Presence of Early Pleistocene Acheulian hominins in South India

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Acheulean/Acheulian denotes an archaeological industry of stone tool manufacture associated with early humans during the lower Palaeolithic era across Africa and much of West Asia, South Asia and Europe. The Palaeolithic era is a prehistoric era distinguished by the development of the most primitive stone tools discovered and covers roughly 99% of human technological prehistory. It extends from the earliest known use of stone tools, probably by hominins such as Australopithecines, 2.6 million years (m.y.) ago, to the end of the Pleistocene around 10,000 BP (ref. 1).

Acheulean tools are typically found with *Homo erectus* remains. It is thought that they first developed out of the more primitive Oldowan technology about 1.76 m.y. ago, by *Homo habilis*. Oldwan/Olduwan is an archaeological term used to refer to the stone tool industry that was used by homonins during the lower Palaeolithic era. It is significant because it was the earliest stone tool industry in prehistoric times being used from 2.6 m.y. ago until 1.7 m.y. ago, which was followed by more sophisticated archeulean industry. The social organization of the earliest/Lower Palaeolithic societies remains largely unknown to scientists, though lower Palaeolithic hominids such as *H. habilis* and *H. erectus* are likely to have had more complex social structures than the chimpanzee societies. Late Oldowan/Early Acheulean humans such as *Homo ergaster*/*H. erectus* may have been the first people to invent central campsites or home bases and incorporate them into their foraging and hunting strategies like contemporary hunter-gatherers, possibly as early as 1.7 m.y. ago[2].

The Pleistocene is the geological epoch from 2,588,000 to 11,700 yrs BP that spans the world's recent period of repeated glaciations. The Palaeolithic era is a subdivision of the Pleistocene epoch. During the Palaeolithic period, humans grouped together in small bands and subsisted by gathering plants and hunting or scavenging wild animals. The Palaeolithic era is characterized by the use of knapped stone tools, although at that time humans also used wood and bone tools and also tools made with other organic materials like leather and vegetable fibres. Due to their perishable nature, these have not been preserved to any great extent. Humankind gradually evolved from early members of the genus *Homo* such as *H. habilis*, who used simple stone tools, into fully behaviourally and anatomically modern humans, *Homo sapiens sapiens* during the Palaeolithic era.

Acheulean technology was the dominant technology for the vast majority of human history starting more than 1 m.y. ago[3]. Their distinctive oval and pear-shaped handaxes have been found over a wide area and some tools attained a high level of sophistication suggesting that the roots of human art, economy and social organization arose as a result of their development. Although it developed in Africa, the industry is named after the type site of Saint-Acheul, now a suburb of Amiens in northern France (not to be confused with the rural commune of Saint-Acheul), where some of the first examples were identified in the 19th century.

Attirampakkam in India was discovered in 1863 by Robert Bruce Foote and is one among a cluster of sites constituting the southernmost extension of the South Asian Acheulian. The site has been studied intermittently for over a century[4–6], culminating in recent archaeological excavations under Pappu. Attirampakkam is located ca. 47 km inland from the east coast (13°13′50″N and 79°53′20″E; 37.5 m asl) on the banks of the Attirampakkam gully, an ephemeral stream that joins the Kortallayar River about 1 km downstream from the site[7]. Annual rainfall (105–125 cm) currently peaks between September and December, and rain rills dissect the site so that artefacts become exposed as they erode out of an area of 50,000 m^2. The regional topography comprises the NNE–SSW-trending Allikulli and Satyavedu hills (200–380 m amsl) in the west. These are uplifted and well-preserved palaeodeltas of the early Cretaceous. They consist of cobble conglomerate that was sourced by the quartzitic Cuddappah ranges to the west. The low-lying areas of the piedmont are underlain by shaly marine rocks of the Avadi Formation. Being coeval and intertonguing with the conglomerate beds, these may represent the palaeodelta bottom set beds. The shales are capped by Tertiary laterite. Throughout the region, lateritic gravels (1.5–2.5 m thick) sourced by these outcrops contain Acheulian to Middle Palaeolithic artefacts. Stratigraphically younger ferricrete layers, which also represent eroded gravels sourced by the laterite, contain Middle Palaeolithic artefacts, and microliths occur on the surface. At Attirampakkam, however, Acheulian tools also occur in abundance within an Argillaceous Formation previously assigned to the Avadi Formation.

Determining when hominin populations routinely crafting these Acheulian stone tools inhabited India is critical for understanding the dispersal of this distinctive technology across Eurasia. Limited evidence has suggested that Acheulian hominins appeared in India substantially later than in Africa or southwest Asia[8]. According to Sheila Mishra (Department of Archaeology, Deccan College, Pune), 'Acheluan artefacts are found in Quaternary deposits of Africa, Europe and India, but it is only in Africa that the acheluan has been dated to the lower Pleistocene. In both Europe and India attempts at dating Acheluan by absolute methods have not been able to push the antiquity of the acheluan beyond half a million years. These artefacts are found in most parts of peninsular India in both surface and alluvial context. Radiocarbon dates obtained primarily for alluvial deposits were initially interpreted as implying that they were no earlier than the Late Middle Pleistocene to Early Late Pleistocene.'

Studies at this site revealed that, during the Early Pleistocene, India was already occupied by hominins fully conversant with an Acheulian technology including handaxes and cleavers among other artefacts. This implies that a spread of bifacial technologies across Asia occurred earlier than previously accepted[9].

Extensive excavations since 1999 have exposed a sequence of stratified deposits

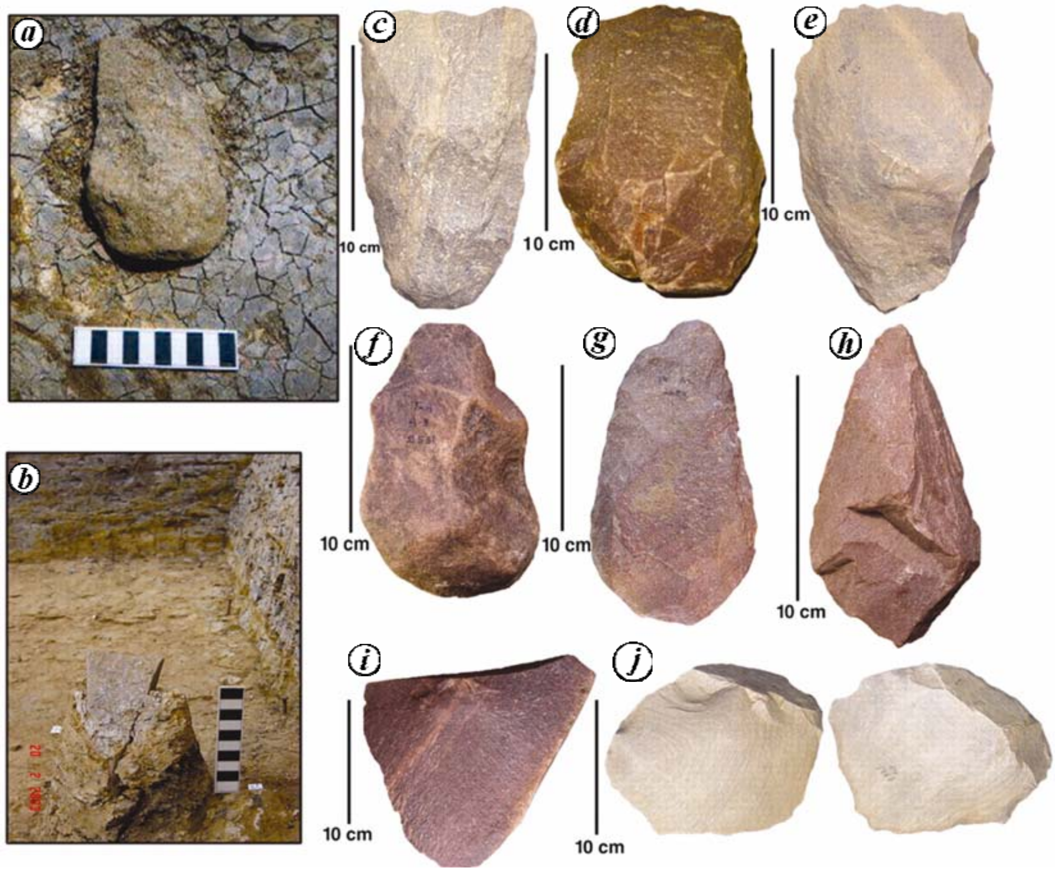

Figure 1. Acheulian artefacts in trench T8. Close-up of artefacts in layers 6 (***a***) and 7 (***b***). Artefacts include cleavers (***c***, ***d***), large flake tool with a cleaver-like working edge (***e***), handaxes (***f*** and ***g***), trihedral (***h***), large flake (***i***) and Kombewa flake (***j***).

reaching a maximum thickness of ~9 m. In all the trenches, Acheulian assemblages were encountered continuously within deposits (layers 6–8) derived from eroding Cretaceous shale and sandstone outcrops in the catchment. These floodplain sediments aggraded during occupation, leading to repeated burial of artefacts discarded at the site. Alternating sand and silty clay beds lacking palaeosols suggest periodic cycles of sediment deposition without lengthy interruptions. The suspended silt particles settled out under conditions of low-velocity laminar over bank stream-flow, burying the stone tools without displacing them. A disconformable upward sequence of coarse lateritic gravels, clay-rich silts and finer lateritic gravels overlies layer 6 and contains later Acheulian to late Middle Palaeolithic assemblages. Such a complete stratified sequence emphasizes the long-term attractiveness of this site.

Pappu said, 'We obtained 3528 Acheulian artefacts from trench T8 (Figure 1), excavated specifically to investigate the deeper layers. The tools were crafted primarily on fine- to coarse-grained quartzite, a source material widely available as cobble and boulder deposits in the near hinterland. Artefacts include retouched and trimmed large cutting tools (> 10 cm), including handaxes, cleavers, trihedrals, unifaces and other retouched/trimmed large flakes, as well as smaller flake tools with only a few artefacts on cobbles. Large flakes were minimally retouched, generally retaining a small proportion of cortex. Among the bifaces, handaxes predominate and are mainly on end- or obliquely struck large flakes displaying variability in flaking techniques and shapes, with elongate and ovate shapes predominating. Cleavers (parallel-sided, divergent, and convergent) remain scarce, are on flakes, and range from minimally shaped cleaver-flakes to reduced cleavers. Cores for detachment of large flakes are absent, implying that Acheulian hominins were transporting to Attirampakkam large flakes and partly to fully shaped tools from surficial quartzite cobble beds used as quarrying sites noted elsewhere in the region. Further shaping and reduction were carried out at Attirampakkam, as indicated by waste flakes that include biface thinning flakes'.

Sediment depositional histories were revealed using pairs of radioactive cosmogenic nuclides and exploiting their respective half-lives. Because these artefacts are quartzite, they were amenable to cosmic-ray exposure dating. This technique is based on the accumulation in quartz exposed at the earth's surface of rare nuclides produced by neutrons and muons through nuclear reactions induced by high-energy cosmic radiation. Researchers in this study used 10Be ($T1/2 = 1.387 \pm 0.012$ m.y) and 26Al ($T1/2 = 0.717 \pm 0.017$ m.y.) to date the burial of six quartzite artefacts from layers 6 and 8. During exposure at the surface, 26Al/10Be ratios vary between ~3.5 and ~7.1, depending on exposure time and local denudation. Given that before artefact production and burial at the site, hominins initially collected source materials with similar preburial surface-exposure histories from the surrounding landscape, the measurement of 26Al/10Be concentration ratios within artefacts will determine their burial age.

This approach can be applied to artefacts from Pleistocene archaeological sites that were rapidly buried to depths exceeding 5–10 m or to older samples in cave sites where production is instantaneously halted by complete shielding from cosmic radiation. At Attirampakkam, however, comparatively shallow burial may have failed to interrupt production entirely. The measured nuclide concentrations, therefore, are the sum of the inherited nuclides at the time of deposition, corrected for radioactive decay, and of the concentration produced at a constant depth since burial.

Depending on the model used for depth-dependent nuclide production by muons, results of this study provide age brackets ranging from a minimum burial-age estimate with a weighted sample mean of 1.51 ± 0.07 Ma, to a maximum burial-age estimate with a weighted mean of 1.68 ± 0.07 Ma. According to researchers, physical knowledge of the muonic contribution to *in situ* nuclide production is currently being debated and also that Acheulian sites in Africa, southwest Asia and Pakistan are around or younger than 1.6 Ma. They consider the more conservative minimum burial ages to be more likely.

Pappu has mentioned that these minimum ages are validated by results obtained from a continuous palaeomagnetic profile involving 49 samples collected down the 9-m stratigraphic section of trench T8. Interpretation of the results suggests that the sediment sequence was deposited before the normal Brunheschron, that is, before 0.78 Ma. Given the cosmogenic burial ages and the nature of the Acheulian assemblage, we correlate the reverse polarity with the Matuyamachron and place it between the base of the Jaramillo (1.07 Ma) and top of the Olduvai (1.77 Ma) normal subchrons, neither of which have been detected (Figure 2). Considered together, the cosmogenic and palaeomagnetic results indicate that Acheulian hominins were present in South India before 1.07 Ma, according to Pappu.

These ages are contemporary with some other Lower Pleistocene Acheulian sites in Africa and southwest Asia. The earliest known dates for the Acheulian (~ 1.6–1.4 Ma) are from East Africa. Early Acheulian sites in South Africa have also yielded an age of ~ 1.6 Ma, suggesting rapid and widespread dispersal of this technology across Africa.

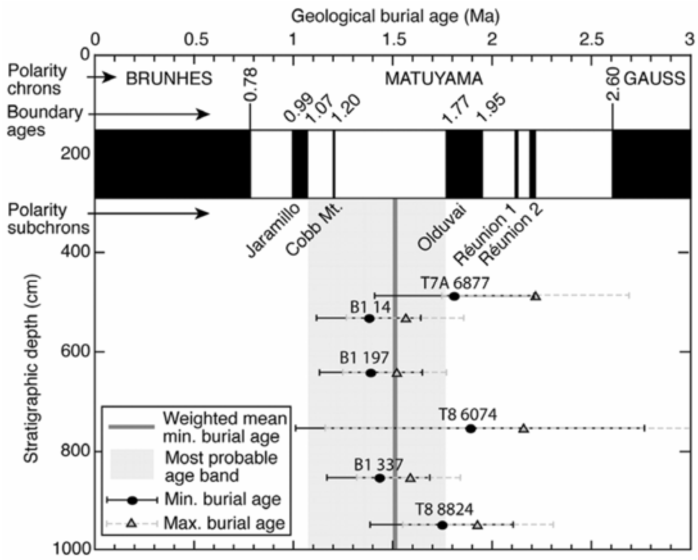

Figure 2. Age constraints on artefact burial stratigraphy at Attirampakkam. Samples are from three separate trenches (T3, T8 and T7A).

Closer to India, the age of the Acheulian at 'Ubeidiya (Israel) is estimated at ~ 1.4 Ma, and the sequence at Gesher Benot Ya'aqov was formed between 0.7 and 0.8 Ma. In the Bose basin, China, Acheulian-like bifaces date back to ~ 0.8 Ma. In South Asia, there is at present little unequivocal evidence for a pre-Acheulian Early Pleistocene occupation, barring ages of ~ 2 Ma attributed to artefacts from Riwat and 2.2–0.9 Ma from the Pabbi Hills, Pakistan. Estimated ages for the Acheulian near Potwar, Pakistan, are 0.4–0.7 Ma. Sparse radiometric ages from sites in India have placed the Acheulian within the Middle Pleistocene, with a few dates suggesting an early Middle to Early Pleistocene age. However, these ages often exceed the limits of confidence of the methods used. They include an electron spin resonance (ESR) mean age of 1.27 ± 0.17 Ma, assuming linear U uptake, on two herbivore teeth from Isampur; an ESR age of ~ 0.8 Ma (lacking uncertainty envelopes) on calcrete from the Amarpura Formation, Rajasthan, which has been correlated with the Acheulian site of SingiTalav; dates ranging from ~ 1.4 to 0.67 Ma for the tephra at Bori (Kukdi River), and palaeomagnetic measurements with evidence of reversals at the sites of Bori, Morgaon, Gandhigram, Andora and Nevasa. However, the reliability of these ages has, in each case, been questioned on various grounds. Likewise, the age and stratigraphic position of artefacts and faunal remains from the Early Pleistocene Dhansi Formation along the River Narmada are yet to be firmly established.

On the basis of data from controlled excavations and two independent dating methods, Pappu *et al.*[9] believe that their estimation for ages from Attirampakkam shows that the Acheulian in India is older than previously thought. Evidence from other sites in South Asia should be reconsidered and re-dated.

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