Chapter 7

Indian Lithic Technology Prior to the 74,000 BP Toba Super-eruption: Searching for an Early Modern Human Signature

Michael Haslam, Chris Clarkson, Michael Petraglia, Ravi Korisettar, Janardhana B., Nicole Boivin, Peter Ditchfield, Sacha Jones & Alex Mackay

The South Asian Middle Palaeolithic, or Middle Stone Age (Misra 1989; Allchin & Allchin 1997), is a largely techno-typological construct poorly constrained by chronometric data. As recently reviewed by James & Petraglia (2005; see also James 2007), this phase is characterized by a geographically variable flake-based industry employing both prepared and unprepared cores, with limited use of retouch and widespread but non-ubiquitous diminutive bifaces. The prepared cores do not adhere to any one particular technique (although discoidal and Levallois reduction are the most common), and show a continuation from the previous Acheulian traditions (Petraglia *et al*. 2003). Evidence for the production of blades in low numbers, and in the absence of standardized unidirectional blade core technology, comes from sites such as Patpara (Blumenschine *et al*. 1983), Bhimbetka (Misra 1985), Patne (James 2007), the Thar desert (Allchin *et al*. 1978) and the Kortallayar Basin (Pappu 2001). The few available dates (most importantly from the 16R dune sequence in Rajasthan: Misra 1995) indicate that Middle Palaeolithic radial core and scraper technologies extend back to perhaps 150,000 years ago, and continue in part until at least 38 kyr BP (Petraglia *et al.* 2009a; see also references in James & Petraglia 2005). Subsequently we see the chronologically variable introduction of technologies that depart from the Middle Palaeolithic, such as microliths and systematic production of blades with increasing use of cryptocrystalline materials, accompanied in some cases by ornaments (Deraniyagala 1992; Sali 1989) and initial adoption of systematic backing technologies currently dated to *c.* 35–30 kyr BP (Clarkson *et al.* 2009; Petraglia *et al.* 2009a).

South Asian genetic and geographic data have recently received increasing attention (Kivisild *et al*. 1999; Field & Lahr 2005; Sun *et al*. 2006; Endicott *et al*. 2007; Field *et al*. 2007; Atkinson *et al*. 2008; Oppenheimer 2009), and a dearth of hominin fossils prior to *c.* 30 kyr BP precludes direct morphological analysis (Stock *et al*. 2007). However, the known Late Pleistocene archaeological record of this region has yet to be comprehensively integrated into contemporary evolutionary debates. To a certain extent, progress in this regard has been hindered by a lack of well-dated stratigraphically secure sites, along with under-development of South Asia-centred frameworks into which findings may be incorporated (Petraglia 2007). One potentially critical palaeoenvironmental event concentrated on South (and parts of Southeast) Asia is the Sumatran Toba volcanic super-eruption of *c.* 74,000 years ago (e.g. Ninkovich *et al*. 1978; Westgate *et al*. 1998; Jones 2007). With ejecta known as the Youngest Toba Tuff (YTT), this significant natural event has acted as a focal point for ongoing debates over population bottlenecks and the potential influence of a volcanic winter on the transition from Oxygen Isotope Stage (OIS) 5 to OIS-4, as well as discussions of the direct impact of Toba ash fall on resident hominin populations (e.g. Rampino & Self 1993; Ambrose 1998; 2003; Oppenheimer 2002; Gathorne-Hardy & Harcourt-Smith 2003). The occurrence of the ash in terrestrial contexts also provides a convenient chronostratigraphic marker (Acharyya & Basu 1993), and consequently an opportunity for assessing if modern human populations were present in the Indian subcontinent at the time of the eruption.

Here we present data on lithic technology from two sites in the Jurreru River Valley of Andhra

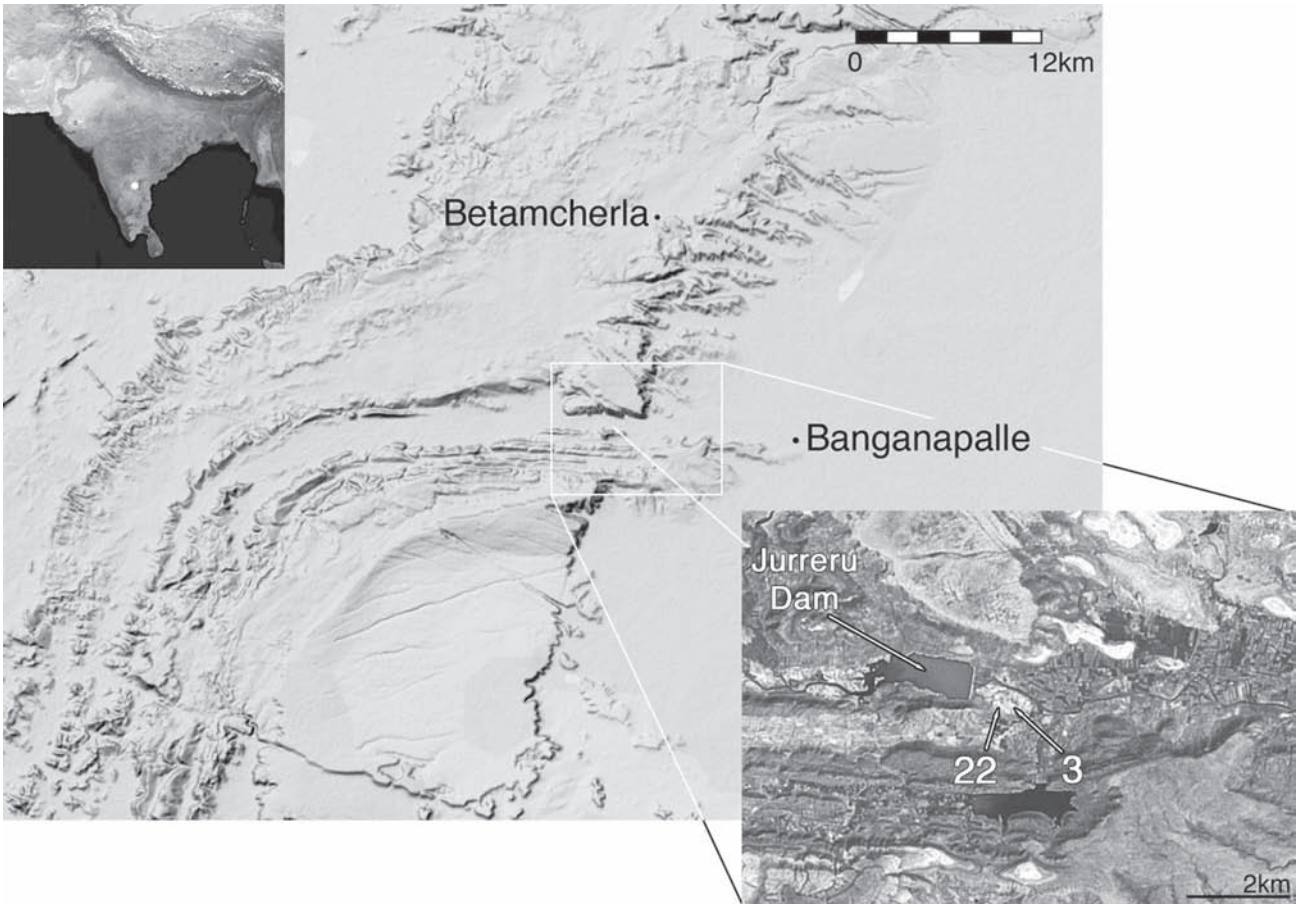


Figure 7.1. *Jwalapuram Localities 3 and 22 in relation to (top left) South Asia, (centre) the Erramala Hills, Andhra Pradesh, and (bottom right) the Jurreru valley and dam. The light-coloured area surrounding the sites, visible immediately to the east of the dam, is exposed Toba ash.*

Pradesh, south-central India, both of which occur stratigraphically immediately below and are sealed by extensive deposits of ash geochemically identified as YTT (Petraglia *et al*. 2007). Analyses of these assemblages provide an initial insight into hominin technological and social conditions at the time of the super-eruption, and supply much-needed data for attempts to discern a signature of modern human arrival in South Asia and the nature of the shift from Middle Palaeolithic to Later Palaeolithic industries.

YTT and the Jurreru River Valley sites

The Jurreru River cuts an eastwards course through the Erramala Hills in the Kurnool District of Andhra Pradesh (Fig. 7.1). Jwalapuram Localities 3 and 22 are located to the south of the river where the valley widens, between the village of Jwalapuram to the east and the present-day Jurreru Dam to the west, and approximately 11 km west of the town of Banganapalle. Archaeological survey of the valley began in 2003, when a published account of Quaternary ash accumulations in the valley (Rao & Rao 1992) led to the discovery of extensive tephra deposits exposed by local mining practices. Subsequent open-site and rockshelter excavations in the valley revealed evidence of hominin occupation from the Acheulian through Indian Middle Palaeolithic and microlithic phases up to the present day (Petraglia *et al*. 2009b).

Electron probe microanalysis (EPMA) characterization of the Jurreru valley volcanic glass sherds demonstrate that they represent a distal deposit of YTT (for methods see Petraglia *et al*. 2007, supporting online material), a finding which is consistent with all previous tephra identifications on the Indian subcontinent (Acharyya & Basu 1993; Shane *et al*. 1995; Westgate *et al*. 1998; although see Lee *et al*. 2004). The sites are approximately 2700 km from the Toba caldera in Sumatra. A total of 225 thickness measurements on ash exposures provide a volume estimate

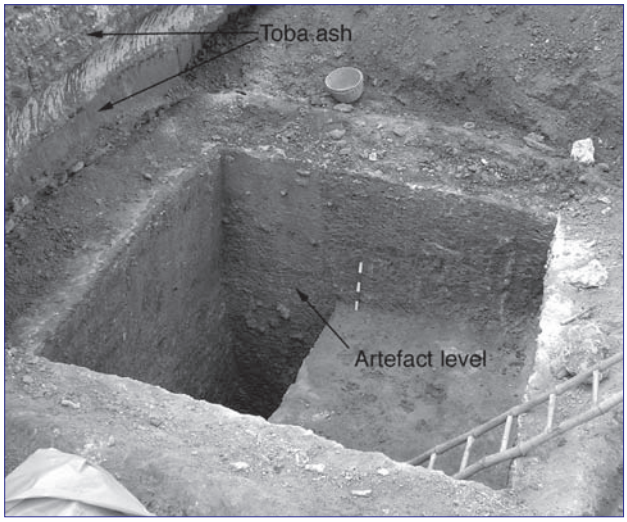


Figure 7.2. *Jwalapuram Locality 3 (below-ash) completed excavation, facing south. Scale is 50 cm.*

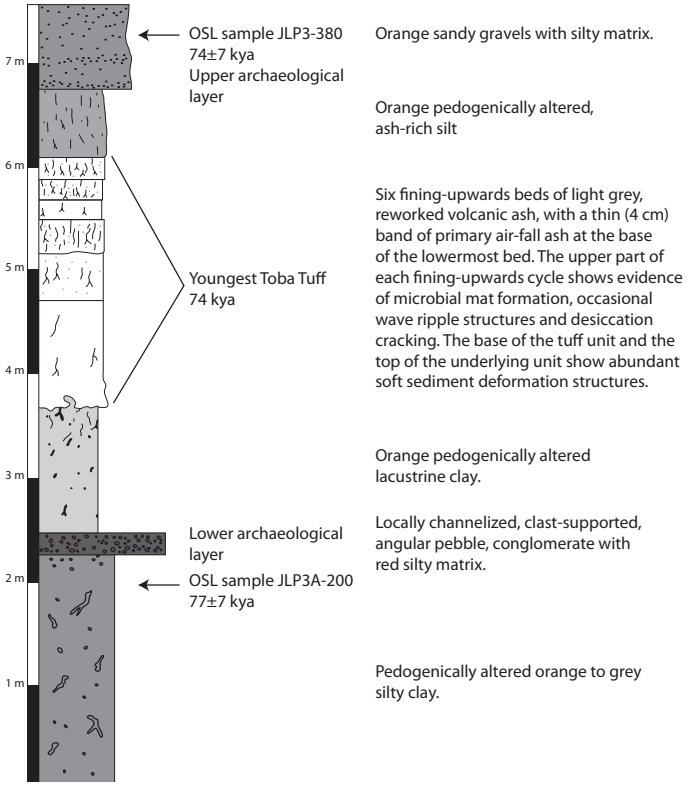


Figure 7.3. *Composite stratigraphy for Jwalapuram Locality 3. The below-ash component comprises sediments from the base of the diagram to the base of the YTT.*

for the remnant Jwalapuram tephra of 7±0.7 × 10^5 m^3. The majority of the ash beds are composed of material that originally fell on the surrounding valley sides and upstream, but was rapidly mobilized and redeposited on the valley bottom before significant entrainment within other sediments could occur. The thickest known tephra accumulation (>2.5 m) occurs in what would have been a local topographical low, and preserves at its base a 4–5 cm-thick layer of primary ash fall. This primary layer rests on clays displaying soft sediment deformation structures, indicating that initial deposition at this location was most likely in a relatively still-water environment. The sites described here targeted strata both directly beneath and at some distance from this thickest tephra deposit.

Locality 3, below YTT

To obtain a full sedimentary sequence from above and below the thickest exposed tephra bed, as well as from the tephra itself, two locations approximately 20 m apart in the same ash quarry were explored (Petraglia *et al*. 2007). These sites are located less than a kilometre west of Jwalapuram village and were collectively designated Jwalapuram Locality 3. The starting surface of the below-ash excavation was the exposed quarry floor, where local mining activity had removed all tephra down to the clay substrate interface (Fig. 7.2). This excavation surface directly underlay the remnant primary ash layer, and is hypothesized to have been submerged at the time of ash fall.

In total, a 3 m by 3 m area was excavated below the tephra in 5–10 cm levels. Culturally sterile and pedogenically altered orange-brown clay sediments were encountered for the first *c.* 110 cm below the tephra (Fig. 7.3). This level contained possible manganese granules and calcium carbonate nodules; the latter are common *in situ* post-depositional occurrences in the valley. Between 110 and 145 cm depth the clays gave way to a compact clast-supported angular conglomerate with a red silty matrix, containing a total of 214 lithic artefacts. Beneath this level the sediments were once again sterile silty clays with calcium carbonate concretions. Excavation ceased at a depth of 385 cm below the tephra. An optically stimulated luminescence sample (OSL; JLP3A-200) was taken from within the silty clay at a depth of *c.* 175 cm, and returned an age of 77±6 kyr BP based on the weighted mean palaeodose for the single-grain data set (see Petraglia *et al*. 2007, supporting online material). This brackets the artefact sample to a period within a few thousand years before the Toba eruption, with the formation of more than a metre of clays subsequent to artefact deposition and prior to the ash fall likely associated with floodplain or wetland development.

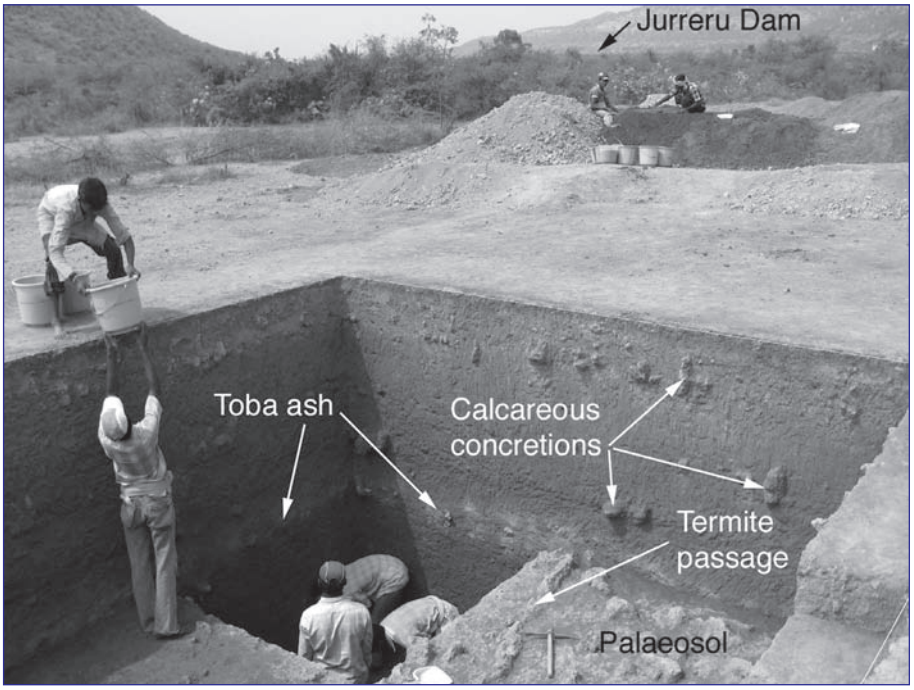


Figure 7.4. *Jwalapuram Locality 22 excavation in progress, facing west.*

Locality 22

Subsequent excavation aimed to identify and excavate a locality on the margins of the suspected paludal area, to characterise occupation deposits at the time of the Toba eruption and to supplement the findings from Jwalapuram Locality 3. It was hypothesized that the marginal sedimentary sequence would be typified by distinct palaeosol development capped by thin, possibly discontinuous, reworked YTT mixed with terrigenous sediment and deposited sub-aerially (i.e. without evidence of water-settling). A section cutting through a disused well west of Locality 3 indicated these characteristics, and a 5 m by 5 m trench designated Jwalapuram Locality 22 was placed *c.* 10 m to the west of the well site (Fig. 7.4). The surrounding landscape is predominantly flat scrub and acacia, with agricultural fields to the south, ash mining to the east, the Jurreru River to the north, and an east–west trending ridge of hills to the west that forms the southern margin of the Jurreru Dam. Jwalapuram Locality 22 is located approximately 420 m west of Locality 3.

The surface of the site and the immediate surrounding area was liberally covered in fresh limestone flakes, resulting from modern flaking activity and chiefly derived from construction of limestone shoring for the nearby well. These flakes were found only within the upper zone of modern disturbance, in otherwise culturally sterile deposits. Excavation at Locality 22 was conducted in 5–10 cm levels, and reached a maximum depth of 375 cm, at which point the local water table was encountered. YTT deposits at the site comprised isolated ash lenses and reasonably pure ash pods within an ashy silt matrix (Fig. 7.5). The tephra content of the silt increased from approximately 170 cm depth to an abrupt interface with a thick pedogenically altered clayey silt palaeosol at 190 to 200 cm. The latter stratum, with occasional sand inclusions, extended to the base of the excavation. Few artefacts were encountered below the top 10 cm of the buried palaeosol. A clay-rich band, with iron and manganese granules concentrated into possible scour fills, was located some 50 cm above the ash/paleosol interface. This layer contained a small number of lithic artefacts including a microblade core, and two pieces of bone. Compact red silt sediments overlying this layer were culturally sterile, with bands of large calcareous concretions resulting from *in situ* diagenesis.

The boundary between the ashy silt and underlying palaeosol is sharp but undulating, providing a further point of difference with the typically flat (water-derived) lower tephra-clay interface seen at Jwalapuram Locality 3. The palaeosol surface and the 5–10 cm below this revealed a total of 796 flaked stone artefacts (Fig. 7.6), with the large majority of these lying horizontally and displaying few signs of extended transport (i.e. size sorting or channel accumulation). Nevertheless, indicators of trampling and abrasion do occur (see below). Distributed

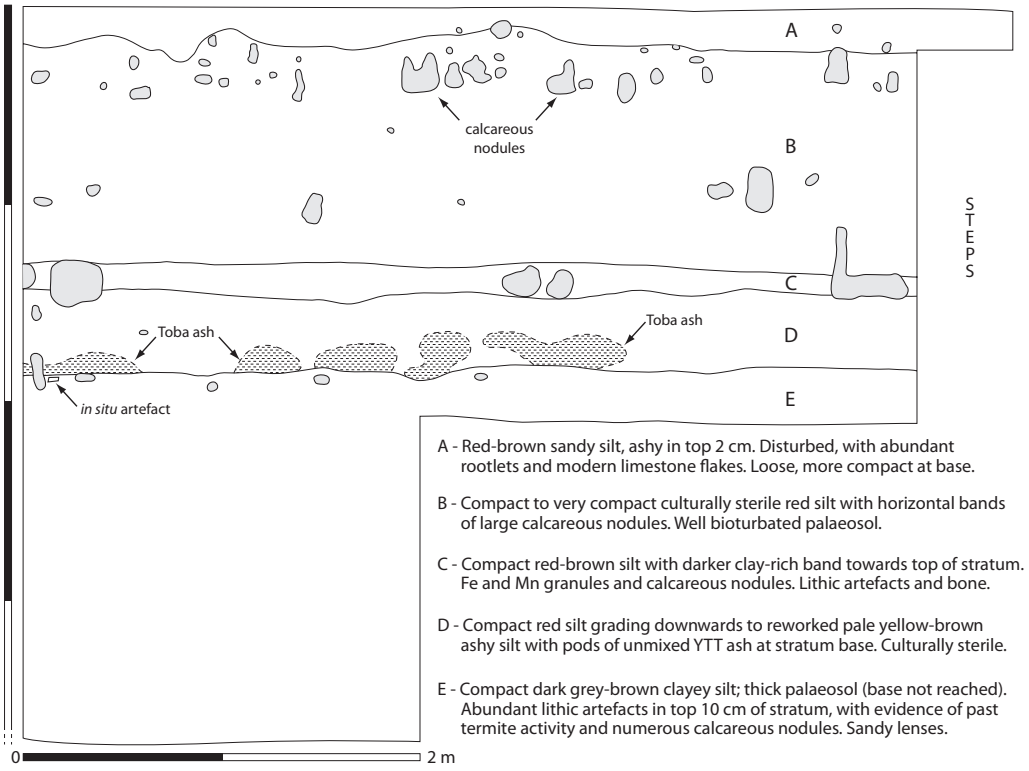


Figure 7.5. *Jwalapuram Locality 22 north profile.*

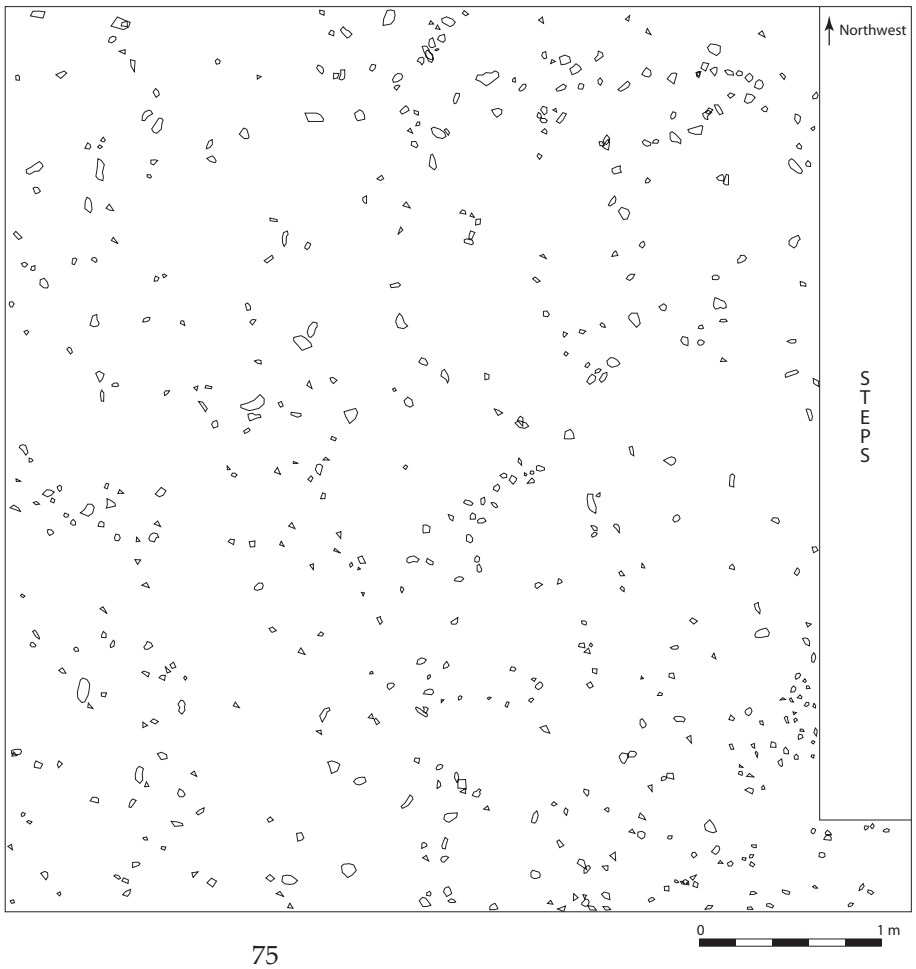


Figure 7.6. *Spatial distribution of artefacts recovered from the palaeosol immediately underlying the* c. *74 kyr* BP *YTT ash layer, Jwalapuram Locality 22.*

through the first few centimetres of the palaeosol were a number of horizontal, concreted and elongate micritic infilled structures, which are identified as termite passage-ways. These were interspersed with diagenetic calcium carbonate concretions, as seen at other stratigraphic boundaries at the site. Collectively, these findings are currently interpreted as the upper layer of a natural soil that was exposed (or lightly vegetated) and occupied immediately prior to the Toba super-eruption.

Lithic technology and its implications

We present here an initial examination of the lithic component of these secure contexts. Note also that although artefacts were recovered from both above and below the Toba ash at both localities, only data from beneath the YTT deposits are discussed here.

Techno-typological characteristics of the Locality 3 and Locality 22 assemblages

The Jwalapuram Locality 22 assemblage consists of 796 stone artefacts and the Locality 3 assemblage includes 214 artefacts. Detailed attribute analysis (see Petraglia *et al*. 2007, supporting online material) has to date been conducted on all the Locality 3 material and 344 of the Locality 22 artefacts, and it is these data that are discussed here. The composition of both assemblages is shown in Table 7.1, presenting a breakdown into standard technological classes as well as more formal typological elements where appropriate. The Jwalapuram Locality 22 assemblage is larger and hence a broader range of technological and typological elements is present, consistent with the sample-size effects seen in most lithic assemblages (Grayson & Cole 1998; Hiscock 2001). Both assemblages are dominated by unretouched flakes, comprising 72 to 77 per cent of the assemblages. Flaked pieces, which clearly derive from conchoidal manufacture but lack the diagnostic features required to determine technological category, also make up a large proportion of the assemblages at 7 to 11 per cent.

The varied core assemblage from Jwalapuram Locality 22 indicates that multiple core-reduction strategies were in use at the time of the Toba eruption, with bidirectional, Levallois, discoidal and single and multiplatform core reduction present. Only a single multiplatform core was recovered from the smaller Locality 3 assemblage. Multiplatform cores are easily the most common form at Locality 22, and it is therefore not surprising that the sole core from Locality 3 is of this type. A small weathered biface, manufactured from the same locally available limestone as the majority of other artefacts in the assemblage, was also found below the ash at Jwalapuram Locality 22.

Table 7.1. *Techno-typological composition of the below-ash Jwalapuram Localities 22 and 3 assemblages.*

Type	22	3	% of 22	% of 3	Total
Core types					
Bidirectional core	3	0	0.9	0.0	3
Discoidal core	1	0	0.3	0.0	1
Levallois core fragment	1	0	0.3	0.0	1
Single platform core	2	0	0.6	0.0	2
Biface	1	0	0.3	0	1
Core fragment	0	1	0.0	0.5	1
Multiplatform core	7	1	2.0	0.5	8
Flakes and hammerstones					
Hammerstone	0	2	0.0	0.9	2
Flake	265	156	77.3	72.9	421
Flaked piece	24	24	7.0	11.2	48
Flake types					
Blade	2	7	0.6	3.3	9
Éclat debordant	2	0	0.6	0.0	2
Levallois flake	2	0	0.6	0.0	2
Microblade segment	2	0	0.6	0.0	2
Retouched					
Unifacial point	1	0	0.3	0.0	1
Bifacial point	1	0	0.3	0.0	1
Burin	1	0	0.3	0.0	1
Burinated scraper	0	1	0.0	0.5	1
Tanged point	1	0	0.3	0.0	1
Scrapers and retouched fragments	28	22	8.2	10.3	50
Totals	**344**	**214**			558

The larger range of flake types found at Locality 22 (Figs. 7.7 & 7.8) is consistent with the range of core forms found at the site: Levallois flakes and éclat debordants (flakes that remove the lateral edge of radial cores) both indicate that radial flaking from faceted platforms was taking place at the site. Blades and microblades are also present in small numbers, though blades are more common at Jwalapuram Locality 3.

Retouched implements and fragments mostly consist of various kinds of scrapers (including notches), making up 8–10 per cent of the assemblages (for illustrations of retouched Locality 3 artefacts: see Petraglia *et al*. 2007). However, burins and points (tanged and untanged, unifacial and bifacial) are also present. A tanged point from Locality 22 has ventral trimming of the bulb to create two pronounced concavities on either side of the faceted platform, and distal unifacial retouch that forms a stout tip. No comparative study of tanged points from Middle Palaeolithic contexts in India has been attempted, and

Table 7.2. *Comparison of size and shape for complete flakes from below-ash Jwalapuram Localities 22 and 3.*

Attribute	Site	N	Mean	Std. deviation	*t*	df	Mean difference	*p*
Weight (g)	22	43	26.38	59.96	–0.02	122	–0.30	0.98
	3	81	26.68	72.27				
Length (mm)	22	41	30.13	22.71	–1.04	70	–4.30	0.30
	3	78	34.44	18.99				
Proximal width (mm)	22	40	19.79	14.45	0.44	59	1.12	0.66
	3	75	18.67	9.79				
Medial width (mm)	22	43	23.29	17.09	–1.23	73	–3.74	0.22
	3	76	27.03	13.82				
Distal width (mm)	22	39	17.71	13.55	–0.08	64	–0.20	0.94
	3	74	17.91	10.81				
Maximum dimension (mm)	22	43	37.80	24.30	–0.36	68	–1.54	0.72
	3	81	39.33	18.41				
Thickness (mm)	22	43	11.09	8.74	0.12	85	0.20	0.91
	3	78	10.90	8.57				
Platform width (mm)	22	40	18.61	14.03	1.17	53	2.81	0.25
	3	69	15.80	7.83				
Platform thickness (mm)	22	40	8.28	7.52	1.00	58	1.32	0.32
	3	71	6.96	4.90				
Platform angle	22	36	69.94	13.64	–1.11	72	–3.11	0.27
	3	70	73.06	13.91				
Length:Width	22	43	1.28	0.75	–0.68	76	–0.09	0.50
	3	76	1.37	0.64				
Mean GIUR	22	43	0.15	0.39	1.24	51	0.08	0.22
	3	81	0.07	0.18				
Angle of margin contraction or expansion	22	43	7.70	24.46	1.30	77	5.75	0.20
	3	81	1.95	21.43				
Mean retouched edge angle	22	43	12.57	25.66	0.67	77	3.14	0.50
	3	81	9.43	22.72				
Length:Thickness	22	43	3.17	1.75	–1.34	64	-0.40	0.19
	3	78	3.57	1.20				

none has been precisely dated, so we are as yet unable to make statements about the similarity of this point to other examples from South Asia.

Shape and size comparisons for the Locality 3 and Locality 22 flake assemblages

In virtually all respects, the complete flakes from Jwalapuram Localities 22 and 3 are identical. Student *t*-tests performed on a comparison of the means for a wide range of dimensional attributes, as well as ratios of two dimensions expressing flake shape and a measure of retouch intensity (Kuhn 1990), all show non-significant results (see Table 7.2). Likewise, the proportions of different scar orientations (unidirectional from the proximal end versus radial,

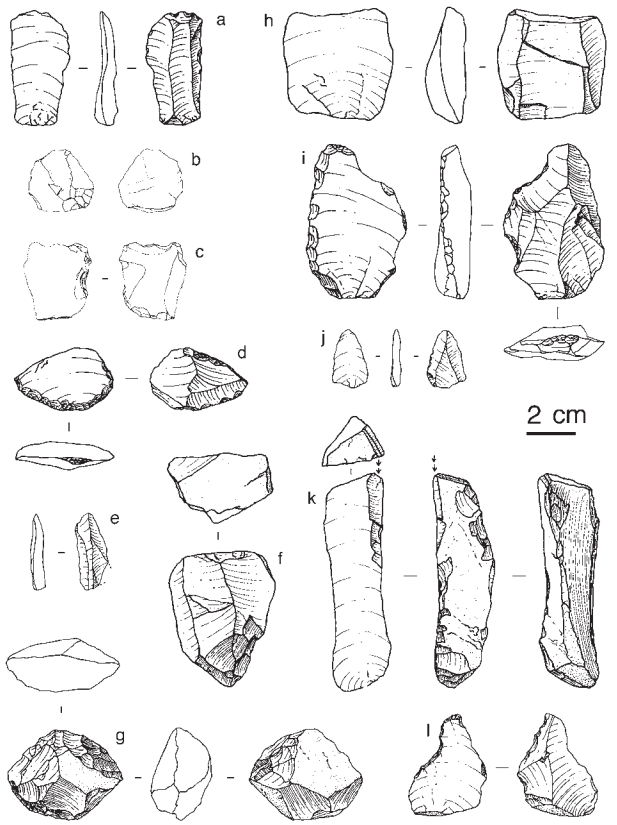


Figure 7.7. *Jwalapuram Locality 22 lithic artefacts: (a) blade; (b, h, i, j) radial flakes; (c) scraper; (d) bifacial point; (e) microblade; (f) bidirectional core; (g) radial core; (k) burin; (l) retouched flake.*

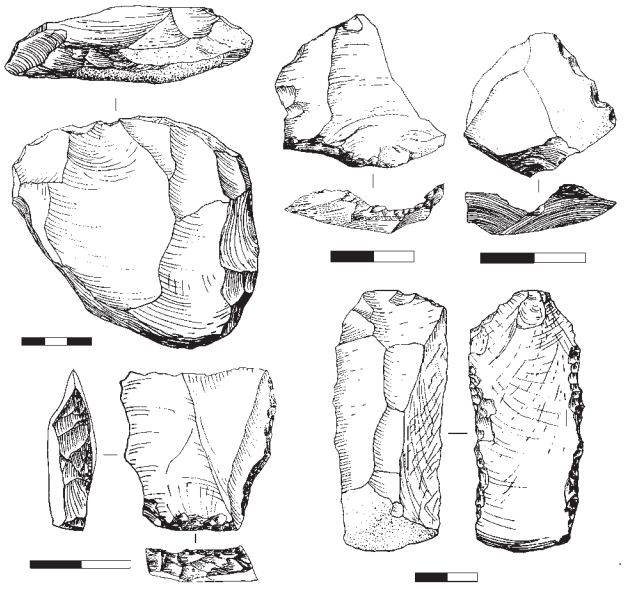


Figure 7.8. *Jwalapuram Locality 22 lithic artefacts. Clockwise from top left: Levallois core; two radial flakes with facetted platforms; blade with possible retouch; éclat debordant. Scales are in centimetres.*

Table 7.3. *Comparison of frequencies of different platform types on complete flakes and proximal fragments, below-ash Jwalapuram Localities 22 and 3.*

Locality	% cortical only	% cortical and conchoidal	% Crushed	% Dihedral	% Focalized	% Multiple conchoidal	% Single conchoidal
3	14	0	9	9	3	12	54
22	9	2	8	9	0	33	40
Total no.	**20**	**2**	**15**	**16**	**2**	**43**	**84**

Table 7.4. *Frequencies of platform preparation on complete flakes and proximal fragments from below-ash Jwalapuram Localities 22 and 3.*

Locality	% None	% Both	% Faceting	% Overhang removal	Total
3	51.81	1.20	2.41	44.58	139
22	65.47	5.04	15.83	13.67	83
Total	134	8	24	56	222

Table 7.5. *Percentages of raw materials used at Jwalapuram Localities 22 and 3, below-ash.*

Locality	Chalcedony	Chert	Dolerite	Limestone	Quartz	Quartzite
22	0.3	1.7	8.2	89.5	0.0	0.3
3	6.1	10.7	1.0	59.8	0.9	21.5

bidirectional and non-proximal orientations) found on the dorsal surfaces of flakes shows no significant difference between Localities 22 and 3 (χ^2 = .476, p = 0.495). This means the two samples likely derive from the same or very similar populations in terms of methods of core preparation and flake removal.

From this comparison we can conclude that flakes discarded at Jwalapuram Localities 22 and 3 tend to be quite heavy, relatively stout but not thick, with parallel to gently tapering lateral margins, relatively large and low-angled platforms, and dorsal scar patterns that tend to show slightly more unidirectional alignments from the proximal end than radial and non-proximal orientations.

Some significant differences between the assemblages nevertheless exist. Flakes from Locality 3, for example, possess higher proportions of single conchoidal, cortical and crushed platforms, whereas Locality 22 flakes have higher proportions of single conchoidal and cortical, and cortical and multiple conchoidal platforms, with small differences in the proportions of dihedral platforms (χ^2 = 32.7, p = <0.0005) (Table 7.3).

Another difference is present in the proportions of different forms of platform preparation (Table 7.4). Jwalapuram Locality 22 flakes show a much higher proportion of platform faceting and unprepared platforms, but much lower proportions of overhang removal. These differences are significant (χ^2 = 32.06, p = <0.0005) and clearly reflect different emphasis in core preparation between locations, but given the strong similarity in flake form, they may simply represent specific responses to working individual cores, or different emphasis on different reduction strategies that yield flakes of much the same form. Furthermore, these differences in platform type and preparation may partially reflect the vagaries of sampling, since our own experiments show that a wide range of platform types and preparation can be generated by various types of radial and bidirectional core reduction. Given small sample size, different platform types will be present in varying proportions.

Raw materials

The most marked difference between the Locality 22 and Locality 3 assemblages lies in the proportions of raw materials used (see Table 7.5). While stone artefacts at both localities are predominantly made from limestone, Locality 3 shows higher proportions of chert, chalcedony and quartzite, whereas Locality 22 has significantly more dolerite. This suggests that a greater range of raw material type was more frequently reduced at Locality 3 than Locality 22, although the actual raw materials employed were much the same at both locations.

All of the raw materials found at both localities can be obtained on the foothills surrounding the valley, with quartzite easily obtained from the escarpment a short distance to the north, limestone, chert, quartz and chalcedony from hillslopes to the north and south, and dolerite from a dike that snakes its way along the southern hillslopes of the Jurreru Valley. Raw material acquisition is therefore likely to be predominantly local, with all materials available within a few kilometres (or less) of the sites. The greater raw material richness at Jwalapuram Locality 3, with greater emphasis on chert and chalcedony, could indicate that this assemblage accumulated within the context of a base camp from which foraging trips around the surrounding landscape were mounted. Locality 22, on the other hand, seems to represent more concentrated use of limestone, perhaps representing the accumulation of debris from short term occupation and single procurement

episodes. The limestone utilized at Locality 22 is identical in appearance and fracture patterns to that seen outcropping in the Jurreru valley at nearby Jwalapuram Locality 20 (Petraglia *et al*. 2009b).

Site formation

High rates of artefact breakage and edge damage suggest destructive site formation processes were active at Jwalapuram Localities 22 and 3. A total of 83 per cent of the artefacts from Locality 22 are broken in some way, and 67 per cent from Locality 3. At Locality 22, breaks are mostly caused by manufacturing errors in the form of longitudinal splits. At Locality 3, the majority of breakage is transverse snapping, which may have resulted from either manufacturing errors or trampling/retouch/use. Again this difference may reflect the emphasis at Locality 22 on primary flaking and at Locality 3 of a wider range of activities.

Edge damage is difficult to separate from retouch on many flakes with modified lateral margins at both Jwalapuram Locality 3 and Locality 22. The possibility cannot yet be ruled out that retouch is rarer than the percentages in Table 7.1 suggest, and that heavy trampling and rolling of artefacts can account for much of the damage. Retouch often appears isolated, haphazard and alternating between dorsal and ventral, without any appearance of having created a continuous edge. Heavy abrasion and edge rounding are also present on some pieces, and aeolian weathering appears to have affected many artefacts. Retouch on other pieces appears quite deliberate, forming marked concavities, or continuous retouched margins. Further examination of tool edges under high magnification is required to determine the extent of site weathering and site formation processes, as well as use-wear, on the creation of the large 'retouched' assemblage.

Discussion

The two localities described here provide an initial perspective on the activities and movements of the hominin occupants of the Jurreru valley immediately prior to the YTT ash-fall. They also comprise the first well-dated and detailed record yet discovered in India of hominin activities at the OIS-5/-4 transition, and contribute valuable data to ongoing debates over the presence or otherwise of modern humans in South Asia at this time. Both sites employed a range of core-reduction systems that produced extremely similar flakes in terms of size, shape and dorsal morphology. However, significant differences in the abundance of certain core types with resulting differences in the proportions of platform types suggest greater emphasis on radial flaking at Jwalapuram Locality 22, and more flaking of rotated cores at Locality 3, resulting in slightly more Levallois flakes at the former and slightly more blades at the latter. The proportions of different raw materials are also markedly different between the two sites, with Locality 3 exhibiting greater use of a range of material types, and Locality 22 showing much more focus on the use of limestone. The range of scraper forms is very alike at both localities, but Locality 22 is unique owing to the appearance of tanged and unifacial and bifacial points. These are very rare in the Indian Middle Palaeolithic (James 2007), but could indicate the use of hafted projectiles, something rarely documented among pre-modern humans (Shea 1988; Shea *et al*. 2001).

The Jurreru Valley Toba ash-fall isochron has allowed us to identify a relatively intact and extensive palaeosurface occupied by Middle Palaeolithic hominins. While the below-YTT assemblages from Jwalapuram Localities 3 and 22 may not be precisely coeval given their stratigraphic positioning relative to the ash, they are tightly constrained by chronometric dating and the Toba tephra, and the strong similarities in flake form and the reliance on local raw materials at both sites point to clear continuities in both the desired flake products and the nature of procurement and movement within the valley. We can therefore emphasize that predominantly local procurement of lithic resources, a flexible approach to core reduction techniques (perhaps with a chronological component) and a regularity of artefact morphological production are characteristic of the technological industry present at the two sites. These trends should serve as hypotheses to be tested against the records of other late OIS-5/early OIS-4 assemblages recovered from within and peripheral to South Asia (e.g. Zuraina 2003).

The 'Middle–Upper Palaeolithic transition' in South Asia: an inappropriate template

What are the implications of the Indian Middle Palaeolithic record for our understanding of the nature of modern human dispersal out of Africa, and the Middle to Upper Palaeolithic transition as seen in Europe? For the moment we can leave aside the possibility that now-extinct *Homo sapiens* lineages extended their initial movement out of Africa some 90–120,000 years ago beyond the known occupation of the Levant (Shea 2003) into India, although this cannot be ruled out on present evidence. There is, however, broad acceptance that initial modern human dispersal into the Indian subcontinent occurred before 50 kyr BP, and perhaps prior to 70 kyr BP, based on dates for Australasian

colonization and genetic coalescence (Roberts *et al*. 1994; Oppenheimer 2009). Unequivocally, at no time during or close to this period do the South Asian lithic data provide evidence of a technological 'revolution' to parallel the changes seen at the European Middle/Upper Palaeolithic boundary (Mellars 2007). Instead, the data suggest that the earliest humans entering South Asia used technologies based on the African Middle Stone Age, similar to those previously created by other hominins on the subcontinent from the late Middle Pleistocene onwards (Misra 1995). The inappropriateness of transposing expectations derived from the European transition to other regions has been noted before (e.g. McBrearty & Brooks 2000; James & Petraglia 2005), and we reaffirm it here.

The fact that humans arrived in South Asia with very similar lithic propensities to the existing non-*sapiens* groups is unsurprising, as commonalities in the lithic output of different hominins have been recorded elsewhere. The Levantine Middle and Later Middle Palaeolithic assemblages were considered for some time to be similar enough to be evidence of continuity, even though the former was created by *Homo sapiens* and the latter by Neanderthals (Shea 2008). Close similarities have also recently been documented between the technological strategies of *Homo floresiensis* and *Homo sapiens* at Liang Bua in Indonesia (Moore *et al.* 2009). The lithic industries of these sites could be parsimoniously assigned to a single tradition, were it not for accompanying skeletal remains, and in this regard the continuing lack of South Asian Late Pleistocene hominin remains before *c.* 35–30 kyr BP (Deraniyagala 1992) is a persistent barrier.

Only one major Late Pleistocene technological shift — from Middle Palaeolithic to systematic microlithic technologies — has been identified within South Asia. Recent postulation has suggested that this may in fact be a signature of initial modern human dispersal, linking the South Asian microliths typologically to those found in the South African Howiesons Poort and various East African sites (Mellars 2006). This speculation, however, unravels in the face of genetic and dating evidence. The earliest microliths in South Asia appear at around 35 kyr BP, and correspond to environmental deterioration and a demographic spike seen in reconstructed genetic histories of human occupation of the Indian subcontinent (Clarkson *et al.* 2009; Petraglia *et al.* 2009a). Importantly, this spike is clearly not a marker of new populations entering the region, but an autochthonous differentiation and expansion, as revealed by a thorough review and modelling of available South Asian genetic sequences (e.g. Kivisild *et al.* 2003; Sahoo *et al.* 2006; Sengupta *et al.* 2006). In any case, the appearance of microlithic technologies in this region is much too late to allow for subsequent colonization of Australasia by 45–60 kyr BP (O'Connell & Allen 2004), recognizing the human propensity for rapid occupation of large landmasses. Indeed, entry into South Asia 35–30 kyr BP may have been prohibited by desertification of the region's northwest at the time (Petraglia *et al.* 2009a, fig. 1 and supplementary material).

Conclusion

The lithic data presented here add much-needed empirical focus to discussions of the technology and ultimately taxonomic identity of the hominins in southern India *c.* 74,000 years ago. Comparable data sets are nonexistent for any other region of South Asia, and the emerging Jurreru Valley results therefore establish a behavioural baseline for this time period. Continued exploration of the Jurreru palaeolandscape holds significant promise for constructing the first chronologically constrained and technologically comprehensive record for the South Asian Late Pleistocene. In the absence of fossil evidence, the lithic data set, in combination with genetic coalescence ages and chronometric dating, offers the most productive means currently available to accurately identify the timing, manner and behavioural correlates of the modern human dispersal into India.

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