Chapter 7
The East African Early Acheulean of Peninj (Lake Natron, Tanzania)

Fernando Diez-Martín, Policarpo Sánchez-Yustos, and Luis de Luque

Abstract The Pleistocene record of Peninj, dated to 1.5–1.4 Ma and located on the Western shore of Lake Natron (Tanzania), is one of the classic archaeo-paleontological sources for the study of the early Acheulean in Africa. Beginning with the seminal project led by Glynn Isaac in the decades of 1960s and 1980s, other research programs have been carried out in Peninj since then, particularly the landscape archaeology approach undertaken by M. Domínguez-Rodrigo between 1995 and 2005. In 2007, fieldwork was resumed in the area and a new project is currently in progress. As a result of this long-lasting scientific effort, the variety of geological, contextual, technological, and spatial information gathered so far can shed light on a number of aspects related to the early Acheulean record identified in the three different archaeological areas of Peninj (the Type Section, the North and the South Escarpments). This paper presents a synthesis of the history of research in Lake Natron and the geology of the Peninj Group. It also reviews some of the main discussions related to the Type Section technology, the bifacial hierarchical centripetal method hypothesis, and the Oldowan–Acheulean dichotomy for the attribution of the lithic samples in the framework of the archaeological record of Peninj. The paper includes a synthesis of the new data gathered in the Acheulean sites of the Escarpments in the course of the present research project and, finally, a regional interpretation of the early Acheulean of the Lake Natron.

Keywords Lake Natron • Technology • LCTs • Landscape Type Section • Escarpments

7.1 History of Scientific Research in Lake Natron

Lake Natron is in northern Tanzania near the border with Kenya (Fig. 7.1). It is but one of many shallow, salty, and alkaline water bodies located in the Eastern branch of the Great Rift Valley. Along with Lake Magadi (Kenya), Lake Natron is part of a Basin covering some 1000 km^2 (Luque 1996). The intense tectonic activity that characterizes the Great Rift Valley has led to Lake Natron being surrounded by a number of volcanoes (Luque et al. 2009a). Those of Sambu and Shompole lie to the north, Gelai to the east, and Lengai and Kerimasi to the south. Lake Natron is at the bottom of a pronounced Basin at an altitude of 610 m, surrounded by Escarpments that reach up 2942 m in the case of the Gelai volcano, or 1800 m for the Serengeti Plateau. This topography gives rise to an exceptionally dry climate. In this extreme ecological context the predominant vegetation is savannah-mosaic with intercalations of shrubby prairies, and with a gradation toward more or less open woodland with acacias.

Lake Natron was not explored by Westerners until well into the 19th century. It was mainly German explorers who studied the geography, cartography, and geology of the Natron Basin. Between 1882 and 1883, the German explorer Gustav Adolf Fischer undertook a voyage for the Hamburg Geographic Society into Maasai territory. The Ol Doinyo Lengai volcano attracted the attention of the biologist O. Neumann in 1894, and of the M. Schöller expedition in

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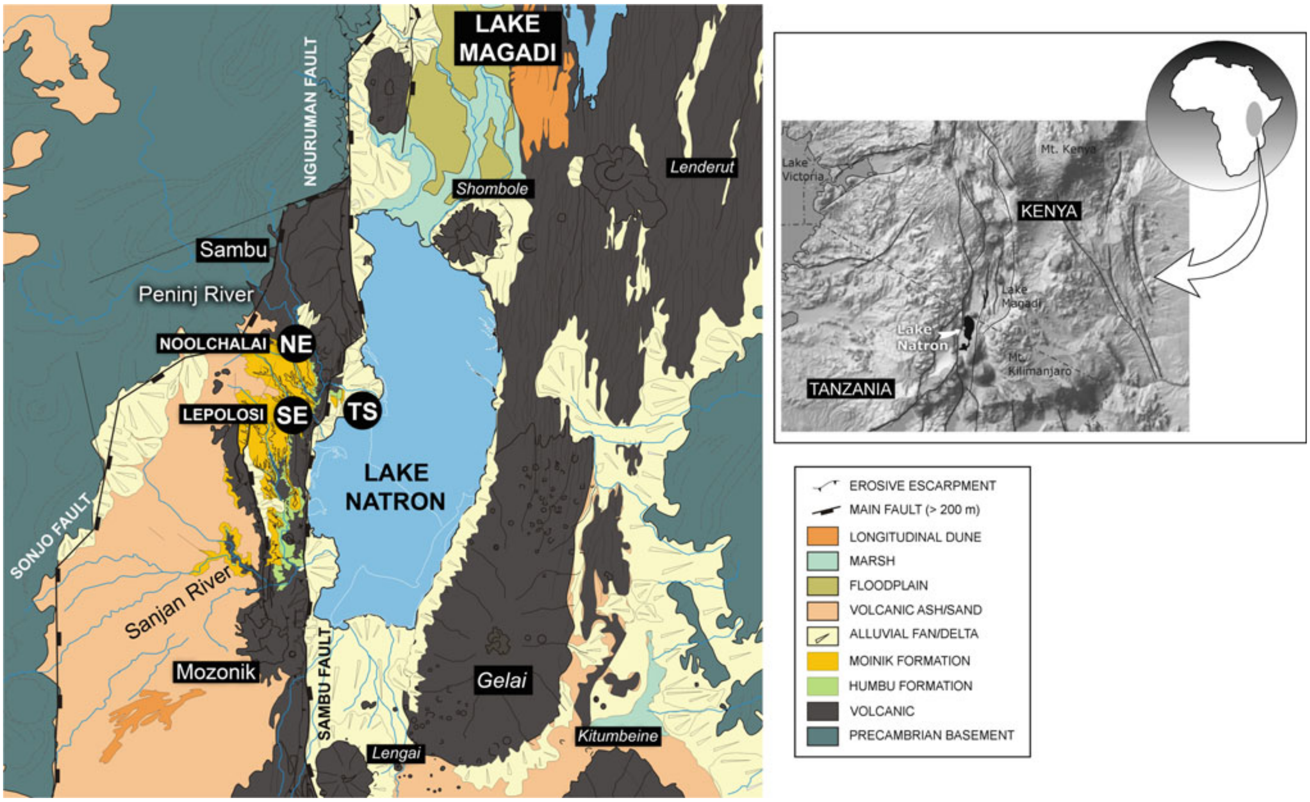

Fig. 7.1 Geological map of the Lake Natron and location of the three fossiliferous areas: Type Section (TS), North Escarpment (NE), South Escarpment (SE)

1896–1897 to equatorial East Africa and Uganda.[1] Of particular importance were the expeditions of the German geologists F. Jaeger and C. Uhlig. Between 1904 and 1910, under the auspices of the Otto Winter Foundation, they undertook a series of geological studies and made a map of the region (Uhlig and Jaeger 1942).

After World War I, a period of systematic paleoanthropological exploration in African emerged (Gowlett 1990: 18). However, during these years the archaeological potential of Lake Natron remained unknown, even though geological, petrological, and hydrochemical work continued in the Natron Basin (Guest 1953). Lake Natron would, however, burst onto the world paleoanthropological stage via the discovery of *Zinjanthropus boisei* at Olduvai Gorge (Leakey 1959). At the beginning of August 1959, while journeying to Nairobi from Olduvai for the scientific announcement of her historical discovery, Mary Leakey became aware of the potential archaeological interest of some of the sediments outcropping along the West bank of Lake Natron. The busy years that followed, devoted to the excavation of FLK and media exposure to the fossils discovered in Olduvai, kept Mary and Louis Leakey away from any exploration around Lake Natron (Morell 1996). In 1963, however, Richard Leakey "rediscovered" the same deposits while flying in a small plane from Nairobi to Olduvai. This led to a first brief exploration by Richard and Glynn Isaac. That first fieldwork visit led to the recognition of the outcrops they sought at the mouth of the River Peninj (the area later known as Maritanane and Type Section), and the collection of a handful of fossils.

In early January 1964, Leakey and Isaac set out for Lake Natron on the first archaeological survey of the area. On 11 January the exceptional find of a *Paranthropus* mandible took place (Leakey and Leakey 1964). A second expedition by Isaac and Leakey to Lake Natron occurred between the months of July and September 1964 (Isaac 1964). This second expedition undertook a preliminary geological study of the Lake Natron Basin and provided a description of a regional sedimentary sequence that Isaac named the Peninj Group (Isaac 1965, 1967). Two important Acheulean sites were also discovered and excavated at the top of the Sambu Escarpment, which were then given the names MHS and RHS (Isaac 1969).

Though Peninj appeared to be a propitious place to begin examining the Acheulean period (Isaac and Curtis 1974), events would divert attention elsewhere. Richard Leakey

[1] 1901: *Mitteilungen über meine Reise nach Äquatorial-Ostafrika und Uganda 1896–1897.* [A report of my journey in Eastern Equatorial Africa and Uganda between 1896 and 1897].

joined a new French-American project in the valley of the River Omo in Ethiopia (Morel 1996). Isaac also had obligations that would take him away from Lake Natron for nearly 17 years (Isaac 1977; Isaac and Isaac 1997). He took renewed interest in Peninj in 1981, when he led a brief reconnoitering expedition (Isaac 1981–1982). A new project started up in 1982, with an international team co-led by Isaac, Amini Mturi, and Maurice Taieb. The geological and paleontological studies undertaken by Taieb between 1981 and 1984 were the most productive of all those in this period (Taieb and Fritz 1987). Unfortunately, only superficial archaeological studies could be undertaken between 1981 and 1982 (Isaac 1982). The sudden death of Isaac in 1985 was a significant setback to their endeavors. Thanks to the field notes and other unpublished documentation, including a detailed proposal for an archaeological intervention sent to the National Science Foundation (Isaac 1982), we know that Isaac's research was conceived as an integrative landscape archaeology project.

In 1994, a new round of paleoanthropological research began in Peninj, led by M. Domínguez-Rodrigo. The project conducted extensive research until 2005, following the same precepts of landscape archaeology that Isaac designed for this enclave (that included both site and regional or off-site fieldwork). The geological and stratigraphic data for the Peninj Group were meticulously reviewed and updated, along with paleoecological analyses. Fieldwork was also resumed in the three archaeological areas documented in Peninj: Maritanane or Type Section, MHS-Bayasi (South Escarpment), and RHS-Mugulud (North Escarpment). Abundant sites in all these three areas were extensively excavated, and spatial, technological, taphonomic, and functional studies were performed (Luque 1995, 1996; Domínguez-Rodrigo 1996; Domínguez-Rodrigo et al. 2001a, b, 2002, 2005, 2009a; Downey and Domínguez-Rodrigo 2002–2003; de la Torre et al. 2003, 2008; de la Torre 2009). Fieldwork has continued in the area since 2007, with a new team working on extending and complementing this earlier work (Diez-Martín 2008; Diez-Martín et al. 2009a, 2010, 2011, 2012, 2014a, b).

7.2 The Peninj Group: Geology, Dating, and Archaeological Areas

The Pleistocene sediments located in the southwestern area of the Natron Basin were described systematically by Glynn Isaac in a sequence known as the Peninj Group (1965, 1967). The geology and geomorphology of the Peninj Group were subsequently refined by Luque et al. (2009a, b). Although sediments of the Peninj Group crop out in three different areas (North and South Escarpments, and Type Section) (Fig. 7.1), the reference for the Peninj Group was provided by the badland outcrops located around the mouth of the modern Peninj River delta, which cover a surface of some 1 km^2 (the area known as Maritanane and Type Section; Fig. 7.2; Luque et al. 2009b). This area, intensely modified by tectonic and erosive activity (Foster et al. 1997), constitutes a complex web of gullies exposing most of the geological sequence:

Fig. 7.2 Panoramic view of the Type Section area of Peninj

- The series defined by Isaac lies on older Plio-Pleistocene volcanic materials. At the base of the Peninj Group are the Sambu lavas, 400 m of volcanic materials deposited when the Sambu volcano entered periods of great eruptive intensity, bracketed between 3.5 and 2 Ma by means of K/Ar datings (Isaac 1967; Isaac and Curtis 1974).
- Above this basalt basement lie the Hajaro Beds, a set of sandy, clayey and basaltic materials deposited before the existence of the Peninj River and its drainage network, in about 2 Ma (Thouveny and Taieb 1987).
- Above the Sambu and Hajaro sediments lie the materials of the Peninj Group. These reach 80 m in thickness and contain the fertile layers with paleontological and archaeological remains. The Peninj Group is divided into two ~40 m thick units (Isaac 1965, 1967):
- At the base, the Humbu Formation consists largely of sandstone and alluvial deposits, intercalated with a complex sequence of tufaceous materials. In the middle part of the Humbu sequence is the Main Tuff, a thick volcanic deposit that includes the Wa Mbugu basalt interbedded (Isaac and Curtis 1974).
- The Main Tuff constitutes the reference for dividing the Humbu Formation into three members, from bottom to top: the Basal Sands and Clays (BSC), the initial detritic infill of the Basin and the unit where the *Paranthropus* jaw was discovered (Leakey and Leakey 1964); the Main Tuff itself (MT).
- The Upper Sands and Clays (USC) where most of the archaeological sites discovered so far are located (Domínguez-Rodrigo et al. 2009a; Fig. 7.3).

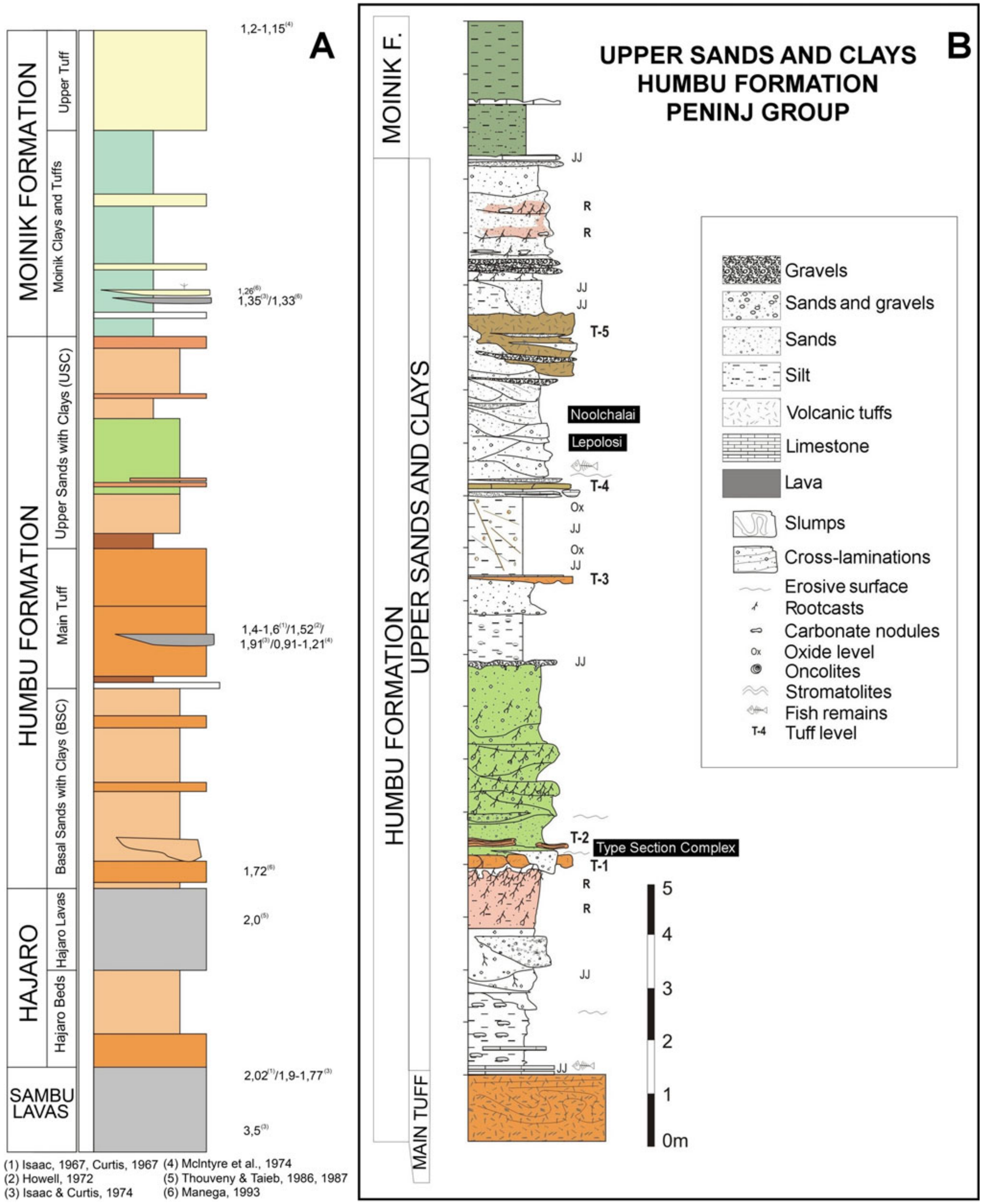

Fig. 7.3 **A** Type stratigraphic column of the Peninj Group; **B** type stratigraphic column of the Upper Sands with Clays member (USC) in the Humbu Formation of the Peninj Group, and situation of the main archaeological horizons

- On top of the Humbu Formation, the Peninj Group ends with the Moinik Formation, a 40-m-thick deposit of lacustrine sediments, where some Acheulean sites have also been discovered (Diez-Martín et al. 2009b).

Precise dates for the archaeological evidence of Peninj remain controversial. The diagenetic alteration undergone by the tuffs exposed in the Peninj Group prevent reliable datings (Luque et al. 2009a, b; McHenry et al. 2011). The poor quality of the tephra layers is responsible for the contradictory results obtained by the different dating efforts carried out in Peninj. Based on the various radiometric (K/Ar and Ar/Ar) analyses undertaken in the Wa Mbugu basalt in the Main Tuff (Howell 1972; Isaac and Curtis 1974; McIntyre et al. 1974) and in the base of the Moinik Formation (Isaac and Curtis 1974; Manega 1993), and supported by paleomagnetic correlations (Thouveny and Taieb 1987), the archaeological evidence deposited within the USC unit has been preferentially bracketed between 1.7 and 1.4 Ma (Isaac and Curtis 1974; Domínguez-Rodrigo et al. 2009a, 2002). However, recent ^{40}Ar/^{39}Ar dating of the Peninj Group carried out by Deino et al. (2006) suggests a slightly different chronological scenario. According to this new data, the Wa Mbugu basalt would be dated to 1.19 Ma, while the Upper Moinik Tuff would close the Peninj Group at about 1.01 Ma. Thus, the archaeological sites preserved within the USC would have been deposited within a short period of time, between 1.2 and 1.1 Ma, significantly younger on average than previously assumed. de la Torre et al. (2008) have already pointed out severe contradictions between the new chronological framework proposed by Deino and colleagues, the techno-typological characteristics of the Peninj Acheulean, and its close correlation with the Olduvai Acheulean, dated to 1.5 Ma (Leakey 1971). While bearing in mind the stratigraphic inconsistence produced by the chronological discrepancies between old and new datings and the need of further geochronological research in the area (McHenry et al. 2011), we agree with de la Torre et al. (2008) when they claim for a closer link of the Peninj Acheulean to the chronological framework originally proposed by Isaac and Curtis (1974).

The USC alluvial sediments in which all the archaeological and paleontological remains have been preserved crop out in three different areas: Lepolosi (South Escarpment) and Noolchalai (North Escarpment) on the Sambu Escarpment, and Maritanane or Type Section, in the Peninj River delta (Fig. 7.1). All three were discovered and preliminarily studied between 1963 and 1964 by the Leakey–Isaac expedition. It is important to remark that the archaeological evidence contained within the USC mostly appears to result from two discrete depositional episodes (Fig. 7.3).

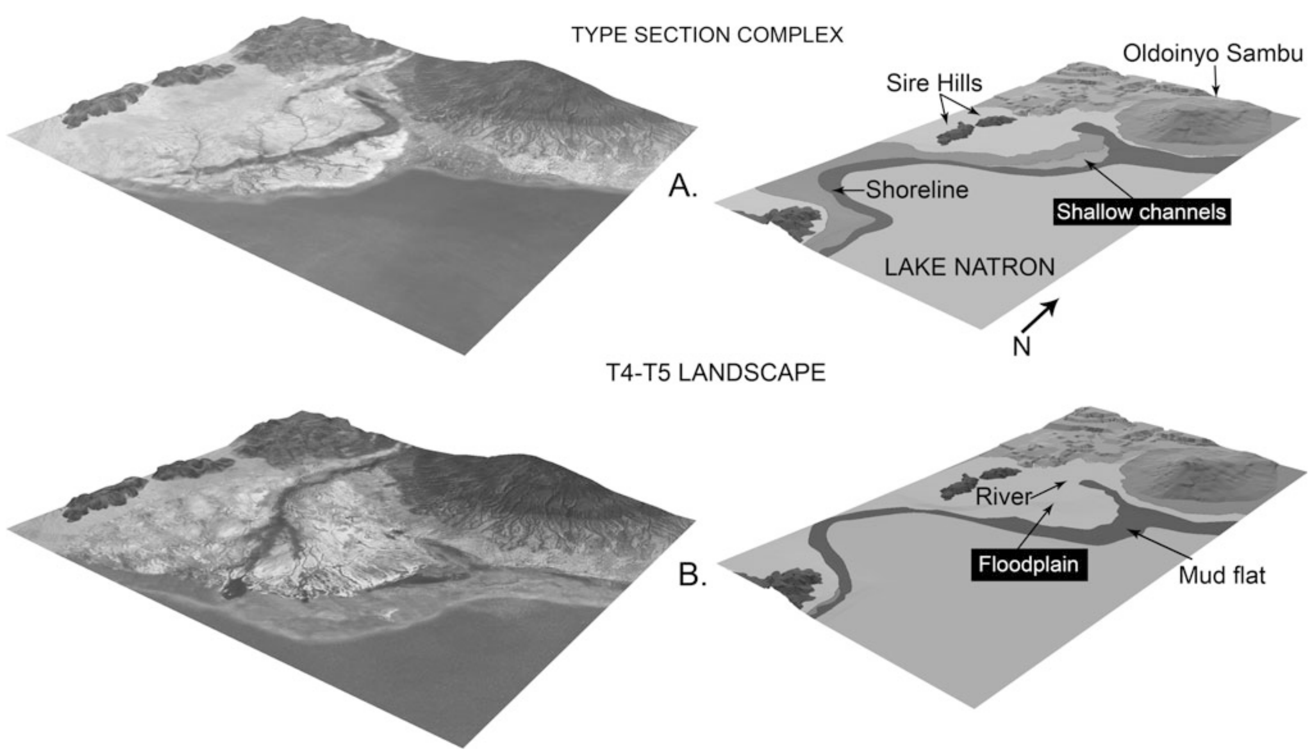

Fig. 7.4 Paleogeographical reconstruction of the Natron Basin during: **A** The Type Section Complex and **B** the T4–T5 stratigraphic interval, within the USC of the Humbu Formation

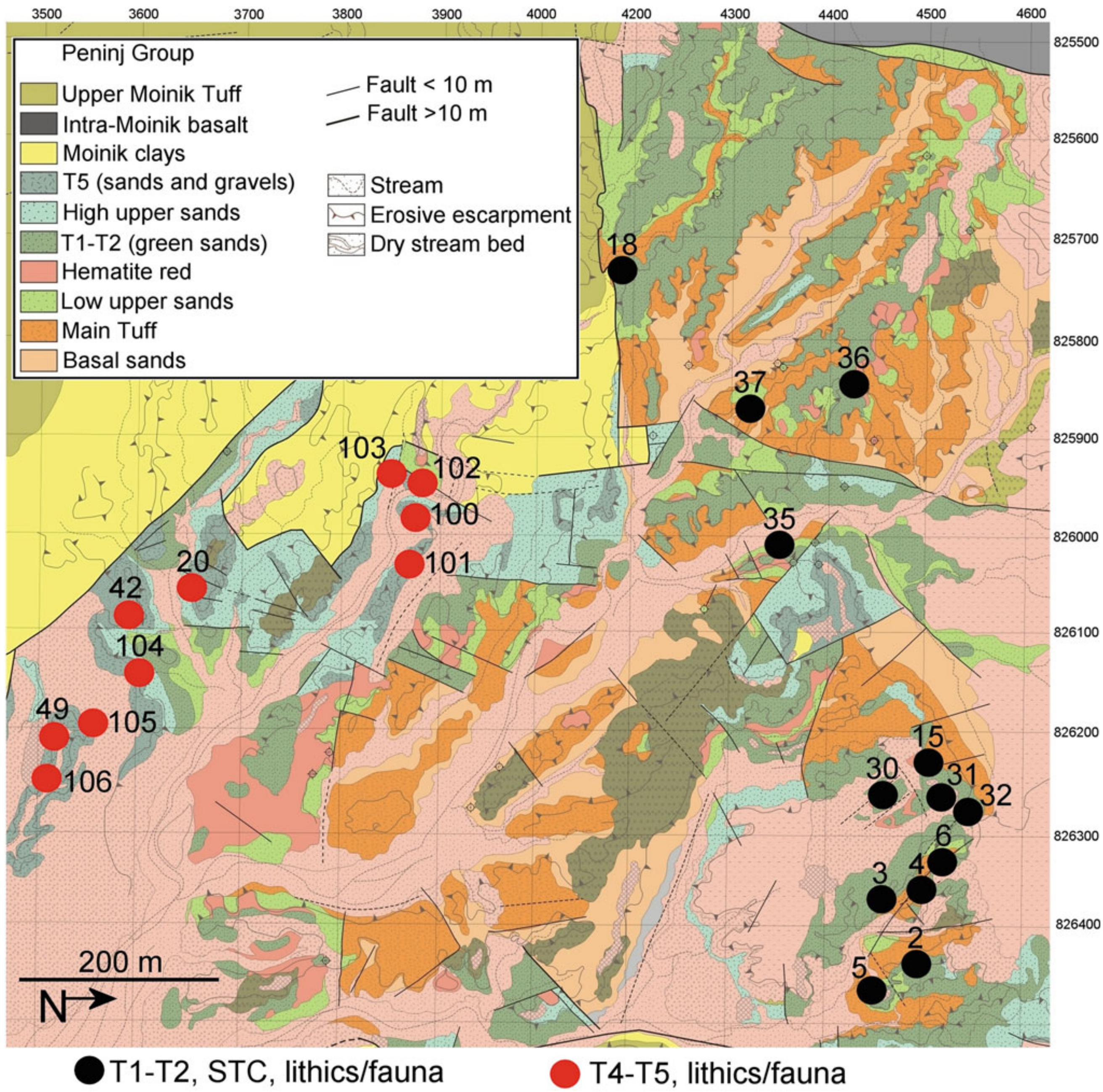

Fig. 7.5 Geological map of the Type Section area of Peninj and location of the main sites with lithics and/or fauna in the T1–T2 and T4–T5 depositional intervals

The oldest is represented by a paleosol of sands and clays between Tuffs 1 and 2[2]. This layer is very rich in lithic and faunal remains which were deposited in the context of an alluvial fan in which shallow channels drained toward the lake (Fig. 7.4: A) (Domínguez-Rodrigo et al. 2009b). This layer is particularly well preserved in the Type Section and, conversely, not represented in the South and North Escarpments. Thus, in the Type Section area, this paleosurface has been the subject of intense study and spatial cataloguing within the 1995–2005 landscape archaeology project. The many localities recognized here fall within what is known as the Type Section Complex (Domínguez-Rodrigo et al. 2002, 2009b; Fig. 7.5). The second of these depositional episodes roughly appears

[2]The USC member has a thickness that varies between 4 and 20 m. It consists of alluvial facies constituted by clays, silts, sands, and dolomitic carbonates. These alluvial materials are interbedded with five volcanic tuffs (from bottom to top, T1 to T5) (Luque et al. 2009b) (Fig. 7.3)

between Tuffs 4 and 5, toward the top of the Humbu Formation. It is associated with a different landscape context, related to relatively large, high-energy fluvial channels over the floodplain (Fig. 7.4: B). This depositional episode crops out particularly well in the North and South Escarpment areas (Domíngez-Rodrigo et al. 2009c, d). Conversely, it is poorly persevered in the Type Section area (Fig. 7.5). Thus, it is important to note that in Peninj there is a heterogeneous and biased preservation of archaeological resources in the three study areas: the TSC bracketed between T1 and T2 is preserved in the Type Section area, while the archaeological sites related to the interval between T4 and T5 are much better represented in sites located on the Sambu Escarpment area. This bias in terms of differential preservation has consequences in the regional interpretations of hominin landscape use in the Basin.

7.3 The Archaeology of the Type Section Complex: Current Issues

As stated above, the Type Section Complex (TSC) is a fertile horizon deposited between T1 and T2, in a penecontemporaneous context of a deltaic channel system near the lake margin. Although archaeological materials have also been discovered in other stratigraphic positions in the Type Section area (de la Torre 2009; Domínguez-Rodrigo et al. 2009a), most of the remains, including a wealth of stone tools and fossil bones, come from this exceptionally well-preserved paleolandscape window (Domínguez-Rodrigo et al. 2002, 2009b). Based on the lithic categories predominantly represented in the TSC lithic collections (hammerstones, cores, small and medium-sized flakes, scarce retouched flakes), this industry was originally labelled as Oldowan (de la Torre et al. 2003; de la Torre 2009). However, the identification of complex core exploitation models that included core hierarchization and flake predetermination (the so-called bifacial hierarchical centripetal model, BHCM, that accounted for 30% of the core collection retrieved from the TSC) introduced new elements to the debate on the cognitive capabilities of the purported "Oldowan" hominins (de la Torre et al. 2003) and had a significant impact in subsequent literature (Davidson and McGrew 2005; Delagnes and Roche 2005; Harmand 2007; Braun et al. 2008; Semaw et al. 2009; White et al. 2011). Recent reappraisals of the TSC industry, along with a comprehensive set of experimental studies aimed at testing the validity of the BHCM at Peninj, have forced a revision of various issues related to the TSC industry (Diez-Martín et al. 2012).

7.3.1 On the Bifacial Hierarchical Centripetal Method

Following de la Torre et al. (2003: 218), cores related to the BHCM, as identified in the TSC of Peninj, consisted of: (1) two surfaces separated by a plane of intersection, in which (2) the relation between surfaces was hierarchical, with the main surface acting as the exploitation area (aimed at obtaining flakes) and the subordinate surface serving as a preparation surface (aimed at preparing striking platforms). The hierarchical relation between both surfaces (preparation/exploitation) seemed non-interchangeable, as their role was maintained stable through all the flaking process. (3) The maintenance of this volumetric structure was aimed at obtaining predetermined flakes. (4) Flakes detached from the main flaking surface were parallel or sub-parallel with respect to the intersection plane. (5) The preparation surface produced secant flakes with respect to the intersection plane between both surfaces.

It was argued also (de la Torre et al. 2003; de la Torre and Mora 2009: 182) that many of the cores retrieved from the TSC represented the continuity of a single technological sequence and that this sequence could be reconstructed. Based on the fact that the dimensional relation between unifacial centripetal, hierarchical centripetal, and multifacial irregular cores (the three most abundant core types identified at the Type Section) seemed to be constant, in a decreasing trend from the former to the latter, these authors (de la Torre and Mora 2009: 180–183) created a theoretical model that explained in detail the way in which the sequence was performed by hominins. This model encompassed six consecutive phases (de la Torre and Mora 2009: Fig. 7.52), in which several archaeological specimens could actually be inserted (ibid: Fig. 7.53): (1) The core would initially be exploited centripetally on one surface. (2) As the unifacial centripetal exploitation continued, the core would lose its peripheral convexities. (3) The loss of the required convexities would make exploitation difficult, and in order to reactivate the convex volume of this striking surface, it would be necessary to start preparation in the sagittal plane. (4) This reactivation would produce a hierarchical core, as explained above. (5) Once the hierarchical pattern was established, the model would continue in successive series. (6) Core exhaustion would imply a final irregular multifacial form.

A recent analysis of a sample of 46 cores included in the TSC industry (most of them used as referential specimens for exemplifying the BHCM by de la Torre et al. 2003 and de la Torre and Mora 2009) has pointed out remarkable discrepancies with previous interpretations of the core sample (Diez-Martín et al. 2012; Figs. 7.6 and 7.7). The new set of diacritical diagrams showed that different reduction sequences were carried out in the Type Section and that this operational variety correlates with the different blank shapes available in the area (spherical and sub-spherical, hemispherical, and angular). According to these core blanks the collection could be divided into two different exploitation groups: (a) massive blanks (spherical, sub-spherical and polyhedral shape), for which reduction was based on different unipolar series intersected orthogonally, although in few cases an incipient centripetal organization of negative scars can be documented, or pairs of negative scars that intersect perpendicularly and tend to overlap as a result of core rotation (Fig. 7.6: A and 7.6: B); (b) medium-sized hemispherical and flake blanks. In these cases, exploitation starts with parallel short series (two or three negative scars) that converge in a bipolar manner. The exploitation continues first with alternate isolated detachments and then with new unipolar series that, in some cases, converge again in a bipolar way. Later phases of the reduction sequence show centripetal and orthogonal schemes (Fig. 7.7: B).

Raw material quality seems to have played an important role in the operational schemes carried out by hominins in the Type Section. The following associations have been identified (Diez-Martín et al. 2012; Fig. 7.8): (1) Group 1: Poor quality basalts (mostly related to massive blanks) show a partial alternation of negative scars and a remarkably low degree of exploitation. (2) Group 2: Other basalts and nephelinites of medium to good quality (hemispherical and flake blanks) show a medium degree of exploitation through unipolar and orthogonal series. (3) Group 3: Very good and optimal basalts were intensively exploited in centripetal, orthogonal, and orthogonal–polyhedral sequences. Group 1 seems to have been unconnected with the others: spherical and sub-spherical relatively heavy volumes show a limited exploitation (less than 10% of core mass) and could have been related, among other tasks, to percussion activities. Several medium-sized nephelinite cobbles were used in percussion activities after being successfully exploited as cores. It is worth bearing in mind that some of the cores included in the earliest stages of the BHCM by previous researchers actually belong to this Group 1. Groups 2 and 3 might be interconnected and might represent different parts of the same reduction scheme (initial reduction phase and a full exploitation phase).

In sum, taking into account the constrains imposed by core blank morphology and raw material quality, recent interpretations of the core sample retrieved from the TSC industry show that exploitation strategies were driven by the technical principle of discontinuous alternation of different surfaces (preferentially two) in the knapping process, rather than by a hierarchization of the volumes. Knappers were here systematically undertaking the unipolar exploitation of

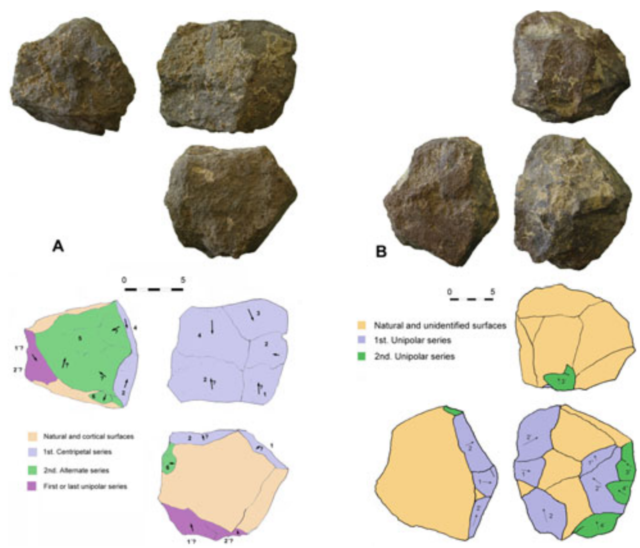

Fig. 7.6 Photographs and diacritical schemes of cores selected as representative examples of the various phases hypothesized for the BHCM (de la Torre and Mora 2009). **A** ST31 A-28 (Example of Stage 1). Large basalt cobble of very low quality showing orthogonal series of detachments on two different surfaces. Note the polyhedral-like morphology and the absence of a unifacial centripetal pattern. **B** ST4 U0-33 (Example of Stage 3). Very low quality and irregular basalt blank showing unifacial orthogonal series on one surface. Note the polyhedral shape and the lack of preparation on transverse and sagittal planes

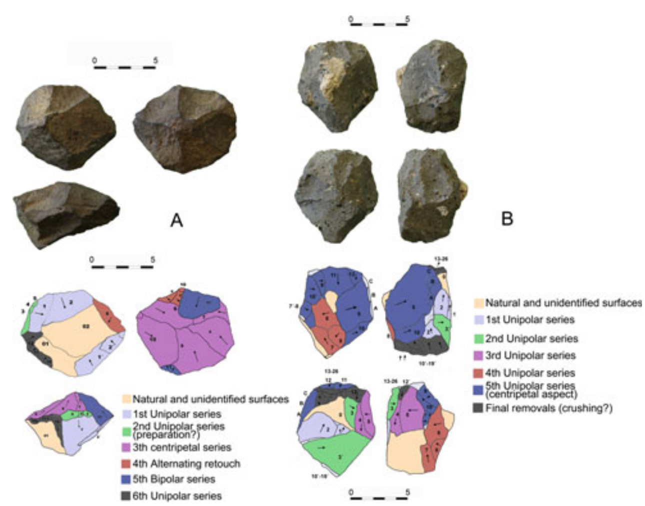

Fig. 7.7 Photographs and diacritical schemes of cores selected as representative examples of the various phases hypothesized for the BHCM (de la Torre and Mora 2009). **A** ST46-A17 (between Tuffs 4–5 in Type Section). Core on good quality basalt showing orthogonal/discoid-like exploitation by the combination of unipolar and bipolar/centripetal series. **B** ST32-S2 (Example of Stage 4) Core on good quality nephelinite showing orthogonal/discoid-like exploitation by the combination of unipolar series

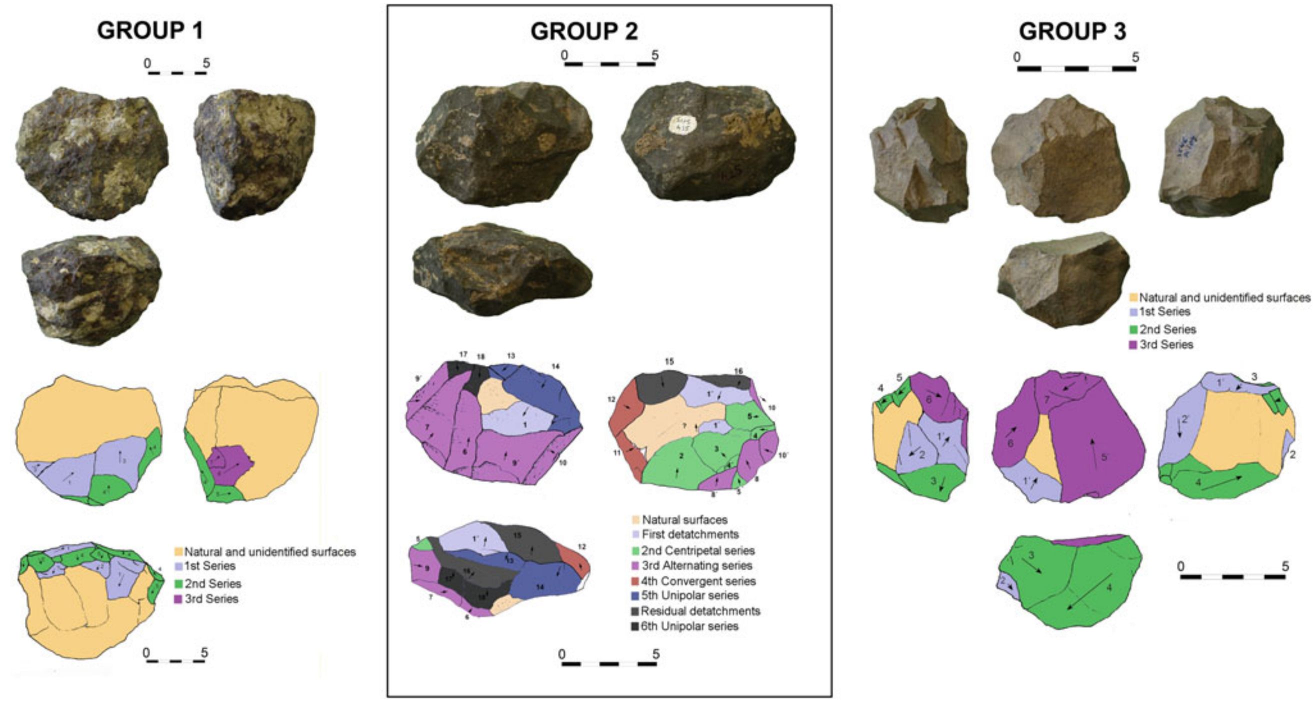

Fig. 7.8 Examples, photographs, and diacritical schemes of the different associations identified in the core sample of the Type Section: **A** Group 1: Poor quality basalts showing a partial alternation of negative scars and a remarkably low degree of exploitation (ST2-12). **B** Group 2: Basalts and nephelinites of medium/good quality hemispherical and flake blanks showing a medium degree of exploitation through unipolar and orthogonal series (ST4-S15). **C** Group 3: Very good/optimal basalts, intensively exploited in centripetal, orthogonal, and orthogonal–polyhedral sequences (ST46-A104, between Tuff 4 and 5, at the Type Section)

appropriate striking surfaces as intensively as possible. In the course of this reduction scheme, the generation of new appropriate striking platforms favored the exploitation of new, adjacent surfaces. This technical principle differs substantially from the discontinuous discoid technique (where each new blow strikes on the edge of previous negative scars) or the Levallois technique (where striking platform preparation shows a complex set of technical gestures).

In the Type Section, the use of this discontinuous alternation has resulted in orthogonal or opposed reduction strategies, although centripetal discoid in appearance (see Moore and Perston 2016 for a similar conclusion). Although some cores show a clear centripetal organization of negative scars, the only reduction pattern that seems to show consistency is constituted by long knapping series of discontinuous alternation.

7.3.2 *Oldowan or Acheulean? The Cultural Attribution of the TSC Industry*

The TSC industry shares a quite homogeneous stratigraphic position, on a paleosol directly located on the surface of Tuff 1 (Luque et al. 2009a, b), and was deposited in a relatively short period of time and within the same environmental context: an alluvial area in a deltaic environment at the intersection of river channels (Domínguez-Rodrigo et al. 2009b: 105). This environment was repeatedly visited by hominins to process carcasses obtained in the vicinity of the alluvial area. The absence of high-density lithic patches, the predominance of scatters over the landscape and the composition of the lithic aggregates would suggest sporadic hominin incursion in this area (Domínguez-Rodrigo et al. 2005). The lithic collections retrieved from this paleosurface, in agreement with a scenario of low anthropogenic impact and high raw material flow, are characterized by the production of small to medium-sized flakes retaining no cortex on their dorsal surfaces, with a very low percentage of retouched tools and few cores, hammerstones and unmodified cobbles. Due to their composition, the TSC assemblages were first defined as belonging to the Oldowan technocomplex (de la Torre et al. 2003), in a moment in which it overlapped chronologically with the first Acheulean in other parts of East Africa (Semaw et al. 2009).

However, a recent regional reinterpretation of the Lake Natron archaeological evidence has claimed that this industry fits much better within the Acheulean technocomplex and not with the Oldowan as previously stated (de la Torre 2009). From this new perspective, the core and flake component of the Type Section industry would represent a functional–economic–technical adaptation to an alluvial environment of the same humans that produced the more evident Acheulean sites located on top of the Sambu Escarpment, placed in a more distal position from the lake floodplain (Domínguez-Rodrigo et al. 2009c, d). There are strong reasons to support this new cultural attribution (Diez-Martín et al. 2012): (1) Some of the flakes recovered in the TSC assemblages have been identified as handaxes or Large Cutting Tool (LCT) resharpening/configuration flakes. Following the experimental work by Goren-Inbar and Sharon (2006), a number of small, relatively long, and thin flakes show remnants of what has been interpreted as a invasive edge on the margins or present plain dorsal faces. Handaxe flow (input and output) in the Type Section complex industry would be implicit through the presence of these objects in some assemblages; (2) large flakes (about 10 cm long) have been retrieved in sites such as ST2. Furthermore, recent analysis of the core sample suggests that the knappers of the Type Section were aware of the advantages of knapping large hemispherical flakes, as they provided a good natural interaction between two surfaces. Although large flakes found in the Acheulean sites of the Escarpment are significantly larger (Diez-Martín et al. 2014a, b), the production of this type of blank, either for large tool configuration or (as should be the case in the Type Section) for exploitation, has been considered to be a representative technological trait of the early Acheulean (Isaac 1984, 1986). (3) The Acheulean at Peninj, profusely documented in the North and South Escarpments, is stratigraphically related to a slightly younger depositional event in the USC member (post-Tuff 4) of the Humbu Formation (Domínguez-Rodrigo et al. 2009c, d). Clearly defined Acheulean sites (including large flakes and various types of LCTs) located in the same stratigraphic position have also been found in archaeological aggregates in the Type Section area (e.g. at ST 23, 28, 46, 48, 75, 76) (Figs. 7.9 and 7.10), as well as in other younger positions of the Moinik Formation, as at ST 69 (Diez-Martín et al. 2009a). Furthermore, the oldest Acheulean site documented in the Peninj region (PEES1, where, among the 21 specimens retrieved, 16 detached objects, 1 core, 1 chopper, 2 polyhedrons, and 1 handaxe were included) has been found in the South Escarpment directly on the Main Tuff and, thus, older than the sites studied here (Domínguez-Rodrigo et al. 2009c). It seems apparent then, that the TSC is bracketed between clearly defined Acheulean sites. This evidence advocates that, beyond typological variability, the different archaeological areas in the Lake Natron region should be considered sub-systems of a regional Acheulean system interconnected with and driven by different environmental, locational, economic and functional interests and/or constraints. New interpretations of the core assemblage retrieved in the Type Section favors a scenario in which hominins were maximizing raw material and intensively exploiting some pieces (specifically those showing a final morphology similar to the discoid method *sensu lato*). This fact, together with the high percentage of flakes without cortex on dorsal areas and striking platforms (Type 6), supports the idea that some good quality basalts and nephelinites were quarried at a certain distance (the mid-section of the Peninj River area, for instance) and discarded in the delta of the Peninj River (the Type Section) in an advanced stage of reduction. This reinforces the idea that rock supplies were intensively flowing along an interdependent and interconnected landscape. Formal variability observed in the Natron area (e.g., core and flake assemblages versus assemblages where large flake configuration is observed) would be related to some sort of synchronic (functional or environmental) and not diachronic (Oldowan–Acheulean) variability (Isaac 1977: 98), although the hypothetical presence of groups with different technological traditions cannot be ruled out.

de la Torre (2009) has suggested that the key trait that supports a link between the various industries retrieved from the Lake Natron area is precisely represented by the BHCM, found both in the TSC (where LCTs are formally lacking) and the Acheulean assemblages recovered from post-T4 sediments in both the Escarpments and the Type Section (where abundant LCTs have been found). Following this perspective, de la Torre (2009: 103) suggests that “the ability to exploit the entire volume of a piece through a structured bifacial method… which is what defines the ST Site Complex cores-shares the same technical scheme usually attributed to the Acheulean”. A number of authors have already remarked on the technological and conceptual affinities between Acheulean handaxe production and complex hierarchical reduction strategies (Rolland 1995; Schick 1998; DeBono and Goren-Inbar 2001; Tryon et al. 2006; Lycett et al. 2010). Thus, from this perspective, the BHCM would be the expression of the same technical model and the humans that inhabited the region and produced assemblages both with and without handaxes shared the same technological concept and knapping structure (the technical skills and methods shared by a human community, as defined by Boëda (1991) and Pelegrin (1985).

Recent technological reassessment of the reduction strategies documented in Peninj (Diez-Martín et al. 2012,

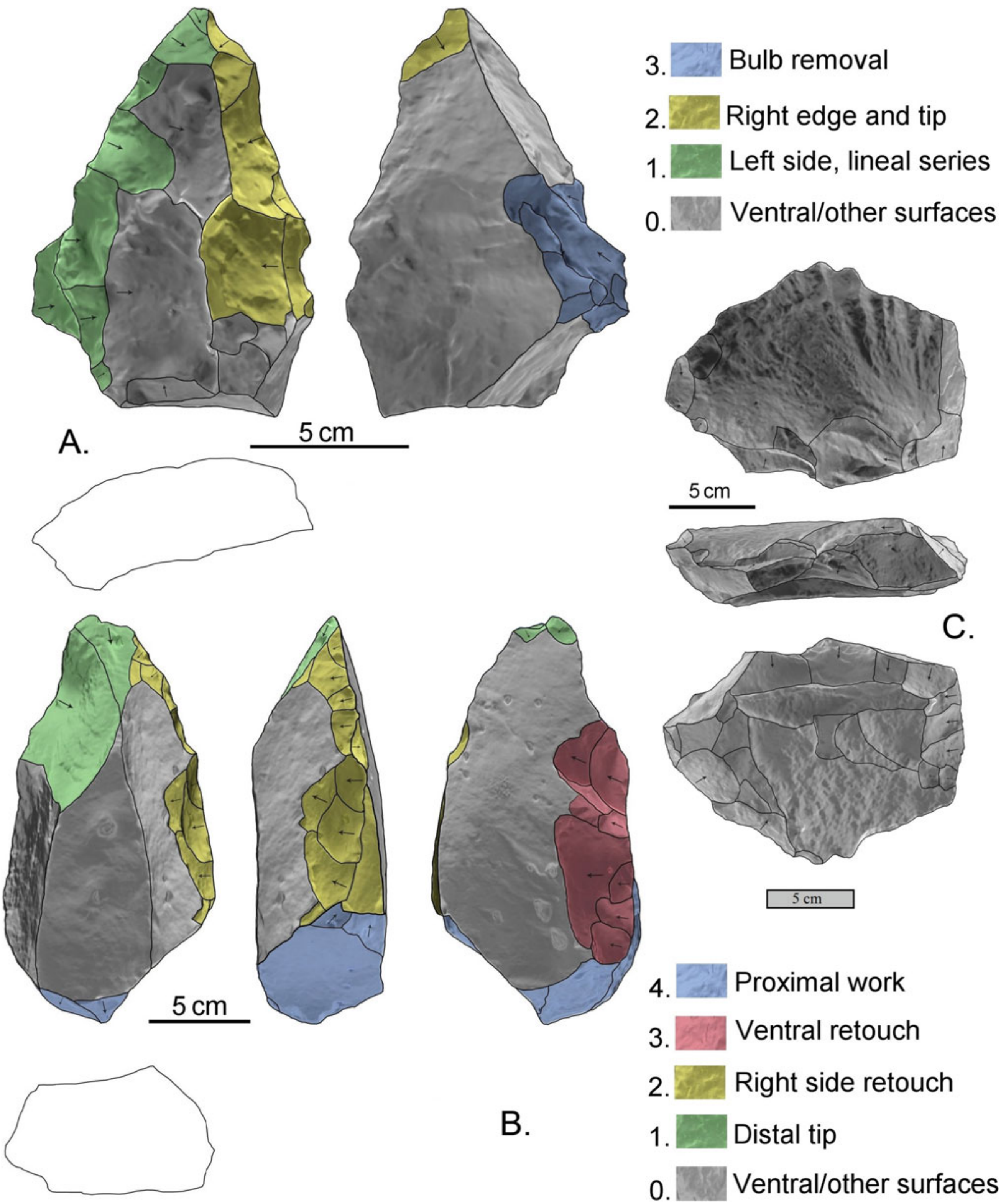

Fig. 7.9 Lithic implements recovered from various sites in the Type Section (T4–T5 stratigraphic interval): **A** LCT (ST23-2) on a basalt large flake blank showing two unifacial series converging in a distal tip, that is reinforced through a final ventral detachment. **B** LCT (ST46-A174) on a basalt large and thick flake blank, showing two alternate side series plus a third series aimed at distal tip configuration. **C** Basalt large flake (ST48-A15) with dorsal retouch and ventral removal of the butt area

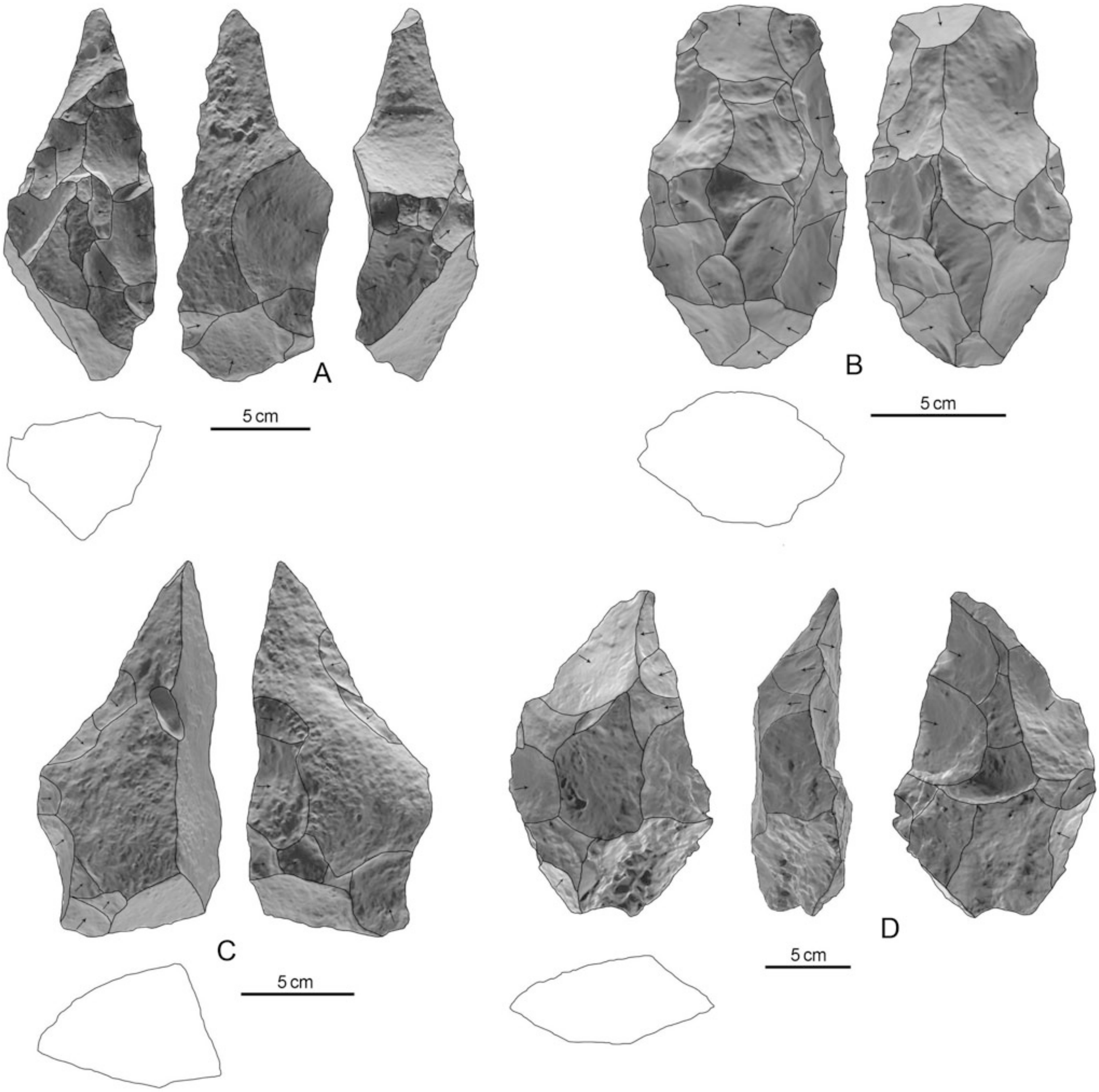

Fig. 7.10 Lithic implements recovered from various sites in the Type Section (T4–T5 stratigraphic interval): **A** and **C** Pointed/trihedral LCTs on large basalt flakes from ST28. **B** Basalt cleaver from ST23. **D** Pointed bifacial LCT on basalt from ST104

2014a, b) casts doubt on the role played by the reduction methods for the definition of such a shared knapping structure among the human populations that inhabited the Natron Basin during the Early Pleistocene. Current information does not fully support the existence of the so-called BCHM among the Type Section knappers (Diez-Martín et al. 2012); thus it cannot be the link between this industry and the Escarpment industries, where the BCHM shows similar interpretative shortcomings (Diez-Martín et al. 2014a, b). If the same species was responsible for the production of the varied technical behaviors displayed in the Natron area, the links connecting such a variety of technical solutions expressed within the regional structure of the Basin must be found elsewhere.

7.4 The Acheulean in the Escarpments

7.4.1 Lepolosi (Former MHS-Bayasi, South Escarpment)

Lepolosi, as it is known by the local Maasai people, is the most important archaeological site in the South Escarpment area. The site was discovered by Margaret Cropper in 1964, during the second paleoanthropological expedition undertaken by Glynn Isaac and Richard Leakey to Lake Natron. The site, which was given the arbitrary name of MHS, was the subject of both an unsystematic collection of surface items and a 13 m^2 step excavation. This step trench rendered 38 Acheulean specimens (Isaac 1965, 1967). After a new visit to the site, now renamed Bayasi, by Isaac in 1981 (Isaac 1982), archaeological fieldwork resumed in Natron at MHS-Bayasi in 1996 (Domínguez-Rodrigo et al. 2009c). Together with a new geological study of the area (ibid.: 205–210), in 1996, 2000, and 2002, a total surface of ~20 m^2 was opened in the site, unearthing a large collection of artifacts, including significant clusters of Large Cutting Tools (ibid.: Figs. 9.19, 9.20). In the course of this new fieldwork, sampling carried out in both the site's paleosol and upon stone tools allowed the identification of different types of phytoliths preserved on artifact cutting edges (from the genus *Acacia*) versus the surrounding soil (mostly grasses) (Domínguez-Rodrigo et al. 2001b). This sharp difference was interpreted as a clear functional indicator, suggesting that the sampled large tools were used for activities involving woodworking. Between 2008 and 2011, in the framework of the current research project, another ~43 m^2 were excavated in this site (Diez-Martín et al. 2014a).

Lepolosi is located on the Sambu Escarpment, 500 m above Lake Natron. The Peninj Group outcrops in this area, overlying the Sambu lavas, and is mostly represented by the Main Tuff member and the USC (8–10 m thick) in the Humbu Formation overlain by dozens of meters of silty and volcanic sediments pertaining to the Moinik Formation. From a stratigraphic point of view, it is placed around 3 m on top of the T4 tephra layer and below a fluvial level of sand and quartz gravels around 2 m thick. The T5 tephra layer, stratigraphically deposited on top of T4, has not been preserved in the vicinity of the site. The archaeological horizon is formed of approximately 1-m-thick greenish muddy sandstone interbedded laterally with rootmarked sandstone lenses (Domínguez-Rodrigo et al. 2001b, 2009c). Current paleoenvironmental interpretation suggests that the site was deposited in the context of low-energy distributary channels on a floodplain related to a swampy fluvial–alluvial environment (Domínguez-Rodrigo et al. 2009c; Luque et al. 2009a).

7.4.2 The Site of Noolchalai (Former RHS-Mugulud, North Escarpment)

Noolchalai, as it is called by local Maasai people, is located in the North Escarpment area, in a densely vegetated area on the southern hillsides of the Ol Doinyio Sambu volcano. Originally named RHS, it was discovered by Richard Leakey in 1964. After a survey, in the course of which 161 basalt artifacts were recovered, a ~48 m^2 excavation unearthed 215 tools on a bank adjacent to a small watercourse that seemed to be comparable to EF-HR in Bed II at Olduvai Gorge (Isaac 1965: 118, 1982). In 1981 Isaac undertook further archaeological work in the site, now renamed Mugulud. In 1995, 2001, and 2002, fieldwork was resumed in the North Escarpment (Domínguez-Rodrigo et al. 2009d). This work included an excavation that opened an additional 38 m^2 adjacent to Isaac's grid. In the course of their archaeological work, Domínguez-Rodrigo and colleagues retrieved 352 lithic artifacts, 197 from the surface, and 155 from their excavation. A total of 126 small (<3 cm) and heavily weathered bone fragments were also unearthed from the excavation that seemed to have no connection with the lithic sample (ibid.: 241). Between 2009 and 2013, new fieldwork was undertaken in Noolchalai and the surrounding area, which included an archaeological excavation in the site and in other high-density patches discovered in the vicinity plus a complete set of geological, sedimentological, and geoarchaeological studies (Diez-Martín et al. 2014b).

The Pleistocene outcrops in the North Escarpment area include materials of Humbu and Moinik Formations of the Peninj Group. Humbu sediments are relatively scarce, while Moinik materials are abundant and thick. The sediments outcropping around the archaeological site of Noolchalai include the uppermost part of the USC of the Humbu Formation, a discordant contact with the Moinik Formation and the first few meters of the Moinik alluvial sequence. Initially, Isaac (1965) located the stratigraphic position of Noolchalai in the uppermost part of the USC. Later observations (Diez-Martín et al. 2014b) led to the conclusion that the site is stratigraphically located at the base of the Moinik Formation that, discordant after an intense erosive period, had incorporated archaeological materials originally sedimented on top of the Humbu Formation. Due to a more energetic context and a more irregular paleolandscape toward the base of the site, the first steps of this reworking of Humbu materials include the heaviest and largest lithic specimens of Acheulean assemblages originally deposited in the Humbu Formation. Therefore, the lithic industry recovered from the base of Noolchalai (Moinik Formation) is the by-product of an intense erosive process that transported sediments previously deposited in the USM of the Humbu Formation to their current location (Diez-Martín et al. 2014b).

7.4.3 The Early Acheulean Technology from the Escarpments

The abundant lithic collections retrieved in the course of the different research projects undertaken in the North and South Escarpment areas (Table 7.1), particularly significant in the case of LCTs, addresses some of the currently open issues related to the technological characterization of the East African early Acheulean (Diez-Martin and Eren 2012). At both sites most of the technological processes are related to the manipulation or transformation of basalt raw material (Diez-Martín et al. 2014a, b). Fine-grained and good quality boulders originated in the vicinity of the Sambu volcano were also available in the middle section of the Peninj River watercourse. Acheulean toolmakers took advantage of the different natural morphologies of cobbles and boulders to undertake different tasks. Medium-sized basalt cobbles were used for both percussion activities and flake production purposes. Basalt and quartz core exploitation processes represented at Lepolosi and Noolchalai show that toolmakers were selecting specimens of both raw materials for a systematic production of medium-sized flakes using a variety of unifacial, bifacial, and multifacial exploitation patterns. Multifacial/polyhedral cores, particularly in the relatively high numbers of quartz polyhedrals that have been retrieved from Lepolosi (Diez-Martín et al. 2014a), were also intensively used in percussion activities, as revealed by the presence of battered and intensively blunted ridges.

Table 7.1 Distribution of the lithic samples retrieved from Lepolosi and Noolchalai sorted by lithic category

Lithic category	Collection	
	Lepolosi (n)	Noolchalai (n)
Cobbles	32	8
Hammerstones	26	7
Cores	60	59
Detached products	376	260
Fragments	32	47
LCTs	139	202
Undetermined/chunks	45	–
Total	710	583

Although examples of bifacial centripetal cores have been found in both sites (i.e., discoids in which a bifacial continuous alternation model was undertaken for the detachment of flakes), they constitute a residual pattern. Confirming again a previous diagnosis of the Type Section reduction patterns (Diez-Martín et al. 2012), the current interpretation does not support the presence of a reduction model in which a recurrent successive exploitation/preparation of surfaces with asymmetrical and non-interchangeable areas occur (i.e., the BHCM; Fig. 7.11: A). The main goal of these reduction

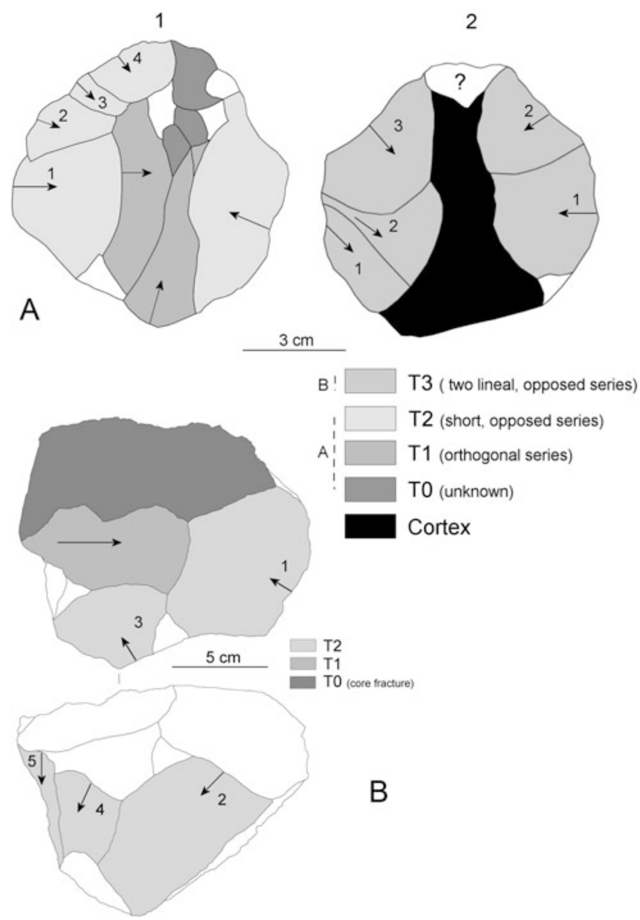

Fig. 7.11 **A** Diacritical scheme of a core retrieved from Noolchalai and previously identified as an example of BHCM (de la Torre 2009: Figure 11). The chronological reconstruction of the knapping process is as follows: after previous undetermined reduction sequence (Time 0), face **A** shows two subsequent series of (T1) orthogonal and (T2) lineal, short, and opposed detachments. Reduction then continues on face **B** (T3) with two opposed series of lineal detachments. **B** Diacritical reconstruction of a core found on surface in Noolchalai and previously identified as an example of large flake core (de la Torre et al. 2008: Figure 9A). The specimen shows a clear fracture area affecting part of the volume and masking part of the knapping structure. The detachment included in T1 is the remnant of a previous series. T2 represents a bifacial alternation of detachments using the same striking platform

models mainly related to lineal and orthogonal knapping gestures (as seen on the flake dorsal patterns identified) was the production of usable medium-sized flakes that, on few occasions, were subject to rather unsystematic retouch.

An undetermined fraction of the flake sample must be the desired by-products of the aforementioned reduction strategies, although another undetermined fraction of flakes must be related to core rejuvenation and LCT configuration processes. To a certain extent different fractions of different operational sequences (i.e., those related to exploitation and shaping activities) must have been produced on-site. Apart from the medium-sized cores themselves, this is confirmed by a wide range of detached products, including edge core flakes and LCT shaping flakes recovered from both Lepolosi and Noolchalai.

Along with those operational processes aimed at the production and marginal retouch of medium-sized flakes, the production and subsequent transformation into LCTs of large flake blanks (>10 cm) constitute a relevant technological trait of these Acheulean sites. Very large and thick flakes were being detached in the vicinity and transported on-site fully or partially shaped in their final desired forms. While empirical data confirm, at least at Lepolosi, a partial resharpening of a number of LCTs, arguing for an on-site large blank production is more contentious. We have identified a number of cores showing negative scars larger than the average flakes detached from medium-sized cores. However, these specimens show no clear exploitation pattern and it is impossible to rely on them for the interpretation of the operational sequences used by the Acheulean toolmakers to produce the huge flakes they were using as LCT blanks. As in many other Acheulean cases (Sharon 2007), no clear large cores have been retrieved so far in excavation from the Acheulean sites in Lake Natron. This is true for Lepolosi, where our excavated large flake cores are invalid for an assessment of the operational processes undertaken for the production of these blanks. This is also true for Noolchalai, where no unambiguous large flake cores have been unearthed from an archaeological context. At Noolchalai, it has been claimed

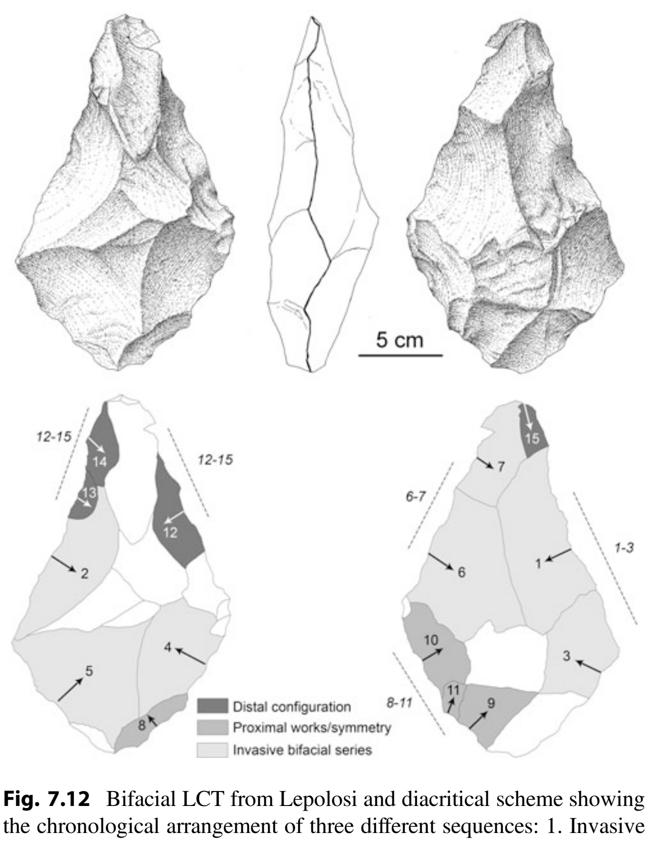

Fig. 7.12 Bifacial LCT from Lepolosi and diacritical scheme showing the chronological arrangement of three different sequences: 1. Invasive bifacial series; 2. Proximal reduction aimed at symmetrical enhancement; 3. Distal configuration aimed at tip shaping

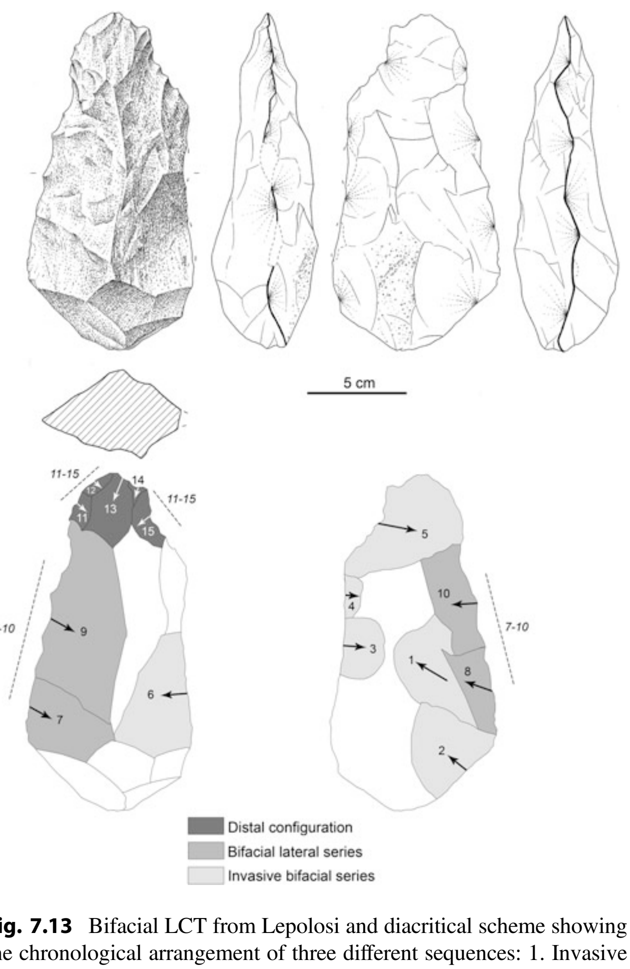

Fig. 7.13 Bifacial LCT from Lepolosi and diacritical scheme showing the chronological arrangement of three different sequences: 1. Invasive bifacial series; 2. Lateral bifacial knapping; 3. Distal configuration aimed at tip shaping

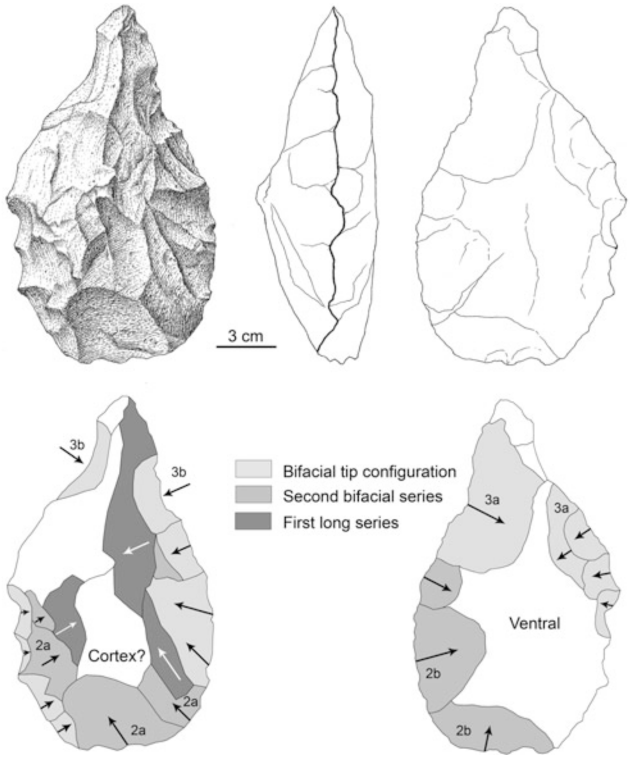

Fig. 7.14 Bifacial LCT from Noolchalai, and diacritical scheme showing a bifacial treatment of the volume (through a long and invasive series) followed by an intense bifacial configuration of the distal tip

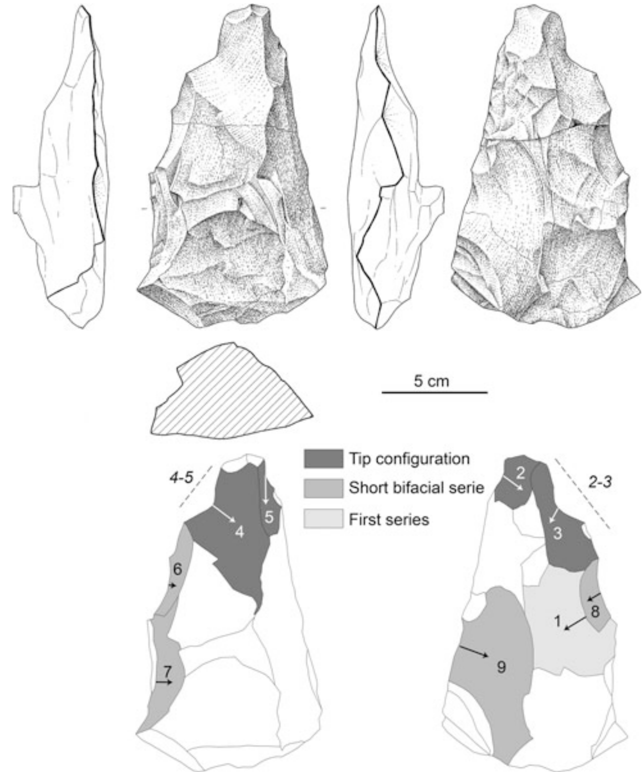

Fig. 7.16 Pointed LCT from Lepolosi and diacritical scheme showing the chronological arrangement of three different sequences: 1. Invasive series; 2. Bifacial short and sinuous (denticulate) lateral series (with no apparent functional meaning); 3. Tip configuration

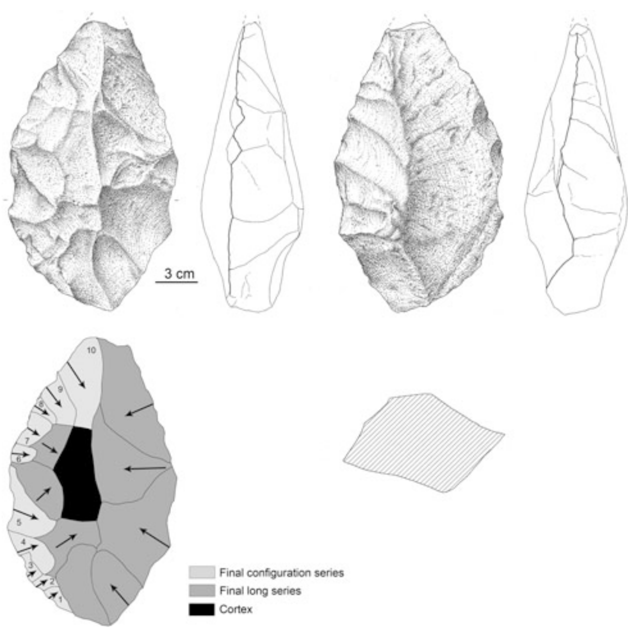

Fig. 7.15 Bifacial LCT from Noolchalai, and diacritical scheme showing the following sequence: invasive series on the dorsal surface, aimed at the volumetric treatment of the artifact; second alternation of detachments on both surfaces aimed at the final configuration

that some surface specimens are good proxies for the definition of large flake production in the Peninj area (de la Torre et al. 2008: Fig. 9.19). However, these items show ambiguous technical patterns (Dominguez-Rodrigo et al. 2009d; Diez-Martin et al. 2014b; Fig. 7.11: B).

In the Peninj Acheulean, the only available data to hypothesize about large core reduction systems come from the technical patterns seen in LCTs or in plain large flakes. Analysis of flake dorsal patterns and section morphology suggests that toolmakers were using bifacial patterned models to obtain regular blanks and to maximize cutting edge and/or tip production (via the production of concavities in the plane that eventually would be considered the dorsal surface, before the detachment of the large flake). This process was mainly obtained through orthogonal intersections (Diez-Martín et al. 2014a, b). Although this hypothesis remains conjectural, the technological patterns described here (Texier and Roche 1995) would imply a considerable amount of standardization in their large core production strategies. The places where boulders were originally processed, the stage of reduction in which the cores were transported and the spatial implications of large core management are issues that remain completely elusive.

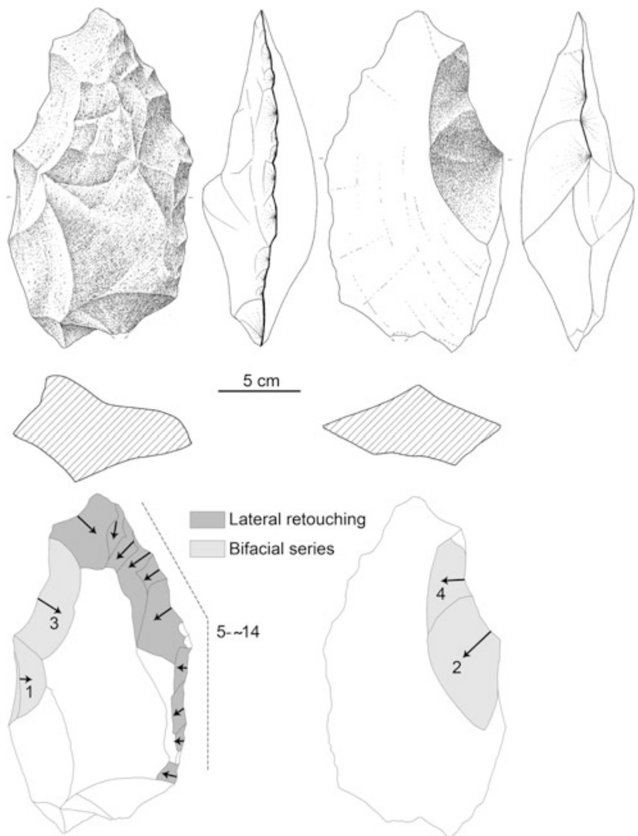

Fig. 7.17 LCT from Lepolosi and diacritical scheme showing the chronological arrangement of two different sequences: 1. Bifacial series aimed at butt thinning and probably grasp; 2. Unifacial marginal and sinuous (denticulate) series

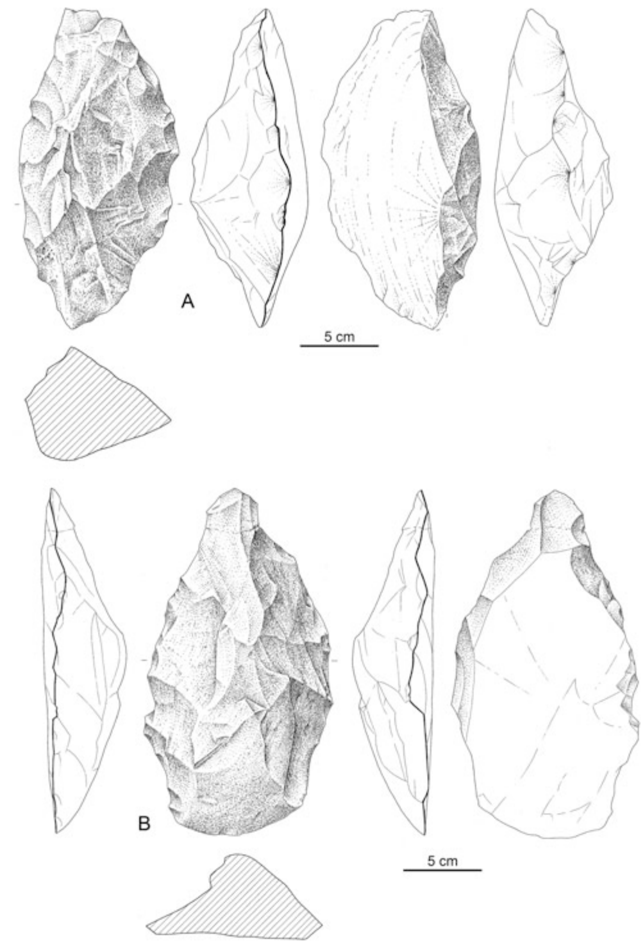

Fig. 7.18 Pointed LCTs from Lepolosi: **A** Knife. **B** LCT with marginal bilateral retouch associated to a distal tip and enhancement through marginal and bilateral notch retouch of proximal natural cutting edge

According to this volumetric awareness, in the Escarpments Acheulean toolmakers had the precise knowledge to produce normative handaxes (Diez-Martín et al. 2014a, b). Through long, invasive, and bifacial knapping series they were able to symmetrically transform the original blanks and to create rather biconvex symmetrical volumes. A number of examples retrieved from excavation confirm this pattern (Figs. 7.12, 7.13, 7.14, 7.15). However, at Peninj, LCT shaping interests seemed to have been driven by more functional and less time-consuming factors. Along the collection of normative bifaces and cleavers, the bulk of the LCT sample is defined by more ad hoc and casual shaping processes. Toolmakers were interested in more superficial transformation of large flake blanks in order to produce points and/or active cutting tools. Rather than driven by the volumetric principles of symmetry and bifacial shaping, configuration processes are full of examples of practical solutions for achieving their functional goals: creating distal or lateral abrupt areas for ergonomic purposes, retouching precise areas to create or simply enhance tips, delimiting areas to enhance natural acute cutting edges, or briefly retouching long edges. This set of solutions, apparently casual on occasions, seem effective configuration strategies to add an extra functional meaning to the massive and heavy flake blanks. Certainly these tools were created to combine strength and shape in order to serve for precise tasks. This array of solutions has created a quite diverse group of final forms, among which knives, picks or heavy-duty scraper-like forms can be identified (Figs. 7.16, 7.17, 7.18). A quite diversified pattern for the production of LCTs emerges, in which, on one hand, the ability or interest in configuring symmetric bifacial volumes and shaping normative cleavers and, on the other hand, maximization of functional solutions are combined (Fig. 7.19).

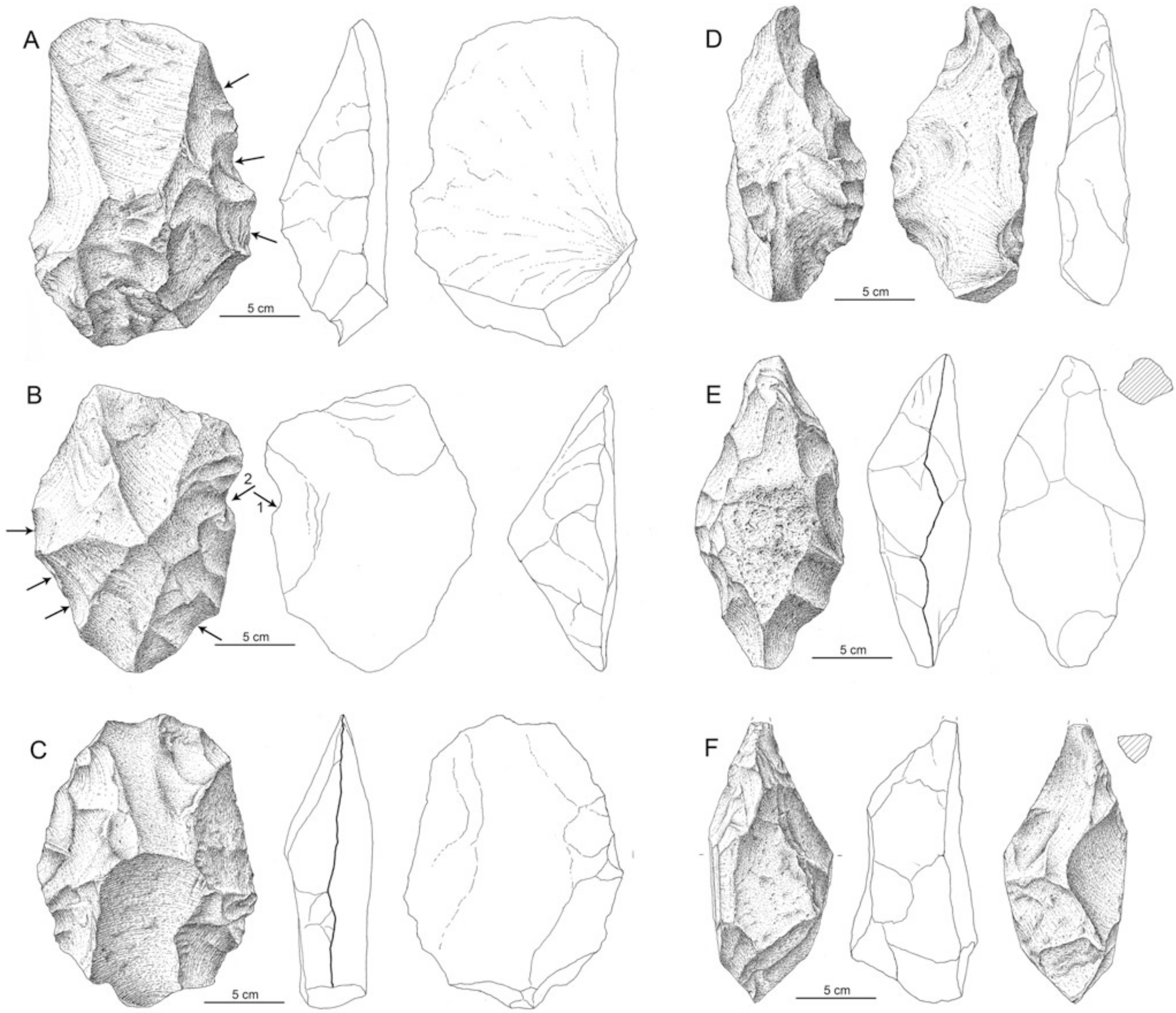

Fig. 7.19 LCTs from Noolchalai: **A**–**C** cleavers, **D**–**F** pointed and pick-like specimens

7.5 A Regional Interpretation for the Acheulean of the Natron Basin

Taking into consideration the disparate integrity of Noolchalai (reworked in a new Moinik location from an unknown Humbu depositional context) and Lepolosi (a low-energy floodplain context with limited, mostly vertical, post-sedimentary disturbance), both sites reproduce a similar technological pattern, particularly evident in the case of the LCT shaping processes. It seems plausible that both locations in the uppermost section of the USC member of the Humbu Formation would represent similar responses to similar landscape constraints and/or functional frameworks.

Glynn Isaac (1982) was aware of the importance of the regional component in the Peninj record. The regional interconnection of the Peninj record was enlarged (Domínguez-Rodrigo et al. 2009a), particularly through the "ecological hypothesis" for the origin of the Acheulean (Domínguez-Rodrigo et al. 2005). This hypothesis suggested that the archaeological record located in the different fertile areas at Peninj (TSC in the Type Section, North Escarpment, and South Escarpment) showed traces of spatial behaviors that were related to each other. The assemblages deposited in the TSC corresponded to an alluvial area in a deltaic environment close to the lake shore in which hominins processed carcasses and discarded few and relatively small stone tools, probably in the framework of sporadic incursions in the area. Conversely, the accumulation of LCTs in the Escarpments, away from the lacustrine environment, would suggest alternative and complementary tasks for these aggregates. These alternative tasks would not involve carcass consumption or manipulation, as these Acheulean sites are devoid of fossil bones in connection with the lithic materials. It has been argued that the absence of fauna in these sites must bear a behavioral meaning because it cannot be explained through taphonomic constrains (Domínguez-Rodrigo et al. 2009c, d). Both the fact that the Acheulean in the TSC (T1–T2) and the Escarpments (T4–T5) are not penecontemporaneous and the evidence in the Type Section area of a meager, but significant, number of localities with LCTs in sediments with the same stratigraphic position as those recovered in the Escarpments (T4–T5) could challenge some aspects of the ecological hypothesis, showing that: (a) a chronological, landscape, and environmental gap existed between the TSC industry and the Escarpment industry, and b) that geographic location cannot be considered a determinant factor for the regional archaeological structure (the locational antagonism proximal/distal to the lake margin serving as motor of different techno-economic behaviors).

Nonetheless, recent interpretations of the Peninj record (de la Torre 2009; Diez-Martín et al. 2012) stress the fact that the diverse technological behaviors observed in Peninj are interconnected fractions of the Acheulean techno-complex and that formal differences among them can be interpreted from a regional perspective. Thus, beyond variability, the different archaeological areas of the Lake Natron should be considered as sub-systems of a regional Acheulean system interconnected with and driven by different environmental, locational, economic, and functional interests. From this perspective, the set of technological patterns observed in the main sites of the Escarpments can add new data to this regional interpretation. The diagram represented in Fig. 7.20 aims to constitute an update of the ecological hypothesis for the Acheulean in Peninj, showing a hypothetical interaction of the different types of localities recorded or envisioned in Peninj and their functional meaning.

Place A is represented as an area devoted to the exploitation of large cores for large flake procurement, in which fractions of configuration processes cannot be certainly excluded. These extractive quarries have been recognized by a number of authors in the archaeological record (see contributions in Goren-Inbar and Sharon 2006), while a number of experimental works have provided insights into the way large flakes might have been produced in these quarry areas (Jones 1994; Toth 2001; Madsen and Goren-Inbar 2004). In the Acheulean of Lake Natron such extractive places have not been recognized yet. Despite the presence of cores from which relatively large flakes have been detached (≤ 10 cm) in both Lepolosi and Noolchalai, to date we have no empiric information about the actual cores from which very large flakes were being detached. Mean maximum length of large flakes in the Peninj Acheulean is 155 mm in Noolchalai and 163 mm in Lepolosi. Such heavy implements would require the exploitation of massive cores, currently absent in the Peninj archaeological record.

Place B is a site in which large implement configuration and use took place. Large flakes would reach these places in order to be transformed and used in specific tasks, although the production of usable medium-size flakes would also occur. We find reasons to suggest that Noolchalai, Lepolosi, and other high-density patches recently discovered on top of the Sambu Escarpment (Fig. 7.21) would fit within this type of places. Due to the very bad preservation of T4–T5 sediments in the Type Section area, and the meager lithic collections retrieved from this interval, it would be unwise to include these sites within this theoretical model. The

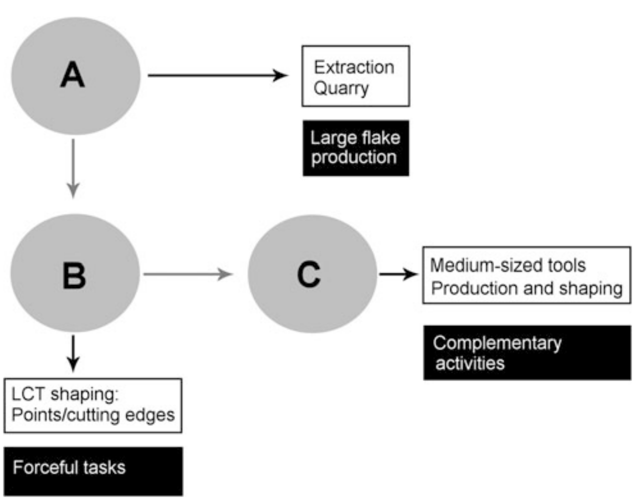

Fig. 7.20 Hypothetical model for the regional archaeological system of the Acheulean in the Natron Basin

Fig. 7.21 High-density patch of Acheulean tools in the Noolchalai area (Noolchalai-2 site)

functional meaning envisioned for Place B sites is corroborated by the following facts: (a) large flake transfer is reinforced by the lack of correlation between LCT maximum length (specimens that, due to their scarce transformation, tend to preserve indications of their original size) and the core collection retrieved from these sites; (b) evidence of LCT shaping has been found in both sites, particularly through the recognition of configuration flakes within the lithic collections. This fact would support the idea that, at least to some extent, resharpening processes would have taken place in-site; (c) although formal Acheulean implements have been found in both sites (handaxes, cleavers, and trihedral picks), the bulk of the LCT collection at the two sites is formed by specimens casually transformed in order to produce very precise morpho-functional patterns: pointed areas and/or long segments. On a number of occasions the functional interest of these active areas is reinforced by the configuration of prehensile areas via abrupt reconditioning of opposed areas. Despite being aware of the principles of volumetric bifacial transformation and geometric symmetry, proved by the existence of normative Acheulean implements, the toolmakers were recurrently stressing their interest in shaping specific active forms in massive and heavy artifacts. This persistent goal would suggest a particular functional meaning to be undertaken in the place: tasks in which specific interactive actions (related to the action of tips and robust cutting edges) would need the concurrence of heavy and massive volumes. The combination of strength and very precise morpho-functional areas envision a number of economic activities, among which woodworking (suggested by the phytoliths retrieved on LCT implements from ES2-Lepolosi; Domínguez-Rodrigo et al. 2001a) should still be taken into consideration; (d) combined with the LCT shaping and use, the exploitation of cores for the production of usable medium-sized flakes also took place in the Escarpments Acheulean sites. Here we find the presence of a variety of medium-size core reduction models, including unipolar, orthogonal, and multifacial. Core rejuvenation flakes and a diverse variety of medium-sized flakes indicate that complementary knapping activities would have taken place here.

In this model, Place C represents a site in which alternative activities to those undertaken in Place B took place. An indicative sign of alternative functional meaning would be the absence of the conspicuous LCT accumulation seen in Noolchalai, Lepolosi, and other sites in the Escarpments. Although the first example is more contentious (as it is located in a derived secondary context), the significant accumulation of large implements in a specific location of the low-energy floodplain in ES2-Lepolosi constitutes an exceptional patch in the paleolandscape. This accumulation of both raw material and large implements in the Escarpments markedly contrasts with what we see in the Type Section area. We agree with other authors (Downey and Domínguez-Rodrigo 2002–2003; Domínguez-Rodrigo et al. 2005; de la Torre et al. 2008), when they claim for a certain behavioral pattern to explain this differences in the archaeological record. In this framework, we consider that the archaeological sites located in the TSC could fit well within Type C sites, in which hammerstones, medium-sized cores, medium-sized flakes and a number of retouched flakes could indicate processing tasks complementary to those undertaken in Type B sites. In the Type Section sites, associated with the processing of herbivore carcasses, the lithic assemblages are characterized by the production of small to medium-sized flakes, with a very low percentage of retouched tools, cores, hammerstones, and unmodified cobbles (de la Torre and Mora 2009; Diez-Martín et al. 2012). Furthermore, LCT resharpening flakes and relatively large flakes (≤ 10 cm) indicate some sort of regional raw material and tool flow in which Acheulean toolmakers were maximizing raw material and intensively exploiting a number of core specimens.

This theoretical model is an updated version of the ecological hypothesis for the Acheulean (Domínguez-Rodrigo et al. 2005), in an attempt to overcome an excessively rigid conception of the locational constraints, after the evidence that the proximal versus distal to the lake margin parameter was not determinant to explain the technological variability in the Peninj archaeological record (i.e., LCTs recovered from the Type Section). At this point, it seems more plausible that the variability seen in the Acheulean of the Natron Basin (sites with abundant LCTs versus sites dominated by small and medium-sized flakes and cores), rather than being driven by locational parameters is related to environmental/functional/ecological/economic constraints: those based on the dichotomy alluvial fan and shallow channels (T1–T2) versus high-energy channels and floodplains (T4–T5). Nevertheless, in the Lake Natron Acheulean most regional information available to us has a technological character. Although more contextual information is needed at a regional scale, the spatial component of the technological information gathered so far cannot be underestimated. The coherent technological patterns seen in the Escarpments and the Type Section are indicating the dramatic influence of functional and economic parameters in the development of the Acheulean techno-complex in East Africa.

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