuations and faunal/floral evolutionary episodes. Through recent studies, it was determined that the Boulder Conglomerate’s deposition commenced in the Pakistani Siwaliks at approximately 1.0 Myr ago (slightly earlier than in India) (Rendell et al. 1989). Therefore, its time-transgressive nature does not allow us to recognise it as a marker horizon despite its intermittent, but conspicuous presence along the entire Siwalik range.

▲ Distribution of Acheulian sites in the Siwalik region

Due to a high rate of ongoing erosion and neo-tectonic activity, Siwalik sediments have not yielded stratified palaeolithic material of such integrity as known from other regions in the Old World. All documented Siwalik Acheulian sites occur in varying geological and geographical contexts throughout Pakistan, India, and Nepal (Table 2 and Figure 2). In Pakistan, they occur in association with Upper Siwalik sediments as well as on erosional 'terraces' of the Soan river valley. In India, the known biface localities are situated on Siwalik frontal slopes, and in Nepal, they are located within *dun* sediments adjacent to the hills and in folded alluvial deposits. This inter-regional diversity in the geology and artefact morphology hints at potential techno-chronological differences within the Siwalik Acheulian facies, as well as with the Soanian. All known Siwalik Acheulian sites are described in greater detail below.

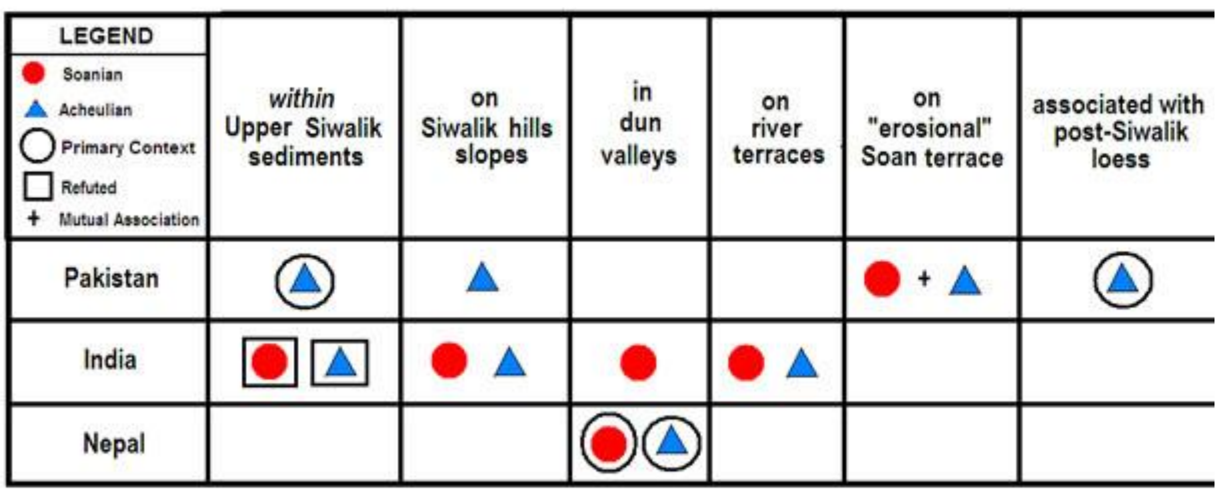

Figure 2. Geographical and geological contexts of all known palaeolithic sites in the Siwalik region. (adapted from Chauhan and Gill, 2002).

COUNTRY	SITES		CHRONOLOGY	"GEO-CONTEXT"	INVESTIGATOR(S)
Pakistan	Chauntra Ghariala Balawal MS 163	Chak Sighu Rawalpindi Chakri Adiala	Unknown	On erosional "terraces", on various Siwalik Formation surfaces, and in post-Siwalik loess	H. De Terra & T.T. Paterson (1930s)
	Morgah		Unknown	on a "terrace"	E.B. Pinford (?)
	Dina * Jalapur *		700-400 kyr	in Upper Siwalik gritstone/conglomerate	British Archaeological Mission to Pakistan (1980s)
India	Kangar Jatwar Kot Lalwan Sabaur Palata Babahar Jhangrian Ramanpur Karura Supalwan	Khanpur Kuhi Garhi Suna Ghanaura Saumundri Aitbarapur Tikhni Daulatapur Marawari Chandikotla	Not older than 200 kyr (according to the investigator)	On the frontal slopes of various Siwalik Formations	G.C. Mohapatra (1970s-80s)
Nepal	Satpati * Gadari *		late Middle to early Upper Pleistocene	Within dun valley sediments	G. Corvinus (1980s-90s)

Table 2: Known Acheulian sites in the Siwalik region. (* Denotes primary or in situ context.)

Pakistan

The first systematic search for palaeolithic sites in the sub-Himalayan region was initiated by the Yale-Cambridge Expedition (in the 1930s) in the Soan River Valley and the Potwar Plateau, located in present-day Pakistan (then part of India) (Figure 1). At the time, H. de Terra and T.T. Paterson (1939) relied heavily upon the four-fold glacial sequence developed in Europe and applied the same system in the Indian subcontinent. Their aims involved integrating the regional geology, chronology, and the associated palaeolithic material. Their efforts resulted in the location of a multitude of palaeolithic sites of varying ages and traditions, including the discovery of the Soanian tradition (named after the Soan River).

Paterson's interpretations of the Acheulian-Soanian occurrences in the Soan Valley

In the Soan valley, Soanian artefacts occur in mixed surface contexts with Acheulian artefacts, as well as independently (de Terra and Paterson 1939)[Footnote 2]. Paterson divided the technological differences with the Soanian being based on flakes, and the Acheulian (then called the "Stellenbosch") predominantly consisting of handaxes (Rendell et al. 1989). His conclusions were based on his experience with the Clactonian tradition (a core-and-flake industry) of Britain, and the European palaeolithic research paradigms prevalent at the time (Dennell and Hurcombe 1989). Due to the lack of stratified sites, the team chronologically grouped the artefacts based on their condition and the Soan terrace sequence. They also put forward the idea that the Acheulian was a younger cultural ‘intrusion’ into the Soanian-dominated region (de Terra and Paterson 1939). However, in the ensuing decades their methodology and results were felt, by both geologists and archaeologists, to be erroneous and inapplicable in South Asia (see Gill 1951; Ray and Ghosh 1981).

The role of the British Archaeological Mission to Pakistan

The first serious attempt at the revision of De Terra and Paterson’s work was initiated by the British Archaeological Mission to Pakistan (BAMP) in the late 1970s. Through a project spanning over two decades, the BAMP team established that the Soan river ‘terraces’ were actually erosional features rather than classic river terraces (Rendell et al. 1989). Therefore, Paterson’s chronology assigned to the palaeolithic material (based on the ‘terrace’ sequence) could no longer be held as valid. The BAMP team also succeeded in locating and dating sites ranging from the Lower to the Upper Palaeolithic, including two Acheulian sites at Dina and Jalalpur (Figure 1) (Rendell et al. 1989). At Dina, a handaxe was found within and underlying a quartzite conglomerate, and at Jalalpur fourteen artefacts, including two handaxes, were recovered from a gritstone/conglomerate lens (Rendell and Dennell 1985). The investigators correlated the artefact-bearing horizons with deposits that were previously dated to 700 to 400 kya through palaeomagnetism by R.G.H. Raynolds and others (Allchin 1995). The age of these Acheulian occurrences broadly correlates with several early Acheulian sites further south in peninsular India. Interestingly, the investigators did not encounter Soanian artefacts as per De Terra and Paterson’s description (see Paterson and Drummond 1962), and as such do not regard it as an independent lithic tradition (Dennell and Hurcombe 1989).

India

In India, ‘proto-handaxes’ or ‘Abbevilian’ handaxes found alongside Soanian tools were first reported by Lal (1956) from the Beas-Banganga Valley of Himachal Pradesh. Classic Acheulian bifaces were first collected by Mohapatra (1981) on the Siwalik frontal range around Hoshiarpur in Panjab (Figure 1). The number of artefacts in Mohapatra’s collection totals one hundred and twenty from twenty-one sites dispersed in a NW-SE linear pattern. The bifaces are broadly comparable with other Middle and Late Acheulian artefacts from peninsular India. They are considered to be geologically and geographically separate from the Soanian and occur in isolation in the Siwalik frontal range. According to Mohapatra (1981), Acheulian populations occupied the relatively flat surfaces of the Siwalik frontal slopes, while the Soanian populations predominantly occupied adjacent terraces and the *duns*. Mohapatra has emphasised a cultural difference to explain this disparity in geographical distribution. However, the (contradicting) fact that Soanian sites also occur on the Siwalik frontal slopes (albeit in lower density near the Acheulian sites), makes the situation highly challenging when attempting to understand hominid land-use patterns and associated chronologies. According to Mohapatra (1981; 1990), the Acheulian sites cannot be older than the Upper Pleistocene, since the Siwalik slopes were not tectonically stable prior to that time. However, recent workers such as Kumar et al. (2001) and Powers et al. (1998) have successfully demonstrated that certain Siwalik frontal slopes were uplifted during the late Upper Pleistocene and Holocene. In contrast to Mohapatra’s view above, this highlights that the Siwalik frontal slopes were never ‘tectonically stable’ and that neo-tectonic activity is a regionally ongoing process. Knowledge of associated neo-tectonic processes further complicates the matter regarding our understanding of Acheulian land-use patterns, the age of the artefacts, and the timing of site upliftment.

Further claims of Acheulian finds in the Indian Siwaliks have been made in the past, but not accepted by other South Asian prehistorians. For instance, Sharma (1977) reported Acheulian bifaces from within Upper Siwalik deposits near Chandigarh, however Mohapatra (1981) later challenged the stratigraphical position of the artefacts. Although R.V. Joshi (1967-68) also reported Acheulian artefacts in the adjacent Kangra region in Himachal Pradesh, these were later classified as being non-Acheulian in morphology, from a re-analysis by Joshi himself (Karir 1985).

Nepal

The earliest stratified evidence of the Acheulian in the Nepali Siwaliks essentially comes from two sites in the Dang-Deokhuri (*dun*) valleys in Nepal. The sites (Gadari and Satpati) yielded handaxes through erosion, indicating occupation on the banks of the ancient Babai River. These sites mark the north-easternmost extension of the Acheulian in the Indian subcontinent and are the first reports of the industry in this part of the sub-Himalayas (Corvinus 1990) (Figure 1). The Gadari handaxes were recovered from the basal gravels of the alluvium and thus, belong to the oldest period of the *dun*. The artefacts are made on quartzite cobbles or large flakes by primary flaking and step flaking. One is a small oval handaxe, with a jagged bifacial edge. Another specimen is a larger handaxe (manufactured on a flake) with a much straighter edge. An oval unfinished handaxe, a pick, a large cleaver, and a number of large cores and flakes were also recovered. The Satpati site was discovered in the early 1990s and is situated at the foot of the Siwalik hills, west of the Narayani River where it merges with the Terai Plains. The site (consisting of 18 artefacts) is in the folded alluvial sandstones and gravels of the Gangetic alluvium, which were a part of the tectonic activities of the last phase of the Himalayan uplift, later becoming exposed by the folding of the geological beds (Corvinus 1995).

Although the assemblages at both sites are small, they reflect the diversity of tool-types utilised during the Lower Palaeolithic in the region. Corvinus (1996) states that the handaxes are made in the Indian Acheulian tradition, thus suggesting technological influence from India. As in Pakistan, the fact that only two Acheulian sites were encountered in over ten years of exploration signifies a marginal Acheulian presence in the region, when compared with the other Lower Palaeolithic industries of diverse typological resolution in Nepal. With the exception of De Terra and Paterson's finds in the early

1930s, all other Siwalik Acheulian sites from Pakistan, India, and Nepal were reported only within the last twenty-five years.

▲ The Acheulian-Soanian Dichotomy

Owing to the shared geomorphological surface contexts of Acheulian and Soanian sites in the Siwalik region (Figure 2), both lithic traditions have been perceived to be contemporaneous by previous workers (Mohapatra 1990). Consequently, their techno-cultural relationship has been in contention due to their mutual (albeit loose) association, and the issue remains unresolved (see Misra and Mate 1995). One obstacle is the enigmatic 'techno-temporal' identity of the Soanian. Despite numerous intermittent investigations spanning over seven decades, the Soanian has yet to be adequately defined and chronologically isolated. The principle rationale behind this void is the dearth of rich stratified sites in the Siwalik region. The lack of sedimentary deposition during and following hominid occupation has prevented their preservation through natural burial. Furthermore, recent work (Chauhan and Gill 2002) has shown that a combination of subsequent tectonic, erosional, and anthropogenic processes has contributed to the destruction or disturbance of most known sites, notably those on the Siwalik slopes. Nonetheless, the value of lithic surface scatters should not be overlooked (Rendell et al. 1989; Sullivan 1992; Tainter 1979) and most of our knowledge of Siwalik prehistory is derived from such contexts.

Over the decades, two general arguments have emerged regarding the Acheulian and Soanian relationship, particularly from work conducted by South Asian archaeologists (Misra and Mate 1995; Mohapatra 1990). One argument supports an individual technological identity for the Soanian, mainly based on morphological features, certain tool-types, and the absence of classic bifaces. The other school of thought holds that the Soanian is a unique technological facies of the Acheulian and should not be separated. The latter opinion is primarily based on the premise that choppers (and other pebble/cobble based tools) also occur within Acheulian assemblages and that bifaces are not always present (Stiles 1978). These investigators find difficulty in accepting that two distinct cultural groups could have lived in such close proximity for so long without influencing each other's technological repertoires (Sali 1990).

Gaillard's comparison of the two traditions

In support of the first argument, results from a comparative technological analysis between an Early Acheulian assemblage (from Singi Talav, Rajasthan) and a Soanian assemblage (from Dehra-Gopipur, Himachal Pradesh) were employed (Gaillard 1995). According to Gaillard (1996), both traditions have a strikingly similar processing sequence, mainly in terms of trimming, utilising large cortical flakes, and utilising semi or non-cortical flakes (the latter two receiving further retouching). From this cursory observation of globally shared lithic traits, Gaillard states: "The question still remains as to why the Soanian people did not make handaxes although they were able to do so" (1995: 243). The author finds this statement archaeologically irrelevant and sees several weaknesses in the investigator's reasoning:

a) It was never established (through dating) whether both of the assemblages were coeval. Although Gaillard assigns both to the Lower Palaeolithic, they may not have been contemporary. From recent observations and studies, the Soanian is now increasingly considered (by the author) to be a late Lower or early Middle Palaeolithic industry of a Mode 2/3 classification rather than of Mode 1.

b) Furthermore, both assemblages in the study are separated by a wide geographical expanse and several eco-systems. Therefore, variations in artefact density, morphology, technology, chronology, and function are inevitable. Thus, these assemblages cannot be compared with each other.

c) It is known from previous research that Acheulian sites are highly diverse in terms of general processing techniques, modes of biface production, and overall behavioural resolution (Stiles 1978). In other words, there was no particular incentive to compare the Dehra-Gopipur Soanian assemblage specifically with that from Sigvi Talav. If the former assemblage were to be compared with another Acheulian site, the results may have been identical or divergent depending on the absence or presence of multiple typo-technological idiosyncrasies. Regarding the implications of techno-morphological diversity, the same may also apply to Soanian sites [Footnote 3].

c) Various types of Soanian choppers, scrapers, and flakes can most probably perform the same functions as handaxes and cleavers and require less manufacturing effort, thus making bifaces obsolete. In other words, although the Soanian people knew how to produce bifaces (according to Gaillard), they may not have had a functional need for them. This may explain the dearth of bifaces and the abundance of Soanian artefacts in the Siwalik region.

Moreover, Gaillard's (1995, 1996) conclusions do not clarify the 'techno-chrono-geographical' variances and relationships (if any) between the Soanian and Acheulian sites in the Siwalik region. Differences in temporal resolution, functional aspects, raw-material availability, environment, behavioural implications, and subsistence strategies must have contributed immensely to the diversity and tempo of the Siwalik palaeolithic sequence. An observation, slightly varied from Gaillard's, has been made by Krantz about differences in function as a potential factor for the typological diversity between the two industries:

Had the Soanian tool makers any inclination or desire to make a handaxe they could have done so quite easily with their techniques. Clearly the handaxe was a tool design for which they had no use (Krantz 1972: 69).

Other workers have also emphasised on the differences rather than the similarities of two such diverse industries. For example, Karir has worked in the Pinjore *dun* and documented and studied several Soanian sites (which he collectively designates as the Pinjore-Nalagarh *dun* lithic industry) and states:

The Pinjore-Nalagarh *dun* lithic industry belongs to the pebble tool tradition like that from the Soan Valley in the Potwar, Beas Valley in Kangra and the Jammu region. The character of this industry is seen in its peculiar typology and technique which are quite distinct from those of the Chelles-Acheulian tradition. Therefore, comparison of the Pinjore-Nalagarh *dun* industry cannot be made with those industries that do not belong to this tradition (Karir 1985: 120).

Similar issues with other non-biface industries

Similar issues concerning technological variances have been raised at other palaeolithic sites in the Old World. For instance, at Olduvai Gorge in East Africa, Developed Oldowan (the Oldowan is the most simple and earliest known chopper-and-flake industry) bifaces are known to be contemporary with Early Acheulian bifaces in mid-Bed II (Schick and Toth 1993). Several possibilities, ranging from cultural differences (Leakey 1971) to functional differences (Schick and Toth 1993), have been explored by various workers to explain the variance in artefact morphology and tool types between the two industries. Subsequent long-term research strategies, specifically raw-material analysis, have revealed that Developed Oldowan bifaces are cruder because inferior raw material was found closer to an ancient lake (Schick and Toth 1993). Sites closer to the ideal raw material (further from the lake) seem to yield a higher quality of bifaces (Acheulian). At some localities in the Koobi Fora region of East Africa, most of the raw material was obtained from stream and riverbeds rather than from outcrops (Isaac 1997). Similar situations have also been recently observed by the author in the Siwalik region (Chauhan and Gill 2002).

Another example of the question of 'technological contemporaneity' is provided by the Acheulian-Clactonian relationship in Britain. Interestingly, the general body of evidence, history of research, and the resulting interpretations and debates on the Clactonian are strikingly similar to that of the Soanian (see White 2000). Although a consensus has yet to be reached on the Clactonian's relationship with the regional Acheulian, White (2000) concludes that handaxe assemblages in the British Isles do not seem to have been contemporaneous with non-handaxe assemblages. In light of new evidence such as general observations on raw material exploitation, artefact types, and the dating of *dun*sediments (discussed below), this observation may also hold true for Acheulian and Soanian assemblages in the Himalayan foothills.

Raw Material Constraints

All Lower Palaeolithic industries (e.g. Acheulian, Oldowan) throughout the Old World are generally separated on the basis of their respective typo-technological attributes, rather than from their raw material shape or form. For instance, Oldowan type assemblages from several parts of the Old World have been justifiably classified under the Mode I category (e.g. at Olduvai, at Zhoukoutien, in Southeast Asia, and so on. Also see Clark 1977) (Footnote 4). The artefacts have been casually manufactured predominantly from basalt, quartz, and other types of rock available in the vicinity of the sites and represent the earliest known artefacts in the palaeolithic record. In comparison, the Acheulian has been assigned a Mode II classification on the basis of its aesthetic and symmetrical qualities and more advanced flaking techniques (Clark 1977). At Olduvai Gorge, both angular blocks and rounded clasts have been utilised by early Pleistocene hominids to produce both Oldowan and Acheulian artefacts (Schick and Toth 1993).

The recognition of the Soanian, as an independent industry, has been traditionally governed by its raw material form/shape, absence of classic bifaces, and its conspicuous presence in the sub-Himalayan region. Such qualities as its typological characteristics, flaking strategies, a holistic comparison with the regional Acheulian, and other pertinent properties have not been taken into consideration when labelling it a distinct lithic tradition. The possibility that the Soanian was a technological substitute for the late Acheulian (based on tool-types and relative chronology) has never been explored. In the Siwaliks, such factors as raw material size constraints and 'morpho-techno-functional' overlapping in both industries may indicate a gradual decrease in biface production over time (discussed below).

Biface production: clast size and artefact size

Although general observations can be made to understand the obtainable quantity and sizes of rounded clasts, their present-day availability is probably considerably different than that during Pleistocene times. Moreover, the selected maximum size of the original clast cannot be determined unless a biface or core is found with all or most associated flakes that can be refitted. When manufacturing a classic biface (of reasonable size) from rounded raw material, a relatively large blank is highly desirable since more cortex needs to be removed when compared with an angular (flake) blank. This is primarily due to the fact that rounded raw material accommodates a limited number of flat striking platforms (or positions for initial trimming) when compared with angular forms. In rounded forms, one is forced to start chipping at the perimeter of the blank or clast and work one's way inwards to prepare the core/striking platform ([Figure 3a](#)). In angular blanks, the majority of cortex is initially removed when a large flake is initially struck from the core. This latter concept can also be applied to boulders when extracting a series of large flakes for biface manufacture, thus initially removing a higher amount of cortex more efficiently ([Figure 3b](#)). When the same is attempted on a cobble, the resulting cores and flakes are restrictive in size to allow further trimming for biface production. The largest Soanian artefacts (discounting cores) are a variety of choppers on cobbles of consistent sizes ([Figure 4](#)), excepting the occasional artefacts on boulders.

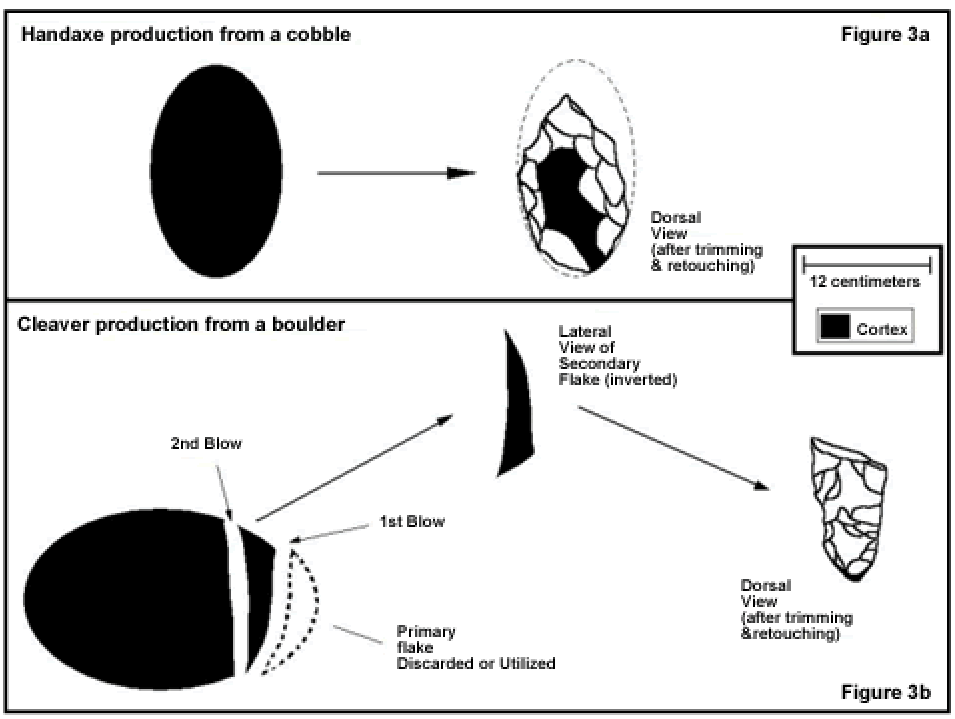

Figure 3. Acheulian biface production techniques from boulders and cobbles.

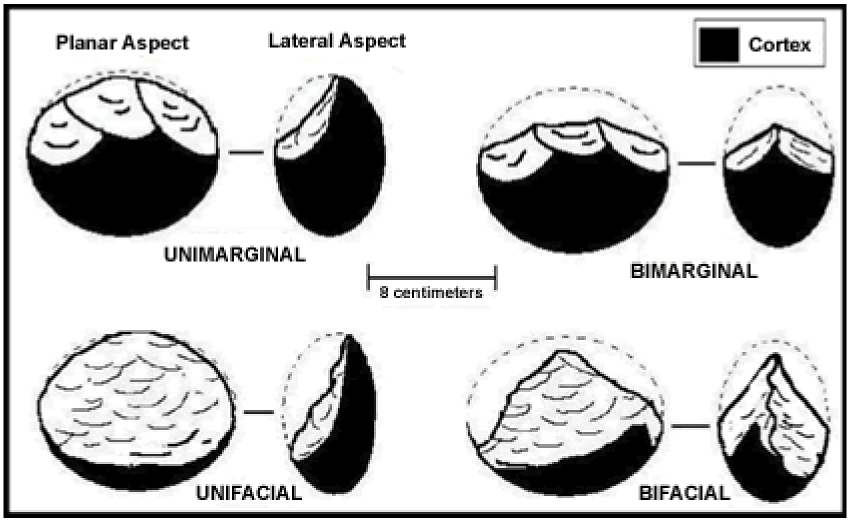

Figure 4. Typo-morphological varieties of Soanian choppers.

A close correlation between the dimensions of the original raw material clast and the finished tool has been acknowledged by Mohapatra (1990). Therefore, from metrical analysis of bifaces (on rounded clasts) and an understanding of their reduction strategy through experimental flintknapping, one can (approximately) gauge the minimum size requirements of the original blanks. The knowledge of this ratio prior to biface production can safely allow considerable reduction of the blank or removal of the cortex without compromising the intended size of the resulting biface. For instance, some Siwalik bifaces range between 9.9 to 15.2 centimetres in length (Table 3). The minimum size of the blank would have to be proportionately larger in length and diameter, perhaps by at least 50 to 70 percent. This principle is explicit if the intention is to remove all or most of the cortex through hard-hammer percussion, unless they were made on large flakes derived from boulders. These differences in the size and reduction strategies, along with selective exploitation of the raw material in the Siwalik region has been previously studied by Mohapatra (1990). However, utilising soft-hammer or hammer-on-anvil rather than hard-hammer techniques may allow the use of slightly smaller cobbles since the former techniques permit a greater degree of flaking precision. The correlation between raw-material size and form and the absence of bifaces has also been emphasised from studies on other lithic industries, such as the Clactonian in Britain (see White 2000).

COUNTRY	SITE	ARTIFACTS	LENGTH (in cms)	AVERAGE (in cms)
PAKISTAN	MS 163	1 Handaxe	13.1	13.1
	Morgah	12 Handaxes	9.3 - 17.5	13.9
	Morgah	3 Cleavers	15 - 15.3	15.2
	Chak Sighu	7 Handaxes 1 Cleaver	6.6 - 18	12.1
	Jalalpur	2 Handaxes	12 - 13.6	12.8
	Dina	1 Handaxe	13	13
INDIA	Hoshiarpur Siwaliks	"Bifaces" (67%)	largest- 19.4	14.8
		Cleavers (21%)	largest - 19.8	13.4
NEPAL	Gadari	2 Handaxes	8.3 & 11.6	9.9

Table 3: Average length dimensions for some bifaces from select Acheulian sites in the Siwalik region [Footnote 5].

Differences in artefact density and raw material availability

The raw material utilised for the production of both Siwalik Acheulian and Soanian artefacts was the same-quartzite pebbles, cobbles, and boulders. However, general field observations reveal that quartzite pebbles and cobbles are much more abundant than boulders in the Siwalik ecozone. This differentiation in clast size may have also existed during hominid occupation of the region. If this is true, the amount of sizeable clasts (large cobbles and boulders) available for the production of classic Acheulian bifaces would have been inadequate. This scant availability of large blanks may explain the low number of Siwalik Acheulian sites. Furthermore, the low density of artefacts at all Siwalik Acheulian localities demonstrates that the bifaces were manufactured elsewhere but utilised and abandoned in the Siwalik region. This observation is confirmed by the absence of debitage, biface-thinning flakes, and cores. Factory/workshop sites of the Acheulian tradition have not yet been reported from anywhere in the Siwalik region. In contrast, high-density factory sites of the Soanian tradition have been observed by de Terra and Paterson (1939; Paterson and Drummond 1962) in Pakistan and recently by the author in India. Although smaller artefacts are prone to surface transport through erosion and heavy monsoon rains, notably at low-density sites (Chauhan and Gill 2002), this processes cannot be taken for granted at *all*known sites. This difference in artefact density may be explained in part through a change in the availability of raw material(s).

Prior to the formation (and concluding depositional phases) of the Boulder Conglomerate Formation, the availability of suitable raw material in the Siwalik region was minimal. The Boulder Conglomerate formed over a long period of time through fan formation which was critically dependent on the upliftment of the Lesser Himalayas to the north, the source of the conglomerates. For example, Mohapatra (1990) states that the Siwalik Frontal Range area was still receiving the conglomeratic material and simultaneously rising between 0.35 and 0.2 myr ago. Moreover, when the Formation subsequently became prominent in the region, quartzite nodules were not available consistently throughout the hill range. Other sources of the same raw material (i.e., in uplifted palaeo-channels within other Siwalik formations, in the small channels emanating from the hills, *dun* terraces, and so on) most probably became available only after 0.2 myr ago, when Boulder Conglomerate sedimentation was in its terminal phase (Mohapatra 1990). However, this broad generalisation is made complicated due to the time-transgressive nature of the Boulder Conglomerate and needs to be supported through intensive mapping and dating of such sediments. Its genesis, development and age as a lithological unit varies from region to region, primarily owing to an intense but sporadic tectonic history. In fact, various exposures visible today did not form a continuous, contemporaneous landscape during hominid occupation. This latter observation plays a meaningful role in assigning a relative chronology to the palaeolithic material in the Siwalik hills.

Despite the difference in edge-angles and a compromise in overall functional efficiency, Soanian tool-types may have gradually replaced Acheulian core-tools at a functional level owing to the meagre availability of large nodules or clasts for biface production. For instance, Schick and Toth (1993) have demonstrated through feasibility experiments that different tool-types were utilised by early hominids to achieve different tasks. Interestingly, all activities mentioned by them, including hide slitting and scraping, heavy and light-duty butchery, bone breaking, nut cracking, and heavy and light-duty woodworking, can be accomplished through the use of bifacial and/or non-bifacial tool-types. Although they have compared the Oldowan with the Acheulian in East African palaeoecological and archaeological contexts, such concepts may also be applicable to the Soanian.

For instance, Soanian bifacial and bimarginal choppers can (probably) functionally replace Acheulian handaxes. Large flakes from boulders and unifacial and unimarginal choppers may be able to replace Acheulian cleavers in the same manner. In fact, the Siwalik Acheulian may have chronologically overlapped (briefly) with the Soanian at one point in time before the latter became the predominant lithic tradition in the region. In addition, both Soanian sites and late Acheulian assemblages in general, appear to share advanced tool-types such as Levallois flakes/cores and distinct scraper types. These advanced features and tool-types are markedly absent in the Siwalik Acheulian facies, hence hinting at its own older antiquity. In light of these techno-functional similarities, the Soanian may be regarded as a sub-Himalayan ‘variant’ of the late Acheulian and understood in terms of a change in planning behaviour in an evolving landscape.

▲ Temporal frameworks

Most palaeolithic sites in the Siwalik region appear to represent hominid occupation following the formation of the hills, both spanning the Pleistocene. Surprisingly, workers have been debating the Soanian-Acheulian dichotomy based on the assumption that both traditions were contemporaneous, without any stratigraphical and geochronological confirmation. The fact that both traditions belong to the Middle to Upper Pleistocene and/or Lower Palaeolithic phase does not rule out the possibility that they may not have been contemporary. If this turns out to be the case, then the direction and objectives of archaeological queries alter drastically. Traditionally, previous workers have placed the Siwalik Acheulian as being younger than the Soanian. For example, discussing the sole ‘mutual’ association of Soanian and Acheulian tool-types documented by de Terra and Paterson (1939) at Chauntra, Mohapatra (1990: 254) states: 'Here the Acheulian could have arrived much later than the Late Soanian, probably during the Riss-Würm Interglacial or even later'.

However, from comparative observations of landforms, tectonic history, artefact density, and the timing of raw material availability and size constraints discussed above, the Siwalik Acheulian appears to be chronologically older than the Soanian, the latter occurring in relatively younger sedimentary contexts. Indeed in Nepal, Corvinus (1995) has reported Acheulian artefacts in much older deposits in comparison to the Soanian-like assemblages in the area (though these have not been labelled as Soanian). In Pakistan, Rendell et al. (1989) have provisionally placed the early palaeolithic in the Soan Valley as simply being older than 30 kya. Scholars such as Sen (1954) have also opined that the Acheulian is older than the Soanian. This application of broad relative chronologies is the sole option available to prehistorians until *in situ* artefacts are recovered and precisely dated on a consistent basis.

Recent OSL Dates

Recent optically stimulated luminescence (OSL) dating of alluvial fans in the Pinjore *dun* valley (India) suggests that fan formation initiated well before 57 ka BP and continued at least up to 20 ka BP (Suresh et al. 2002). Sedimentation within the *dun* probably started after ~200 ka, and well after closing of sedimentation in the Siwalik basin. The sudden termination of fan deposition in the *dun* was followed by the subsequent river incision and terrace formations. The oldest associated terrace formations are proposed to be between 20 and 15 ka in age (Suresh et al. 2002) and have yielded several Soanian sites throughout the *dun* (Karir 1985). These dates do not apply to similar geomorphological features located in other *duns*, nor do they represent all known Soanian assemblages. The latter is particularly true if the Soanian existed within an extended and dynamic technological gradient. However, the dates certainly imply a rather young age for the Soanian sites known from the Pinjore *dun* terraces. Furthermore, the dates (if accurate) demonstrate a longer continuation than previously known of heavy-duty implements, such as choppers and core-scrapers, in the Soanian toolkit. Since these Pinjore-Nalagarh *dun* assemblages appear to be contemporaneous with the Upper Palaeolithic phase, the Soanian is in need of careful re-analysis and re-interpretation.

Conclusion

The Siwalik Acheulian is dispersed in varying geological and ecological settings, demonstrating a highly varied settlement pattern (indicating site-selection) and temporal record. From observations of raw-material size, associated artefact-size, and from the lack of original cortex, the majority of Siwalik Acheulian bifaces appear to have been manufactured through either the reduction of large quartzite cobbles and/or by the removal of large flake blanks from quartzite boulders. General observations further indicate that Acheulian bifaces occur in a lower density than Soanian artefacts in the Siwaliks. This may primarily be due to the increasing availability of quartzite pebbles and cobbles of restricted sizes and the virtual scarcity of boulders. Soanian artefacts were, most certainly, manufactured when the raw material was in abundance.

Acheulian bifaces were (most probably) made in, or transported into and abandoned in the Siwalik region, where large quartzite clasts were generally absent or available in minimal quantities. In concordance with the neo-tectonic history of the Siwalik belt, quartzite clasts in rounded form only became available (where the Boulder Conglomerate Formation was *not* generally present) during the late Middle Pleistocene and onwards. Therefore, Soanian sites cannot be older than the initial availability of the associated raw material, notably when considering the large density of artefacts at such sites. The geological features at all known Lower Palaeolithic sites in the Siwalik region display a general pattern of differential temporal placement. Acheulian occurrences in the Siwaliks, although comparatively low in number, tend to be recovered from older geological scenarios than the Soanian. This perception is broadly sustained by such evidence as young OSL dates for specific Soanian assemblages, geomorphic and landform contexts, raw material availability, and artefact densities.

Considering our present state of knowledge of the Siwalik palaeolithic record, understanding the Acheulian-Soanian dichotomy continues to be a highly challenging endeavour. The hypothesis presented above, involving the

Siwalik Acheulian's technological and temporal attributes, can only be conjectural at this stage and more intensive investigations are needed to support or challenge it. Without the recovery of primary stratified sites, larger numbers of artefacts, suitable material for absolute dating, and associated hominid fossils, our knowledge pertaining to hominid identity, the timing of colonisation, site-catchment, ecological adaptations, behavioural and technological changes, and mobility patterns (among others) in the Siwaliks will continue to remain fragmentary. Until then, the abundant surface sites warrant considerable attention and can confidently reveal such valuable aspects of hominid behaviour as ecological preferences, artefact-processing trajectories, tool-type frequencies, and overall strategies to raw material exploitation. Overall, the 'chrono-techno-geographical' differences between all palaeolithic sites in the Siwaliks strongly display varied subsistence strategies and a change in environmental adaptations through time.

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Footnotes

[1] This paper reintroduces a topic (the Acheulian-Soanian dichotomy) that has been debated for over seven decades and only attempts preliminary hypothesis-building at an exploratory level. The concepts presented here need more supporting evidence before they can be fully substantiated.

[2] Acheulian sites found by de Terra and Paterson are not discussed in detail here due to revised interpretations of the local geology and associated terrace sequences. However, for their original interpretations, refer to de Terra and Paterson (1939) and Paterson and Drummond (1962). For the revision of their work, refer to Rendell et al. (1989).

[3] The author is presently engaged in analyzing a rich

Soanian workshop/factory site, of which the results are to be published in a separate paper. The work should reveal previously unknown tool types and modes of lithic manufacture.

[4] The utilization of the "MODE" system to classify lithic assemblages was first initiated by Clark (1977). Mode 1 is represented by pre- and non-Acheulian lithic technologies (Lower Palaeolithic); Mode 2 includes Acheulian or biface technology (Lower Palaeolithic); Mode 3 comprises Middle Palaeolithic flake-based technologies; and Mode 4 is represented by Upper Palaeolithic blade technology.

[5] Length dimensions for artefacts from Pakistan and Nepal were calculated from illustrations and photographs from Dennell (1986) and Corvinus (1996). Therefore, these length estimates should be considered as approximate. For the Hoshiarpur sites in India, the dimensions are provided by Mohapatra (1981).

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